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Imaging materials — Photo books — Test methods for permanence and durability

Matériaux pour l'image — Albums photos — Méthodes d'essai de permanence et de durabilité

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 42, *Photography*.

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.

Introduction

Photo books are bound books with printed pages comprised of integrated photos, along with artwork and text, designed by and usually dedicated to a limited group of people.

Like photographic prints, photo books are produced on the widest available spectrum of production, from large run commercial facilities to one-off home kits. Their expected permanence and durability can cover a similarly broad range. Careful consideration should be given to the materials used in the construction of photo books to insure high permanence of the printed images[32] and of the books themselves[33].

Photo books are typically stored in a closed condition, either in a stack or on a book shelf; consequently environmental factors that may adversely affect displayed prints, such as light and ozone, may not be applicable to the preservation of the inside pages of a photo book. The user is cautioned that these factors may become relevant if the photo book is displayed or otherwise exposed to light or other environmental factors for an extended period of time. ISO 18937 and ISO 18941 provide guidelines on testing for the effect of light and ozone on photo books.

The test methods included in this document assume that the photo book will be stored and used in environments that may or may not be climate controlled. For this reason, it includes test conditions designed to assess the adverse effects of humidity and temperature that may be outside of recommended long-term and medium-term storage conditions as described in ISO 18920. It also includes test conditions intended to simulate short duration exposure of photo books to the interior of a hot vehicle.

This document contains many specific tests for various binding systems and printing processes. It is not the intention of this document to require that all possible combinations be tested. Testing all combinations of sizes, cover materials, binding options and printing processes is not possible due to the large number of combinations. However, testing representative combinations of materials is encouraged.

Imaging materials — Photo books — Test methods for permanence and durability

1 Scope

This document specifies test methods to assess the permanence and durability of photo books, including cover and pages.

This document is applicable to photo books which contain reflection colour prints made with colour hardcopy materials of all types, including those from either traditional analogue printing or modern digital printing processes. The same performance test methods apply, regardless of the printing process. Because of the large number of combinations of sizes, cover materials, binding options and printing processes, testing of all possible combinations is not within the scope of this document. Instead, a representative selection of printed pages, cover materials and binding options that are used in the makeup of the photo book are tested.

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 527-3, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

ISO 11800:1998, *Information and documentation — Requirements for binding materials and methods used in the manufacture of books*

ISO 18913, *Imaging materials — Permanence — Vocabulary*

ISO 18924, *Imaging materials — Test method for Arrhenius-type predictions*

ISO 18931, *Imaging materials — Recommendations for humidity measurement and control*

ISO 18936, *Imaging materials — Processed colour photographs — Methods for measuring thermal stability*

ISO 18937, *Imaging materials — Photographic reflection prints — Methods for measuring indoor light stability*

ISO 18941:2017, *Imaging materials — Colour reflection prints — Test method for ozone gas fading stability*

ISO 18946, *Imaging materials — Reflection colour photographic prints — Method for testing humidity fastness*

ISO 18949[1)], *Imaging Materials — Reflection colour photographic prints — Method for testing stability under low humidity conditions*

ISO 19594, *Graphic technology — Test method for the determination of the binding strength for perfect-bound products — Page-pull test working upwards*

ASTM F904, *Standard Test Method for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials*

1) Under preparation. Stage at the time of publication: ISO/DIS 18949:2018.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18913 and the following 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
photo book
bound book with printed pages comprised of integrated personal photos along with artwork and text, designed by and usually dedicated to a limited group of people

3.2
cover
protective covering on the front, back, and spine of a book, including any associated adhesives, binding boards, liners, and laminates

3.3
blister
localized delamination of a multilayer assembly that looks like a bubble

3.4
delamination
separation of a laminated assembly into its constituent layers, either in whole or in part

3.5
laminate
layer of material that goes over one or both sides of a printed page

Note 1 to entry: Usually the laminate layer provides moisture barrier and abrasion resistance, as well as UV shielding, to add protection to the photo images from physical damage and colour fading.

3.6
laminate
<film> clear polymeric layer applied using thermosetting or pressure-sensitive adhesive to one or both surfaces of a print to improve durability

3.7
laminate
<liquid coating> water-based, solvent-based, or UV-curable liquid protective coating applied to one or both surfaces of a print to improve durability

3.8
laminated assembly
multilayer structure typically comprising a paper support, one or more barrier layers, an imaging layer, and a protective laminate top layer

Note 1 to entry: Laminated assemblies include films or coatings adhered to the surface of pages or covers, prints adhered back-to-back to each other forming a completed page.

3.9
lay-flat
binding that allows for an uninterrupted image across the binding, either by using flexible, hinged pages or by adhering the front and reverse sides of each page together

3.10
sandwich sample holder
metal fixture intended to hold three components in a flattened, pressed-together position so that airflow to the printed areas of the middle component is restricted as a function of the permeability of the two outer components

Note 1 to entry: This type of sample holder is suitable for sandwich thermal test method written in Annex D.

3.11
sample sandwich thermal test method
thermal stability test method that complies with ISO 18936 except that the sandwich sample holder is used in place of the free hanging sample holding method

3.12
blocking
undesired adhesion between sheets of printed material that occurs under moderate pressure, high temperature, or high humidity, while in storage or in use that leads to undesirable effects such as delamination, paper splitting, tearing, ferrotyping, colourant transfer, or edge deformation

3.13
sticking
temporary adhesion of prints in a stack or pages in a photo book but without physical damage when adjacent prints or pages are separated

3.14
ferrotyping
changes in surface gloss resulting from intimate contact with another surface, often associated with high humidity

Note 1 to entry: The term ferrotyping is derived from a historical term associated with silver halide photography. It is a process used to produce a very high gloss surface on a gelatine silver halide print in which a damp print is placed in contact with a highly polished surface, such as chromium-plated steel, and dried under conditions of elevated temperature and pressure.

3.15
bleeding
lateral migration of colourant

3.16
colourant transfer
transfer of colourant from one sheet to the other sheet, when both sheets are placed in direct contact

3.17
curling
physical deformation of a page, a cover, a stack of prints or a bound photo book resulting in departure from physical flatness with the tendency to curve into a concave or convex shape

3.18
wrinkling
physical deformation of a page or a cover of a photo book resulting in departure from physical flatness with the tendency to make furrows, crinkles, folds, ridges or creases

3.19
warp
distortion of the front and/or back covers of a bound book, so that the covers do not lie flat against the book block

3.20
book block
text block, including the endpapers and other materials added by the binder, before casing in

3.21
waviness
physical deformation of a page or a cover of a photo book resulting in departure from physical flatness with the tendency to curve alternately in opposite directions, resembling or suggesting waves

3.23
cockle
planar distortion in flat materials, especially paper or vellum, that is characterized by puckering, waves, or rippling

3.24
edge fluting
wave-shaped deformation along the edges of cut sheets and may be caused by an expansion of the edge of the material, which is exposed to greater variations in temperature and humidity than the centre

4 Image permanence tests for covers and pages

4.1 General

Although the individual pages of most photo books are not typically exposed to light and pollutants in the ambient environment for long periods of time, it is useful to know how stable the printed pages are if the book were to be left open to the environment for extended periods of time. Therefore, the tests described in this clause are intended to be carried out on individual printed sheets or pages of a photo book. In addition, these tests are also intended for photo book covers. Different use profiles are addressed in specification documents.

Thermal stability, light stability, ozone resistance and humidity resistance of printed sheets and covers may be evaluated according to the test methods given in ISO 18936, ISO 18937 (indoor home lighting condition), ISO 18941, and ISO 18946, respectively.

Light stability and ozone resistance, as measured according to ISO 18937 and ISO 18941 will reflect the performance that can be expected for a cover that contains pictures or for the underlying printed sheets, if a cover has a window opening that shows the first page, or if the book is displayed or otherwise left in an open state for long periods of time. However the most important issue regarding image permanence of photo books is generally dark storage.

NOTE Information regarding physical abrasion testing is provided in Annex B.

4.2 Sample preparation

The samples shall consist of the parts of a photo book, including pages, liner and end sheets, and covers, separated into individual page size components. Printable components, including a printable cover — if applicable — shall be printed with a test target. These parts are then bound in the same process (time and machine settings) as the book for which the test is intended. At least two replicate samples are recommended. Alternatively, test specimens shall be cut off from the book. For general testing purposes, users of this document are free to choose whatever target patches and starting densities they feel are appropriate for their testing needs. An example of such a target is included in ISO 18944 along with requirements and recommendations for sample preparation. Applicable International Standard(s) for specification of print life may require the use of specific targets. If a protective lamination film or varnish coating is applied to the photo book, either on the book cover or in its inner sheets, the same protective film or varnish coating shall be applied on the test samples. The photo book components shall be conditioned at 23 °C and 50 % RH for 24 h prior to testing.

NOTE Be aware that different starting densities of the test prints may yield different test results in terms of fading rate. Once a test sample density is chosen, it is important to be consistent across all test samples for comparison. If testing is being done according to a standard that uses specific starting densities those densities need to be adhered to.

At least two replicate samples of each photo book component part are required, both printed and unprinted. Replicates of each photo book component part shall be located in different regions of the respective test chambers (light, ozone, etc.).

The measurement and sample holding conditions and measurement procedures given in ISO 18936 shall be followed. In particular, care shall be taken to use consistent ambient light levels and hold times in each iteration of the sample holding and measurement process. Density shall be measured for printed patch areas, and colorimetric values shall be measured in the D_{min} (minimum density) patch areas of the printable components and in the centre, of each unprinted component. Density and colorimetric values from the replicate samples shall be averaged before calculations are performed.

4.3 Thermal stability during long-term dark storage

4.3.1 General

Long term stability shall be evaluated in accordance with ISO 18936, the test method, and ISO 18924, the Arrhenius analysis. It should be noted that the test results of the short term high temperature test may not correspond to the long term stability.

4.3.2 Procedures

The sealed bag method, as detailed in ISO 18936, shall be used to test individual pages or covers. In addition to the required sealed bag method, the 'free hanging' method, also detailed in ISO 18936, may be used to minimize page or cover interactions; it does not, however, reflect the actual storage conditions of the photo book. The 'free hanging' test does not simulate interactions between components that may be present in a photo book, such as between the cover and the first page. To simulate those interactions the user may conduct a "sandwich" type thermal ageing test as described in Annex D.

During actual storage of photo books the temperature and humidity will fluctuate, including potentially large fluctuations depending on the differences in seasons. The testing shall be done at a relative humidity (RH) of 50 %. However, because the effects of humidity on image stability can differ markedly from one product to another, it is useful to evaluate its effect. This is done by means of a temperature test series carried out at different relative humidity. If the relative humidity during storage is expected to be significantly lower than 50 % RH, such as when stored in accordance with some conditions specified in ISO 18911, ISO 18920 or in an arid climate, or significantly higher, as in a tropical climate, the relative humidity selected for the test should correspond to the storage conditions. Such tests are often conducted at conditions of various % RH levels, such 20 % RH to pick up low humidity effects and 70 % RH to pick up high humidity effects. In order to make use of the Arrhenius method in ISO 18924, the temperatures used shall span a minimum range of 20 °C.

4.3.3 Reporting

Reporting shall comply with the reporting requirements of ISO 18936. The results of these tests are reported as temperatures and time for thermal testing to reach the observed losses in optical densities, together with the percentage of optical density losses, or the amount of densitometric and/or colorimetric change observed for a given temperature and time. Reporting shall include results for each tested photo book component, printed and unprinted. For each photo book component, reporting shall also include the presence or absence of physical and biological changes including, but not limited to, delamination, adhesive failure, mould growth, and blocking. In particular, if a sample photo book component held in the interior of a three layer sandwich in the sandwich sample holder adheres to or transfers colourant to the materials comprising the outer layers of the three layer sandwich, this failure shall be reported. In addition, visible edge yellowing, differentiating the component edge region from the interior shall be reported.

4.4 Light stability

4.4.1 General

The test method for "simulated indoor daylight typical home display" according to ISO 18937, shall be used. For general testing purposes, users of this document are free to choose whatever target patches and starting densities they feel are appropriate for their testing needs. An example of such a target is included in ISO 18944 along with requirements and recommendations for sample preparation.

NOTE Be aware that different starting densities of the test prints can yield different test results in terms of fading rate. Once a test sample density is chosen, it is important to be consistent across all test samples for comparison. If testing is being done according to a standard that uses specific starting densities those densities need to be adhered to.

4.4.2 Covers

The total cumulative exposure shall be 20 Mlx·h. Data may also be collected at lower and higher cumulative exposures if applicable to the usage case.

4.4.3 Pages

The total cumulative exposure shall be 2 Mlx·h. Data may also be collected at lower and higher cumulative exposures if applicable to the usage case.

NOTE The total cumulative exposure of 20 Mlx·h corresponds to 25 y exposure assuming that 12 h a day at a light level of 200 lx. 200 lx is the light level for book shelves at library which is described in ISO 8995. The pages are typically not exposed to as much light as the covers, and it is estimated to be less than ten percent of the cover value.

4.4.4 Reporting

Reporting shall comply with the reporting requirements of ISO 18937. The results of these tests are reported as the amount of densitometric or colorimetric change observed for a given cumulative exposure (lx·h) together with the percentage losses in optical densities. If multiple exposures are used, the results are reported as the cumulative exposure to reach the observed densitometric or colorimetric change together with the percentage losses in optical densities.

4.5 Ozone stability

4.5.1 General

The test method described in ISO 18941 shall be used. For general testing purposes, users of this document are free to choose whatever target patches and starting densities they feel are appropriate for their testing needs. An example of such a target is included in ISO 18944 along with requirements and recommendations for sample preparation.

NOTE Be aware that different starting densities of the test prints can yield different test results in terms of fading rate. Once a test sample density is chosen, it is important to be consistent across all test samples for comparison. If testing is being done according to a standard that uses specific starting densities those densities need to be adhered to.

4.5.2 Covers

The total cumulative exposure shall be 1 450 µl/l·h. Data may also be collected at lower and higher cumulative exposures if applicable to the usage case. Unless otherwise specified, the test shall be carried out at 1,0 µl/l, with an operational uniformity of ±0,1 µl/l ozone as specified in ISO 18941:2017, 9.4. Other optional concentrations, such as 0,5 µl/l or 5,0 µl/l, may be useful for testing. If concentrations other than 1,0 µl/l are used, the operational uniformity tolerances shall be ±10 % of aim or the best achievable with the test equipment. If greater than ±10 %, the actual tolerance shall be reported. If optional concentrations are used, the tester should evaluate the materials for ozone reciprocity

behaviour before making any comparative conclusions. For testing at ozone concentrations greater than 1,0 µl/l, reciprocity testing shall be conducted at an ozone concentration of 1,0 µl/l or lower (as discussed in ISO 18941:2017, Annex B).

NOTE 1 µl/l = 1 ppm (1×10^{-6}) and is measured in terms of volume.

4.5.3 Pages

The total cumulative exposure shall be 145 µl/l·h. Data may also be collected at lower and higher cumulative exposures if applicable to the usage case. Unless otherwise specified, the test shall be carried out at 1,0 µl/l, with an operational uniformity of ±0,1 µl/l ozone as specified in ISO 18941:2017, 9.4. Other optional concentrations, such as 0,5 µl/l or 5,0 µl/l, may be useful for testing. If concentrations other than 1,0 µl/l are used, the operational uniformity tolerances shall be ±10 % of aim or the best achievable with the test equipment. If greater than ±10 %, the actual tolerance shall be reported. If optional concentrations are used, the tester should evaluate the materials for ozone reciprocity behaviour before making any comparative conclusions. For testing at ozone concentrations greater than 1,0 µl/l, reciprocity testing shall be conducted at an ozone concentration of 1,0 µl/l or lower (as discussed in ISO 18941:2017, Annex B).

NOTE The total cumulative exposure of 1 450 µl/l·h corresponds to 25 y exposure to ozone gas of 6,6 nl/l concentration. Median ambient indoor ozone concentrations of 9 nl/l and 4,5 nl/l were determined for different regions worldwide. The 6,6 nl/l is the half point of the discussion. The pages are typically not exposed to as much ozone as the covers, and it is estimated to be less than ten percent of the cover value.

4.5.4 Reporting

Reporting shall comply with the reporting requirements of ISO 18941:2017, Clause 10. The results of these tests are reported as the amount of densitometric or colorimetric change observed for a given cumulative exposure (µl/l·h) together with the percentage losses in optical densities. If multiple exposures are used, the results are reported as the cumulative exposure to reach the observed densitometric or colorimetric change together with the percentage losses in optical densities.

4.6 Humidity stability

4.6.1 General

The test method and target patches described in ISO 18946 and ISO 18949 shall be used.

4.6.2 Covers and pages

The tests of Method A of ISO 18946 (high humidity) and ISO 18949 (low humidity) shall be run and results reported as described in ISO 18946 and ISO 18949.

4.6.3 Reporting

Reporting shall comply with the reporting requirements of ISO 18946 and ISO 18949. Reporting the specific humidity fastness test result (Method A of ISO 18946 and ISO 18949) shall include reporting of the humidity (% RH) and temperature test conditions, the test time duration and the delta E resulting over the test duration. For each photo book component, reporting shall also include the presence or absence of physical and biological changes including, but not limited to, delamination, adhesive failure, mould growth, and blocking.

5 Book integrity tests

5.1 General

Testing the book integrity of a photo book is conducted by a set of mechanical durability tests, which are related to transportation, usage, and storage on a bookshelf.

In general, some material used as binding or lamination may degrade gradually with age. Therefore, each mechanical durability test is performed on a photo book in its initial state and after a period of short term ageing.

Test methods of book integrity consist of page-pull test, peeling and delamination tests (including for covers and pages), and book block attachment to the cover.

NOTE 1 Page adhesion of a photo book caused by heat and humidity is addressed in Clause 6.

NOTE 2 Deformation of a photo book caused by heat and humidity is addressed in Clause 7.

NOTE 3 Information in extreme tests for photo book integrity is provided in Annex C.

5.2 Ageing conditions

Parameters of accelerated sample ageing for assessing the changes in ageing related mechanical integrity include: temperature range, relative humidity set point and total test duration. Users of this document are encouraged to select a proper set of test conditions based on their application needs and the expected storage environment in the life-cycle of the photo book products for the market they are serving.

As a typical condition of short term ageing, the temperature cycling protocol of ISO 11800:1998, Annex C shall be applied. Mechanical integrity of the photo book shall be measured both before and after the following sequence of exposures:

a) 72 h exposure to 54 °C ± 3 °C;

b) 72 h exposure to −6 °C ± 3 °C;

c) 6 h exposure to 24 °C ± 6 °C.

NOTE 1 With certain hot melt adhesives with low glass transition temperature or softening temperature, (for example certain ethylene vinyl acetate adhesives with lower softening temperature than 54 °C) some failure issues can occur during the book integrity tests. However, those issues can or cannot occur in actual room temperature storage.

NOTE 2 If a single ageing chamber is used for temperature cycling, add 2h to 3h of transition time between the two temperature extremes.

5.3 Page pull test

5.3.1 General

The tensile page-pull test measures initial strength of page attachment. Page attachment ensures that photo book pages remain an integral part of the completed photo book. Poorly attached pages may become separated and lost or damaged. The aim of the testing of book blocks is to identify possible weaknesses of the binding quality. The test method described in ISO 19594 or that described below in 5.3.3 shall be used.

NOTE The scope of ISO 19594 is for adhesive-bound books only, but the methods described in this document can be applied for other book block constructions as well.

The binding strength is evaluated by pulling out a single sheet from the book block using a material testing system and a specified test fixture. The test is performed in such a way that the test sheet is

clamped on the complete fore edge while the opened book block is fixed at the specimen holder with a specified preload. The test sheet is pulled out upwards by a force acting perpendicular to the binding edge. The maximum force resulting from the pull-out procedure is measured. The binding strength of the specimen is calculated by dividing the maximum force by the spine length of the book block.

The number of test positions of a sample depends on the thickness of the book block and the number of sheets differing from the majority of the sheets (special sheets). There shall be a minimum of three test positions. These test sheets shall be located at 10 %, 50 % and 90 % of the total number of pages. Additional test positions are recommended, including the first and last printed page in the book block.

NOTE For a book block with 100 pages, the test sheets are those with the pages 10, 50 and 90.

For each test position at least two specimens shall be tested.

5.3.2 Test procedure

Test apparatus and test procedure described in ISO 19594 or the method described in 5.3.3 shall be used. Because the method of ISO 19594 cannot be applied to connected page type photo books, an alternate test method is provided below.

5.3.3 Alternate test procedure

5.3.3.1 General

The test shall be done with a tensile strength test equipment which can hold books. The test equipment and the procedures described in ISO 527-3 shall be applied. ISO 527-1 specifies the general principles for determining the tensile properties of plastics and plastic composites under defined conditions and may be useful for additional information in the use of ISO 527-3. Tests shall be performed at a temperature of 23 °C ± 5 °C and a relative humidity between 35 % and 75 %. This alternate method can be applied to all types of photo book block constructions.

5.3.3.2 Preparation of test specimen

The photo books can be tested as they are. However, it is recommended to cut the books into 40 mm width using a sharp cutting machine, such as a guillotine cutter or a rotary cutter, taking care not to affect the page attachment. Because photo books may be expensive, cutting test specimens into 40 mm widths will yield large numbers of specimens from a single photo book. The length can be also shortened in order to fit the gap of the specimen holder of the tensile pull equipment.

The edge of the front cover or back cover shall be gripped with the lower specimen gripper of the tensile pull equipment. The page which is located at 10 %, 50 % or 90 % of the total number of pages shall be gripped with the upper specimen gripper of the tensile pull equipment.

5.3.3.3 Application of the preload

Application of the preload shall be accomplished as follows:

a) zero the force transducer;

b) apply a preload of 70 N on the downholder (the speed of the upper traverse during the positioning of the downholder should be 50 mm/min);

c) fix the position of the downholder once equilibrium has been achieved.

5.3.3.4 Execution of the pull procedure

Execution of the pull procedure shall be accomplished as follows:

a) apply tensile force with a speed of 1 000 mm/min until the maximum force has been reached;

b) record the maximum force measured and the spine length of the book block;

c) observe the test procedure, recognize and record any effects.

5.3.3.5 Inspection

Inspect the test specimen after the pull procedure and record the physical condition of the spine and binding, the tensile force and elongation to break.

5.3.4 Calculation of the binding strength

The binding strength shall be calculated separately for each test position.

Measurement values of test sheets with glue penetration shall be excluded from any calculation.

Measurement values of ruptured test sheets shall be marked with a ">" (greater than).

The binding strength is calculated according to Formula (1):

$$F_b = F_{max} / l \quad (1)$$

where

F_b is the binding strength [N/cm];

F_{max} is the maximum force [N];

l is the spine length [cm].

The mean of all binding strength values is calculated for each test position. If at least one of the maximum forces for a test position is marked with a ">", the mean shall also be marked with a ">". Values marked with a “>” shall be excluded from the calculation of the coefficient of variation.

NOTE An example of classification scale for binding strength is included in Table A.1.

5.4 Peeling and lamination durability

5.4.1 General

Applying a protective laminate to a photograph can prevent a variety of unwanted physical or environmental damage. For this reason, photo book covers, and in some cases photo book pages, are laminated to protect against damage.

Humidity, temperature, the presence of residual solvents and the use of incompatible laminates may cause delamination to take place over time. Photo book covers are particularly vulnerable to delamination because of the stresses that take place near the spine.

Lamination includes films or coatings adhered to the surface of prints, prints adhered back-to-back to each other forming a completed page, and films or coatings used to protect the cover.

Laminates are typically composed of polyvinyl acetate, polyvinyl chloride, polyurethane, polyester, polypropylene or other polymeric material. Depending on the specific formulation, laminates may be applied as a film with an adhesive at either room temperature or at elevated temperatures. They may also be applied as a liquid coating which is subsequently dried to remove the carrier fluid or cured in the case of a radiation curable laminate.

5.4.2 Resistance to delamination

An important aspect of photo book durability is resistance to delamination caused by the environmental stressor of temperature cycling. Over time, this tends to cause ageing-related delamination of either laminated film or coated sheets because often the thermal expansion coefficient of the underlying paper (or other imaging material) and the laminated material are different. The resulting interface stress could lead to delamination or other undesirable visual defects, such as forming blisters under the laminated film, or the laminated pages become curved, which is a sign of internal stress build up to the extent that exceeds the bending resistance of the substrate material.

5.4.3 Assessment of age related lamination and binding strength

In order to assess ageing-related changes in lamination strength on printed images (such as the cover of a photo book), the test method described in 5.4.4, following the procedures found in Annex E, shall be used. In order to assess ageing-related losses in binding strength on back-to-back combined pages in a photo book, the test method described in 5.4.5, following the procedures found in ASTM F904, shall be used.

Samples shall be aged according to 5.2. Any measurable reduction in lamination strength of the aged samples in comparison to the control samples indicates ageing-related degradation of the adhesive bond of the laminated film. The magnitude of loss in lamination strength after ageing will provide a basis for selection of different lamination products or varnish coating products.

NOTE For the lamination durability test described in 5.4.4 and 5.4.5, consider adding additional ageing cycles as needed, in case one ageing cycle does not reveal ageing-related weakening of lamination strength beyond the noise level of the methods

5.4.4 Peeling resistance and lamination bond strength for protective laminate

Peeling resistance and lamination bond strength shall be measured according to the procedure given in Annex E. The page and cover material shall consist of the laminated substrate printed at maximum density (R, G, B code values = 0, 0, 0).

All test samples shall be prepared in the dimension specified in Annex E, conditioned at 23 °C, 50 % RH for 24 h prior to applying the lamination and before testing the lamination strength. At least three replicate samples are required. The measurement shall be done in both the horizontal and vertical direction (i.e., machine and cross directions of the substrate) and both results shall be reported.

Results for the three samples evaluated at each test condition shall be averaged to obtain the classification for a specific substrate.

NOTE 1 This test does not apply to some photo books because preparing the free edge of the protective laminate to test for peeling strength is difficult due to the following reasons:

— the laminate for photo books is thin;

— forming a free end of the laminate in lamination process is hard in many cases.

NOTE 2 An example of classification scale is included in Table A.2.

5.4.5 Internal bond strength for glued single side sheets

If sheets are only printed on one side, the sheets have to be glued together for a double sided printed book. That can be done with hot melt or with special gluing (intermediate) sheets.

For manufacturability, it is important that the initial gluing strength is sufficient; however, it is of equal importance that after a long period of time the single sheets will not fall apart. Therefore, internal bond strength shall be tested using ASTM F904, which requires peel testing to be accomplished in the paper's machine direction of manufacture. However, testing with this method for photo books with glued sheets shall be accomplished with peeling done perpendicular to the photo book spine because the machine direction of the paper is not easily determined and not relevant for photo books using glued sheets.

5.4.6 Test sample preparation, results assessment and reporting

Sample preparation shall follow the requirements in the chosen test standard, either the procedures in Annex E or ASTM F904. For testing the lamination strength of an imaged photo book cover, sample preparation should include image printing of different colourants at their maximum density, as described in Annex E. The number of sample duplications shall also follow the requirements of the standard used. Regardless which test standard is used, a set of control samples (with necessary duplications) shall be prepared under the same conditions as the test samples, and maintained at ambient conditions of 23 °C and 50 % RH during the test sample ageing period. After the ageing period is completed, these control samples shall be tested for lamination strength, alongside the aged test samples.

The lamination strengths of the aged samples and control samples shall be compared to determine the impact of ageing, and results shall be recorded. The ageing conditions used (minimum and maximum cycling test temperatures, relative humidity set point, and number of cycling days) shall also be recorded as well as which test standard was used to assess the loss of lamination strength after ageing. In addition, any visual defects that become apparent after ageing, such as blister in the lamination interface or distortion of the laminated sheets, shall also be included in the comparison of ageing related damages, and be recorded.

5.5 Book block attachment to the cover (heat durability)

5.5.1 General

A photo book is expected to remain together as an integral unit during its expected lifetime. If the binding becomes separated or pages are lost, the photo book has failed in this function. Consequently, the bindings and all pages in a photo book are expected to remain intact and together as a unit when tested under suitable conditions.

Both before and after the short term ageing described in 5.2, adhesion of the book block and the cover shall be examined. Any failure of the cover lining material and/or book block to adhere to the cover spine as a result of this testing shall be reported and the failure mode shall be specified. Table A.3 provides qualitative guidelines to describe various failure modes. Specific test procedures are given in 5.5.2 and 5.5.3.

5.5.2 Book binding strength (heat durability)

Adhesive force of the book binding shall be tested in accordance with ISO 11800 which tests whether the bonded materials can be separated without damage, either before or after the ageing specified in 5.2.

NOTE Other maximum temperatures can be used to evaluate books that are not required to meet the conditions currently mandated.

Any failure of adhesion of the cover lining material and/or the text block after this heat durability test shall be reported and the failure mode shall be specified.

5.5.3 Opening and closing durability

Photo books with a black printed spine, equivalent to sRGB values of 0, 0, 0, shall be visually evaluated for delamination after 1 000 opening and closing cycles. The book shall be opened with approximately the same number of pages on each side. During the opening and closing cycles, the pages shall be held down but not rigidly fixed in place. The selected pages shall be approximately 50 % of the way through the book block. The pages shall be held approximately two-thirds of the way between the spine and the cover. The book shall also be evaluated for other failure modes, including but not limited to separation of the text block from the cover, separation of individual pages from the text block, and separation of the cover from the spine. The final report shall include a description of any delaminations that occurred,

including the length and width of the delaminations, as well as a description of any other failure modes that were observed.

NOTE In addition to the previous test, the open-close durability test can be conducted at page locations that are approximately 10 % and 90 % of the way through the book block.

See Figure 1 for an example of a page turner device that can be used for this test.

Figure 1 — Example of a page turner device for use in the open-close test

6 Book blocking

6.1 General

The primary objective of this suite of test methods is to assess the durability of photo books in a closed condition. Tests representative for books left open on a desk or table are provided in Clause 4.

Elements of use to be simulated with blocking tests:

a) Long term storage:

   1) Book shelf;

   2) Stacked books;

b) Short term transport:

   — Vehicle interior.

6.2 Test conditions

There are two substantially different elements of use that need to be considered for closed photo books: long term storage under moderate environmental conditions and shorter term transport under more extreme environmental conditions. In either case, the primary stress factors that need to be considered are temperature, humidity, and pressure. Tests that subject a stack of printed pages to a combination

of temperature, humidity, and pressure, as in the case of closed photo book, are often referred to as blocking tests, and the primary response factors are physically sticking or binding of pages together, ink retransfer to an adjacent facing page, physical deformation of the page (wrinkling, curling, ferrotyping, etc.), and degradation of image quality (colorimetric or densitometric changes, changes in gloss, sharpness or resolution, etc.).

For the two long term storage cases, book shelf and stacked books, two separate temperature/humidity conditions are given, to simulate either hot/dry (summer attic) or warm/moist (unconditioned) storage conditions. Based on studies of the home environment of photographic consumers[3], the hot/dry condition is reasonably simulated by running the test at 50 °C and 20 % RH, and the warm/moist condition is reasonably simulated by running the test at 25 °C and 85 % RH. A fixed pressure of 1 kPa shall be used for either of these two environmental conditions, and the test duration shall be 2 days.

NOTE 1,0 kPa corresponds to the approximate pressure at the bottom of a stack of ten books, each containing 100 pages of standard paper (with a basis weight of 148 g/m^2). It also corresponds to the approximate pressure experienced in a tightly packed book shelf.

The primary differences between long term storage and short term transport are that during short term transport the closed book would spend a shorter duration under a somewhat hotter environment. Because the hot air in a closed car interior should have a comparable dew point to the ambient exterior environment, the relative humidity is scaled appropriately to the temperature of the test. An illustrative example follows: assume that the exterior atmosphere on a typical hot summer day is 35 °C (95 °F) and 80 % RH, then the relative humidity of that same air heated to 60 °C (140 °F) would be 24 %. In this case, a treatment condition of 60 °C/25 % RH for 8 h is the requirement for short term transport. Because a photo book being transported in a car is not likely to experience the same pressures as one in a stack of books or in a tightly packed bookshelf, a reduced pressure of 0,5 kPa is required for this test condition.

Table 1 — Summary of the three test conditions used for the closed book blocking test

Use Case Simulated	Temperature °C	Relative humidity %	Pressure kPa	Duration
Long term storage (hot/dry)	50	20	1	2 days
Long term storage (warm/humid)	25	85	1	2 days
Short term vehicle storage	60	25	0,5	8 h

NOTE Test conditions of this table are outside the recommended storage conditions as defined in ISO 18920 and ISO 18934, under which occurrence of blocking is not expected.

6.3 Test target design

A test target comprising patterns of horizontal and vertical colour bars, such as shown in Figure 2 shall be used for the blocking test. Sample target size is shown for illustration purposes; they could be larger or smaller. The two targets shall be placed face to face, as well as against any interleaving sheets or cover materials that will come in contact with the printed pages in the closed book. The final "sandwich" shall be placed under the appropriate weight to achieve the specified pressure for each of the test conditions.

Figure 2 — Test target to use for blocking tests

The test target consisting of saturated cyan, magenta, yellow, black, red, green, and blue colour bars shall be printed using the same colour management, print driver settings, or other printing process settings that would normally be used when printing the actual photo book pages. If the printing process used to produce the photo book also includes additional primary or spot colour inks, then these colourants shall also be included on the test pattern. The colour bars of the test target shall have a density of at least 1,5. If the imaging system is not capable of 1,5 density then the density used shall be the maximum capable of the imaging system.

If the printing process or subsequent photo book production process also includes a layer or layers deposited over the printed areas on the substrate, either image wise or as a substantially continuous layer, e.g., by dry lamination, liquid lamination, or other post-coating process, then these layers shall also be included as part of the test pattern.

6.4 Conditioning of test specimen

The test pattern, blank pages, and other optional test materials shall be assembled into a stack as described in 6.5.1. Prior to assembly of the stack, all sheets shall be conditioned at 23 °C ± 1 °C and 50 ± 5 % relative humidity for at least 24 h.

6.5 Test methods

6.5.1 General

The test methods described herein comprise a stack of test patterns, blank pages, and other photo book component materials that is sandwiched between top and bottom plates, upon which a weight or load is applied as summarized in Table 1. An example of a test jig which can be used for the closed book test is described in Rima and Burge (2009)[27].

As an alternative to a stack of diagnostic test patterns, blank pages, and other photo book components as described above, a fully bound and assembled photo book shall be subjected to the three conditions summarized in Table 1 and described in detail in 6.5.4 to 6.5.6. If a fully bound book is tested, the book shall be printed and assembled with the same materials and in the same manner as a book that would be sold or provided to the end-user. This shall include representative images and graphic layouts typical of a consumer photo book. A fully bound book shall be conditioned at 23 °C ± 1 °C and 50 ± 5 % relative humidity for at least 24 h.

For either the stacked test target configuration or the fully bound book alternative, at least two replicate samples shall be tested at each test condition.

In order to achieve the required pressure for each of the test conditions, a weight, which is the same area dimensions as the stacked test target or the fully bound photo book, is chosen to produce the required pressure.

NOTE The mass needed to achieve the required pressure can be determined using the formula below;

$m = 10{,}2 \times (L_p \times l_p)$

where

m is the mass needed in grams;

L_p is the page length of a photo book measured in centimetres;

l_p is the page width of a photo book measured in centimetres;

10,2 is a factor coming from the conversion of 1 kPa = 10,197 gram·force/cm^2.

Other test conditions are allowed in addition to these required conditions if such conditions correspond to a particular usage case. In such case, the specific combinations of temperature, humidity, pressure, and test duration, and the rationale for choosing such conditions, shall be included in the report.

6.5.2 Equipment and calibration

Test chambers which can control temperature and humidity to within the specifications described below shall be used.

Each test chamber shall be calibrated for relative humidity control and measurement accuracy by using a chilled mirror hygrometer or other type of measurement device as stipulated in ISO 18931. The calibration shall include the temperature and relative humidity ranges that are to be used in the ensuing test processes. A check of the calibration shall be performed when there is any indication of sensor failure. Ongoing use of redundant sensors is recommended so that sensor integrity can be ascertained.

6.5.3 Test environment control

The relative humidity shall be maintained and controlled throughout testing with

a) an operational fluctuation within ±3 % RH of aim,

b) a running average, sampled at least every 15 min, of the operational fluctuation within ±1 % RH of aim, and

c) an operational uniformity within ±2 % RH of aim, at a constant temperature.

The running average shall not include the transition time of 1 h after door closing. Select regions of the test chamber for use that meet the required operational uniformity conditions. If the running average of the operational fluctuation does not meet the requirement it shall be documented and explained.

The air temperature inside the chamber shall be maintained and controlled throughout testing with an operational fluctuation within ±2,0 °C of aim. The 24 h running average of the operational fluctuation, sampled at least every 15 min, shall be within ±1,0 °C of aim. The running average shall not include the test condition transition time of at most 1 h after the test condition is initiated. Operational uniformity of the equipment at the test conditions shall be evaluated prior to test start and shall be within ±2,0 °C of aim. Regions of the test chamber shall be selected for use to comply with the required operational uniformity conditions. If the running average of the operational fluctuation does not meet the requirement it shall be documented and explained.

The air flow shall be sufficiently high to produce uniform temperature and humidity conditions in the chamber.

6.5.4 Long term storage (hot/dry) test

An environmental chamber shall be equilibrated and controlled to a nominal set point of 50 °C and 20 % relative humidity. The test specimens — stacks of test prints or bound photo books with applied loads of 1,0 kPa — shall be placed on wire racks with sufficient space between them to allow for air circulation. The test specimens shall be incubated for 48 h under these conditions. At the end of the test duration, the test specimens shall be removed from the test chamber and re-equilibrated to 23 °C ± 1 °C and 50 ± 5 % relative humidity for 24 h. The assembled stack of test prints or bound photo book, including the applied load, is maintained until re-equilibration has occurred.

6.5.5 Long term storage (warm/humid) test

An environmental chamber shall be equilibrated and controlled to a nominal set point of 25 °C and 85 % relative humidity. The test specimens — stacks of test prints or bound photo books with applied loads of 1,0 kPa — shall be placed on wire racks or perforated shelves with sufficient space between them to allow for air circulation. The test specimens shall be incubated for 48 h under these conditions. At the end of the test duration, the test specimens shall be removed from the test chamber and re-equilibrated to 23 °C ± 1 °C and 50 ± 5 % relative humidity for 24 h. The assembled stack of test prints or bound photo books, including the applied load, is maintained until re-equilibration has occurred.

NOTE If necessary to avoid condensation, it is suggested that the chamber be pre-warmed to 25 °C and RH below 50 %. The test specimens shall then be moved into the chamber, and allowed to warm up for ~15 min before raising the chamber RH set point to the 85 % target. The 48 h ageing test time shall begin once the chamber RH reaches the 85 % target.

6.5.6 Short term transport test

An environmental chamber shall be equilibrated and controlled to a nominal set point of 60 °C and 25 % relative humidity. The test specimens — stacks of test prints or bound photo books with applied loads of 0,50 kPa — shall be placed on wire racks with sufficient space between them to allow for air circulation. The test specimens shall be incubated for 8 h under these conditions. At the end of the test duration, the test specimens shall be removed from the test chamber and re-equilibrated to 23 °C ± 1 °C and 50 ± 5 % relative humidity for 24 h. The assembled stack of test prints or bound photo books, including the applied load, is maintained until re-equilibration has occurred.

6.6 Evaluation

6.6.1 General considerations

The primary response factors of a photo book when subjected to the combination of heat, humidity, and/or pressure are ferrotyping, adhesion or blocking. Another possible response is the migration of colourants, either laterally, with a corresponding change in hue or sharpness, or from one page to a facing page. A third possible response factor is edge deformation of the stack or bound book, giving rise to the appearance of wrinkling or curling. Less likely to occur, but worth noting is any evidence of delamination of any of the layers on the printed pages.

6.6.2 Reporting

After the test specimens have been re-equilibrated to 23 °C ± 1 °C and 50 ± 5 % relative humidity for 24 h, the samples shall be visually inspected. Observed phenomena shall be reported. Typical evaluation items are listed in Table 2.

Table 2 — Evaluation items for book blocking test

Inspection item	Phenomenon description
Sticking	Pages stick together, but no surface change
Ferrotyping	When pages are separated, changes in surface gloss observed
Colourant migration	Colourant transferred to adjacent area
Edge deformation	Deformation is observed in lateral view
Delamination	When pages are separated, delamination of the surface occurs

NOTE An example of sample classification scale is included in Tables A.4 and A.5.

6.6.3 Additional evaluations

In addition to the inspection items listed above, any other evidence of degradation shall be noted. Additionally for the stacked target test specimen, changes in density, colorimetry, sharpness, and/or gloss may be optionally measured for the printed target and any of the facing blank sheets.

7 Deformation caused by humidity

7.1 Page deformation of a photo book (waviness)

7.1.1 General

The dimensional stability of a photo book upon long term storage or keeping is most likely affected by the temperature and humidity that the book is stored at. High humidity is believed to be the primary stressor, and temperature a contributory stressor; however, low humidity conditions can also cause deformations. Changes from a high humidity or high temperature condition to a low humidity or low temperature condition may further stress the pages of a photo book. Poor dimensional stability of the printed pages can affect the flatness of the page, observed as curl, edge fluting, cockle and waviness. It can also affect the thickness of a page, resulting in measurable changes in paper caliper, or the book itself resulting in dimensional changes with possible consequences to the integrity of the binding.

NOTE High humidity will also promote fungal growth.

7.1.2 Procedure

The photo book shall be conditioned at 23 °C and 50 % RH for 24 h prior to testing. The closed photo book shall then be stored at 25 °C and 85 % RH. Measurements shall be taken at time zero, one week, and four weeks to test for page flatness and rate of change in flatness. Additional measurements early in the test cycle are recommended. The flatness of the book pages (waviness) shall be measured by dividing the maximum amplitude (mm) by the thickness (mm) of the total book pages. Also the amount of waves per metre width of the photo book shall be calculated. Measurements shall be taken within 30 min after removal from the high humidity condition. See Figure 3.

NOTE 1 Increasing the number and precision of data points taken in the test, will facilitate identification of when the pages have reached equilibrium. It is possible that the duration of the test cycle can be determined by examining the change in waviness as a function of time until it has been determined that the change in waviness is no longer statistically significant.

NOTE 2 The book used for this test can also be used for the warp test at 85 % RH.

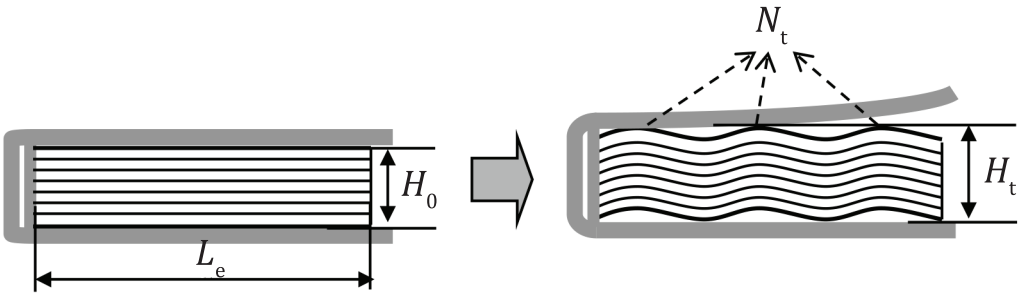


Figure 3 — Illustration of waviness showing before (left) and after (right) testing

Key

H_0 thickness before testing
H_t maximum height after testing
N_t observed number of waves
L_e edge length

7.1.3 Reporting

Calculated value of wave height ratio, H_r and calculated number of waves per length, N_r (m^{-1}), shall be reported. Both calculations shall be done; calculations are only for the book block, not the cover.

$$H_r = \frac{H_t}{H_0}$$

where

H_r is the height ratio

H_t is the maximum height after testing (mm);

H_0 is the thickness before testing (mm).

$$N_r = \frac{N_t}{L_e}$$

where

N_r is the number of waves per length (m^{-1});

N_t is the observed number of waves;

L_e is the edge length (m).

In addition, waviness, W (m^{-1}), which is the product of the above two calculations, is recommended. It shows relatively good correspondence with the visual assessment.

$$W = H_r \times N_r$$

where W is waviness level (m^{-1}).

NOTE An example of classification scale is included in Table A.6.

7.2 Cover deformation of a photo book (warp)

7.2.1 General

The most significant cause of warp is moisture being absorbed or released with the resulting expansion or contraction of the materials, which compromise a hard cover. Unbalanced expansion or contraction of any of these components relative to each other or within themselves may manifest itself as a warp. A binder of photo books needs to control the rate of expansion or contraction of the components used (hygroexpansivity) and the moisture balance within the bound product.

Moisture vapour barriers such a coatings or lamination on covering materials can interfere with the distribution of moisture in the delicate sandwich compromising a hard cover. A de-warping machine may control warp if covers are de-warped prior to casing-in.

Warp may be inherent in the manufacturing process or may be a consequence of environmental changes experienced after manufacture. The manufacturing process and the choice of materials determine the propensity for warp. A book cover is a sandwich, which consists of cover boards, the covering materials, the endpapers, the case-making adhesive and the casing-in materials. Factors that determine the likelihood that a photo book will warp include cover boards, covering material, end sheets, case making process, casing-in operations, and manufacturing process.

Warp is objectionable when it is concave toward the user and when it is convex with each cover bending toward the text block. The absence of warp, or a flat cover, is preferred.

Warp is also dependent on the temperature and humidity in the location the photo book is stored. ISO 18920 recommends storage at 25 °C or less, with 20 % to 50 % relative humidity. Storage at conditions outside of this range is likely to increase warp.

Samples shall consist of a fully-assembled photo book including cover and printed text block. The photo book shall be conditioned at 23 °C and 50 % RH for 24 h prior to testing. At least two replicate samples are required at each environmental condition. Replicates shall be located in different regions of chamber.

7.2.2 Procedure

Warp shall be measured as the deviation, d, between the maximum height, l_2 minus the thickness, l_1 of the spine[34]. Measurements shall be taken at time zero, one week, and four weeks to test for cover flatness and rate of change in flatness. Additional measurements early in the test cycle are recommended. The maximum warp of the two photo books evaluated at each condition shall be reported. See Figure 4.

NOTE Increasing the number and precision of data points taken in the test, will facilitate identification of when warp of the book has reached equilibrium. It is possible that the duration of the test cycle can be determined by examining the change in warp as a function of time until it has been determined that the change in warp is no longer statistically significant.

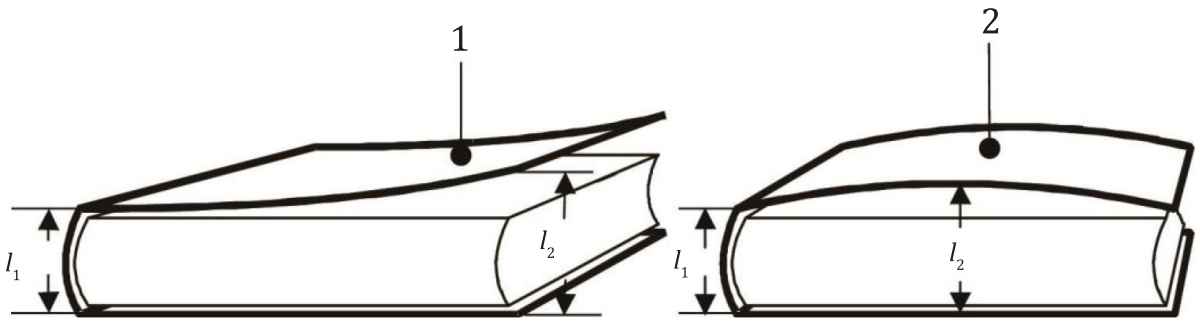


Figure 4 — Example of a concave (left) and convex (right) product

Key

1 concave cover
2 convex cover
l_1 thickness of the spine
l_2 length from the highest point of the concave or convex cover to the bottom

The deviations, d, shall be measured at the start of the test, as well as after 1 and 4 weeks of each condition:

a) at 23 °C ± 2 °C and 50 % ± 10 % RH;

b) at 23 °C ± 2 °C and 85 % ± 5 % RH;

c) at 23 °C ± 2 °C and 20 % ± 5 % RH.

where $d = l_2 - l_1$.

NOTE 1 Six books are required for this test, two for each humidity condition.

NOTE 2 The book used for the 85 % RH test can also be used for the waviness test.

7.2.3 Reporting

Initial and 4-week maximum warp deviation d, ($l_2 - l_1$), whether the deviation is concave or convex to the user, along with temperature, and humidity shall be reported. Any delamination, adhesive failure, or other change to the photo book that takes place during the warp test shall also be recorded.

NOTE An example of classification scale is included in Table A.7.

Annex A
(informative)

Guidelines for data interpretation

The following illustrative examples show one possible classification system for the test methods for durability described in this document.

Table A.1 — Page attachment tensile strength (susceptibility to page separation)

Susceptibility to page separation	Binding strength N/cm
A	Binding strength >7,0
B	5,1 < binding strength ≤7,0
C	2,0 < binding strength ≤5,1
D	Binding strength ≤2,0
NOTE This table corresponds to 5.3.	

Table A.2 — Susceptibility to cover and page delamination

Susceptibility to cover and page delamination	Lamination strength N/cm
A	Lamination strength ≥2,0
B	1,0 ≤ lamination strength <2,0
C	Lamination strength ≤1,0
NOTE This table corresponds to 5.4.	

Table A.3 — Photo book susceptibility to binding separation

Susceptibility to binding separation	Observed results
A	Book block laminate shows no cracking or separation
B	Book block laminate shows cracking without separation along the spine
C	Book block laminate shows some separation, along the spine
D	Book block laminate shows complete separation, along the length of the spine
NOTE This table corresponds to 5.5.	

Table A.4 — Susceptibility to blocking for adhesion

Susceptibility to blocking	Test results
A	No adhesion, ferrotyping, or edge deformation
B	Adhesion but easily separated with no surface damage
C	Adhesion, ferrotyping was observed after separation with no delamination
D	Pages cannot be separated or separation of pages results in delamination of surface
NOTE This table corresponds to 6.6.	

Table A.5 — Susceptibility to blocking for colourant migration

Susceptibility to blocking	Test results
A	No colourant migration
B	Minimal colourant migration
C	Noticeable colourant migration
D	Significant colourant migration
NOTE This table corresponds to 6.6.	

Table A.6 — Susceptibility to waviness of photo book pages for the calculated waviness value

Susceptibility to waviness	Product of (maximum amplitude of the waves) and (amount of waves per length of 1 m)
A	The value < 12,5
B	12,5 ≤ the value < 25
C	The value ≥ 25
NOTE This table corresponds to 7.1.	

Table A.7 — Susceptibility to warp for the maximum deviation, *d*, relative to the user

Susceptibility to warp	Maximum warp deviation *d* warp concave mm	Maximum warp deviation *d* warp convex mm
A	$d < 0,8$	$d < 1,0$
B	$0,8 \leq d < 2,0$	$1,0 \leq d < 3,0$
C	$2,0 \leq d < 3,0$	$3,0 \leq d < 5,0$
D	$d \geq 3,0$	$d \geq 5,0$
NOTE This table corresponds to 7.2.		

Annex B
(informative)

Abrasion

B.1 General

Abrasion damages photo book pages and covers. It takes many forms, including pages against pages, pages against the cover, cover against cover for paper or cloth covers and cover against hard materials such as book stands or book shelves. The effect of abrasion on printed pages may be minimized by paper selection and colourant selection as well as by ensuring the printing system is optimized for stabilizing the printed image, for example, adequately drying, curing, and/or fusing the printed image. If a window is present, the edge may also abrade the first page. Such damage is particularly likely if the window is cut directly from the cover leaving a rough edge. Damage may be minimized by wrapping the cover material around the edge of the window.

B.2 Procedures

B.2.1 Test method selection

ISO 18947 is applied to non-cloth covers, laminated paper covers and pages. The test target should be solid patches of white (D_{min}), cyan, magenta, yellow, pure black, process black, red, green, and blue printed of the test materials. The receptor should be an unprinted piece of the material representative of the different use case scenarios

ISO 105-X12 is applied to cloth covers. The test target should be solid patches of white (D_{min}), cyan, magenta, yellow, pure black, process black, red, green, and blue (as well as spot colours if those are used in the cover) printed on the test materials. This test measures the amount of resistance the cover material has to transferring colourant to a special piece of cloth (crock cloth). The test is run on a Crock Meter or JIS K-5701 and it measures the amount of transfer of coloured matter-whether a dye, print, impregnated colour, or other colouring. The resistance to transfer, whether run wet or dry, is considered an attribute. The results are reported after making a visual observation against a standard.

ASTM D5053 or JIS K5701 is applied to leather covers. The test target should be solid patches of white (D_{min}), cyan, magenta, yellow, pure black, process black, red, green, and blue (as well as spot colours if those are used in the cover) printed on the test materials. This test measures the amount of resistance the cover material has to transferring colourant to a special piece of cloth (crock cloth). The test is run on a Crock Meter and it measures the amount of transfer of coloured matter-whether a dye, print, impregnated colour, or other colouring. The resistance to transfer whether run wet or dry is considered an attribute. The results are reported after making a visual observation against a standard.

B.2.2 Test condition — Non-cloth covers

Test condition of Table B.1 should be used.

Table B.1 — Abrasion test condition for non-cloth covers

Load	0,69 N/cm^2
Cycling rate	43 cycles/min
Line speed	8,2 cm/s
Number of cycles	100
Temperature/RH	23 °C/50 % RH

B.2.3 Test condition — Pages

Test condition of Table B.2 should be used.

Table B.2 — Abrasion test condition for pages

Load	0,30 N/cm^2
Cycling rate	43 cycles/min
Line speed	8,2 cm/s
Number of cycles	100
Temperature/RH	23 °C/50 % RH

B.2.4 Test condition — Cloth or leather covers

Before testing, condition the specimen and rubbing cloth for at least 4 h in an atmosphere of 20 °C ± 2 °C and 65 ± 2 % relative humidity by laying each test specimen and each piece of rubbing cloth separately on a screen or perforated shelf. Some fabrics such as cotton or wool may require longer periods of conditioning. Test condition of Table B.3 should be used.

Table B.3 — Abrasion test condition for cloth or leather covers

Force	9 N
Cycling rate	60 cycles/min
Number of cycles	20
Temperature/RH	23 °C/50 % RH
NOTE The number of cycles for cloth and leather covers is lower than for pages because cloth or leather uses the Crock test, while the Sutherland Rub test is used for pages.	

B.2.5 Evaluation and reporting

For cloth covers, samples are be evaluated as documented in ISO 105-X12:2016, Clause 7, and results are reported as documented in ISO 105-X12:2016, Clause 7. For leather covers, samples are evaluated as documented in ASTM D5053-03(2015), Section 9. The following evaluation is carried out for each non-cloth and non-leather cover and page sample tested. The parameters, conditions and results as mentioned in ISO 18947:2013, Clause 9 are reported:

— Visible assessment;

— Percent density loss from colour patch;

— Absolute density gain of the receptor;

— Absolute density gain of an adjacent non-imaged area;

— Absolute change in gloss of the colour patch (gloss angle is defined as a function of the gloss of the starting patch).

Annex C
(informative)

Extreme photo book tests

WARNING — These tests do not reflect recommended usage conditions but have proven useful in the production environment since they are easily carried out and give quick results.

C.1 Subway test

The subway test is meant to test the page attachment of adhesive bound books. This document does not include the use or applicability of this test because it does not represent typical photo book usage; however, it is provided here for information. It can be done quickly, easily, and without any testing equipment and as such can be of use in nearly any book production setting. This test is done manually:

— Open the bound book completely in three, equal places — front, centre, back.

— Bring the front cover and the back cover back-to-back at each location.

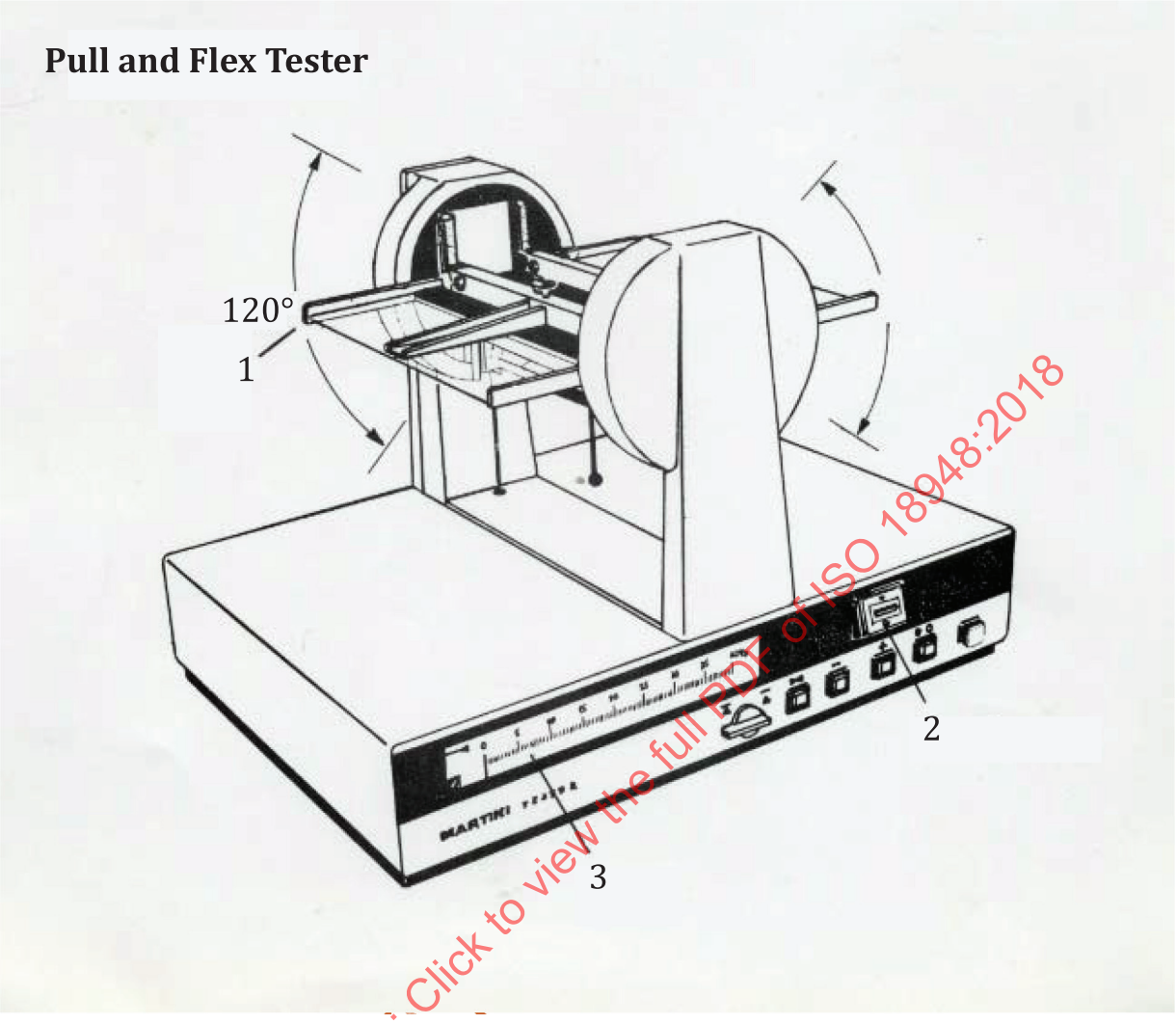
— Assess performance. Any loosening of the bound sheets at any of the three locations is rated as poor performance.

C.2 MIT fold test

The MIT fold test is used to measure the ability of a product to maintain its strength after repeated folding. The test specimen is subjected to repeated 270° folds, under tension, until failure. It is meant to simulate the repeated opening and closing of a book and thereby aid in predicting what its useful life may be. The higher the number, the greater the endurance. This test includes repeated 270° folds, which are not characteristic of typical photo book usage scenarios.

C.3 Test method for tensile page flex

The tensile page-flex[25] tests the strength and endurance in the binding edge. It is particularly relevant to determine the effect of fatigue after use. On panorama photo books, such a test will also test the integrity of the scoring, lamination, adhesion and coating in the binding fold.



Key

1 table
2 counter
3 scale

Figure C.1 — Example test apparatus for tensile page flex

The testing apparatus machine, see Figure C.1 should be able to flex a sheet through an angle of 120°, which is an accumulation of two 60° rotations around a pivot point. Three different sheets, equally divided within a binding are tested, front, centre and back. To obtain these sheets, divide a book block in half — use centre sheet. Divide the remaining front and back parts in half again and use these sheets for flex testing. Testing is done at 60 cycles/min and the sheet to be tested is subjected to a load factor of 1 N/cm. If a sheet is torn, record the number of completed cycles and discontinue the test.

When loading an adhesive bound book into a flexing device, at least two sheets on each side should not be clamped down and allowed to move freely. This procedure avoids applying unwanted stress onto the selected sheets to be tested.

This test is only applicable to true lay-flat bindings. It is not applicable to flex the sheets of a side-sewn book or any other method of binding that does not lie flat. On such books, with a built-in clamping effect, the flex-testing would go on indefinitely.

To test the Panorama image bindings, select a sheet as described above. However, since most of these types of bindings are made with relative stiff papers, there is no need to have free-floating sheets on