United Nations ECE/TRANS/WP.29/GRSG/2017/6

Economic and Social Council

Distr.: General
1 February 2017

Original: English

Economic Commission for Europe

Inland Transport Committee

World Forum for Harmonization of Vehicle Regulations

Working Party on General Safety Provisions

112th session
Geneva, 24-28 April 2017
Item 4 of the provisional agenda
Regulation No. 43 (Safety glazing)

Proposal for Supplement 6 to the 01 series of amendments to Regulation No. 43 (Safety glazing)

Submitted by the expert from Germany*

The text reproduced below was prepared by the expert from Germany to fully align (a) the provisions for the headform test with deceleration measurement and (b) the test of resistance to abrasion with those of the corresponding standard ISO 15082:2016-11. Main amendments according to this standard are the addition or modification of important test details, the correction of the headform calibration values and the introduction of abrasion reference materials, the latter combined with an abrasive-wheel qualification and a correction calculation (for plastic materials only).
Document ECE/TRANS/WP.29/GRSG/2015/22 submitted by the expert from Hungary and informal document GRSG-111-05 presented by the expert from Poland have been taken into account in the proposed description of the abrasion test machine. The modifications to the current text of UN Regulation No. 43 are marked in bold characters for new and strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2016–2017 (ECE/TRANS/254, para. 159 and ECE/TRANS/2016/28/Add.1, cluster 3.1), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

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I. Proposal

Annex 3

Paragraphs 3.2.1. to 3.2.3., amend to read:

"3.2.1. Apparatus

……

…… The elastic properties of the phantom head on impact are determined by the hardness and the thickness of the intermediate ring (13) and the basin.

Instead of the data transmission via cables, wireless data transmission (e.g. radio transmission) may be used. In this case, it shall be ensured that those electronic components additionally installed in the headform do not influence mass, gravity centre point and spring force of the headform. Those electronic components shall be installed on the base plate (24) only. A mass correction, if necessary, is also restricted to the base plate at that surface which faces the hollow space within the headform. If additional miniature components for controlling of the electronic modules are required (e.g. micro switches, loading sockets for voltage supply), these may replace the co-axial cables. In this case the original holes in the cover plate (29) and the protective cap (30) have to be used for the installation and wiring.

……

List of pieces for the 10 kg headform of Figure 2.1

Position No.	*Number of pieces*	*Standard notation*	*Material*	*Remarks*
1	1	Magnetic holding device	Steel ~~DIN 17100~~ **EN10025-2-E295GC**	-
2	1	Vibration damper	Rubber / Steel	Diameter: 50 mm Thickness: 30 mm Thread: M10
3 **(a)**	4	HF connector BNC	-	**Coupler-coupler (EN 122120)**
4	1	Hexagonal nut ~~DIN 985~~ **ISO10511-M10-05**	-	-
5	6	Disc ~~DIN 125~~ **ISO7090-6-200HV**	-	-
6 **(a)**	3	Transition piece	-	-
7	6	Cylinder screw ~~DIN 912~~ **ISO4762-M6x140-8.8**	-	**Torque about 12 Nm**
8	3	Hexagonal nut **ISO10511-M8-05**	-	**Torque about 4 Nm (ref. paragraph 3.2.2.3.)**
9	3	Disc	Steel ~~DIN 17100~~ **EN10025-2-E295GC**	Hole Diameter: 8 mm Outer Diameter: 35 mm Thickness: 1.5 mm
10	3	Rubber ring	Rubber, hardness 60 IRHD	Hole Diameter: 8 mm Outer Diameter: 30 mm Thickness: 10 mm
11	1	Damping ring	~~Packing with~~ **Gasket** paper	Hole Diameter: 120 mm Outer Diameter: 199 mm Thickness: 0.5 mm

Position No.	*Number of pieces*	*Standard notation*	*Material*	*Remarks*
12	-	-	-	-
13	1	Intermediate ring	~~Butadien~~ **Butadiene**-rubber, hardness **about 60** IRHD ~~about 80~~	Hole Diameter: 129 mm Outer Diameter: 192 mm Thickness: ~~4 mm~~ **about 6 mm (ref. paragraph 3.2.2.3.)**
14	3	Guide tube	~~Polytetra-fluorethen~~ **Polytetrafluoroethylene** (PTFE)	Inner Diameter: 8 mm Outer Diameter: 10 mm Length: 40 mm
15	3	Hexagonal nut **ISO10511-M8-05**	-	-
16	3	Threaded bolt DIN 976-**1-M8x90-B-8.8**	-	-
17	3	Screwed insert	Cast alloy ~~DIN 1709-GD-CuZn 37Pb~~ **EN1982-CuZn39Pb1Al-C-GP**	**Dimensions M8x12 (DIN 7965)**
18	1	Basin	~~Polyamid~~ **Polyamide** 12 **(ISO 1874-1)**	-
19	1	Cover	~~Butadien~~ **Butadiene**-rubber	Thickness: 6 mm Rib on one side
20	1	Guide bush	Steel ~~DIN 17100~~ **EN10025-2-E295GC**	-
21	4	Counter sunk screw **ISO2009-M5x10-5.8**	-	-
22	1	Damping disc	~~Packing with~~ **Gasket** paper	Diameter: 65 mm Thickness: 0.5 mm
23	-	-	-	-
24	1	Base plate	Steel ~~DIN 17100~~ **EN10025-2-E295GC**	-
25	1	Set screw with hexagonal socket	Class of strength 45H **(ISO 898-5)**	-
26	1	Tri-axial mounting block	-	-
27	3	Acceleration gauge	-	**ref. paragraph 3.2.2.1.**
28	1	Wood component	Hornbeam, glued in layers	-
29	1	Cover plate	Alloy **EN573-3 ; EN AW-5019** (**EN AW**-AlMg5)	-
30	1	Protective cap	~~Polyamid~~ Polyamide 12 **(ISO 1874-1)**	-
Note **[(a)]: These components are unnecessary in case of wireless data transmission. In this case, other components for data transmission are installed in the headform (e.g. radio transmitter), ref. para. 3.2.1.**				

3.2.2. Adjustment and calibration

…… the cross arm's fall is dampened and the phantom head falls onto the sample. **If wireless data transmission is used instead of the data transmission via cables, the guide system can be omitted if there is no risk of obstruction of the free vertical drop by any cables.**

No impulse may be given to the phantom head by the drop appliance or by the measuring cable **(if applicable)**, so that it is accelerated only by gravity and falls vertically.

……

3.2.2.1. Measuring device which allows determining HIC-values with the headform described under paragraph 3.2.1., **for recording and evaluation of the measured deceleration curves $a_x(t)$, $a_y(t)$ and $a_z(t)$, transmitted from the headform acceleration gauges via cables or wireless: acceleration gauges, measuring and recording instruments according to ISO 6487, channel-amplitude class CAC 5,000 m/s² and channel-frequency class CFC 1,000 Hz.**

3.2.2.2. Equipment to calibrate the phantom head

……

~~A steel~~ **An** impact plate which is made of steel is 600 mm x 600 mm in size and at least 50 mm thick. The impact surface shall be polished:

surface roughness ~~R_{max} = 1 µm~~ **average R_a < 0.5** µm, flatness tolerance t = 0.05 mm.

3.2.2.3. Calibration and adjustment of the phantom head

……

The impact plate shall be clean and dry and during the test shall lie non-positively on a concrete base. **Alternatively, the impact plate may be placed in a massive supporting device if this device is connected to a concrete foundation.**

……

The greatest deceleration a_z from the various drop heights on the z-axis shall lie within the limits given in the table:

Drop height mm	*Greatest deceleration a_z as a multiple of acceleration due to gravity g*
50	~~64 ± 5~~ **82 ± 8**
100	~~107 ± 5~~ **128 ± 8**
150	~~150 ± 7~~ **167 ± 10**
254	~~222 ± 12~~ **227 ± 14**

The deceleration curves should be based on a ~~unimodel~~ **unimodal** vibration. The deceleration curve of the drop height of 254 mm shall run at least ~~1.2 ms~~ **1.5 ms** and at most ~~1.5 ms~~ **2 ms** over 100 g.

……

3.2.3. Supporting fixture ~~for testing flat test pieces is as described in paragraph 3.1.3.~~"

Insert new paragraphs 3.2.3.1. and 3.2.3.2., to read:

"**3.2.3.1. For testing flat test pieces, the support is as described in paragraph 3.1.3. but with the modification that the rubber gaskets shall be 50 mm +1/-0 mm wide (instead of 15 mm ± 1 mm), covering the borders of the two steel frames completely. The minimum recommended torque for M20**

bolts is 30 Nm. Alternatively, other pressing techniques may be used, e.g. hydraulic or pneumatic pressing.

3.2.3.2. **For testing complete glazing, the support shall consist of a rigid piece corresponding to the shape of the pane so that the headform weight faces the internal surface. The pane shall be clamped to the supporting structure by means of appropriate devices, with interposed stripes of rubber of hardness 70 IRHD and thickness of about 3 mm, the width of contact over the whole perimeter being about 15 mm.**"

Paragraph 3.2.5., amend to read:

"3.2.5. ~~Tests on complete glazing (used for a drop height between 1.5 m and 3 m). Place the glazing freely on a support with an interposed strip of rubber of hardness 70 IRHD and thickness of about 3 mm.~~ **Test procedure**

The **flat test piece or the complete** glazing shall be clamped to the supporting structure **according to paragraph 3.2.3.1. respectively 3.2.3.2**. ~~by means of appropriate devices~~. **The torque on the bolts respectively the amount of hydraulic or pneumatic pressure shall ensure that the movement of the test piece during the test will not exceed 2 mm.** The surface of the **test piece or** glazing shall be ~~substantia11y~~ substantially perpendicular to the incident direction of the headform weight. The headform weight shall strike the **test piece or** glazing at a point within 40 mm of its geometric centre on that face which represents the inward face of the plastic glazing when the latter is mounted on the vehicle, and shall be allowed to make only one impact.

~~Starting from a selected initial drop height, the drop heights should be raised by 0.5 m respectively in each further experiment.~~ The deceleration curves occurring on impact on the sample for a_x, a_y and a_z should be recorded according to time t.

…… The acceleration components a_x and a_y should be smaller for vertical impact than 0.1 a_z."

Paragraph 3.2.6., amend to read (also replacing equation (2)):

"3.2.6. Evaluation

……

~~The time for which a deceleration of 80 g with a_{res} is continually exceeded and the greatest deceleration of a_{res} should be determined.~~ The HIC-value should be calculated as a measurement of the danger of blunt skull-brain-injuries using the following equation (2):

(2) ~~$HIC = (t_2 - t_1)^{-1.5} \left(\int_{t_1}^{t_2} a_{res}(t)\,dt \right)^{2.5}$~~

$$HIC = \max f(t) = \max_{t_1,t_2} \left[(t_2 - t_1)^{-1.5} \left(\int_{t_1}^{t_2} a_{res}(t)dt \right)^{2.5} \right]$$

The integral limits t_1 and t_2 should be selected in such a way that the ~~integral~~ **function f(t)** takes a maximal value."

Paragraph 4.1., amend to read:

"4.1. ~~Apparatus~~ **Taber test apparatus**"

Paragraphs 4.1.1. to 4.1.2., amend to read (also renumbering Figure 4 to 4.1 and inserting new Figure 4.2):

"4.1.1. Abrading instrument[1]**,** shown diagrammatically in ~~Figure 4~~ **Figures 4.1 and 4.2** and consisting of:

(a) A horizontal turntable, with centre clamp, which revolves counter-clockwise at ~~65 to 75~~ **a fixed speed of 60 ± 2 rev/min or 72 ± 2** rev/min;

(b) Two weighted parallel arms each carrying a special abrasive wheel freely rotating on a ball-bearing horizontal spindle; each wheel rests on the test specimen under the pressure exerted by a mass of 500 g. **The distance between the internal faces of the wheels shall be 52.4 mm ± 1.0 mm (which corresponds to a distance between the symmetry planes of the wheels of 65.1 mm). The horizontal offset of a virtual line, which runs through both wheel axes, from the turntable axis shall be 19.05 mm ± 0.30 mm.**

(c) A vacuum suction system (not depicted in Figures 4.1 and 4.2) and vacuum pick-up nozzle to remove debris and abrasive particles from the test piece surface during testing. The height of the vacuum pick-up nozzle shall be adjustable, and the nozzle openings shall have a diameter of 11 mm.

The turntable of the abrading instrument shall rotate regularly, substantially in one plane (the deviation from this plane shall not be greater than ±0.05 mm at a distance of 1.6 mm from the turntable periphery).

The wheels shall be ~~mounted in such a way that when~~ **placed evenly on the test piece in their full width. When** they are in contact with the rotating test piece they rotate in opposite directions so as to exert, twice during each rotation of the test piece, a compressive and abrasive action along curved lines over an annular area of about 30 cm^2.

[1] A suitable abrading instrument is supplied by ~~Teledyne~~ Taber **Industries** (United States of America).

~~Figure 4~~ **Figure 4.1**
Diagram of abrading instrument

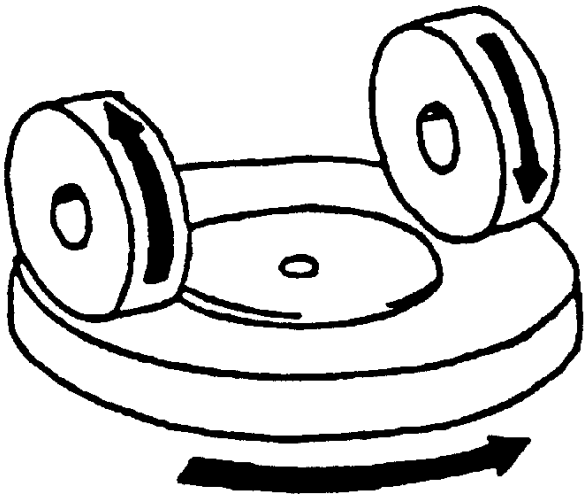
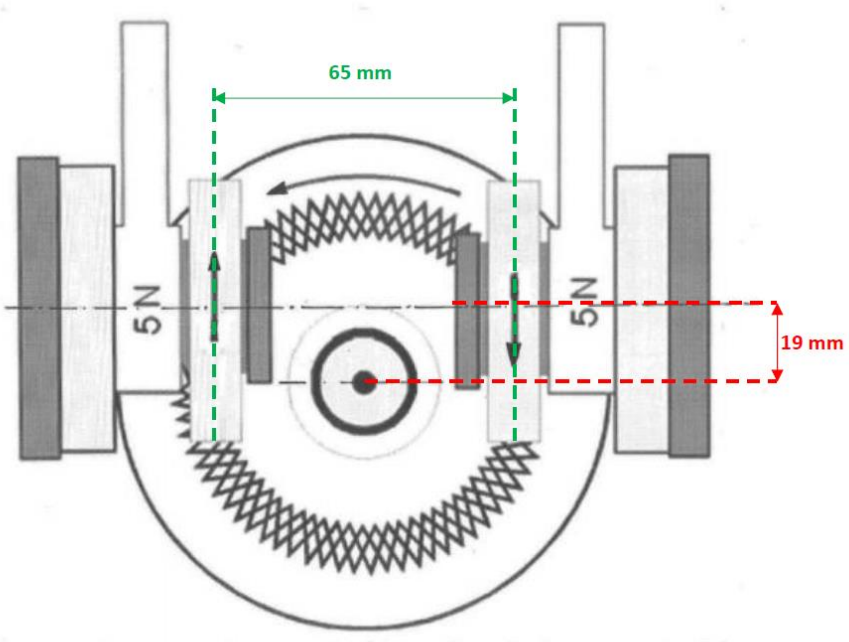


Figure 4.2
Diagrammatical top view of abrading instrument
Effective weight of wheels on test piece, distance between wheel symmetry planes and offset between wheel and turntable axes are indicated (values rounded to integers).



4.1.2. Abrasive wheels[2], ~~each 45 to 50 mm in diameter and 12.5 mm thick, composed of a special finely screened abrasive embedded in a medium hard rubber. The wheels shall have a hardness of 72 ± 5 IRHD, as measured at four points equally spaced on the centreline of the abrading surface, the pressure being applied vertically along a diameter of the wheel and the readings being taken 10 seconds after full application of the pressure.~~ **having a cylindrical shape and composed of a resilient binder and abrasive particles such as aluminium oxide and silicon carbide particles. The abrasive particles shall have a particle size between 20 µm and 102 µm and uniform distribution throughout the resilient binder. Each wheel shall be molded to a hub which includes an axial hole 16.0 mm ± 0.1 mm, allowing the wheels to be mounted to the flange holder on the abraser arms. The sides of the wheel shall be parallel, and each wheel shall be 12.7 mm ± 0.3 mm wide and have an external diameter of less than 52.5 mm and in no case less than 44.4 mm.**

~~The abrasive wheels shall be prepared for use by very slow rotation against a sheet of flat glass to ensure that their surface is completely even.~~"

Insert new paragraphs 4.1.2.1. to 4.1.2.3., to read:

"**4.1.2.1. Testing of glass**

The abrasive wheel shall be such that the light scatter resulting from abrading (final haze minus initial haze, ref. paragraph 4.5.1.) of each of three float glass samples subjected to 1,000 cycles of abrasion is within 0.7 per cent ± 0.5 per cent. The float glass shall be 3 mm to 4 mm in thickness and of at least 70 per cent luminance transmittance. Abrasion should be conducted on the upper glass side (air or fire side).

4.1.2.2. Testing of plastic materials

The abrasive wheel shall be such that the light scatter resulting from abrading (final haze minus initial haze, ref. paragraph 4.5.1.) of each of three AS4000S[3] hard-coated polycarbonate samples subjected to abrasion is within the qualification ranges[4] of 0 per cent to 2.6 per cent after 100 cycles, 0.5 per cent to 6.3 per cent after 500 cycles and 1.0 per cent to 7.4 per cent after 1,000 cycles.

The AS4000S hard-coated polycarbonate samples shall be free of any inhomogeneity in the surface when examined with a human eye and have a luminous transmittance of at least 70 per cent and a primer coating thickness of 0.5 µm to 1.5 µm and topcoat coating thickness of 4.5 µm to 8.5 µm after thermal curing for 30 minutes at 130 °C. The AS4000S reference hard-coated samples shall be supplied with a certificate of analysis of manufacturing quality for coating thicknesses, cure time and cure temperature. An alternative reference hard-coated polycarbonate sample can be used, provided a correlation has been developed against

[2] Suitable abrasive wheels may be obtained from ~~Teledyne~~ Taber **Industries** (United States of America)**, type Calibrase CS-10F**.

[3] **Hard-coating polysiloxane type AS4000S (AS4000 type coating adjusted to flow coating of large sheets) by Momentive Performance Materials (Germany).**

[4] **The qualification ranges have widths of (4 x s_R), where s_R is the reproducibility standard deviation determined in a round robin test (conducted by Technical Committee ISO/TC22/SC11 in year 2013) for each cycles number and the above mentioned factor represents the probability of P = 95 per cent.**

the standardized AS4000S hard-coated polycarbonate reference samples. Any proposed alternative hard-coated polycarbonate sample shall meet the same qualification requirements as the reference AS4000S hard-coated polycarbonate sample.

The wheels are qualified if all measured haze values for the three AS4000S hard-coated polycarbonate reference samples per cycles number, and for each of the three cycles numbers[5], are within the qualification ranges. Only if this requirement is fulfilled, the test will be proceeded using these wheels. The average of the measured values for the three AS4000S hard-coated polycarbonate reference samples per cycles number is used to calculate a correction factor per cycles number for exactly this wheel pair (ref. paragraph 4.5.2.2.). This correction factor is used to correct the measured values obtained when testing a test piece with this wheel pair.

4.1.2.3. Standardization of abrading wheels

The fine side of a Taber ST-11 refacing stone (or equivalent) shall be used for resurfacing the abrasive wheels. It is important that the turntable platform runs true on the abraser and that the refacing stone lies flat on the turntable platform.

In case a new refacing stone is used during the life time of a qualified wheel pair, a new qualification as described in paragraphs 4.1.2.1. respectively 4.1.2.2. shall be performed, and (for testing of plastic materials only) the correction factor shall be redetermined for that wheel pair.

To ensure that the abrading function of the wheels is maintained at a constant level, prepare the abrading wheels prior to each test. Mount the wheels on their respective flange holders, taking care not to handle them by their abrasive surfaces. Affix the load[6] corresponding to a total load of 500 g (per wheel) to the abraser. Visually inspect the fine side of the Taber ST-11 refacing stone and only use it if no contaminations are visible. Mount the visually checked Taber ST-11 refacing stone (or equivalent) on the turntable, fine side up, and secure using the nut.

Lower the vacuum nozzle and adjust the height to 1 mm above the refacing stone with a gage having a thickness equal to 1 mm or a gage pin having a diameter equal to 1 mm. After setting the height of the vacuum nozzle, ensure the rear vacuum nozzle does not contact the refacing stone. Set the vacuum suction force so that a residual pressure of 13.7 kPa (137 mbar) or lower results. Lower the arms so the wheels contact the surface of the ST-11 refacing stone. Reface the wheels for 25 cycles.

After refacing, use a soft bristle, anti-static brush to lightly brush the wheel surfaces to remove any loose particulate matter. A brush found suitable for this purpose is a soft-fibre, static-dissipative brush manufactured from an acrylic fibre (0.04 mm filament diameter) that

[5] The wheel qualification shall be carried out for each of the three cycles numbers (100, 500 and 1,000) regardless of whether it might be intended to use the wheel pair on test pieces at selected cycle numbers only.

[6] In case of a Taber abraser, the accessory mass for a total load of 500 g shall weigh 250 g ± 1 g.

has been chemically bonded with a layer of copper sulphide to produce an electrical resistance of 3 to 5 x 10^{-4} Ω/cm.

New wheels or wheels trued using a diamond tool refacer (such as Taber diamond wheel refacer, or equivalent), shall firstly be broken in with 100 cycles on the fine side of the ST-11 refacing stone followed by a test on the material to be evaluated (results to be discarded).

The fine side of the ST-11 refacing stone has a limited life and shall be replaced after 7,500 cycles (approximately 300 refacings).

A thin fin of wheel material is sometimes formed on the left hand edge of the wheel as the main body of the wheel wears down. To remove, gently rub the edge of the wheel using your gloved finger prior to refacing. Avoid touching the running surface of the wheel.

The maximum allowed time between refacing and testing shall not exceed 2 minutes."

Paragraph 4.1.3., amend to read:

"4.1.3. ~~Light source consisting of an incandescent lamp with its filament contained within a parallelepiped measuring 1.5 mm x 1.5 mm x 3 mm. The voltage at the lamp filament 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.~~ **Hazemeter[7], shown diagrammatically in Figure 5.1 and consisting of:**"

Insert new paragraphs 4.1.3.1. and 4.1.3.2., to read:

"**4.1.3.1.** **A light source of colour temperature 2,856 K ± 50 K and a photodetector, and the combination shall be filtered to provide an output corresponding to the luminosity response of the 1931 CIE Standard Colorimetric Observer with CIE Standard Illuminant A. The output shall be proportional to within 1 per cent to the incident flux over the range of flux used. The photometric stability for source and detector shall be constant throughout the test of each test piece.**

4.1.3.2. **An integrating sphere to collect transmitted flux; the sphere may be of any diameter as long as the total port areas do not exceed 4.0 per cent of the internal reflecting area of the sphere. The entrance and exit ports shall be centred on the same great circle of the sphere, and there shall be at least 2.97 rad (170°) of arc between centres. The exit port shall subtend an angle of 0.14 rad (8°) at the centre of the entrance port. With the light trap in position, without the test piece, the axis of the irradiating beam shall pass through the centres of the entrance and exit ports. For a hazemeter, position the photocell or photocells on the sphere 1.57 rad ± 0.17 rad (90° ± 10°) from the entrance port and baffle it from direct exposure to the entrance port. In the pivotable modification where the interior wall adjacent to the exit port is used as the reflectance reference, the angle of rotation of the sphere shall be 0.140 rad ± 0.008 rad (8.0° ± 0.5°).**"

[7] **A suitable instrument for measuring haze is supplied by BYK-Gardner (Germany).**

Paragraphs 4.1.4. and 4.1.5., amend to read (also replacing Figure 5.1):

"4.1.4. ~~Optical system consisting of a lens with a focal length f of at least 500 mm and corrected for chromatic aberrations. The full 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 mm ± 1 mm. This diaphragm shall be situated at a distance of 100 mm ± 50 mm from the lens on the side remote from the light source.~~ **Illuminate the test piece by a substantially unidirectional beam; the maximum angle that any ray of this beam may make with the beam axis shall not exceed 0.05 rad (3°). This beam shall not be vignette at either port of the sphere.**

When the test piece is placed against the entrance port of the integrating sphere, the angle between the perpendicular to the test piece and a line connecting the centres of entrance and exit ports shall not exceed 0.14 rad (8°).

An aperture or diaphragm shall be centrally inserted in the haze measuring apparatus to centre the light beam on the abradant track and limit it to a diameter of 7 mm ± 1 mm at the test piece.

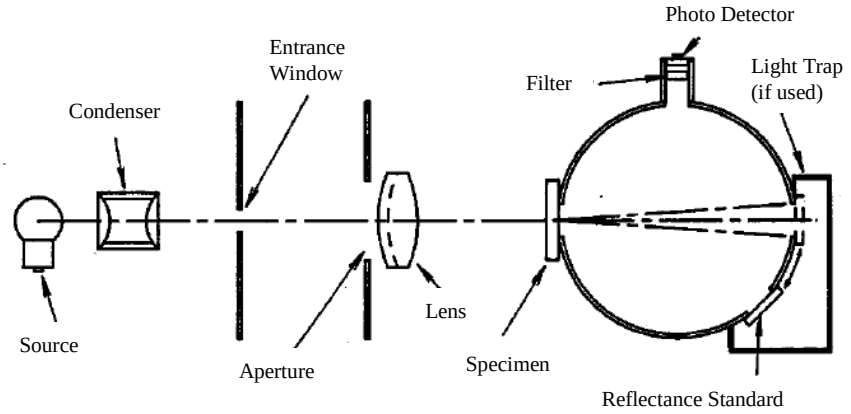
When the reduced light is unobstructed by a test piece, its cross section at the exit port shall be approximately circular, sharply defined, uniformly bright, and concentric within the exit port, leaving an annulus of 0.023 rad ± 0.002 rad (1.3° ± 0.1°) subtended at the entrance port.

The surfaces of the interior of the integrating sphere, baffles, and reflectance standard, if used, shall be of equal reflectance, matte, and highly reflecting throughout the visible spectrum.

A light trap shall be provided that will absorb the beam completely when no test piece is present, or the instrument design shall obviate the need for a light trap.

Forward scattering glass standards can be used to check that the optical system of the hazemeter is properly adjusted.

Figure 5.1
Hazemeter



4.1.5. ~~Equipment for measuring scattered light (see Figure 5), consisting of a photoelectric cell with an integrating sphere 200 to 250 mm in diameter. The sphere shall be equipped with entrance and exit ports for the light. The entrance port shall be circular and have a diameter at least twice that of the light beam. The exit port of the sphere shall be provided with either a light trap or a reflectance standard, according to the procedure described in paragraph 4.4.3. below. The light trap shall absorb all the light when no test piece is inserted in the light beam.~~

~~The axis of the light beam shall pass through the centre of the entrance and exit ports. The diameter b of the light exit port shall be equal to 2 a.tan 4°, where a. is the diameter of the sphere. The photoelectric cell shall be mounted in such a way that it cannot be reached by light coming directly from the entrance port or from the reflectance standard.~~

~~The surfaces of the interior of the integrating sphere and the reflectance standard shall be of substantially equal reflectance and shall be matt and non-selective.~~

~~The output of the photoelectric cell shall be linear within ±2 per cent over the range of luminous intensities used. The design of the instrument shall be such that there is no galvanometer deflection when the sphere is dark.~~

~~The whole apparatus shall be checked at regular intervals by means of calibration standards of defined haze.~~

~~If haze measurements are made using equipment or methods differing from those defined above, the results shall be corrected, if necessary, to bring them into agreement with those obtained by the apparatus described above.~~

Test piece holder

A suitable holder shall be used to permit positioning the test piece on the hazemeter so that the light beam is centred in the abradant track and the test piece is flush at the measurement port.

Calibrate the hazemeter with the test piece holder before the initial measurement of the haze with no test piece present and verify that the reading of the hazemeter is zero.

The whole apparatus shall be checked at regular intervals by means of calibration standards of defined haze.

If haze measurements are made using equipment or methods differing from the above, the results shall be corrected in order to be in agreement with those obtained by the apparatus described above."

Paragraph 4.2., amend to read:

"4.2. Test conditions

Temperature: ~~20 °C ± 5 °C~~ **23 °C ± 2 °C**

Pressure: 860 to 1,060 mbar

Relative humidity: ~~60 ± 20~~ **50 ± 5** per cent."

Paragraphs 4.4.1. to 4.4.3., amend to read:

"4.4.1. **Cleaning**

~~Immediately before and after the abrasion,~~ **Before testing, remove any protective masking material from the test pieces. If required, clean the test pieces using a practice recommended by the manufacturer, or if none is recommended,** clean the test pieces in the following manner:

(a) ~~Wipe with a linen cloth under clear running water,~~ **Using an Isopropyl alcohol (IPA) soaked lint free cloth, gently wipe both surfaces of the test piece in a linear motion to remove any remaining particulate. For those materials where IPA influences the surface characteristics or does not yield a satisfactory result, use a cleaning solution of water with a commercial (e.g. dish-washing) detergent added or a cleaning solution that is compatible with the test piece. First wipe the test piece vertically; then wipe the test piece horizontally; and as a final cleaning step wipe the edges,**

(b) Rinse with distilled**, deionized** or demineralized water,

(c) ~~Blow~~ **Dry by pressing lightly between two linen cloths, or blow** dry with ~~oxygen~~ **clean air** or nitrogen~~,~~**.**

~~(d) Remove possible traces of water by dabbing softly with a damp linen cloth. If necessary, dry by pressing lightly between two linen cloths.~~

Inspect to confirm that there are no water spots or other residue before haze measurement.

Any treatment with ultrasonic equipment shall be avoided. After cleaning, the test pieces shall be handled only by their edges and shall be stored to prevent damage to, or contamination of, their surfaces. **It is recommended that latex gloves be worn at all times throughout this test.**

4.4.2. **Conditioning**

Condition the test pieces for a minimum time of 48 hours at ~~20 °C ± 5 °C~~ **23 °C ± 2 °C** and ~~60 ± 20~~ **50 ± 5** per cent relative humidity. **Begin the testing within 5 minutes after removal from conditioning.**

When not in use, the abrasive wheels shall be stored in the same conditions of temperature and humidity.

4.4.3. **Initial haze measurement**

~~Immediately place the test piece against~~ **Place the unabraded test piece in the hazemeter test piece holder with the side to be abraded facing** the entrance port of the integrating sphere. The angle between the normal (perpendicular) to the surface of the test piece and the axis of the light beam shall not exceed 8°.

Take four readings as indicated in the following table:

……

Calculate the total transmittance $T_t = T_2/T_1$.

Calculate the ~~total~~ **diffuse** transmittance T_d as follows:

$$T_d = \frac{T_4 - T_3(T_2/T_1)}{T_1 - T_3}$$

Calculate the percentage haze, or light~~, or both,~~ scattered, as follows:

$$\text{Haze, or light}\sout{\text{, or both,}}\text{ scattered, } = \frac{T_d}{T_t} \times 100\ \%$$

Measure the initial haze of the test piece at a minimum of four equally-spaced points ~~in~~ **along** the unabraded ~~area~~ **track** in accordance with the formula above. Average the results for each test piece. In lieu of the four measurements, an average value may be obtained by rotating the piece uniformly at 3 rev/sec or more.

~~For each type of safety glazing, carry out three tests with the same load. Use the haze as a measure of the subsurface abrasion, after the test piece has been subjected to the abrasion test.~~

~~Measure the light scattered by the abraded track at a minimum of four equally spaced points along the track in accordance with the formula above. Average the results for each test piece. In lieu of the four measurements, an average value may be obtained by rotating the piece uniformly at 3 rev/sec or more.~~"

Insert new paragraphs 4.4.4. to 4.4.6., to read (inserting also new Figure 5.2):

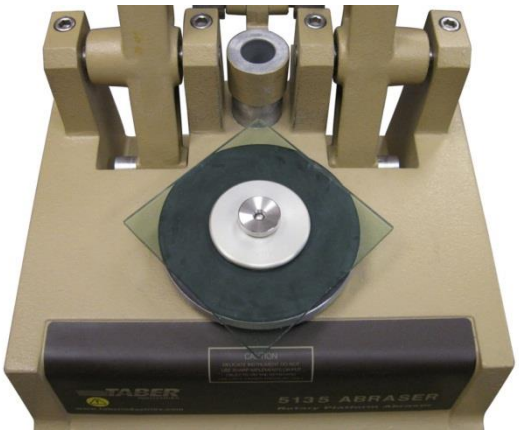
"**4.4.4. Abrasion**

For each type of safety glazing, carry out three tests with the same load. Use the haze as a measure of the subsurface abrasion, after the test piece has been subjected to the abrasion test.

Mount the test piece on the abraser turntable platform with the side to be abraded facing up. The test piece shall be mounted at a 45° angle from the front of the machine as shown in Figure 5.2. Secure using the clamp plate and nut. Affix the load corresponding to a total load of 500 g (per wheel) to the abraser. Lower the vacuum pick-up nozzle and adjust the height to 1 mm above the test piece surface with a gage having a thickness equal to 1 mm or a gage pin having a diameter equal to 1 mm. After setting the height of the vacuum nozzle, ensure the rear vacuum nozzle does not contact the test piece surface.

Set the vacuum suction force so that a residual pressure of 13.7 kPa (137 mbar) or lower results. Lower the arms so the wheels contact the surface of the test piece. Set the counter to zero and programme the appropriate number of cycles. Start the abraser and subject the test piece to abrasion for the selected number of cycles.

Figure 5.2
Abraser turntable with test piece mounted at 45° from machine front



4.4.5. Cleaning after abrasion

After the abrasion test is done, handle the test pieces by their edges to prevent contamination of their surfaces. Using a soft bristle, anti-static brush, lightly brush off any debris adhered to the surface of the test pieces or alternatively rinse the test pieces with distilled, deionized or demineralised water. Clean the test pieces following the procedure described in paragraph 4.4.1.

After each test, inspect the vacuum nozzle for debris and clean as required by using a brush, vacuum cleaner or other suitable means.

4.4.6. Final haze measurement

Place the abraded test piece in the hazemeter test piece holder with the abraded side facing the entrance port of the integrating sphere. Measure the light scattered by the abraded track (final haze) at a minimum of four equally-spaced points along the track in accordance with the formulas of paragraph 4.4.3. If the abrasion track is not homogeneous, up to 16 equally spaced points along the track may be measured. Average the results for each test piece. The angle between the normal to the surface of the test piece and the axis of the beam shall not exceed 8°. In lieu of the four measurements, an average value may be obtained by rotating the piece uniformly at 3 rev/sec or more."

Paragraph 4.5., amend to read:

"4.5. ~~The abrasion test will be carried out only at the discretion of the laboratory conducting the test with due regard to the information already at its disposal.~~

~~Except for glass plastics materials, changes in the interlayer or materials thickness will not normally necessitate further testing.~~ **Expression of results**"

Insert new paragraphs 4.5.1., 4.5.2., 4.5.2.1. and 4.5.2.2., to read:

"4.5.1. General

Subtract the average initial haze from the average final haze, the difference representing the light scatter resulting from abrading the test piece also called Δ haze.

4.5.2. Correction calculation, for testing of plastic materials only

The measured Δ haze value shall be corrected using a correction factor based on the value which has been determined for the AS4000S hard-coated polycarbonate reference samples by testing with the same wheel pair (ref. paragraph 4.1.2.2.).

4.5.2.1. Calculate the corrected delta haze value as follows:

$$\Delta haze_c(r) = \Delta haze_m(r) \times X_c(r)$$

Where:

$\Delta haze_c(r)$ **is the corrected delta haze value of a test piece at a certain cycle number r,**

$\Delta haze_m(r)$ **is the delta haze value obtained by subtracting measured initial haze from measured final haze of the test piece at a certain cycle number r,**

$X_c(r)$ **is the correction factor of the wheel pair used to test the above-mentioned test piece at the same cycle number r, as determined according to paragraph 4.5.2.2.**

4.5.2.2. **The correction factor[8] is determined twice during the lifetime of its wheel pair, at the beginning (at a wheel diameter of approximately 52 mm) and after half of its life time (at a wheel diameter of 48 mm). At the beginning, no additional measurement is necessary since the data of the wheel qualification can be used to calculate the correction factor as described below.**

If a new refacing stone is used during the life time of that wheel pair, the correction factor shall be determined once more, provided that wheel pair has passed a new qualification.

Calculate the correction factor for a certain wheel pair according to

$$X_c(r) = \Delta haze_{rv}(r) / \Delta haze_{av}(r)$$

Where:

$\Delta haze_{rv}(r)$ **is the delta haze reference value[9] of the AS4000S hard-coated polycarbonate reference samples at a certain cycle number r:**

100 cycles: $\Delta hazerv(100) = 1.1$ **per cent,**

500 cycles: $\Delta hazerv(500) = 2.8$ **per cent,**

1,000 cycles: $\Delta hazerv(1{,}000) = 3.7$ **per cent.**

$\Delta haze_{av}(r)$ **is the actual delta haze value of the AS4000S hard-coated polycarbonate reference samples at a certain cycle number r. This value is the mean value actually determined for the respective wheel pair by testing three reference samples at that cycle number with this wheel pair (ref. paragraph 4.1.2.2.).**"

[8] **It is sufficient to determine the correction factors of a wheel pair only for those of the three cycles numbers (100, 500 and 1,000) which have actually been selected for testing of test pieces.**

[9] **These fixed $\Delta haze_{rv}(r)$ values for the AS4000S hard-coated polycarbonate reference samples are the mean values per cycles number obtained in the round robin test by those participating test labs which proved to use qualified wheels according to paragraph 4.1.2.2.**

II. Justification

1. In the current description of equipment and procedure of the headform test with deceleration measurement and the test of resistance to abrasion, important details are completely missing or need to be updated. In the case of the headform test, the current values for the headform calibration cannot be reproduced and, therefore, shall be corrected. Furthermore, the description of the test equipment should be updated in consideration of the current state of the art, e.g. introduction of wireless data transmission. In case of the abrasion test with the so-called "Taber abraser", round robin tests have shown the need to improve reproducibility.

2. All required modifications are included in the latest revision of the corresponding ISO standard, i.e. ISO 15082:2016-11. For improvement of the abrasion test reproducibility, reference materials have been introduced to exclude variations in the abrasive-wheel quality and for a correction calculation (the latter in case of plastic materials only).

3. Document ECE/TRANS/WP.29/GRSG/2015/22, submitted by the expert from Hungary and supplemented by GRSG-111-05 (tabled by the expert from Poland), has also been considered in the above proposal for clarification of the parameters of the abrading instrument.