INTERNATIONAL STANDARD

**ISO 11142**

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# Micrographics — Colour microfilm — Application of the exposure technique to prepare line originals and continuous-tone originals

*Micrographie — Microfilm en couleurs — Application de la technique d'exposition pour préparer des originaux au trait et des originaux en demi-ton*

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# Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 11142 was prepared by Technical Committee ISO/TC 171, *Document management applications*, Subcommittee SC 2, *Application issues*.

# Micrographics — Colour microfilm — Application of the exposure technique to prepare line originals and continuous-tone originals

## 1 Scope

This International Standard applies the exposure technique to the preparation of line originals and test charts, to their exposure on film including the necessary test originals (see Clause 5) and to the evaluation of test exposures on colour microfilm.

In addition, this International Standard applies to the exposure technique and the evaluation of available continuous-tone originals, ready to be microfilmed (see Annex A).

This International Standard is intended to contribute to a reproducible colour rendition with respect to the original. As far as process control is concerned, the film manufacturer's recommendation should be observed.

This International Standard does not take into account the influences of projection characteristics of microfilm readers on the subjective impression of projected colour microfilms.

NOTE For viewing colour microfilms, the translucent screens of microfilm readers should be neutral grey (see Annex A).

## 2 Normative references

The following referenced documents are indispensable for the application 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 5-3:1995, *Photography — Density measurements — Part 3: Spectral conditions*

ISO 105-A01:1994, *Textiles — Tests for colour fastness — Part A01: General principles of testing*

ISO 128, *Technical drawings — General principles of presentation*

ISO 216:1975, *Writing paper and certain classes of printed matter — Trimmed sizes — A and B series*

ISO 446:2004, *Micrographics — ISO character and ISO test chart No. 1 — Description and use*

ISO 2469:1994, *Paper, board and pulps — Measurement of diffuse reflectance factor*

ISO 3334:1989, *Micrographics — ISO resolution test chart No. 2 — Description and use*

ISO 3664:2000, *Viewing conditions — Graphic technology and photography*

ISO 10550:1994, *Micrographics — Planetary camera systems — Test target for checking performance*

CIE 15.2, *Colorimetry*

# 3 Exposure technique

## 3.1 Introduction to exposure technique

The exposure technique and the copying procedure have great influence on the colour quality of the end product. Therefore, the conditions listed in 3.2 to 3.6 for the colour temperature of the illuminating lamp, the spectral characteristics of the exposure lens, the basic filtration and other influences shall be fulfilled.

## 3.2 Illumination of the original

The original shall be illuminated by light of constant intensity and having a distribution temperature of 3 200 K to 3 400 K, because colour microfilm is adjusted to a colour temperature of 3 200 K (see also 3.4).

## 3.3 Exposure lenses

All lenses used for exposing colour microfilms shall be colour-corrected.

## 3.4 Exposure

The exposure shall only be adjusted by modifying the exposure time, but not by changing the lamp current. Cameras for colour microfilming shall be equipped with a shutter, which allows adjustment of the exposure time.

NOTE Changing the lamp current would result in a shift of the distribution temperature.

## 3.5 Filtration

The adaptation of the lamps to the distribution temperature specified in 3.2 shall be made by means of correction filters placed over the light source.

If it is necessary to adjust the colour microfilm to the illumination of the original, this can be done by placing suitable conversion filters over the exposure lens.

## 3.6 Stray light

When exposing colour microfilm, stray light falling on to the original shall be avoided.

NOTE A variety of methods may be used depending on the stray light source; e.g. placing a black curtain around the microfilming installation can aid in avoiding light from sources other than the one used to illuminate the original. Other examples of stray light include light reflected from objects and from the clothing of the personnel operating the microfilming installation.

## 3.7 Copy board

The copy board to hold the original shall have a dark and non-reflecting surface.

# 4 Originals made on uncoloured material (drafting paper, transparent paper, drafting foils) for recording on colour microfilm

## 4.1 Colour of the material

### 4.1.1 General

The selected material shall have a spectral reflectance factor $R_{457} = (80\,^{+5}_{0})\,\%$.

$R_{457}$ means that the spectral reflectance factor $R$ is measured at the wavelength 457 nm. This measurement is made with standard illuminant A (see ISO 2469).

#### 4.1.2 Transparent paper or drafting paper

If originals on transparent paper or drafting paper are placed on a sheet of white paper for microfilming in reflected light, it shall be considered that the light passes through the original twice. Thus, the background may reproduce on the colour microfilm with a distinct colour cast.

#### 4.1.3 Glass plate

Frequently the originals curl. Therefore it is necessary to place a glass plate over the original. This can produce a colour shift.

### 4.2 Colour of inks and pencils

To ensure the subjective separation of the individual hues on the colour microfilm, all inks, drafting inks and coloured pencils used to prepare the originals shall be those listed in Table 1, having a colour difference of $\Delta E^*_{ab} \leqslant 4$, in accordance with CIE 15.2.

The same colours shall be used to prepare originals by means of plotters.

The colour rendition of inks, drafting inks and coloured pencils shall be evaluated subjectively, but shall be recorded objectively through measures.

To ensure adequate colour separation even when microfilming at a later date, the colours shall not fade when exposed to light or in dark storage (see also ISO 105-A01).

It is recommended to obtain information on storage properties from the manufacturer of inks, drafting inks and coloured pencils. Currently there is no information available on colour toners used in non-photographic processes and laser printers.

**Table 1 — Colour names and characteristic colour numbers (as guidelines) for illumination with standard illuminant D65 for the 2° standard colorimetric observer**

| Parameter | Colour name | | | | | |
|---|---|---|---|---|---|---|
| | Blue (B) | Green (G) | Red (R) | Yellow (y) | Magenta (m) | Brown (bn) |
| | Characteristic colour coordinates[a] $T:S:D$ | | | | | |
| | 17:5:2 | 23:5:2 | 8:6:2 | 1:6:1 | 13:3:3 | 5:3:5 |
| **Standard chromaticity**[b] $x$ | 0,188 | 0,314 | 0,533 | 0,426 | 0,276 | 0,419 |
| **Coordinates**[b] $y$ | 0,202 | 0,455 | 0,314 | 0,48 | 0,221 | 0,364 |
| **Colorimetric value**[b] $Y$ | 16,6 | 41,9 | 16,9 | 61,9 | 14,7 | 9,8 |
| NOTE Although cyan is one of the negative colours in colour photography, it is not used in this International Standard because in reproduction it can easily be mistaken for blue. Cyan was therefore replaced by brown. | | | | | | |
| [a] $T$ = hue number; $S$ = saturation degree; $D$ = darkness degree of brightness. | | | | | | |
| [b] For definitions, see CIE 15.2. | | | | | | |

### 4.3 Colours for ink pads

Colours for ink pads may be used if they fulfil the conditions of 4.2.

### 4.4 Colour ribbons

Colour ribbons used to type text into originals shall be of the single-use type, e.g. one-way carbon ribbons. Fabric ribbons shall not be used.

### 4.5 Presentation of details in newly prepared continuous-tone originals

Coloured details on newly prepared continuous-tone originals (image elements, writings, etc.) shall be made larger than comparable black-and-white elements in order to ensure legibility.

If this is not the case for a continuous-tone original already present, the legibility may be reduced or the size of the copy made has to be changed, e.g. by microfilming only part of the original.

### 4.6 Width of lines and characters

The width of lines and characters on originals to be colour microfilmed shall meet the requirements of ISO 128.

### 4.7 Uniformly coloured areas

Uniform colour areas of the original shall be represented by coloured cross-hatchings.

### 4.8 Adhesive foils

Adhesive foils with or without information (e.g. cross-hatching, arrows, etc.) may be used.

## 5 Test charts

### 5.1 Test chart S for line originals on uncoloured paper

#### 5.1.1 General

The elements of the test chart are specified in 5.1.2 to 5.1.5.

#### 5.1.2 Size and material

The size of the test chart is A4, in accordance with ISO 216. The spectral reflectance factor $R_{457}$ of the material is defined in 4.1, the layout in Figure 1. The test chart shall be kept in a dust-free and light-tight sleeve.

Dimensions in millimetres

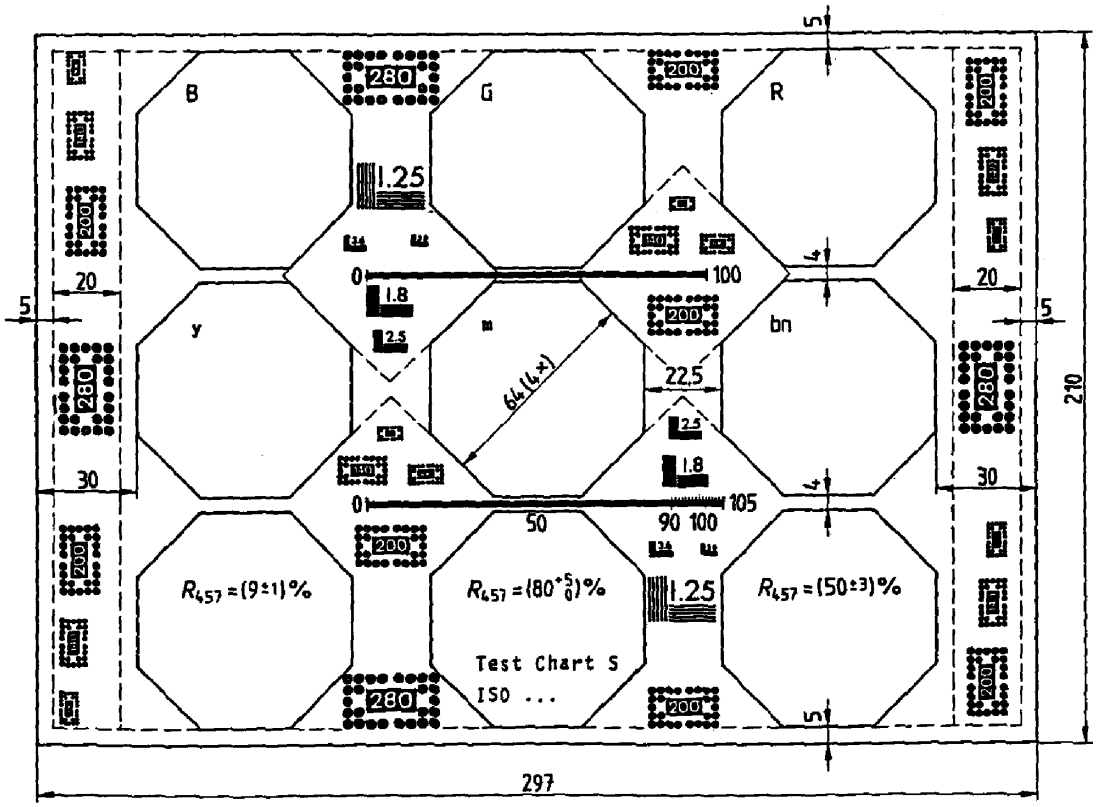



**Figure 1 — Original test chart S**

### 5.1.3 Colour patches and grey patches

There are nine patches, each measuring 64 mm, to check colour rendition and contrast.

Six patches are coloured blue (B), green (G), red (R), yellow (y), magenta (m), brown (bn). See also 4.2.

Three patches are neutral grey, having spectral reflectance factors $R_{457}$ = (9 ± 1) %, (50 ± 3) % and $(80^{+5}_{0})$ %.

At a reduction ratio 1:24, the test patches with the dimension of 64 mm will be reproduced on the microfilm with a dimension of 2,66 mm. In this case, a measuring aperture of 2,4 mm diameter shall be chosen.

NOTE 1 The sequence B-G-R should be respected because colour-densitometric evaluations are usually performed in this sequence and the colours are not always mentioned when quoting colour values.

NOTE 2 When selecting the reduction ratio of the microfilm reproduction (see also 5.1.5), it should be remembered that the diameter of the measuring aperture of the colour densitometer must, for technical reasons, be somewhat smaller than the patch to be measured on the microfilm.

### 5.1.4 Groups of test symbols

#### 5.1.4.1 General

There are two ISO characters available for measuring the quality produced on the microfilm, ISO character No. 1 and ISO character No. 2.

#### 5.1.4.2 ISO character No. 1

Ten groups of ISO characters are arranged on the test original for subjectively assessing the sharpness of the microfilming (see Figure 2). These are combinations of the ISO character No. 1 specified in ISO 446.

Each group of characters is identified by a characteristic number for the ISO character No. 1 specified in ISO 446. The sizes are arranged according to 1: $\sqrt{2}$ .

280 - 200 - 140 - 100 - 71

#### 5.1.4.3 ISO character No. 2

Two groups of resolution test patterns are arranged on the test original for objective measurements of the resolution. These are combinations of the ISO resolution test pattern No. 2 in accordance with ISO 3334.

Each group of resolution test patterns is identified by a characteristic number for the ISO resolution test pattern No. 2. The sizes are arranged close to 1: $\sqrt{2}$ .

1,25 - 1,8 - 2,5 - 3,6 - 5

#### 5.1.4.4 Relationship between the two groups of test symbols

The structure of ISO character No. 1 contains 3,5 line pairs (LP). Table 2 gives the relationship between characteristic numbers of ISO character No. 1 and ISO resolution test pattern No. 2.

The steps in the range of ISO test symbols with different dimensions in ISO character No. 1 and ISO resolution test pattern No. 2 are adapted to each other. (ISO character No. 1 is equal to 3,5 LP, see Table 2.)

**Table 2 — Relationship between the two groups of ISO test symbols**

| Characteristic numbers of ISO character No. 1 | Characteristic numbers of ISO resolution test pattern No. 2 |
|---|---|
| 280 | 1,25 |
| 200 | 1,8 |
| 140 | 2,5 |
| 100 | 3,6 |
| 71 | 5,0 |

#### 5.1.4.5 Determining resolution

Resolution can be determined using the quality index method. (See Annex A.)

Table 3 contains the sizes of ISO characters No. 1 and ISO resolution test pattern No. 2 and the number of line pairs (LP) per millimetre on the colour microfilm for a microfilming reduction ratio of 1:24.

**Table 3 — Characteristic numbers of the ISO characters No. 1 and ISO resolution test pattern No. 2 and corresponding line pairs per millimetre**

| | Test original | Colour microfilm | |
|---|---|---|---|
| | Number of the ISO characters No. 1 in accordance with ISO 446 | Size of the test symbol<br>mm | Corresponds to the line pairs<br>(LP)/mm |
| ISO character No. 1 | 280 | 0,116 6 | 30 |
| | 200 | 0,083 3 | 42 |
| | 140 | 0,058 3 | 60 |
| | 100 | 0,041 6 | 84 |
| | 71 | 0,0291 6 | 120 |
| | Characteristic number of the ISO resolution test pattern No. 2 | Size of the test symbol | Corresponds to the line pairs |
| | | mm | (LP)/mm |
| ISO resolution test pattern No. 2 | 1,25 | 0,033 3 | 30,03 |
| | 1,8 | 0,023 1 | 43,22 |
| | 2,5 | 0,016 7 | 59,8 |
| | 3,6 | 0,011 8 | 84,7 |
| | 5,0 | 0,008 3 | 120,5 |

### 5.1.5 Ruler

The upper ruler measuring 100 mm serves to determine the reduction ratio when microfilming (see Figure 1). The lower ruler has 1 mm subdivisions between 90 mm and 105 mm, thus the exact ratio of enlargement can be determined (see also 6.1.5).

## 5.2 Test chart H for continuous-tone originals made on uncoloured paper

### 5.2.1 Size and material

The size of the test chart is A4, in accordance with ISO 216. The spectral reflectance factor $R_{457}$ of the material is defined in 4.1, the layout in Figure 2. The test chart shall be kept in a dust-free and light-tight sleeve.

Dimensions in millimetres

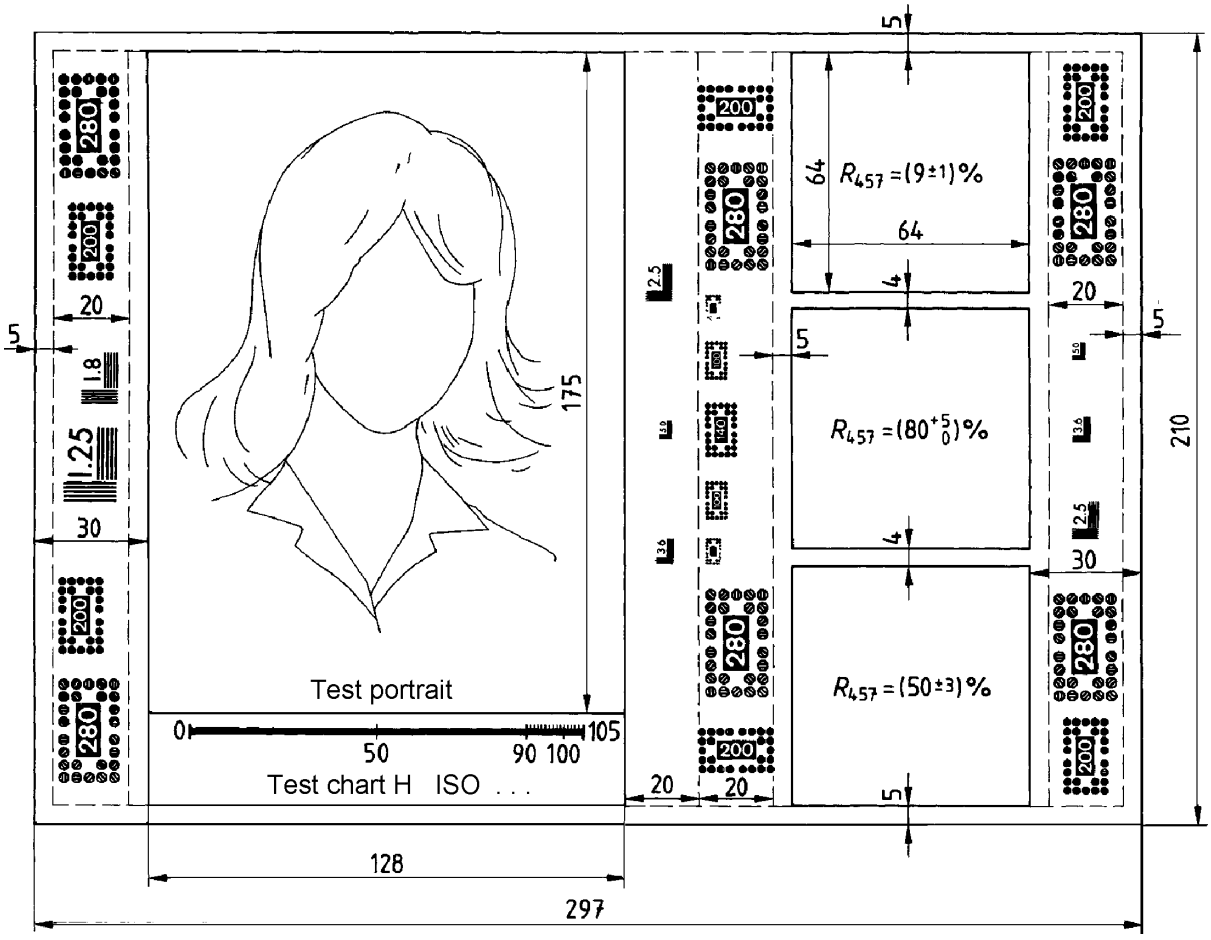



**Figure 2 — Test chart H**

### 5.2.2 Test portrait and grey patches

The colour rendition and the contrast are determined by means of the test portrait (128 mm × 175 mm) and of the three grey patches (64 mm × 64 mm) having spectral reflectance factors $R_{457}$ of (9 ± 1) %, (50 ± 3) % and $(80^{+5}_{0})$ %. (See also notes to 5.1.3.)

### 5.2.3 Groups of test symbols

See 5.1.4.

### 5.2.4 Ruler

The 100 mm ruler serves to determine the reduction ratio in microfilming (see Figure 2). By means of the 1 mm divisions between 90 mm and 105 mm, the exact ratio of an enlargement can be determined (see 6.2.4).

# 6 Evaluation of reproductions of the original test charts on colour microfilm

## 6.1 Evaluation of the test chart S

### 6.1.1 General

The evaluation is only made for the final product, which may be obtained either by a reversal process or a negative-positive process.

### 6.1.2 Evaluation of the colour patches

The colour patches of the end product shall be compared visually with the colour patches of the original test chart in order to assess colour deviations according to their brightness, chroma and hue.

The subjective assessment should be documented by a colorimetric or densitometric objective measure.

Colorimetric measures of the original test chart and the end product make a numerical comparison possible.

If the measures are made with a colour densitometer, the colour density shall be measured with three filters as specified in ISO 5-3. The diameter of the measuring aperture must be chosen based on the reduction ratio of the microfilming (see 5.1.3).

For a given film material, the exposure conditions, i.e. exposure time and filter values, and the processing latitude may be defined and adjusted to the theoretical values in view of matching the colour rendition with the original.

For visual comparison of the colour microfilm and the original test chart, the light source for the illumination shall produce the same light quality as that used for microfilming (see 3.1).

A film manufacturer is free to indicate, in a table, the optical density of colour patches for its film material.

The limits for colour deviations between original test chart and end product shall be defined.

### 6.1.3 Evaluation of the grey patches

The projection densities of the three grey patches shall be measured in accordance with ISO 5-3.

NOTE For monitoring processing quality, it is advisable to compare the projection densities of a microfilmed grey step wedge with those of a reference wedge supplied by the film manufacturer.

### 6.1.4 Smallest recognisable test-symbol size

The microfilming shall be done in such a way that the grey patch, having a spectral reflectance factor $R_{457}$ = (50 $\pm$ 3) % (see 5.2.3), is reproduced with an optical density $\lambda$ = 0,7. Under these conditions the best possible evaluation of the test-symbol size can be made.

Use a microscope with 50× magnification to find the smallest clearly recognized test-symbol size (see Annex A).

In order to be recognized and legible, the details of coloured elements (image elements, writing, graphic elements, etc.) shall be reproduced larger than black-and-white elements.

For an analogue test-symbol evaluation for black-and-white materials, it is necessary, according to ISO 10550, to have an optical density of 1,0 $\pm$ 0,1.

#### 6.1.5 Determination of the reduction ratio of the microfilming and magnification ratio of the enlargement

The reduction ratio $V_A$ of the microfilm is a numerical value which compares a given length (in millimetres) on the microfilm to the corresponding length of 100 mm on the original test chart:

$$V_A \frac{l}{100} = \frac{1}{x}$$

The 105 mm ruler on test chart S (see Figure 1) may be used to determine the exact magnification ratio of the enlargement.

### 6.2 Evaluation of the test chart H

#### 6.2.1 Evaluation of the test portrait

The test portrait on the colour microfilm shall be compared subjectively with the portrait on the original test chart H. For visual comparison the colour microfilming and the original test chart shall be illuminated with light sources of light type D50 in accordance with ISO 3664:2000.

NOTE The use of the light type D50 for this visual comparison facilitates the application of colour microfilm for printing.

#### 6.2.2 Evaluation of the grey patches

See 6.1.3.

#### 6.2.3 Smallest recognisable test symbol size

See 6.1.4.

#### 6.2.4 Determination of the reduction ratio of the microfilming and magnification ratio of the enlargement

See 6.1.5.

In addition to 6.1.5, the 1 mm division between 90 mm and 105 mm of the ruler (see Figure 2) may be used to determine the magnification ratio of the enlargement.

# Annex A
(informative)

# Test chart

## A.1 Ready-made continuous-tone original test charts

See Clause 1.

The range and technique of preparation of colour continuous-tone original test charts are so vast that no universally valid recommendations for their preparation can be given. In addition, when colour microfilming for archival and documentation purposes, the original test charts have frequently been prepared a long time in advance. The microfilming technique to be applied in these cases aims at obtaining the best possible result in spite of colour deviation that may exist in the original.

## A.2 Evaluation in a microfilm reader

See Clauses 1 and 6.

Colour microfilms may be evaluated in microfilm readers type “colour” having a translucent or an opaque viewing screen. To assure colour fidelity and distinct colour separation, such microfilm readers should have the following characteristics.

— Projection of the colour microfilm with the light type used for microfilming (see 3.1) on to a neutral grey translucent screen or on to a white, non-glossy opaque screen. Parts of the microfilm reader directly adjacent to the screen (surrounding the projected image) should be dark, non-coloured and matte.

— The light intensity on the translucent or opaque screen should be significantly higher than that of microfilm readers type “Literature, Newspaper” and type “Technical drawings”. The temperature in the film gate and image sharpness should meet the requirements of ISO 6198.

## A.3 Resolving power, graininess and maximum optical density, $\lambda_{max}$

This refers to 6.1.3.

In film materials there is a correlation between resolving power, graininess and maximum optical density. This has an influence on the smallest clearly recognizable test character size. It is recommended that the user obtain information from the film manufacturer.

## A.4 Metameric colours

Colour samples that look identical under a given illumination may look different under another illumination if their spectral reflection characteristics are different. This applies in particular to the visual comparison of the original test chart and the colour microfilming (see 6.1.2), if this comparison is made with an illuminant different from the standard illuminant D65.

## A.5 Subjective testing using ISO characters No. 1 and No. 2

See 5.1.4.

For different fundamental examinations, the use of two different ISO characters is necessary.

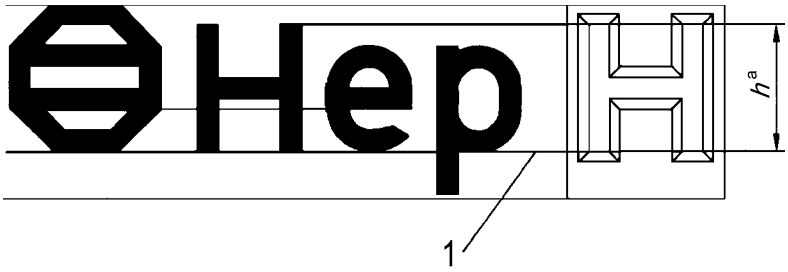
— ISO character No. 1, specified in ISO 446, is represented by an octagon as a typographical character. This character is valid only for a subjective testing method (visual evaluation) for legibility tests.

— ISO character No. 1 permits, after inspection (direct or by a microscope), the relationship to different characters of different languages with respect to character size; e.g. 5/7 = 0,714 ≈ 1: $\sqrt{2}$ of overall dimensions of ISO character No. 1 are equivalent directly to small block capital letter “H” (see Figure A.1).

This is an important aid to determining the character size for microfilming.

— ISO resolution test pattern No. 2 in accordance with ISO 3334 consists of fine pairs in two different directions. This resolution test pattern is valid only for objective measurements [determination of resolving power and contrast by Modulation Transfer Function (MTF)].

— ISO resolution test pattern No. 2 is not valid for subjective testing because the observer sees, during the subjective evaluation, the course (direction) of line-pairs structure while believing he/she sees the line pairs themselves.




**Key**

1 base line

a Character height of capitals.

**Figure A.1 — Comparison between ISO character No. 1 and character height**

## A.6 Calculation

Quality index is based on the evaluation of microimages of the ISO resolution test chart No. 2 (see ISO 3334). The ISO test chart No. 2 is a series of patterns with line-pair frequencies ranging from 1 (LP)/mm to 18 (LP)/mm.

For the purposes of this International Standard, the quality index, $QI$, of a microfilming system should be determined by the following equation:

$$QI = P \times H$$

where

$QI$ is the Quality Index;

$P$ is the highest pattern number from the ISO test chart No. 2 resolved in the microimage;

$H$ is the height of the lower case 'e' in the original document, in millimetres.

For excellent reproduction, in which the details of characters are clearly defined, $QI$ should be 8 or more. If a $QI$ of approximately 5 is obtained, the reproduction should be able to be read without difficulty, although characters with serifs or other fine details may not be well formed. If the $QI$ is 3 or less, the reproduction may only be able, at best, to be read with difficulty, the letters 'e', 'c', and 'o' being partly closed (or worse).

A $QI$ of 3,6 is regarded as marginal image quality.

# Bibliography

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