
**Rigid cellular plastics — Spray-applied
polyurethane foam for thermal
insulation —**

Part 1:
Material specifications

*Plastiques alvéolaires rigides — Mousse de polyuréthane projetée
pour l'isolation thermique —*

Partie 1: Spécifications des matériaux



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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 8873-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 10, *Cellular plastics*.

This first edition of ISO 8873-1, together with ISO 8873-2 and ISO 8873-3, cancels and replaces ISO 8873:1987, which has been technically revised.

ISO 8873 consists of the following parts, under the general title *Rigid cellular plastics — Spray-applied polyurethane foam for thermal insulation*:

- *Part 1: Material specifications*
- *Part 2: Application*
- *Part 3: Test methods*

Introduction

ISO 8873 defines the requirements for rigid cellular plastic spray polyurethane foam when used as a thermal insulation in buildings and non-buildings.

This part of ISO 8873 specifies requirements for the physical properties of rigid cellular plastic spray polyurethane foam and lists the test methods to be used.

The designer has the responsibility for confirming that the physical properties provided by material manufactured to this part of ISO 8873 will conform to the requirements for a specific application.

Rigid cellular plastics — Spray-applied polyurethane foam for thermal insulation —

Part 1: Material specifications

WARNING — Persons using this document should be familiar with normal laboratory practice, if applicable. This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any regulatory requirements.

1 Scope

This part of ISO 8873 specifies minimum requirements and test methods for spray-applied polyurethane rigid cellular plastic, used as a thermal insulation for both building, whether applied on a building site or in a prefabrication (manufacturing) facility, and non-building applications. The material is also known as *in-situ* thermal insulation.

The spray-applied polyurethane rigid cellular plastic thermal insulation is not to be used when the continuous service temperature of the substrate is outside the range of $-60\text{ }^{\circ}\text{C}$ to $+80\text{ }^{\circ}\text{C}$.

The test methods used to determine the material properties provide a means of comparing different cellular plastic thermal insulations. They are intended for use in specifications, product evaluations and quality control. They are not intended to predict end-use product performance.

Spray-applied polyurethane rigid cellular plastics are to be applied (installed) in accordance with the manufacturer's instructions and the requirements of ISO 8873-2. Applications, requirements for applications and limitations of use are included in ISO 8873-2.

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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 844, *Rigid cellular plastics — Determination of compression properties*

ISO 845, *Cellular plastics and rubbers — Determination of apparent density*

ISO 1663, *Rigid cellular plastics — Determination of water vapour transmission properties*

ISO 1926, *Rigid cellular plastics — Determination of tensile properties*

ISO 2796, *Cellular plastics, rigid — Test for dimensional stability*

ISO 2896, *Rigid cellular plastics — Determination of water absorption*

ISO 4590, *Rigid cellular plastics — Determination of the volume percentage of open cells and of closed cells*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

ISO 8302, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

ISO 8873-2:—¹⁾, *Rigid cellular plastics — Spray-applied polyurethane foam for thermal insulation — Part 2: Application*

ISO 8873-3:—²⁾, *Rigid cellular plastics — Spray-applied polyurethane foam for thermal insulation — Part 3: Test methods*

ISO 10456, *Building materials and products — Hygrothermal properties — Tabulated design values and procedures for determining declared and design thermal values*

ISO 11561, *Ageing of thermal insulation materials — Determination of the long-term change in thermal resistance of closed-cell plastics (accelerated laboratory test methods)*

ISO/IEC 17024, *Conformity assessment — General requirements for bodies operating certification of persons*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

authority having jurisdiction

officer or officers having authority, under appropriate regulatory instruments, to exercise enforcement

3.2

certification organization

impartial body possessing the necessary competence and reliability to operate a certification system in accordance with ISO/IEC 17024, in which the interests of all parties concerned with the functioning of the system are represented

3.3

equipment manufacturer

manufacturer of equipment designed for spray-application of rigid polyurethane cellular plastic thermal insulation

3.4

***in-situ* thermal insulation**

thermal insulation product produced or taking its final form at the site of application and which achieves its properties after installation

3.5

spray-applied polyurethane foam

rigid cellular plastic material with substantially closed cell structure based on polyurethanes, which is foamed *in-situ* by the catalysed reaction of polyisocyanates and polyhydroxyl compounds, expanded with blowing agents

3.6

spray polyurethane foam contractor

individual, organization or corporation who is responsible for all requirements and obligations for the installation of the product

1) To be published.

2) To be published.

3.7**spray polyurethane foam installer**

individual or worker who applies the chemical components by mixing and spraying them to form the rigid cellular plastic spray polyurethane foam product

NOTE The installer is responsible for the actual installation and site requirements identified by the manufacturer and/or ISO 8873-2 for application of the product. The installer shall be trained, and qualified as having demonstrated the required knowledge for proper application of the product by a Certification Organization (CO). The installer shall follow the requirements for installation and the obligations for installers identified by the manufacturer and ISO 8873-2.

3.8**spray polyurethane foam system manufacturer**

manufacturer/supplier of the liquid chemical components, polyisocyanates and a polyhydroxyl blends containing also flame retardants, blowing agent and catalysts (system), which are designed to be mixed and sprayed to form rigid polyurethane foam insulation material *in situ*

4 Requirements**4.1 General requirements**

Rigid cellular plastic spray-applied polyurethane foam thermal insulation shall be applied by a spray polyurethane foam contractor using a spray polyurethane foam installer in accordance with ISO 8873-2 and the instructions given by the chemical manufacturer.

When applied, the polyurethane rigid cellular plastic thermal insulation shall not present a health hazard to the potential occupants nor shall the cured insulation have any residual odour.

Special applications may require properties other than, or in addition to, those specified in this part of ISO 8873. These properties, when agreed upon by the interested parties, may be added to the requirements of this specification.

When stored in accordance with the chemical manufacturer's instructions, applied in accordance with ISO 8873-2, and within the shelf life of the chemicals as declared by the manufacturer, the chemical components shall produce an insulation that meets the requirements of this part of ISO 8873.

4.2 Categories

Category IA: Suitable for non-load-bearing insulations that may not be exposed to weather, such as wall insulations, interior roof insulations and similar applications where the insulation is only required to be self-supporting, expanded with fluorocarbons and producing a predominantly closed-cell product.

Category IB: Suitable for non-load-bearing insulations that may not be exposed to weather, such as wall insulations, interior roof insulations and similar applications where the insulation is only required to be self-supporting, expanded with carbon dioxide and producing a predominantly semi-closed-cell product.

Category IC: Suitable for non-load-bearing insulations that may not be exposed to weather, such as wall insulations, interior roof insulations and similar applications where the insulation is only required to be self-supporting, expanded with carbon dioxide and producing a predominantly open-cell product.

Category IIA: Suitable for limited-load-bearing insulations that may or may not be exposed to weather, intended for surfaces carrying foot-traffic from maintenance personnel only, such as overdeck insulations or similar applications where elevated temperatures may be encountered and when compressive creep resistance is required, expanded with fluorocarbons and producing a predominantly closed-cell product.

Category IIB: Suitable for limited-load-bearing insulations that may or may not be exposed to weather, intended for surfaces carrying foot-traffic from maintenance personnel only, such as overdeck insulations or similar applications where elevated temperatures may be encountered and when compressive creep resistance is required, expanded with carbon dioxide and producing a predominantly closed-cell product.

5 Sampling

5.1 General

Random sampling shall be carried out by a third-party company according to provisions stipulated by the certification agency, purchaser or as described in this product specification.

Sampling shall be done by a third-party organization or as agreed to between the manufacturer and the purchaser.

For testing purposes, select at random an unopened container of each component material and store within the temperature range of 13 °C to 21 °C (or as specified on the containers) until a period of two weeks before the end of shelf life as declared by the manufacturer prior to the preparation of the sample panels. Unless otherwise specified, the frequency of testing and the number of sample panels shall be left to the discretion of the inspection authority.

5.2 Preparation of sample panels

Samples of rigid polyurethane cellular plastic thermal insulation panels that are representative of the end product shall be prepared by a spray polyurethane foam installer (as specified in 4.1). Specimens used for testing shall be cut from these sample panels using a band saw or similar equipment.

Unless otherwise specified in the test method, the sample panels shall be made by spraying the product onto a 16-mm thick polyethylene board (or other boards which, with the use of a release agent, will allow the skin of the material to be left intact) to achieve the manufacturer's declared foam density. All testing shall be conducted with specimens that all have the same density. A single batch (lot) of material shall be used to produce an entire set of sample panels required to produce individual specimens in the size required by the testing laboratory to conduct all of the tests. The finished sample panels shall have a nominal thickness of 60 mm [containing one external skin and a minimum of one internal skin but no more than three internal skins (pass lines)]. The ambient temperature in the area where the sample panels are produced and the substrate temperature shall be $(23 \pm 5) ^\circ\text{C}$ and the ambient relative humidity shall not exceed 80 %, unless otherwise specified and so reported. The size of the foam sample panels shall be a minimum of 1 m × 1 m.

The manufacturer shall use a single batch (lot) of material, which represents the material specification requirements used in their Quality Control Programme. All tests for the physical properties shall be carried out using foam specimens cut from the same sample panels, sprayed using a single batch (lot), which has been formulated and installed in order to represent the installed foam density required by the manufacturer.

5.3 Conditioning of sample panels

Unless otherwise specified, sample panels (with the polyethylene, or other, board still attached to the foam) shall be conditioned in accordance with ISO 291 for 48 h at $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \% \text{RH}$, or $(23 \pm 5) ^\circ\text{C}$ and $(50_{-10}^{+20}) \% \text{RH}$ prior to cutting and testing for physical properties.

5.4 Preparation of specimens

Specimens shall be cut from the sample panels described in 5.2 and conditioned in accordance with 5.3. All specimens cut from the sample panels shall have been produced from the same batch (lot) of material for all of the testing. Unless specified otherwise, specimens shall be 50 mm thick and shall contain one pass line (internal skin) within the specimen for all specimens required for testing purposes. All specimens shall be obtained from the conditioned sample panels by removing the foam specimen from the polyethylene (or other) board and cutting the specimen to the size required by the testing equipment. The one external skin [opposite to the polyethylene (or other) board] shall be removed to produce a flat specimen. The skin that was produced by the polyethylene (or other) board is to be left intact.

The testing laboratory shall check the flatness of the specimens to determine acceptability before using them. All measurements shall be determined in the "flat" position.

6 Test methods

6.1 Air permeance

Determine the air permeance in accordance with ISO 8873-3 on a 1 m × 1 m specimen. A minimum of five specimens should be tested over a range of six pressure differences from 50 Pa to 500 Pa. The air leakage rate at 75 Pa shall be taken from the linear regression line ($r^2 = 0,99$) of the 30 data points. The specimen for testing shall be prepared in accordance with Clause 5 and to the size outlined in ISO 8873-3.

6.2 Apparent core density

Determine the apparent core density in accordance with ISO 845 using at least five core specimens. The specimen used for apparent core density shall have all exterior skins removed and shall not contain more than three internal pass lines.

6.3 Compressive strength

Determine the compressive strength in accordance with ISO 844, using five core specimens measuring (150 × 150 × 50) mm each.

6.4 Dimensional stability

Determine the dimensional stability in accordance with ISO 2796, except that the conditioning time shall be 14 d at (23 ± 2) °C and (50 ± 5) % RH. Measure the dimensional changes after the 50-mm-thick specimens have been exposed to the following conditions (use at least three specimens for each exposure condition):

- 28 d at (−20 ± 3) °C, ambient humidity;
- 28 d at (80 ± 3) °C, ambient humidity;
- 28 d at (70 ± 3) °C, (97 ± 3) % RH.

Report the percentage change for all three dimensions obtained for each exposure. Express the results as a “plus %” when there has been expansion and as a “minus %” when there has been shrinkage.

6.5 Surface burning characteristics

Determine the surface burning characteristics of the insulation in accordance with requirements of the authority having jurisdiction.

6.6 Open-cell content: Volume

Determine the open-cell content volume as the average of the measurements according to ISO 4590 using three 25-mm³ core specimens.

6.7 Initial thermal resistance

Determine the thermal resistance for a 50-mm specimen in accordance with ISO 8301 or ISO 8302 at a standard mean temperature of 24 °C and a temperature differential of (23 ± 5) °C. Optionally, thermal resistance may be determined at other additional designated mean temperatures (−4 °C, 4 °C, 44 °C). In cases of dispute, use ISO 8301. Report the density of the tested specimens.

For the thermal resistance per unit thickness, determine the thermal resistance on at least three specimens 50 mm thick after 14 days at (23 ± 2) °C. Report the density of the tested specimens.

The design and declared thermal resistance shall be calculated in accordance with ISO 10456.

6.8 Long-term thermal resistance (LTTR)

Determine the long-term thermal resistance (LTTR) in accordance with ISO 11561.

When measuring the thermal resistance, the mean temperature shall have a temperature difference across the specimen of $(23 \pm 5) ^\circ\text{C}$.

This thermal resistance value shall be the design thermal resistance value for the purposes of energy calculations.

The LTTR value depends on the material thickness. The LTTR shall be determined and reported for 25-mm, 50-mm and 75-mm products. From the above data points, LTTR values can be determined for products from 12 mm to 100 mm. Other thicknesses may be tested and reported. The value determined shall meet the minimum requirement listed in Table 1.

Table 1 — Physical properties

Property	Unit	Requirements					Test method
		Category I			Category II		
		A	B	C	A	B	
Air permeance at 75 Pa	$\text{l}/(\text{s}\cdot\text{m}^2)$	0,02	Declared		0,02	0,02	ISO 8873-3
Apparent core density	kg/m^3	Declared					ISO 845
Compressive strength (min.)	kPa	100	80	—	170	170	ISO 844
Dimensional stability at	%						ISO 2796
–20 °C (max.)		± 1	± 1	—	± 1	± 1	
80 °C (max.)		± 5	± 5	—	± 5	± 5	
70 °C, (97 ± 3) % RH		± 10	± 10	—	± 10	± 10	
Surface burning characteristics: flame spread		Declared					Determined by authority having jurisdiction
Open-cell content (max.)	%	15	60	—	15	15	ISO 4590
Initial thermal resistance: 50-mm specimen 14 d at $(23 \pm 2) ^\circ\text{C}$	$\text{m}^2\cdot\text{K}/\text{W}$	2,27	1,56	1,25	2,27	1,56	ISO 8301 or ISO 8302
Long-term thermal resistance (LTTR) for a 50-mm-thick specimen	$\text{m}^2\cdot\text{K}/\text{W}$	1,92	1,47	1,25	1,92	1,47	ISO 11561
Tensile strength	kPa	120	100	—	200	200	ISO 1926
Tensile adhesion	—	Cohesive failure in the foam					ISO 8873-1
Volatile organic emissions	—	Declared					Determined by authority having jurisdiction
Water absorption (max.)	% (by volume)	—	—	—	4	4	ISO 2896
Water vapour permeability	$\text{ng}/(\text{Pa}\cdot\text{s}\cdot\text{m})$	4,5	9,0	—	4,5	4,5	ISO 1663

NOTE The test methods used to determine the material properties provide a means of comparing different cellular plastic thermal insulations. They are intended for use in specifications, product evaluations and quality control. They are not intended to predict end-use product performance.

6.9 Tensile strength

Determine the tensile adhesive strength in accordance with ISO 1926, using a minimum of five specimens perpendicular to the flat insulation surface.

6.10 Substrate adhesion

Bond a circular metal plate, approximately 50 mm in diameter and equipped with a hook, with a suitable resinous or polymeric adhesive, to the clean, dry surface of the foam which has been sprayed onto 12,5-mm plywood. Make a circular cut around the outside of the plate through the full thickness of the foam, perpendicular to the substrate. After the recommended cure time of the adhesive, gradually apply a tensile force, using a commercially available adhesion tester, through the hook, perpendicular to the substrate, until failure occurs. Note the mode of failure, whether at the substrate or internally in the foam, and at what force the failure occurred. When failure occurs between the adhesive and the spray polyurethane foam or the foam and the substrate, repeat the test.

The adhesion of the foam shall be deemed adequate if failure occurs by cohesive failure within the foam (see Note) rather than by delaminating from the substrate, interlaminar adhesive failure or failure of the adhesive bonding of the testing device to the cellular plastic.

NOTE "Within the foam" means not nearer to the substrate or interlaminar bonding than about 1 mm.

6.11 Volatile organic emissions

For formulations intended for use in inhabited spaces, the volatile organic compound emissions from the applied cellular plastic shall be tested and health hazards evaluated in accordance with the appropriate methods selected by following the guidelines given in ISO 8873-3. The authority having jurisdiction shall determine the acceptable limits.

6.12 Water absorption

Determine the water absorption in accordance with ISO 2896 (96-h immersion method), using at least three specimens (150 × 150 × 50) mm each.

6.13 Water vapour permeability

Determine the water vapour permeability using a core specimen of (25 ± 3) mm thickness, in accordance with ISO 1663 at 23 °C and a relative humidity gradient from 0 % to 50 %, or at 38 °C and a relative humidity gradient from 0 % to 88,5 %.

7 Reporting requirements

Test data shall be reported in the form of a table with property, result and pass/fail columns, including results for all properties listed in this part of ISO 8873, followed by a statement on whether the product met the requirements of this part of ISO 8873. Other optional properties may be tested and reported in a similar manner if requested by the manufacturer or supplier.

In addition to the information specified in the individual test methods, all reports describing the testing of the thermal insulation in accordance with this part of ISO 8873 shall include the following information:

- a) chemical manufacturer's name, address, production facility address and product designation;
- b) type and name of the product and other product description;
- c) lot number and date of manufacture;
- d) information about sampling;
- e) description of thermal resistance test apparatus, calibration standards used and their source;
- f) name and location of the laboratory performing the tests and the accreditation agency for the laboratory;
- g) a report of all test results according to the test methods and apparent core density of the specimen;

- h) a summary of measured results compared to the requirements of this part of ISO 8873 with indication that the property has passed/failed;
- i) declaration of conformity with ISO 8873-1.

When follow-up testing is required, the agency conducting the sampling shall be identified and a statement included as to whether the method of sampling was unspecified and random.

An appendix to the report shall contain the data used to generate the above items.

8 Marking, labelling and packaging

8.1 Packaging

Unless otherwise specified, the liquid components shall be packaged in the manufacturer's standard containers or transported in bulk.

8.2 Marking and/or labelling

8.2.1 Marking for identification of manufacturer

Each manufacturer/supplier shall determine a means by which their product, after being sprayed, is easily and uniquely identified on the job site as being their product, which the manufacturer declares meets the requirements of this part of ISO 8873. (A manufacturer's marking could be a distinct ink colour added, or a material added to their system, which could be identified at the installation site.) Additional requirements for identification of the installed product by use of a job-site label are required by ISO 8873-2.

8.2.2 Labelling

Each liquid component container shall be clearly identified as either polyisocyanate component ("A") or resin component ("B"). Unless otherwise specified, each container shall be marked with

- a) manufacturer's name,
- b) product name,
- c) type of material (e.g. IA),
- d) net mass of the contents of the packaged material,
- e) country of manufacture,
- f) lot number,
- g) date of manufacture,
- h) "use before" date,
- i) the means to identify the installed product, and
- j) ISO 8873-1.

9 Manufacturer's documentation

The manufacturer (supplier) shall provide the spray polyurethane foam contractor with, as a minimum, the following:

- a) a description of the chemical components including their properties;
- b) a material safety data sheet for each component;
- c) instructions for safe handling, use and disposal of the chemical components;

- d) type of operation of the spray equipment and operation parameters;
- e) ambient temperature limitations at application;
- f) temperature, type and preparation of substrate;
- g) physical properties of the insulation;
- h) limitations for use of the insulation;
- i) shelf life of the components, and
- j) method used by the manufacturer to identify the installed spray polyurethane foam insulation on site that the manufacturer declares meets the requirements of this part of ISO 8873.

