
**Paints and varnishes — Coating
materials and coating systems for
exterior wood — Natural weathering test**

*Peintures et vernis — Produits de peinture et systèmes de peinture
pour bois en extérieur — Essai de vieillissement naturel*

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Published in Switzerland

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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 16053 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*. It is technically equivalent to EN 927-3.

This second edition cancels and replaces the first edition (ISO 16053:2004), which has been technically revised. The main changes are as follows:

- a) the dimensions of the test panel and the requirements for the wood used for the test panels have been changed;
- b) the requirements concerning the inclination of the growth rings relative to the exposed surface of the test panel have been changed;
- c) the measurement of the film thickness has been described more precisely;
- d) the assessment of the exposed test panels now also includes an assessment of their general appearance;
- e) the photographic rating scale for mould growth (Annex C in the previous edition) has been deleted and mould growth is now assessed in accordance with ISO 4628-1.

Paints and varnishes — Coating materials and coating systems for exterior wood — Natural weathering test

1 Scope

This International Standard specifies a natural weathering test for exterior wood coating systems mainly intended for decoration and protection of planed and sawn wood.

The test provides a means of evaluating the performance of a wood coating system during outdoor exposure. It forms the basis for the performance specification given in EN 927-2.

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 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 2409, *Paints and varnishes — Cross-cut test*

ISO 2431, *Paints and varnishes — Determination of flow time by use of flow cups*

ISO 2808:2007, *Paints and varnishes — Determination of film thickness*

ISO 2810, *Paints and varnishes — Natural weathering of coatings — Exposure and assessment*

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°*

ISO 4628-1:2003, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 1: General introduction and designation system*

ISO 4628-2, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 2: Assessment of degree of blistering*

ISO 4628-4, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 4: Assessment of degree of cracking*

ISO 4628-5, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 5: Assessment of degree of flaking*

ISO 4628-6, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 6: Assessment of degree of chalking by tape method*

ISO 7724-1, *Paints and varnishes — Colorimetry — Part 1: Principles*

ISO 7724-2, *Paints and varnishes — Colorimetry — Part 2: Colour measurement*

ISO 7724-3, *Paints and varnishes — Colorimetry — Part 3: Calculation of colour differences*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3 Principle

The resistance to natural weathering of the coating system under test, applied to a wood substrate, is assessed. Durability is evaluated by determining the changes in decorative and protective properties of coatings after 12 months of exposure.

The standard test substrate has been selected to be *Pinus silvestris* (European redwood or Scots pine, subsequently referred to as pine) in order to obtain relevant results more rapidly. Moreover, the sapwood, which is usually present in joinery timber, is used instead of heartwood because paint failure is more evident on the former.

Differences in quality of wood, and in the weather and site conditions, are recognized and allowed for in the method by comparing the test with a reference system. The composition of the reference system (designated the “internal comparison product” or “ICP”) is specified in Annex A.

The standard test substrate is pine sapwood with the rear side of the panel untreated. However, supplementary information on coating performance may be obtained by conducting optional tests on additional wood species, on pine modified or impregnated by industrial processes, by using a pine panel containing a water trap in its exposed face, or by coating the rear side of the panel.

Optional tests are described in Annex E. It is emphasized that they can serve only to provide additional information.

4 Apparatus and materials

4.1 Exposure racks, inclined at an angle of 45° to the horizontal, on which the specimens are facing towards the equator, in accordance with ISO 2810.

4.2 Glossmeter, for the measurement of specular gloss in accordance with ISO 2813, at 60° geometry.

4.3 Tristimulus colorimeter or spectrophotometer, for the measurement of colour and calculation of colour difference in CIELAB colour coordinates in accordance with ISO 7724-1, ISO 7724-2 and ISO 7724-3.

4.4 Tape and cutting tool, for the assessment of adhesion in accordance with ISO 2409.

4.5 Microscope, with a magnification of $\times 10$, for the assessment of surface defects.

4.6 Microscope, for the measurement of film thickness in accordance with ISO 2808:2007, method 6A.

4.7 Self-adhesive, transparent tape, in accordance with ISO 4628-6, for the assessment of chalking.

4.8 Climate chamber.

5 Sampling

Take a representative sample of the product tested, or of each product in the case of a multi-coat system, as described in ISO 15528.

Examine and prepare each sample for testing, as described in ISO 1513.

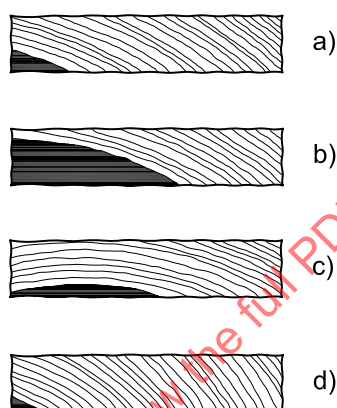
6 Test panels

6.1 Wood

The wood shall be pine that has been selected to be free from knots, cracks and resinous streaks, to be straight-grained and of normal growth rate (i.e. 3 to 8 annual rings per 10 mm). The inclination of the growth rings to the face shall be 5° to 45° (see Figure 1).

The wood shall be free from blue stain and evidence of surface or bulk fungal infection. Abnormal porosity (caused by bacterial attack) shall be avoided (see Clause B.10).

The wood shall be conditioned at $(20 \pm 2)^\circ\text{C}$ and a relative humidity of $(65 \pm 5)\%$ to an equilibrium moisture content of $(13 \pm 2)\%$.



The top of the panel is the exposed side, the bottom is the rear side.

- a) Example of a panel with heartwood which is not closer than 10 mm to the test surface (as required by 6.2) and fulfilling the requirement for growth ring orientation (5° to 45°) on the exposed side.
- b) This panel does not meet the specification because the heartwood is too close to the exposed side.
- c) This panel does not meet the specification because the growth ring orientation is not within the range 5° to 45° . The growth rings are inclined at -10° at the left-hand side of the exposed surface and at 30° at the right-hand side. Consequently, part of the surface contains wood cut at a tangent to the growth rings (growth ring inclination 0°), with considerable risk of crack formation.
- d) This panel does not meet the specification because the growth ring orientation is not within the range 5° to 45° . The growth rings are inclined at 45° at the left-hand side of the exposed surface but at 70° at the right-hand side.

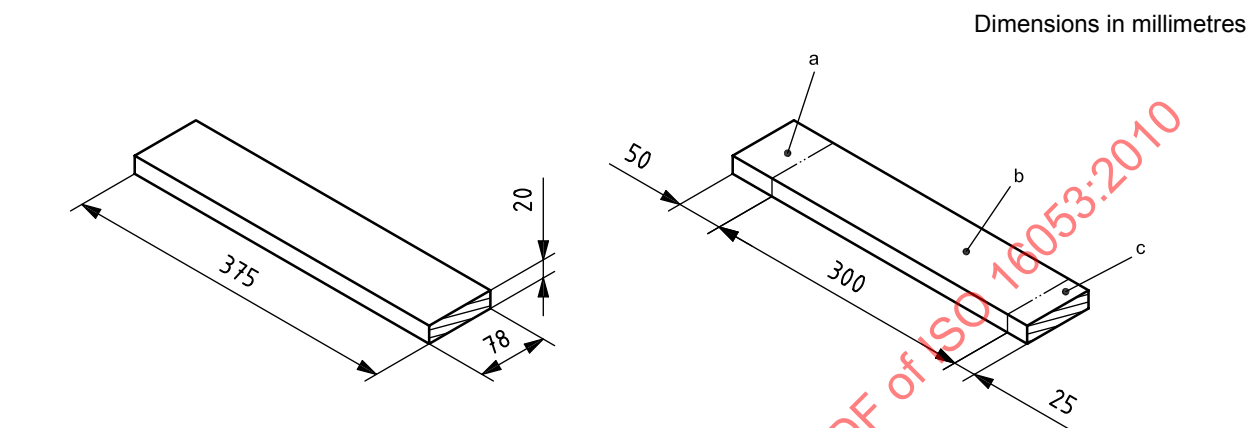
Figure 1 — Examples of acceptable and unacceptable panels (shown in cross-section)

6.2 Preparation and selection of wood panels

The panels shall be cut from boards planed all round and shall be nominally $(375 \pm 2) \text{ mm} \times (78 \pm 3) \text{ mm}$ and $(20 \pm 2) \text{ mm}$ thick. For details of panel preparation, see Figure 2. The panels shall be planed to a smooth and uniform finish. In order to avoid having an aged wood surface, the panels shall be hand-sanded (using 150-mesh sandpaper) immediately before coating. Rounding of edges is not permitted.

The panels shall be selected to give a sapwood test surface on the convex side of the growth rings, with any heartwood confined to a zone no closer than 10 mm from the front side. Heartwood shall be checked with the reagent described in Clause B.11, at both ends of each panel.

Any panels showing surface splitting shall be rejected. Where the presence of some minor defects in the test area is unavoidable, their position shall be noted and their influence excluded during assessment of coating performance.



Key

1, 2 and 3 exposure panels

R unexposed reference panel

a Sealed end (may be used for numbering of test panels).

b Section for application of coating system.

c Sealed end.

NOTE The figure is not to scale.

Figure 2 — Details of test panels

6.3 Preparation of coated panels

6.3.1 Wood conditioning

Prior to coating, condition the panels at $(20 \pm 2) ^\circ\text{C}$ and a relative humidity of $(65 \pm 5) \%$ until constant mass is reached. Keep the panels under the same conditions during drying of the coating system and during subsequent storage of the panels before exposure. Panels may be transferred for brief periods to other ambient conditions where this is required for the conduct of specific operations or assessments.

6.3.2 Preparation of panels for the test coating

For each system, select four panels on a random basis from the available supply. Three panels shall be used for exposure and the fourth shall be an unexposed reference panel.

Apply the coating system to the front and side faces of each panel. The front side of the panel is the side which was facing the bark of the tree. The rear of the panel and the end-grains shall be left uncoated.

Apply the coating system using the method specified by the manufacturer to give a wet film thickness corresponding to the mean value ($\pm 20\%$) of the manufacturer's recommended spreading rate.

Record the quantity of coating applied to each test panel and subsequently calculate a mean value for the four panels. The values should preferably be stated in g/m^2 , but may also be expressed as wet film thickness (in micrometres).

6.3.3 Preparation of panels for the internal comparison product (ICP)

Prepare four panels by applying the ICP (see Annex A) to the front and side faces of each panel. The rear of the panel and the end-grains shall be left uncoated. Apply the ICP by brushing in three coats, allowing a drying period of 16 h to 24 h between coats. The spreading rate shall correspond to a total of $(150 \pm 30) \text{ g/m}^2$ of wet film. The dry film thickness shall be $(50 \pm 10) \mu\text{m}$ on pine.

One set of ICP panels, exposed at the same time as the test coatings, may serve as the comparison for one or more test coatings.

6.3.4 Sealing and ageing

When the test coatings and ICP have dried, seal the ends of the panels thoroughly with at least two coats of a flexible, moisture-impermeable white paint, for example of the long-oil alkyd type, capable of withstanding 2 years of natural exposure without breakdown. This sealant may be applied by brushing or dipping. The sealant shall be applied to the bands marked "a" and "c" at the ends of the panel shown in Figure 2. It is important that the sealant be applied all round, i.e. that the front, sides, end-grains and rear face of the bands be coated.

After sealing, age the panels for approximately 7 days in the climate chamber (4.8) at $(20 \pm 2) ^\circ\text{C}$ and a relative humidity of $(65 \pm 5) \%$ before carrying out initial panel examinations.

Exposure shall start at the latest 28 days after completion of sealing.

6.3.5 Thickness of the coating

Determine the dry film thickness of the ICP and the test coating using the unexposed reference panels. Examine three small chips of coated wood removed from each reference panel by microscopy in accordance with ISO 2808:2007, method 6A. The three chips shall be removed at three different places spaced evenly across the panel width. Make five measurements on each of the three chips and calculate and record the mean value in micrometres.

The thickness is stated in micrometres and refers to the layer on (above) the wood surface. Systems can penetrate the wood material to some extent, but this part is not included in the determination.

7 Procedure

7.1 General

Carry out all examinations in accordance with Annexes B and C.

7.2 Examination before exposure

Before exposure carry out the following measurements:

- mass of coating system applied (by weighing);
- coating thickness (see 6.3.5);
- gloss;
- colour.

Assess the adhesion on the reference panel for the test coating and the ICP.

As wood is a natural material, unexpected defects might be detected in the coated panels just before exposure, even though the wood material has been selected, inspected and prepared in accordance with the requirements given in 6.1 and 6.2. If such panels, as an exception are exposed, the type, size and position of the defects shall be noted, so as to avoid any influence on the assessment after exposure.

For further details, see Annexes B and C.

7.3 Exposure

Expose three of the four panels, with their long edge horizontal and the 50 mm band to the left of the exposed face, for a period of 12 months, using the exposure racks (4.1). Record the starting and finishing dates.

Store the reference panels indoors at a temperature of $(20 \pm 2) ^\circ\text{C}$ and a relative humidity of $(65 \pm 5) \%$.

7.4 Examination after exposure

7.4.1 Examination on the exposure racks

At the end of the 12-month exposure period, examine the panels on the exposure racks and record any blistering. Move the panels from the racks to the laboratory and condition for 7 days at a temperature of $(20 \pm 2) ^\circ\text{C}$ and a relative humidity of $(65 \pm 5) \%$.

7.4.2 Laboratory examination of unwashed panels

Assess the panels for the following properties:

- flaking;
- cracking;
- mould growth;
- chalking;
- general appearance.

7.4.3 Laboratory examination of washed panels

After the first examinations (7.4.1 and 7.4.2), wash the panels by sponging with clean lukewarm water to remove surface deposits and atmospheric pollutants, and allow to dry.

Examine the coating on the reference and exposed panels for gloss and colour.

Examine the coating on the exposed panels for mould growth, adhesion and general appearance.

8 Precision

Precision data are not yet available. They will be included in a later revision.

9 Expression of results and test report

The test report shall contain at least the following information:

- a) all details necessary to identify the product tested, including the name and address of the manufacturer or supplier of the coating system tested and the name or other identification details of the coating system tested, including the batch number, a description of the coating system, the method and date of application, the coating thickness and the colour;
- b) a reference to this International Standard (ISO 16053);
- c) the name and address of the testing laboratory;
- d) the exposure site;
- e) the identification number of the test report;
- f) the name and address of the organization or the person who ordered the test;
- g) the method of sampling used, the date of sampling and the person responsible for the sampling;
- h) the date of receipt of the coating system tested;
- i) the exposure period (starting and finishing dates);
- j) any deviations from the test methods specified;
- k) the test results;
- l) the date of authorization of the test report.

An example of a suitable form is given in Annex D.

A copy of the test report together with the data sheets should be stored to comply with quality assurance requirements.

Annex A (normative)

Internal comparison product (ICP) alkyd stain

Component	Name	Supplier	Remarks	Amount % (by mass)
Alkyd	Synolac TM 6005 W	Cray Valley	65 % non volatile matter content	52,82
Pigment, red	Sicoflush TM L2817	BASF	40 % pigment in paste ^a	4,63
Pigment, yellow	Sicoflush TM L1916	BASF	40 % pigment in paste ^a	2,30
Rheological additive	Bentone TM 34	Rheox	10 % premix in white spirit (85 %), and ethanol (5 %)	0,60
Ca drier	Nuodex TM Ca 5 %	Servo	5 % calcium, non-volatile-matter content about 55 %	2,77
Co drier	Nuodex TM Co 10 %	Servo	10 % cobalt, non-volatile-matter content about 75 %	0,37
Zr drier	Nuodex TM Zr 12 %	Servo	12 % zirconium, non-volatile-matter content about 45 %	0,30
Biocide	Preventol TM A5	Bayer	Powder (90 % active ingredients)	0,72
HALS ^b	Tinuvin TM 292	Ciba-Geigy		0,45
Antiskin	Exkin TM 2	Servo	Methyl ethyl ketoxime	0,20
Solvent	Varsol TM 40	Exxon		34,84
Total % (by mass)				100,00
^a Particle size $\leq 10 \mu\text{m}$. ^b Hindered-amine light stabilizer (free-radical quencher).				

The following properties and values should be checked by the manufacturer.

Density: 0,90 g/cm³ to 0,91 g/cm³.

Viscosity: 33,5 s, determined with a 4 mm flow cup as specified in ISO 2431, which corresponds to a kinematic viscosity of 39 mm²/s.

Colour: Apply the ICP with a wet film thickness of 90 μm on the non-absorbing side of a LenetaTM card. After 24 h of drying, determine the colour as described in Clause B.2. The following values are guidelines for final colour:

$L \approx 56$

$a \approx 42$

$b \approx 52$

Add the ingredients in the order given and follow good manufacturing practice.

Record the date of manufacture on the containers.

Store in well sealed containers and use within 2 years of manufacture.

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Annex B (normative)

Details of test methods

B.1 Gloss and change in gloss

Measure the specular gloss in accordance with ISO 2813 using a glossmeter at 60° incident light angle. Determine the value for each area along the grain, i.e. with the light beam parallel to the grain. Obtain three measurements on separate areas along the length of the panel. Then displace the glossmeter to one side and obtain three measurements on adjacent areas with the light beam incident on the panel from the opposite direction. Take the mean of the six measurements obtained.

Calculate the mean values for the change in gloss of the three exposed panels, CG_{ex} , and of the unexposed reference panel, CG_{ref} , to one decimal place.

B.2 Colour and colour change

Measure the colour in accordance with ISO 7724-2 using the measurement geometry 45/0 or d/8 with specular component included (sci/spin). The geometry used shall be stated in the test report. Determine the CIE 1976 colour coordinates ($L^*a^*b^*$) for the standard illuminant D65 and the standard observer 10° for each panel as a mean of six single measurements.

Calculate the change in colour ΔE_{ab}^* of each of the three exposed panels and of the unexposed reference panel. Calculate the mean of the change in colour of the three exposed panels. State the final result to one decimal place.

B.3 Blistering

The assessment of the quantity (density) and size of the blisters is made on each exposed panel separately in accordance with ISO 4628-2.

Calculate and record the mean ratings for the quantity and the size to one decimal place.

B.4 Flaking

Assessment of quantity (density) and size is made on each exposed panel separately in accordance with ISO 4628-5, using a microscope of $\times 10$ magnification (4.5).

Calculate and record the mean ratings for the quantity and the size to one decimal place.

B.5 Mould growth

Assessment is made on each exposed area separately in accordance with ISO 4628-1, using a microscope of $\times 10$ magnification (4.5).

B.6 Cracking

The assessment of quantity (density) and size is made on each exposed panel separately in accordance with ISO 4628-4.

Calculate and record the mean ratings for the quantity and the size to one decimal place.

B.7 Chalking

The assessment is made on each exposed panel separately in accordance with the procedure described in ISO 4628-6. Take care to distinguish between chalking and dust.

Calculate and record the mean rating to one decimal place.

B.8 General appearance

The assessment is made on each exposed panel separately in accordance with ISO 4628-1:2003, Table 3, in comparison to the unexposed reference panels.

Calculate and record the mean rating to one decimal place.

B.9 Adhesion

B.9.1 General

The assessment is made on each exposed panel separately in accordance with the procedure described in ISO 2409.

B.9.2 Apparatus and materials

B.9.2.1 Cutting tool: Single-blade cutting tool with 20° to 30° edge and other dimensions as specified in ISO 2409.

B.9.2.2 Transparent pressure-sensitive adhesive tape, (25 ± 10) mm wide, with a minimum tensile strength of 200 N per 25 mm width and an adhesion of 6 N to 10 N per 25 mm width as specified in ISO 2409. The tape shall be stored at (20 ± 2) °C and a relative humidity of (65 ± 5) %.

B.9.3 Procedure

Perform the test twice on each exposed panel, recording the individual results without decimals. Calculate and record the mean value for each panel to one decimal place. Calculate and state the mean value for all three panels to one decimal place.

B.10 Test for abnormally porous wood

Abnormally porous wood can be detected qualitatively by the rapid absorption of a drop of propan-2-ol (isopropanol) applied to the surface; the drop should not be absorbed in less than 30 s by normal wood. Carry out the test at not less than six places widely separated on the rear face of the test panel.

B.11 Test for heartwood in pine

Heartwood content shall always be checked on the end-grain of both ends of each test panel using a fresh solution of, for example, Fast Red B salt (5 g/ml in deionized water) or Solid Blue Salt B (2 % in deionized water).

NOTE Fast Red B has no reported mutagenic or teratogenic effects; however, it should be treated as a suspected carcinogen. Reference should be made to up-to-date, relevant health and safety data sheets.

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Annex C

(normative)

Assessment requirements for panels of test coatings and ICP

Table C.1 — Assessment requirements for panels of test coatings and ICP

Panel designation (Test coatings and ICP)	Exposure panels			Unexposed reference panels
	1	2	3	R
Wood species	Pine			
Inspection^a				
Before exposure				
a) Spreading rate	x	x	x	x
b) Coating thickness				x
c) Gloss	x	x	x	x ^b
d) Colour	x	x	x	x
e) Initial defects	x	x	x	x
After exposure				
f) Blistering (on site)	x	x	x	x
g) General appearance	x	x	x	
h) Flaking	x	x	x	x
i) Cracking	x	x	x	x
j) Chalking	x	x	x	x
k) Mould growth	x	x	x	x
After exposure and washing				
l) General appearance	x	x	x	
m) Mould growth	x	x	x	
n) Gloss	x	x	x	x ^b
o) Colour	x	x	x	x
p) Adhesion	x	x	x	x
^a The inspections should preferably be carried out in the order indicated, a) to p). ^b The gloss measurement is repeated on the unwashed unexposed reference panel at the end of the exposure period (see Clause B.1).				

Annex D (informative)

Suggested format for a test report

Exterior wood coating system — Natural weathering test (ISO 16053 and EN 927-3)

TEST REPORT					
Test system:					
Classification in accordance with EN 927-1:					
Tested on: (substrate)					
Assignment: (job No., etc.)					
Tested for: (client)					
Tested by: (laboratory)					
Exposure site:					
Starting date:			Finishing date:		
Coat No.	Manufacturer	Trade name (or sample reference)	Description	Application method and date	Amount applied (mean value)
1					
2					
3					
4					
Application interval Coat 1-2 2-3 3-4					
Dry film thickness in μm (see 6.3.5)	Test system:				
Similarly for ICP	ICP: Manufacturer, batch number, production date				
Remarks:					

Exterior wood coating system — Natural weathering test (ISO 16053 and EN 927-3)

System: Internal comparison product (ICP)

Results:

Property	Wood species	Evaluation-scale test method	Reference panel	Results after 12 months of exposure			
				Individual values			Mean value
Change in gloss CG		ISO 2813					
Change in colour ^a DE		ISO 7724-3					
Blistering ^b BL		ISO 4628-2					
Flaking ^b FL		ISO 4628-5					
Cracking ^b CR		ISO 4628-4					
Chalking CH		ISO 4628-6					
Mould growth MG		ISO 4628-1					
Adhesion AD		Annex B of this International Standard					
General appearance GA		ISO 4628-1					
^a Measurement geometry: 45/0 or d/8.							
^b Only the quantity is considered for the performance specification in EN 927-2.							

Exterior wood coating system — Natural weathering test (ISO 16053 and EN 927-3)

System: Test system

Results:

Property	Wood species	Evaluation-scale test method	Reference panel	Results after 12 months of exposure			
				Individual values			Mean value
Change in gloss CG		ISO 2813					
Change in colour ^a DE		ISO 7724-3					
Blistering ^b BL		ISO 4628-2					
Flaking ^b FL		ISO 4628-5					
Cracking ^b CR		ISO 4628-4					
Chalking CH		ISO 4628-6					
Mould growth MG		ISO 4628-1					
Adhesion AD		Annex B of this International Standard					
General appearance GA		ISO 4628-1					

^a Measurement geometry: 45/0 or d/8.

^b Only the quantity is considered for the performance specification in EN 927-2.

Conclusion:

Signature:

Date:

The result of this test is only to be reproduced in full; extracts may only be published with the written permission of the testing laboratory.

Enclosed:

- Results in detail
- Photographs (optional)