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Non-destructive testing -Industrial radiographic films -

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

Essais non destructifs - Films utilises en radiographie industrieffe -

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

Reference number
ISO 11699-2:1998(E)

Contents

International Organization for Standardization
Case postale 56 · CH-1211 Geneve 20 · Switzerland
Inlemet iso@iso.ch

Printed in Switzerland

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 nonnally 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.

Intemational Standard ISO 11699-2 was prepared by Technical Committee ISOfTC 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 forms an integral part of this part of ISO 11699.

Introduction

This part of ISO 11699 describes a procedure for the control of the film processing systems by users by processing calibrated pre-exposed strips.

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

The user processes the pre-exposed strips in his system and records the results.

In this part of ISO 11699, 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 system classification.

Non-destructive testing - Industrial radiographic films -

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

1 Scope

This part of ISO 11699 describes a procedure for the control of film processing systems.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 11699. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11699 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 11699·1:1998, *Non-destructive testing - Industrial radiographic films - Part* 1.' *Classification of film systems for industrial radiography.*

3 Definitions

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

3.1 film system: Combination of film and film processing which is carried ou in accorcance with the instructions of film manufacturer and/or the manufacturer of the processing chemicals [ISO 11699-1].

3.2 film system class: Film system classification according to the limiting values given in table 1 of ISO 11699-1:1998.

3.3 film strip: Piece of film material on which a step wedge can be exposed.

3.4 pre-exposed film strip: Film strip that is pre-exposed so as to present at least ten different densities after processing.

3.5 net density: 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 x 100 mm. The pre-exposed film strips contain a step wedge for density measurements and a blank area for base plus fog density and long term storage time test.

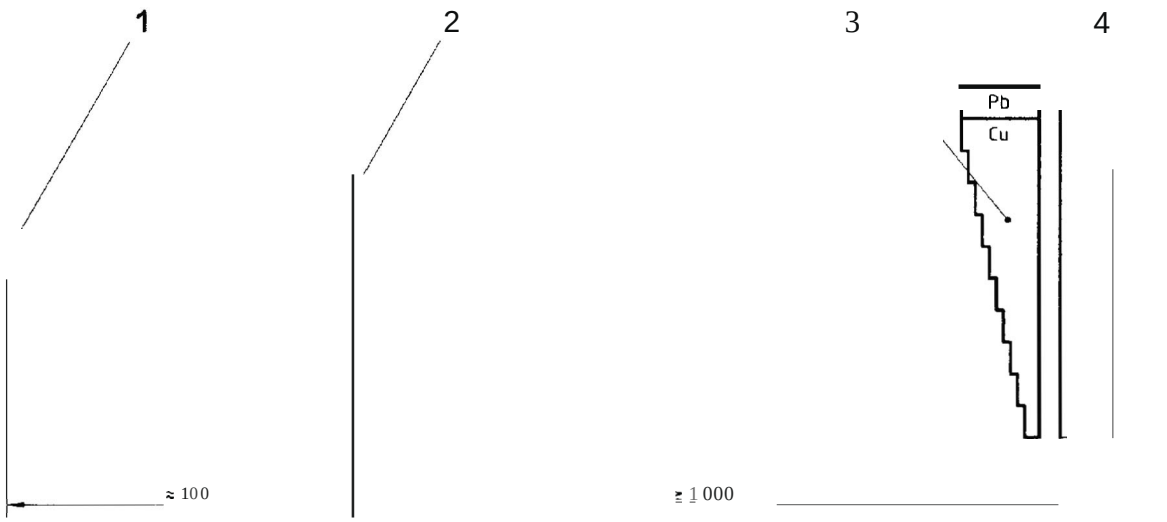
4.2 selection of film strip type

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 .

4.3 Examples of production of pre-exposed film strips

The exposure arrangement is shown in figure 1. The step wedge design is described in figure 2 and table 1. A different design and material can be used if it provides the same density steps.

Dimensions in millimeters



Key
1 Source
2 3 mm thick copper prefilter
3 Wedge
4 Film

Figure 1 - Example of an exposure arrangement

The successive steps of 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 is a constant potential X-ray tube operated at approximately 150 kV. The exposure time is chosen in this way so as to obtain a net density of approximately 2 at one of the first six steps (going from low to high densities) of the step/wedge after processing the pre-exposed film strip in the conditions of the system classified according to ISO 11699-1 .

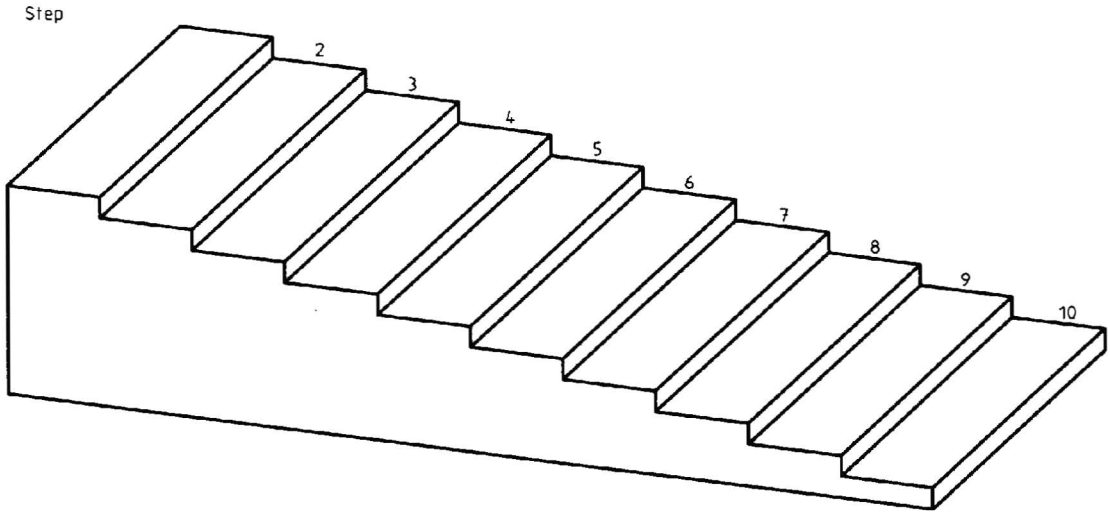


Figure 2 - Design of step wedge

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	8,8
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:

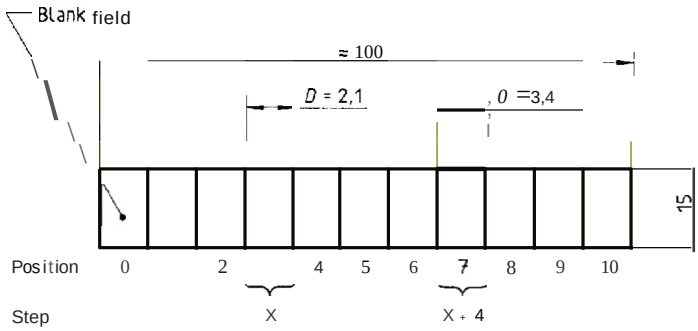
Reference speed index Sr:

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

Reference contrast index C_r:

The average value of the net densities of step X + 4 is calculated. The reference contrast index reference is the positive difference of the average densities of the steps X and X + 4, rounded to one decimal place.

Dimensions in millimeters



NOTE - Position and density of steps X and X + 4 on the strip may vary.

Figure 3 - Example of test strip

4.5 Pre-exposed film strip-certificate

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 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 (Sr):

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

For testing compliance with a classified film system, the same brand of pre-exposed film and film of the film system under verification shall be used.

If the reference value 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.

5.1 Processing conditions

5.1.1 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.

5.1.2 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.

5.2 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.

5.3 Evaluation of the pre-exposed film strips

5.3.1 Calibration of densitometer

For density measurements, a densitometer with a minimum density range from $D = 0$ to $D = 4$ shall be used.

The densitometer shall be calibrated using a reference wedge. The densitometer shall be considered calibrated, when the measured densities of the reference wedge match the specified densities to within ± 0,1.

5.3.2 Parameters for processing system evaluation

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

- cx: 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:

$$C_X = (D_{x+4} - D_X)\frac{S_r}{S_x} \quad \ldots (1)$$

DO: density of step 0

D_x: density of step X

S_x: speed index $D_x - D_0$

5.3.3 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 destilled water. One drop of the test solution is applied to a blank part of the processed film. After two minutes the excess fluid is removed. This procedure is repeated on the other side of the film, opposite to the first spot. The stain obtained is compared with a chart supplied by the film manufacturers.

6 Interpretation of results

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 6.1 to 6.3.

6.1 Limits for Do

The value of *Do* shall be less than 0,3.

6.2 Speed index (Sx)

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

6.3 Contrast index (ex)

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 (6.1);

g) speed index S_x and reference speed index S_r (6.2 and 4.5);

h) contrast index C_x and reference contrast index C_r (6.3 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.

Annex A
(nonnative)

Method for processing control

This annex defines an additional procedure to enable users to assess consistency of processing.

The objective is to achieve a routine quality control, not to establish absolute conformance with a classified film system. The frequency shall be adapted to the requirements of the inspection application.

A.1 Strips for processing control

Although the same pre-exposed strips as for the classification compliance test can be used, this is not required for monitoring the processing quality. For this purpose strips that have at least three steps can be used:

step A: an unexposed step to measure base density plus fog;

step B: a step exposed to a density of approximately LJ = 2, to be used as speed indicator;

step C: a step exposed to a density of approximately D = 3,5 to establish a contrast indicator.

A.2 Parameters for sensitometric evaluation

The parameters for sensitometric evaluation are:

DO: density of step A;

speed indicator: density of step B;

contrast indicator: density of step C minus the density of step B.

A.3 Reference values

Reference values for the sensitometric indices are obtained in the following way (processing conditions shall be according to 5.1 and 5.2).

At least three test strips shall be processed and the values for base plus fog, speed indicator and contrast indicator determined. The values obtained in this way shall be within a tolerance of 0,10. This procedure has to be repeated at least three times with a minimum delay of 24 hours. For each parameter, the *average* of at least nine values is calculated. This value is the reference value for processing control.

These reference values shall be determined each time film strips from a new batch are used.

A.4 Interpretation of results

A test strip shall be processed regularly, and the parameters determined. The processing quality is consistent if the test results differ by less than the permitted tolerances.

A.4.1 Limits of *Do*

The density of step A shall not exceed 0,3.

A.4.2 Speed indicator

The speed indicator shall not differ by more than ± 0,3 from the established reference.

A.4.3 Contrast indicator

The contrast indicator shall not differ by more than + 15 % and -10 % from the established reference.

A.5 Documentation

The acquired results shall be recorded according to clause 8, but the sensitometric indices (see A.2) will be displayed as a function of time.

IC5 19.100; 37.040.20

Descriptors: non-destructive tests, industrial radiography, radiographic film, film processing, control procedures.

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