INTERNATIONAL STANDARD

ISO 6328

Second edition
2000-05-01

Photography — Photographic materials — Determination of ISO resolving power

Photographie — Surfaces sensibles — Détermination du pouvoir résolvant ISO

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6328 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO 6328:1982), which has been technically revised.

In this revision, the description of the process of evaluating images has been expanded. The specifications of the resolving power camera's objectives have been altered slightly, and the illustration of a resolving-power camera has been moved to informative annex A. The text describing qualification of the camera has been expanded to include the target.

This second edition also contains many other changes, most of which were made for the sake of clarity of understanding. Among these changes is a clarification of part of the scope. The definitions have also been expanded; some terms have been substituted for others in order for their usage to be more consistent and their meaning to be clearer. The term "element" has been introduced in place of "test pattern" and "tribar resolving-power target" replaces "test chart". Other terms introduced or clearly defined include "target polarity", "limiting element" and "ISO resolving power".

Annex A of this International Standard is for information only.

Introduction

The resolving power of a photographic material is used to estimate the smallest detail that may be visually observable when recorded on the material. It combines the effects of modulation transfer function, graininess and contrast, all of which contribute to overall image quality, and human observers, each of whom may differ in their assessment of quality. The method is particularly useful for appraising materials that will be viewed at high magnification such as microfilm, 8 mm and 16 mm motion picture film, etc. However, resolving power should not be expected to predict overall image quality in every situation, because image quality is too complex to be described by a single factor. This is particularly the case for low-contrast continuous-tone products.

Resolving power as measured by photographing suitable tribar resolving-power targets is very dependent on conditions of measurement, and the structure of the target element. It depends markedly on the photographic conditions employed and on the presence of background glare from the illuminated target. It is affected by such factors as the spectral content of the light used, the exposure level, the focus, processing procedures, the lens aperture at which the test is made, the contrast of the target and the magnification of the camera lens and the microscope through which the images are observed, etc.

The judgment exercised by the human observer in determining resolving power can be a source of significant experimental error. The criterion of resolution given in this International Standard was selected because it appeared to admit less latitude in interpretation than others. The description of the process of evaluating images has been expanded in this revision.

Photography — Photographic materials — Determination of ISO resolving power

1 Scope

This International Standard specifies a method for determining the resolving power of photographic films, plates and papers, including black-and-white films, black-and-white printing papers, colour-reversal films, colour-negative films, and colour-printing papers.

Materials designed for X-ray and other high-energy radiation are excluded, as are photographic materials used in medical radiography where the exposure source is an intensifying screen in contact with the film (sensitized on one or two sides). Also excluded are materials having photo-polymer, diazo, etc. light-sensitive layers.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 497:1973, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*.

ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications*.

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
element
three parallel bars and two spaces of equal width and separation

3.2
group number
number of square dots preceding the array of elements which is used to locate a position on the tribar resolving-power target

3.3
tribar resolving-power target
array of identical elements that decrease in size (geometrically), and typically spirals towards the centre of the target format

3.4
spatial period
within an element of a tribar target, the distance between the leading edges of two consecutive bars

NOTE The spatial period is usually expressed in millimetres (mm).

3.5
spatial frequency
reciprocal of the spatial period denoting the number of identical bar and space pairs that can be contained within an overall width of 1 mm

NOTE The spatial frequency is expressed as reciprocal millimetres (cycles per millimetre).

3.6
contrast ratio
ratio of the luminances of the bars of the element to the luminance of the surround or the antilog of the density difference between the bar and its surround

3.7
target polarity
transmission relationship of the parallel bars and their surround

3.7.1
negative polarity
light bars against a dark surround

3.7.2
positive polarity
dark bars against a light surround

3.8
camera
optical system by which the tribar resolving-power target is imaged and recorded, with suitable reduction in size, on the photographic material being tested

3.9
reference surface
flat surface against which the emulsion side of the photographic material is pressed during exposure

3.10
qualification
⟨camera⟩
attainment of the necessary high optical performance of a camera, essential for its use in determining resolving power

3.11
replicate set
series of images of the tribar resolving-power target made at the same focus and exposure settings

3.12
exposure series
series of images made at different exposure settings

3.13
focus series
series of images made at different focus settings

3.14
resolving power
ability of a photographic material to maintain, in the developed image, the separate identity of parallel bars when their separation is small

NOTE The resolving power is numerically equal to the spatial frequency of the smallest element that can be resolved.

3.15
limiting element
that element in the image of the tribar resolving-power target selected by the observer, with reasonable confidence, to be at the threshold of no longer being able to distinguish three bars and two spaces, even if the number were not known to be three

3.16
resolving power of a replicate set
median of the resolving-powers of the test material in images of the replicate set

3.17
maximum resolving power
resolving power of the test material under conditions of optimum focus and exposure and the test conditions defined in this International Standard

3.18
ISO resolving power
averaged maximum resolving power, rounded according to Table 5 and ISO 497

NOTE There is an ISO high-contrast and an ISO low-contrast resolving power.

4 Sampling and storage

In determining the resolving power of a product, it is important that the samples evaluated yield the average results obtained by users. This will require evaluating several different batches periodically under the conditions specified in this International Standard.

Prior to evaluation, the samples shall be stored according to the manufacturer's recommendations for a length of time that simulates the average age at which the product is normally used. When no specific recommendation is made, storage shall comply with the specifications of ISO 554, 23 °C ± 2 °C and a relative humidity of (50 ± 5) %. Several independent evaluations shall be made to ensure the proper calibration of equipment and processes. The basic objective in selecting and storing samples as described above is to ensure that the material characteristics are representative of those obtained by a consumer at the time of use.

5 Test method

5.1 Principle

The resolving power of a material is determined by visual inspection of the image of the tribar resolving-power target recorded on the test material by means of a suitable camera system. It depends on the contrast ratio, polarity and exposure. The resolving power passes through a maximum as the exposure is changed from a value at the toe of the characteristic curve to a value toward the shoulder. Furthermore, the resolving power passes through a maximum as the focus setting is given successive values that vary from one side of the correct focus to the other.

In brief, the procedure is to first determine the exposure that gives the best-resolved image of the tribar resolving-power target, using the focus setting determined during the camera qualification test. A through focus series is then run at this exposure level to optimize focus. The maximum resolving power obtained from this series is used to determine the ISO resolving power of a sample using the scale defined in Table 5.

Because of the granular structure of the image when viewed under magnification, a replicate set often yields a range of resolving power values. To mitigate the effect of this variable, ISO resolving power is defined below in terms of the median value of a set of not less than nine replicate images made at the same focus and exposure setting.

Microscopic examination and readout of the tribar target's image is required to determine resolving power. Since the technique involves observer judgment in determining the finest element resolved, experience has shown that, without application of the procedures of this International Standard, observers may differ by more than a factor of two in the resolving power value they assign to the same image.

NOTE No known set of calibrated images exists for training and definition purposes.

Accordingly, this International Standard provides a set of guidelines that, when applied, has been shown to produce consistent results within and between observers. With training and use of these guidelines, experienced observers should agree to within ± 1 element or about ± 12 % (in terms of cycles per millimetre) for single-point estimates, and ± 6 % for mean estimates with a standard deviation of ± 6 %.

5.2 Apparatus

5.2.1 Element

The element shall be the three parallel bars and two spaces of equal width and separation, inscribed in a square as shown in Figure 1. For a negative-polarity target, the shaded part of Figure 1 represents the darker portion, and the unshaded part the lighter portion, of the field of view. The bar length to width aspect ratio shall be 5:1. In terms of displacement L (period distance in millimetres) of the bars and interspaces, the dimensions of the square are 2,5 L x 2,5 L. The shaded part of Figure 1 is termed the "surround".

The width of the bars and the width of the interspaces shown in Figure 1 shall be within ± 2,5 % of the aim value. The overall width and length of the element (2,5 L) shall also be within ± 2,5 % of the aim value.

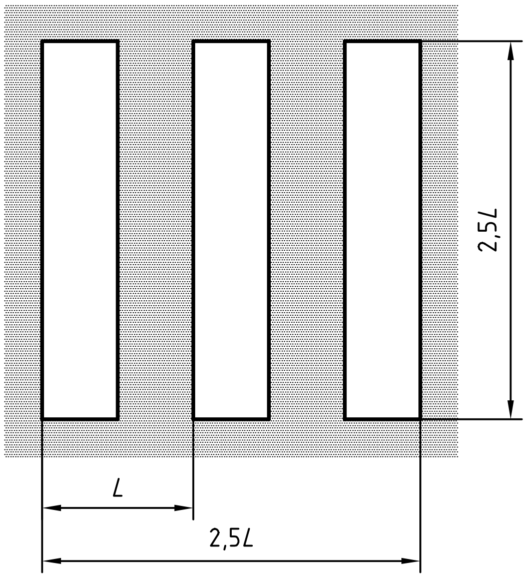


Figure 1 — Element test pattern

The spatial frequency, expressed as reciprocal millimetres, of the element may be calculated by one of the methods described in a) or b) below. Selection is based upon the measurement instrumentation that provides the highest dimensional accuracy within the distances being measured.

a) By measuring the bar interspace distance, or period L, in millimetres, and applying the formula:

$$\text{Spatial frequency} = \frac{1}{L}$$

b) By measuring the overall element width (2,5 L), in millimetres, and applying the formula:

$$\text{Spatial frequency} = \frac{2{,}5}{\text{Overall element width}}$$

5.2.2 Tribar resolving-power target

The tribar resolving-power target shall be an array of elements as illustrated in Figure 2.

The spatial frequencies of the elements in the array shall be as shown in Table 1. The change in spatial frequency between successive elements shall be equal to $20\sqrt{10}$. This corresponds to increments of about 12 %.

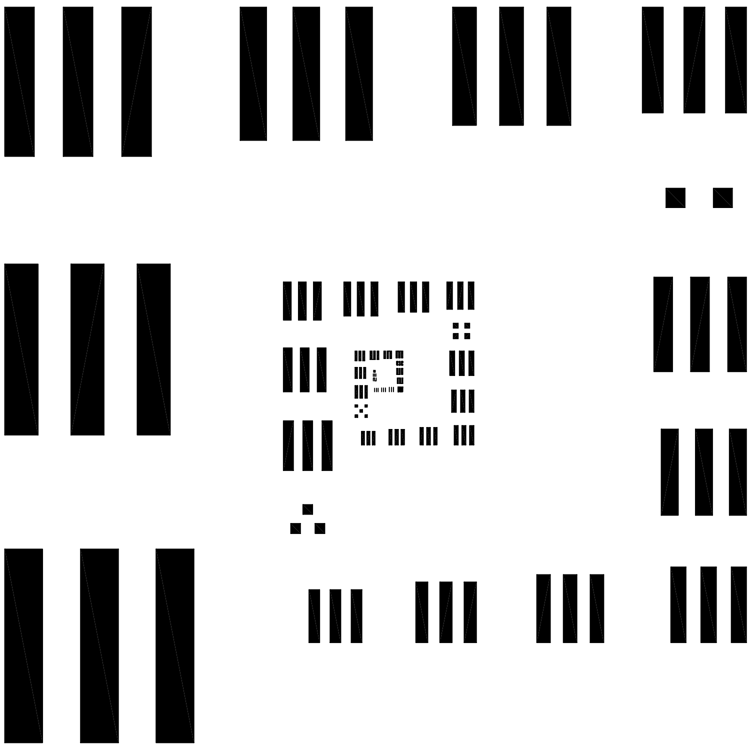
The tribar resolving-power target shall be a spectrally non-selective neutral transparency.

The array of elements in Figure 2 is approximately 100 mm square and is centred in a surround that is about 125 mm square. The two horizontal lines are 100 mm ± 0,5 mm apart and are used to determine the magnification.

The luminance of the three bars of each element and the luminance of the surround shall be measured at the position of the eyepiece which serves as the imaging lens.

NOTE A spot photometer may be used to measure the luminance of the surround and that of the largest bars to verify the contrast ratio of the tribar resolving-power target in the resolving-power camera. Since it will not be feasible to measure the luminance of the smaller bars with the spot photometer, a micro-densitometer may be used to verify the contrast uniformity of the target from the largest to the smallest elements.

This International Standard specifies tribar resolving-power targets of two different contrast ratios and polarities.



Although a negative-polarity tribar resolving-power target has light bars on a darker background, for the sake of clarity of reproduction, this figure shows the bars black against a white background.

Figure 2 — Tribar resolving-power target

Table 1 — Spatial frequency of elements

Values of frequency in reciprocal millimetres

Element within the group	Group number						
	1	2	3	4	5	6	7
1	0,100	0,200	0,398	0,794	1,58	3,16	6,31
2	0,112	0,224	0,447	0,891	1,78	3,55	7,08
3	0,126	0,251	0,501	1,00	2,00	3,98	7,94
4	0,141	0,282	0,562	1,12	2,24	4,47	
5	0,158	0,316	0,631	1,26	2,51	5,01	
6	0,178	0,355	0,708	1,41	2,82	5,62	

NOTE The entries are the values of L^{-1} in reciprocal millimetres for the 39 elements in the tribar resolving-power target of Figure 2. The number of square dots in Figure 2 indicates the group number. A convenient way to identify each element for recording purposes is to use the form 3/2, where 3 is the group number and 2 indicates the second element in that group.

5.2.2.1 High-contrast tribar resolving-power target

For the high-contrast tribar resolving-power target, the common logarithm of the contrast ratio shall be at least 2,0. This is equivalent to a contrast ratio of 100:1 or greater.

5.2.2.2 Low-contrast tribar resolving-power target

For the low-contrast tribar resolving-power target, the common logarithm of the contrast ratio shall be 0,20 ±0,02. This is equivalent to a contrast ratio of approximately (1,585 ± 0,073):1.

5.2.2.3 Illumination of the tribar resolving-power target

The tribar resolving-power target shall be illuminated by a diffuse light source with spectral characteristics similar to those for which the material is designed, and shall be specified when quoting the ISO resolving-power. The target luminance should facilitate using an exposure time that falls within the film manufacturer's suggested range to avoid reciprocity failure.

Within the area of the elements, the illuminance shall be uniform to within ± 2,5 % of the mean level. Outside the element area (up to a distance of 10 mm outwards from the edges), the illuminance shall be uniform to within ± 5 % of the mean level. The target is removed (referred to as open-gate) when these measurements are being made with a spot photometer.

5.2.3 Camera

The camera may consist of a compound microscope (objective, eyepiece, and draw tube), a means to accurately position the objective with respect to the photographic material, and a means for holding the photographic material flat.

A typical camera of this type is shown in Figure A.1 of annex A. The design, construction and mounting of the camera should be such as to minimize the possibility of unintended relative motion, resulting from vibration, etc., between the microscope and the photographic material being exposed. It is also important to control flare and inter-reflections in the optical system to avoid undesirable degradation of the image of the tribar resolving-power target at the focal plane.

While it is necessary to carefully specify some aspects of camera design in order for users to get consistent results, it is recognized that other designs are permissible so long as they are shown to give the same result as that achieved with the requirements of this International Standard.

5.2.3.1 Microscope objectives

The microscope objectives shall be apochromatic, may be of the planapochromatic type, with blackening on the inside and appropriate for operation without a cover-glass or oil.

The objectives used shall meet the following requirements.

a) For determining the ISO resolving power of photographic materials up to 300 mm^{-1}, a high-quality apochromatic objective with a numerical aperture of 0,25 or greater is required.

b) For determining the ISO resolving power of photographic materials greater than 300 mm^{-1}, a high-quality apochromatic objective with a numerical aperture of 0,60 or greater is required.

5.2.3.2 Microscope eyepiece

The microscope eyepiece should be designed for use with the objective used in the camera (a × 10 compensating eyepiece has been found acceptable).

A diaphragm shall be located in the plane of the exit pupil. Its diameter shall be the same as the objective pupil through the eyepiece.

5.2.3.3 Draw tube

The eyepiece and the objective shall be mounted rigidly in a draw tube. Since some objectives perform best at a mechanical tube length significantly different from the nominal value, the mechanical tube length should be optimized for the objective used.

5.2.3.4 Reference surface

The camera shall contain a flat reference surface against which the emulsion side of the photographic material is pressed during exposure. The central hole in the reference surface shall be as small as practical, but shall not block any of the relevant light and shall not interfere mechanically with the objective. The area of the reference surface shall be kept to a minimum to minimize the risk of dust and dirt affecting the focus. Provision shall be made to hold films and papers flat; a flat vacuum back has been found satisfactory for this purpose.

5.2.3.5 Precision of the focus setting

The focus setting of the camera shall be capable of being reset to within 1 µm.

5.2.3.6 Reduction ratio of the camera

The overall optical-system magnification reduction factor, measured at the image plane, for the lower (0,25 or greater) numerical aperture objective-lens system shall be 200 times ± 2,5 %. On the photographic test material, this will result in spatial frequencies 200 times the values given in Table 1. For the higher (0,60 or greater) numerical aperture lens objective system, the spatial frequencies shall be 400 times ± 2,5 % the values given in Table 1.

5.2.3.7 Qualification of the camera and target

A camera and target shall be deemed to have qualified if the following requirements are met.

a) The camera and target shall be capable of determining the resolving power of very high resolution material[1)] when using a negative-polarity target.

b) The camera and target for measurement of high-contrast resolving powers up to 300 mm^{-1} shall yield an ISO high-contrast resolving power of at least 800 mm^{-1} and an ISO low-contrast resolving power of at least 500 mm^{-1} on the cited material[1)].

c) The camera and target for measurement of high-contrast resolving powers above 300 mm^{-1} shall yield an ISO high-contrast resolving power of at least 1 250 mm^{-1} and an ISO low-contrast resolving power of at least 800 mm^{-1} on the cited material[1)].

NOTE It is recognized that the use of positive-polarity targets may result in additional optical flare, and therefore reduce the effective target contrast. Ideally, if a positive-polarity target is to be used, one would wish to qualify the camera with a positive-polarity target. However, the use of positive-polarity targets is not recommended for camera qualification due the lack of photographic materials with suitably high resolving powers.

5.2.4 Viewing microscope

The processed photographic material shall be evaluated by inspection with a microscope.

Ordinary high-quality achromatic microscope objectives are satisfactory for the viewing microscope. For the purpose of this International Standard, oil-immersion microscope objectives shall not be used to evaluate resolving power test images.

The recommended magnification of the viewing microscope is between 0,5 and 1,0 times the resolving power, in reciprocal millimetres, that is being determined.

For resolving powers under 1 000 mm^{-1}, the numerical aperture of the objective shall be not less than 0,001 times the resolving power that is being determined or shall be not less than 0,9, whichever is less.

The luminance of the developed image seen by the observer should be adjusted to a comfortable value. The light source should have a continuous spectrum. In particular, a source having spectral lines shall not be used with colour materials.

Images of the tribar resolving-power target shall be evaluated with the same type of illumination normally used with the material. Normally, films are viewed by transmitted light and papers by reflected light, but there are exceptions and these should be noted. Care shall be taken to ensure that the illumination is sufficient when inspecting papers.

For the purpose of qualifying the camera as described in 5.2.3.7, the test material[1)] images shall be microscopically viewed using a lens objective of × 100 magnification and a total magnification of at least × 1 000. The numerical aperture of the lens shall be 0,9 or greater.

5.3 Optimum-exposure test

5.3.1 Ambient conditions

Samples shall be exposed at a temperature of 23 °C ± 2 °C and relative humidity of (50 ± 5) %.

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1) KODAK High Speed Holographic Film (ESTAR Base) SO-253 (develop D-19 for 5 min. at 20 °C) or a film with equivalent contrast, grain structure and demonstrated resolving power. KODAK High Speed Holographic Film is the trade name of a product supplied by KODAK. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of the product named.

5.3.2 Exposure

Make an exposure series with the camera focus set close to the best focus. The series shall have approximately equal increments in the logarithm of relative exposure. Make replicate exposures at each exposure level. Replicate sets for each exposure level shall contain an odd number of pictures. A minimum of three pictures is required in each replicate set. The detailed procedure for determining optimum exposure is described in 5.3.6.

To avoid problems with failure of the reciprocity law, the duration of the exposure shall be comparable to that ordinarily used for the material.

5.3.3 Delay before processing

In the time between exposing and processing, the latent image may change. This characteristic should be recognized when establishing the optimum exposure.

5.3.4 Processing

The chemicals, processing steps, equipment, and processing conditions shall be those ordinarily used for the material. Where relevant, the processing may be as the manufacturer recommends for the material being evaluated.

Since processing can influence the measured resolving power, specifications for the process shall be described when reporting the ISO high (or low)-contrast resolving power for a material.

5.3.5 Evaluation of images

5.3.5.1 Criterion of resolution

In order that an observer may judge that an element is resolved, the image of the bars shall be perceived in such a way that the number of bars can be counted with reasonable confidence even if the number is not known to be three. The concept of "reasonable confidence" is intended to indicate a level of confidence that is somewhere between complete confidence and no confidence at all. The rationale for this approach is that there is important information beyond the resolution level where the elements are read with certainty.

Guidelines for determining the limiting element or the maximum resolvable element in the image of a tribar resolving-power target are as follows:

a) Each element shall be judged independently, regardless of the appearance of the image of the other elements.

b) Rounding of the corners and shortening of the bars are reasonable effects to expect in a just-resolved element. The element image should show three bars as approximately equal in length. However, the element may be judged resolved if any one bar is at least half as long as the other two and the element otherwise meets the criteria.

c) There should be a visual perception of density difference between the bars and their surround for the entire length of the bars even though this density difference may not be uniform for the length of the bar due to granular microstructure of the material or other artifacts.

d) An element which is independently judged resolved shall be considered not resolved if the images of the next lower and next higher spacial frequency elements are not resolved. An element which is independently judged not resolved shall be considered resolved if both of the adjoining elements are resolved. Table 2 illustrates examples of these two cases.

e) Spurious[2)] resolved elements should not be counted.

[2)] An element that depicts a shift in phase will be observed as a density reversal of the bars and the spaces (i.e., an effective interchange of the position of the elements' bars and interspaces). This may also be accompanied by a different number of lines (other than three) in the element.

Table 2 — Resolving power examples

group/element	Example A	Example B
6/1	Y	Y
6/2	Y	Y
6/3	N	N
6/4	Y	Y
6/5	N	Y
6/6	N	N
In the above examples, "Y" denotes resolved, and "N" denotes not resolved. The correct reading to record for Example A is 6/2 and for Example B, 6/5.		

5.3.5.2 Procedure for evaluating the resolving power of a replicate set

The criterion of 5.3.5.1 shall be used to determine whether an element is resolved. The resolving power is defined as the greatest spatial frequency of the element that is resolved by this criterion.

The resolving power of a replicate set of images is defined as the median of the resolving powers of the test material in images of the replicate set. The median of an ordered set of values is the value above and below which falls an equal number of values.

5.3.6 Optimum exposure

Determine the resolving power of each image of the exposure series. Table 3 shows the exposure series obtained for a typical film. Plot the median resolving power for the replicate set of each exposure level versus the logarithm of the relative exposure as illustrated in Figure 3. Draw a smooth curve through the plotted points, and determine the exposure corresponding to the maximum; this is termed the "optimum exposure".

To ensure that the optimum exposure is correctly determined, two requirements must be fulfilled. First, the total range used in the exposure series shall be sufficient to ensure that the curve passes through a maximum. The second requirement ensures that the increment in the log exposure series is not too large.

Draw a vertical line in the plot at the optimum exposure. Then select the four plotted points that lie closest to this line, two on either side of the line. (In Figure 3, these are the points with the abscissae of approximately 0,6; 0,7; 0,8 and 0,9.) The largest resolving power in this set of four shall be not more than two times the smallest resolving power in the set.

Table 3 — Exposure series

Exposure setting	Replicates			Median
	No. 1	No. 2	No. 3	
1	—	—	—	
2	—	—	—	
3	—	—	—	
4	45	45	45	45
5	89	100	79	89
6	126	126	112	126
7	126	158	126	126
8	141	141	126	141
9	126	141	112	126
10	126	112	100	112

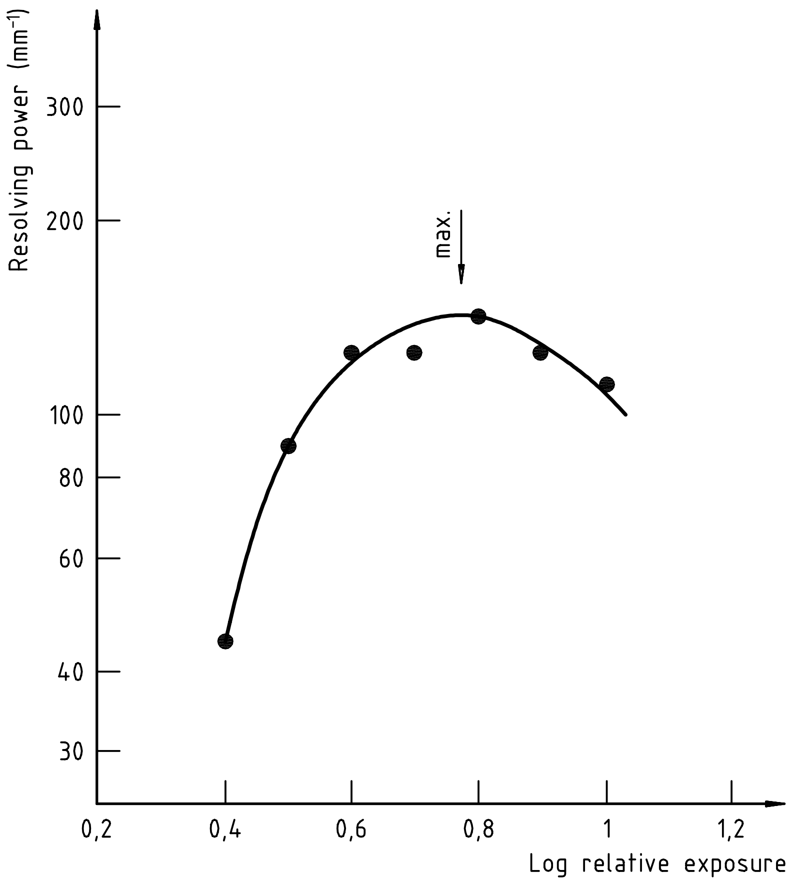


Figure 3 — Exposure-series plot

5.4 Optimum-focus test

5.4.1 Ambient conditions

Samples shall be exposed at a temperature of 23 °C ± 2 °C and a relative humidity of (50 ± 5)%.

5.4.2 Exposure

Make a focus series using the optimum exposure determined. Focus settings shall be separated by equal increments in the image plane. The replicate sets made at each focus setting shall contain an odd number of pictures, with a minimum of nine.

5.4.3 Delay before processing

Same as 5.3.3.

5.4.4 Processing

Same as 5.3.4.

5.4.5 Evaluation of Images

Same as 5.3.5.

5.4.6 Optimum focus

For each relative focus setting, determine the median resolving power of the replicates. Table 4 shows the focus series values obtained for a typical film. Plot the median resolving power for each replicate set for each focus setting versus the focus setting, as illustrated in Figure 4. Draw a smooth curve through the plotted points and determine the focus setting corresponding to the maximum; this is termed the "optimum focus".

To ensure that the optimum focus is correctly determined, two requirements must be fulfilled. First, the total range used in the focus series shall be sufficient to ensure that the curve passes through a maximum. The second requirement is to ensure that the focus setting increment in the focus series is not too large.

Draw a vertical line in the plot through the maximum of the curve. Then select the four plotted points that lie closest to this line, two on either side of the line. The largest resolving power in this set of four shall be not more than two times the smallest resolving power in the set.

Table 4 — Focus series

Relative focus setting	Replicates									Median
	No.1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	
–2	158	100	126	141	112	158	141	112	100	126
–1	141	126	141	126	141	126	158	141	89,1	141
0	141	141	126	141	141	158	126	126	89,1	141
+1	141	158	126	126	141	141	178	141	89,1	141
+2	112	126	141	141	126	126	141	112	79,4	126

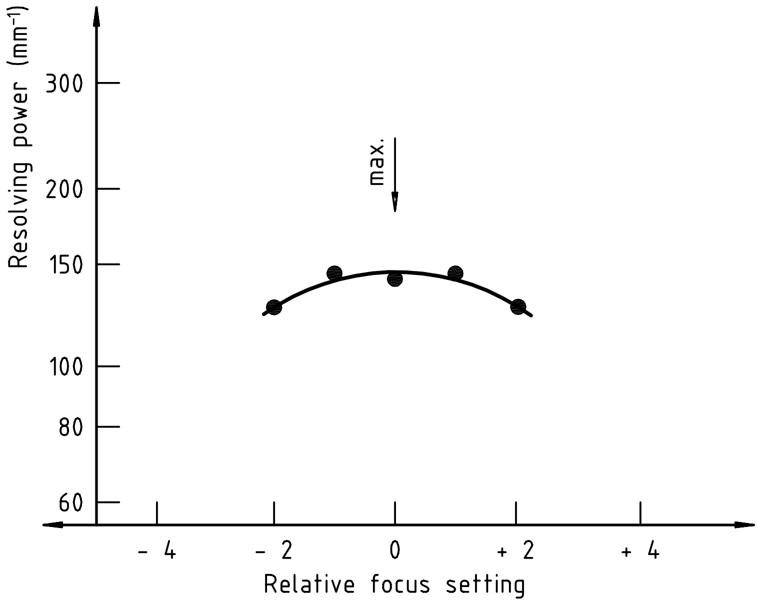


Figure 4 — Focus-series plot

5.5 Maximum resolving power

The maximum of the plot of the median resolving powers obtained in 5.4.6 is the "maximum resolving power" of the sample under test.

To ensure that the maximum resolving power has been correctly determined, the maximum resolving power of the sample shall be compared with the maximum resolving power of the optimum-exposure series determined in 5.3.6.

The maximum resolving power of the optimum-exposure series shall not be less than 75 % of the maximum resolving power of the sample. If it is found that this criterion is not met, the procedure in 5.3.6 shall be repeated at the "optimum focus" setting; followed by a repetition of the optimum-focus series defined in 5.4.6.

5.6 Alternative test

The procedure described in 5.3 and 5.4 involves making a set of exposures (exposure series), and processing the material, then making a second set of exposures (focus series), and processing the material a second time. This two-step procedure minimizes the number of images that need to be made and evaluated.

Some laboratories have highly automatic equipment, however, and may prefer to make one set of exposures that includes all of the combinations of exposure and focus settings. When this method is used, prepare plots like those in Figure 3 at each of a number of different focus settings, and determine the optimum exposure from the curve that appears to be at the best focus. Then prepare a plot as shown in Figure 4, on the basis of pictures made at the optimum exposure.

6 Product classification

6.1 Resolving power scale

ISO resolving power shall be obtained directly from the arithmetic average of maximum resolving powers for a sample using table 5 which shows the rounding method to be used. This is then designated the ISO high- or low-contrast resolving power of the sample tested, depending on whether the contrast ratio of the test chart is greater than 100:1 or is 1,6:1, respectively.

6.2 Resolving power of a product

The resolving power of a product (as distinguished from that of a specific sample of a product) shall be based on the average of the maximum resolving powers determined for at least three samples of the product when selected, stored, and tested, as specified above. The ISO high- or low-contrast resolving power of a product is then determined from the average maximum resolving power for the different batches using Table 5.

7 Product marking and labelling

The resolving power of a product determined by the method specified in this International Standard and expressed according to Table 5 may be designated ISO high- or low-contrast resolving power and denoted in the form ISO-RP 320 or ISO-RPL 320 depending on the contrast of the target.

To ensure correct interpretation, the target contrast ratio, target polarity, exposure time, illuminant, and processing conditions should be specified when reporting the ISO resolving power.

Table 5 — ISO resolving power

Range of calculated resolving power		**ISO resolving power number[a]**
from	**to**	
17,8	22,3	20
22,4	28,1	25
28,2	35,4	32
35,5	44,6	40
44,7	56,1	50
56,2	70,7	63
70,8	89,0	80
89,1	111	100
112	140	125
141	177	160
178	223	200
224	281	250
282	354	320
355	446	400
447	561	500
562	707	630
708	890	800
891	1 110	1 000
1 120	1 400	1 250
1 410	1 770	1 600
1 780	2 230	2 000
2 240	2 810	2 500

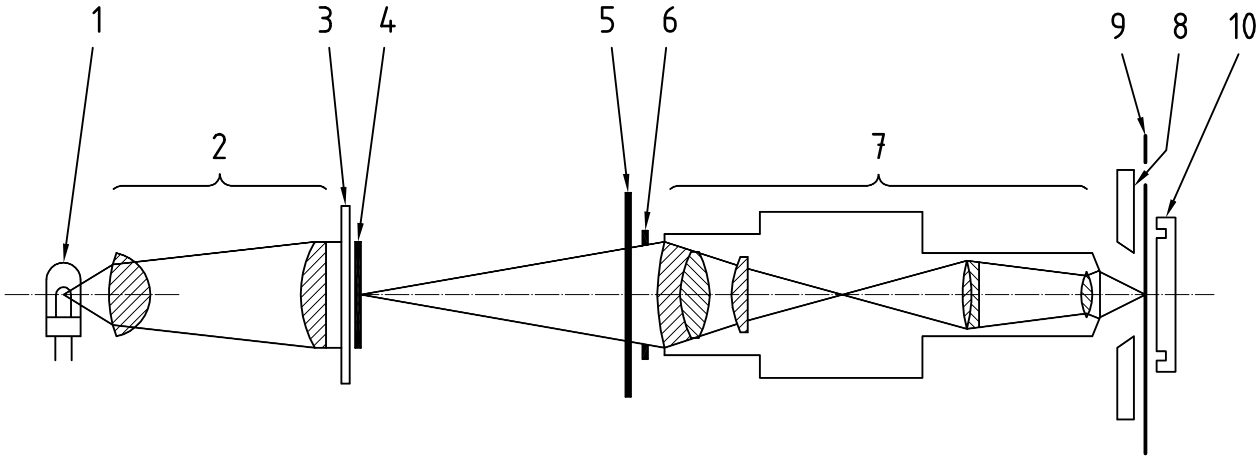
NOTE Since the significant figures in this table repeat in each decade, it can easily be extended in either direction.

[a] These numbers represent the first rounding of preferred numbers according to ISO 497.

Annex A
(informative)

Illustration of an example of a resolving-power camera

Figure A.1 illustrates a typical resolving-power camera configuration which conforms to the specifications in this International Standard.



Key

1 Lamp
2 Illumination optics
3 Diffuser
4 Tribar resolving-power target
5 Shutter
6 Diaphragm
7 Imaging optics
8 Reference surface
9 Photographic material
10 Vacuum back

Figure A.1 — Resolving-power camera

ICS 37.040.20

Price based on 15 pages