INTERNATIONAL STANDARD

ISO 8502-4

Second edition
2017-01

Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness —

Part 4: Guidance on the estimation of the probability of condensation prior to paint application

Préparation des subjectiles d'acier avant application de peintures et de produits assimilés — Essais pour apprécier la propreté d'une surface —

Partie 4: Principes directeurs pour l'estimation de la probabilité de condensation avant application de peinture

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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.

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 (see 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 (see www.iso.org/patents).

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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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 12, *Preparation of steel substrates before application of paints and related products*.

This second edition cancels and replaces the first edition (ISO 8502-4:1993), which has been technically revised with the following changes:

a) normative references have been updated;

b) mercury thermometer has been replaced by thermometer in Clause 4 a);

c) additional information is given in the note to Clause 4 b);

d) combined instrument described in Clause 4 d);

e) notes on instrument properties have been added in Clause 4;

f) in 5.2, "at a given atmospheric pressure" has been added to read "Their parameters are air temperature and relative humidity at a given atmospheric pressure";

g) in 5.3, it has been added that non-contact thermometers should not be used;

h) 5.4 has been changed to account for the definition of high and low risk of condensation given in Clause 3;

i) description of the procedure with combined instruments has been added in 5.5.

j) a reference to the formula used in Annex A has been added.

ISO 8502 consists of the following parts, under the general title *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness:*

— *Part 2: Laboratory determination of chloride on cleaned surfaces*

— *Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)*

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— *Part 4: Guidance on the estimation of the probability of condensation prior to paint application*

— *Part 5: Measurement of chloride on steel surfaces prepared for painting (ion detection tube method)*

— *Part 6: Extraction of soluble contaminants for analysis — The Bresle method*

— *Part 9: Field method for the conductometric determination of water-soluble salts*

— *Part 11: Field method for the turbidimetric determination of water-soluble sulfate*

— *Part 12: Field method for the titrimetric determination of water-soluble ferrous ions*

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Introduction

The performance of protective coatings of paint and related products applied to steel is significantly affected by the state of the steel surface immediately prior to painting. The principal factors that are known to influence this performance are as follows:

a) presence of rust and mill scale;

b) presence of surface contaminants, including salts, dust, oils and greases;

c) surface profile.

The ISO 8501, ISO 8502 and ISO 8503 series of International Standards have been prepared to provide methods of assessing these factors, while the ISO 8504 series provides guidance on the preparation methods that are available for cleaning steel substrates, indicating the capabilities of each in attaining specified levels of cleanliness.

These series of International Standards do not contain recommendations for the protective coating systems to be applied to the steel surface. Neither do they contain recommendations for the surface quality requirements for specific situations even though surface quality can have a direct influence on the choice of protective coating to be applied and on its performance. Such recommendations are found in other documents such as national standards and codes of practice. It will be necessary for the users of these International Standards to ensure that the qualities specified are

— compatible and appropriate both for the environmental conditions to which the steel will be exposed and for the protective coating system to be used, and

— within the capability of the cleaning procedure specified.

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The four series of International Standards referred to above deal with the following aspects of preparation of steel substrates before application of paints and related products:

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— ISO 8501 on visual assessment of surface cleanliness;

— ISO 8502 on tests for the assessment of surface cleanliness;

— ISO 8503 on surface roughness characteristics of blast-cleaned steel substrates;

— ISO 8504 on surface preparation methods.

Each of these International Standards is in turn divided into separate parts.

Some paints (but not all) require dry surfaces when being applied to steel structures. Thin films of condensed water on steel surfaces are mostly invisible. It is therefore important to have a method by which the probability of condensation can be estimated prior to the application of paint.

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Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness —

Part 4: Guidance on the estimation of the probability of condensation prior to paint application

1 Scope

This part of ISO 8502 gives guidance on the estimation of the probability of condensation on a surface to be painted. It may be used to establish whether conditions at the job site are suitable for painting or not.

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.

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ISO 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

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3 Probability of condensation

The relative humidity of the air and the steel surface temperature are the basis for the estimation of the probability of condensation, but there is no simple rule to employ. The situation is complex because there are a multitude of factors which have an influence on the condensation and evaporation of moisture, such as

— heat conductance of the structure,

— solar radiation on the surface,

— flow of ambient air around the structure, and

— contamination by hygroscopic substances on the surface.

These factors sometimes provoke wetting or prevent drying locally on the surface, e.g. where the surface temperature remains low or tends to fall due to heat losses or where the air becomes quickly saturated due to reduced ventilation. Naturally, the same factors sometimes have the opposite effect. Therefore, any test results should be interpreted with the greatest care.

Unless otherwise agreed, the steel surface temperature should generally be at least 3 °C above the dew-point when paints are used.

NOTE 1 For paints that are tolerant to moisture on the surface, a temperature difference less than 3 °C might be acceptable.

Other temperature differences may be specified by the paint manufacturer or agreed by the interested parties.

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If the difference between the surface temperature and the dew-point is below or will fall below the required and/or agreed minimum, the probability of condensation should be considered as being “high”.

If the difference is above and will remain above the required and/or agreed minimum, the probability of condensation should be considered as being “low”.

It is important to judge whether a temperature drop, sufficient to cause condensation, is likely to occur during the critical period. Table 1 may be used to help with this determination.

If the relative humidity is 85 % or higher, then painting should be judged critically as the dew-point is a maximum of 2,5 °C away.

If the relative humidity is high (92 % or dew-point 1,3 °C away), painting should only be considered if conditions can be confidently expected to remain static or improve during the application and drying period.

NOTE 2 This period is usually approximately 6 h.

If the relative humidity is apparently satisfactory (for example, 80 % or dew-point 3,4 °C away), the environmental conditions over an appropriate time period ahead, often about 6 h, should still be considered in order to ascertain that dew conditions will not occur.

4 Instruments

The following instruments should be used, although instruments other than those described may be used provided that they have an equivalent or greater accuracy.

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a) For air temperature measurements, thermometers accurate to ±0,5 °C.

b) For air humidity measurements, any of the following instruments.

1) Aspirated psychrometers and whirling (sling) hygrometers, including tables for calculation of humidity (see ISO 4677-1 and ISO 4677-2, respectively), accurate to ±3 % RH.

NOTE 1 The aspirated psychrometer is the reference instrument type according to the World Meteorological Organization (WMO).

2) Digital electronic hygrometers based on measurement of capacitance change of polymer films, accurate to ±3 % RH and capable of operating at any relative humidity in the range 0 % RH to 100 % RH and at any temperature in the range −40 °C to +80 °C.

3) Digital electronic hygrometers based on measuring the resistance change in a salt bridge, accurate to ±2 % RH and capable of operating at any relative humidity in the range 0 % RH to 97 % RH and at any temperature in the range 0 °C to 70 °C.

Due to the sensitivity to hysteresis, electronic dew point gauges should be handled according to manufacturer specifications and the probability for hysteresis should be prevented to maintain correct results. The probe should, for example, not be exposed to large temperature/humidity variations. Condensation on the sensor surface may give offset reading in the order of 10 %, for some sensor types lasting for days.

NOTE 2 Hygrometers are sensitive to contamination; salts or other substances adsorbing moisture will cause erroneous readings.

NOTE 3 Hygrometers require calibration; some types, as sensors using a salt bridge, more often than others.

c) For surface temperature measurements, digital electronic thermometers, accurate to ±0,5 °C.

Magnetic surface thermometers may be used provided that they have the required accuracy and are left on the surface for sufficient time to reach the surface temperature.

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d) Digital electronic instruments measuring air temperature, surface temperature and humidity, capable of calculating the dew point, as well as the difference between the air temperature and the dew point.

5 Procedure

5.1 Using the instruments described in Clause 4 a) and Clause 4 b), measure the air temperature to the nearest 0,5 °C and the relative humidity.

5.2 Calculate the dew-point, which is a logarithmic function of the vapour pressure at the actual temperature. There are tables or charts from which the dew-point can be determined. Their parameters are air temperature and relative humidity at a given atmospheric pressure. Such a table is given in Annex A. Commercial dew-point calculators of sufficient accuracy may also be used.

Table 1 — Temperature drop needed for condensation to occur, as a function of the relative humidity

Relative humidity, %	98	95	92	90	85	80
Temperature drop, °C	0,3	0,8	1,3	1,6	2,5	3,4
NOTE The figures are mean values for air temperatures from 0 °C to 35 °C. For a given air temperature, more accurate figures can be obtained from Annex A.						

5.3 Using the instrument described in Clause 4 c), measure the steel surface temperature. Take at least one temperature measurement for every 10 m^2 of the surface and adopt the lowest measured temperature in calculating the dew point. Non-contact thermometers (IR-thermometers) should not be used to measure surface temperature due to interference with the surrounding air.

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When selecting locations for temperature measurements, any variation in the thickness of the steel and the effect of shade should be considered.

NOTE Some digital electronic hygrometers also measure the air temperature and calculate the dew-point temperature automatically.

5.4 Estimate the minimum surface temperature (above the dew-point) that is needed to obtain a “low” risk of condensation under the prevailing environmental conditions, see Clause 3.

5.5 If using a combined instrument described in Clause 4 d), points 5.1 to 5.4. shall be replaced by the following procedure: Read the dew point, calculate or read the difference between the dew point and the surface temperature and check if risks for condensation are considered “low” or “high”, see Clause 3.

6 Test report

The test report shall include the following:

a) a reference to this part of ISO 8502, i.e. ISO 8502-4;

b) the date of carrying out the measurements (including the day and hour), expressed in accordance with ISO 8601;

c) a description of the instruments used;

d) the calculated dew-point;

e) the measured steel surface temperature;

f) the difference between the steel surface temperature and the dew-point;

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g) the minimum temperature difference needed to avoid condensation;

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

i) an estimate of the probability of condensation as being "high" or "low".

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Annex A
(informative)

Table for determination of dew-point

Table A.1 gives the dew-point temperature, t_d, as a function of the air temperature, t, and the relative humidity, RH.

The following instructions are given for the use of Table A.1.

— Enter the table at values of relative humidity which straddle the actual (measured) value.

— Enter the table at values of air temperature which straddle the actual (measured) value.

— Identify the corresponding four intersection values of dew-point temperature, make a linear interpolation in two steps and round off to 0,1 °C.

The values given in Table A.1 are computed from the following formula, derived from an approximate formula known as the Magnus formula[3], valid for $t \geq 0$ °C and 101 kPa air pressure.

$$t_d = 234,175 \times \frac{(234,175 + t)(\ln 0,01 + \ln RH) + 17,080\,85t}{234,175 \times 17,080\,85 - (234,175 + t)(\ln 0,01 + \ln RH)}$$

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NOTE As can be seen from the formula, t_d is a comparatively simple function of two variables, t and RH. This function therefore lends itself to calculations by use of an ordinary scientific programmable calculator. Such a calculator, including its programme, can be regarded as being equivalent to the table. It is superior to the table in that it presents without interpolation a direct reading of the dew-point temperature. In addition, a small pocket-type calculator is usually easier to manipulate on site than a comprehensive table covering several A4 format pages. To make sure that the calculator is properly programmed, put in any tabulated pair of t-and RH-values and compare the result with the corresponding value of t_d in the table.

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Table A.1 — Dew-point temperature t_d as a function of the air temperature *t* and the relative humidity RH at 101 kPa air pressure

Relative humidity *RH* (%)	Air temperature, *t* (°C)									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	-49,7	-49,1	-48,5	-47,9	-47,3	-46,6	-46,0	-45,4	-44,8	-44,2
2	-43,6	-43,0	-42,3	-41,7	-41,0	-40,3	-39,7	-39,0	-38,4	-37,7
3	-39,9	-39,2	-38,5	-37,8	-37,1	-36,5	-35,8	-35,1	-34,4	-33,7
4	-37,1	-36,4	-35,7	-35,0	-34,3	-33,6	-32,9	-32,2	-31,5	-30,8
5	-34,9	-34,2	-33,5	-32,8	-32,1	-31,3	-30,6	-29,9	-29,2	-28,5
6	-33,1	-32,4	-31,6	-30,9	-30,2	-29,4	-28,7	-28,0	-27,2	-26,5
7	-31,5	-30,8	-30,1	-29,3	-28,6	-27,8	-27,1	-26,3	-25,6	-24,8
8	-30,2	-29,4	-28,7	-27,9	-27,1	-26,4	-25,6	-24,9	-24,1	-23,4
9	-28,9	-28,2	-27,4	-26,6	-25,9	-25,1	-24,3	-23,6	-22,8	-22,1
10	-27,8	-27,0	-26,3	-25,5	-24,7	-23,9	-23,2	-22,4	-21,6	-20,9
11	-26,8	-26,0	-25,2	-24,4	-23,7	-22,9	-22,1	-21,3	-20,5	-19,8
12	-25,9	-25,1	-24,3	-23,5	-22,7	-21,9	-21,1	-20,3	-19,6	-18,8
13	-25,0	-24,2	-23,4	-22,6	-21,8	-21,0	-20,2	-19,4	-18,6	-17,8
14	-24,2	-23,4	-22,6	-21,8	-21,0	-20,2	-19,4	-18,6	-17,8	-17,0
15	-23,4	-22,6	-21,8	-21,0	-20,2	-19,4	-18,6	-17,8	-17,0	-16,1
16	-22,7	-21,9	-21,1	-20,2	-19,4	-18,6	-17,8	-17,0	-16,2	-15,4
17	-22,0	-21,2	-20,4	-19,6	-18,7	-17,9	-17,1	-16,3	-15,5	-14,6
18	-21,4	-20,5	-19,7	-18,9	-18,1	-17,2	-16,4	-15,6	-14,8	-14,0
19	-20,8	-19,9	-19,1	-18,3	-17,4	-16,6	-15,8	-15,0	-14,1	-13,3
20	-20,2	-19,3	-18,5	-17,7	-16,8	-16,0	-15,2	-14,3	-13,5	-12,7
21	-19,6	-18,8	-17,9	-17,1	-16,3	-15,4	-14,6	-13,7	-12,9	-12,1
22	-19,1	-18,2	-17,4	-16,5	-15,7	-14,9	-14,0	-13,2	-12,3	-11,5
23	-18,6	-17,7	-16,9	-16,0	-15,2	-14,3	-13,5	-12,6	-11,8	-10,9
24	-18,1	-17,2	-16,4	-15,5	-14,7	-13,8	-13,0	-12,1	-11,3	-10,4
25	-17,6	-16,7	-15,9	-15,0	-14,2	-13,3	-12,5	-11,6	-10,8	-9,9

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