INTERNATIONAL STANDARD

ISO 16925

First edition
2014-02-01

Paints and varnishes — Determination of the resistance of coatings to pressure water-jetting

Peintures et vernis — Détermination de la résistance des revêtements à un jet d'eau sous pression

Reference number
ISO 16925:2014(E)

COPYRIGHT PROTECTED DOCUMENT

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

Paints and varnishes — Determination of the resistance of coatings to pressure water-jetting

1 Scope

This International Standard specifies a test method for the assessment of the resistance of coatings to pressure water-jetting. The test method simulates the effects pressure water-jetting has on a coating.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 2808, *Paints and varnishes — Determination of film thickness*

ISO 4618, *Paints and varnishes — Terms and definitions*

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

ISO 17872, *Paints and varnishes — Guidelines for the introduction of scribe marks through coatings on metallic panels for corrosion testing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and the following apply.

3.1
fracture strength
force required to exceed the attachment forces

— between coats or between coat and substrate (adhesion) and/or

— within a coat (cohesion)

[SOURCE: ISO 16276-1:2007, 3.1]

3.2
adhesion
phenomenon of attachment at the interface between a solid surface and another material caused by molecular forces

Note 1 to entry: Adhesion should not be confused with cohesion.

[SOURCE: ISO 4618:2006, 2.6]

3.3
cohesion
forces that bind a film into an integral entity

Note 1 to entry: Cohesion should not be confused with adhesion.

Note 2 to entry: Breaks in cohesion can occur within the coating as well as the substrate. In case of breaks within the substrate, it is subsumed under the term material delamination.

[SOURCE: ISO 4618:2006, 2.54, modified — Note 2 to entry has been added.]

4 Principle

The resistance of a coated test specimen to the loss of adhesive strength is tested by means of defined pressure water-jetting.

The extent of the damage of the test specimen primarily depends on, besides the adhesive strength, the space between nozzle and test piece, the volumetric flow rate, the test time, the geometry of the nozzle, the impact area, the angle of impact, and the water temperature of the jet, as well as the cutting and scribing tool.

The evaluation is carried out by means of a visual comparison of pictures, in which characteristic values are related to the peeled-off areas.

The parting line (plane) of the peeling shall be indicated in the test report (e.g. substrate/priming coat).

5 Apparatus and materials

Ordinary laboratory apparatus, together with the following:

5.1 Pressure water-jet, consisting of a high-pressure pump and a nozzle.

A high-pressure pump conveys the water from a storage bin. To avoid influences from variations in pressure, it is necessary that the pressure and the volumetric flow rate be adjustable at the nozzle described below.

The water temperature shall be adjustable to ± 2 °C.

The temperature shall be adjusted in accordance with Annex A. Necessary safety devices on the pressure side of the unit, as e.g. pressure relief valve and by-pass valve, shall exist. If the jetting is unsteady, a flow calming section may be installed in front of the nozzle. A pulsation of the water jet at the opening of the pump is inadmissible. In order to reach a reproducible result, the nozzle shall be solidly mechanically fixed and the test specimen shall be secured against slipping. For the adjustment of the volumetric flow rate, a nozzle with a jet angle of 25° and a volumetric flow rate of 6 l/min at 2 MPa (20 bar) is required (see Annex A).

The following technical data should be attainable:

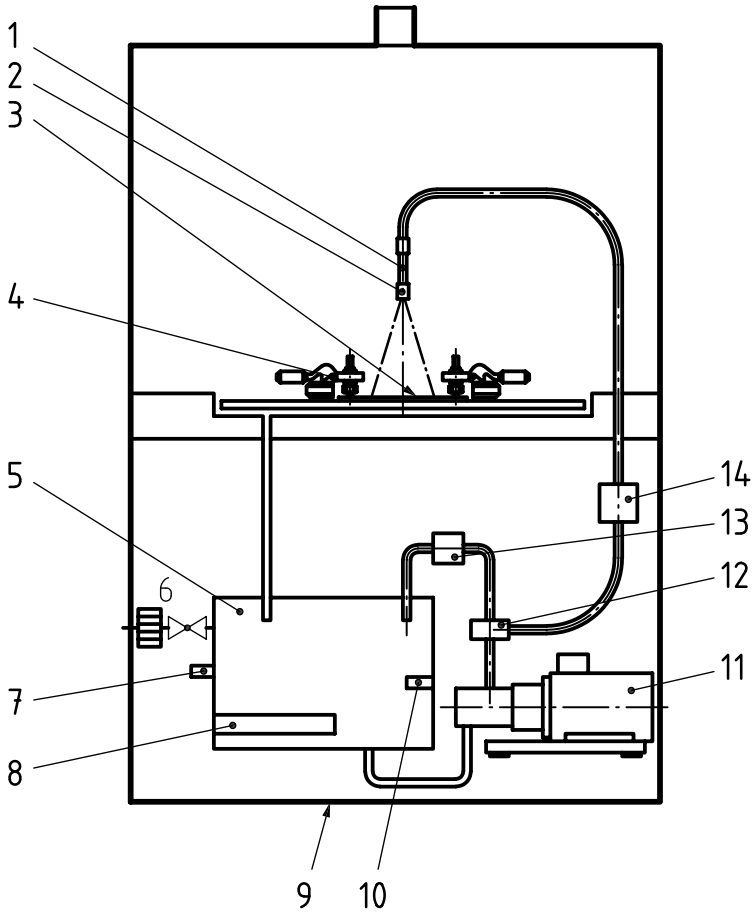
— volumetric flow rate: 8 l/min to 14 l/min

— pressure: 4 MPa (40 bar) to 13 MPa (130 bar)

— temperature: 20 °C to 80 °C

— jetting time: 10 s to 300 s

Figure 1 shows the schematic construction of a pressure water-jet apparatus which is specially built for these tests.



Key

1	flow calming section	8	heating
2	high-pressure valve, height adjustable	9	base frame, moveable
3	test specimen	10	temperature sensor
4	clamping element	11	high-pressure pump
5	feed tank	12	by-pass valve
6	floating valve with filter	13	pressure relief valve
7	water shortage safeguard	14	pressure transmitter

Figure 1 — Schematic construction of a pressure water-jet apparatus

5.2 Cutting or scribing tool, to be agreed by the interested parties.

The following cutting and scribing tools are appropriate: cutter knife ("C"), scribing tool according to van Laar ("L") or scribing tool according to Sikkens ("S"), in accordance with ISO 17872.

The tool should be safely usable.

5.3 Time measuring device (stopwatch).

6 Sampling

Take a representative sample of the product being tested in accordance with ISO 15528.

Examine and prepare each sample for testing in accordance with ISO 1513.

7 Preparation of test specimens

7.1 Test specimens

The test specimens should preferably be plane. The size of the test specimens as well as the number of tests shall be agreed by the interested parties.

Test specimens (building components) can have different adhesive strengths. It is recommended that different parts of the test specimen (building components) be tested.

7.2 Preparation and coating

The conditions of coating, drying/hardening, as well as stoving, shall be agreed.

Before testing, the coated test specimens shall be conditioned either 48 h at 60 °C or 7 days at room temperature. In case of conditioning at 60 °C, the specimen shall be cooled down to room temperature before the cut or scribe (see 8.1) is introduced.

7.3 Thickness of coating

Determine the dry film thickness of the coating, in micrometres, in accordance with one of the procedures specified in ISO 2808.

8 Procedure

8.1 Introducing the cut or the scribe

Make sure that the test specimen is securely fastened when introducing the cut or the scribe.

Introduce both of the cuts or scribes vertically through the coating into the substrate using the cutting or scribing tool, as shown in Figure 2. The depth of the cut or scribe into the substrate should be as minimal as possible. The length of the first cut or scribe shall be at least 100 mm, if the geometry of the part allows that. At an angle, introduce a second cut or scribe with a minimum length of 20 mm. The cuts or scribes shall be introduced straight-line at an angle of approximately 30°. An automatic cutting or scribing device may be used. Residues of the coating shall be removed from the cut or scribe.

NOTE The depth of the cut or scribe into the substrate influences the result.

The cutting or scribing tools should be checked regularly and replaced if necessary.

Dimensions in millimetres

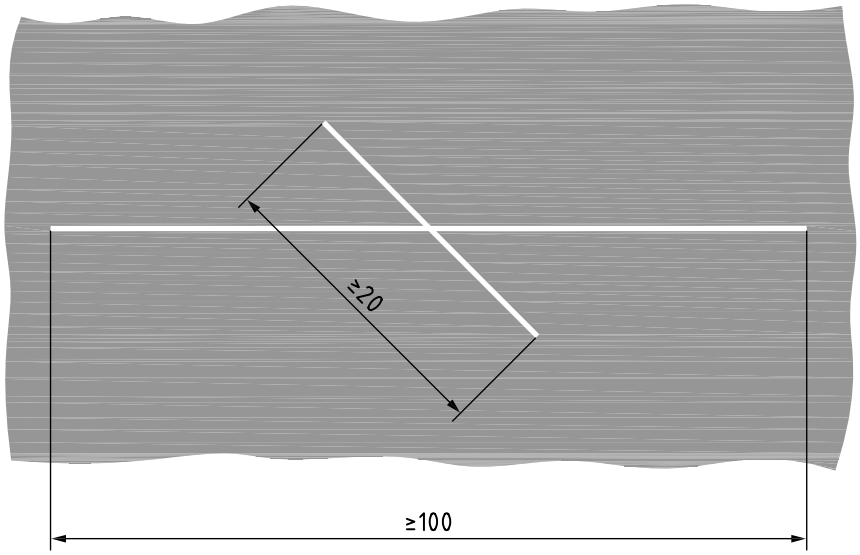


Figure 2 — Introducing the cuts or scribes (St Andrew's cross)

8.2 Testing

After inserting the test specimen into the apparatus (e.g. using a spacer block), calibrate the space between test specimen and nozzle.

Operate the pressure water-jetting apparatus at room temperature.

Three test methods (A, B, or C – see Table 1) are preferred as well as three possible scribing tools (C, L, or S – see 5.3). The test method to be applied, the scribing or cutting tool to be used, and the water pressure shall be agreed.

Table 1 — Test methods

Test method	Water temperature °C	Impact angle	Space between nozzle and sample mm	Flow rate l/min	Duration of jetting s
A	60 ± 2	90° ± 2°	100 ± 1	11,3 ± 0,2	30 ± 1
B	60 ± 2	90° ± 2°	100 ± 1	11,3 ± 0,2	60 ± 1
C	60 ± 2	90° ± 2°	130 ± 1	11,3 ± 0,2	60 ± 1

For jetting, deionized water should be used.

When using automatic and manual devices, fasten the test specimen so that the water jet impacts as shown in Figure 3. The jet impacts in the middle above the point of intersection onto the longer one of both cuts/scribes.

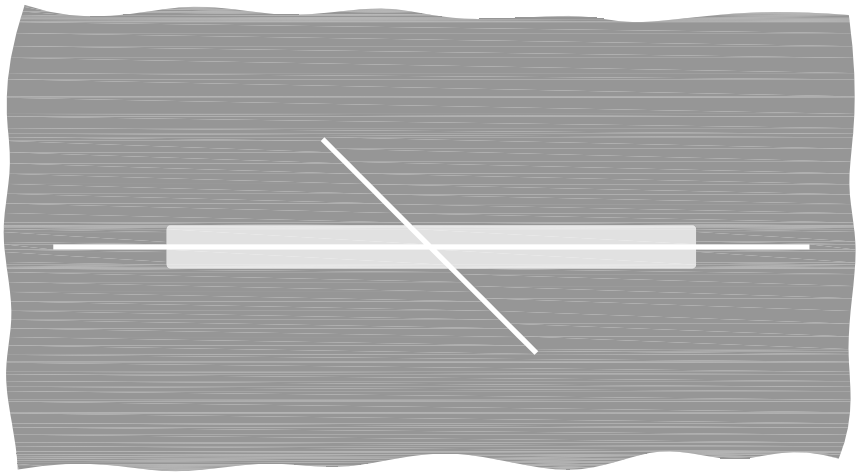


Figure 3 — Jetting area

9 Evaluation

9.1 General

Damage is recognizable when the coating loosens or flakes, regardless of which coat sustains the damage.

9.2 Evaluation with pictures to compare

Carry out the evaluation visually, comparing the specimen with the pictures.

In the course of the visual evaluation, a characteristic value is laid down by comparing with the illustrations in Figures 4 to 9. A characteristic value between 1 and 5 results, depending on the degree of damage. No damage corresponds to the characteristic value 0. In addition to the evaluation, if applicable, the attribution of the separation from the main separation level or to the respective film shall be indicated.

The result of the visual assessment is indicated in dependence of the applied method, for example:

— method A: characteristic value A;

— method B: characteristic value B;

— method C: characteristic value C.

NOTE In addition, by measuring the areas of flaking (maximum width, in millimetres, or area, in square millimetres), the overall damage can be evaluated. The overall damage is calculated by summing up all damaged areas of the test specimen. Even the smallest areas of flaking are measured and calculated, and all areas added to the overall damage.

10 Precision

10.1 General

The data regarding the repeatability and reproducibility limits have been determined in an interlaboratory test. Representatives of the automotive industry have been involved in the interlaboratory test.

The interlaboratory test aimed at determining the precision of the test method. As a standard substrate, polycarbonate/polybutylene terephthalate (PC/PBT) panels were coated with coating materials exclusively produced for this interlaboratory test. The interlaboratory test was conducted in accordance

with three different methods. In this International Standard, the data relative to precision were obtained by method A (see Table 1). The test panels were centrally produced. The St Andrew's cross was introduced into the coating with a defined new utility knife. Each participant conducted the testing with his own pressure water-jetting apparatus device. The test panels were visually assessed in comparison to the pictures (see 9.2). Also, the overall damage area was calculated (see 9.2, note).

The data relative to the repeatability limit and the reproducibility limit do not account for the influence of the preparation of test specimens (see Clause 7).

Deviations of precision can occur due to different substrates.

10.2 Repeatability limit (r)

The repeatability limit r is the value below which the absolute difference between two test results (each the mean of valid duplicates) can be expected to lie when this method is used under repeatability conditions. In this case, the test results were obtained on identical material by one operator in one laboratory within a short interval of time using the standardized test method. In this International Standard, the repeatability limit r is one characteristic value with a preset probability of 95 %.

10.3 Reproducibility limit (R)

The reproducibility limit R is the value below which the absolute difference between two single test results (each the mean of valid duplicates) can be expected to lie when this method is used under reproducibility conditions. In this case, the test results are obtained on identical material by operators in different laboratories using the standardized test method. In this International Standard, the reproducibility limit R is two characteristic values with a preset probability of 95 %.

11 Designation

The example below shows the designation of the test method in accordance with this International Standard.

EXAMPLE

Method A (in accordance with ISO 16925:2013, Table 1), with scribes introduced using a scribing tool according to Sikkens (S) (in accordance with ISO 16925:2013, 5.2):

Pressure water-jetting test ISO 16925:2013 — A — S

12 Test report

The test report shall contain at least the following information.

a) all details necessary to identify the tested coating (manufacturer, product designation, batch number, coating process, etc.);

b) a reference to this International Standard (ISO 16925:2013);

c) the type of substrate (manufacturer, product designation, batch number, injection moulding process, etc.) and preparation of surface;

d) the conditions of coating, drying/hardening or stoving as well as the ageing time and conditioning before the testing;

e) the test method, the cutting or scribing tool and the water pressure used (see 8.2);

f) the result of the test as indicated in Clause 9, including the parting line;

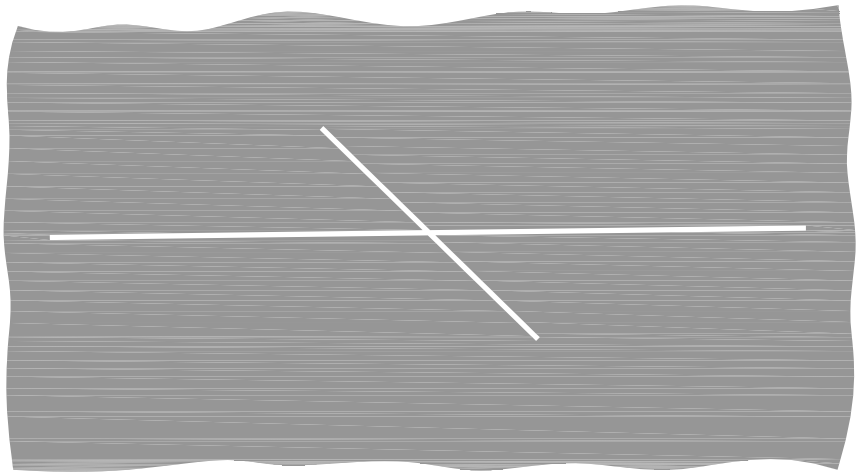
g) any deviation from the specified test method;

h) any special agreements between the interested parties, that are not included in c) and d);

i) any unusual features (anomalies) observed during the test;

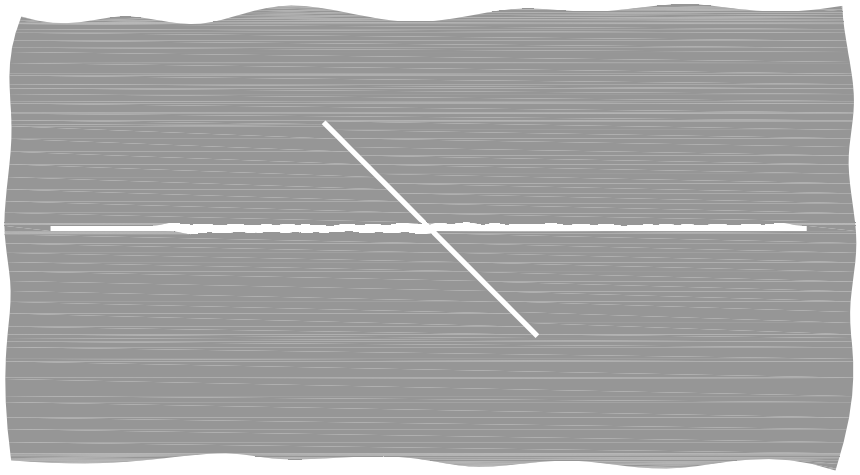
j) the date of the test;

k) the person who undertakes the test.

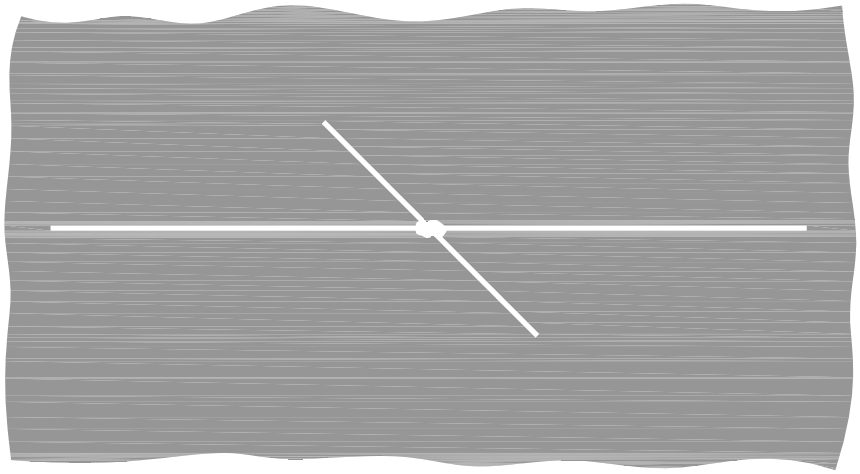


Characteristic value 0

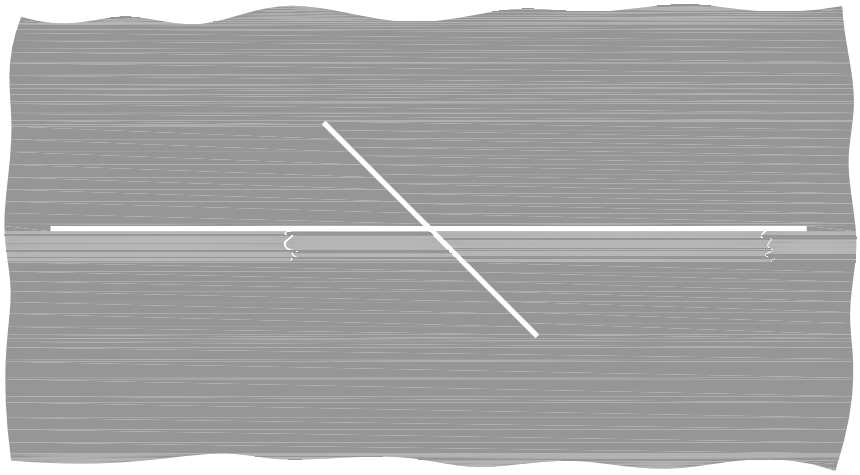
Figure 4 — Characteristic value 0 for pressure water-jet damage



a) Characteristic value 1a

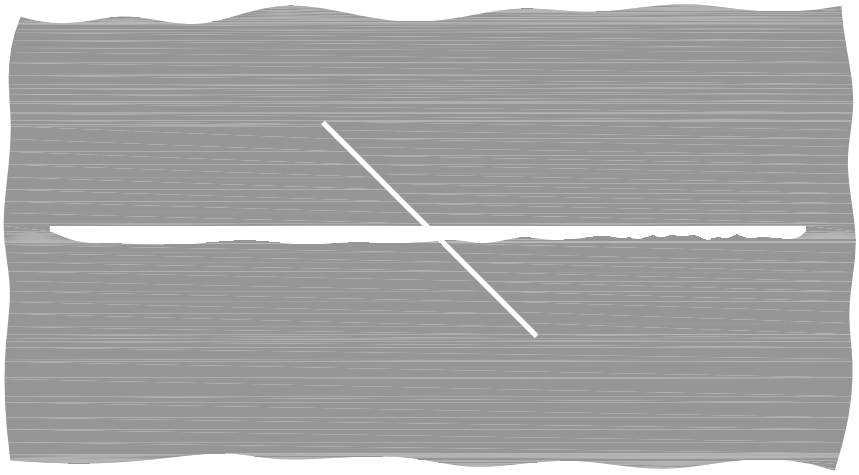


b) Characteristic value 1b

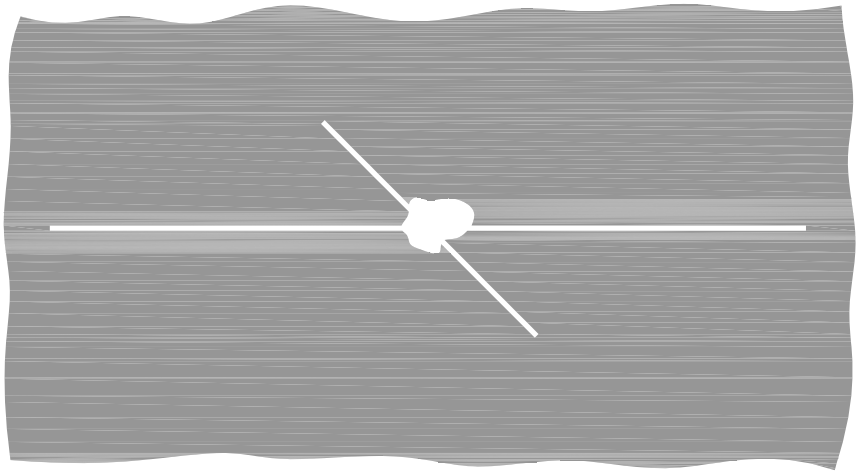


c) Characteristic value 1c

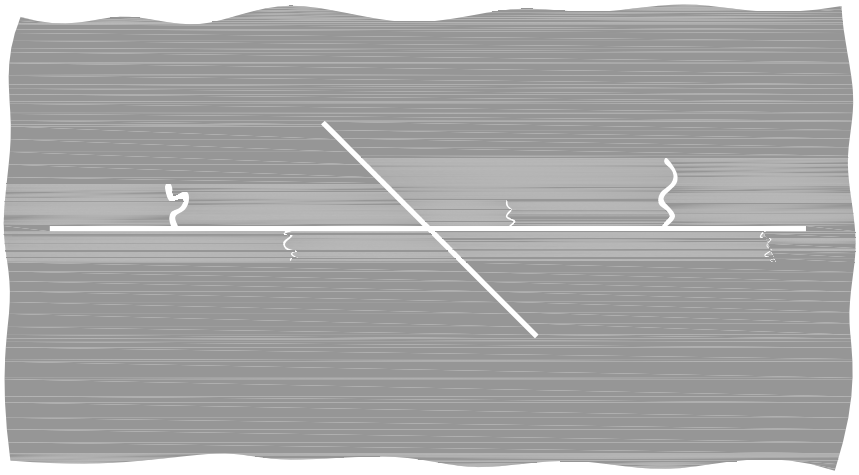
Figure 5 — Characteristic value 1 for pressure water-jet damage



a) Characteristic value 2a

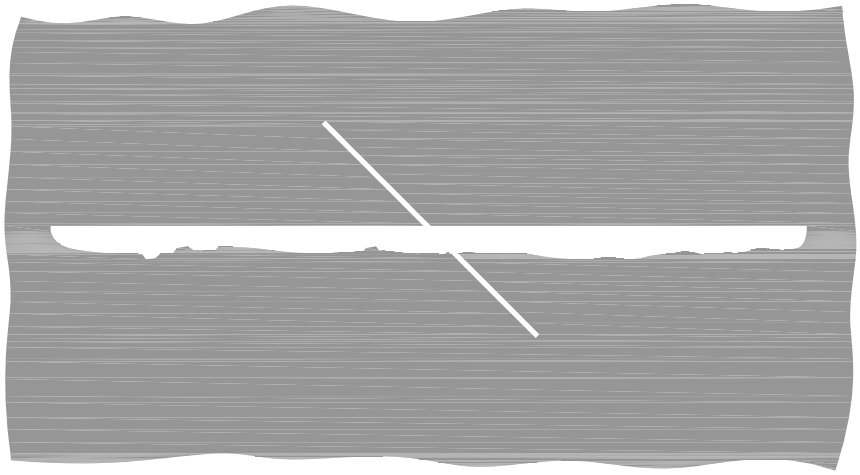


b) Characteristic value 2b

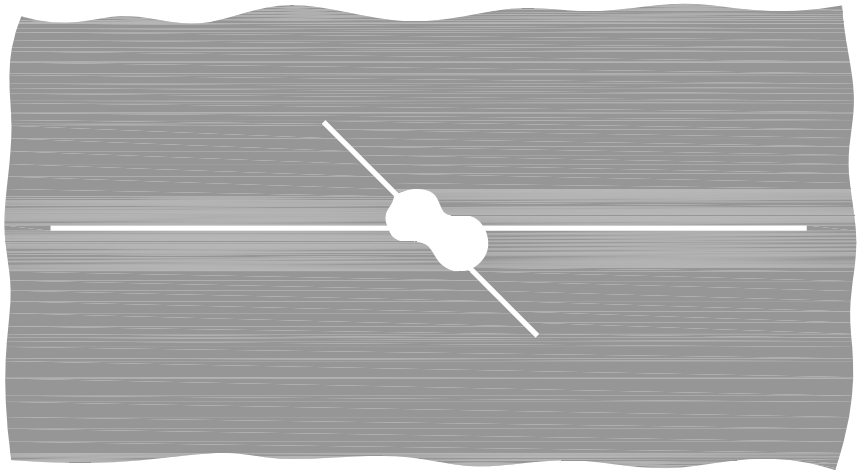


c) Characteristic value 2c

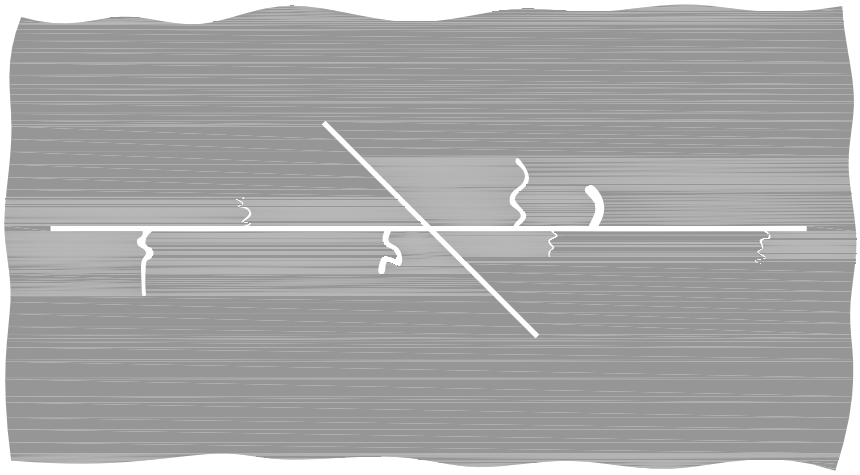
Figure 6 — Characteristic value 2 for pressure water-jet damage



a) Characteristic value 3a

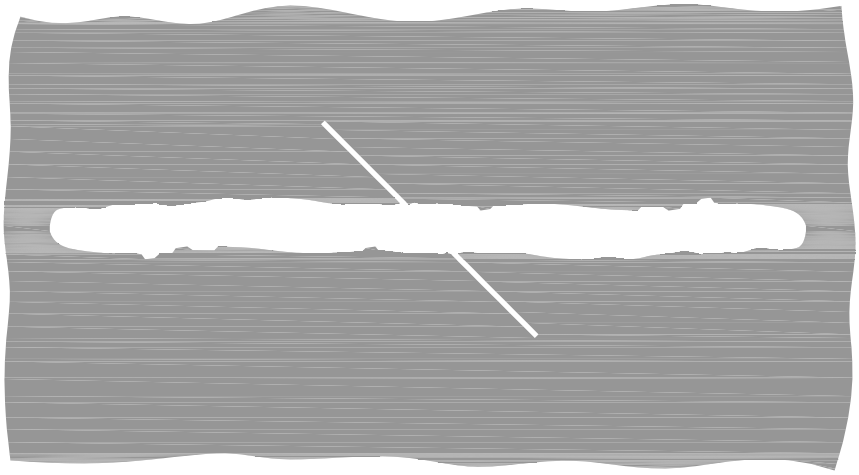


b) Characteristic value 3b

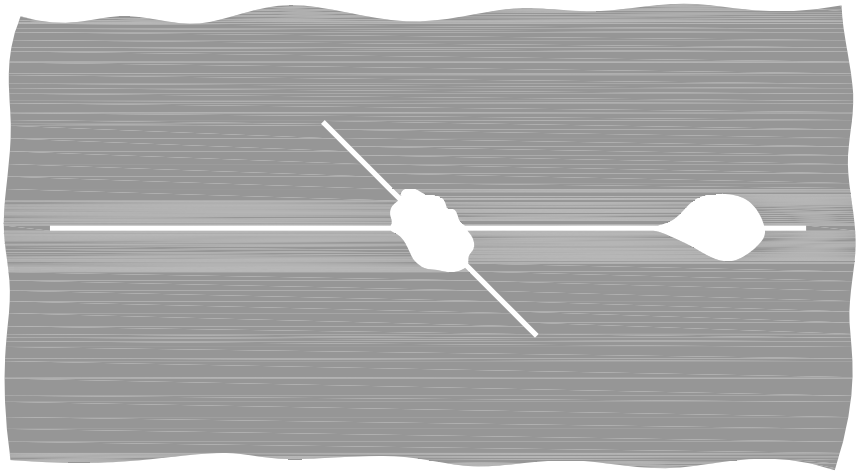


c) Characteristic value 3c

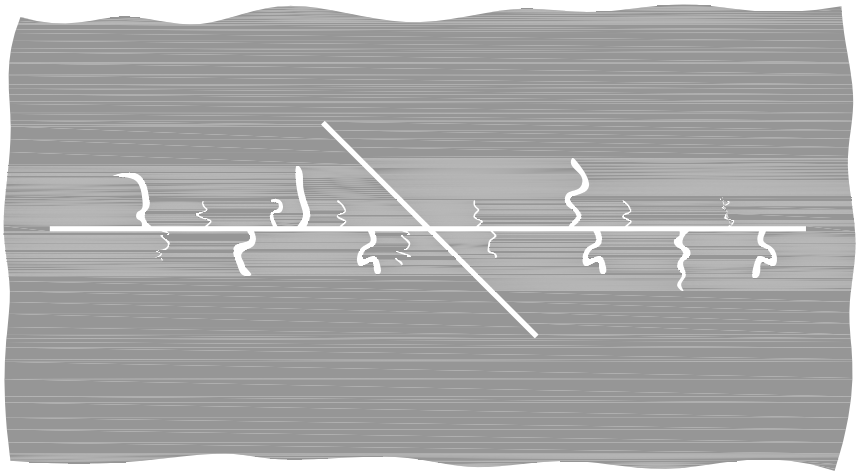
Figure 7 — Characteristic value 3 for pressure water-jet damage



a) Characteristic value 4a

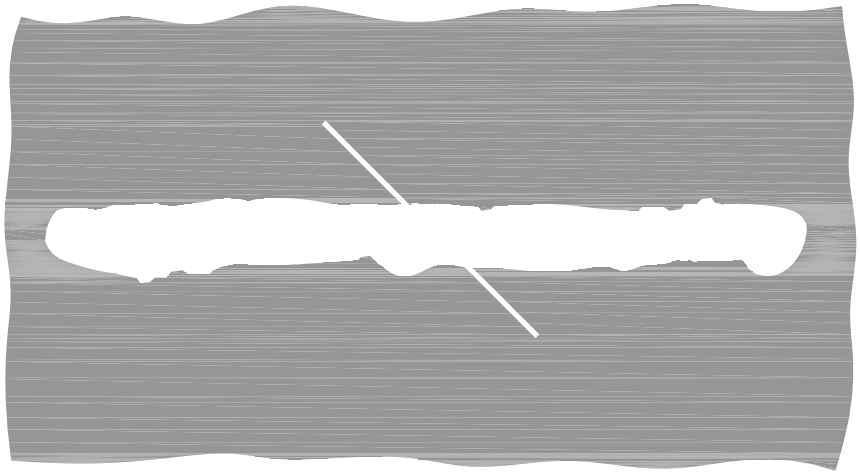


b) Characteristic value 4b

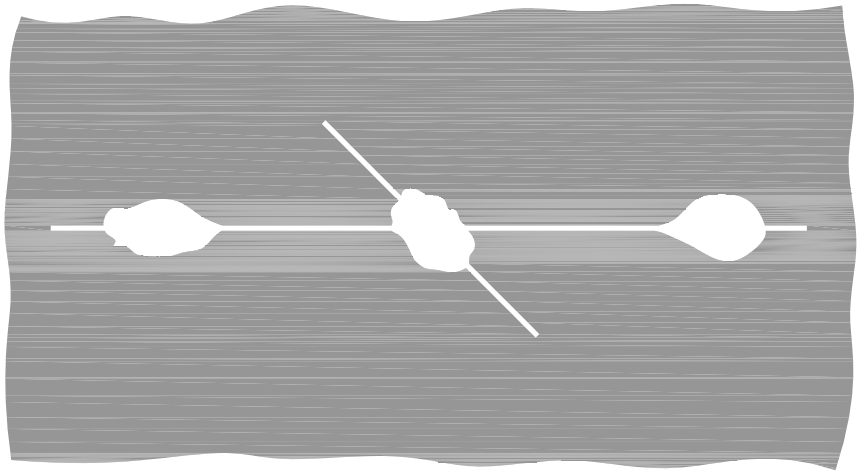


c) Characteristic value 4c

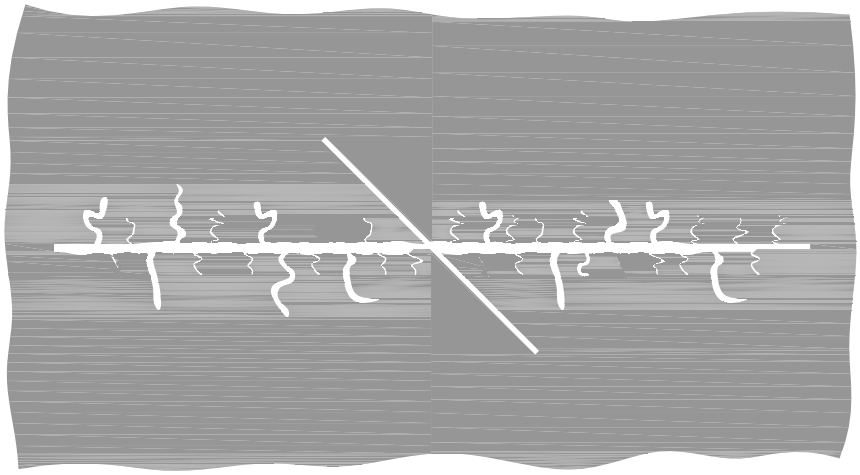
Figure 8 — Characteristic value 4 for pressure water-jet damage



a) Characteristic value 5a



b) Characteristic value 5b



c) Characteristic value 5c

Figure 9 — Characteristic value 5 for pressure water-jet damage

Annex A
(normative)

Calibration of the test apparatus

A.1 Apparatus and materials

Ordinary laboratory apparatus, as well as the following.

A.1.1 Temperature measuring device, with sensor, capable of measuring to 0,5 °C.

A.1.2 Balance, weighing to 10 g.

A.1.3 Time measuring device (stopwatch), capable of measuring ± 0,1 s.

A.1.4 Container, for the determination of the volumetric flow rate for at least 20 l of water.

A.1.5 Plastic block, made of polystyrene rigid plastic foam.

The kind of the polystyrene rigid plastic foam shall be agreed by the interested parties.

A.1.6 Length measuring device, capable of measuring ± 0,1 mm.

A.2 Procedure

A.2.1 General

For calibration, adjust the pressure water-jet apparatus in accordance with method B (according to 8.2).

A.2.2 Calibration of water temperature

Bring the pressure water-jetting apparatus to the operating temperature and let water jet for at least 1 min. Subsequently, let water jet for 1 min into a container containing the temperature sensor. Read off the temperature immediately. Conduct the determination in quintuplicate. The water temperature shall remain constant during the course of the calibration.

The water temperature shall be (60 ± 2) °C.

A.2.3 Calibration of volumetric flow rate

Calibrate the volumetric flow rate, q_V, in litres per minute, by differential weighing.

Determine the tare weight, m_0, of the container on the balance precisely to 10 g. Adjust the pressure water-jet apparatus in accordance with method B. Collect the water in the container entirely. Subsequently,

determine the mass of the container with the water, m_1, on the balance precisely to 10 g. The difference equals the mass of the collected water, m_2, as given in Formula (A.1):

$$m_2 = m_1 - m_0 \tag{A.1}$$

Since the water density, ρ_{water}, is approximately equal to 1,0 g/cm^3, the collected volume, V_{water}, is given by Formula (A.2):

$$V_{water} \approx m_2 \tag{A.2}$$

For a jetting time of 60 s (equal to 1 min), and given the relationship in Formula (A.3), it can be determined that the collected mass m_2 should equal the volumetric flow rate, expressed in litres per minute.

$$q_V = \frac{dV}{dt} \tag{A.3}$$

The volumetric flow rate shall be (11,3 ± 0,2) l/min.

A.2.4 Calibration of the water jet

The conditions for the calibration of the jetting are in accordance with method B. For the calibration of the jetting, a stainless steel precision flat film extrusion die with a volumetric flow rate of the nozzle of 6 l/min at 2 MPa (20 bar) and a jet angle 25° is used. This nozzle is required to produce an even liquid distribution during the entire jetting.

When using an automatic pressure-water apparatus, fasten the polystyrene rigid plastic foam in the apparatus so that the jet cannot move the block. When using a manual apparatus, fasten the block in a similar fixture.

After jetting, the length and the width of the impact are measured. See Figure A.1.

The mean length of the impact shall be (73 ± 5) mm and the mean width (8 ± 1) mm on average.

Dimensions in millimetres

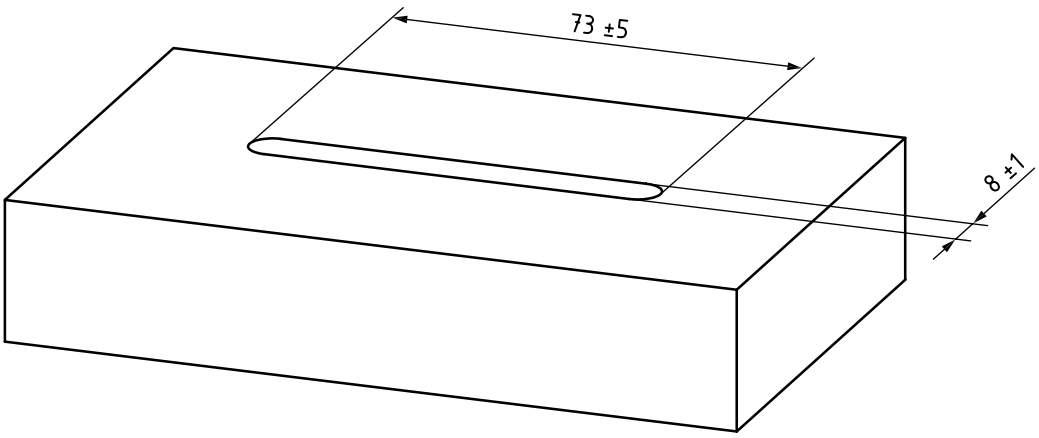
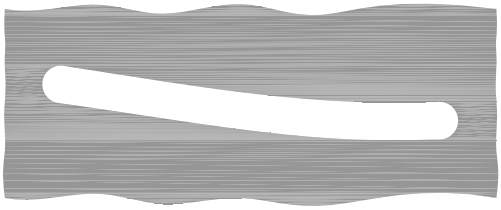
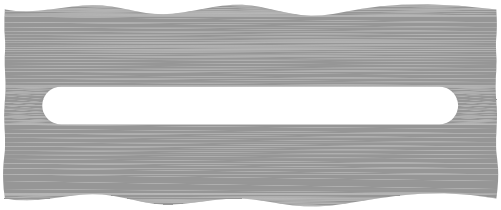


Figure A.1 — Measures of the washed-out areas in the polystyrene rigid plastic foam

Additionally, the homogeneity of the jetting is assessed visually. The jetting shall be evenly deep and straight. Frayed edges and sinuous lines are not acceptable and suggest uneven pressure (see Figure A.2).



a) With complaints



b) Without complaints

Figure A.2 — Jetting in comparison

Bibliography

[1] ISO 4618:2006[1)], *Paints and varnishes — Terms and definitions*

[2] ISO 16276-1:2007, *Corrosion protection of steel structures by protective paint systems — Assessment of, and acceptance criteria for, the adhesion/cohesion (fracture strength) of a coating — Part 1: Pull-off testing*

1) Under revision.

ICS 87.040

Price based on 17 pages