Designation: D 3458 – 00 (Reapproved 2005)

An American National Standard

Standard Specification for Copies from Office Copying Machines for Permanent Records[1]

This standard is issued under the fixed designation D 3458; 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 specification covers copies from office copying machines where the copied material is expected to have maximum or substantial life expectancy.

1.2 This specification is divided into two parts, paper and imaged copy. The parts appear as follows:

Part 1—Paper, Sections 6-16
Part 2—Imaged Copy, Sections 17-22

1.3 Part 1 describes the procurement process for obtaining paper that will have the proper life expectancy for the intended purpose.

1.4 Part 2 describes a procedure for estimating the durability of the image on copy from an office copying machine.

1.5 As indicated in Appendix X1.4 and X1.5, this specification may be used as a guide.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product
D 1030 Test Method for Fiber Analysis of Paper and Paperboard
D 1968 Terminology Relating to Paper and Paper Products
D 3424 Test Methods for Evaluating the Relative Lightfastness and Weatherability of Printed Matter
D 4714 Test Method for Determination of Effect of Moist Heat (50 % Relative Humidity and 90°C) on Properties of Paper and Board
D 4988 Test Method for Determination of Alkalinity of Paper as Calcium Carbonate (Alkaline Reserve of Paper)
D 5625 Test Method for Measuring Length, Width, and Squareness of Sheeted Paper and Paper Products
D 5634 Guide for Selection of Permanent and Durable Offset and Book Papers
F 1319 Test Method for Determination of Abrasion and Smudge Resistance of Images Produced from Business Copy Products (Crockmeter Method)

2.2 *TAPPI Standards:*

T 236 Kappa Number of Pulp[3]
T 400 Sampling a Single Lot of Paper, Paperboard, Fiberboard, or Related Products[3]
T 401 Fiber Analysis of Paper and Paperboard[3]
T 410 Grammage of Paper and Paperboard (Weight Per Unit Area)[3]
T 411 Thickness (Caliper) of Paper and Paperboard[3]
T 412 Moisture in Paper[3]
T 414 Internal Tearing Resistance of Paper[3]
T 425 Opacity of Paper (15 %/Diffuse Illuminant A, 89 % Reflectance Backing and Paper Backing)[3]
T 452 Brightness of Pulp, Paper and Paperboard (Directional Reflectance at 457 nm)[3]
T 509 Hydrogen Ion Concentration (pH) of Paper Extracts—Cold Extraction Method[3]
T 511 Folding Endurance of Paper (MIT Tester)[3]
T 544 Effect of Moist Heat on Properties of Paper and Board[3]

2.3 *ISO Standard:*

ISO 9706 Paper for Documents—Specifications for Permanence—Normative Annex—Special instructions for determining kappa number[4]

3. Terminology

3.1 *Definitions*—Terms used in this specification are defined in accordance with Terminology D 1968.[5]

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 paper that has resistance to water penetration.

3.1.2 *alkaline-filled paper*, *n*—a paper containing an alkaline filler, such as calcium carbonate, having a pH value above 7 (extract pH usually in the range from 7.5 to 10.0), and

[1] This specification is under the jurisdiction of ASTM Committee D06 on Paper and Paper Products and is the direct responsibility of Subcommittee D06.92 on Test Methods.

Current edition approved Sept. 1, 2005. Published September 2005. Originally approved in 1975. Last previous edition approved in 2000 as D 3458 – 00.

[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] Available from the Technical Association of the Pulp and Paper Industry, 15 Technology Parkway South, Norcross, GA 30092.

[4] Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

[5] See also *Dictionary of Paper*, Tappi Press.

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 liquid penetration.

3.1.4 *base paper*, *n*—the fiber network existent prior to the application of any material onto the surface of that fiber network.

3.1.4.1 *Discussion*—An example of paper, internally sized, in preparation for a coating or surface sizing operation.

3.1.5 *coated paper*, *n*—paper which has been coated on one or both sides with a minimum coat weight of 2.5 lb/3300-ft^2 (3.7 g/m^2) of coating material per side.

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

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

3.1.7 *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 paper that has resistance to water penetration.

3.1.8 *office copies, quick copies, imaged copies*, *n*—reproductions made by direct or indirect electrostatic printing, ink jet printing, thermographic processing, or similar processing as contrasted with conventional printing, such as letterpress or offset.

3.1.9 *xerographic paper*, *n*—a grade of paper suitable for copying by the electrostatic process.

3.1.9.1 *Discussion*—These papers are bond grade and are characterized by a smooth finish, heat stability, noncurling qualities, and brightness.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *high referral*, *adj*—in paper, descriptive of any grade of paper designed for use in situations involving frequent handling.

3.2.2 *life expectancy*[6], *LE*—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.

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

3.2.2.2 *maximum life expectancy, LE-1000, n*—for paper, the document is expected to be usable for 1000 years under prescribed conditions.

3.2.2.3 *high life expectancy, LE-100, n*—for paper, the document is expected to be usable for 100 years under prescribed conditions.

3.2.2.4 *medium life expectancy, LE-50*—for paper, the document is expected to be usable for 50 years under prescribed conditions.

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

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

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

4. Classification—Types

4.1 Three types of papers for use in office copying machines are described, according to life expectancy level. These life expectancy levels are differentiated by pH and type of filler or sizing, or both. For situations where the copies will be handled frequently, the grade is described as "high referral." A higher tearing resistance is specified for this category, a folding endurance requirement is optional, and the purchaser may wish to specify all or part cotton or linen.

4.2 *Type I, Maximum Life Expectancy, 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 from 7.5 to 10.0.

4.2.1 *Grade 1*—Ordinary use.

4.2.2 *Grade 2*—High referral.

4.3 *Type II, High Life Expectancy, LE-100*—Neutral- or alkaline-sized paper with an extract pH, usually in the range from 6.5 to 8.5.

4.3.1 *Grade 1*—Ordinary use.

4.3.2 *Grade 2*—High referral.

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

4.4.1 *Grade 1*—Ordinary use.

4.4.2 *Grade 2*—High referral.

5. Ordering Information

5.1 Orders shall specify type and grade, dimensions, color, and, if necessary, paper stock and printing requirements. The paper shall perform suitably in the specific copying machine in which it is intended to be used.

PART 1—PAPER (see Note 1)

6. Scope

6.1 Part 1 covers the life expectancy and durability of coated and uncoated papers for permanent records, where these papers are intended to be used in various types of office or quick copy (xerographic) processes.

6.2 It has been shown (1-5)[7] that life expectancy is at least an approximate function of the pH of an aqueous extract of the paper. Three pH levels, reflecting three levels of life expectancy are specified.

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

[7] The boldface numbers in parentheses refer to references at the end of this specification.

6.3 The use of papers with controlled acidity, or of papers manufactured under neutral or alkaline conditions, especially papers with an alkaline filler, such as calcium carbonate that absorbs acidic gases from the atmosphere and can neutralize acidic materials formed in the aging of paper, would be expected to contribute significantly to the life expectancy of paper-based records.

6.4 An accelerated aging procedure is used in this specification to evaluate the stability of coated papers and of papers treated with an alkaline surface size.

6.5 This specification is based on fiber sources used in the production of paper that contains no more than 1 % lignin for papers used in archives, libraries, and other permanent records. However, under proper conditions (see X1.6) paper containing more than 1 % lignin may be employed for many other end uses in paper for records that are required to have a substantial life expectancy.

NOTE 1—A specification for office copy papers, Specification D 3460, includes xerographic paper. It does not include requirements related to life expectancy.

7. Significance and Use

7.1 The only completely valid way to check the life expectancy of paper is to store it under the relevant conditions for the expected lifetime of the document, perhaps several hundred years. As this is not feasible, one must rely on observations made on historical documents, and on current knowledge of factors, in terms of paper properties and paper composition, that increases life expectancy. Accelerated aging also may be used.

7.2 In this specification, requirements are given in terms of the following:

7.2.1 Physical tests to identify potential durability in service,

7.2.2 Tests related to composition of the paper that are indicative of stability,

7.2.2.1 For maximum life expectancy, the presence of an alkaline filler, such as calcium carbonate, to serve as a buffering agent,

7.2.2.2 Fiber analysis, or a certificate from the supplier concerning fiber composition, and

7.2.2.3 A test for pH, within the limits described in 8.2.4.

7.3 Papers with neutral or alkaline pH without a filler of 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. An acid paper may be coated with a formulation containing calcium carbonate. In cases of uncertainty, the supplier should provide an affidavit concerning the extract pH of the base paper.

7.4 Optional accelerated aging procedures are described in Section 13 and in X1.3.

8. Composition and Chemical Requirements

8.1 *Fiber Analysis, (see Test Method D 1030)*—The paper shall be made from cotton, linen, or fully bleached chemical pulp. Virgin or recycled fiber may be used in any proportion as agreed upon between the buyer and the seller at time of purchase, as long as the paper meets the requirements of this specification. The kappa number (from ISO 9706) shall not exceed five.

8.2 *Hydrogen Ion Concentration (pH) Cold Extraction*—See TAPPI T 509.

8.2.1 *Type I, Maximum Life Expectancy, LE-1000*—7.5 to 10.0.

8.2.2 *Type II, High Life Expectancy, LE-100*—6.5 to 8.5.

8.2.3 *Type III, Medium Life Expectancy, LE-50*—Minimum 5.5.

8.2.4 Some papers may have been given an alkaline surface size or an alkaline coating. The base paper of these papers may be acid and, therefore, of questionable stability, but would exhibit an alkaline extract pH. There is no known procedure for measuring the extract pH of the base paper of a paper to which an alkaline surface size, or alkaline coating, has been applied. The manufacturer should furnish an affidavit that the pH of the base paper conforms to the limits set forth above. The pH test is valid if the analyst can be ensured that the base paper does not have an alkaline surface size or an alkaline coating. The accelerated aging procedure, as described in X1.3, may be used as an indicator of stability.

8.3 *Filler*—Type 1 paper shall contain an alkaline filler such as calcium carbonate. The minimum shall be 2 %, calculated as calcium carbonate, based on the oven-dry weight of the finished paper. Test for the presence and amount of carbonate as described in Test Method D 4988.

9. Physical Properties

9.1 *Grammage (Weight per Unit Area)*:

9.1.1 Weight per unit area is not a requirement of this specification, unless agreed upon between the buyer and the seller, but the nominal weight per unit area may be used to assist in describing the paper.

9.1.2 Most copy papers are in the 75-g/m^2 class (20 lb, 17 × 22 500), but some 60-g (16-lb) and 90-g (24-lb) papers are supplied. If the purchaser specifies a weight per unit area, the variations of test unit averages within a shipment (or lot) should be not more than 5 % above or below the specified weight. If grammage is measured, use TAPPI T 410.

9.2 *Thickness*—Thickness is not a requirement of this specification unless agreed upon between the buyer and the seller. If specified, thickness should be expressed as micrometres (1×10^{-6} m) or as mils (1×10^{-3} in.), and the variation of test unit averages within a shipment (or lot) should be not more than 5 % above or below the specified value. If thickness is measured, use TAPPI T 411.

9.3 *Internal Tearing Resistance*—The average internal tearing resistance in each direction should be not less than that given in Table 1. Tearing resistance shall be measured using Test Method D 689 or TAPPI T 414.

9.4 *Directional Reflectance (Brightness)*—For white papers, the average brightness should be not less than 75 %. The brightness requirement does not apply to colored papers. Optical brighteners are not excluded unless specifically stated at time of purchase. Brightness shall be measured in accordance with TAPPI T 452.

9.5 *Opacity*—If the paper is to be printed on both sides, the minimum opacity should be not less than 85 %. For printing on

TABLE 1 Guidelines for Papers for Use in Office Copying Machines for Permanent Records

Type	pH[A]	Tearing Resistance[B]				Folding Endurance[B] (Double Folds), 9.8 N or 1000 gf tension		Brightness, min	Opacity,[C] min	Retention after Aging, min, %[D]
		Grade 1		Grade 2						
		gf	mN	gf	mN	Grade 1	Grade 2	%	%	Tear
I	Alkaline filler, 7.5 to 10.0	30	295	50	490	...	200	75	85	80
II	6.5–8.5	30	295	50	490	...	200	75	85	70
III	5.5, min	30	295	50	490	...	200	75	85	60

[A] The extract pH of the coating of a coated paper may be radically different from that of the base paper and cannot be used as an indicator of stability. One must rely on the accelerated aging test as an indicator of stability for coated papers.

[B] These values are representative of stronger papers that are supplied specifically for office copying machines. Characteristics of these papers also depend on copy machine requirements. If more durable papers are required, Specification D 3290 may be used, but a statement," The paper shall perform properly in the copy machine for which it is intended," should be included.

[C] May be reduced to 80 % if paper is to be printed on one side only.

[D] See Test Method D 4714.

one side only, the opacity requirement may be reduced to 80 %. Opacity shall be measured in accordance with TAPPI T 425.

9.6 *Folding Endurance*—The average fold number in each direction should be not less than that given in Table 1.

9.7 *Color*—The paper may be requested as white or colored, and the hue should be described at the time of purchase.

10. Dimensions, Trim, and Grain

10.1 *Dimensions and Trim*—The paper shall be furnished in the size, or sizes specified at the time of purchase, to a tolerance of ±1/32 in. (0.8 mm), and shall be trimmed square. Dimensions and trim shall be measured by Test Method D 5625.

10.2 *Grain*—The paper shall be supplied grain long or grain short at the option of the seller, unless specified otherwise by the buyer.

11. Additional Requirements

11.1 *Sizing*—The paper shall be internally sized and surface sized so that it will be suitable for the intended purpose, as indicated by the buyer.

11.2 *Printing Properties*—The paper shall be suitable for the duplication process for which it is purchased.

11.3 *Lightfastness*— If lightfastness is of concern to the purchaser, use Test Method D 3424, Sections 3 and 5, as agreed upon between the buyer and the seller.

12. Sampling

12.1 The paper shall be sampled in accordance with Practice D 585, using Plan II for all properties, or TAPPI T 400.

13. Retention of Physical Properties After Accelerated Aging

13.1 Moist aging at 90°C and 50 % relative humidity (Test Method D 4714 or TAPPI T 544), as outlined in X1.3, may be used. This procedure requires a humid oven.

14. Inspection

14.1 Inspection of the paper shall be agreed upon between the buyer and the seller as part of the purchase contract.

15. Certification

15.1 Upon request of the buyer, a manufacturer's certification that the paper was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

15.2 Test results obtained by both the seller and the buyer shall be made available, upon request, to either party.

15.3 As the extract pH of a paper would be influenced by an alkaline surface size, or by an alkaline coating, it is desirable to request an affidavit from the manufacturer that the extract pH of the base paper, without coating, conforms to the limits specified in 8.2.

16. Packaging and Marking

16.1 The paper shall be properly packaged, as agreed upon between the buyer and the seller, to provide adequate protection during shipment and storage.

16.2 Each package shall be marked to show the type of paper, quantity, color, size, basis weight (weight per unit area), and the name of the manufacturer.

PART 2—IMAGED COPY

17. Scope

17.1 Part 2 covers the permanence and durability of images made on coated or uncoated paper used in the direct or indirect electrostatic copy processes and other types of office or quick copy systems.

17.2 It is limited to those cases where the material that forms the image is deposited on a paper substrate.

17.3 The office copy, or quick copy, field is changing so rapidly that it is impossible to evaluate every process or to devise test methods that can be used to evaluate the permanence and durability of all of them.

18. Significance and Use

18.1 This part of the specification focuses on the performance of the copying machine and its ability to make durable copies. Therefore, the copying machine should be properly maintained and in good working order.

18.2 The durability of the image is evaluated by using paper of the required life expectancy and a proper test target for making the copies.

19. Classification

19.1 Although many office copy processes are available for transferring images to plain paper or to coated paper, no distinctions are made among these processes.

20. Test Target

20.1 In order to evaluate papers or copy machines, or both, it is desirable to use a standard test chart, usually called a test target, for this purpose. Although one could prepare a test chart, for proper comparisons between the buyer and the seller it is desirable to use a standard test chart.

20.2 Test targets or test charts are available.[8]

21. Sampling

21.1 At least 100 sheets of imaged copy shall be obtained for evaluation either from the supplier or from preparation of copy on a selected machine. The copy machine should be in good working order and properly adjusted to produce good copy. Sheets for evaluation shall be selected at random from the sample.

22. Copy Evaluation

22.1 As no test methods are available for measuring how well the image adheres to the paper, improvise by (*1*) using an optical scanner or a densitometer **(6), (7), (8)** after abrasion; (*2*) using an adhesive tape to remove poorly adhering image; (*3*) using a finger rubbing test, or (*4*) using a pencil eraser. The latter three tests are preferable, but are not scientific. They require an experienced technician, and are not amenable to standardization or interlaboratory comparison. Test Method F 1319 uses a crockmeter to evaluate the integrity of printing and writing, and Test Method F 362 uses the Taber abraser in a procedure similar to that given in 22.2.

22.2 *Abrasion Resistance*—Taber abraser, Model 5130, or equivalent, using Calibrase wheels designated as CS-10F, auxiliary weights of 500 g, specimen holder, Grade E-100-125, and specimen mounting cards, Grade S-36.[9] Directions for the care of abrasion wheels are given in Appendix X2. Abrade each specimen for a total of 20 cycles.

22.3 *Retention of Print Contrast After Abrasion*:

22.3.1 *Optical Scanner*— Hueber and Gouin **(8)** used an optical scanner to measure image reduction, before and after abrasion, of one or more letters for several types of copy machines and papers, and found that image reduction ranged from less than 5 % to more than 80 %. No correlations were developed between image reduction and deterioration of copy during use. This is an attractive procedure for measuring adherance of the image to paper, but an image analyzer is somewhat costly.

22.3.2 *Optical Character Reader (Reflectometer)*—Subt and Koloski **(7)** used a reflectometer with a 1:1 lens and 4.8-mm diameter solid block test area to measure print contrast before and after abrasion. No correlations were developed between print contrast retention and deterioration of copy during use. This is a reasonably good procedure, and an optical character reader is not as costly as an optical scanner.

22.4 *Tape Peel Test*— Subt and Koloski **(7)** found that the resistance of the image to removal during an 180 peel test with a particular tape[10] could be used as a criterion of adhesion of image to paper. The resistance of the image to removal could be evaluated visually or with a reflectometer.

22.5 Subt and Koloski showed that a rough correlation existed among print contrast retention (reflectometer) after abrasion with the Taber abraser, print contrast retention after the laboratory peel test, and the visual tape peel test.

22.6 *Finger Rubbing Test and Eraser Test*—These tests are strictly subjective and must be developed by each technician.

[8] A satisfactory test chart may be obtained as Standard Reference Material (SRM) 1010a from the National Institute for Standards and Technology, Gaithersburg, MD 20899. SRM 1010a also is known as ANSI and ISO Test Chart No. 2.

[9] The sole source of supply of the apparatus known to the committee at this time is Teledyne Taber, 455 Bryant St., N. Tonawanda, NY 14120. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[10] 3M #230 Drafting Tape.

APPENDIXES

(Nonmandatory Information)

X1. ADDITIONAL INFORMATION

X1.1 As there are many variables in the manufacture of paper and in the use and storage of records, it is impossible to place definite values on the number of years that various categories of records will endure. It has been established that the rates of both natural and accelerated aging are approximate functions of the pH of the paper. The following information may be used as guidance:

X1.1.1 *Type I Papers, Maximum Life Expectancy, LE-1000*—Machine-made papers with an alkaline filler have existed, apparently with little change, for almost 100 years. Handmade papers containing an alkaline filler have survived for almost 400 years **(9)**. Acid papers have survived that long, but their condition is, comparatively speaking, not as good and is an approximate function of pH.

X1.1.2 *Type II Papers, High Life Expectancy, LE-100*—The probable life expectancy of these papers should lie somewhere between the life expectancy of Type I and Type III papers.

X1.1.3 *Type III Papers, Medium Life Expectancy, LE-50*—The relative condition of paper in old books and documents has been correlated approximately with pH **(1)**. It has been reported that the condition of papers in U.S. Government files with pH values as low as 6.2 have survived over 60 years **(5)**,

and the physical properties of these papers are an approximate function of pH. A minimum pH of 5.5 should indicate longevity greater than 60 years.

X1.2 Papers containing cotton or linen, or both, are considered to be more durable than wood pulp papers. As both rag and wood pulp papers may cover a broad spectrum of life expectancy and durability, generalizations on the basis of fiber content alone are not useful. Cotton linters are not as strong as cotton fiber.

X1.3 During the development of Guide D 5634, and during the development of a National Information Standards Organization (NISO) standard for permanent paper, about 60 papers were aged for 12 days at 90°C and 50 % relative humidity (Test Method D 4714, TAPPI T 544). The selection of percent retention values after aging for various levels of life expectancy is subjective, but enough information is available to make this approach attractive. The retention of tensile energy absorption, and of tearing strength, after aging for 12 days at 90°C and 50 % relative humidity should be 90 %, or higher, for maximum life expectancy; about 80 %, or higher, for high life expectancy; and about 70 %, or higher, for medium life expectancy.

X1.4 Paper may be procured on the basis of a standard sample, on the basis of requirements other than those listed in this specification, or one or more of the requirements may be waived. In order to obtain the degree of life expectancy required, it is very important that the pH requirements of this specification, or the aging requirement in X1.3, be met for the type and grade of paper purchased.

X1.5 Several processes are in use for the production of images on paper in office copying machines. In some cases, the machines and materials are available only from one manufacturer. In other cases, one may buy the machine from one supplier, the paper from another, and the imaging materials from yet another. In addition, a manufacturer may change the composition of his product at any time without notice. It is desirable for a buyer to establish a reliable source of supply, test the product, and obtain assurance that significant changes will not be made without notice.

X1.6 Historically, specifications for paper for permanent records have limited fiber sources to those that would result in no more than 1 % lignin in the papers. The use of alkaline papermaking technologies, including the use of alkaline sizing and alkaline fillers, may change the situation for some applications. Although some yellowing occurs during light exposure and dark storage, laboratory data show that the strength properties of alkaline papers containing substantial quantities of lignin do not change appreciably during accelerated aging in a moist atmosphere **(10, 11)**.

X1.6.1 There are many other end uses where alkaline papers with alkaline size and containing an alkaline filler and substantial quantities of lignin, would be suitable for long-term use and, for economic reasons, desirable. The user would decide whether yellowing during light exposure or long-term storage, or both, would be acceptable. These needs should be agreed upon between the buyer and the seller and written into standards intended for the purpose.

X1.7 Appearance properties, such as color and reflectance (brightness, whiteness, and so forth) that might be affected by light and by dark aging may be important to the user. The traditional use of bleached chemical wood or cotton fiber has been recognized as a way to preserve appearance properties.

X1.7.1 As fiber sources are less uniform than in the past, it is desirable to measure the effect of light and dark storage on the appearance properties of paper.

X2. CARE OF ABRASION WHEELS

X2.1 Mount the CS-10F wheels as marked on the swing arms with 500-gf weights on each arm. Dress for 50 cycles using 150-grit dressing pads supplied by the manufacturer of the abrasion instrument. Replace the dressing pad with a heavy rough-textured bond paper and run for 10 cycles. The wheels are ready for use. Redress the wheels every 200 cycles.

X2.2 Because of an observed tendency of the wheels to take a slight set in the direction of the turntable rotation, reverse the wheels and dress after approximately 1000 cycles.

REFERENCES

(1) Barrow, W. J., *Deterioration of Book Stock; Causes and Remedies*, The Virginia State Library, Richmond, VA, 1959.

(2) Wilson, W. K., Harvey, J. L., Mandel, J., and Worksman, T., "Accelerated Aging of Record Papers Compared with Normal Aging," *Tappi*, Vol 38, No. 9, 1955, p. 543.

(3) Van Royen, A. H., "Comparison of the Accelerated Aging of Cellulose with Normal Aging at Room Temperature, *Association Technique de L'Industrie Papetiere Bulletin* , Vol 6, 1957, p. 223; *Papierwereld* , Vol 12, 1958, p. 219; *Abstract Bulletin of the Institute of Paper Chemistry*, Vol 29, 1958, p. 92.

(4) Wilson, W. K., and Parks, E. J., "Comparison of Accelerated Aging of Book Papers in 1937 with 36 Years Natural Aging," *Restaurator*, Vol 4, 1980, pp. 1 to 55.

(5) Dahl, S., "Evaluation of Condition of Manifold Papers in File," National Institute of Standards and Technology Report 10429, June 1971.

(6) Parks, E. J. and Wilson, W. K., "Evaluation of Archival Stability of Copies from Representative Office Copying Machines," *National Bureau of Standards Report NBSIR* 74-498, April 30, 1974.

(7) Subt, Sylvia, and Koloski, J. G., "Archival Xerographic Copying—Special Development Study for NARA," Government Printing Office, Quality Control and Technical Dept., Washington, DC 20401.

(8) Hueber, R. P. (NARA), and Gouin, J. (GPO), "Evaluations of a Video Image Analyzer for Testing the Abrasion Resistance of Copies from Office Copying Machines, "Unpublished report, 1981.

(9) Hanson, F. S., "Resistance of Paper to Natural Aging," *The Paper Industry and Paper World*, February 1939, pp. 1157–1163.

(10) NISO 239.48-1992 Permanence of Paper for Publications and Documents in Libraries and Archives, National Information Standards Organization, 4733 Bethesda Ave., Bethesda, MD 20814.

(11) ISO 9706 Information and Documentation—Paper for Documents—Requirements for Permanence.