
Paper — Requirements for stability for general graphic applications

*Papier — Exigences pour évaluer la stabilité pour les applications
graphiques générales*

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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 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

Introduction

This document is intended for papers used for general graphic applications. Paper meeting the requirements of this document will not undergo any significant loss of mechanical properties under normal use and storage conditions. Typical applications include paper products, such as copy paper, brochures, maps and books, which can tolerate some changes in optical properties over time, the magnitude of which may vary with the type of paper and papermaking conditions. Such changes, if any, will not affect the legibility or reproducibility of the information.

This document effectively responds to market needs and environmental requirements. In recent years, there have been an increased trend and interest worldwide in the use of bleached chemithermomechanical pulp (BCTMP), alkaline peroxide mechanical pulp (APMP) and secondary fibre pulp for general applications, such as copy paper, brochures, maps and books which are not intended for permanent storage. Thus, this document will open up opportunities for high-yield pulp producers and paper manufacturers to develop and market a wide range of products containing mechanical fibre, as well as most types of recycled fibre. In particular, coated and uncoated printing and writing papers containing high-yield pulps, such as BCTMP or most types of recycled fibre, can be classified as stable paper, as long as they meet the specifications described in this document. This document will also be of benefit to paper customers and consumers as it provides them with options depending on their end-use applications.

The benefits of using mechanical fibre and/or most types of recycled fibre in paper products may range from improvement in some paper attributes, such as opacity, and lower production costs, to higher sustainability and a greatly reduced environmental footprint. In particular, the amount of virgin fibre, energy consumption, use of water resources, levels of greenhouse gas and other emissions, and solid discharge are significantly lower with the utilization of high-yield pulp and/or most types of recycled pulp in paper production.

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Paper — Requirements for stability for general graphic applications

1 Scope

This document specifies the requirements for the stability of paper for general graphic applications. It is applicable to all types of uncoated, coated and filled papers.

NOTE For information on International Standards on paper permanence (see ISO 9706), archival paper permanence and durability (see ISO 11108) and on paper stability for general graphic applications (see ISO 20494), refer to [Annex C](#).

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 186, *Paper and board — Sampling to determine average quality*

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

ISO 536, *Paper and board — Determination of grammage*

ISO 1974, *Paper — Determination of tearing resistance — Elmendorf method*

ISO 5630-3, *Paper and board — Accelerated ageing — Part 3: Moist heat treatment at 80 degrees C and 65 % relative humidity*

ISO 6588-1, *Paper, board and pulps — Determination of pH of aqueous extracts — Part 1: Cold extraction*

ISO 10716, *Paper and board — Determination of alkali reserve*

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

paper stability

ability of paper to retain its intended functionality for *general graphic applications* (3.2), under normal use and storage conditions

Note 1 to entry: Stability for the purpose of this document differs from permanence which is required for paper used for documents to be stored over long periods of time, as in libraries, archives and other protected environments (see ISO 9706).

3.2

general graphic applications

printing and writing on graphic paper for all applications not intended for permanent storage

Note 1 to entry: Typical products used for general graphic applications include newspapers, magazines, catalogues, books, office printouts and copies.

3.3

alkali reserve

compound (such as calcium carbonate) that neutralizes acid that might be generated as a result of natural ageing or from atmospheric pollutants

Note 1 to entry: Determined as specified in ISO 10716.

4 Principle

In this document, the requirements for the stability of paper for general graphic applications are given in terms of

- minimum tearing resistance prior to accelerated ageing,
- retention of tearing resistance after accelerated ageing,
- minimum content of a substance (such as calcium carbonate) that neutralizes acid action, measured by the alkali reserve test, and
- maximum and minimum pH values of a cold water extract of the paper.

5 Sampling

Always handle the paper sample with clean cotton gloves.

If the average quality of a lot is to be determined, sampling shall be carried out in accordance with ISO 186. Where possible, test specimens shall not include areas containing watermarks, creases or visible damage. If another type of sample is to be tested, make sure that the specimens taken are representative of the sample received. Select sufficient sheets of adequate size for performing the tests required in this document.

6 Requirements for paper stability

6.1 Tearing resistance

6.1.1 Conditioning

The sheets shall be conditioned at 23 °C and 50 % relative humidity in accordance with ISO 187 prior to testing.

6.1.2 Tear testing

The tear test shall be performed as described in ISO 1974, and the grammage shall be determined according to ISO 536.

For papers of grammage 70 g/m² or higher, the tearing resistance in any direction (machine and cross), before ageing, shall be at least 350 mN. For papers of grammage below 70 g/m², the tearing resistance, before ageing, expressed in millinewtons, shall be at least r as calculated from [Formula \(1\)](#):

$$r = 6g - 70 \quad (1)$$

where

- g is the grammage of the paper, in g/m²;
- 6 is a constant with dimension mN·m²/g;
- 70 is a constant with dimension mN.

6.2 Retention of tearing resistance

Accelerated ageing tests at 80 °C and 65 % relative humidity shall be conducted on the paper for a period of 12 d (288 h) as described in ISO 5630-3 (see [Annex D](#)). Prior to, and upon completion of, the accelerated ageing tests, the paper shall be tested for tearing resistance as described in [6.1](#). In order to be classified as stable paper for general graphic applications, the tearing resistance after accelerated ageing shall be at least 80 % of that measured prior to ageing.

6.3 Alkali reserve

The paper shall have an amount of alkali reserve corresponding to at least 0,8 mol of acid per kilogram, determined as specified in ISO 10716.

NOTE 1 An alkali reserve of at least 0,8 mol/kg is typical of levels commonly used in the alkaline papermaking industry.

NOTE 2 When calcium carbonate is used to create the alkali reserve, the requirement is met if the paper contains a minimum of 40 g CaCO₃ per kilogram of paper.

6.4 pH value of aqueous extract

The pH value of an aqueous extract, prepared with cold water and determined as specified in ISO 6588-1, shall be in the range of 7,5 to 10,0.

7 Precision

The reproducibility of the retention of MD (machine direction) and CD (cross direction) tear resistance after accelerated ageing was determined by conducting a round robin study with several virgin and recycled papers. A description of the samples used in this study and the reproducibility results are presented in [Annex A](#). The effect of accelerated ageing on optical properties was determined as part of the round robin study and the results are shown in [Annex B](#).

8 Test report

The test report shall include the following information:

- a) a reference to this document, i.e. ISO 20494;
- b) all information necessary for complete identification of the sample;
- c) the date and place of testing;
- d) the temperature and relative humidity of the atmosphere used to condition the sample;
- e) the test results obtained when testing as specified in [6.1](#) to [6.4](#), expressed as stated in the relevant International Standards;
- f) any deviations from the International Standards used, and any circumstances and influence which might have affected the test results.

9 Statement of compliance

Provided that the paper meets all the requirements of this document, manufacturers can use a statement of compliance, as described in [Annex E](#).

10 Related information

Information on International Standards on paper permanence (see ISO 9706), archival paper permanence and durability (see ISO 11108) and on paper stability for general graphic applications (see ISO 20494) are provided in [Annex C](#).

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Annex A (informative)

Precision

In May 2016, an international round robin study was performed in which seven laboratories from six different countries, Belgium, Brazil, Canada, France, Japan and Italy (two laboratories), participated. Six of the seven laboratories conducted both accelerated ageing and testing and one laboratory conducted testing on paper samples that had already been subjected to accelerated ageing in one of the six laboratories.

A total of 17 paper samples representing the most common types of printing and graphic paper applications, including copy/office paper, lightweight coated (LWC) paper, coated offset and coated/uncoated high basis weight paper, were included in the study. The papers were virgin or recycled, and covered a broad range of mechanical fibre content. They were obtained from paper producers in Brazil, Canada, China, France, Germany, Japan and the US.

Brief descriptions of the virgin and recycled papers are given in [Tables A.1](#) and [A.2](#), respectively. In the case of recycled fibre, the mechanical fibre content was estimated by microscopic analysis. As indicated, all samples complied with the pH of cold water extracts and alkali reserve requirements, as specified in this standard.

Each sample was subjected to accelerated ageing for 12 d at 80 °C and 65 % relative humidity, according to ISO 5630-3. Samples before and after ageing were tested at the same time to ensure that the only changes in properties were due to accelerated ageing, not to natural ageing.

Table A.1 — Description of samples — Virgin papers

Sample	Grammage g/m ²	MD tear resistance before accelerated ageing mN	CD tear resistance before accelerated ageing mN	Mechanical pulp %	pH cold water extracts	Alkali reserve mol/kg
Copy paper	77,4	490	540	0	9,5	2,9
Offset paper	73,8	504	534	0	9,6	3,7
Copy paper, uncoated (I)	79,8	428	548	5	9,6	5,0
Reply card, uncoated	170,2	1252	1440	10	9,2	0,82
Copy paper, uncoated (II)	71,1	370	425	17	9,4	4,2
Printing paper	70,4	349	528	30	9,3	0,83
Offset paper, coated	89,5	561	635	40	9,6	3,7
Reply paper, coated	151,5	753	789	60	9,0	3,2
LWC paper	57,4	169	275	>70	8,4	0,96

Table A.2 — Description of samples — Recycled papers

Sample	Grammage g/m ²	MD tear resistance before accelerated ageing mN	CD tear resistance before accelerated ageing mN	Mechanical pulp %	pH cold water extracts	Alkali reserve mol/kg
Copy paper (I)	73,6	457	546	0	8,7	3,6
Office paper (I)	79,3	529	612	14	9,3	4,2
Copy paper (II)	64,0	492	497	14	8,4	1,3
Pre- and post-consumer recycled paper	75,1	468	480	22	8,7	3,1
Office paper (II)	83,5	588	653	39	9,1	2,8
Office paper (III)	79,8	449	566	54	9,1	3,1
Office paper (IV)	78,0	422	525	62	8,6	3,2
Office paper (V)	78,4	383	510	76	8,6	3,2

The precision data reported in [Tables A.3 to A.6](#) reflect the variability, among participating laboratories, of tear retention as a result of possible differences in design and/or fluctuations in temperature or relative humidity of the climate-controlled chambers used for accelerated ageing. Tear retention is expressed as a percentage of tear resistance after accelerated ageing compared with that before ageing.

Only reproducibility data are reported; no repeatability data are available since each laboratory conducted only one round of accelerated ageing for each sample.

The calculations have been made according to ISO/TR 24498[4].

The reproducibility limits reported in [Tables A.3 to A.6](#) are estimates of the maximum difference which would be expected in 19 of 20 instances, when comparing two test results for material similar to those described under similar test conditions. These estimates may not be valid for different materials or different test conditions.

NOTE Reproducibility limits are calculated by multiplying the reproducibility standard deviation by 2,77, where $2,77 = 1,96 \sqrt{2}$.

Table A.3 — Estimation of the reproducibility of the retention of MD tear resistance after accelerated ageing — Virgin papers

Sample	Number of laboratories	Mean MD tear retention %	Standard deviation S_R %	Coefficient of variation C_{V^R} %	Reproducibility limit R %
Copy paper	7	98,6	2,6	2,6	7,2
Offset paper	7	95,9	3,8	4,0	10,5
Copy paper, uncoated (I)	7	96,6	6,0	6,2	16,6
Reply card, uncoated	5	99,4	6,1	6,1	16,9
Copy paper, uncoated (II)	7	98,6	3,5	3,6	9,7
Printing paper	5	92,6	6,0	6,5	16,6

Table A.3 (continued)

Sample	Number of laboratories	Mean MD tear retention	Standard deviation	Coefficient of variation	Reproducibility limit
		%	S_R %	C_{V^R} %	R %
Offset paper, coated	7	97,1	5,2	5,4	14,4
Reply paper, coated	5	98,1	7,9	8,0	21,9
LWC paper	7	101	7,4	7,3	20,5

Table A.4 — Estimation of the reproducibility of the retention of MD tear resistance after accelerated ageing — Recycled papers

Sample	Number of laboratories	Mean MD tear retention	Standard deviation	Coefficient of variation	Reproducibility limit
		%	S_R %	C_{V^R} %	R %
Copy paper (I)	6	97,9	3,9	4,0	10,8
Office paper (I)	6	93,3	7,1	7,6	19,7
Copy paper (II)	5	96,9	2,6	2,7	7,2
Pre- and post-consumer recycled paper	7	97,6	2,1	2,2	5,8
Office paper (II)	6	97,7	3,4	3,5	9,4
Office paper (III)	6	96,8	4,9	5,1	14,1
Office paper (IV)	5	95,6	2,4	2,5	6,6
Office paper (V)	5	99,5	3,4	3,4	9,4

Table A.5 — Estimation of the reproducibility of the retention of CD tear resistance after accelerated ageing — Virgin papers

Sample	Number of laboratories	Mean MD tear retention	Standard deviation	Coefficient of variation	Reproducibility limit
		%	S_R %	C_{V^R} %	R %
Copy paper	7	99,6	3,3	3,3	9,1
Offset paper	7	97,0	3,9	4,0	10,8
Copy paper, uncoated (I)	7	93,8	7,5	8,0	20,8
Reply card, uncoated	5	97,9	4,6	4,7	12,7
Copy paper, uncoated (II)	7	99,5	2,0	2,0	5,5
Printing paper	5	97,1	2,4	2,5	6,9

Table A.5 (continued)

Sample	Number of laboratories	Mean MD tear retention	Standard deviation	Coefficient of variation	Reproducibility limit
		%	S_R %	C_{V^R} %	R %
Offset paper, coated	7	97,2	4,2	4,3	11,9
Reply paper, coated	5	101,1	3,9	3,9	10,8
LWC paper	7	103,8	11,8	11,4	32,7

Table A.6 — Estimation of the reproducibility of the retention of CD tear resistance after accelerated ageing — Recycled papers

Sample	Number of laboratories	Mean MD tear retention	Standard deviation	Coefficient of variation	Reproducibility limit
		%	S_R %	C_{V^R} %	R %
Copy paper (I)	6	96,7	1,6	1,6	4,4
Office paper (I)	6	103,5	7,5	7,2	19,9
Copy paper (II)	5	97,2	1,5	1,5	4,2
Pre- and post-consumer recycled paper	7	96,4	2,3	2,4	6,4
Office paper (II)	6	95,9	3,0	3,1	8,3
Office paper (III)	6	94,8	2,8	3,0	7,8
Office paper (IV)	5	97,5	3,8	3,9	10,5
Office paper (V)	5	97,6	3,2	3,3	8,9

Annex B (informative)

Effect of accelerated ageing on optical properties

In order to assess the effect of accelerated ageing on the optical properties of the paper samples used in the round robin study (see [Annex A](#)), most of the common optical properties [brightness (see ISO 2470-1 and ISO 2470-2), colour (see ISO 5631-1 and ISO 5631-2) and opacity (see ISO 2471)] were measured before and after accelerated ageing. [Tables B.1](#) and [B.2](#) show average values of D65 brightness, D65 b* (as an indication of yellowing) and opacity, for information purposes. A complete report of all data, including C brightness, and C and D65 colour (L^* , a^* , b^*), is available from Reference [\[14\]](#).

**Table B.1 — D65 brightness, D65 b* and opacity before
and after accelerated ageing — Virgin papers**

Sample	D65 brightness		D65 b*		Opacity	
	Before	After	Before	After	Before	After
Copy paper	103,6	95,8	-12,0	-7,9	90,7	91,5
Offset paper	108,1	101,4	-16,6	-13,2	91,4	92,0
Copy paper, uncoated (I)	107,1	97,4	-15,3	-10,4	94,6	95,5
Reply card, uncoated	99,6	89,3	-7,8	-2,5	97,3	98,1
Copy paper, uncoated (II)	105,0	93,7	-14,3	-8,7	92,5	93,7
Printing paper	81,1	66,9	-1,3	6,8	94,1	95,7
Offset paper, coated	71,7	65,0	11,9	13,9	91,7	94,6
Reply paper, coated	91,6	79,4	-3,9	2,8	97,3	98,3
LWC paper	81,0	68,9	-4,0	3,6	92,4	94,5

**Table B.2 — D65 brightness, D65 b* and opacity before
and after accelerated ageing — Recycled papers**

Sample	D65 brightness		D65 b*		Opacity	
	Before	After	Before	After	Before	After
Copy paper (I)	109,9	99,4	-18,0	-11,8	93,6	94,4
Office paper (I)	102,2	94,7	-15,3	-10,8	94,0	94,7
Copy paper (II)	72,3	68,2	1,8	4,4	92,4	92,9
Pre- and post- consumer recycled paper	59,0	57,3	5,2	6,9	98,3	98,2
Office paper (II)	100,2	86,7	-10,8	-4,2	93,0	94,6
Office paper (III)	87,9	75,9	-7,6	-0,96	96,7	97,5
Office paper (IV)	79,7	66,5	-0,93	6,24	95,8	97,2
Office paper (V)	69,3	61,0	3,9	8,7	98,0	98,6

Annex C (informative)

International Standards on paper permanence, archival paper permanence and durability, and on stability for general graphic applications

International Standards on paper permanence (see ISO 9706^[2]) and archival paper permanence and durability (ISO 11108^[3]) are primarily intended for archival and library documents, stored in protected environments, that are expected to remain substantially unchanged over time. According to ISO 9706, in order for paper to be classified as permanent it shall have a minimum tear resistance, a minimum alkali reserve, an alkaline pH of aqueous extracts, as well as a resistance to oxidation which requires the paper to have a Kappa number of less than 5, corresponding to about 1 % lignin. ISO 11108, which provides specifications for both permanence and durability of archival paper, requires, in addition, the predominant use of non-wood fibres.

At the time when ISO 9706 was developed, in 1994, the presence of lignin was suspected to have a negative influence on paper stability. However, since then several research projects involving laboratories in the US, Canada and Europe have been conducted under the auspices of ASTM^[9] and the Canadian General Standard Board (CGSB)^{[10][11]}. One of the key findings was that in alkaline papers buffered with calcium carbonate, the presence of lignin has no negative impact on mechanical permanence. Lignin-free papers also require an alkaline buffer in order to retain their mechanical permanence. An alkali reserve is also highly effective in reducing the negative impact of airborne pollutants in both lignin-containing and lignin-free sheets. However, for lignin-containing papers, the loss of brightness (yellowing) occurs faster than for lignin-free papers.

The limitation on Kappa number in ISO 9706 excludes the presence of modern pulps with higher lignin content, such as high-yield chemical pulps, BCTMP, APMP and most recycled pulps, in paper products classified as “permanent” according to the requirements of ISO 9706. Such pulps can be used in a wide range of paper products intended for general graphic applications with no significant loss of mechanical properties.

[Table C.1](#) outlines the main differences in applications and furnish requirements between ISO 9706 on paper permanence, ISO 11108 on archival paper permanence and durability, and ISO 20494 on paper stability for general graphic applications. None of these standards specifies any requirements for optical stability.

ISO 20494 is mostly based on the mechanical permanence requirements of Canadian Standard CAN/CGSB-9.70-2016^[5], German standard DIN 6738^[6] and Dutch standard, NEN 2728^[7].

Table C.1 — Differences in applications, and furnish requirements among International Standards

International Standard	Application	Paper furnish requirement
ISO 9706	Paper documents stored in libraries, archives and other protected environments	Restricted to paper with a Kappa number of less than 5,0 (about 1 % lignin content)
ISO 11108	Archival paper with the same permanence requirements as for ISO 9706 and with high durability (able to withstand the effects of wear and tear during use)	Cotton, cotton linters, hemp, flax, or mixtures thereof. If a minor fraction of fully bleached chemical pulp is used to reach a desirable performance, the amount shall be specified.
ISO 20494	Graphic paper for general applications, not intended for permanent storage, including newspapers, magazines, catalogues, books, office printouts and copies with some tolerance to small changes in optical properties over time	No restrictions with regard to cotton, linen or wood fibre type or lignin content