D.T.D.5592A

Ministry of Defence
Defence Procurement Agency, ADRP2
Abbey Wood
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BS34 8JH

OBSOLESCENCE NOTICE

All DTD specifications were declared obsolescent from 1st April 1999. All DTD 900 series approvals also lapsed at that time. The standards will no longer be updated but will be retained as obsolescent documents to provide for the servicing of existing equipment.

Further Guidance

The aim in declaring the specifications obsolescent is to recognise that the documents are not being updated and thus should be used with care by both purchaser and supplier. For example, a specification could contain valid technical information but may also contain type approval clauses that contradict procurement policy and/or use materials that do not comply with environmental legislation. The obsolescent specification can still be used as a basis for a purchase provided that the supplier and purchaser agree suitable changes to the specification within the purchase order/contract.

For the DTD 900 system, each specification has provided an MoD approved material and process. For these items, the declaration of obsolescence will constitute the termination of both the extant MoD approval and the continuing MoD assessment that had underpinned those approvals. Again, the technical content of the document remains valid and can be used by both purchaser and supplier as a basis for a contract but an acceptable (to the parties) approval/assessment procedure would be required.

PROCUREMENT EXECUTIVE

MINISTRY OF DEFENCE

D.T.D. 5592A

March 1981

Aerospace Material Specification

ACRYLIC SHEETS FOR AIRCRAFT GLAZING

NOTE 1. This specification is one of a series issued by the Procurement Executive, Ministry of Defence, either to meet a limited requirement nor covered by an existing British Standard (Aerospace Series) or to serve as a basis for inspection of material, the properties and uses of which are not sufficiently established to warrant submission to the British Standards Institution for standardization.

NOTE 2. The tests employed in this specification are chosen for their reproducibility and ability to control the properties of the material. They are not intended to be simulated service tests which, because of variability of test conditions, may be unsatisfactory for control purposes.

NOTE 3. This specification calls for the use of substances and/or test procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitabilily and in no way absolves either the supplier or the user from statutory obligations related to health and safety at any stage of manufacture or use.

This specification has been devised for the use of the Ministry of Defence and its contractors in the execution of contracts for the Ministry and, subject to the Unfair Contract Terms Act 1977, the Ministry will not be liable in any way whatever (including but without limitation negligence on the part of the Ministry, its servants or agents) where the specification is used for other purposes.

SECTION 1

Scope

This specification controls the supply of as-cast transparent acrylic sheets for aircraft glazing and other applications. Materials covered by this specification are suitable for fabricating by the processes described in 2.1.

SECTION 2

Related documents

2.1 The fabrication of acrylic panels and shapings DTD 925D.

2.2 Spectacle lens material. British Standard 3062: 1970.

2.3 Methods of testing plastics. British Standard 2782 Part 1, Method 120C (1976)
Method 121A (1976)
Part 3, Method 320C (1976)

SECTION 3

Composition

The sheets shall be made from a stable polymer or copolymer consisting essentially of methyl methacrylate, shall contain no plasticizer and shall be controlled under the conditions specified herein.

SECTION 4

Optical requirements

4.1 The sheets viewed through the cast surface shall meet the colour requirements of clause 3 of the reference given in clause 2.2 above. The average absorptivity shall be determined for each of the following spectral bands:

400 nm - 500 nm
500 nm - 580 nm
580 nm - 700 nm

The limits of colouration shall be such that:

(i) in the band 500-580 nm the average absorptivity does not exceed 0.1 per cent per mm

(ii) the difference in average absorptivity between any two of the above spectral bands does not exceed 0.08 per cent per mm thickness.

4.2 The white light transparency of the sheets shall be such that, when determined by the method described in Appendix 1, the value shall not be less than:

91% for sheet less than 2.5 mm in thickness

90% for sheet between 2.5 mm and 8 mm in thickness

89% for sheet between 8 mm and 12 mm in thickness

88% for sheet between 12 mm and 20 mm in thickness

85% for sheet between 20 mm and 50 mm in thickness

4.3 The ultra-violet light transmission at any wavelength in the range 290-330 nm when determined by the method described in Appendix 2 shall not exceed the values shown in Figure 1.

4.4 There shall be no visual distortion when the sheets are examined by the method described in Appendix 3.

4.5 The sheets shall meet the inspection requirements of Section 10.

SECTION 5

Tensile strength

When determined by the method described in Appendix 4 the tensile strength of the material shall be not less than 70 MPa.

SECTION 6

Dimensions

6.1 The sheet size and thickness shall be specified in the contract or order.

6.2 The thickness of the sheet at any point shall not differ from the nominal thickness by more than plus or minus the value taken from Figure 2.

SECTION 7

Retention of strength after crazing

For material greater than 6 mm in thickness, the test specimens shall be machined on one face only to a thickness of 6.0 mm. The as-cast face shall be in tension in the test. For material of 6.0 mm or thinner, the test specimens shall be the thickness of the sheet. Tests shall be made on ten specimens in accordance with Appendix 5. Each specimen shall be required to sustain a loading of 10.4 MPa (maximum bending stress) at 35 ± 3°C, for a continuous period of not less than 24 hours. Failure of more than one specimen during this period shall mean rejection of the batch. If only one specimen fails, a further two sets of samples from different sheets shall be selected from the same batch and tested in accordance with Appendix 5. If any of these specimens fail, the batch shall be rejected.

SECTION 8

Thermal requirements

8.1 For sheet thickness less than 3 mm the Vicat Softening Point, when determined by the method given in Appendix 6 shall not be less than 110°C and shall be within ± 5°C of the value agreed between the manufacturer and the Type Approving Authority.

8.2 For sheet of 3 mm or more in thickness, the Temperature of Deflection under Load when determined by the method of Appendix 7 shall not be less than 100°C and shall be within ± 5° C of the value agreed between the manufacturer and the Type Approving Authority.

8.3 After heating by the method described in Appendix 8 the material shall be free from blisters and shall comply with the requirements of Section 4 and Section 10.

SECTION 9

Fabrication

9.1 Sheets shall be capable of being bonded by the process described in clause 2.1.

9.2 Sheets shall be capable of being formed using pressure and heat in the temperature range 135-170°C as defined in clause 2.1.

SECTION 10

Visual inspection requirements

The sheets shall have a high polish and shall comply with the following requirements.

10.1 Each sheet shall be visually inspected as described in Appendix 9 and any defect areas marked and defined as:

(i) Crazing
(ii) Fibres between 0.5 and 3 mm in length - minor defect.
(iii) Foreign matter between 0.15 and 0.4 mm^2 in area - minor defect.
(iv) Surface faults between 0.15 and 0.4 mm^2 in area - minor defect.
(v) Foreign matter between 0.4 and 0.6 mm^2 in area - major defect.
(vi) Surface faults between 0.4 and 1.0 mm^2 in area - major defect.
(vii) Fibres, foreign matter and surface faults smaller than minor defects - sub-minor defect.

NOTE One surface fault not greater than 4 mm^2 in area may be removed from any sheet by polishing providing the sheet subsequently complies with the optical and thickness requirements.

10.2 Sheets containing any crazing or any other voids shall be rejected. Sheets containing defects greater in length or area than specified for major defects in clause 10.1 shall also be rejected.

10.3 Major and minor defects as defined in clause 10.1 shall be acceptable providing:

(i) An area enclosed by a circle of radius 150 mm with each major defect as centre contains no other major defect and not more than 3 minor defects.
(ii) An area enclosed by a circle of radius 150 mm and centre at any point on the sheet which does not include a major defect, contains no more than 5 minor defects.
(iii) In an area enclosed by a circle of radius 150 mm and centre at any point on the sheet, the total area of sub-minor defects is less than 2 mm^2.

10.4 Uncut sheets having, within 100 mm of the edges, defects which are unacceptable as defined by clause 10.2, shall be considered as acceptable.

SECTION 11

Type approval

Before any particular manufacturer's materials are supplied as complying with this specification, the manufacturer shall obtain type approval. Application for approval shall be submitted to the Director of Materials Quality Assurance, Royal Arsenal East, Woolwich, London SE18 6TD together with:

(i) Evidence that materials comply with all the requirements specified herein
(ii) Samples of the materials at least 600 mm square for which approval is sought.
(ii) Details of the composition, supplied in confidence to the Director of Materials Quality Assurance.
(iv) Recommended forming and fabrication instructions.
(v) Details of sheet thicknesses and maximum sizes available.

SECTION 12

Formulation changes

Any proposed change whatsoever by the manufacturer in the formulation and/or the production process shall be notified to the Design Authority, through the Aeronautical Quality Assurance Directorate, Harefield House, Harefield, Middlesex UB9 6BB. If the change is considered to be significant the material shall be designated a new product which shall require specific and separate approval. The changed material if approved shall be given a new name and trade symbol.

SECTION 13

Sampling and inspection

13.1 A sheet of material shall be taken, at random, from each batch for testing for compliance with Section 14 of this specification.

13.2 At the discretion of the inspector any batch of material may be tested to the full requirements of this specification.

SECTION 14

Acceptance tests

Any manufacturer's material granted type approval under this specification shall be subject to and comply with the requirements of the following acceptance tests:

14.1 Each sheet:

Clause 6.2 (Dimensions)

Section 10 (Visual inspection)

14.2 Each batch:

Clause 4.1 (Colour)

Clause 4.4 (Visual distortion)

Section 8 (Thermal requirements)

Batch is defined as all the sheets poured from the same casting mix.

14.3 At not more than three-monthly intervals one further batch selected at random by the inspector:

Clause 4.2 (White light transparency)

Clause 4.3 (Ultra-violet light transmission)

Section 5 (Tensile strength)

Section 7 (Retention of strength after crazing)

SECTION 15

Keeping qualities

Sheets stored under the conditions recommended by the manufacturer shall fully meet the requirements of this specification for a period of 5 years, from date of despatch. Sheets stored for more than 5 years from the date of despatch shall be retested for compliance with Clause 14.2 of this specification.

SECTION 16

Protection and packaging

16.1 Individual sheets shall be protected on both surfaces by a masking system approved by the Head of Materials Department, RAE, which can be readily removed without injury to the surfaces. The masking must protect the surfaces from damage during delivery, storage, normal handling and cutting operations.

16.2 The packaging shall be suitable for maintaining the material in its original condition and the sheets shall be supported to avoid damage.

SECTION 17

Marking

Each sheet of material shall be clearly marked on the protective masking with:

17.1 This specification number.

17.2 The name or trade symbol of the manufacturer as designated in the approval.

17.3 The manufacturer's batch number or reference.

17.4 The sheet thickness.

NOTE: The markings called for in clauses 17.1 and 17.2 shall be spaced at intervals of not less than 600 mm over the surface protective masking.

APPENDIX 1

Determination of white light transmission

1 Scope and field of application

This method specifies the determination of visible light transmittance of planar sections of transparent plastics employing a defined light source and a photometer with a spectral response corrected to approximate that of photopic vision.

2 Definition

Visible light transmittance is defined as the energy flux of an emerging beam of light compared with that of the incident parallel beam falling upon the specimen under examination.

3 Apparatus

The apparatus, as shown in Figure 3, consists of a stabilised light source with associated optical system to produce a collimated parallel beam, specimen holder and photometer all rigidly mounted on a convenient optical bench.

3.1 Light source

3.1.1 The light source shall be a gas-filled tungsten filament lamp of photometric quality operating at a colour temperature of 2855 ± 100K. The power supply to this lamp should be stablished to ensure short-term constant light output.

3.1.2 The light source is combined with an optical system to produce a parallel light beam of area at least I cm^2 and of approximately circular cross-section.

3.2 Integrating Sphere Photometer

3.2.1 The integrating sphere may be of any diameter exceeding 150 mm so long as the total port area does not exceed 2 per cent of the internal reflecting area of the sphere. The axis of the irradiating beam shall pass through the centre of the entrance port and the centre of the integrating sphere. The photocell shall be positioned on the sphere 90° from the entrance port.

3.2.2 The light beam shall not be vignetted at the entrance port of the integrating sphere.

3.2.3 Reflecting surfaces - the surfaces of the interior of the integrating sphere, and baffles shall be of substantially equal reflectance, matt, and highly reflecting throughout the visible wavelength region. A highly reflecting matt sphere paint should be used.

3.3 Photocell

3.3.1 The radiant flux within the sphere shall be measured by a photo-electric cell, the output measurements of which shall be proportional within ±0.5 per cent to the incident flux over the range of intensity used. Spectral conditions for source and receiver must be constant throughout the test of each specimen. The design of measuring instrument shall be such that there shall be a zero reading when the sphere is dark.

3.3.2 The spectral response of the photocell shall be corrected to approximate that of photopic vision.

3.4 The specimen shall be mounted normal to the beam.

4 TEST SPECIMENS

4.1 Preparation. Specimens should be cut from sheets. The surfaces of the test specimens shall be substantially flat and parallel. Both surfaces shall be washed with clean water and then rinsed with distilled water and allowed to dry.

4.2 Dimensions. The test specimens shall be substantially larger than the entrance port of the integrating sphere. The thickness of the specimens shall be measured in three places to an accuracy of 0.02 mm.

5 PROCEDURE

5.1 The apparatus shall be set up and allowed sufficient time to reach thermal equilibrium before measurements are made.

5.2 A reading (a) of the measuring instrument is made without the transparent specimen in place.

5.3 A second reading (b) is made with the specimen placed between the collimator and integrating sphere and adjacent to the entrance port thereof.

5.4 The procedure shall be repeated for each of two additional specimens from the same sheet.

6 EXPRESSION OF RESULTS

The per cent visible light transmittance is calculated from:

$$\text{Per cent visible light transmittance} = 100\ \frac{b}{a}$$

7 TEST REPORT

The test report should include:

7.1 Individual values and average value of per cent visible light transmittance for three specimens.

7.2 Average value of thickness of these three specimens.

APPENDIX 2

Determination of ultra-violet radiation transmission at 290 to 330 nm

1 SCOPE AND FIELD OF APPLICATION

This method specifies the determination of the ultra-violet light transmission at any wavelength in the range 290 to 330 nanometres.

2 APPARATUS

2.1 Light Source

The light source shall be capable of producing a continuous ultra-violet spectrum over the range 290 to 330 nm (air cooled deuterium arc is suitable).

2.2 Spectrophotometer

The spectrophotometer shall be capable of a wavelength accuracy of ±3 nm and a reproducibility of ±2 nm and band width of 10 nm over the range of 290 to 330 nm. It shall have an adequate spectral response in the ultra violet range. The output response shall be linear within ±0.5% and shall be capable of being read to an accuracy of ±0.5%.

3 SPECIMENS

For the purposes of the present method three test specimens are taken from entire sheets. Specimens shall have a high polish and be free from scratches and grazes. The test specimens shall be of a suitable size to fit the equipment used. Specimens shall be cleaned on both surfaces before measurements are made.

4 PROCEDURE

4.1 The measurements shall be made with the optical axis normal to the sample and each measurement shall be an integration of the transmission over an area of at least 1 cm^2.

4.2 When using a recording double beam spectrophotometer it is only necessary to position the sample in the sample compartment and to record the transmission over the range specified.

4.3 When using a single beam non-recording spectrophotometer individual readings have to be made with and without the sample in position, and the transmission factor calculated from the result.

4.4 The thickness of the sheet shall be determined in close proximity to the area where the transmission has been measured, to an accuracy of 0.2 mm.

5 TEST REPORT

The test report for the three specimens shall include:

5.1 The percentage transmission over the wavelength range used.

5.2 The thickness of the sheet.

APPENDIX 3

Method for the determination of freedom from visual distortion

A screen with alternate and adjacent black and white bands of width 13 mm shall be mounted with the lines vertical. It shall be of such a size that it is able to form a complete background for the largest sheet to be inspected. The screen shall be evenly and brightly illuminated.

The sheet to be inspected shall be held in a vertical plane at a convenient height by a support set at an angle of 60° to the screen, and one edge of the sheet shall be in contact with one edge of the screen.

The screen shall be observed through the sheet and examined for any distortion of the bands.

The sheet shall then be rotated in a vertical plane through 90° and the screen again examined for distortion. For the inspection of very large thick sheets it may be convenient to rotate the screen in a vertical plane through 90°, or to provide an additional vertical screen with horizontal bands rather than rotating the sheet itself.

APPENDIX 4

Method for the determination of tensile strength

The method of test and specimens required shall be those defined in BS 2782, Part 3, 1976. Method 320C; the rate of grip separation shall be 5mm/minute, and conditioning of samples shall be as given in BS 2782, Introduction.

APPENDIX 5

Determination of retention of strength after crazing

1 SCOPE AND FIELD OF APPPLICATION

This method examines the ability of a material to maintain its strength over an arbitrary period under load, after the application of a solvent which is known to induce crazing in such materials.

2 DEFINITIONS

For the purposes of this method, retention of strength after crazing is defined as the tendency of the specimen to lose strength over a period of 24 hours at 35 ±3°C because of the possible inception of crazing at the commencement of this period. The application of acetone under controlled conditions is utilised to induce crazing, and the specimen is loaded to develop the outer fibre stress as stated in the material specification.

3 APPARATUS AND MATERIAL

3.1 A suitable cantilever loading arrangement shall be set up as in Figure 4, the fixed support and fulcrum being horizontal and parallel with radiused contact faces.

3.2 Suitable weights may be hung from the loading point to induce the required fibre stress.

3.3 A supply of acetone of analytical reagent grade is required.

4 TEST SPECIMENS

4.1 The specimen shall consist of a strip of the material 25 mm wide and 175 mm long cut from sheet. Material thicker than 6.0 mm shall be machined on one face to 6.0 mm and this shall be face B (see figure 4) during test. The edges of the strip shall have a polished finish and be free from chipping.

4.2 A hole 6 mm in diameter shall be drilled with centre 15 mm from one end and on the centre line of the strip to facilitate loading (see figure 4).

4.3 The protective masking shall be removed and the specimen washed in clean water at 30° to 40°C, rinsed in distilled water and allowed to dry.

5 CONDITIONING

5.1 After heat treatment and annealing the specimens shall be conditioned at a temperature of 35 ± 3°C, for a period of 24 hours immediately prior to testing under the same conditions.

5.2 The apparatus shall also be conditioned at a temperature of 35 ± 3°C, for a period of 24 hours immediately prior to the test.

6 PROCEDURE

6.1 The test specimens shall be freely suspended in an air circulating oven and maintained at a temperature of 155° ± 2°C for a period of 30 minutes and then annealed in an air circulating oven to the manufacturers instructions prior to testing.

6.2 The width and thickness of the specimen shall be measured after annealing to the nearest 0.02 mm at a point 125 mm from the centre of the hole.

6.3 The specimen shall be supported as shown in figure 4 and loaded with weights suspended from the hole. The loading applied shall be calculated from the formula:

$$\text{Loading (Newtons)} = \sigma \frac{B\ A^2}{6\ L}$$

where: σ = required outer fibre stress in MPa.

B = width of the specimen at fulcrum in millimetres

A = thickness of the specimen at fulcrum in millimetres

L = distance from fulcrum to loading point in millimetres to the nearest 0.1 mm.

6.4 Acetone at 35 ± 3°C shall be liberally applied to face A (see figure 4) for 5 minutes continuously with a soft brush, care being taken to ensure that the acetone-wetted area extends to the position above the fulcrum. The specimen shall then be left undisturbed for 24 hours.

APPENDIX 6

Method for the determination of Vicat softening point

The method of test and specimens required shall be those defined in BS 2782, Part 1, 1976. Method 120C.

APPENDIX 7

Method for the determination of temperature of deflection under load

The method of test and specimens required shall be those defined in BS 2782, Part 1, 1976. Method 121A.

APPENDIX 8

Method for the determination of thermal stability

A sheet representative of the manufacturing batch shall be hung in an air circulating oven at a temperature of 165°C + 5°C for 1 hour. The specimen shall be removed from the oven, allowed to cool to room temperature while hanging vertically and then examined.

APPENDIX 9

Method for examination and measurement of defects

1 Examination for Defects

A white screen large enough to accommodate the largest sheet shall be set up at a convenient height and provided with uniform illumination. The sheet shall be supported parallel to the plane of the screen and examined for any defects.

The sheet shall then be placed in front of a matt black screen of similar dimensions situated in a darkened room so that the only light falling on the sheet is from a suitable number of fluorescent tubes situated parallel to two opposite edges of the sheets and in same plane. The illuminated sheet shall be examined for any defects.

2 Measurement of defects

With the sheet under strong oblique illumination the defects shall be identified and measured by means of a Brinell (or equivalent) inspection microscope of magnification approximately 10 and fitted with a graticule graduated in 0.1 mm. The area of each defect shall be assessed as approximating to the nearest sample geometric shape.

Approved for issue,

D K Thomas

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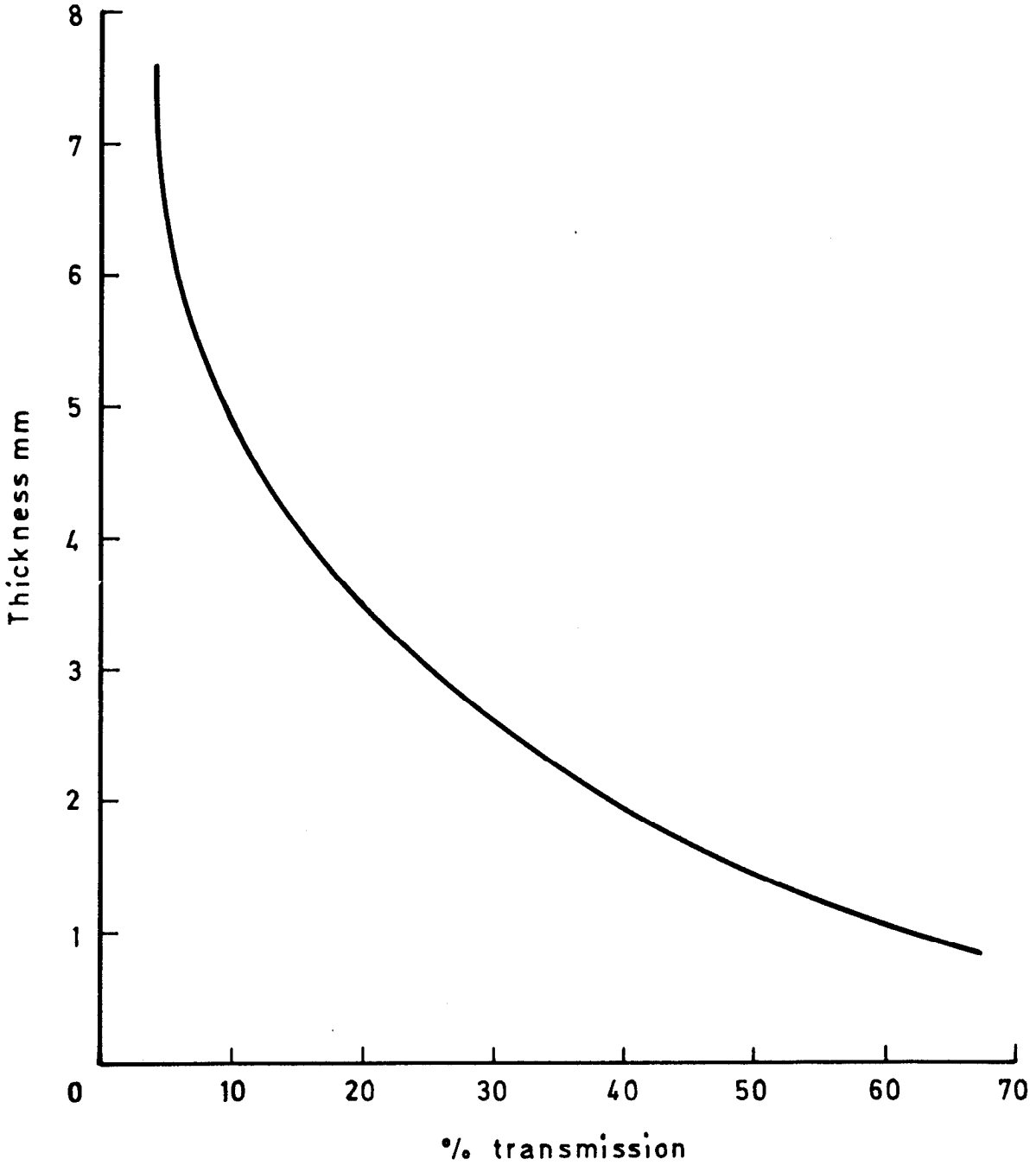
Printed in England for Her Majesty's Stationery Office by Robendene Ltd., Amersham
Dd 7 I8838 9/81



Note For thickness greater than 7mm the transmission is approximately 4%.

Fig 1 Maximum permissible ultra-violet transmission in the range 290-330 nanometres

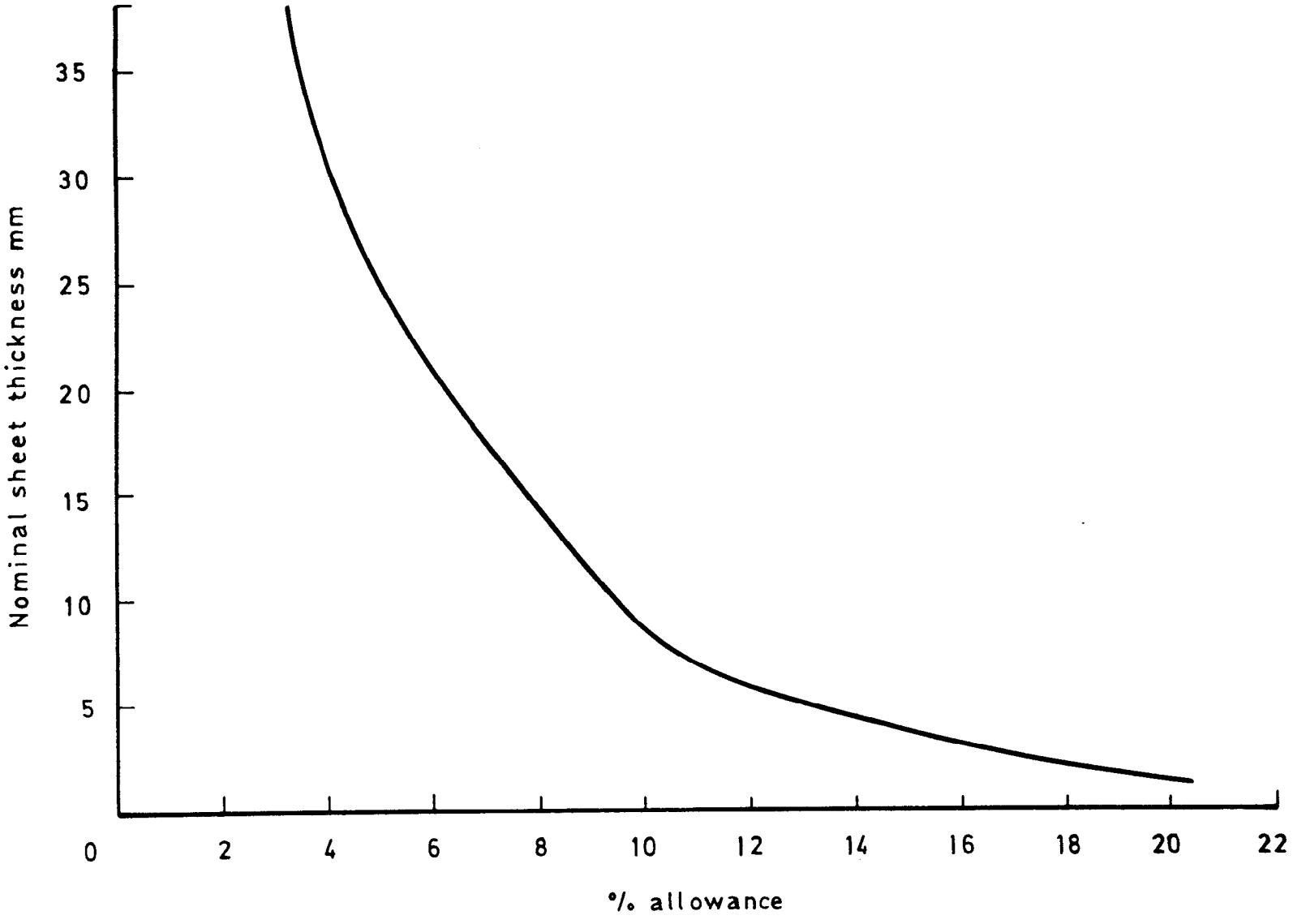


Fig 2 Thickness tolerances on sheet material

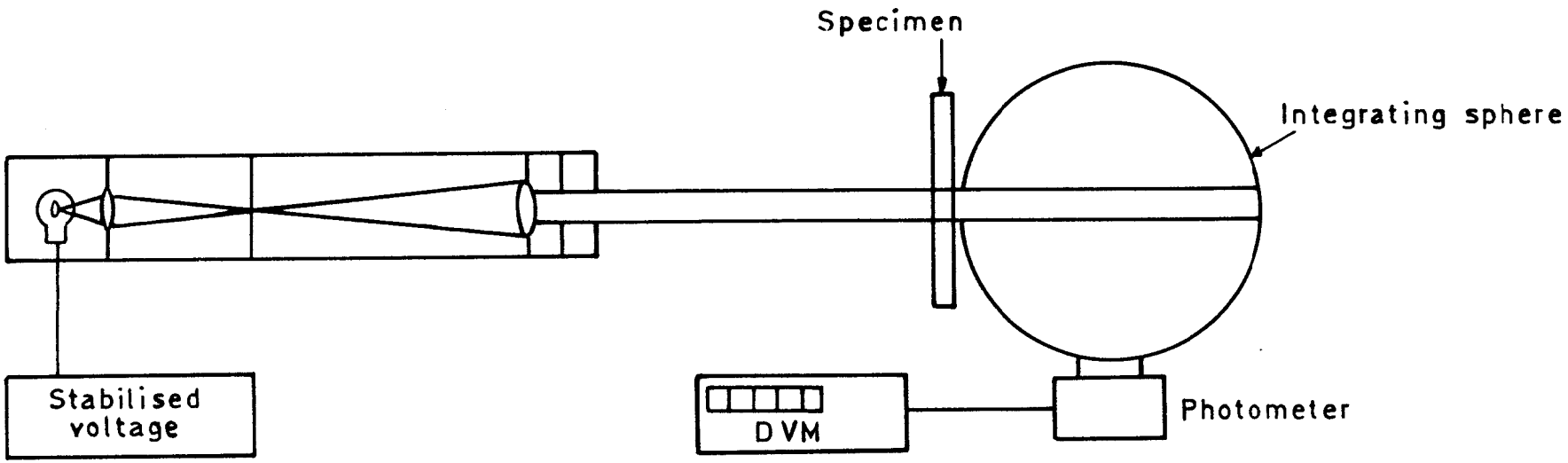
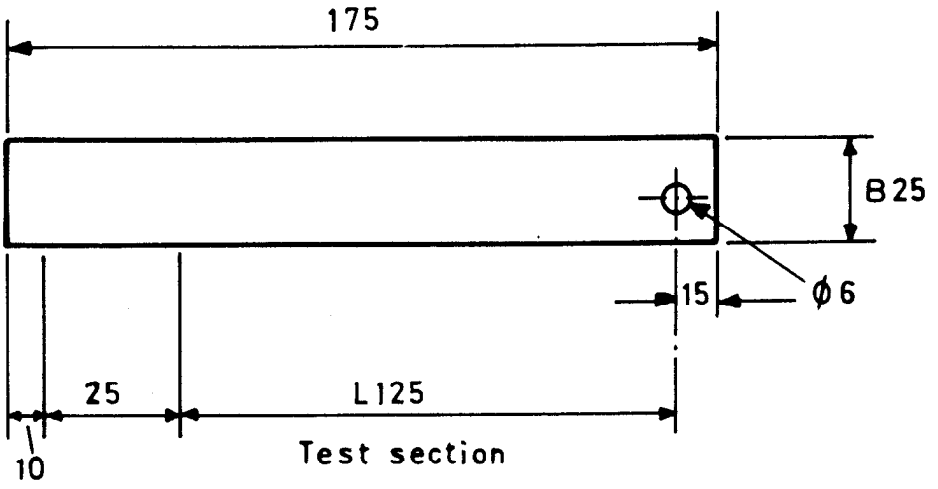
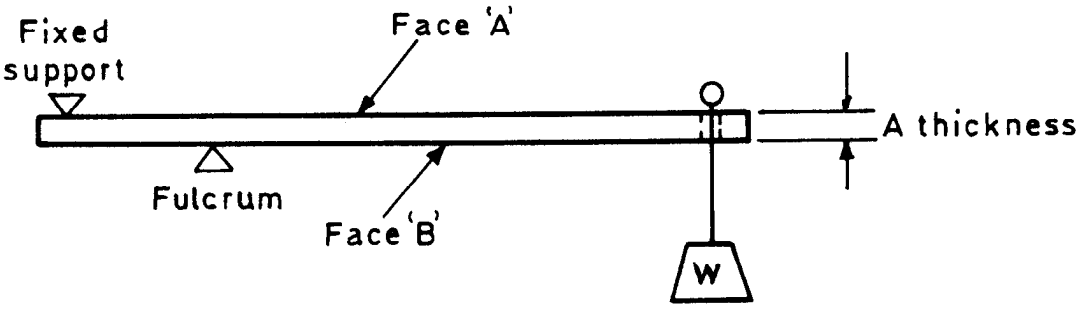


Fig 3 Measurement of white light transmission



Test specimen



Loading geometry

Dimensions in millimetres

Fig 4 Test specimen and loading geometry for retention of strength after crazing test