

Library of Congress Preservation Directorate
Specification Number 600-611 – 11
Specifications for Singlewall E-Flute Corrugated Board
For Protective Enclosures

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Scope

Corrugated board that meets the requirements set forth in this specification is intended for use in the construction of a variety of protective enclosures (boxes) for the housing of library materials. Construction may be either die-cut or machine cut by either contracted or in-house operations.

1. Composition and Chemical Requirements

1.1 Fiber

The stock used for both the liner and the medium must be made from rag or other high alpha-cellulose content pulp, minimum of 87%, as defined in ISO 18902. It must not contain any post consumer waste recycled pulp.

1.2 Lignin

The stock used for both the liner and the medium must give a negative reading for lignin as determined by the phloroglucinol test when tested according to ASTM D 1030, X5 spot stains, and shall have a Kappa number of 5 or less when tested according to TAPPI T 236.

1.3 Impurities

The stock used for both the liner and the medium must be free of metal particles, waxes, plasticizers, residual bleach, peroxide, sulfur (which will be less than 0.0008% reducible sulfur as determined by TAPPI T 406), and other components that could lead to the degradation of the board itself, or the artifacts stored therein.

1.4 Metallic Impurities

Iron must not exceed 150 ppm and copper shall not exceed 6 ppm when tested according to TAPPI T 266.

1.5 Optical Brighteners

The stock used for both the liner and the medium must be free of optical brightening agents.

1.6 pH

The stock used for both the liner and the medium must have a pH value within a range of 8.0 - 9.5 as determined by TAPPI T 509, cold extraction (modified by slurring sample pulp before measurement).

1.7 Alkaline Reserve

The stock used for both the liner and the medium must contain an alkaline reserve with a minimum of 2% and a maximum of 5% calculated as CaCO₃ when tested according to TAPPI T 553 (modified by slurring sample pulp before measurement).

1.8 Sizing

Only neutral or alkaline sizing shall be used. No alum rosin or rosin sizing should be used, as determined by TAPPI T 408.

2. Physical and Performance Requirements

2.1 Basis Weight

The stock must meet the following requirements for basis weight as determined by TAPPI T 410.

2.1.1 Liner

The minimum basis weight should be 33 lbs/ 1,000 ft²

2.1.2 Medium

The minimum basis weight should be 26 lbs/ 1,000 ft²

2.2 Color

The color of the stock should be tan, cream, or buff, or will be specified on the purchase order. The color must not be so dark that it obscures color-dependent test evaluations, e.g., spot test stains.

2.3 Color Bleeding

The color must show no bleeding when soaked in distilled water for 48 hours while held under suitable weight in contact with white bond paper. The color must not rub off.

2.4 Color Retention

The color of the stock must not change more than 5 points of brightness as measured by directional reflectance at 457 nm (TAPPI T 452), when exposed 24 hours to a Xenon arc lamp in an Atlas Weatherometer under the following conditions: Irradiance Level: 1.0 watts/m² at 420 nm. Inner filter: Borosilicate glass. Outer filter: clear soda lime glass. Black panel temperature: 50°C. Wet bulb depression: 8.5°C.

2.5 Surfaces and Smoothness

The outer surface of the liner board should be finished to resist soiling and must be free of fingerprints, dirt, bubbles, knots, shives and other imperfections. The smoothness of the stock must be no more than 320 Sheffield units, when tested according to TAPPI T 538.

2.6 Scores and Folds

The liner facings must show no visual surface breaks longer than 1/2" inch when scored and/or folded 180 degrees parallel to the flutes of the board. Test will be conducted as described for singlewall corrugated fiberboard, section 9.3 of ASTM D 4727.

2.7 Abrasion

The outer surfaces of the stock must show a loss of less than 2% in weight when tested with a #CS10 wheel and 100 wear cycles according to TAPPI T 476.

2.8 Burst Strength

The board must meet a minimum requirement of 150 psi when tested according to TAPPI T 810.

2.9 Delamination

There must be no continuous visual surface break of the plies when the board is flexed 180 degrees both parallel and across the flutes when tested as described for singlewall corrugated fiberboard, section 9.3 of ASTM D 4727.

2.10 Bending Stiffness

The board must meet a minimum requirement of 14 lbf per inch in the machine direction, and 8 lbf per inch in the cross direction, when tested according to TAPPI T 836.

2.11 Flat Crush

The board must meet a minimum requirement of 85 psi when tested according to TAPPI T 825.

2.12 Adhesive

The adhesive must not soften or run. The adhesive must not cause the stock to become transparent or alter the color of the stock. The adhesive must not yellow, discolor, or fail (causing delamination) over time. The adhesive should not contain sulfur, iron, copper or other ingredients that may be detrimental to photographic materials. The adhesive should not contain or generate oxidants. Pressure-sensitive or rubber-based adhesives are not acceptable. The adhesive must not extend beyond the joined area.

3. Product Requirements

3.1 Construction

The boards should be constructed as single-wall E-Flute corrugated board, as defined in section 6.4 of ASTM D 4727. Each sheet should be constructed with the flutes running parallel to the long dimension of the sheet. The smoothest side (felt side) of the liners should be the outer surfaces of the board. The wire side of the liners should be next to the corrugated medium, to promote maximum adhesion. The flutes of the medium must be adhered to each liner all along the tips of the flutes.

3.2 Workmanship

Edges must be cut square and clean, and sizes accurate.

3.3 Dimensions

Each sheet of E-Flute board should be a maximum of 48 x 96 inches, or a minimum of 48 x 56 1/2 inches, or as specified on the purchase order.

3.5 Marking

There must be no identification marks on the board.

4. Packaging and Identification

4.1 Inner Packages

Each package must plainly identify the type, size and number of items within, the name of the supplier or manufacturer, year of manufacture, and manufacturing run or batch number.

4.2 Outer Package

The items must be packed in standard commercial containers that are constructed to ensure that they arrive at the Library of Congress in dry, undamaged condition. The outside of each container must be identified by type, size and number of items within; manufacturing run or batch number; LC Purchase Order / Contract number and line number.

5. Compliance with Specification

5.1 Quality Assurance Testing

The Library of Congress has the right to perform any of the tests set forth in the specification where such tests are deemed necessary to ensure that supplies conform to prescribed requirements.

5.2 Sampling

To sample for testing, shipments will be sampled according to ANSI/ASQ Z1.4, inspection level S-2, AQL 2.5%.

5.3 Methods

Tests will be conducted in accordance with specified test methods of the American National Standards Institute (ANSI), the American Society for Testing and Materials (ASTM), the Technical Association of the Pulp and Paper Industry (TAPPI), and the International Organization for Standardization (ISO). Publications describing these tests may be ordered directly from the technical associations, their websites, or other on-line standards vendors.

5.4 Acceptance

Materials will be accepted when the Library of Congress has ascertained that the products comply with all parts of the specification. A quick reference table of the physical and chemical requirements and test methods used to ascertain compliance is provided in section 5.5.

FAILURE TO MEET ANY PART OF THE SPECIFICATION WILL BE CAUSE FOR REJECTION

5.5 Table of Physical and Chemical Requirements and Test Methods

Property	Requirement	Test Method
Lignin	Negative / Kappa 5	ASTM D 1030, X5 or TAPPI 236
Reducible Sulfur	< 0.0008%	TAPPI T 406
Iron	≤ 150 ppm	TAPPI T 266
Copper	≤ 6 ppm	TAPPI T 266
pH	8.0 – 9.5	TAPPI T 509, cold extraction, slurried pulp
Alkaline Reserve	2 – 5%	TAPPI T 553, slurried pulp
Alum Rosin Sizing	Negative	TAPPI T 408
Basis Weight	Liner: ≥ 33 lbs / 1,000 ft ² Medium: ≥ 26 lbs / 1,000 ft ²	TAPPI T 410
Color Bleeding	No bleed in 48 hours	See section 2.3
Color Retention	≤ 5 pts	TAPPI T 452
Smoothness	≤ 320 Sheffield	TAPPI T 538
Creases and Folds	No fraying, cracking, splitting	ASTM D 4727, section 9.3
Delamination	No continuous break	ASTM D 4727, section 9.3
Abrasion	≤ 2%	TAPPI T 476
Burst Strength	150 psi	TAPPI T 810
Flat Crush	≥ 85 psi	TAPPI T 825
Bending Stiffness	14 lbf/ ft MD 8 lbf/ ft CD	TAPPI T 836

Configuration Management

Date	Revision History
21-Jul-1998	Last revision of document.
14-Dec-2009	Revised and reformatted for release as PDF document, with new title.
15-Aug-11	Revisions to sections 2.1, 2.6, 2.8, 2.9, 2.11, 2.12