Designation: D7298 – 06 (Reapproved 2011)ε1

Standard Test Method for Measurement of Comparative Legibility by Means of Polarizing Filter Instrumentation[1]

This standard is issued under the fixed designation D7298; 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.

ε[1] NOTE—Minor editorial corrections were made to Sections 3.2.5, 3.2.6, and 7.3 in April 2011.

1. Scope

1.1 This test method provides an objective means to comparatively measure the ease of reading printed matter for use in package labeling.

1.2 This test method is not intended to quantify the legibility of a printed item against a standard but to compare its legibility against other items.

1.3 This test method uses human subjects to view printed matter mounted in a specialized instrument.

1.4 The user of this test method must be aware that results may differ from one age group of subjects to another.

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]

D996 Terminology of Packaging and Distribution Environments

3. Terminology

3.1 *Definitions*—Terms and definitions used in this test method may be found in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *age group*—subjects are grouped by ages in a specified range.

3.2.2 *analyzer*—a moveable polarizing filter; the subject operates a hand wheel to rotate the analyzer (see Fig. 1 and Fig. 2).

3.2.3 *degrees of rotation*—the angle of rotation of the analyzer where 0 is equivalent to no light transmission and 90 is equivalent to full light transmission.

3.2.3.1 *Discussion*—At 0° rotation, the analyzer and polarizer optical axes are perpendicular to one another.

3.2.4 *easel*—located on top of the moveable stage; it is a platform where printed matter is placed to be read (see Fig. 1 and Fig. 2).

3.2.5 *hand crank*—a crank located at the front of the instrument that adjusts the distance of printed matter by moving the stage and easel. When it is rotated clockwise, it moves the moveable stage closer to the subject, and when it is rotated counterclockwise it moves the stage away from the subject (see Fig. 1 and Fig. 2).

3.2.6 *hand wheel*—a wheel subjects turn to rotate the analyzer. Counterclockwise rotation increases the light transmitted and raises the legibility index. Clockwise rotation decreases the light transmitted (see Fig. 1 and Fig. 2) and lowers the legibility index.

3.2.7 *legibility*—the ease of deciphering or reading printed matter, as measured by the legibility index in this test method.

3.2.8 *legibility index*—the name given to the degrees of rotation of the analyzer, the reporting unit for the measurement of legibility. The first point where the printed matter becomes easy forthe subject to read.

3.2.9 *moveable stage*—a device topped with an easel that is mounted on a track within the legibility instrument that adjusts the distance between the subject and the easel.

3.2.10 *polarizer*—a fixed polarizing filter, mounted in the instrument (see Fig. 1 and Fig. 2).

3.2.11 *subject*—the person viewing the printed matter in the instrument and controlling the rotation of the analyzer.

3.2.12 *tester*—the person conducting the experiment.

3.2.13 *training reference*—A standard message created in an 8 point font. Subjects view the training reference before data

[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.32 on Consumer, Pharmaceutical and Medical Packaging.

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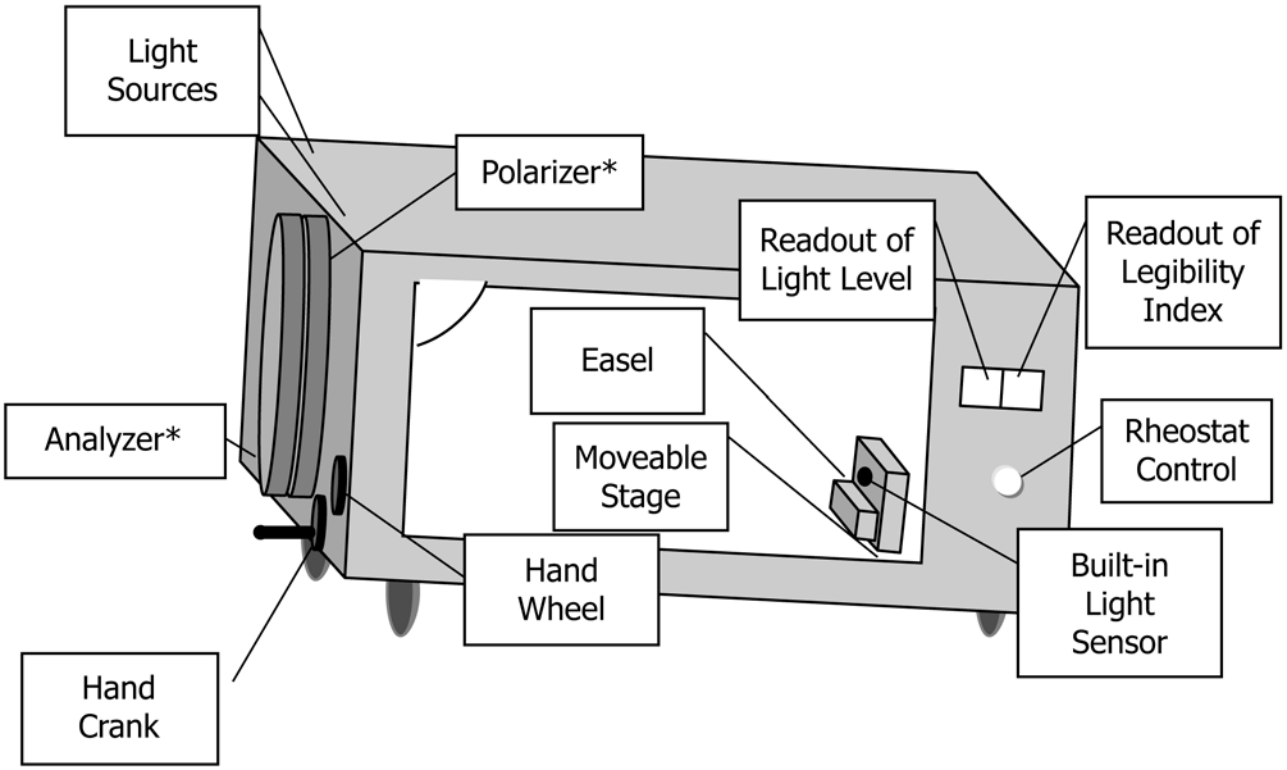
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



NOTE 1—*Analyzer and polarizer are actually just inside the front wall of the instrument; subject looks through them using a shielded eyepiece (See photo in Fig. 2). They are shown in the schematic to give researchers a clear idea of the instrument's construction.

FIG. 1 Schematic of the Legibility Instrument

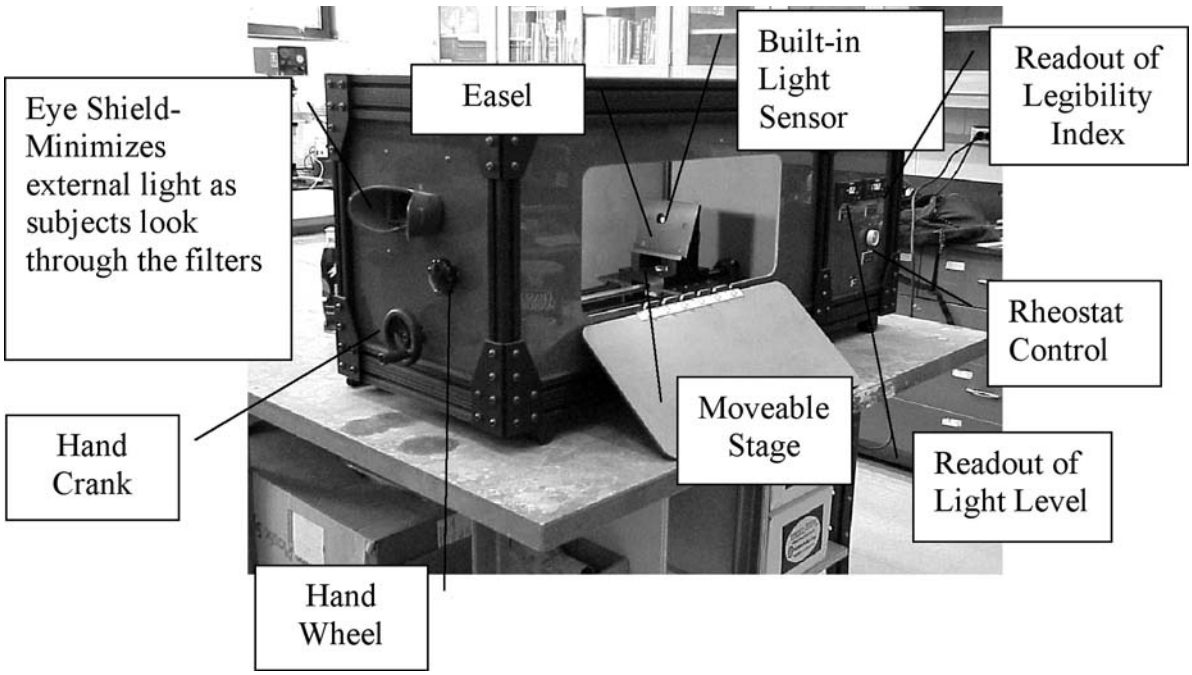


FIG. 2 Photo of Legibility Instrument

collection begins so that they become accustomed to the instrument without affectingtest results.

4. Summary of Test Method

4.1 This test method describes a means for evaluating the legibility of printed matter such as package labeling, printed inserts, and carton graphics by defining a standard procedure for measuring the comparative legibility of printed matter under consistent, controlled light conditions by the use of a specialized instrument.

5. Significance and Use

5.1 This test method assists in evaluating the effect of layout, typeface, type size, color, and background on the legibility of printed matter.

5.2 Previous research[3] has shown that results are more significantly impacted by subject age than any other effect. Older subjects tend to require more light when using this instrument. Because subjects age at different rates as a result of lifestyle and genetics, variability of data tends to increase with increasing age. This test method was developed using subjects of ages 19 to 28 years. It is advised that subjects age 19 to 28 be used in cases where variability needs to be kept to a minimum.

5.3 Testers can compare legibility between various groups of subjects (by age, light intensity, distance, vision characteristics of the subjects) and one against other label configurations within groups of subjects

6. Apparatus

6.1 The legibility instrument[4] (see Fig. 1 and Fig. 2) is a rectangular structure designed to minimize light leakage and to provide an internal platform to hold printed matter to be tested.

6.2 The interior shall have a gray or black matte surface to minimize internal light reflection.

6.3 An end panel shall have a polarizer and an analyzer mounted in its center, controlled by a hand wheel (see Fig. 1).

6.4 The analyzer is capable of being rotated to a maximum of 90° (relative to the polarizer). This rotation allows the filters to go from total light blockage to full light transmission (sensitivity is to be 0.1° of rotation).

6.5 The instrument shall have a moveable stage. On top of the moveable stage is an easel that is angled so its surface and the surface of the filter are parallel (see Fig. 1 and Fig. 2). The easel holds the reference copy.

6.5.1 The stage is capable of moving from a distance of 15 in. (38 cm) from the subject's eyes to a distance of 22 in. (56 cm) from subject's eyes.

6.5.2 A hand crank on the front panel of the instrument is used to move the stage.

6.5.3 Two incandescent flood lamps, capable of achieving the desired light level, shall illuminate the instrument's interior. Light is projected toward the easel, and is controlled by a rheostat. The instrument should be constructed so that the angle of the light source relative to the easel does not produce glare.

6.5.4 The instrument shall have a light sensor, which measures the illumination incident on the easel.

6.5.5 The instrument shall have an eye shield to position the test subject's eyes and shield the filters from ambient light.

6.5.6 The instrument is not capable of accommodating the height of the subject. Chair height shall be adjustable by the subject.

7. Equipment Controls and Monitors

7.1 *Analyzer rotation control (hand wheel),* capable of rotating the analyzer through a full 90°, from total light blockage to full transmission.

7.2 *Analyzer rotation measurement (readout of legibility index),* having a sensitivity of 0.1°.

7.3 *Rheostat,* capable of providing variable light levels.

7.4 *Built-in light sensor (readout of light level),* a digital readout instrument capable of measuring light levels to 0.1 fc.

7.5 *Stage distance,* measurable to an accuracy of ±1 cm (0.4 in.).

8. Procedure

8.1 Using the hand crank, the tester adjusts the moveable stage so that the distance from the easel to the subject's eyes falls between 16 in. (41 cm) and 20 in. (51 cm).

8.2 The tester shall measure and record the visual acuity of the subject, using a near distance visual acuity card with the Snellen visual acuity[5] scale.

8.3 The tester shall record the subject's gender and age

8.4 The tester rotates the analyzer to a position of 0° of rotation (so that no light passes through).

8.5 With the door of the instrument closed, the rheostat is used by the tester to adjust the light level inside the instrument to 25 ± 1 fc.

8.6 The tester places the training reference onto the easel.

8.6.1 The reference should be flat against the easel and not curled.

8.7 The subject is instructed by the tester to wear any eyewear that they would normally use to read package labels and to look into the eye shield, and allow time for his/her eyes to adjust. It is important to note that some subjects that wear bi or tri-focals may have difficulty using the instrument.

8.7.1 Any corrective eyewear that is used by the subject will be recorded.

8.8 The tester instructs the subject to rotate the hand wheel counterclockwise "until the first point that the subject can easily read printed matter without straining their eyes."

8.9 The tester records the legibility index, the degrees of rotation required by the subject.

[3] Bix, L., Gilliland, D., Chen, B., and Sung, H., from unpublished file, "Using the Polariscope as a Measure of Legibility," December,1997.

[4] Information presented here was based on the Lockhart Legibility Instrument, an instrument developed by Dr. Hugh Lockhart at Michigan State University. For further information, contact Hugh Lockhart at lckhrt@msu.edu.

[5] 20/20, 20/30, 20/40, 20/50, 20/60, 20/80, 20/100, 20/200.

8.9.1 This value will not be reported, but is recorded so that subjects are not aware that it is a training reference.

8.10 The tester returns the analyzer to the 0° (no light transmission) position.

8.11 Steps 8.6 – 8.9 are repeated for a second training reference. An analysis of residuals[3] revealed that the first two readings using this instrument tended to be higher than those that followed, due to an "adjustment period" as people became accustomed to the instrument. As a result of this finding, the use of two training references per test has been included in this test method.

8.12 The tester places the printed matter onto the stage.

8.12.1 The test material should be flat against the stage and not curled.

8.13 The subject is instructed by the tester to look into the eye shield, and allow time for the eyes to adjust. (See 8.7.)

8.14 The tester instructs the subject to rotate the hand wheel counterclockwise "until the first point that the subject can easily read the printed matter without straining their eyes."

8.15 The tester records the degrees of rotation required by the subject as the legibility index.

8.16 The tester returns the analyzer to the 0° (no light transmission) position.

8.17 Steps 8.11 – 8.15 are repeated until the test material is exhausted. Research to date indicates that subjects can affect results by "learning" the message. Therefore, experimental design should be carefully considered to eliminate the learning effect.

9. Report

9.1 The report shall contain the age range of each test group and the subject's ages within each group.

9.2 The report shall contain the mean legibility index.

9.3 The report shall contain the standard deviation.

9.4 The report shall contain the test location, test date, and time of day.

9.5 The subject's visual acuity and gender shall also be recorded.

9.6 The subject's use of eyewear, and the type of eyewear, shall be recorded.

9.7 Any deviations from this test method must be noted in this report.

10. Precision and Bias

10.1 *Precision:*

10.1.1 Because there is only one legibility instrument, results presented in this precision statement represent standard deviations obtained from subjects tested at Michigan State University only.

10.1.2 Six cards were measured by 19 subjects to develop a statement regarding precision. Each card was printed in 10 point Helvetica Light using a Hewlett Packard 722 Ink Jet printer. Each card contained a different message; messages had been shown in previous studies to have statistically marginal[6] or insignificant effect[7] at α=0.05. Messages were printed in a black on white contrast and were centered on a 3 by 4 in. index card. Test matter as large as approximately 12 in. across and 8 in. high has been measured using this instrument. It is advised that test matter no larger than this be tested.

10.1.3 Viewing distance from the subject to the card was fixed at 18.5 in. and subjects were asked to rotate the handle until the first point that they could "easily read the words on the cards without straining their eyes."

10.1.4 The coefficient of variation across all subjects and all messages was 47.6 %. Coefficients of variation are much smaller when they are examined on a per subject basis (see Fig. 1). When the coefficients are measured between subjects, as reported here, they are much larger. It is important to note that much of the variability of observations is attributable to the differences in subjects themselves. It is for this reason that using narrow age ranges when testing is advised.

10.1.5 The graph in Fig. 3 shows the coefficients of variation by subject, across all six messages.

10.2 *Bias*—The bias for this test method has not been determined because there is no know reference available.

11. Keywords

11.1 analyzer; label; legibility; legibility index; light level; polarizer; test

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[6] Bix, L., "The Effect of Subject Age on Legibility," Master's Thesis, Michigan State University, 1998.

[7] Lockhart, H. and Bix, L. from unpublished file, "Color Contrast Studies," 1996.

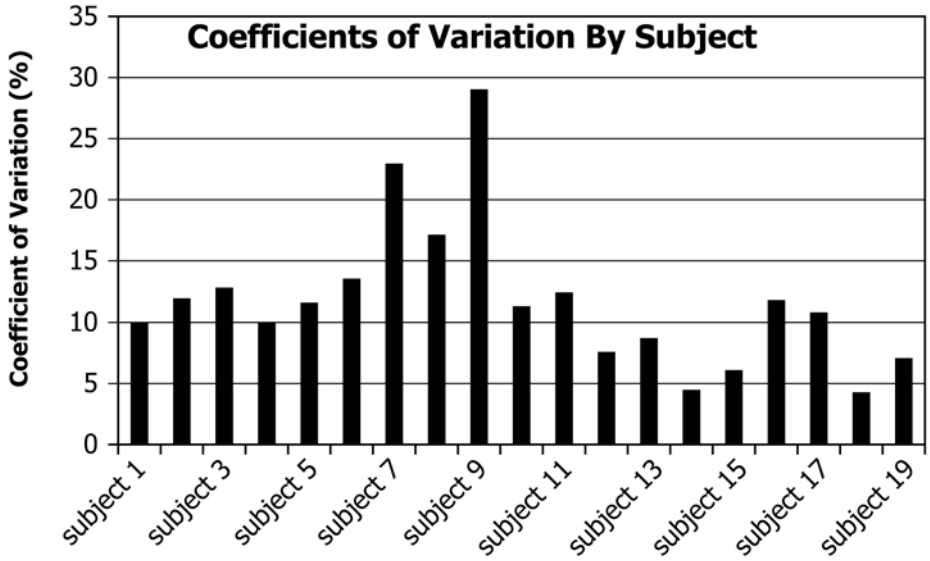

FIG. 3 Coefficients of Variation by Subject