
**Plastics piping and ducting systems —
Plastics pipes and fittings — Method for
exposure to direct (natural) weathering**

*Systèmes de canalisations et de gaines en matières plastiques —
Tubes et raccords en matières plastiques — Méthode pour l'exposition
directe aux intempéries*



Reference number
ISO 16871:2003(E)

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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.

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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 16871 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*.

Introduction

Outdoor exposure tests of the type specified in this International Standard are needed to evaluate the performance of plastics piping components or materials when exposed to direct sunlight. The results of such tests should be regarded only as an indication of the effect of exposure to direct weathering by the method described. Results obtained after exposure for a given time may not be comparable to those obtained after other exposures of equal time using the same method. When identical materials are exposed at different times for extended periods of several years, they generally show comparable behaviour after equal exposure intervals. However, even in long-term tests, the results may be affected by the season in which the tests are started.

The results of short-term direct-weathering tests can give an indication of the relative outdoor performance, but should not be used to predict the absolute long-term performance of a pipe, fitting or joint. Even results of tests carried out for longer than 24 months can show an effect of the season in which the exposure started. Comparisons of non-full-year exposures will exhibit seasonable effects.

The test method chosen is usually designed to expose the material to the most severe conditions associated with any particular climate. It should, therefore, be borne in mind that the severity of exposure in actual use is, in most cases, likely to be less than that specified in this International Standard, and allowance should be made accordingly when interpreting the results. For example, vertical exposure at 90° from the horizontal is considerably less severe in its effects on plastics than near-horizontal exposure, particularly in tropical regions, where the sun is most powerful at high zenith angles.

Surfaces facing away from the equator are much less likely to be degraded than equator-facing surfaces because they are less exposed to solar radiation. However, the fact that they may remain wet for longer periods may be of significance for materials affected by moisture.

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1 Scope

This International Standard specifies a method for exposing plastics pipes and fittings, individually or assembled, or as pieces therefrom, to natural weathering in order to assess changes.

NOTE 1 The exposure is considered appropriate for evaluating components subject to yard storage prior to installation and use without further exposure to direct weathering, and is quantified to promote rationalization of exposure doses and comparability of data.

NOTE 2 For exposures appropriate to tropical or equatorial conditions, attention is drawn to ISO 877.

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 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 877:1994, *Plastics — Methods of exposure to direct weathering, to weathering using glass-filtered daylight, and to intensified weathering by daylight using Fresnel mirrors*

ISO 2818, *Plastics — Preparation of test specimens by machining*

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

3 Principle

Test pieces, comprising all or part of a pipe section, a fitting or a jointed assembly, are mounted on a rack under specified conditions and directly exposed to natural weathering until a given minimum total solar radiant exposure per unit area has been received.

Climatic conditions and incident radiation are monitored and reported during the exposure period in accordance with this International Standard or the referenced standards.

If necessary (see Note 1), additional, comparable, test pieces are tested to establish initial values for one or more properties and/or are stored under protected conditions before testing to enable comparison of the property or properties with and without weathering.

NOTE 1 Additional test pieces are unnecessary if the data required can be obtained only from exposed test pieces, e.g. by comparison of quantitative colour measurements before, during and/or after exposure or colour comparisons between masked and unmasked zones on the test piece.

NOTE 2 It is assumed that the following test parameters are set by the standard making reference to this International Standard:

- a) if applicable, the ambient parameters to be recorded (see 4.2.2);
- b) the size, shape and method of preparation of test pieces (see 5.1);
- c) the number of test pieces to be exposed to weathering and, if applicable, to be stored as control test pieces (see 5.2 and 6.1);
- d) if applicable, the sampling procedure to be used (see 5.3);
- e) the solar energy per unit area (see 6.2);
- f) the alignment of the pipe axes (see 6.2);
- g) the frequency and method of cleaning (see 6.3);
- h) if applicable, details of the property(ies) to be measured and the method of measurement, in accordance with the referring standard, and whether or not any shaped profiles (see 6.5) should be prepared before or after exposure (see 5.1 and 5.2).

4 Apparatus

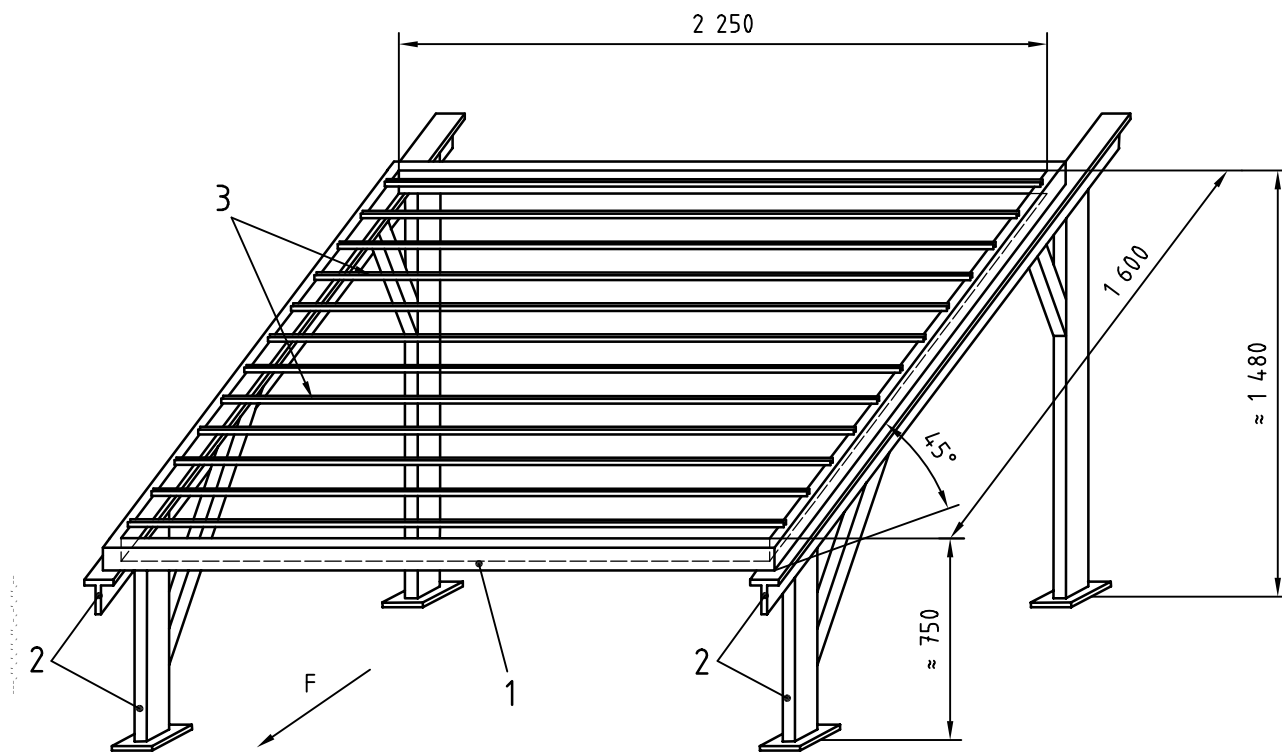
4.1 Test piece support rack

The rack shall conform to ISO 877 for the construction requirements and location of a rack having the following characteristics selected from ISO 877:

- a) it shall be constructed from inert materials which shall not affect the test results (see ISO 877:1994, Subclause 5.1);
- b) it shall be capable of supporting test pieces (see Clause 5) such that the exposed surface of the test piece is at 45° to the horizontal, facing the equator;
- c) there shall be no obstructions, including adjacent racks, in an easterly, westerly or equatorial direction, subtending a vertical angle greater than 20°, or in a polar direction an angle greater than 45°;
- d) it shall have mounting fixtures that are secure but apply as little stress as possible to the test pieces and permit shrinkage, expansion or warpage to occur without constraint greater than would apply in normal service or necessary to prevent sagging during exposure, at the same time preventing rotation of the test pieces.

An example of a rack for exposing pipe test pieces with typical dimensions is shown in Figures 1 to 3.

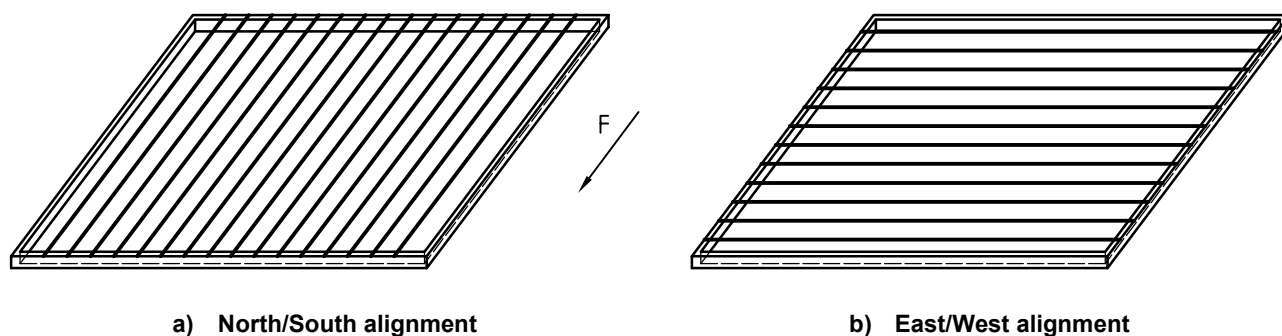
Dimensions in millimetres



Key

- 1 removable rack, 1 600 mm × 2 250 mm
- 2 support for rack
- 3 removable carrier bars
- F to the equator

Figure 1 — Typical exposure rack for plastics pipes



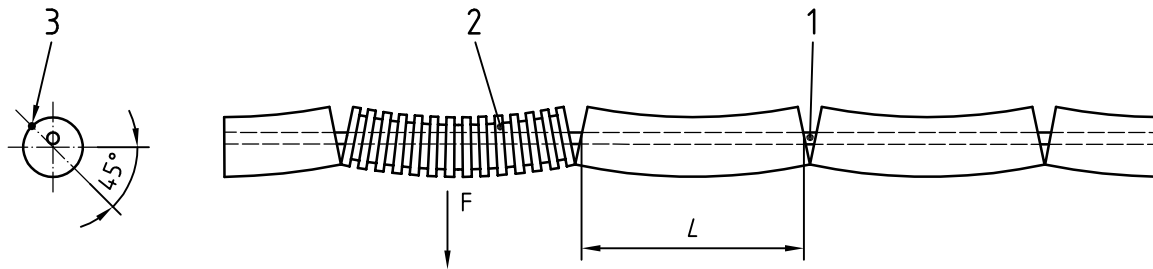
a) North/South alignment

b) East/West alignment

Key

- 1 removable rack, 1 600 mm × 2 250 mm
- F to the equator

Figure 2 — Schematic test arrangements



Key

- 1 removable carrier bars
 - 2 test piece
 - 3 crown (centre of exposed surface) of test piece with East/West support
- F to the equator
 L 200 mm

Figure 3 — Mounting of test pieces

4.2 Apparatus for measurement of climatic factors

4.2.1 Solar radiation

The test site shall be equipped with instruments conforming to ISO 877:1994, Subclause 5.5.1, or equivalent, capable of recording and measuring the total received solar radiant exposure of the test pieces cumulatively to an accuracy of 5 %.

The instruments used to measure radiant exposure shall be mounted on fixtures that are closely adjacent to the exposure rack area. The solar irradiance shall be measured with a pyranometer (see ISO 877:1994, Subclause 5.5.1.1), with the plane of its receiver mounted parallel to the plane of the exposure test rack, i.e. at 45°. The solar irradiance shall be recorded and integrated to give the solar radiant exposure in joules per square metre for each exposure stage. Care shall be exercised to ensure that no objects are permitted to reflect disproportionate amounts of sunlight onto the receiver, and to ensure that the pyranometer's foreground matches that of the exposure test pieces as closely as possible. The pyranometer glass dome shall be cleaned at least weekly with distilled or deionized water and dried with a soft lens-type tissue.

NOTE Alternatively, reference can be made to the data from a local metrological centre, providing correlation with the test site has been demonstrated.

4.2.2 Ambient conditions

If comparative records of other ambient parameters are required by the referring standard, the test site, or a nearby climatically comparable weather station, shall be equipped with instruments capable of measuring at least the following:

- a) daily maximum and minimum levels of air and/or test piece temperature, to the nearest degree Celsius;
- b) daily maximum and minimum levels of relative humidity, to within 5 % RH;
- c) total monthly amounts of rainfall, to within 10 mm.

4.2.3 Climate classification

The climate at the location of the apparatus shall be described using the applicable classification in accordance with ISO 877:1994, Annex B.

5 Test pieces

5.1 Preparation of test pieces from pipes and fittings

The size and shape of the test piece(s) shall be as specified in the referring standard, depending upon the property(ies) to be measured.

In the absence of such guidance, for pipes the test piece as exposed shall comprise a complete section about 1 m long, and for fittings the test piece as exposed shall comprise a complete fitting and for joints the test piece as exposed shall comprise a complete joint.

Except for obtaining initial values prior to exposure, any shaped profiles (see 6.5) for obtaining comparative values for exposed and non-exposed test pieces shall be prepared after the same period of time, i.e. all before or all after the relevant exposure stage.

Any necessary machining of test pieces, from the wall of a pipe or fitting, shall be done in accordance with ISO 2818, as applicable, and any preconditioning necessary to enable such machining shall be recorded. For components of composite structure, such test pieces shall be cut from the component, or a part thereof, after exposure or shall have sealed edges, to avoid inducing spurious interlaminar damage, unless weathering effects on the cross-section are to be incorporated into the assessment of the results.

5.2 Number of test pieces

The number of test pieces for each set of test conditions (see Clause 6) shall be as specified in the referring standard, if applicable, and otherwise shall be at least that specified in the appropriate test method for the property or properties to be measured after exposure.

The total number of test pieces required shall be determined by any necessity for establishment of initial values, if the test method is destructive, and any necessity for establishment of values on control samples maintained without exposure to weathering.

NOTE For determination of mechanical properties, it is recommended that the number of test pieces exposed be increased as appropriate (typically doubled) relative to that required by the test method concerned, to compensate for any greater standard deviation in the data for the property from weathered test pieces.

5.3 Sampling

Sampling to obtain samples for use as, or sources of, test pieces shall be carried out as specified by the referring standard, if applicable, and otherwise samples comprising the thinnest wall section within a random range of diameters shall be selected from a product range.

6 Procedure

6.1 General

Identify the relevant test pieces and, if applicable, obtain initial data measurements and store any control samples or test pieces in the dark and any applicable standard atmosphere in accordance with the referring standard and/or test method.

6.2 Exposure

6.2.1 Identify each test piece on the rear face relative to its mounting on the rack by indelible marking of a type and/or in an area that will not affect the results of subsequent tests.

6.2.2 Mount and expose the test pieces in accordance with ISO 877:1994, method A, so that the crown of the test piece is exposed at a 45° angle of tilt from the horizontal, facing the equator (see Figures 1 and 3).

For pipes, unless otherwise specified in the referring standard (see the Note), the pipe axis shall be aligned with either the North/South axis or the East/West axis. The crown of the test piece shall comprise the line passing through the uppermost point of each cross-section along the test piece in the case of alignment with the North/South axis.

If the pipe is aligned with the East/West axis, the crown of the test piece shall comprise the line on the exposed surface corresponding to the section radii at 45° to the horizontal (see Figure 3). When the test piece is positioned in the rack, it shall be marked so that a check can be made to ensure that rotation has not occurred.

NOTE For pipes with external profiles which would give rise to persistent shadows in a North/South alignment, it may be more appropriate to align the pipe axis with the East/West axis [see e.g. Figure 2b)].

6.2.3 During exposure, determine and record the following climatological data:

- a) temperature and relative humidity, if required (see 4.2.2):
 - monthly mean of daily maxima,
 - monthly mean of daily minima,
 - monthly maximum and minimum;
- b) solar radiation: total received solar radiant exposure (irradiation), in gigajoules per square metre, monthly;
- c) precipitation (rainfall): total monthly amount, if required (see 4.2.2);
- d) any other observations of conditions likely to affect the results, e.g. any atmospheric pollution or other contamination or interference with the test pieces.

6.2.4 Continue the exposure until the test pieces have received a total solar radiant exposure of not less than that prescribed by the referring standard.

NOTE 1 For exposures appropriate to tropical or equatorial conditions, attention is drawn to ISO 877.

NOTE 2 Time alone is not acceptable for quantifying the amount of natural weathering (see the Introduction).

NOTE 3 During periods of time when the test pieces are covered with snow and ice, no exposure will be received.

6.3 Cleaning of test pieces

Unless otherwise specified by the referring standard, clean the test pieces by using water and non-abrasive wipes or brushes prior to any testing, but not during exposure.

6.4 Monitoring of colour change

If the effects of exposure are to be monitored using assessment of colour change, the changes can be determined in accordance with ISO 4582 and using a grey scale conforming to ISO 105-A02 for determination of colour contrast, for example.

6.5 Testing

6.5.1 If specimens are to be removed from the exposed test piece for subsequent testing (e.g. tensile testing) after weathering, obtain at least one (set of) specimen(s) from the weathered crown of the test piece.

6.5.2 If complete weathered test pieces are to be subjected to subsequent localized testing (e.g. impact testing), select the test zone as that associated with the exposed surface of the test piece.

7 Test report

The test report shall include the following information:

- a) a reference to this International Standard and to the referring standard if applicable;
- b) test piece details, including:
 - 1) a full description of the sample(s) and its (their) origin;
 - 2) the shape and method of any preparation of the test piece(s);
 - 3) the number(s) of test pieces exposed;
 - 4) if applicable, the number(s) of test pieces tested without exposure;
 - 5) details of the shape and number of any specimens removed from test pieces, and whether or not these were exposed to natural weathering as individual specimens;
- c) test conditions, including:
 - 1) the exposure aspect of the test pieces (i.e. 45°, facing the equator);
 - 2) the location and details of the exposure site (e.g. longitude, latitude, altitude, annual climate characteristics: see 4.2.3);
 - 3) the nature of any support, masking or attachments used;
 - 4) details of marking applied to indicate the crown of the test piece as exposed;
 - 5) the method used for determining exposure and stages;
 - 6) details of washing, if any;
- d) details of the climatic conditions during the test, including:
 - 1) the total solar radiant exposure received, in gigajoules per square metre, and the dates of the beginning and end of the exposure;
 - 2) climatological data and origin, obtained in accordance with 4.2.1, 4.2.2, 4.2.3 and 6.2, if applicable;
- e) any factors which may have affected the test, such as any incidents or any operating details not specified in this International Standard.

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