INTERNATIONAL STANDARD

ISO 11699-1

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Non-destructive testing — Industrial radiographic films —

Part 1:
Classification of film systems for industrial radiography

Essais non destructifs — Films utilisés en radiographie industrielle —

Partie 1: Classification des systèmes relatifs aux films pour la radiographie industrielle

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 11699-1 was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 5, *Radiation methods*.

ISO 11699 consists of the following parts under the general title *Non-destructive testing — Industrial radiographic films*:

— *Part 1: Classification of film systems for industrial radiography*

— *Part 2: Control of film processing by means of reference values*

Annex A of this part of ISO 11699 is for information only.

Non-destructive testing — Industrial radiographic films —

Part 1:
Classification of film systems for industrial radiography

1 Scope

The purpose of this part of ISO 11699 is to fix the performance of film systems.

This part of ISO 11699 is applicable to the classification of film systems in combination with specified lead screens for industrial radiography (non-destructive testing). It is intended to ensure that the image quality of radiographs — as far as this is influenced by the film system — is in conformity with the requirements of International Standards such as ISO 5579. This part of ISO 11699 does not apply to the classification of films used with fluorescent intensifying screens.

Additional methods for evaluating the photographic process are described in ISO 11699-2 by which the performance of film systems can be controlled under the conditions given in industry.

2 Definitions

For the purposes of this part of ISO 11699, the following definitions apply.

2.1 film system: Combination of film and film processing which is carried out in accordance with the instructions of the film manufacturer and/or the manufacturer of the processing chemicals.

2.2 gradient G**:** Local slope of the characteristic curve at a certain density D giving a measure of the contrast obtainable with the film system.

2.3 granularity σ_D**:** Stochastic density fluctuations in the radiograph which are superimposed on the image of the object.

NOTE — The limiting values given in this part of ISO 11699 are related to fixed radiation energies and specified screens.

2.4 ISO speed S**:** Reciprocal value of the dose K_s measured in gray which results at a specified diffused optical transmission density D of the processed film:

$$S = \frac{1}{K_s} \qquad \text{. . . (1)}$$

2.5 film system class: Classification taking into account the limiting values given in table 1.

2.6 gradient-noise ratio: Ratio of the gradient G and the granularity σ_D related directly to the signal to noise ratio.

NOTE — All further parameters determining the signal, such as the modulation transfer function or the energy of the radiation, are considered to be constant.

Table 1 — Limiting values for gradient, gradient-noise ratio and granularity

Film system class	Minimum gradient G_{min} at		Minimum gradient-to noise ratio $(G/\sigma_D)_{min}$ at D = 2 above D_0	Maximum granularity $(\sigma_D)_{max}$ at D = 2 above D_0
	D = 2 above D_0	D = 4 above D_0		
T 1	4,3	7,4	270	0,018
T 2	4,1	6,8	150	0,028
T 3	3,8	6,4	120	0,032
T 4	3,5	5,0	100	0,039

3 Sampling and storage

For product specification it is important that the samples evaluated yield the average results obtained by users. This will require the evaluation of several different batches periodically under conditions specified in this part of ISO 11699. Prior to evaluation, the samples shall be stored according to the manufacturer's recommendations for a length of time in order to simulate the average age at which the product is normally used. The basic objective in selecting and storing samples as described above is to ensure the film characteristics are representative of those obtained by a consumer at the time of use.

4 Test method

4.1 Preparation

The film samples shall be exposed to X-rays from tungsten target tubes. Inherent filtration of the tube, plus an additional copper filter located as close to the target as possible shall provide filtration equivalent to (8,00 ± 0,05) mm of copper. The potential across the X-ray tube shall be adjusted until the half value absorption is obtained with (3,5 ± 0,2) mm of copper. A potential of approximately 220 kV generally meets this requirement.

The film system shall include a front and a back screen of 0,02 mm to 0,04 mm lead. If single coated films are used, the emulsion coated surface shall face the X-ray tube. Good film screen contact shall be ensured.

4.2 Masurement of gradient G

Gradient G relates to a D versus $\log_{10} K$ curve. Gradients G are determined at the two specific density points. These are density 2 above fog and base density and, density 4 above fog and base density. Within the scope of this part of ISO 11699 G is calculated from the slope

$$\frac{\mathrm{d}D}{\mathrm{d}K}$$

of a D versus K curve at density $(D - D_0)$, i. e.

$$G = \frac{\mathrm{d}D}{\mathrm{d}\log_{10} K} = \frac{K}{\log_{10} \mathrm{e}} \times \frac{\mathrm{d}D}{\mathrm{d}K} \quad \text{. . . (2)}$$

where

K is the dose, in gray, required for density $(D - D_0)$;

D_0 is the optical density of an unexposed and processed film including base (fog and base density).

The D versus K curve is approximated by a polynomial of the third order. To obtain a reliable curve a series of exposures is made to provide at least 12 uniformly distributed measuring points between density 1 and 5 above D_0.

The gradient shall be measured with a maximum uncertainty of ± 5 % at a confidence level of 95 %.

4.3 Measurement of granularity σ_D

The granularity is determined by linear scanning of a film of constant diffuse optical density with a microdensitometer. Both emulsion layers shall be recorded; this means that the depth of focus of the microdensitometer has to include both layers. The specular optical density is converted into diffuse optical density after calibration. The standard deviation σ_D is a measure of the granularity.

The optical density of the film shall be $D = 2{,}00 \pm 0{,}05$ above fog and base.

The scanning length on the radiographic film shall be at least 100 mm. The diameter of the aperture of the microdensitometer shall be (100 ± 5) µm.

In order to limit the low frequency noise the data measured with the microdensitometer shall be filtered with a highpass filter with a cutoff spatial frequency of 0,1 line pairs per millimeter.

The granularity shall be determined with a maximum uncertainty of ± 10 % at a confidence level at 95 %. At least six measurements shall be made on different samples.

4.4 Measurement of ISO speed S

The ISO speed S is evaluated for a diffuse optical density $D = 2$ above fog and base D_0. The ISO speed shall be determined in accordance with values given in table 2.

Table 2 — Determination of ISO speed S from dose K_s needed for a film density $D = 2$ above D_0

$\log_{10} K_s$		ISO speed S
from	to	
-3,05	-2,96	1 000
-2,95	-2,86	800
-2,85	-2,76	640
-2,75	-2,66	500
-2,65	-2,56	400
-2,55	-2,46	320
-2,45	-2,36	250
-2,35	-2,26	200
-2,25	-2,16	160
-2,15	-2,06	125
-2,05	-1,96	100
-1,95	-1,86	80
-1,85	-1,76	64
-1,75	-1,66	50
-1,65	-1,56	40
-1,55	-1,46	32
-1,45	-1,36	25
-1,35	-1,26	20
-1,25	-1,16	16
-1,15	-1,06	12
-1,05	-0,96	10
-0,95	-0,86	8
-0,85	-0,76	6
-0,75	-0,66	5
-0,65	-0,56	4

5 Range of classification and limiting values

The film system classes are defined by limiting values which are determined in accordance with clause 5.

In order to assign a film system class the film system shall meet all the limiting values of the gradient, the granularity and the gradient-noise ratio of the system class according to table 1. The classification is only valid for the complete film system. In general, the classification for X-rays as described under 4.1 can be transferred to other radiation energies and metallic screen types as well as films without screens.

On request the manufacturers shall supply a certificate containing full data specified in clause 4 plus the following:

a) Dose K_s;

b) Processing:

— manual or automatic;

— type of chemistry;

— developer immersion time;

— developing temperature.