Designation: D6043 – 01 (Reapproved 2006)

An American National Standard

Standard Guide for Selection of Permanent and Durable Artist's Paper[1]

This standard is issued under the fixed designation D6043; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers artist's papers used in the preparation of permanent or semipermanent artwork. Some works of art are expected to last several hundred years, and others might be expected to last 50 years, or less.

1.2 In selecting artist's papers for a given life expectancy, papers with acceptable strength are evaluated for life expectancy through accelerated aging.

1.3 This guide is to be used for guidance in the purchase of permanent artist's paper.

1.4 As a great variety of artist's papers are to be found in the market place, extensive information on the various kinds of paper in use by artists is beyond the scope of this guide. This guide is concerned mostly with life expectancy of the paper.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product

D589 Test Method for Opacity of Paper (15° Diffuse Illuminant *A*, 89 % Reflectance Backing and Paper Backing)

D644 Test Method for Moisture Content of Paper and Paperboard by Oven Drying

D645/D645M Test Method for Thickness of Paper and Paperboard

D646 Test Method for Grammage of Paper and Paperboard (Mass Per Unit Area)

D689 Test Method for Internal Tearing Resistance of Paper

D774/D774M Test Method for Bursting Strength of Paper

D776 Test Method for Determination of Effect of Dry Heat on Properties of Paper and Board

D828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus[3]

D985 Test Method for Brightness of Pulp, Paper, and Paperboard (Directional Reflectance at 457 nm)

D1030 Test Method for Fiber Analysis of Paper and Paperboard

D1968 Terminology Relating to Paper and Paper Products

D3424 Practice for Evaluating the Relative Lightfastness and Weatherability of Printed Matter

D4714 Test Method for Determination of Effect of Moist Heat (50 % Relative Humidity and 90°C) on Properties of Paper and Board

D4988 Test Method for Determination of Alkalinity of Paper as Calcium Carbonate (Alkaline Reserve of Paper)

D5634 Guide for Selection of Permanent and Durable Offset and Book Papers

2.2 *TAPPI Test Methods:*

T 236 Kappa number of pulp[4]

T 400 Sampling and accepting a single lot of paper, paperboard, fiberboard, or related product[4]

T 401 Fiber analysis of paper and paperboard[4]

T 403 Bursting strength of paper[4]

T 410 Grammage of paper and paperboard (weight per unit area)[4]

T 411 Thickness (caliper) of paper and paperboard[4]

T 412 Moisture in paper and paperboard[4]

T 414 Internal tearing resistance of paper[4]

T 425 Opacity of paper (15°/diffuse illuminant A, 89 % reflectance backing and paper backing)[4]

T 452 Brightness of pulp, paper, and paperboard (directional reflectance at 457 nm)[4]

T 453 Effect of dry heat on properties of paper and board[4]

T 459 Surface strength of paper (wax pick test)[44]

T 479 Smoothness of paper (Bekk method)[4]

T 480 Specular gloss of paper and paperboard at 75 degrees[4]

T 494 Tensile breaking properties of paper and paperboard[4]

---

[1] This guide is under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Standard Documents Relating to Paper and Paper Products.

Current edition approved Nov. 1, 2006. Published November 2006. Originally approved in 1996. Last previous edition approved in 2001 as D6043 – 01. DOI: 10.1520/D6043-01R06.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org.

T 509 Hydrogen ion concentration (pH) of paper extracts (cold extraction method)[4]
T 538 Smoothness of paper and board (Sheffield method)[4]
T 544 Effect of moist heat on properties of paper and board[4]
2.3 *ISO Standard:*
ISO 5630/1 Laboratory Aging of Paper—Aging in a Dry Oven at 105°C[5]
ISO 5630/3 Laboratory Aging of Paper—Aging in a Moist Oven at 80°C, 65 % Relative Humidity[5]
ISO 9706 Paper for documents—Specifications for permanence—Normative Annex—Special instructions for determining kappa number[5]

3. Terminology

3.1 *Definitions:*[6]

3.1.1 *acid-sized paper*, *n*—paper that has been manufactured using a procedure or process at pH values below 7 (usually 4.0 to 6.5) that results in a paper that has resistance to *aqueous-liquid* penetration.

3.1.2 *alkaline-filled paper*, *n*—a paper containing an alkaline filler such as calcium carbonate; having a pH value in excess of 7 (extract pH usually in the range from 7.5 to 10.0), and containing a reserve buffering capacity that can neutralize acidic materials formed in the paper or acidic gases sorbed from the atmosphere.

3.1.3 *alkaline-sized paper*, *n*—paper that has been manufactured using a procedure or process at a pH value above 7 (usually 7.5 to 10.0) that results in paper that has resistance to *aqueous–liquid* penetration.

3.1.4 *neutral-sized paper*, *n*—paper that has been manufactured using a procedure or process at a pH value of 7 (with a normal range of 6.5 to 7.5) that results in a paper that has resistance to *aqueous-liquid* penetration.

3.2 *Description of Terms Specific to Standards for Paper for Permanent Records:*

3.2.1 *durability*, *n—of paper*, the capacity of paper or paperboard to resist the effects of wear in performance situations.

3.2.1.1 *Discussion—Durability* should not be used interchangeably with *permanence*. For example, paper money should be durable, but maximum permanence is not essential.

3.2.2 *life expectancy, LE*[7], *n—for paper*, length of time a product can be expected to maintain its functional (that is, physical, chemical, appearance, and so forth) characteristics when stored under prescribed conditions.

3.2.3 *life expectancy designation*, *n—for paper records*, a rating in years for the life expectancy of paper when stored under prescribed conditions.

3.2.3.1 *maximum life expectancy LE-1000, n—for paper*, a paper is expected to be usable for 1000 years when stored under prescribed conditions.

3.2.3.2 *high life expectancy LE-100, n—for paper*, a paper is expected to be usable for 100 years when stored under prescribed conditions.

3.2.3.3 *medium life expectancy LE-50, n—for paper*, a paper is expected to be usable for 50 years when stored under prescribed conditions.

3.2.4 *paper with a minimum pH value*, *n*—as the stability of paper is an approximate function of pH, one approach in describing a stable paper is to specify a minimum pH value, for example, 5.5. This value can be achieved with a rosin-alum sizing system.

3.2.5 *permanence*, *n—of paper*, the tendency to resist changes in any or all of its properties with the passage of time.

3.2.5.1 *Discussion*—It is expected that the terms maximum, high, and medium permanence will eventually be replaced with maximum, high, and medium life expectancy, or with LE designations LE-1000, LE-100, and LE-50.

4. Significance and Use

4.1 As there is no completely foolproof method for determining the life expectancy of paper, one must rely on observations made on historical records and on current knowledge of factors, in terms of paper properties and paper composition, that increase life expectancy, and on retention of selected properties after accelerated aging.

4.2 Acidic materials incorporated in paper during manufacture (for example, rosin-alum sizing) contribute to deterioration. It has been shown (**1–5**)[8] that the life expectancy of uncoated papers is an approximate function of the pH of the aqueous extract of the paper.

4.3 The use of papers with controlled acidity, or of papers manufactured under neutral or alkaline conditions, especially papers with a calcium carbonate filler that can absorb acidic gases from the atmosphere or can neutralize acidic materials formed during the aging of paper, would be expected to contribute significantly to the life expectancy of works of art on paper.

4.4 Three pH levels, reflecting three levels of life expectancy, are outlined in this guide. As one cannot rely on pH alone as an indicator of stability, minimum retentions of properties after accelerated aging at 90°C and 50 % relative humidity are suggested for the three levels of life expectancy.

4.5 This guide covers the following:

4.5.1 Physical tests to identify potential durability in service.

4.5.2 A minimum percentage retention of selected properties after accelerated aging for 12 days at 90°C and 50 % relative humidity.

4.5.3 Tests related to composition of paper that are indicative of stability.

4.5.3.1 A pH test, for screening only.

4.5.3.2 For maximum life expectancy, the presence of an alkaline filler, such as calcium carbonate, to serve as a buffering agent against attack by acidic contaminants from the atmosphere, and from the paper during aging.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[6] See also the *Dictionary of Paper*, TAPPI Press.

[7] Adapted from American National Standards Institute Committee IT9.1; approved December 1991.

[8] The boldface numbers in parentheses refer to the list of references at the end of this guide.

4.5.3.3 Fiber analysis, or a certificate from the supplier concerning fiber composition.

4.6 Although data from tests that may be performed in the laboratory do not correlate perfectly with use situations, several tests are available that should be useful to estimate the durability of paper. Examples of such tests are tearing force, tensile properties (tensile strength, elongation, and tensile energy absorption) and burst.

4.7 Papers buffered with a calcium carbonate filler, and with fiber composition as described in 7.1.2, are considered to have maximum life expectancy (**1**,**4**,**6**).

4.8 Papers with a neutral or alkaline pH without a calcium carbonate filler, and acid papers with a surface size formulation containing calcium carbonate, may or may not have the expected life expectancy. An acid paper may have been treated with a surface size containing enough calcium carbonate to give an alkaline extract pH, but an acid paper may or may not have been neutralized. Also, an acid paper may have been coated with a formulation containing calcium carbonate pigment. Therefore, an accelerated aging procedure is necessary to ensure the exclusion of such papers. If a paper is not coated with a formulation containing calcium carbonate, or if it is not surface sized with a sizing agent that contains calcium carbonate, the pH test should be valid.

4.9 In order to estimate the relative life expectancy of paper, it is necessary to develop a database on the accelerated aging of several papers covering a spectrum of life expectancies. This information is summarized in Guide D5634. Retentions of selected physical properties after accelerated aging are used as indicators of probable longevity. Examples of such tests include tearing force, tensile strength, elongation, tensile energy absorption (TEA), burst, and brightness.

4.10 Although arbitrary retention limits are suggested for various properties in Table 1, these suggested retention limits are for guidance only. There are no limits to properties that can be measured in the laboratory above which a paper is acceptably durable or permanent, or both, and below which it is not acceptable. Selections must be made on the basis of the potential value of the object, resources, cost, and what is available in the marketplace.

4.11 The parameters known to promote instability in paper also cause degradation in moist accelerated aging. Moist aging is a useful technique for comparing the relative stability of several papers. Paper usually degrades much faster during moist aging than during dry aging.

TABLE 1 Guidelines for Selection of Permanent Paper

NOTE 1—These suggested retention values are based on aging of papers at 90°C and 50 % relative humidity, mentioned in Table 1 of Guide D5634.

Test	Retention Values Related to Permanence,%		
	Medium Life Expectancy	High Life Expectancy	Maximum Life Expectancy
Tensile	85	90	95
Tensile Energy Absorption	70	80	90
Tear	75	85	90
Burst	80	90	95
Brightness	90	92	95

4.12 Coated papers present a special problem with respect to stability. Formulations for bindings in coatings may be developed from a large number of polymeric materials. These formulations are proprietary, and little is known about their stability.

4.13 More study is needed on the effect of coatings on the stability of paper. This is another reason why an accelerated aging procedure is useful in the evaluation of most papers for permanent records, especially coated papers.

5. Classification—Types

5.1 Three types of artist's papers, according to life expectancy, are described. These life expectancy levels are differentiated by pH and type of filler. One cannot rely on pH alone as an indicator of stability, and it is suggested that accelerated aging be used as described in Section 7. A good relationship with the supplier could render accelerated aging unnecessary.

5.2 *Type I, Maximum Life Expectance, LE-1000*—Neutral or alkaline sized paper made with an alkaline filler, such as calcium carbonate, which will give an extract pH usually in the range 7.5 to 10.0.

5.3 *Type II, High Life Expectancy, LE-100*—Neutral or alkaline sized paper with an extract pH usually in the range 6.5 to 7.5.

5.4 *Type III, Medium Life Expectancy, LE-50*—Paper with a minimum extract pH of 5.5.

6. Tests for the Evaluation of Papers

6.1 Tests usually associated with the description of papers, with evaluating papers for durability, for life expectancy, and accelerated aging are given in Table 2.

7. Evaluation of Papers for Life Expectancy

7.1 *Composition Variables*:

7.1.1 The pH requirements and accelerated aging recommendations are in Table 3.

TABLE 2 Tests Potentially Useful For Evaluation of Artist's Papers

NOTE 1—This is a preliminary list of tests germane to the evaluation of artist's papers. Other tests will surface as more information on the requirements of artist's papers become known.

Test	Description	Durability	Accelerated Aging	Life Expectancy
Color	*		*	*
Brightness	*		*	*
Tear index	*	*	*	*
Tensile strength	*	*	*	*
Elongation	*	*	*	*
Tensile Energy Absorption (TEA)	*	*	*	*
Burst	*	*	*	*
Thickness	*			
Grammage	*			
Smoothness	*			
Pick	*			
Specular gloss	*			
Fluorescence	*			
pH	*			*
Fiber Analysis	*			*
Buffer Capacity	*			*