INTERNATIONAL STANDARD

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Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates —

Part 5: Replica tape method for the determination of the surface profile

Préparation des subjectiles d'acier avant application de peintures et de produits assimilés — Caractéristiques de rugosité des subjectiles d'acier décapés —

Partie 5: Méthode de l'empreinte sur ruban adhésif pour la détermination du profil de surface

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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).

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 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 8503-5:2003), which has been technically revised.

A list of all parts in the ISO 8503 series can be found on the ISO website.

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:

a) the presence of rust and mill scale;

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

c) the surface profile.

ISO 8501 (all parts), ISO 8502 (all parts) and ISO 8503 (all parts) have been prepared to provide methods of assessing these factors, while ISO 8504 (all parts) 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 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 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;

— within the capability of the cleaning procedure specified.

The International Standards referred to above deal with the following aspects of preparation of steel substrates:

— ISO 8501 — *Visual assessment of surface cleanliness*;

— ISO 8502 — *Tests for the assessment of surface cleanliness*;

— ISO 8503 — *Surface roughness characteristics of blast-cleaned steel substrates*;

— ISO 8504 — *Surface preparation methods*.

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

It is important to note that numerical characterization of a surface profile is meaningful only when accompanied by an understanding of the errors of measurement and by the realization that different techniques may yield somewhat different numerical values for the profile. Estimates of measurement error associated with different techniques can be obtained from national or international standards or from the equipment manufacturers. As shown in Annex B, values given by the replica tape method align well with those obtained using other parts of ISO 8503.

Information regarding the magnitude of errors associated with use of replica tape is given in Annex A.

Advantages of the replica tape method include the fact that it affords numerical characterization, yields a permanent record, works well on curved surfaces and benefits from a geographically broad base of user experience over a period of several decades.

Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates —

Part 5: Replica tape method for the determination of the surface profile

1 Scope

This document describes a field method for measuring the surface profile produced by any of the abrasive blast-cleaning procedures given in ISO 8504-2. The method uses replica tape and a suitable gauge for measuring, on site, the roughness of a surface before the application of paint or another protective coating.

The method is applicable within the range of profile heights cited for a given grade (or thickness) of replica tape. The commercial grades currently available permit measurement of average peak-to-valley profiles of 20 µm to 115 µm. The method is valid for surfaces that have been cleaned with abrasives.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 4618, *Paints and varnishes — Terms and definitions*

ISO 8503-1, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and ISO 8503-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Principle

The replica film in replica tape consists of a layer of crushable plastic microfoam coated onto a polyester substrate of highly uniform thickness (50 µm ± 2 µm). When compressed against a hard surface, the microfoam collapses and acquires an impression of the surface. The thickness of the replica is a measure of the surface profile.

When the replica film is coated with a thin (80 nm) layer of a ductile and optically reflective metal, such as indium, the replicated surface can be studied with an optical interferometric profiler. When the film

is coated with a similarly thin layer of a ductile and electron-emissive metal, such as gold, platinum or palladium, the replica may be studied with an electron microscope.

NOTE This method measures an "average maximum peak-to-valley profile" because the anvils of the micrometer gauge flatten the replica profile slightly so that the reading equates to an average maximum value, though this is not the same as a mathematical average.

5 Apparatus

5.1 Replica tape, consisting of a square piece of replica film (measuring approximately 10 mm along each side) attached to adhesive-backed paper tape. The film shall be mounted over a hole (approximately 10 mm in diameter) in the centre of a section of the paper tape (approximately 53 mm × 19 mm in size), which is printed with the grade of tape and the corresponding range of profile heights.

NOTE Grades of replica tape are available for measurement of profiles between 20 µm and 64 µm ("Coarse" grade) and between 38 µm and 115 µm ("X-Coarse" grade). Additional grades permit checking measurements at or near the low (20 µm) and high (115 µm) ends of this range. See Annex C.

The tape's adhesive backing prevents movement of the replica film during the test and allows the sample identification and measured profile parameters to be recorded.

The crushed microfoam can be further compressed and should therefore be handled with care, especially when measuring its thickness.

5.2 Micrometer gauge, use a spring-loaded instrument specifically designed for use with replica tape, having a closing force of 1,0 N to 1,2 N and an accuracy of ±5 µm or better. The anvils shall be circular with the upper anvil (that touches the non-compressible polyester side of the replica film) having a diameter of 6,3 mm and the lower face being the same size or larger.

5.3 Compression tool, consisting of a hard, smooth, rounded, approximately spherical (nominal diameter 8 mm) surface that is used to compress the replica film against the surface to be measured. This tool sometimes takes the form of a rod with a compression ball at one end.

6 Maintenance and assurance of calibration for the replica tape method

Each component of the replica tape has its own storage life and effective operating temperature with the replica film being much more durable than the adhesive-backed paper tape.

Replica tape should be stored at room temperature, prolonged storage of replica tape outside the range 5 °C to 30 °C for more than two years is not recommended (see Annex D). Rolls of replica tape are marked with a batch number and date of manufacture. Both should be noted in the test report.

The measuring gauge, while rugged, should be treated with the usual level of care associated with a precision instrument.

The gauge shall be calibrated regularly (e.g. by the equipment manufacturer, their authorized agent or by an accredited calibration laboratory). A certificate of calibration showing traceability to a national measurement standard can be issued. There is no standard time interval for re-calibration, nor is one absolutely required, but a calibration interval can be established based on experience and the work environment. A one-year calibration interval is a typical frequency suggested by many gauge manufacturers.

Gauge accuracy shall then be checked by the operator at regular intervals using appropriate standards in accordance with the manufacturer's instructions. If the results fall outside the limits of accuracy specified by the manufacturer, the instrument shall not be used.

Information on the correlation of ISO comparator measurements with those obtained by replica tape is given in Annex B.

7 Procedure

Select a representative area of the surface for measurement.

Select a grade (thickness) of replica tape that includes the target profile.

Prepare the micrometer gauge by cleaning the anvils and adjusting the zero point to read −50,8 µm, the thickness of the non-compressible polyester substrate. This initial adjustment automatically subtracts the thickness of the substrate from all subsequent readings. Some digital micrometers automatically perform this initial adjustment.

Remove a single piece of replica tape from its release paper. Apply it to the blast-cleaned surface and rub the compression tool (5.3) over the replica film in the centre of the tape, using firm pressure, with a circular and/or x-y motion until the circular area of the replica tape is darkened uniformly.

Remove the tape from the surface and place the replica between the anvils of the measuring gauge, making sure that the tape is centred properly. Release the measuring gauge gently onto the replica and read the profile.

The average of two profile readings constitutes a profile measurement. Manufacturer recommendations provide guidance on whether these two readings should be obtained with the same grade or two different grades.

The number of measurements shall be agreed between the interested parties.

Before the surface under test is measured, the accuracy of this method may be checked by measuring a known profile, such as an ISO comparator.

NOTE The same procedure is used for measuring gauges that read in non-SI units, such as mil or thou (thousandths of an inch; 1 mil or thou approximately 25,4 µm). Gauges calibrated in non-SI units are supplied with instructions appropriate to those units.

8 Specification of acceptable error

An essential part of any specification relating to surface profile is an explicit statement of how the surface profile was determined. Implicit in this specification is an understanding of both the precision and the accuracy associated with a given method of measuring the profile. A discussion of error associated with replica tape measurements is given in Annex A.

The number of readings to be taken and the range of acceptable profiles shall be agreed between the interested parties before measurement starts.

9 Test report

The test report shall contain at least the following information:

a) all the information needed for the identification of the sample tested;

b) a reference to this document, including its year of publication, i.e. ISO 8503-5:2017;

c) replica tape batch number and date of manufacture;

d) measured profiles and location of measurement;

e) micrometer calibration date and record of most recent micrometer accuracy check;

f) the work site identification and project name (if applicable);

g) the date of the test;

h) the name of the operator;

i) any deviations from the procedure;

j) any unusual features observed.

Annex A
(informative)

Measurement errors associated with replica tape determination of profile height

In 1987, a panel of experts convened by NACE International (formerly National Association of Corrosion Engineers) investigated the measurement properties of replica tape. NACE/Standard RP0287 addressed the issue of repeatability and accuracy of measurement and reported the results of round-robin tests in which 14 blasted panels were measured by seven observers. Replica tape and focusing microscope measurements agreed within their 95 % confidence limits (two standard deviations) in 11 of 14 cases. The average difference between the two types of measurement technique was 4,5 µm. It should be noted that some difference is to be expected, based on the fact that the techniques have differing maximum peak-to-valley evaluation distances, evaluation areas and approaches to averaging. This is further discussed in Annex B.

The standard deviation for measurements made by the seven observers, averaged over all 14 panels, was 5,4 µm. The standard deviation for the corresponding focusing microscope profile determinations, averaged over all 14 panels, was 8,1 µm. Confidence intervals comprising two standard deviations (95 % confidence) are commonly specified. A standard deviation of 5,4 µm implies that a single replica tape measurement, by an arbitrary observer, has a 95 % probability of lying within 10,8 µm (two standard deviations) of the nominal replica tape profile.

More recent tests (2011) conducted by ASTM International are generally supportive of the error assessment arrived at by NACE. Measurements were obtained for five test surfaces having profiles in the range 33 µm to 107 µm by investigators at 11 laboratories. Analysis of the resulting data indicate a one standard deviation measurement reproducibility of 3 µm to 6 µm. Manufacturer tests in the 38 µm to 64 µm grade range overlap region suggest a somewhat lower accuracy in this range.

Annex B
(informative)

Guidance on the correspondence between replica tape and ISO comparator determinations of profile height

B.1 Replica tape

A single replica tape measurement samples a circular patch 6,3 mm in diameter and 31 mm^2 in area. Flexing of the polyester substrate and the curvature of the compression ball cause the film to conform to the surface over distances greater than 0,4 mm. Within patches smaller than approximately 0,4 mm, the portion of the ball pressing the film against the surface is effectively flat. These patches constitute the sampling area for individual maximum peak-to-valley determinations. In fact, the evaluation areas overlap so there is multi-patch correlation and the sampling process is somewhat more complex. A measurement using the micrometer gauge approximates the average maximum peak-to-valley heights over all the sampling areas in the 31 mm^2 area evaluated.

B.2 Focusing microscope

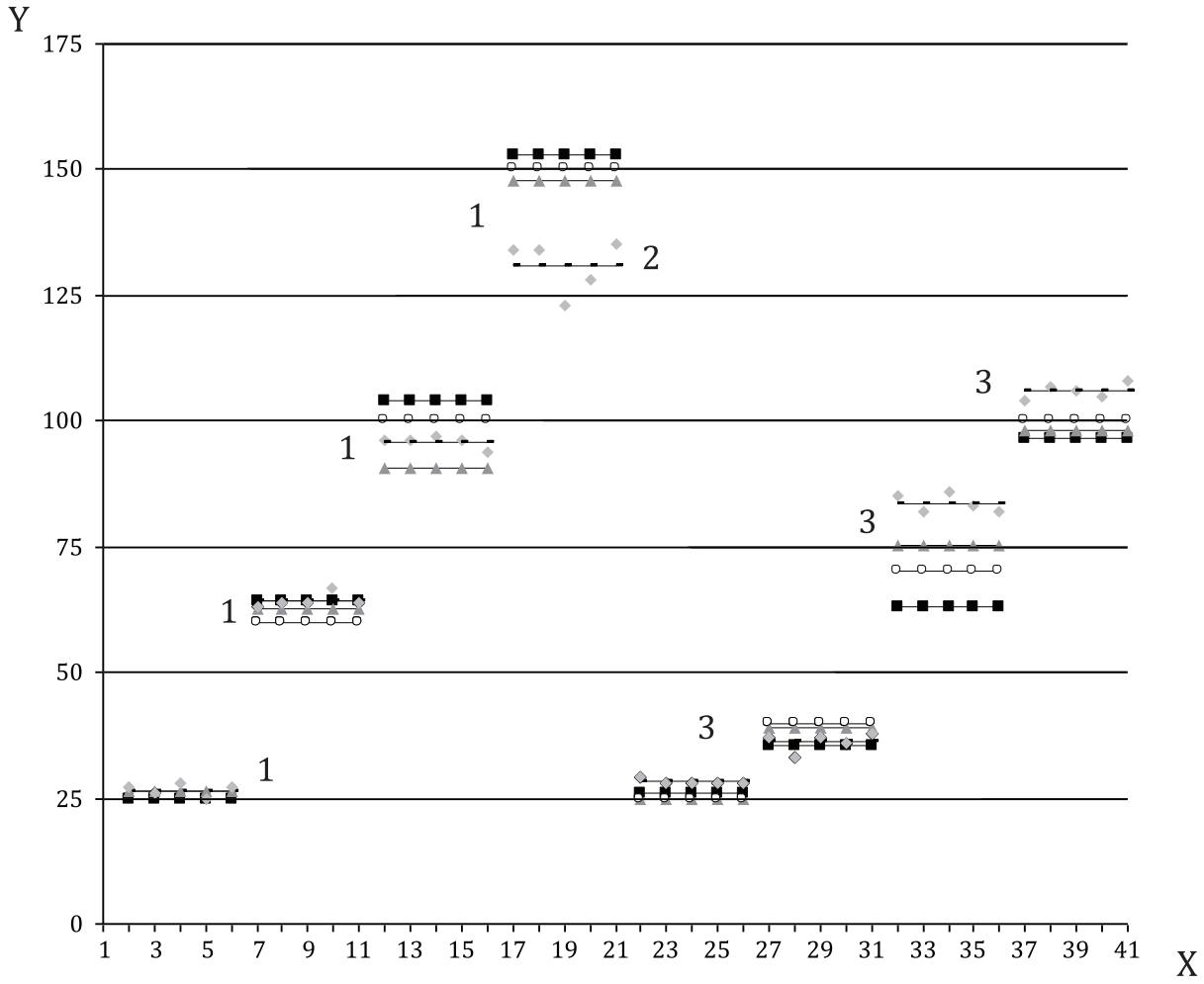
A single maximum peak-to-valley measurement using a focusing microscope covers a sampling region with a diameter of 0,5 mm and an area of approximately 0,2 mm^2. Taking the average of the maximum peak-to-valley distances from 20 of these regions, as specified in ISO 8503-3, gives a total evaluation area of approximately 4 mm^2.

B.3 Stylus device

The sampling length for this method, i.e. the distance over which individual maximum peak-to-valley distances are measured, is 2,5 mm and there are five such lengths in a single traverse of the stylus. For a stylus point with a diameter of 10 µm, the area evaluated on each traverse will be 0,125 mm^2. Taking the average of the maximum peak-to-valley distances from (a minimum of) 10 traverses, as specified in ISO 8503-4, gives 50 sampling lengths with a total area of 1,25 mm^2.

B.4 Comparison of different methods

A comparison of profile readings obtained using various ISO methods is given in Figure B.1.



Key

X	measurement No.
Y	profile (µm)
◆	replica tape measurements
—	replica tape averages
○	comparator (nominal spec)
■—	comparator (microscope)
▲—	comparator (stylus)
1	grit-blasted surfaces
2	upper limit for XC replica tape
3	shot-blasted surfaces

Figure B.1 — Comparison of profile readings using various ISO methods

Annex C
(informative)

Grades of replica tape

The replica tape method is useful for measurement of profile in the 20 µm to 115 µm range. The low end of this range is covered by "Coarse" grade tape; the high end by "X-Coarse" grade, where the term "grade" refers to the thickness of the plastic foam that acquires the impression. "Coarse Minus" and "X-Coarse Plus" grades also exist but are recommended for use *only* to check measurements at the low and high end, respectively, of the 20 µm to 115 µm primary range.

Table C.1 describes these grades.

Table C.1 — Description of grades

Grade description	Nominal foam thickness µm	Measurement range µm	Comment
"Medium"	10	Not Applicable	Measureable only with special instruments
"Coarse Minus"	38	12 to 25	Low end check grade
"Coarse"	75	20 to 64	Lower end of primary measurement range
"X-Coarse"	140	38 to 115	Upper end of primary measurement range
"X-Coarse Plus"	175	116 to 127	High end check grade

Annex D
(informative)

Service life and storage recommendations for replica tape

Testing has shown that replica film is able to produce accurate replicas on surfaces with temperatures over at least the range between –10 °C and +60 °C. At typical room temperatures, it is believed that replicas will store well for years, while uncompressed film may be stored for decades. No failures to uncompressed film have been recorded, despite prolonged storage, at temperatures over the range between 5 °C to 30 °C.

By contrast, the adhesive backing on the paper tape can deteriorate with time. The effect of adhesion failure is that the replica film can slide with respect to the surface being replicated when the film is rubbed for the purpose of compressing it. Sliding will cause "smearing" of the replica. If sliding is observed during the replication process, the replica should be discarded and the adhesive considered suspect.

Bibliography

[1] ISO 8503-3, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 3: Method for the calibration of ISO surface profile comparators and for the determination of surface profile — Focusing microscope procedure*

[2] ISO 8503-4, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile — Stylus instrument procedure*

[3] ISO 8504-2, *Preparation of steel substrates before application of paints and related products — Surface preparation methods — Part 2: Abrasive blast-cleaning*

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