
**Non-destructive testing — Industrial
radiographic films —**

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

Essais non destructifs — Films utilisés en radiographie industrielle —

*Partie 2: Contrôle du traitement des films au moyen de valeurs de
référence*



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Published in Switzerland

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Foreword

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

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 5, *Radiographic testing*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO 11699-2:1998), which has been technically revised. The main changes compared to the previous edition are as follows:

- extension of [Clause 5](#) to mixed film systems and support users of mixed systems in quality control and comparison to classified film systems;
- editorial changes.

A list of all parts in the ISO 11699 series can be found on the ISO website.

Introduction

This document specifies a procedure for the control of the film processing systems by users by processing pre-exposed strips.

These strips are pre-exposed by X-rays and are accompanied by a certificate from the film strip manufacturer.

The user processes the pre-exposed strips in his film processing system and records the results. In this document, [Clause 4](#) shows the responsibility of the film strip manufacturer. The user is responsible for [Clauses 5](#) to [8](#), which show compliance with the chosen film system classification.

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Non-destructive testing — Industrial radiographic films —

Part 2:

Control of film processing by means of reference values

1 Scope

This document specifies a procedure for the control of film processing systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 11699-1, *Non-destructive testing — Industrial radiographic films — Part 1: Classification of film systems for industrial radiography*

ISO 18901, *Imaging materials — Processed silver-gelatin-type black-and-white films — Specifications for stability*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

film system

combination of film and film processing which is carried out in accordance with the instructions of film manufacturer and/or the manufacturer of the processing chemicals

[SOURCE: ISO 11699-1:2008, 3.1]

3.2

film system class

film system (3.1) classification according to the limiting values given in ISO 11699-1:2008, Table 1

3.3

film strip

piece of film material on which different steps of constant optical density are exposed

3.4

pre-exposed film strip

film strip (3.3) that is pre-exposed by X-rays so as to present at least ten different optical density steps after processing

3.5

net density

diffuse optical density without base and fog density

4 Manufacturing of pre-exposed film strips for control of the processing system

4.1 Size

The film strips shall have a minimum exposed area of 15 mm × 100 mm. The pre-exposed film strips contain areas of constant optical densities in increasing optical density steps. These steps are used for optical density measurements and a blank area for base plus fog density and life expectancy test.

4.2 Selection of film strip type

The selected type of film used for the film strips shall have a response to processing which is representative for the set of films which are classified according to ISO 11699-1. Films of film system class C3 or C4 are recommended for exposure of film test strips.

4.3 Examples of production of pre-exposed film strips

The exposure arrangement is shown in [Figure 1](#). The film strip design is described in [Figure 2](#) and [Table 1](#). A different design and material may be used if it provides the same optical density steps.

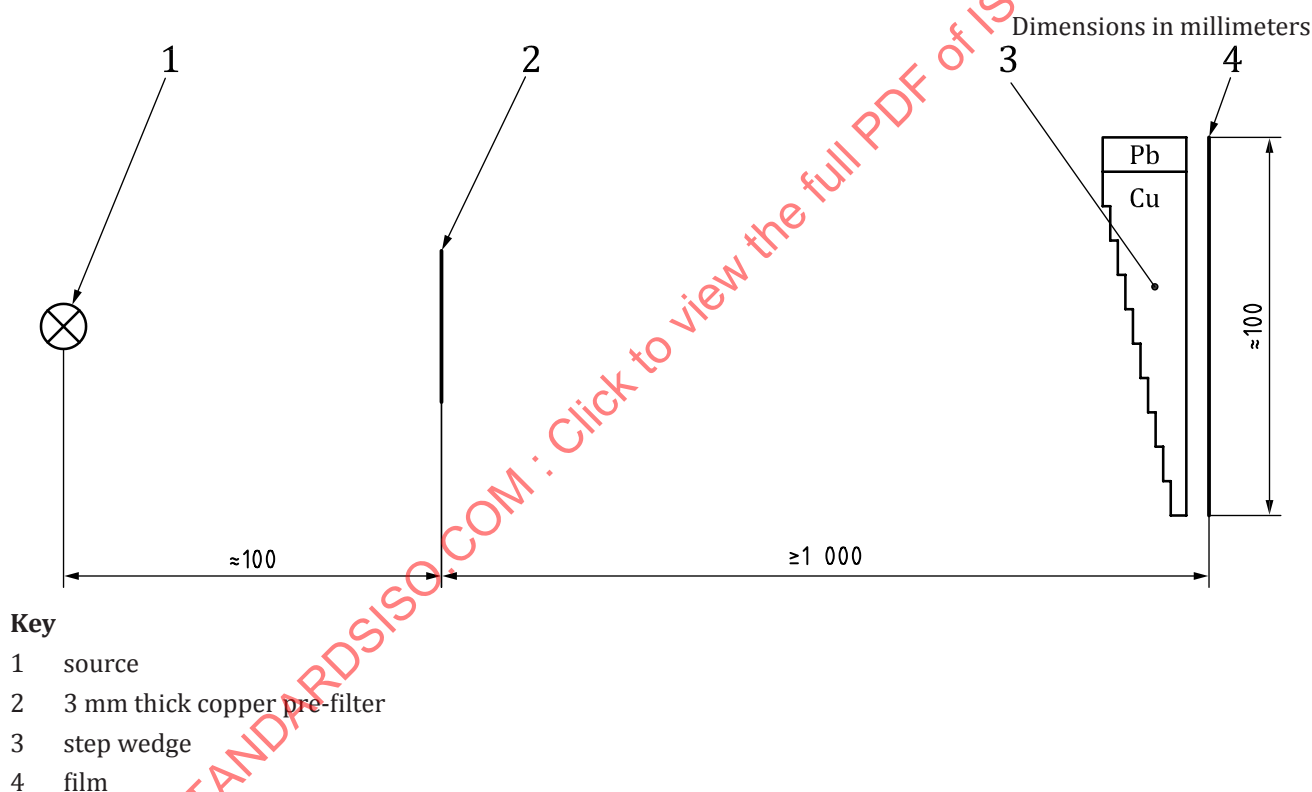
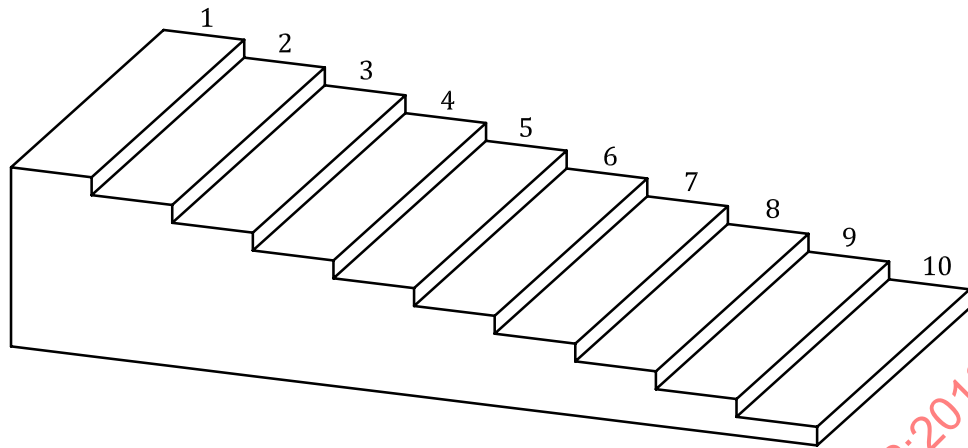


Figure 1 — Example of an exposure arrangement

The successive optical density steps on the film strip shall be exposed in order to obtain density increments of about 0,3 after processing, for example by a step wedge as described in [Table 1](#) and [Figure 2](#).

Appropriate precautions against scattered radiation shall be taken. The radiation source shall be a constant potential X-ray tube operated at approximately 150 kV. The exposure time shall be chosen to obtain a net density of approximately 2 at one of the first six steps (going from low to high densities) of the film strip after processing the pre-exposed film strip at the processing conditions used for film system classification according to ISO 11699-1.

**Key**1 to 10 See [Table 1](#).**Figure 2 — Design of step wedge****Table 1 — Height of steps; material: fine-grained copper**

Step No.	Height for 150 kV mm
1	11,7
2	10,8
3	10,0
4	9,3
5	8,7
6	8,2
7	7,7
8	7,3
9	6,9
10	6,5

4.4 Measurement fields and determination of reference values

The steps for determination of reference values shall be as follows (see [Figure 3](#)):

Step X : the step with a net density close to $D = 2$.

Step $X + 4$: the step with a higher density which is four steps from X .

To obtain the reference values, at least five pre-exposed film strips shall be processed in a classified film system. The resulting densities shall have a maximum variance of $\Delta D = \pm 0,1$.

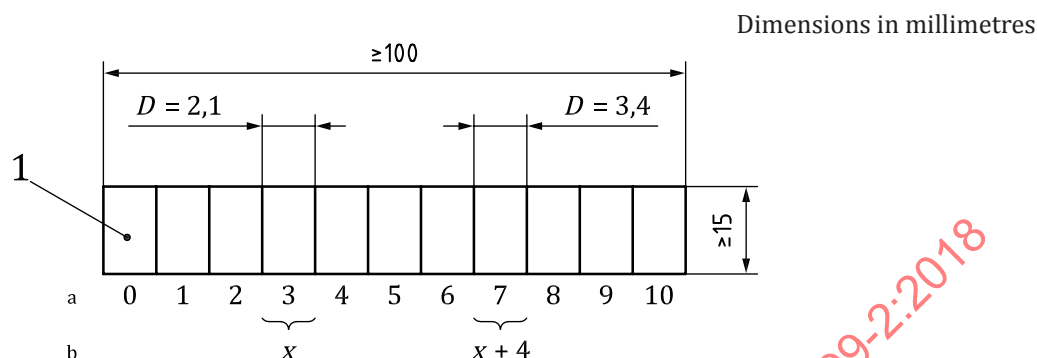
The reference values are obtained as follows:

— Reference speed index, S_r :

The average value of the net densities of step X is calculated. The speed index reference, S_r , is equal to this average value, rounded to two decimals.

— Reference contrast index, C_r :

The average value of the net densities of step $X + 4$ is calculated. The contrast index reference, C_r , is the positive difference of the average densities of the steps X and $X + 4$, rounded to two decimals.



Key

- D optical density
- x step number with a net density close to $D = 2$
- 1 blank field
- a Position.
- b Step.

NOTE Position and density of steps X and $X + 4$ on the strip can vary.

Figure 3 — Example of test strip

4.5 Pre-exposed film strip certificate

Certified pre-exposed strips shall always be accompanied by a certificate from the manufacturer containing the following data:

- a description of the processing system, specifying the processor, chemistry, processing cycle and the temperature;
- the brand name and type of the pre-exposed film strip;
- the reference values for speed index and contrast index and the step numbers for calculating the corresponding indices.

The reference values for the optical densities of all steps should be included in the certificate. The reference values for the optical densities of at least the unexposed area, of step X , and of step $X + 4$ shall be included in the certificate.

The following data shall be displayed as shown:

- Processing: manual or automatic;
 - developer type and immersion time;
 - developing temperature;
 - fixer type and immersion time;
 - fixing temperature.

- Test strip:
 - brand name;
 - type.
- Speed index:
 - reference speed index (S_r);
 - reference step (X).
- Contrast index:
 - reference contrast index (C_r);
 - reference contrast step ($X + 4$).

4.6 Storage of pre-exposed film strips

Pre-exposed film strips shall be stored in a cool and dry place. The manufacturer shall state a date of expiry and the storage conditions.

5 User verification of compliance with a classified film system

5.1 Film systems of same manufacturer of films and processing chemistry

For testing compliance with a classified film system, pre-exposed film strips of the same manufacturer as the films and chemicals under verification shall be used.

If the reference values cannot be achieved at the time of installation of the processing system, the temperature of the developer may be adjusted by ± 2 K from the temperature which was specified in the pre-exposed film strip certificate according to [4.5](#).

5.2 Film systems of different manufacturer's films and processing chemistry (mixed systems)

The film system manufacturer provides the conformity statement on classification for their film types in their processing chemicals and given processing conditions only.

Users may apply "mixed systems", in which the film manufacturer is different from the manufacturer of the film development chemicals, processing system and specified development conditions. In this case users shall process certified pre-exposed film strips from the film manufacturer if demonstration of conformity to the film manufacturer's classification is required. The measured index values in the "mixed" film system shall fulfil all the conditions of [Clause 6](#) when using the reference values for the certified film test strips of the film manufacturer. A user's conformity statement for a mixed system based on the film manufacturer's pre exposed film strips shall then be considered equivalent to the film manufacturer's conformity statement for their film systems consisting of their film types in their processing chemicals and their specified development conditions.

5.3 Processing conditions

5.3.1 Automatic processing

The automatic processor shall be set and maintained according to the recommendation of the manufacturer. To avoid initial transient changes of processing quality, start-up procedures as recommended by the manufacturer shall be followed before developing of the pre-exposed film strips.

If the automatic processor is running continuously, pre-exposed film strips may be processed without further conditioning.

5.3.2 Manual processing

The processing chemicals shall be mixed, replenished and temperature-controlled according to the specified film system classification and the recommendations of the film manufacturer.

5.4 Processing of pre-exposed film strips

To achieve good transport through the automatic processor, the recommendations of the manufacturer, covering processing and transport of small sized films, shall be followed.

5.5 Evaluation of the pre-exposed film strips

5.5.1 Calibration of densitometer

For diffuse optical density measurements, a densitometer with a minimum calibrated density range from $D = 0$ to 4,5 shall be used if the reference film strips have exposed areas with $D > 4,0$, otherwise the calibrated density range of the densitometer shall be at least $D = 0$ to 4,0.

The densitometer shall be calibrated using a reference film strip with certified optical density steps. The densitometer shall be considered calibrated, when the measured densities of the reference film strip match the specified densities to within $\pm 0,05$.

5.5.2 Parameters for processing system evaluation

The parameters for evaluation of the processing system are obtained as follows:

- C_X : contrast index: This is the difference between density D_{X+4} of step $X + 4$ and the density D_X of step X normalized to a reference speed index S_r , to eliminate speed influences. To calculate the contrast index C_X , the following formula is used:

$$C_X = (D_{X+4} - D_X) \cdot \frac{S_r}{S_X} \quad (1)$$

- D_0 : density of step 0;
- D_X : density of step X ;
- S_X : speed index $D_X - D_0$.

5.5.3 Control of fixing and washing

The achieved quality of processed film depends partly on the presence of residual thiosulfate in the film emulsion layers which may be caused by poor fixing or washing conditions.

To evaluate the fixing and washing, the following test shall be performed.

Use a test solution of 10 g of silver nitrate and 30 g of acetic acid per litre of distilled water. Apply one drop of the test solution and apply it to a blank part of the processed film. Remove the excess fluid after two minutes. This procedure is repeated on the other side of the film, opposite to the first spot. The stain obtained shall be compared with a chart supplied by the film manufacturers and the life expectancy of the processed film and shall be determined according to ISO 18901.

6 Interpretation of results

6.1 General

After processing a test strip, the processing system parameters are calculated following 5.3.2. The results are compared with the reference values as given in 4.5. A processing system is in compliance if the test results comply with the conditions given in 6.2 to 6.4.

6.2 Limits for D_0

The value of D_0 shall be less than 0,3.

6.3 Speed index (S_x)

The obtained speed index shall not vary from the specified reference speed index S_r (see 4.5) by more than ± 10 %.

6.4 Contrast index (C_x)

The obtained contrast index shall not vary from the specified reference contrast index C_r (see 4.5) by more than -10 % or $+15$ %.

7 Checking intervals

The processing shall be generally checked after each new preparation of developer solution. Additionally, a regular control is recommended.

If the ambient conditions vary significantly (i.e. mobile darkroom, temperature) or if manual replenishment is applied, the control procedure shall be more frequent.

A more continuous control according to Annex A is recommended.

8 Test report

A report presenting the results shall contain the following information:

- a) date of test;
- b) processing: manual or automatic;
- c) parameter settings: temperature of developer and processing time;
- d) brand name and type of chemistry used;
- e) brand name, type and identification of certified film strips;
- f) base and fog density, D_0 (6.2);
- g) speed index, S_x , and reference speed index, S_r (6.3 and 4.5);
- h) contrast index, C_x , and reference contrast index, C_r (6.4 and 4.5).

The documentation of these results may be in the form of a written report, a display chart or a computer program.

9 Compliance with film system classification

For a film system of a given class, compliance with that class shall be obtained as follows.

When using pre-exposed test strips, the user's film system shall be considered to have the same classification as stated in the manufacturer's data sheets, if the values obtained by processing the test strips fulfil the conditions of [Clause 6](#).

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