

## Evaluating archival box board

### Selecting boards for boxes

Given the range of boxes currently on the market to house and display library and archive collections, choosing between options can prove a difficult task. Cost is certainly one consideration, but cost needs to be evaluated against a number of other factors such as chemical and physical stability, as well as the context of use.

Strictly speaking the term 'archival quality' refers to high quality papers and boards with specific chemical and physical properties designed to ensure the material remains stable for long periods. Unfortunately, there is no legal definition of the term; therefore relying on this description alone isn't enough since any manufacturer can describe a product as being of archival quality.

The **permanence** of a product is one of two factors used to assess paper and board products. Permanent paper products are usually defined as those remaining chemically and physically stable over time. Chemical stability is achieved through the quality of the fibre used, as well as ensuring an alkaline reserve, such as calcium or magnesium carbonate, is added to the fibre helping to combat further acid degradation of the board. All paper products degrade slowly and form acids such as acetic acid, which catalyse further degradation and may migrate to the contents of the box, damaging them.

**Durability** is the second of the two factors and relates to the ability of a product to resist the effects of wear and tear during use. Physical stability and strength is provided through the use of long, high-quality fibre such as cotton or fully bleached softwood pulp. When selecting board for storing archive and library collections both the physical as well as the chemical qualities of the board need to be evaluated.

An effective assessment relies on a number of several interrelated factors of which test results are only one part. The performance of a product over the long-term relates to the design and construction of the product, as well as its use.

### What quality should I be aiming for?

Providing boxes that are both permanent and durable will deliver dividends over time. The National Archives defines three broad categories of board depending on the context of use:

#### **Grade 1 Board Permanent and Durable**

This board will provide for indefinite use of the box and permanent retention of the content.

The board will have a high degree of chemical stability, and be constructed of materials to minimise possible interaction of deterioration by-products and content. The use of long-fibred pulp will impart strength and longevity.

### **Grade 2 Board Permanent**

This board aims for indefinite use of the box, and permanent retention of the content, although physical protection may, in time, be compromised.

The board will have a high degree of chemical stability, and will be constructed of materials to minimise possible interaction of deterioration by-products and content. Longevity and strength may be compromised by the use of shorter length fibre.

### **Grade 3 Board Durable**

Robustness is the main desirable feature of this board, and will therefore only be used for very short-term uses, for example: for transit or very temporary storage.

Materials used for construction will provide a high level of physical protection in storage and during transit.

The corresponding box board specifications for The National Archives to these three categories cannot be considered global, as they have been determined taking into account the particular context of use within The National Archives. These specifications may vary for other institutions and change from time to time as we acquire new knowledge of materials science.

## **What are the agreed standards for evaluating paper and boards?**

There are a number of standards setting out the agreed levels of chemical stability and physical durability for paper, however at present there is no agreed published standard for board used to house library and archive materials.

Standards referring to paper are:

### **International Standards (ISO) for Permanent Paper and Paper Boards**

- ISO 11108:1996 Archival Paper: Requirements for permanence and durability  
Addresses both permanence and durability
- ISO 9706:2000 Paper for Documents: Requirements for Permanence
- ANSI/NISO Z39.48-1992 (R2002) Permanence of Paper for Publications and Documents in Libraries and Archives
- CAN/CGSB-9.70-2000 Permanence of Paper for Records, Books and other Documents
- ASTM D3301-00 Standard Specification for File Folders for Storage of Permanent Records

## **Evaluating chemical and physical properties of paper and board: Some useful terms**

### **Archival paper**

This is a non-specific term, which generally refers to paper that, is both permanent and durable over a long period of time and will not affect objects in contact with it.

### **Permanence**

The ability to remain chemically and physically stable over a long period of time.

### **Durability**

The ability to resist the effects of wear and tear during use.

### **Acid-Free**

Paper or board with a neutral or slightly alkaline pH. Acid-free does not mean wood free.

### **Lignin**

Is a complex aromatic polymer network which functions primarily as a strengthening agent in wood fibre and therefore is a component in paper. Lignin will make paper discolour through photo-oxidation when exposed to light and it has long been associated with low mechanical strength. However, low strength in lignin-containing paper is the result of mechanical pulping and poor fibre-fibre bonding. Chemical pulping of wood may result in very strong paper, even if it contains lignin.

### **Chemical wood pulp**

Pulp made from woodchips by treating with chemicals to separate out the cellulose fibres and dissolve the lignin etc. binding them together. Chemical wood pulp can be bleached or unbleached.

### **Chemical hardwood**

Made from deciduous trees, the pulp is short fibred, has bulk, smoothness and body but not strength.

### **Chemical softwood**

Made from coniferous trees, this pulp has long fibres which provide strength to the sheet.

## **Mechanical wood pulp**

Made by purely mechanical means, ie by grinding wood to pulp. Impurities such as lignin are not removed.

## **Optical brighteners**

Optical brighteners are used by papermakers to make the paper appear whiter. In the past, blue pigments were used to counteract yellowness; now dyes that fluoresce blue or violet when exposed to ultraviolet light, present in daylight are used, e.g. titanium oxide.

## **Fillers**

Fillers often used to make the paper appear whiter and to give a smooth surface for printing are calcium carbonate and kaolin (China clay). An excess of filler or alkaline reserve will have a negative impact on strength properties.

## **Recycled paper**

There is currently no agreed definition of the term recycled paper beyond that it contains recovered fibre from pre and post consumer waste, although various grades have been defined.

## **Permanent paper**

Paper which during long-term storage in libraries and archives or other protected environments will undergo little or no change in properties that affect use.

## **Wood free paper**

Paper made from bleached chemical pulp and is therefore free from wood-based impurities, such as lignin, which are present in both mechanical and unbleached chemical pulp.

## **Size**

Size is a substance that acts as glue, to hold fibres together, to resist water and, for example, to keep ink from bleeding. Size can be applied either to the surface of the sheet (surface size) or, to the pulp (internal size). Permanent paper should be neutrally sized.

## **What tests are used to evaluate paper and boards?**

There are many tests used by the paper industry to evaluate paper and boards and these seldom are associated with long-term use. We have selected tests that we believe will give an indication of the chemical and physical properties of materials.

### **Descriptive tests**

Grammage (TAPPI 411 om-84) this basic test gives the weight of the paper.

### **Chemical Properties: an indication of permanence**

#### **Alkaline reserve (TAPPI T 553 om-05)**

Alkaline reserve can be defined as the addition of materials such as calcium carbonate to the paper or board to neutralize acids as well as to add a reserve of alkalinity to slow down further degradation as a result of natural ageing or pollution.

#### **Ash Tests (TAPPI T 211 om-02)**

The ash test is the standardised measure of the amount of non-fibrous inorganic material in a sample such as pigment, fillers, sizing agents etc. The amount of non-fibrous materials will have an impact on all the properties of a sample.

#### **Fibre Furnish (TAPPI T 401 om-03)**

Fibre-furnish testing aims to determine the character of the paper or board as defined by the type and amount of specific fibre included.

#### **Cobb Tests (BS EN 20535:1994 = ISO 535:1991, TAPPI T 441 om-04)**

The Cobb test measures the amount of water absorbed by a sample of paper or board in 120 seconds (in g/m<sup>2</sup>). Knowing how much water will be absorbed provides an indication of how effectively liquid can be resisted.

#### **Kappa number (TAPPI T 236 om-99)**

There are a number of tests to indicate the lignin content including fibre analysis, chemical tests and IR absorption. The phloroglucinol test will stain lignin-containing fibres red with a depth of colour in proportion to the amount of lignin present. The Kappa number measures the amount of oxidising agent (potassium permanganate) consumed in reaction with the sample and hence the lignin content.

### **pH values: cold extraction (TAPPI T 509 om-02)**

Acid catalysed hydrolysis is often considered the most important factor in the degradation of paper products. pH values are obtained by either cold or hot water extraction. Cold extraction is considered to give the more correct value, as hot water extracts affect other constituents of the paper. 'From an analytical point of view, pH is not considered numerically accurate. This is because pH is based on a log scale which means it is necessary to increase the concentration of acid or alkali by a factor of 10 in order to see a one unit change in value.'<sup>1</sup>

### **Residual Sulphur (TAPPI T 406 om-04)**

As the name suggests, the test for residual sulphur measures the amount of sulphur in a paper sample. Papers used in contact with photographs or negatives should be free of sulphur or sulphides. The sulphur content should be less than 0.0008% for non-tarnishing papers, although slightly larger amounts will not necessarily contribute to tarnishing.

### **Strength Qualities: An indication of durability**

#### **Tensile strength (TAPPI T 404 om-92)**

This is a very common measure used in the paper industry, which gives an indication of fibre strength. Sometimes referred to as 'breaking strength' since what is measured is a load per width rather than the normal load per area. The results also depend on the orientation of the fibre sample and its moisture content. Therefore all tests should be carried out under standard environmental conditions.

#### **Tensile Index (TAPPI T 404 om-92)**

Is a measure used in the paper industry and is calculated by measuring the tensile strength (N/m) divided by the grammage (g/m<sup>2</sup>) of the paper or board.

#### **Burst strength (TAPPI T 403 om-92)**

Is a common measure of strength (combined tensile strength and stretch) of a paper or board and is calculated by measuring the pressure required to rupture a specimen when it is tested on a burst tester under specific environmental conditions. Like tensile testing, burst strength correlates to inter-fibre bonding.

---

<sup>1</sup> Burgess, H. Topics in Photographic Preservation, American Institute for Conservation Photographic Materials Group, 4:1999,100

## **Burst Index (TAPPI T 403 om-92)**

The ratio of the bursting strength (expressed in kPa) and the substance of paper/paperboard (expressed in g/m<sup>2</sup>) determined by standard testing methods.

## **Selecting materials for testing**

The boards subjected to chemical and mechanical testing were randomly selected as part of our quality assurance exercise. Independent testing laboratories in accordance with procedures set out in the following standards carried out all tests:

### **Chemical testing**

- Ash test TAPPI T 211 om-03
- Fibre Furnish TAPPI T 401 om-03
- Alkaline reserve TAPPI T 553 om-05
- Cobb Tests BS EN 20535:1994, ISO 535:1991, TAPPI T 441 om-04
- Kappa number TAPPI T 236 om-99
- pH : cold extraction TAPPI T 509 om-02
- Residual Sulphur TAPPI T 406 om-04

### **Mechanical testing**

- Burst Index TAPPI T 807 om-03
- Burst Strength TAPPI T 807 om-03
- Breaking Load TAPPI T 404 om-92
- Tensile Strength TAPPI T 404 om-92
- Tensile Index TAPPI T 404 om-92

## **Disclaimer**

The content of this part of the website including terms, standards and test results is provided for the purposes of information only. It does not in any way constitute advice, approval or endorsement in connection with any of the products tested or their fitness for purpose, or in connection with the manufacturers, wholesalers, distributors or retailers of those products. The products have been tested by independent testing facilities in accordance with international testing standards. The test results relate only to those specific tests.

1. The National Archives ('TNA') and the British Library ('BL') make no warranty or representation (express or implied), including without limitation in relation to:
  - a. the accuracy, timeliness or completeness of the content of this part of the website;
  - b. any of the products tested;
  - c. the products' fitness for purpose;

- d. any of the manufacturers, wholesalers, distributors or retailers of those products.
2. Your choice and use of any products is entirely at your own risk and the use should always be in accordance with any relevant applicable manufacturer guidance. The TNA and the BL shall not be responsible or liable for any loss or damage of any kind incurred by you as a result of your use of any products or as a result of any dealings you may have with the manufacturers, wholesalers, distributors or retailers of any products.
3. This website provides access via hypertext links to websites which may be of interest to you. This does not in any way constitute endorsement or approval of either the website, or of the organisation concerned, or of any products, services, policies or opinions of that organisation. TNA and the BL do not accept any responsibility for the accuracy, content or legality of the linked websites or organizations or the reliability of the linked websites. The TNA and the BL have no control over the availability of the linked pages and do not guarantee that these links will work all of the time.
4. These disclaimers and exclusions shall be governed by and construed in accordance with English Law under the exclusive jurisdiction of the English courts.



Product	Archival Boxboard (2 layered grey/brown)	Premier Archival Boxboard BDAFBD1000	Archival Boxboard (2 layered white/grey)	Archive Box Board (4 layered board)	Archival Boxboard (2 layered white/grey)	Green Elephant Millboard	
Manufacturer/Supplier	Banner (UK)	Conservation by Design (UK)	Klug (Germany)	Nuttalls (UK)	John Purcell (UK)	Conservation By Design (UK)	
Grammage (g/m <sup>2</sup> )	1004.9	776.38	918.8	1215.1	847.4	1377.3	
Thickness (µm)	1300	984.5	1120		994		
Chemical tests	Ash test	21.2%	10.89%	7.6%		9.3%	
	Fibre furnish	Grey layer: 57% mech. softwd 30% chem. hardwd 13% chem. softwd Brown layer: 60% mech. softwd 25% chem. hardwd 15% chem. softwd	Inner single white ply: 52% chemically pulped hardwd 48% chemically pulped softwd Middle white plies: 59.5% chemically pulped hardwd 40.5% chemically pulped softwd Outer grey plies: 28.5% chemically pulped hardwd 71.5% chemically pulped softwd	White layer: 98% chem. hardwd Grey layer: 87% chem. hardwd 13% chem. softwd	Multi-ply board, 2 outer brown and 2 inner grey layers Ply 1: Outer layer, unbleached sulphate (Kraft), pine Ply 2: Inner grey, 62.5% mech. softwd 24.2% chem. pulped hardwd 13.3% chem. pulped softwd Ply 3: Inner grey, as per ply 2 Ply 4: Outer layer, unbleached softwood sulphate pine as in ply 1	White layer: 43% chem. softwd 57% chem. hardwd Grey layer: 65% chem. softwd 35% chem. hardwd	This board comprises 12 layers
	Alkaline reserve	8.52%	4.4%	6.38%	11.335%	7.66	3.81%
	Cobb tests	Side 1: 35.6 Side 2: 26.0	Grey side: 20.37 White side: 20.40	White layer: 38.8 Grey layer: 36.0	Side A: 30.0 gsm; 30.9gsm Side B: 30.6 gsm	White layer: 38.8 Grey layer: 36.0	
	Cold extraction pH	7.7	9.3	7.5	10.7	7.8	6.6
	Reducible sulphur	0.00041%	0.0028%	0.000078%	0.00077%	0.00030%	0.000104%
	Tensile strength (MD)	24.47 kN/m	40.879 kN/m	36.44 kN/m	28.3 kN/m	53.63 kN/m	
Mechanical tests	Tensile index (MD)	24.35 Nm/g	52.66 Nm/g	39.66 Nm/g	23.37 Nm/g	63.29 Nm/g	
	Burst strength (MD)	1953.5 kPa	1879.59 kPa	1896.1 kPa		2222.4 kPa	
	Burst index (MD)	1.944 kPam <sup>2</sup> g <sup>-1</sup>	2.421 kPam <sup>2</sup> g <sup>-1</sup>	2.064 kPam <sup>2</sup> g <sup>-1</sup>		2.542 kPam <sup>2</sup> g <sup>-1</sup>	
	Breaking load	367.1 N	613.24 N	570.8 N	425.9 N	804.5 N	In excess of 1000 N