TECHNICAL REPORT

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Best practices for the creation/ evaluation of fingerprint analysis in accordance with the ISO 28199 series

Bonnes pratiques pour la création/l'évaluation de l'analyse des empreintes digitales conformément à la série ISO 28199

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Foreword

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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).

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For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Best practices for the creation/evaluation of fingerprint analysis in accordance with the ISO 28199 series

1 Scope

This document gives technical descriptions of X-Y measuring tables together with sample applications, sample evaluations and practical recommendations for visual and metrological evaluation as a supplement to the ISO 28199 series. This document intends to provide further information on this subject to interested parties.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

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

4 Review of previous developments

After the successful introduction of this prediction method for the process behaviour of automobile series paints and an application for a patent in 1994, the ISO 28199 series up to 2009 was developed and published in the years 1999 to 2009, initially in the form of a EUCAR pre-standard within the framework of a EUCAR project (from 2006 onwards, originally initiation of a DIN standard – the DIN 55993 series– which in the meantime has been replaced by the ISO 28199 series).

X-Y measuring tables (scanners) that were innovative at the time were developed to the point of being ready for series production from the mid-1990s onwards. The first fully automated X-Y measuring table was put into service in 1996.

After pre-development in the early 1990s, the first measuring tables were subsequently made ready for series production. Standardization of the evaluation of measurements was very soon demanded by the automotive industry. The aim was that paint suppliers provide process-reliable and suitable coating systems to paint users as early as possible in the approval process for new base coats. In particular, the needs of the automotive industry increasingly demanded the ability to demonstrate process compatibility already in the design phase for new base coats. Further components of and results from X-Y measuring tables included not just the demonstration of process compatibility for coating systems awaiting approval, but also the ability to carry out process compatibility studies for new coating lines, for example.

A new method was developed to ensure the process compatibility of new paints in base coats already in advance of the actual paint approval. This method essentially consists of the application of a film thickness wedge of the base coat (BC, now also a two-layer structure with BC 1 and BC 2) onto standardized steel sheets that have been coated with a particular coil-coating-PUR paint and that have a particular defined substrate structure (visual appearance of a very smooth coil-coating painting). This is followed by coating with clear coat (series clear coat or with a new clear coat that is to be investigated) with a constant film thickness. The film thickness wedge of a paint system that is to be investigated (e.g. new base coat/paint) covers the range of film thicknesses of the series coating process that the new paint is to be used in. A sufficiently high number of measurements are carried out with various optical measuring devices so as to satisfy the requirements of statistical evaluation methods. The film thickness measurement in comparison with the measurements from the optical measuring devices is an important control parameter for an X-Y measuring table.

In the next step, suitable laboratory application systems (initially with pneumatic/pneumatic application, later with special high-rotation bell electrostatic paint sprayguns/pneumatic) were acquired. Today, modern high-rotation bell processes are simulated. Such is the progress that has been made, the various existing high-rotation bell and their coating processes can be simulated with “replacement bells” in laboratory systems in the case of central worldwide approval for various factories, for example. It was of course initially difficult to transfer the correlation of series coating to laboratory applications. Ultimately, success was achieved with the aid of so-called “practical fingerprint panels” also coated onto the bodywork at a suitable location in a frame in series production.

The demands from automotive manufacturers for standardization of evaluation, as mentioned above, resulted in a European Council for Automotive R&D (EUCAR) project with precisely this aim.

EUCAR is an umbrella body of automotive manufacturers that aims to jointly promote research and development in the areas of mobility, technology and processes. Suppliers and/or parties from other sectors also participate alongside automotive manufacturers on projects for these purposes.

The result of this joint project is the former DIN 55993 series, which was published as a draft version in 2006 and which in the meantime has been replaced by the ISO 28199 series.

5 General quality requirements for the creation of a standard test panel

It is important in terms of the predictability of process compatibility that the coating systems to be investigated are coated/produced in a manner as close as possible to the real process onto the standard panels of dimensions 300 mm × 570 mm (see ISO 28199-1) in laboratory systems, for example. Suitable methods for this are described in Clause 9.

The evaluation of the measurement values of various optical measuring devices (e.g. colour, coating structure, gloss, mottling, haze, sparkling) and the classification of the relevant film thicknesses provides information about important process characteristics such as colour stability, gloss and mottling behaviour, and coating structure (e.g. microstructure and ‘orange peel’ texture, depending on the selected measurement method) of the coating systems to be investigated.

This supplies results that allow conclusions to be drawn regarding:

— the properties of base metallic coats, for example, such as those of the effect pigments that are used;

— the hiding power of paints on coloured fillers, for example;

— the colour tone stability in the process film thickness range;

— the wetting behaviour;

— the sagging behaviour;

— the bubble behaviour;

— re-dissolving by a particular clear coat (series standard clear coat or test clear coat);

— the overspray absorption;

— the pinhole behaviour;

— many other base coat or clear coat properties.

6 Current evaluation methods

The system described in the ISO 28199 series and in this document allows conclusions to be drawn about process suitability for a particular coating process (prediction of process suitability) depending on various coating systems and/or various substrates and vice versa.

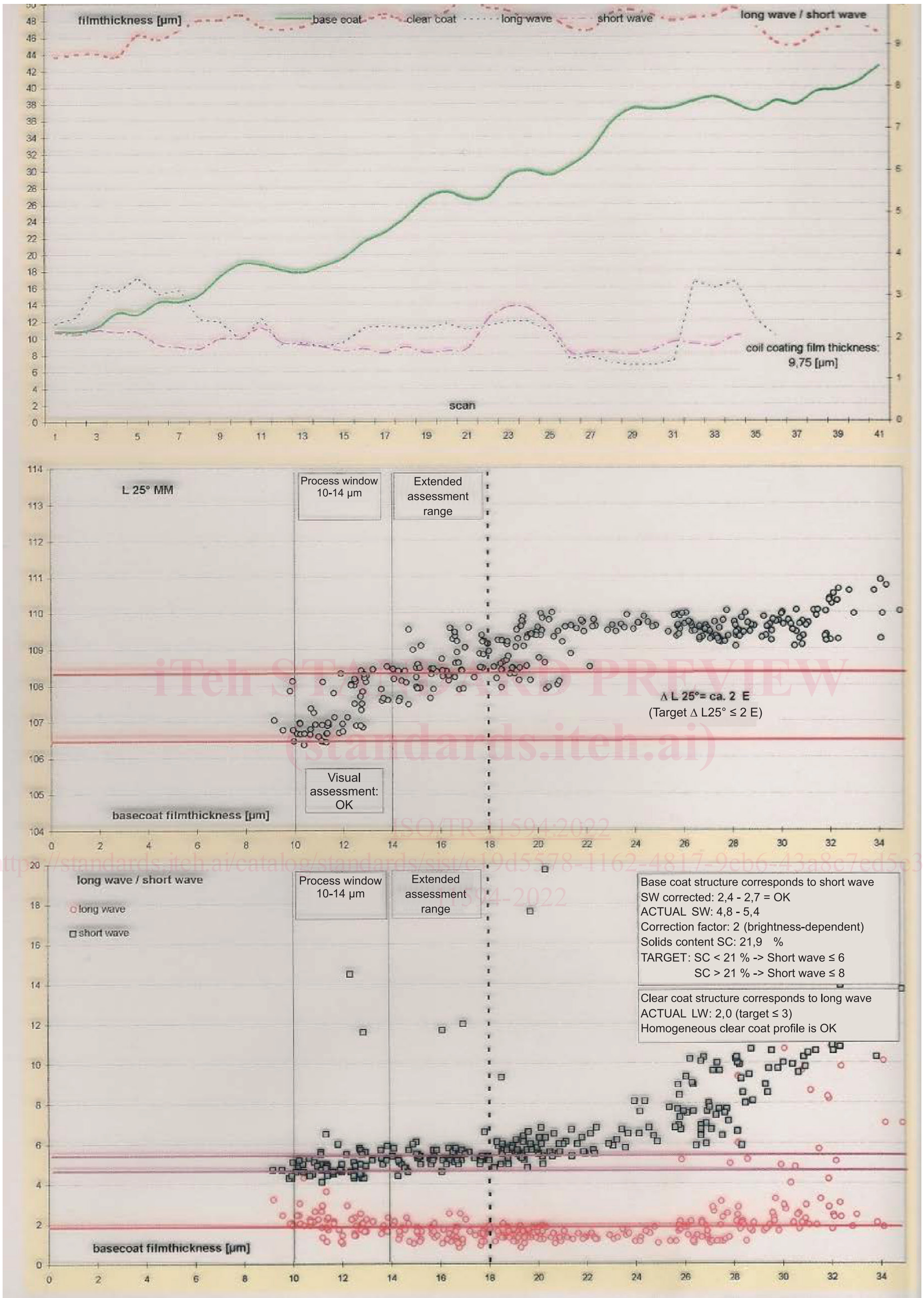
One example in this regard would be the investigation of clear coats:

The clear coat wedge essentially allows conclusions to be drawn about wetting on the relevant substrate itself and about which clear coat structure is present in a previously defined process window.

The method can also be used in the prediction of process suitability of new base coat paints (BC as a one-layer coat or BC 1 and BC 2 as a two-layer coat with BC 1 with constant film thickness and BC 2 as a base coat wedge) with a standard clear coat or with the use of a standard base coat in comparison with various clear coat systems.

7 Selected examples for the graphical presentation of measured quantities from various measuring tables

An early initial example from late 1999/early 2000 of a metallic BC paint wedge as a film thickness profile is presented in Figure 1. The application of the base coat wedge using the old method with pneumatic/pneumatic application had not yet been fully optimized.



SOURCE Reproduced with permission from BMW AG.

Figure 1 — Example from late 1999/early 2000 of a metallic BC paint wedge as a film thickness profile

8 Test panels

Testing the surface quality is a possible method of checking test panels (incoming goods inspection). This can be carried out using a measuring table with suitable measuring devices.

— **Film thickness measurement,** to determine the film thickness distribution on test panels.

— **Colour tone measurement,** to determine a homogeneous colour tone. Important for subsequent determination of the colour consistency and the process hiding power of base coats or topcoats.

— **Structure measurement,** to ensure a homogeneous structure.

— **Gloss measurement,** as a homogeneous reproducible gloss value is important in order to ensure reproducible wetting.

All these measurements have the aim of keeping the influence of the substrate on the measurement results of the coated panel as reproducible and minimal as possible.

As an alternative to pure coil coating sheets, plastic panels can also be used.

It is possible that these already have different surface properties or else different surface properties will be induced, depending on their application purpose. In this regard, both defined cleaning and activation can be necessary, which can be tested by measurement of the surface energy (ISO 19403 series), for example. After coating with specified standard materials, the profile values can be measured in order to monitor and approve the profile properties of the plastics between batches. Analogously to the coil coating sheets, additional measurement of the colour tone and gloss can also be carried out here.

The film thickness measurement can be carried out using a microscope or else, after prior calibration, with the corresponding coating material in comparison with the magneto-inductive measurement on the coil coating sheet.

9 Materials for FAS panels

A so-called wedge panel is created in order to determine the process window of a certain base coat in a paintshop. The so-called Fingerprint Analysis System (FAS) test panels are available in the materials of steel (e.g. bright grey coil coating sheet – steel), aluminium or plastic. The FAS panels are moved onto the X-Y measuring system/table (scanner) for individual measurements either automatically using a magazine or else manually.

In the case of two-layer base coats, the FAS panels are presented with a base coat (BC 1) applied as a constant layer and a base coat (BC 2) applied as a film thickness wedge. In the case of “one-layer base coats”, the single base coat is applied as a wedge, while the clear coat is applied with a constant clear coat thickness both in the case of the two-layer base coat and of a one-layer base coat. Subsequently, an evaluation is carried out based on the determined colour and structure values and, depending on the specifications, on additional measured quantities related to the paints (see Clause 5).

Before this step, attention is to be paid to the transfer/simulation of coating parameters and conditions in the spray booth/surroundings in series production to a laboratory application system (see also Clause 5).

Applications of FAS panel include the following:

— Colour tone styling, paint development, product optimization, quality control, optimization of application processes in the automotive industry. Paint manufacturing industry, strip-coating industry and industries that employ coating application as automated processes.

— Simulation of the series coating process. The simulation of the series coating process can be supported by the methods in ISO 28199.

— The test procedure is based on experience that shows that the film thickness, colour/effects and structure of a coating are important control parameters in the application process, which the main coating properties depend upon directly or indirectly. Additional coating properties such as those listed under measured quantities (see Clause 5) can identify other optimizations of the coating process.

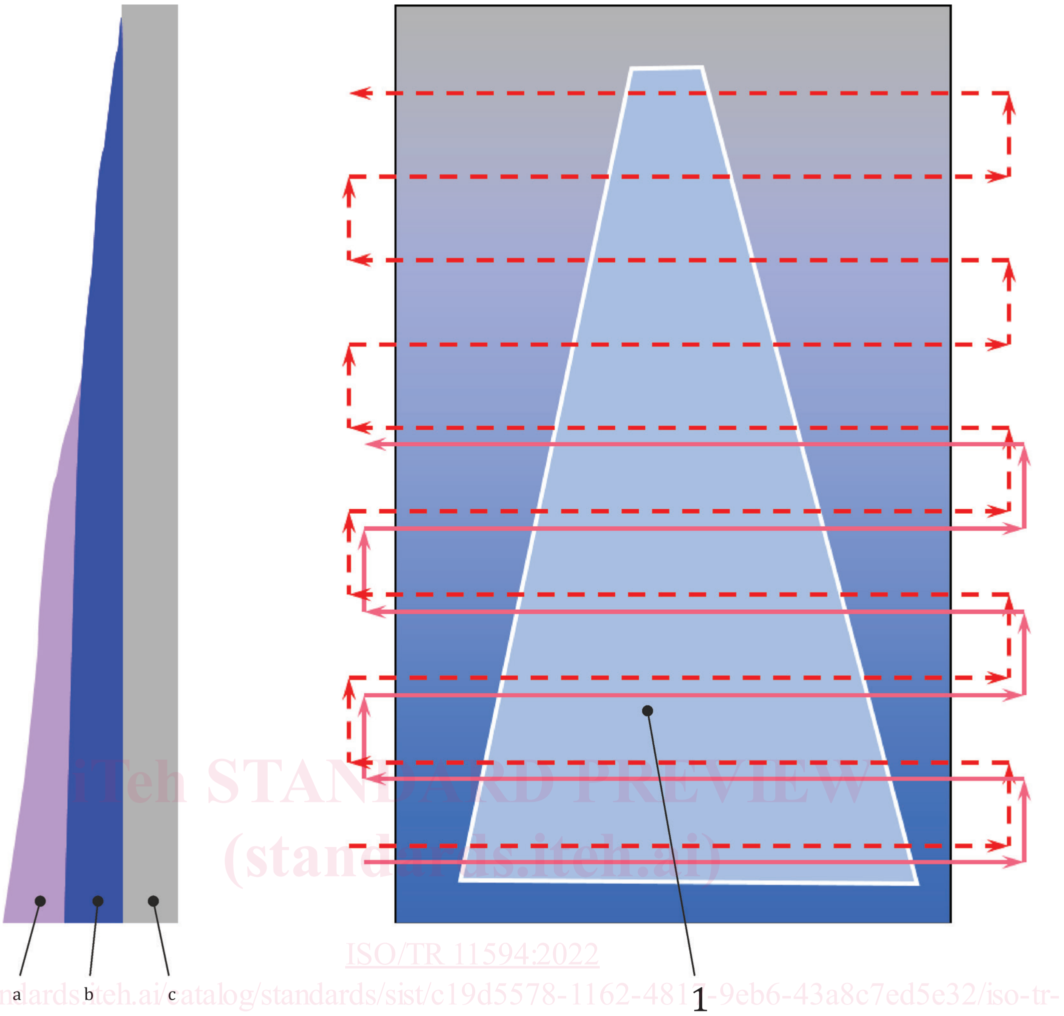
— A wedge panel is created in order to determine the process window of the base coat in a paintshop. Base coat (BC 1), base coat (BC 2) and clear coat are applied to this, for example, and the layer to be examined is coated in wedge form. Subsequently, an evaluation is carried out in accordance with specifications based on the determined colour and structure values or other coating properties.

— See the second example of a scanner available on the marketplace for an example and functional description of FAS software.

10 Wedge layers

The coating of wedge-shaped layers of the coating material to be characterized is important for fingerprint analysis.

When fingerprint analysis was first introduced, wedge-shaped layers were created using two pneumatically applied coats, whereby the fingerprint sheet was completely coated in the first hit of application and only half of it was coated in the second hit of application (see Figure 2). A wedge layer of satisfactory quality was achieved in combination with the down draft that applied during coating during and with gravity.



Key

1 wedge layer

a Second hit of application.

b First hit of application.

c Coil coat substrate.

- - - ► first hit of application

——► second hit of application

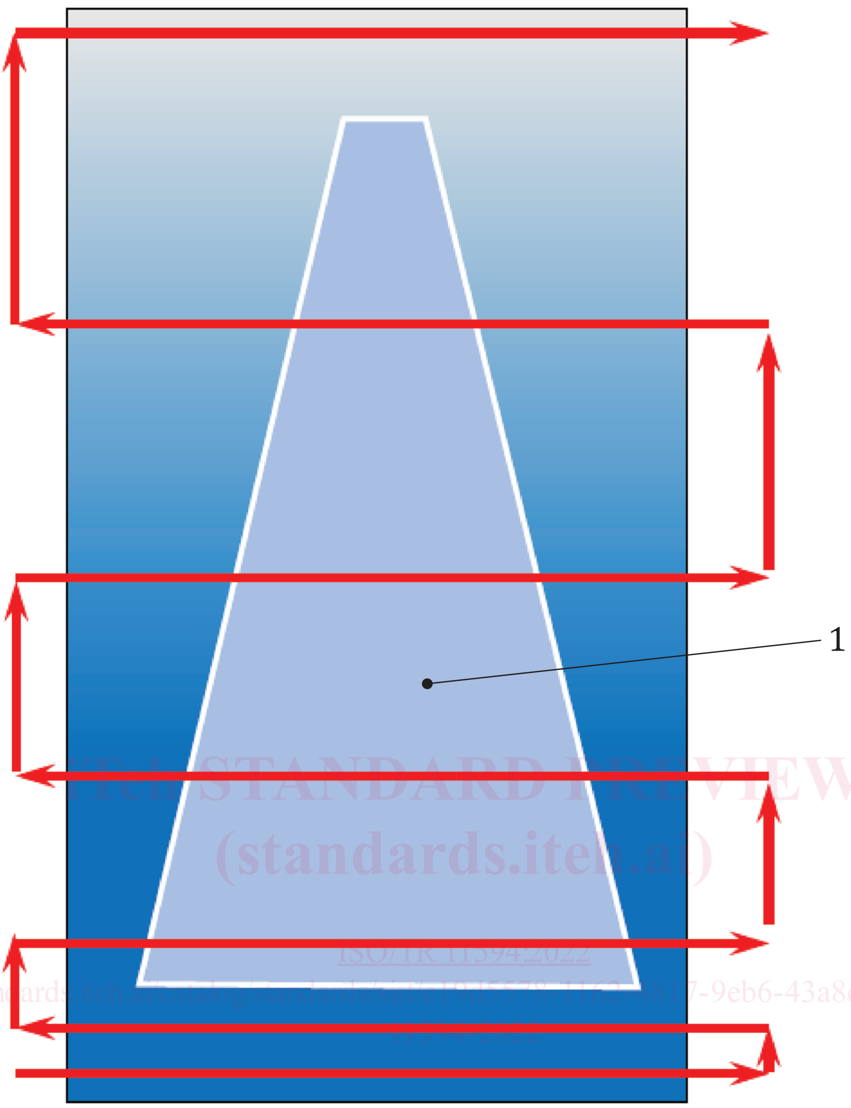
Figure 2 — Creation of a wedge-shaped layer

However, this type of coating (2 × pneumatic) is not usual in e.g. series automotive painting, and as a result, more process-like application methods were required. There was a focus on the use of electrostatically supported high-speed atomization, in particular. To meet this requirement, there was increased use of painting robots in the laboratory area and of highly flexible automatic painting equipment with high-speed atomizers. As a result, wedge layers in the form of single layers with good accuracy became feasible.

11 Possible methods for creating wedge layers

11.1 Through dynamic path distance

Figure 3 illustrates a wedge-shaped coating applied by means of dynamic enlarging of the path distance during the coating step. This is achieved by small path distance at the bottom of the panel and large path distance at the top. All other coating parameters, such as rotational speed, shaping air and paint flow, remain constant.



Key

1 wedge layer

Figure 3 — Wedge-shaped coating by means of dynamic enlarging of the path distance during the coating step

Advantage: The brush parameters can be set to typical series values.

Disadvantage: Wedges of satisfactory quality can only be achieved with great difficulty with this application type as a result of the inhomogeneity of the ESTA-HR spray cone. The membrane overlap is not constant across the entire coating area.

11.2 Through dynamic changing of the quantity of paint (paint flow quantity)

Figure 4 illustrates a wedge-shaped coating by means of dynamic reduction of the paint flow during the coating step. This is achieved by high paint flow at the bottom and low paint flow at the top. All other coating parameters, such as rotational speed, shaping air, paint flow and tip velocity, remain constant.

