
**Plastics — Methods of exposure to solar
radiation —**

Part 2:
**Direct weathering and exposure behind
window glass**

*Plastiques — Méthodes d'exposition au rayonnement solaire —
Partie 2: Exposition directe et exposition derrière une vitre en verre*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 877-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance*.

Together with the other parts (see below), it cancels and replaces ISO 877:1994, which has been technically revised.

ISO 877 consists of the following parts, under the general title *Plastics — Methods of exposure to solar radiation*:

- *Part 1: General guidance*
- *Part 2: Direct weathering and exposure behind window glass*
- *Part 3: Intensified weathering using concentrated solar radiation*

Plastics — Methods of exposure to solar radiation —

Part 2: Direct weathering and exposure behind window glass

1 Scope

This part of ISO 877 specifies a method for the direct exposure of plastics to solar radiation (method A) and a method for the exposure of plastics to glass-filtered solar radiation (exposure behind window glass) (method B). The purpose is to assess property changes produced after specified stages of such exposures. General guidance concerning the scope of ISO 877 is given in ISO 877-1:2009, Clause 1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 877-1: 2009, *Plastics — Methods of exposure to solar radiation — Part 1: General guidance*

ISO 4582, *Plastics — Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or laboratory light sources*

ASTM G 24, *Standard Practice for Conducting Exposures to Daylight Filtered Through Glass*

3 Principle

General guidance is given in ISO 877-1:2009, Clause 4.

4 Apparatus

4.1 General requirements

Refer to ISO 877-1:2009, Subclause 5.1, for general requirements.

When installed, the racks employed in test methods A and B shall be capable of providing the desired angle of inclination (see 6.1) and shall be such that no portion of any test specimen is closer than 0,5 m to the ground or to any other obstruction. Specimens may be mounted directly on the rack or in suitable holders which are then affixed to the rack. Mounting fixtures shall be secure, but shall apply as little stress as possible to the specimens and shall permit shrinkage, expansion or warping to occur without constraint, as far as possible.

In some cases, the object to be exposed is intended to be in direct contact with the ground (e.g. when entire vehicles are exposed). In these cases, the requirements for minimum distance between the specimens and the ground do not apply.

4.2 Test fixture for exposures using method A

The design of the specimen rack shall be suited to the types of specimen being exposed, but for many purposes a flat frame mounted on a support is suitable. The materials used to construct the frame shall conform to the requirements given in ISO 877-1:2009, Subclause 5.1. All materials used for the test fixture shall be corrosion-resistant without the need for surface treatment. Aluminum alloys 6061T6 and 6063T6 and stainless steel have been found suitable for use in most locations. Untreated wood may be acceptable for use in very dry locations. The test fixture may be adjustable with respect to both solar altitude (i.e. tilt) and azimuth.

4.3 Test fixture for exposures using method B

The test fixture shall consist of an open-bottomed box with a framed cover of e.g. window glass, windscreen glass or automotive side-window glass. The box shall be fitted with a specimen rack that is positioned in a plane parallel to that of the glass cover and on which specimens may be mounted directly or in suitable holders. The materials used to construct the box and the rack to which the specimens are attached shall conform to the requirements of ISO 877-1:2009, Subclause 5.1. The test fixture may be adjustable with respect to both solar altitude (i.e. tilt) and azimuth. A schematic diagram of a set of acceptable under-glass exposure cases is shown in Figure 1.

Sufficient space between the cover and the rack is necessary to ensure adequate ventilation; a minimum of 75 mm has been found suitable. To minimize shadows, the usable exposure area under the glass shall be limited to the area of the glass cover reduced by the distance from the cover to the specimens.

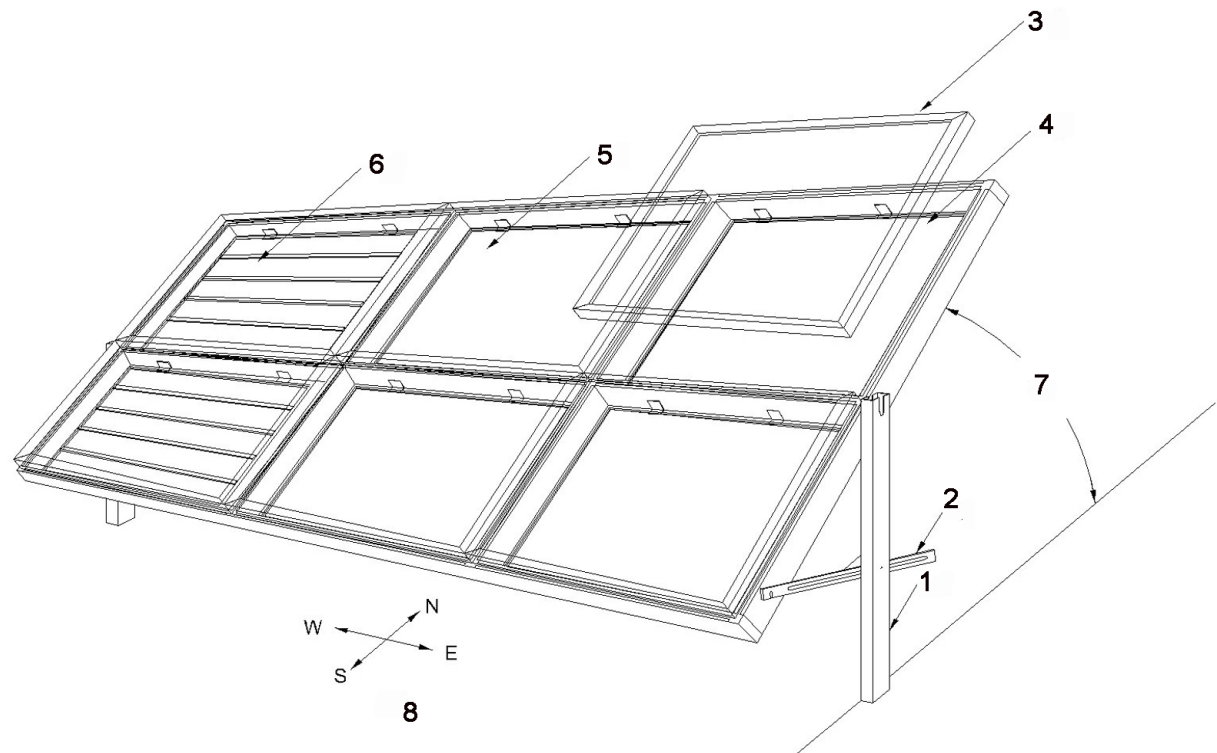
The glass used for the cover shall be flat, uniformly transparent and without defects. For exposures under building-window glass, the glass cover shall be a piece of non-laminated, transparent flat glass. In order to reduce variability due to changes in UV transmission of glass, all new glass shall be pre-aged for a period of 3 months. The thickness of the glass shall be 2 mm to 3,2 mm. Refer to ASTM G 24 for guidance on glass pre-ageing, routine maintenance and the lifetime of such glass.

Other types of glass or glazing materials may be used as agreed upon by the interested parties.

NOTE 1 Exposure under glass may give rise to different results compared to exposure to the open atmosphere because of a difference in spectral irradiance and a difference between under-glass and open-air temperature.

NOTE 2 Information about spectral transmission and solarization of window glass can be found in the following paper: KETOLA, W., ROBBINS, J.S., "UV Transmission of Single Strength Window Glass" in ASTM STP 1202, *Accelerated and Outdoor Durability Testing of Organic Materials*, Warren D. Ketola and Douglas Grossman (Eds), ASTM, 1993.

In order to ensure the greatest consistency in the exposure conditions, it is essential that the transmission of the glass used for method B exposures be regularly measured or that the glass be replaced on a regular basis. If transmission measurements are used for this, monitor transmission at 320 nm. Replace the glass when the transmission at 320 nm has dropped to 80 % or less of the transmission measured when the glass was first installed. If transmission is not measured, replace the glass at least every five years.



Key

- 1 support post
- 2 angle adjustment arm
- 3 glass cover
- 4 wire screen or mesh (optional)
- 5 plywood backing (optional)
- 6 open frame (optional)
- 7 exposure angle
- 8 points of the compass (Northern hemisphere exposures)

Figure 1 — Typical set of exposure cases for weathering of plastics using glass-filtered solar radiation

4.4 Apparatus for measurement of climatic factors

Refer to ISO 877-1:2009, Subclause 5.2.

Radiometers used for the measurement of solar radiation behind glass in method B shall be mounted $75 \text{ mm} \pm 5 \text{ mm}$ behind the glass and parallel to within $\pm 2^\circ$ with the glass cover and the rack on which the specimens are mounted. The glass cover shall be at least $60 \text{ cm} \times 60 \text{ cm}$ in size.

NOTE ASTM G 24 describes a procedure for indirect calculation of total solar radiant exposure.

5 Test specimens

Refer to ISO 877-1:2009, Clause 6.

6 Conditions of exposure of the test specimens

6.1 Exposure aspect

The exposure angle shall be fixed, facing the equator, at an angle of tilt from the horizontal selected from one of the following, depending on the specification or requirements of the exposure test:

- a) Any angle between 0° and 90° from the horizontal, in accordance with the intended application of the material or the requirements of the specification.

NOTE Exposures at tilt angles of 5° or 45° to the horizontal are very commonly used for plastics. 5° exposures are used to minimize pooling of water in horizontal exposures. Other angles may be used to obtain results relevant to special purposes; for example, vertical exposure may be required to simulate conditions on the face of a building while 45° may be used for comparison with established databases.

- b) For maximum annual total solar radiation for exposure locations at latitudes up to 20° from the equator, adjust the tilt angle to be the same as the site latitude.
- c) For maximum annual total solar radiation for exposure locations at latitudes greater than 20° from the equator, adjust the tilt angle to the site latitude minus 5° to 10°.

6.2 Exposure site

Test fixtures shall be located so that there is no shadow on any specimen when the sun's elevation angle is equal to or greater than 20°.

Additionally, for some applications, it may be desirable to include exposure in uncleared areas in jungle or forest regions in order to assess the effects of biological growth, termites and rotting vegetation. In choosing such sites, care shall be taken to ensure that:

- a) the uncleared site is truly representative of the general environment;
- b) the exposure facilities and access paths do not grossly interfere with or modify the environment.

To obtain the most reliable results, exposures should preferably be conducted at sites in a number of different environments, in particular those that resemble as closely as possible the intended conditions of use. For guidance on climatic conditions, see ISO 877-1:2009, Annex A.

7 Exposure stages

7.1 General

The exposure stages at which changes in properties of the test specimen are determined are specified by one of the following procedures.

7.2 Duration of exposure

The exposure stages shall be specified in terms of the duration of the exposure expressed, unless otherwise specified, either in months (for example, 1, 3, 6, 9, etc) or in years (for example 1, 1,5, 2, 3, 4, 6, etc.).

When testing using either method A or B, the results for exposure stages of less than one year will depend on the season of the year in which the exposure was made. With longer exposure stages, seasonal effects will be averaged, but results may still depend upon the particular season in which the exposure was begun (for example, whether the exposure was started in spring or in autumn).

7.3 Solar radiant exposure

Refer to ISO 877-1:2009, Subclause 8.3.

8 Procedure

8.1 Mounting of test specimens

8.1.1 General

For general information regarding the mounting of test and control specimens, refer to ISO 877-1:2009, Subclause 9.1.

8.1.2 Method A

Attach the specimens to an open-backed or backed rack as specified in ISO 877-1:2009, Subclause 9.1. Unless otherwise specified, use the open-backed rack.

8.1.3 Method B

Mount the specimens to be exposed to glass-filtered solar radiation in accordance with the general procedures given in ISO 877-1:2009, Subclause 9.1, but ensure that they are mounted within the area required by 4.3 and that the distance between the specimen surface and the glass cover is at least 75 mm, but not more than 300 mm. In order to minimize shadowing from the top and sides of the exposure case, the usable exposure area under the glass shall be limited to that of the glass cover reduced by twice the distance from the cover to the specimens.

8.2 Mounting of reference materials (if used)

Refer to ISO 877-1:2009, Subclause 9.2.

8.3 Climatic observations

Refer to ISO 877-1:2009, Subclause 9.3.

8.4 Exposure of test specimens

8.4.1 General

Refer to ISO 877-1:2009, Subclause 9.4, for general guidance.

8.4.2 Method A

Periodically inspect the specimens to ensure that they are properly attached to the exposure rack. If specified, wash the specimens in accordance with the procedure described in the specification being followed. If specimens are washed during exposure, details of the washing procedure shall be included in the test report.

8.4.3 Method B

Clean the outside of the glass covers used in method B at regular intervals, as well as immediately after storms that may have deposited dirt, sand or debris. Also clean the underside of the glass covers periodically to remove dust and sample exudates. Clean with water and wipe dry. Upon mutual agreement between the interested parties, periodic washing/dusting off may also be required to remove unwanted debris from the specimens during exposure.

8.5 Determination of changes in properties

Refer to ISO 877-1:2009, Subclause 9.5, for general guidance on the determination of properties before and after exposure, if required.

9 Expression of results

9.1 Determination of changes in properties

Changes in a property or properties of interest should preferably be expressed in accordance with ISO procedures and test methods (see ISO 4582).

9.2 Climatic conditions

Information on the different climatic observations which may be used to describe the conditions during the exposure can be found in ISO 877-1:2009, Subclause 10.3, and information on classes of climate in ISO 877-1:2009, Annex A.

10 Test report

Refer to ISO 877-1:2009, Clause 11, for general requirements.

