INTERNATIONAL STANDARD

# ISO 9236-1

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# Photography — Sensitometry of screen/film systems for medical radiography —

## Part 1:
Determination of sensitometric curve shape, speed and average gradient

*Photographie — Sensitométrie des ensembles film/écran pour la radiographie médicale —*

*Partie 1: Détermination de la forme de la courbe sensitométrique, de la sensibilité et du contraste moyen*



Reference number
ISO 9236-1:1996(E)

## 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.

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.

International Standard ISO 9236-1 was prepared by Technical Committee ISO/TC 42, *Photography*.

ISO 9236 consists of the following parts, under the general title *Photography — Sensitometry of screen/film systems for medical radiography*:

— *Part 1: Determination of sensitometric curve shape, speed and average gradient*

— *Part 2: Determination of the modulation transfer function (MTF)*

— *Part 3: Mammography*

Annex A of this part of ISO 9236 is for information only.





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## Introduction

This part of ISO 9236 provides methods for determining the sensitometric curve shape, the average gradient and the speed of radiographic screen/film/filmholder/processing systems used in medical radiography, except in mammography and dental radiography.

The sensitometric curve, which is also needed for the determination of other properties (as, for example, the modulation transfer function) is measured under low scatter conditions via intensity scale X-ray sensitometry, preferably using an inverse square sensitometer. Since it is unlikely that the curve shape will be energy dependent within the kilovolt range covered by this part of ISO 9236, any one of the four beam qualities corresponding to those used for speed determination may be used for determining curve shape. For the determination of the sensitometric curve shape, the irradiation of the screen/film/filmholder combination need be measured only in relative units.

While the average gradient is determined from the sensitometric curve shape, speed must be measured in a separate way, since the exposure conditions should simulate as closely as possible those which are used in practice. Therefore, scattered radiation is included, accompanied by a slight change of beam quality compared to the beam quality used for intensity scale sensitometry. The exposure is simulated by using appropriate phantoms and tube voltages. The screen/film/filmholder combination is exposed behind the phantom. The exposure is measured in absolute units (gray, Gy) in order to determine the speed.

Speed is generally dependent on X-ray energy and the amount of scattered radiation emerging from the patient. Therefore, a wide variety of speed values may be expected under practical conditions. The four measurement conditions described in this part of ISO 9236 provide values for speed and average gradient which are representative of those found under practical conditions.

Four different techniques are offered, differing in beam quality and fraction of scattered radiation. These techniques simulate four different scenarios of the practice: imaging extremities; skull; lumbar spine and colon; and chest. Speed may be measured for each technique of interest.

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# Photography — Sensitometry of screen/film systems for medical radiography —

## Part 1:
Determination of sensitometric curve shape, speed and average gradient



## 1 Scope

This part of ISO 9236 specifies methods for determination of the sensitometric curve shape, average gradient and speed of a single sample of a screen/film/filmholder/processing system in medical radiography. Special radiographic applications such as mammography, dental radiography and direct-exposing medical radiographic systems (see for example ISO 5799) are excluded.

The filmholder may be any means which ensures close screen/film contact and prevents the film from being exposed to ambient light. In particular, the filmholder may be a light-tight vacuum bag, as often used in the laboratory, or a radiographic cassette as used in medical radiography.

NOTE — Hereafter, screen/film/filmholder combinations will be referred to as "combinations" and will be referred to as "systems" when the processing is included.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9236. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9236 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5-2:1991, *Photography — Density measurements — Part 2: Geometric conditions for transmission density.*

ISO 5-3:1995, *Photography — Density measurements — Part 3: Spectral conditions.*

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

## 3 Definitions

For the purposes of this part of ISO 9236, the following definitions apply.

**3.1 air kerma,** $K$**:** That energy which is transferred by ionizing radiation (for instance X-rays) to air molecules divided by the mass of air in that volume where the energy is released. The unit is the gray (Gy).

**3.2 sensitometric curve:** Plot of the density of a processed photographic film as a function of the logarithm of the exposure.

**3.3 speed, $S$:** Quantitative measure of the response of the screen/film system to radiant energy for the specified conditions of exposure, processing and density measurement.

**3.4 average gradient, $\overline{G}$:** The slope of the straight line joining two specified points on a sensitometric curve.

**3.5 net density, $D$:** Density of an exposed and processed film minus the density of an unexposed and processed sample of that film.

## 4 General requirements

### 4.1 Storage and handling conditions

The film and screens shall be stored according to the manufacturer's recommendations. Before and during exposures, the temperatures of the films and screens shall be maintained at 23 °C ± 2 °C (see ISO 554) and the moisture content of the film shall be such that it will be in equilibrium at a relative humidity of (50 ± 20) %.

### 4.2 Safelights

To eliminate the possibility of safelight illumination affecting the sensitometric results, all films shall be kept in total darkness during handling, exposure and processing.

### 4.3 X-ray equipment

For all tests described in this part of ISO 9236, a 6-pulse, 12-pulse or a high frequency (multipulse) generator shall be used.

For the dose measurement, calibrated detectors shall be used. The accuracy of readings shall be better than ± 5 % for collimated beams without scatter, and better that ± 7 % for radiation measurements behind the phantom when scattered radiation is included.

NOTE — A spherical ionization chamber is recommended for measurements where scattered radiation is involved. The centre of the spherical chamber is to be considered the reference point; the stem of the spherical chamber should point in a direction opposite to the focus direction. If a cylindrical chamber is used, the ratio of diameter to height should be at least 4 to 1.

### 4.4 Processing

Screen/film systems, including either manual or automatic processing, may be tested in accordance with this part of ISO 9236. Processing should be carried out in accordance with the film manufacturer's recommendations. Nothing shall be construed to require the disclosure of proprietary information.

No processing specifications are described in this part of ISO 9236 in recognition of the wide range of chemicals and equipment used. Speed and average gradient values provided by film manufacturers generally apply to the system when the film is processed in accordance with their recommendations so that the photographic characteristics specified for the process are produced. Processing information shall be provided by the film manufacturer or others who quote speed and average gradient values and shall specify the processing chemicals, times, temperatures, agitation, equipment and procedures used for each of the processing steps, and any additional information required to obtain the sensitometric results described. The values for speed and average gradient obtained using other processing procedures may differ significantly. The processing conditions selected by a person using this part of ISO 9236 are, in any case, part of the system being tested. Different speeds for a particular film may be achieved by varying the processes, but the user should be aware that other changes may accompany the speed changes.

In order to minimize any effects due to latent-image instability or process variability, all film samples shall be processed together, neither less than 30 min nor more than 4 h after exposure. Between exposure and processing, the temperature of the film shall be maintained at 23 °C ± 2 °C and its moisture content shall be such that the film will be in equilibrium at a relative humidity of (50 ± 20) %.

Since films are generally processed in practice a few minutes after exposure, the speed observed in practice may differ from that determined by this part of ISO 9236 due to latent-image fading of some films. Therefore, the speed measured with a time delay of 30 min to 4 h between exposure and processing shall be corrected to the value one would obtain if the film were processed soon after exposure. For the purposes of this part of ISO 9236, a time delay of 5,0 min is used for computing speed.

NOTES

1 The information about the necessary correction may easily be gained by exposing film strips in a light sensitometer and varying the time between exposure and processing. Care should be taken that both front and back emulsions are exposed equally by the sensitometer.

2 Since the time required for the many individual exposures to obtain the sensitometric curve is comparatively long, a time delay of at least 30 min between exposure and processing is required. This time delay is considered to be sufficient to minimize any differences in latent-image fading for the individual exposures.

The following processing information and accuracies shall be specified:

a) trade designations of all chemicals, if proprietary; otherwise, the formulae;

b) temperature of the developer to within ± 0,3 °C;

c) temperature of other solutions to within ± 2 °C;

d) immersion times in the developer solution to within 3 %;

e) whether the developer is fresh or "seasoned" (if "seasoned", the type and amount of film used for seasoning), the density of the processed film and the replenishment procedure;

f) agitation specifications, in terms of volume of solution recirculated or rate at which a gas is used;

g) drying temperature to within ± 5 °C;

h) trade designation of processing equipment.

NOTE — The term "seasoned developer" means that the developer is no longer unused or fresh, but is already used and in a "normal working condition".

### 4.5 Densitometry

ISO standard visual diffuse transmission density of the processed images shall be measured using a densitometer complying with the geometric conditions specified in ISO 5-2 and spectral conditions specified in ISO 5-3. Readings shall be made in a uniform area of the image. The densities, $D$, shall be measured with an accuracy of $\Delta D/D = \pm 0{,}01$ or $\Delta D = \pm 0{,}01$, whichever is the greater.



## 5 Determination of sensitometric curve shape

In this part of ISO 9236, intensity scale sensitometry is used to determine curve shape. The intensity is modified according to the inverse-square law by a change of the distance between the radiation source and the combination. As a consequence of filters and other secondary radiation sources in the beam, the relationship between exposure and distance may not obey the inverse-square law. Therefore that relationship shall be calibrated.

### 5.1 Beam qualities

For the determination of the sensitometric curve shape, any of the four beam qualities specified in table 1 may be used. The beam qualities can be achieved by an iterative procedure of half-value layer (HVL) measurements using the specified added filtration. The approximate X-ray tube voltages are recommended as starting values for this procedure (see 7.2.5 and figure 5).

**Table 1 — Beam qualities for the determination of the sensitometric curve shape**

| Beam quality number | Approximate X-ray tube voltage | Half-value layer (HVL) 1) | Added filtration | |
|---|---|---|---|---|
| | kV | mm Al | mm Al | mm Cu + mm Al |
| I | 50 | 3,0 | 5,0 | 0,10 + 1,5 |
| II | 70 | 5,7 | 12,0 | 0,25 + 2,5 |
| III | 90 | 7,4 | 13,0 | 0,25 + 3,5 |
| IV | 120 | 8,5 | 10,0 | 0,20 + 2,5 |

1) The tolerance for the HVL is ± 2 %.

NOTE — The aluminium used as filter material shall have a purity of at least 99,4 % and the copper a purity of at least 99,5 %. If a mixed filter is used, the last layer towards the detectors shall be aluminium. The inherent tube filtration is assumed to correspond to 2,5 mm of aluminium.



## 5.2 Geometry for curve shape determination

The geometrical set-up of the measuring arrangement shall comply with figures 1 and 2. The diaphragm B1 and the added filter(s) shall be positioned near the radiation source. The diaphragms B1 and B2 and the added filter(s) shall be in a fixed relation to the radiation source. The diaphragm B3 and the screen/film/filmholder combination or the radiation detector R2 shall be in a fixed relation at each distance from the radiation source. The incident face of diaphragm B3 shall be 100 mm in front of the plane of the radiographic film. If it has been confirmed that scattered radiation from walls, equipment, etc. does not influence the results, the diaphragm B3 may be omitted. To this end, the radiation aperture of diaphragm B2 may be made variable so that the beam remains tightly collimated as distance is changed.

A diaphragm B4, whose shortest dimension shall be at least 15 mm, may be positioned directly in front of the combination in order to limit the area of the exposure.

The attenuating properties of the diaphragms shall be such that their transmission into shielded areas does not contribute to the results of the measurements by more than 0,1 %. The radiation aperture of the diaphragm B1 shall be large enough so that the penumbra of the radiation beam will be outside the sensitive volume of the monitoring detector R1 and the radiation aperture of diaphragm B2.

The radiation aperture of diaphragm B2 shall be smaller than 100 mm; that of B3 shall have a diameter of 100 mm ± 10 mm.

A monitoring detector R1 may be inside the beam that exposes the combination if it is suitably transparent and free of structure, otherwise it shall be placed outside the beam. The precision of the monitoring detector shall be better than ± 2 %.

An attenuating protective barrier shall be at least 450 mm beyond the last area involved in the measurement. The space between the combination or the radiation detector R2 and the protective barrier shall contain nothing but air.

## 5.3 Exposure

Each exposure of the combination shall be achieved in one uninterrupted irradiation. The exposure time shall be in the range 20 ms ± 10 ms to 200 ms ± 100 ms and shall be kept constant for all exposures.

NOTE — With the use of intensifying screens, reciprocity law failure and the intermittency effect may occur. In order to avoid the influence of these effects, a single irradiation with a constant irradiation time in the specified range of irradiation times is required for each exposure.

The different values of air kerma shall be obtained exclusively by varying the distance from the radiation source to the plane of the radiographic film, with the exposure time and all other conditions of exposure constant. The maximum increments of log exposure shall not be greater than 0,1.

Dimensions in metres

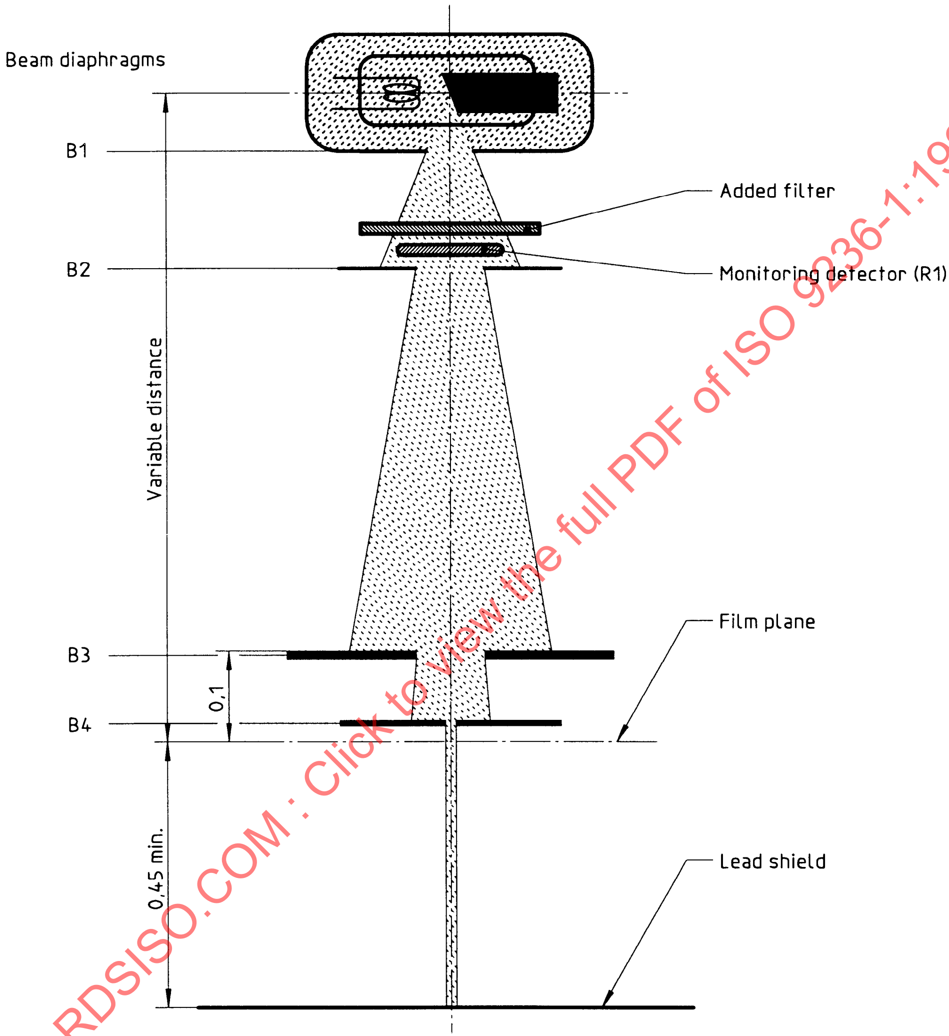



**Figure 1 — Geometric set-up of the inverse-square-law sensitometer for exposure of the screen/film combination**

Dimensions in metres

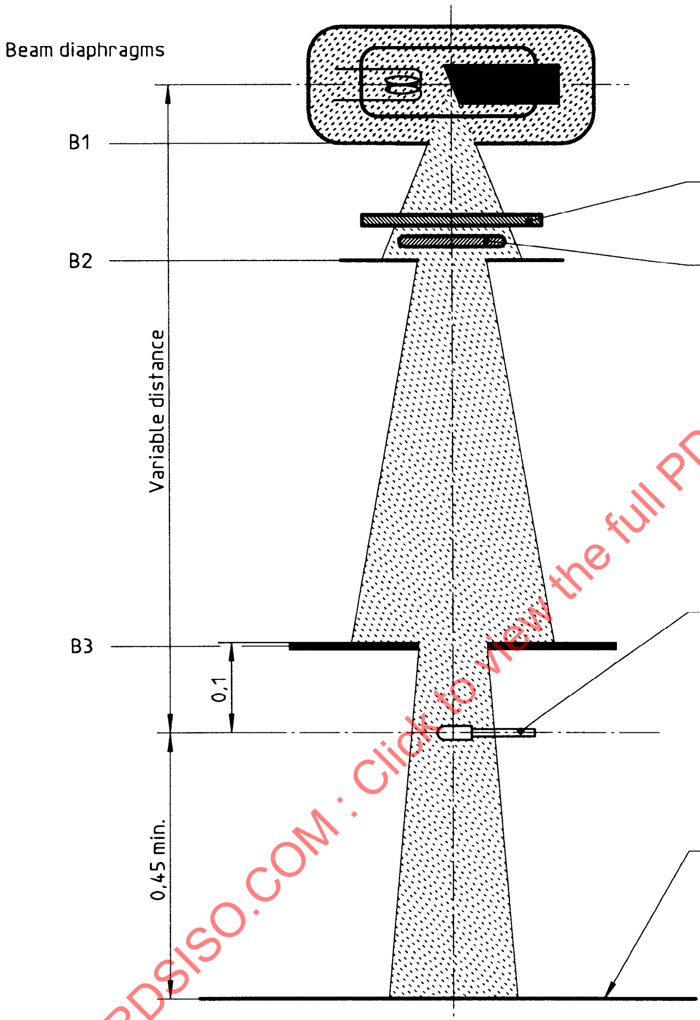





**Figure 2 — Geometric set-up for calibration of the inverse-square-law sensitometer**

For determination of the sensitometric curve, at least 20 different exposures are necessary, equally distributed on a logarithmic scale, that produce net densities from 0,1 to 2,1. To define accurately the curve at low densities, at least three exposures producing net densities between 0,1 and 0,25 shall be made. The time interval between the different exposures should not exceed 30 s, but shall not exceed 2 min.

NOTE — Since it is difficult to manage all necessary steps of moving the filmholder, changing the distance and verifying the monitor reading, an automated procedure is recommended (see annex A).

If one wishes to determine the shape of the sensitometric curve at much higher densities than 2,1 and the required intensity increase is not possible via decrease of distance, the exposure should be increased by an increase of the tube current, but it shall be verified that the higher tube current does not change the beam quality.

### 5.4 Evaluation

The density is plotted against the corresponding log air kerma values. Through the points, a smooth curve is drawn either by hand or by an appropriate algorithm. It should be possible to read densities and relative exposure values (log to the base 10 units) to the nearest 0,01 from the curve (figure 3).

## 6 Determination of average gradient

The average gradient $\overline{G}$ is calculated from:

$$\overline{G} = \frac{D_2 - D_1}{\lg K_2 - \lg K_1}$$

where

$D_2$ and $D_1$ are net densities having the values 2,0 and 0,25 respectively;

$K_2$ and $K_1$ are the corresponding relative values of air kerma extracted from the sensitometric curve.

If a single beam quality is used to determine $\overline{G}$, the beam quality number II (see table 1) should be selected.

NOTE — The average gradient as defined above is the most commonly used single sensitometric parameter used to predict the observed contrast of a developed radiographic image.

## 7 Determination of speed

### 7.1 Definition

The speed $S$ is calculated from:

$$S = K_0/K_S$$

where

$K_0$ is $10^{-3}$ Gy

$K_S$ is the air kerma (in grays) incident on the combination behind a phantom to produce a net density of 1,0.

### 7.2 Beam qualities

For the determination of the speed, the combination shall be irradiated behind a phantom. To simulate the most common applications in general radiography, four exposure conditions are defined and specified in table 2.

The phantoms are described in 7.2.1 to 7.2.4. The purity of the aluminium shall be at least 99,4 %.

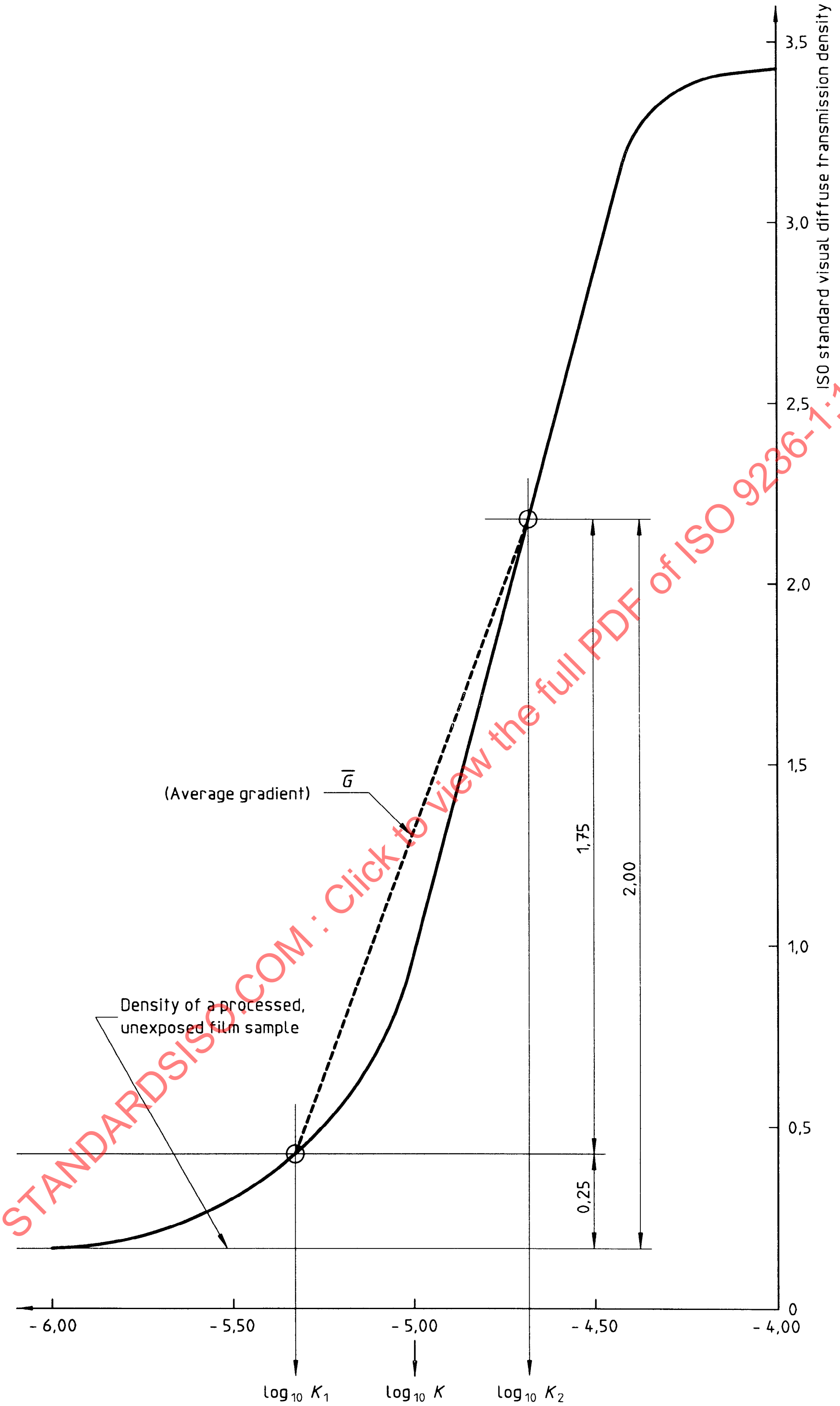



**Figure 3 — Sensitometric curve**

**Table 2 — Specification of techniques**

| Technique number | Approximate X-ray tube voltage 1)<br>kV | Half-value layer<br>mm Al | Exposure times<br>ms | Distance between the back of the phantom and the detector 2)<br>mm |
|---|---|---|---|---|
| **I** Extremities | 50 | 3,0 | 100 ± 50 | 60 |
| **II** Skull | 70 | 5,7 | 200 ± 100 | 60 |
| **III** Lumbar spine and colon | 90 | 7,4 | 200 ± 100 | 60 |
| **IV** Chest | 120 | 8,5 | 20 ± 10 | 60 |

1) The geometry for establishing the tube voltage is described in 7.2.5. The beam qualities for determination of the sensitometric curve shape (table 1) and speed (table 2) correspond to each other.

2) When the detector is the combination, the distance is measured to the film plane; otherwise it is measured to the reference point or plane of the measuring detector.



### 7.2.1 Phantom for technique I

The phantom (see figure 4) shall consist of two poly(methyl methacrylate) (PMMA) slabs, each 25 mm ± 1 mm thick by approximately 0,3 m square. Between the two slabs an aluminium sheet, 2 mm ± 0,1 mm thick and approximately 0,3 m square, shall be sandwiched.

### 7.2.2 Phantom for technique II

The phantom shall consist of a slab of aluminium with a thickness of 12 mm ± 0,1 mm and approximately 0,3 m square.

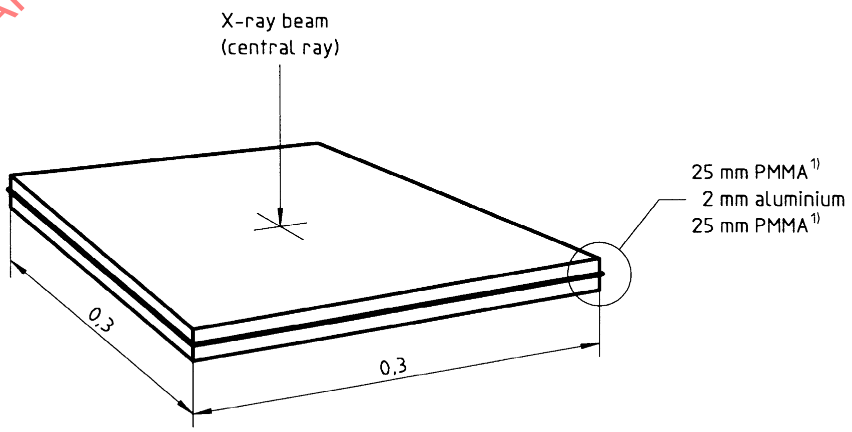
### 7.2.3 Phantom for technique III

The phantom shall consist of the technique II phantom augmented by a contiguous 1,0 mm thick sheet of aluminium for a total thickness of 13 mm ± 0,1 mm.

### 7.2.4 Phantom for technique IV

The phantom shall consist of two slabs of aluminium, each 5 mm ± 0,1 mm thick and approximately 0,3 m square. One slab is positioned near the focus of the X-ray tube (see figure 7), the other one is positioned near the detector.

Dimensions in metres




1) Poly(methyl methacrylate).

**Figure 4 — Phantom for technique I**

### 7.2.5 Establishment of tube voltage

For all measurements of beam quality, the minimum distance between the tube focus and the detector shall be 2 m. The inherent filtration of the X-ray tube (which includes the fixed filtration) shall be equivalent to 2,5 mm ± 0,2 mm of aluminium. To this filtration shall be added either the filtration listed in table 1 or the corresponding phantoms between the tube and the diaphragm. The distance between the beam diaphragm and the detector shall be at least 1,5 m (see figure 5).

The tube voltages given in tables 1 and 2 are recommended as starting values. For each of the techniques to be tested, the tube voltage shall be adjusted until the measured half-value layers of aluminium are within ± 2 % of the values given in table 1 or table 2. For example, for a beam of approximately 70 kV, the tube voltage shall be adjusted so that the exposure rate measured with the skull phantom at the tube will be halved when a slab of aluminium of width 5,7 mm ± 0,1 mm is introduced close to the phantom on the side away from the tube. These adjustments shall be made at the tube currents specified for X-ray exposures in 7.4.

Half-value-layer measurements shall be made with a detector whose spectral response is essentially uniform over the range of beam qualities tested and which is as far away as practicable from the X-ray tube. Collimation at the tube shall be as narrow as possible and still permit the X-ray beam to cover the sensitive volume of the measuring detector.

All subsequent screen/film exposures shall be made at the kilovoltages and tube currents thus established.

## 7.3 Geometry

The geometry for the irradiation of the combination is shown in figures 6 and 7. The detector system (either the combination or the dosimeter) is placed at a fixed distance of 60 mm behind the back of the phantom.

A monitoring-integrating detector shall be mounted near the X-ray tube in such a way that it samples the intensity of the X-ray beam but does not by its absorption lead to a variation of radiant intensity over the radiation field defined by the collimating system. The monitoring detector may be either outside or inside the beam used to expose the combination. The diaphragm B2 shall be adjusted so that the phantom is always fully irradiated.

A measuring-integrating detector replacing the combination shall be positioned as specified in figures 6 and 7 and subclause 4.3.

A lead shield shall be positioned at least 450 mm behind the last area involved in the measurement.



## 7.4 Exposure

Subclause 7.1 states that speed is obtained from an air kerma $K_S$ which results in a net density of 1,0. An approximate value for that air kerma may be determined by measurement at the distance estimated to yield a net density 1,0 as interpolated from the sensitometric exposure series. This air kerma shall be reached using the appropriate phantom at a distance of 1,5 m ± 0,2 m between the focus and the combination, and with the appropriate conditions of tube voltage, tube current and exposure time. Exposure time is either that given by the reading of the generator or by an external shutter.

A screen/film combination in the desired filmholder is then irradiated and the film is processed. If the resulting net density is outside the range 1 ± 0,3, the distance between the focus and the phantom shall be corrected within the limits of 1,3 m to 1,7 m using the sensitometric curve as a guide. Three exposures are then made resulting in three images with net densities $D_i = 1 \pm 0{,}3$. Air kerma values $K_i$ corresponding to these three exposures are then calculated from the monitor readings $M_i$.

Dimensions in metres

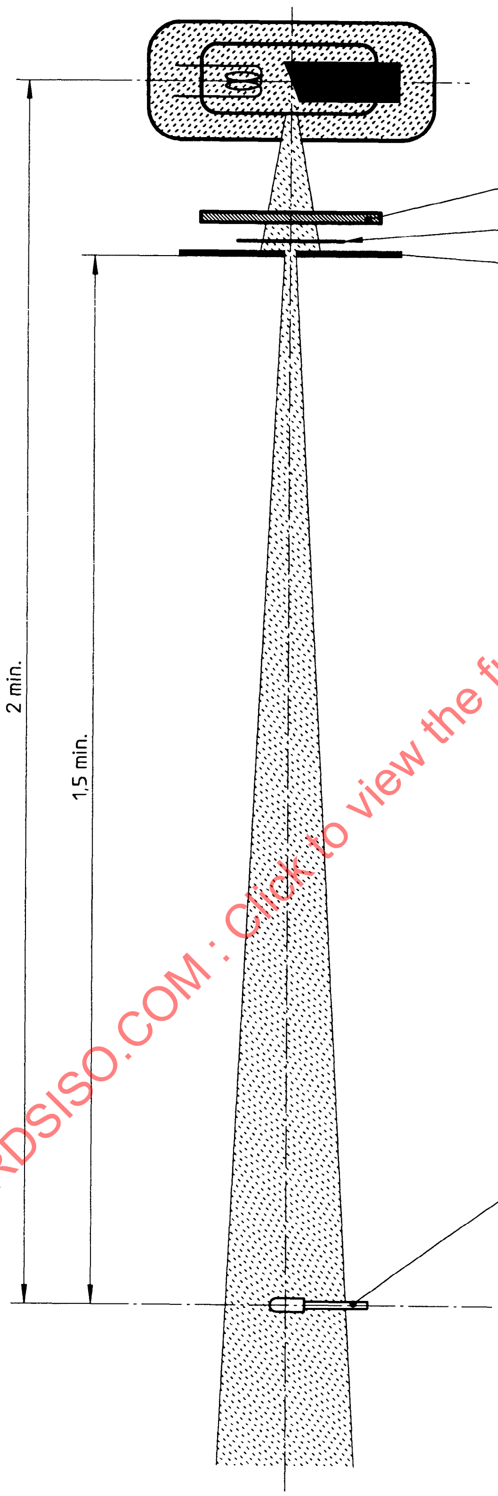





**Figure 5 — Geometric set-up for adjustment of beam qualities used for techniques I, II, III and IV**

Dimensions in metres

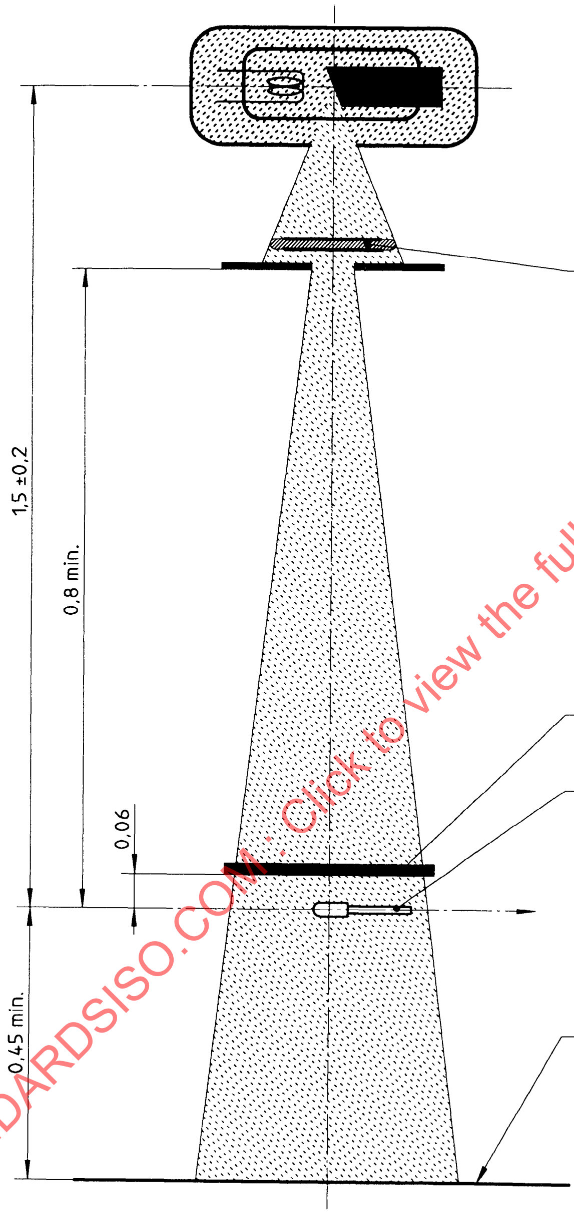





**Figure 6 — Geometric set-up for the measurement of speed (techniques I, II and III)**

Dimensions in metres

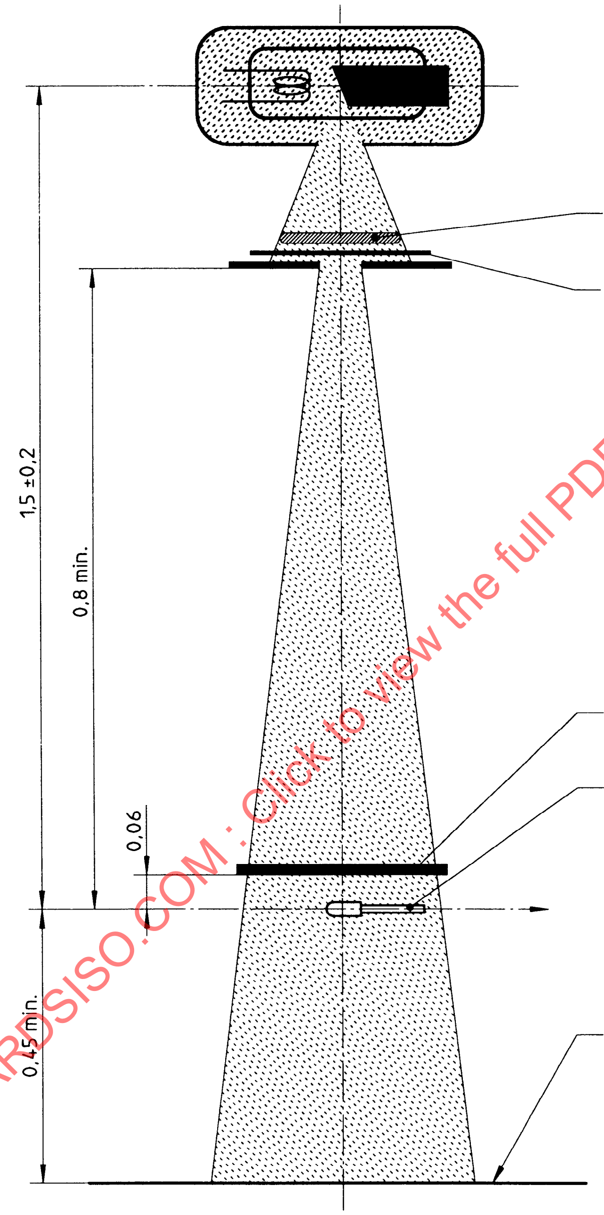





**Figure 7 — Geometric set-up for the measurement of speed (technique IV)**

After the exposure of the combination, it is replaced by the measuring detector and the exposure is repeated, holding the tube voltage, tube current, exposure time and distance to the tube unchanged. The reading $X_m$ of the measuring detector and the concurrent reading $M_m$ of the monitoring detector shall be recorded. If $\overline{X}_m$ and $\overline{M}_m$ are the means of three X-ray irradiations, the air kerma $K_i$ of the combination may be calculated from the corresponding monitor reading $M_i$ using the formula:

$$K_i = M_i(\overline{X}_m/\overline{M}_m)$$

### 7.5 Evaluation

Using the sensitometric curve, the differences $\Delta D_i$ between $D_i$ and 1,0 are transformed into differences, $\Delta \lg K_i$, which are used to correct the calculated $K_i$ values to obtain $K_i$ values for a net density of 1,0. The mean $K_S$ of the three $K_i$ values is used to calculate the speed $S$ using the formula given in 7.1:

$$S = \frac{K_0}{K_S}$$

if $K_S$ is given in grays and $K_0 = 10^{-3}$ Gy.

NOTE — Since, for the purposes of this part of ISO 9236 the shape of the sensitometric curve may be assumed to be independent of beam quality, the correction can be made with a curve produced by any beam quality specified in table 1.



## 8 Speed and average gradient determination without sensitometric curve

If there is interest only in speed and average gradient and not in the sensitometric curve shape, the following alternative procedure may be used.

For every technique described in table 2, the combination is placed at a position 1,5 m ± 0,2 m from the focus, with the appropriate phantom in the beam (see figures 6 and 7). The tube current shall be adjusted to produce a trial image whose processed net density is 1 ± 0,1. With this tube current, the desired HVL, given in table 2, is adjusted according to 7.2.5. Then, three exposures of the combination shall be made at each of two distances 95 % and 105 % of the distance at which the tube current was set. The phantom-film distance shall remain constant at 60 mm during these adjustments.

For each exposure, the reading $M_i$ simultaneously produced by the monitoring detector shall be recorded.

Immediately following each set of the three exposures, the filmholder containing the film and screens shall be replaced by the measuring detector and the previous exposure shall be repeated, holding the tube voltage, tube current, exposure time and phantom-detector distance unchanged. To provide a sufficent output reading from the measuring detector, the total air kerma may be increased by making multiple exposures. The air kerma $K_i$ of the combination is calculated from $M_i$ according to 7.4. For each of the six exposures producing net densities in the vicinity of 1,0, the densities shall be plotted against the measured air kerma. A best-fit straight line shall be drawn through the six densities plotted and from this line the air kerma $K$ to produce a density of 1,0 shall be determined. The speed is calculated using the formula given in 7.5.

The average gradient shall be determined using the same mean distance as used for the speed determination. Only the X-ray tube current shall be changed in order to adjust the exposure required to produce net densities of 0,25 ± 0,05 and 2 ± 0,1. After determining the tube currents required, the desired HVL, given in table 2, is adjusted according to 7.2.5 for each tube current setting. Then, three exposures of the combination shall be made at each of the two different tube currents at each of two distances 95 % and 105 % of the distance at which the two tube currents were set, resulting in a total of twelve exposures. For each exposure, the reading $M_i$ simultaneously produced by the monitoring detector shall be recorded.

Immediately following each set of the three exposures, the filmholder containing the film and screens shall be replaced by the measuring detector and the previous exposure shall be repeated, holding the tube voltage, tube current, exposure time and phantom-detector distance unchanged. The procedure, described above for speed determination, is repeated to determine the air kerma $K_1$ and $K_2$, to produce net densities of $D_1$ = 0,25 and $D_2$ = 2,0 respectively. The average gradient is then calculated using the formula given in clause 6.

## 9 Accuracy

The specified accuracies for the detector, densitometer and beam quality calibration as well as the reproducibility of the monitor chamber, calibration error and uncontrolled scattering may cause the following uncertainties ($\sigma$-values):

$\Delta\overline{G}/\overline{G} = \pm 0{,}05$ and

$\Delta S/S = \pm 0{,}09$

where the largest influence results from the detector calibration and beam quality measurement.

The influence of processing variability is not included.

With the above-mentioned accuracy of the method, the parameters of a specific single screen/film/filmholder/processing system may be measured.

## 10 Test report

The sensitometric curve, speed and the average gradient shall be given in a test report together with the following:

a) name of the test facility;

b) date of the measurement;

c) brand or tradename of the manufacturer or supplier, model or type reference, serial number or year of manufacture of the intensifying screen;

d) brand or tradename of the manufacturer or supplier, model or type reference, emulsion number or year of manufacture of the radiographic film;

e) type of filmholder:

   if a radiographic cassette is used as a filmholder, give the brand or tradename of the manufacturer or supplier, model or type reference, serial number or year of manufacture of the cassette;

f) beam quality or medical application (i.e. technique I, II, III or IV);

g) exposure time;

h) processing conditions:

   if the film is processed under conditions which differ from those recommended by the film manufacturer, then these conditions are to be reported in detail.

If only a single system speed is presented and the system is not dedicated for a special application, as for instance chest imaging, the speed should be given for technique II (table 2).