

**Library of Congress Preservation Directorate**  
**Specification Number 600-611 – 16**  
**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%. 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 TAPPI T 401, Appendix F, 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 CaCO<sub>3</sub> 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 ft<sup>2</sup>

### **2.1.2 Medium**

The minimum basis weight should be 26 lbs/ 1,000 ft<sup>2</sup>

## **2.2 Color**

The color of the stock should be manila, unless otherwise 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/m<sup>2</sup> 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.

## **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 Burst Strength**

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

## **2.8 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.

## **2.9 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.

## **2.10 Flat Crush**

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

## **2.11 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  | TAPPI T 401, Appendix F or TAPPI T 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 <sup>2</sup><br>Medium: ≥ 26 lbs / 1,000 ft <sup>2</sup> | TAPPI T 410                                 |
| Color Bleeding    | No bleed in 48 hours  | See section 2.3                             |
| Color Retention   | ≤ 5 pts   | TAPPI T 452                                 |
| Creases and Folds | No fraying, cracking, splitting   | ASTM D 4727, section 9.3                    |
| Delamination      | No continuous break   | ASTM D 4727, section 9.3                    |
| Burst Strength    | 150 psi   | TAPPI T 810                                 |
| Flat Crush        | ≥ 85 psi  | TAPPI T 825                                 |
| Bending Stiffness | 14 lbf/ in MD<br>8 lbf/ in 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                                       |
| 30-Sept-2016 | Revised Sections 1.1, 1.2, 2.2, 2.5, 5.5. Deleted section 2.7. Editorial update to footer. |