TECHNICAL REPORT

# ISO/TR 11594

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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*



Reference number
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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 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.

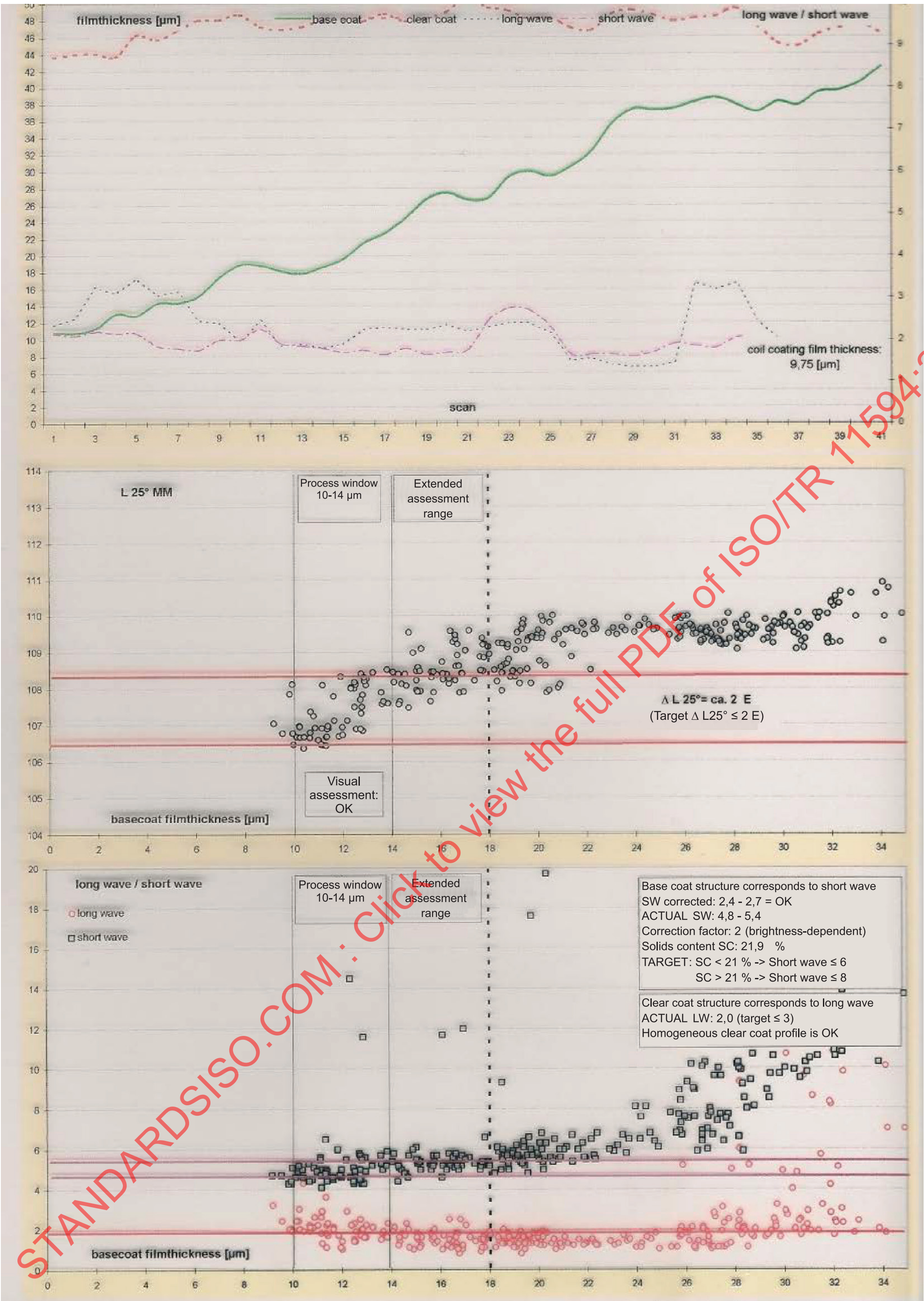
One example in this regard would be the investigation of clear coats:

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.

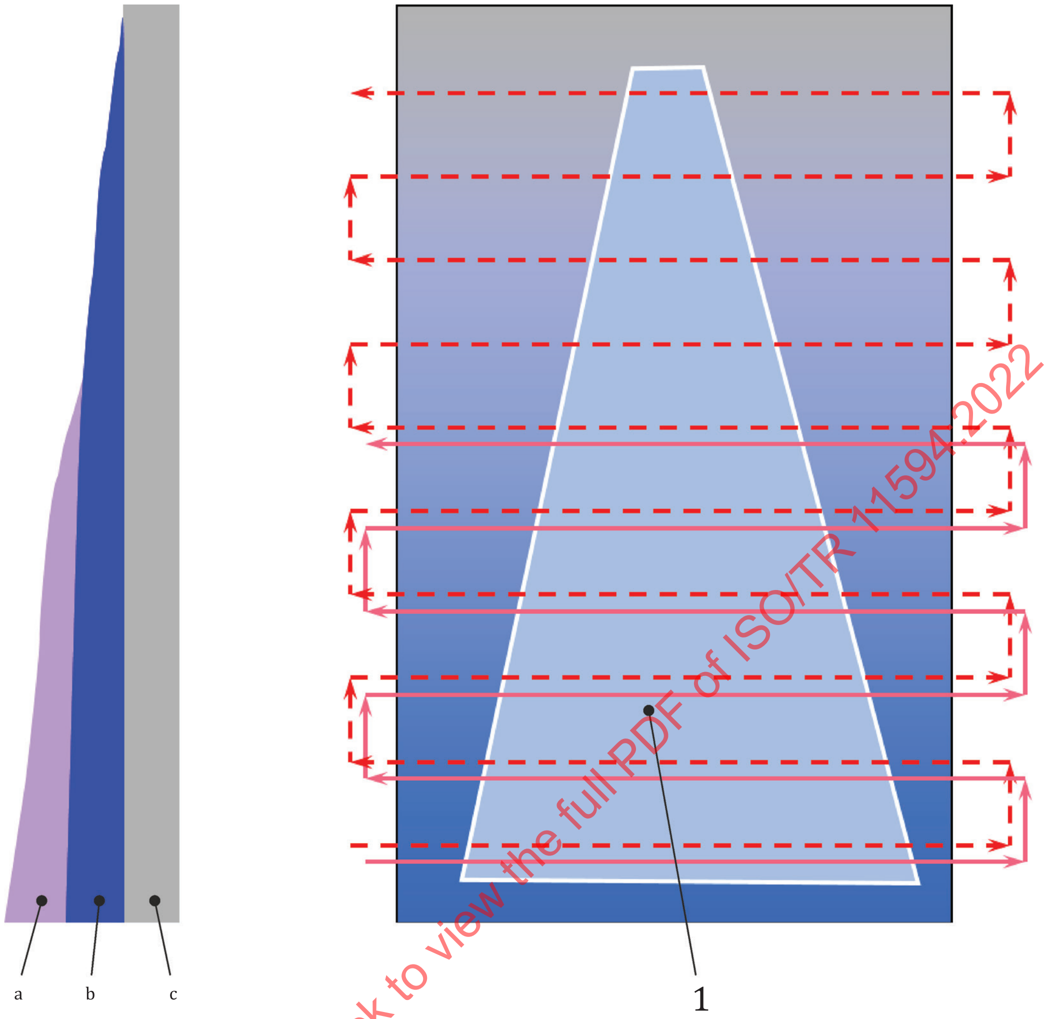
— A wedge panel is created in order to determine the process window of the base coat in a paintshop. Base coat (BC 1), base coat (BC 2) and clear coat are applied to this, for example, and the layer to be examined is coated in wedge form. Subsequently, an evaluation is carried out in accordance with 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**

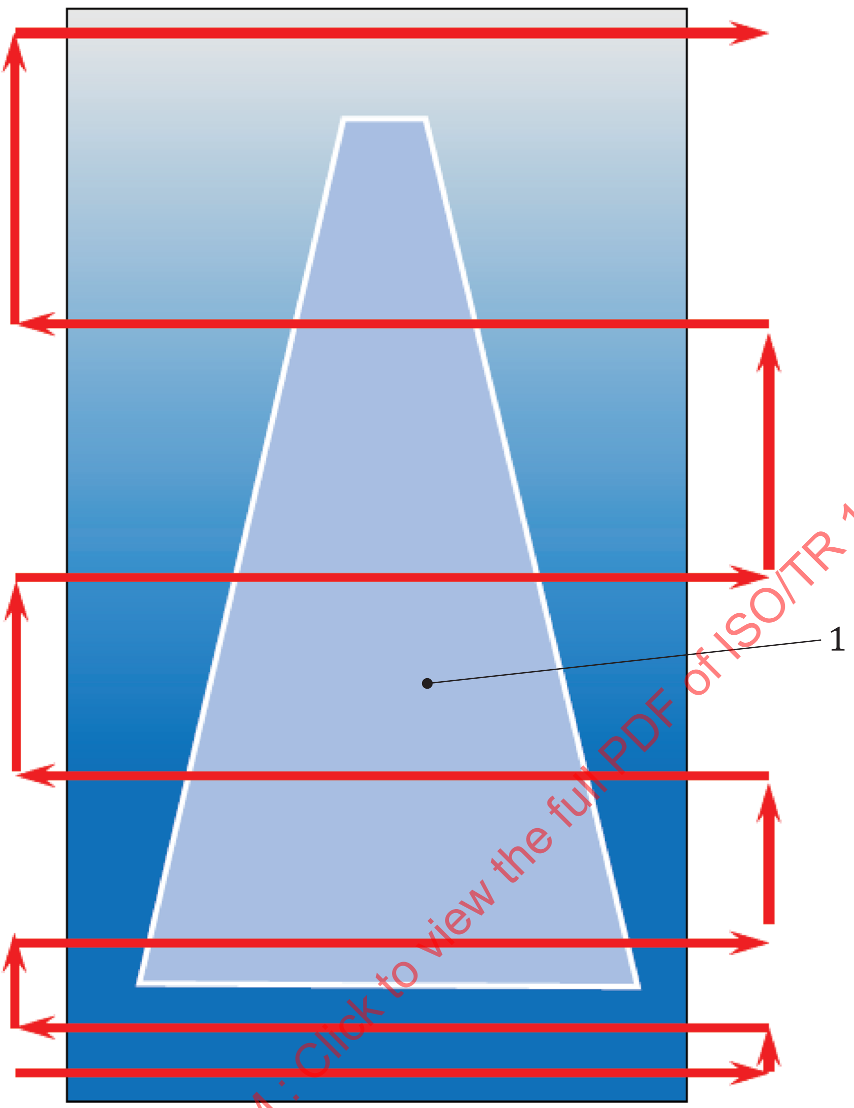


However, this type of coating (2 × pneumatic) is not usual in e.g. series automotive painting, and as a result, more process-like application methods were required. There was a focus on the use of electrostatically supported high-speed atomization, in particular. To meet this requirement, there was increased 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**



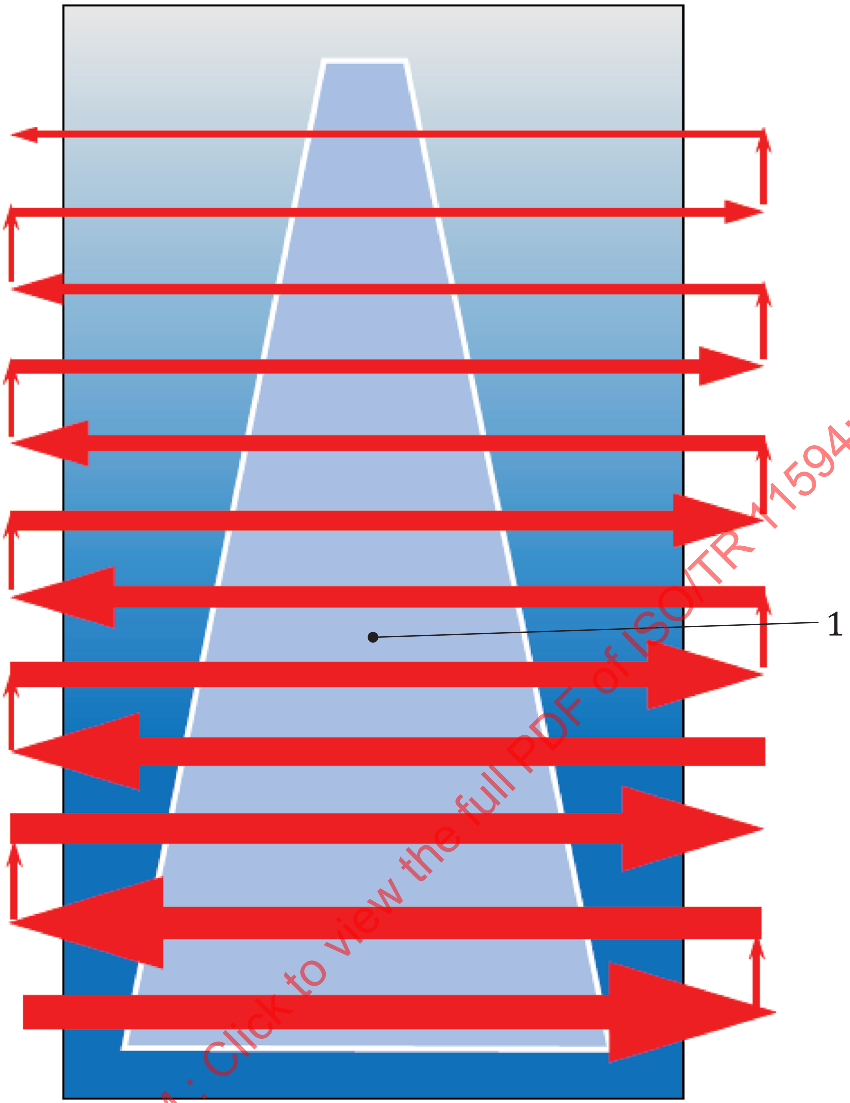
Advantage: The brush parameters can be set to typical series values.

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.






**Key**

1 wedge layer

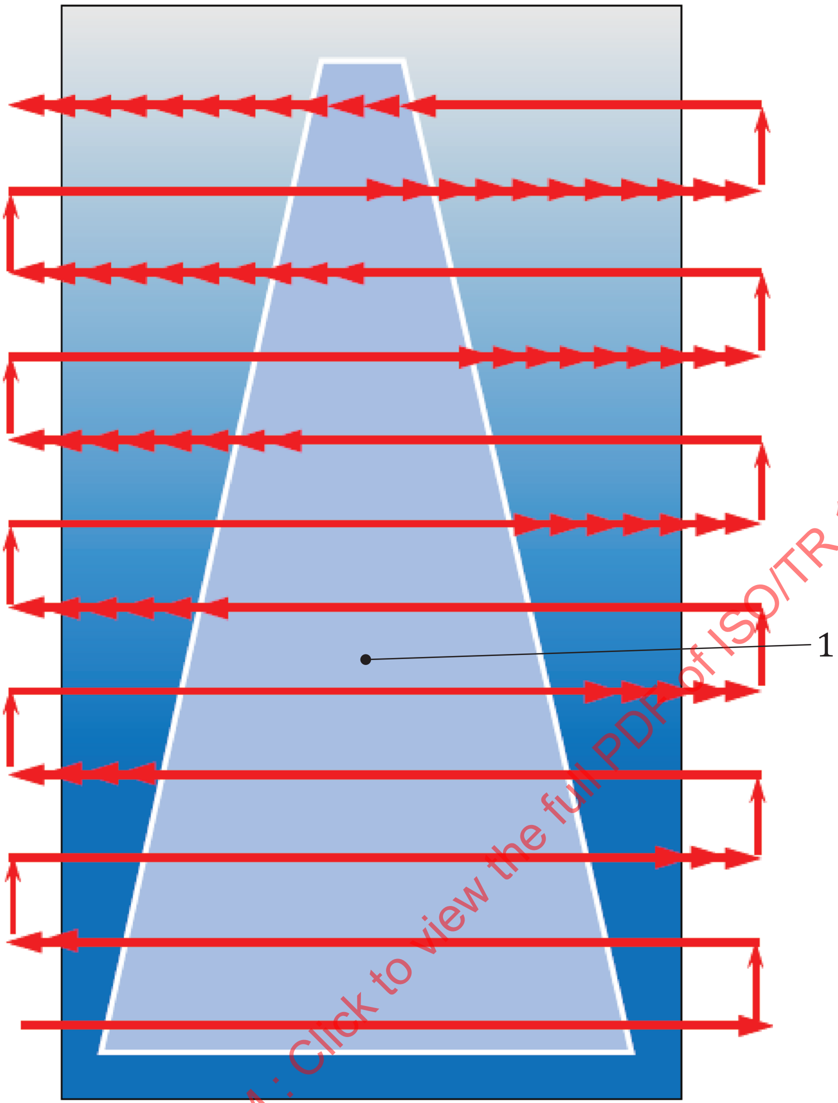
**Figure 4 — Wedge-shaped coating by means of dynamic reduction of the paint flow during the coating step**

Disadvantage: Wedge quality is only mediocre because the SB50 % value (spray pattern 50 % value) changes with the change in the paint flow. This disadvantage can be addressed by adapting the air quantities assigned to the relevant paint quantities (shaping air and/or horn/atomizing air). However, complete correlation with series parameters is then no longer possible.

The different paint flow quantities for each coating path also result in different atomization behaviour of the coating material. This can lead to overlapping and/or a change in coating properties that depend on film thickness.

### 11.3 Through dynamic changing of the tip velocity

Figure 5 illustrates a wedge-shaped coating by means of dynamic increasing of the tip velocity during the coating step. This is achieved by low speed at the bottom and high speed at the top. All other coating parameters, such as rotational speed, shaping air, paint flow and tip velocity, remain constant.




**Key**

1 wedge layer

**Figure 5 — Wedge-shaped coating by means of dynamic increasing of the tip velocity during the coating step**

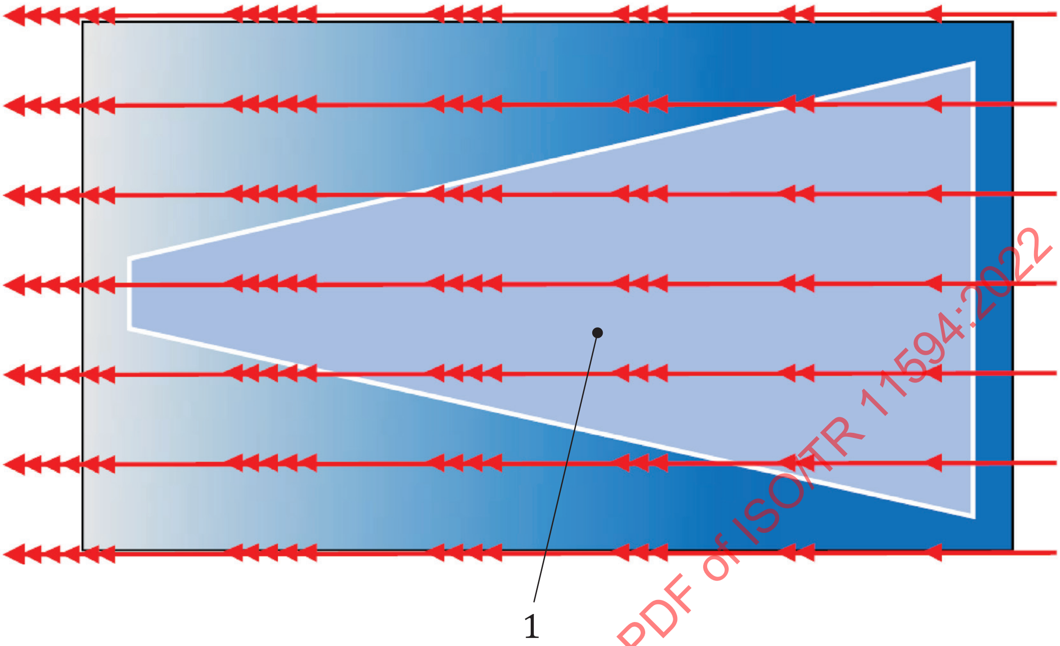


Advantage: Very good wedge quality because the spray pattern does not change as a result of the constant brush parameters (preferably analogous to series production) and the path distance can be set to achieve ideal overlapping.

Disadvantage: In certain cases, the tip velocity can be outside of the typical range for series production.

The increasing use of integrated coating processes led to consideration being given to the combination of two wedge layers on a test sheet (either in the same orientation or else rotated through 180° with respect to one another). However, it became evident that the reliability of this type of assembly as a basis for drawing conclusions is very questionable as only a limited number of film thickness combinations can be evaluated here. It is generally more useful to apply layer 1 with a constant film thickness and to coat layer 2 onto this as a wedge (or vice versa). This possibly means that the constant layer needs to be represented by different values on a number of test sheets, but the conclusions drawn relating to process compatibility will then be significantly more reliable.

If highly flexible automatic painting equipment/robots are available, a variant of this type of application can be implemented. In this case, the tip velocity is varied within a coating path (see Figure 6), which is not possible with all automatic painting equipment.




**Key**

1 wedge layer

**Figure 6 — Wedge-shaped coating by means of variation of the tip velocity within a coating path**



With this application variant, it is beneficial to align the sheet and the coating paths horizontally with respect to one another for coating and then to turn the sheet in the vertical direction for the corresponding flash-off times. Coating starts on the right at a low tip velocity and finishes on the left at a high tip velocity. This results in a film thickness wedge with a high film thickness on the right and a lower film thickness on the left. The advantages and disadvantages correspond to those of the application with a constant tip velocity for each coating path above.

## 12 Further information on wedge-shaped coating

With the use of application parameters that are as close as possible to production line conditions, it is possible that a stably (±3 µm) increasing film thickness wedge cannot be created with these parameters.

In this case, deviations larger than ± 3 µm is permitted.

Normally, the variable parameters are:

— paint flow

— shaping air, fan air, atomizing air

— rotational speed of the bell

— object distance

— high voltage

— path distance

The resulting SB50 % then determines the overlapping, which is also specified by customer data. All in all, a steadily rising wedge often cannot be created.

However, subsequent measurement on a measuring table always facilitates the evaluation of the measurement value as a function of film thickness. In this case, the spatial resolution is more continuous for wedges with non-constant application.

In principle, wedges can be created by multiple applications or by variable speeds. The application method is to be selected by the user and depends on the issue to be investigated.

| | | |
|---|---|---|
| Multiple applications: | dry application | → e.g. critical overspray absorption |
| Variable pulling speed: | wet application | → e.g. critical sagging |

## 13 Measuring tables

To ensure reproducible measurement of test panels, a machine-based and automated solution is recommended.

Up to now, the following variants have been implemented:

a) Multi-axis robots

The measuring devices used are moved across the test panel in the specified measurement patterns by a multi-axis robot.

b) X-Y measuring table

An axis system moves the measuring devices horizontally across the test panels, and lowering is carried out either electro-mechanically or pneumatically. In this layout, it is possible to measure devices simultaneously in parallel, e.g. in the case of waiting periods due to the calculation of measurement data. These measuring tables are generally equipped with storage that is implemented either in the form of magazines with compartments or else as belt systems. More recent systems have quick-change devices that also allow for the use of measuring devices outside of the measuring table.

With current state-of-the-art technology, the test panels to be measured have machine-readable labels, for example, in the form of self-adhesive stickers with QR codes. With the aid of integrated reader devices, these can then be assigned to prepared measurement jobs in the control software.

See Figures 7 and 8 for examples of automated measurement devices.

**Figure 7 — X-Y table produced by ASIS**



**Figure 8 — X-Y table produced by ORONTEC**

A measurement programme that is individually adapted for the measurement criteria and measurement area is created for the measurement of the test panels. The exact dimensions of the surface that are to be measured on a test panel are to be defined in the individual programmes. This is implemented through exact specification of the coordinates that are to be measured on a test panel, and the properties to be measured on the surface of the test panel are also to be taken into account.

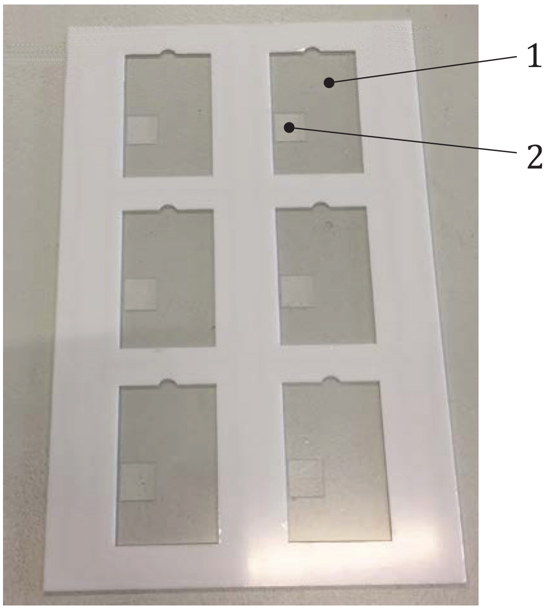
Test panels can be made of iron, aluminium or plastic. The test panels are fed into the system for individual measurements either automatically using a magazine or else manually.

c) Further areas of application

In practice, the automated measurement devices are also used for other purposes:

— Measurement of smaller test panels

Storage in automated measurement devices is designed for a particular format, e.g. 300 mm × 570 mm. Carriers that generally take the form of plastic carriers (see Figure 9) are used in order to facilitate work on smaller test panels such as standard sheets in the 100 mm × 200 mm format. Machine-readable codes (e.g. QR codes) can be stuck to the back of the test pieces and these can be identified in the automated measurement device using reader devices.




**Key**

1 cutout for test piece

2 cutout for QR code

**Figure 9 — Example of a plastic carrier**



— Testing of the automatic coating equipment with the aid of spray pattern analysis (see ISO 28199-1)

Film thicknesses on a test panel are measured here in a uniform measurement pattern. The measurement data can be visualized or statistically evaluated using various methods. One possible parameter in this regard is the “spray pattern SB50 %”, which is interpreted as the spray pattern diameter (in cm) at 50 % of the maximum film thickness.

— Combined substrates

As non-destructive measurement of film thicknesses on non-metallic substrates has not been technically feasible up to now, combinations of test panels made of plastic or glass, for example, and a steel sheet, for example, can be used. In this case, the non-metallic test panels for coating are stuck to the steel sheet, and the film thicknesses are measured on the metallic substrate after coating and are compared with the other measurement data (e.g. colour, surface structure or gloss).

d) Maintenance

Automated measurement devices are test devices for which it is ensured that the measurement error that is introduced is as low as possible. The measurement error is primarily increased by the positioning of the test piece and of the measuring device in the form of a variance in the measurement location in the X and Y directions. Variances in the position (e.g. tilting) and the application pressure can also occur. This is tested at regular intervals. It is advisable that internal guidelines for preventive maintenance are used for the machines and devices, insofar as these are not already covered by standards. This applies particularly to adherence to safety guidelines.

## 14 Current state-of-the-art technology for measuring devices

### 14.1 Film thickness measuring devices

Measuring devices based on the magnetic-inductive principle for ferromagnetic substrates or based on the eddy current principle for aluminium substrates, for example, are easy to integrate into the system.

Contactless measurements by means of high-frequency thermal methods are also possible, as well as ultrasound-based systems and devices based on impulse thermography.

### 14.2 Colour-measurement devices

It is essential that multi-angle spectrophotometers are used here. Measuring devices with additional information such as sparkles and/or graininess are advantageous in the context of paint recipe development, but less so in the optimization of the coating process. These values are not relevant for the determination of process compatibility.

Examples of devices with additional information are BYK-mac i and X-Rite MA-Tx series, and without additional information, is Konica Minolta CM-M6[1)].

### 14.3 Measuring devices for determining surface structure

Several devices from the wave-scan range produced by BYK Gardner[2)] are being used to determine the surface structure.

However, measuring devices with new (image-based) technologies such as the Rhopoint TAMS™[3)] are to be mentioned, which are increasingly being used in response to new specifications from manufacturers.

### 14.4 Measuring devices for determining mottling

The cloud-runner from BYK Gardner[4)] is available, which can be used to measure the variation in brightness along a measurement path and present this quantitatively in numbers. However, in order to measure the two-dimensionally distributed mottling of a coating, correspondingly many measurements are then made at defined separation distances alongside one another. Only then can a measurement made with this device be referred to as a mottling measurement.

## 15 Monitoring of test equipment

If a company implements a quality management system such as ISO 9001 or IATF 16949, all quality-relevant measurements can be traceable to international standards.

To ensure this, a process of monitoring of test equipment with regular checks is beneficial. It is advisable that all tests and the measurement standards used within the framework of these checks are documented.

In this way, it can be ensured that, in the case of a defect in a measurement system, only those products back to the last correct test will be tested again.

The monitoring of test equipment is a process for regular checking of the test equipment used (measurement systems) with the aim of ensuring constant quality in production. Further information on this is given in DIN 32937.



1) BYK-mac i from BYK-Gardner, MA Tx series from X-Rite, and CM-M6 from Konica Minolta are examples of suitable devices available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

2) Wave-scan range produced by BYK Gardner is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3) Rhopoint TAMS™ is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

4) Cloud-runner from BYK Gardner is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

## 16 Software

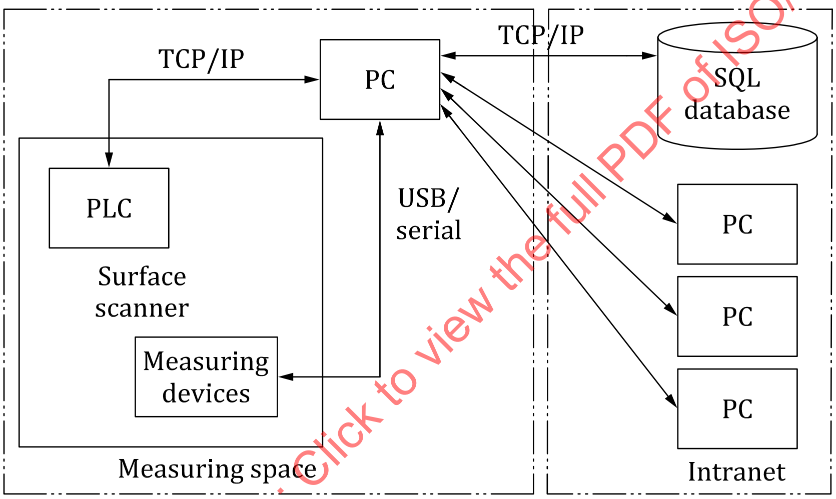
Measurement, processing and evaluation of data are carried out digitally, preferably using a PC. In many cases, the equipment (e.g. X-Y table) is controlled by separate programmable logic controllers (PLCs). Communication with a higher-level system that implements the overall control can take place by means of an OPC (UA) interface, for example.

The measuring devices used generally have (e.g. USB) ports and corresponding drivers that have been programmed for Microsoft Windows operating systems. For this reason, a PC with a Microsoft Windows operating system is generally the higher-level controller.

The measurement data can be stored in databases (e.g. in the SQL format). It is also possible to store additional data such as templates for measurement patterns or target values, tolerances, and environmental data such as temperature and humidity.

PCs or servers have been used as storage media for these databases in the past, but cloud services can also be used too in principle if these are compatible with safety guidelines.

One possible structure of the hardware components used is shown in Figure 10.




**Key**

PC personal computer
PLC programmable logic controller
SQL structured query language
TCP/IP transmission control protocol/internet protocol
USB universal serial bus

NOTE This method/principle is according to the ISO 28199 series.

**Figure 10 — Control principle for an automated measurement device**



Measurement data can be exportable through open interfaces in standard formats such as CSV (comma-separated values). This opens up the possibility of processing the measured data in separate programs based on individual specifications.

# 17 Visual evaluation of test panels

## 17.1 General

Visual evaluation of test panels is carried out in large, special illumination chambers (D65 standard illuminant) at different distances and from different observation angles, for example.

A visual comparison supplements the measured characteristic features of the coating system to be evaluated with visual results that are currently not measurable. Examples include defects such as sagging, pinholes, bubbles or angle-dependent colour changes outside of usual measurement geometries and light conditions.

NOTE The dimensions of light comparison cabins for batch release panels or master panels, for example, are too small and not suitable for this application. For this reason, measuring table panels with dimensions of 570 mm × 300 mm are usually assessed visually.

Figure 11 of a special illumination chamber explains how a visual assessment chamber can look.

The most important finding that can be established in a special illumination chamber is that a comparison of measuring table results and the visual impression only correlates if the observation geometry corresponds to the measurement geometry. If this is the case, comparable or correlative results are achieved. Examples include:

— colour stability measurements for effect base coats in the specified process window;

— systematic cloud evaluations;

— determination of the process hiding power;

— development of new characteristic parameters with optimized conformity with the visual impression, e.g. coating structure, particular effects with metallic paints.

## 17.2 Illumination chamber for the visual assessment of standard X-Y measuring table panels, taking into account the specifications in ISO 3668

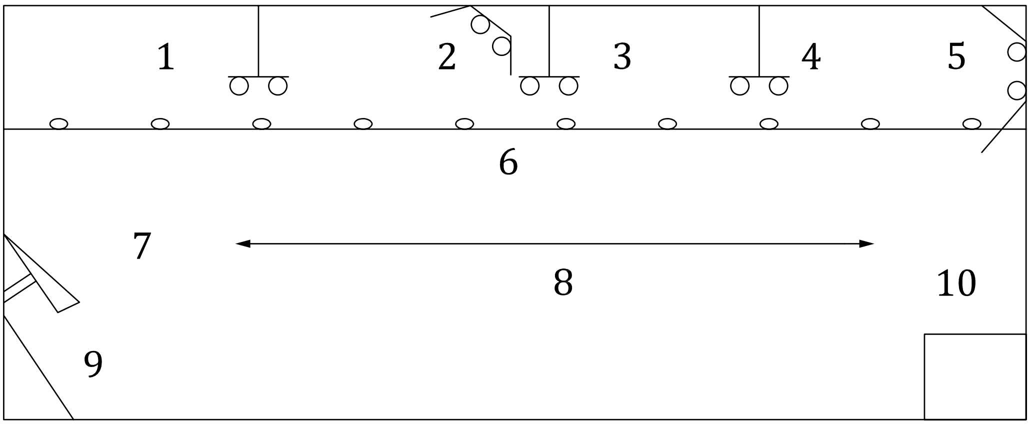
### 17.2.1 Aim

To be able to measure what one can see, and vice versa.

The positions of visual characteristic features (bubbles, protrusions, wide runs, sagging, etc.) are determined and associated with the film thickness measurements (measuring cells) on the test panel.

NOTE 1 One possible aid in the case of critical properties is to make use of reference data or panels for comparison purposes.

See Figure 11 for an example of an illumination chamber.




**Key**

1 lighting strip

2 45° lighting strip

3 lighting strip 3

4 lighting strip 4

5 red lighting strip (5)

6 sailcloth for scattered light that can be closed automatically

7 remote controlled frame to tilt coated panels to “critical” angles (making coating faults/effects visible)

8 observation height

9 45° position for “dark cloud observation” for metallics

10 deposit/storage for coated panels

NOTE 2 The illumination chamber is painted with RAL colour 7035 (all walls + base with a similar colour as a felt covering – ceiling white and 7035 in parts).

**Figure 11 — Schematic diagram of an illumination chamber**

Overview of the layout of illuminant fittings, lux, colour temperature, rotatable frame etc., positioning aids in the illumination chamber. Lighting strips 1, 3 and 4 have covers just like 2.

### 17.2.2 Dimensions (example)

The width of the illumination chamber is 3,30 m, the length approximately 5,60 m and the height 2,45 m, for example. The length of the fluorescent tubes is 1,50 m in this example; this corresponds to the chamber width. The walls, ceiling, base and equipment are to be painted in a neutral, matt grey tone, e.g. RAL 7035 (bright grey) to avoid undesired reflections and scattered light.

17.3 describes illumination equipment as examples from the automotive industry.

## 17.3 Possible items of equipment (illumination in accordance with ISO 3668)

### 17.3.1 Fluorescent tubes

Fluorescent tubes, for example: 58 watt, light colour 6 500 K daylight white, colour code 965 daylight white, colour rendering index (Ra) 90-100, luminous flux (lumen) 4450, beam angle (degrees) 360, lumen-watt ratio (lm/W) 79 (4 fluorescent tubes per strip × 4) with 2 housings / strip = 8 housings.

The fluorescent tubes fulfil these conditions as much as possible for light comparison of coated FAS panels with a base coat wedge and constant clear coat film thickness or a clear coat wedge with constant base coat film thickness in the process window area and, if necessary, with constant coating films of base coat and clear coat as FAS process panels and/or also visual evaluation of coated parts, e.g. plastic suspensions.



Application/evaluations:

— Mottling on metallic coatings, process hiding power, distance-dependent coating structure, coating structure.

— Visually observable effects such as sparkle on special effect pigments.

— Example of a lighting element (halogen spot): Rohrlux, HL 100 75 W 12 V FL[5)]

— Distance between the Rohrlux lamp and the FAS panel on frame/ramp (denoted as X) is approximately 2 m.

The illumination angles for detecting sparkle correspond to those of commercially available colour-measurement devices. These are set up using aids such as lasers or simple long rods and an angle gauge, just as in the case of illumination with fluorescent tubes.

Additional applications:

— Image clarity, run and sagging behaviour of the clear coat across a clear coat wedge and in comparison with the process panel with constant film thickness and, if necessary, of the base coat (e.g. in the film thickness range created from hiding power and within the process window).

### 17.3.2 Yellow halogen lamp and daylight lamps

For every 2 double lamps: Position between 1 in Figure 11 and the illumination chamber wall and/or for 5 in Figure 11, installed vertically in the ceiling of the illumination chamber.

a) Halogen lamp: e.g. Philips Master Colour CDM– T with 150 W/830 (UN Block Made in Belgium L3)[6)]

b) Daylight lamp: e.g. Philips Master Colour CDM – T with 150 W/942 (UN Block Made in Belgium L3)

Applications:

— The brightness of the illumination sources are controllable.

— Point-shaped illumination sources are adjustable in terms of their angle of incidence.

— It is advisable to not use illumination sources with a diffusor or other coverings, apart from the use of sailcloth to create scattered light.

— Evaluation of metamerism with various illuminants.

Series of photos for an example of an illumination chamber for visual light comparison of FAS panels and hazard notices for operation: Series of fluorescent lamps numbers 3, 4 and 5 (see Figure 11) with sailcloth pulled across slightly for 4 (see Figures 12 and 13).



5) Rohrlux, HL 100 75 W 12 V FL is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

6) Philips Master Colour CDM– T with 150 W/830 (UN Block Made in Belgium L3) is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

Figure 12 — Sailcloth pulled across fully for indirect illumination / scattered light (see number 5 in Figure 11)



Figure 13 — FAS panel for evaluation on the rotatable frame (see number 7 in Figure 11)