GUIDELINES for RECYCLED CONTENT in PAPER and PAPERBOARD PACKAGING
Guidelines for Recycled Content in Paper and Paperboard Packaging was developed by GreenBlue’s Sustainable Packaging Coalition®, a membership group that brings together businesses, educational institutions, and government agencies to collectively broaden the understanding of packaging sustainability and develop meaningful improvements for packaging solutions.

www.sustainablepackaging.org
Introduction

Use of recycled content is of increasing interest to brand owners and retailers for a number of reasons, not least because it is one environmental strategy that consumers understand. In addition, the use of pre consumer recycled content is an effective efficiency measure while the use of post consumer recycled (PCR) content helps to support existing and new markets for recovered materials.

These guidelines draw heavily upon existing general information about paper and fiber recycling, while offering new insights that characterize the opportunities to use recycled fiber content in 20 high-volume packaging applications in retail environments. They also identify the key considerations that must be addressed when introducing or increasing the use of recycled content in those applications. The information in this resource is based on the knowledge and experience of technical practitioners who design and engineer fiber packaging and/or operate pulp and paper mills. The scope of this guidance is limited to the US and some commonly used fiber packaging applications across multiple sales categories found in most major retail environments—excluding club stores—as shown to the right.

A standard set of information was collected for each packaging application in order to capture a comprehensive data set that would fully characterize the opportunities and limitations for using recycled content (which includes both pre and post consumer fiber) in paper and paperboard packaging. The information provided for each application includes characterization of the opportunity to use recycled content based on:

- Packaging performance requirements
- Regulatory compliance requirements
- Technical/operational factors
- Aesthetic considerations
- Material availability
- Cost

This resource is intended as an educational resource for both producers and users of paper and paperboard packaging. By providing detailed and specific information related to the use of recycled content, packaging buyers at retailers and consumer packaged goods companies can become more proficient in specifying recycled content, which should help inform aggressive packaging specifications that converters can realistically strive to deliver on. The information also can help to minimize research and development costs involved in conducting (or duplicating) independent research into the appropriate parameters for recycled content use in specific packaging formats.

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Introduction

OPPORTUNITIES FOR RECYCLED CONTENT USE
A number of factors contribute to the feasibility of incorporating recycled content into various packaging applications. These factors vary based on the quality and consistency of the recovered fiber, types of additives used to produce the fiber substrate, and the treatment of the fiber during the packaging conversion process. Mill processing capabilities also can play a role in the use of recycled content as not all pulp and paper mills are equipped to process high volumes of recycled content. Each mill’s limitation to recycle fiber is based on its ability to cope with the laminates and other modifications made to the original fiber substrate.

Based on the scope of this initiative, the greatest opportunities to use recycled content, ranked from highest to lowest, are in the following applications:
- Cereal and pasta boxes
- Trash bag cartons
- Grocery bags
- Pizza boxes
- Cat litter boxes
- Paperboard coffee canisters

Not surprisingly, these packaging formats already contain the highest average percentages of recycled content in the market place ranging from:
- 90 to 100 percent for cereal and pasta boxes
- 90 to 100 percent for trash bag cartons
- 90 to 100 percent in grocery bags
- 43 percent in pizza boxes
- 40 to 50 percent in paperboard coffee canisters
- > 40 percent in cat litter boxes

The primary reasons that higher percentages of recycled content are used in these applications include the facts that:
- With a 71.8 percent1 recovery rate for paper and paperboard packaging, more post consumer recovered fiber is available for use.
- The industry average pre and post consumer recycled content for various types of corrugated boxes is 43 percent, but higher levels are commonly available.
- Many paperboard carton applications and mini-flute corrugated boxes are unbleached and do not require high print quality.
- Spiral-wound containers, such as coffee canisters, are generally made with an inside composite liner, paperboard body, and exterior label. Recycled content can be incorporated into the paperboard body and exterior label while the composite liner serves as a barrier preventing direct food contact with recycled fiber.

A small number of applications currently use low levels (i.e., less than 20 percent) of recycled content, but are believed to have a medium to high potential to contain higher levels in the short- to mid-term. These include retail shopping bags, apparel hang tags, golf ball boxes, sugar and flour bags, artisan bread bags, and take-out food service bags. There are few barriers to increasing the use of recycled content in shopping bags, hang tags, or golf ball boxes, with customer requirements for high printability and other aesthetic considerations being the primary obstacle. The primary challenge for increasing recycled content in sugar and flour bags is that the recycled fiber must be compliant with Title 21 Part 176.260 of the FDA Code of Federal Regulations, which allows for the use of recycled fiber provided that it does not cause the product to become “adulterated or misbranded” due to any migration of “poisonous or deleterious” substances. Specific information about this requirement is addressed in the Food and Drug Direct Contact Compliance section of these guidelines.

Only five out of the 20 packaging applications reviewed in this process do not utilize any recycled content, and in the estimation of the project’s working group, the ability to introduce recycled content into these applications in the short-term is considered to be low. Three of these applications—over the counter pharmaceutical boxes, software boxes, and frozen food boxes—are frequently made from solid bleached sulfate board or coated unbleached kraft with performance and/or aesthetic requirements that are difficult to meet using high levels of recycled content. However, it is increasingly possible to include recycled fiber in middle layers of multi-ply solid bleached sulfate (SBS) or coated unbleached kraft (CUK) paperboards and still achieve the pure, blue-white print quality in the outer layer. Butcher wrap, used to wrap meat and other food products, must be able to withstand considerable exposure to liquids and meet strict FDA regulations, making the use of recycled content quite challenging and impractical. Similarly, microwave popcorn bags must be virtually contaminant free as, for example, any metal flakes in the fiber could cause fires when microwaving.

COMMON CHALLENGES
Six factors emerged as the primary challenges to recycled content use:
- Breakdown of the length and strength of the fibers during repulping, which limits the number of times fiber can be recycled.
- Demand for post consumer recycled fiber already exceeds supply.
- The move toward single stream recycling is increasing contamination of the existing recovered fiber streams.
- Critical performance requirements such as strength (compression, edge crush, burst, and tensile strength), stiffness or rigidity, moisture resistance, grease resistance, and freeze/thaw tolerance can be harder to achieve with recycled paper or paperboard.
- Mill technology and equipment affects a mill’s ability to process recycled fiber. While US mills are increasingly capable of working with both virgin and recycled content, some may have only limited capacity to work with recycled paper and paperboard.
- Recycled content used in drug or direct food contact packaging must be able to demonstrate compliance with applicable sections of FDA 21CFR170 through 21CFR180.

Additional considerations are generally related to:

- Material quality due to a variety of treatments that can cause “stickies” and other contaminants in the pulp.
- Price fluctuations in both virgin and recycled fiber.
- Competition for recycled fiber from outside the U.S. over 35 percent of the fiber recovered in the US is exported.
- Aesthetics, depending upon consumer sensibilities and market positioning.

Many of the challenges associated with the use of recycled content can be overcome. Known solutions to those challenges and other best practices for optimizing recycled content are offered in these guidelines. Whether a challenge becomes an actual limitation often depends upon a supplier’s and/or customer’s requirements, and technical capabilities with the need for additional water treatment to allow the water to be captured and reused or properly released as an effluent can increase cost. Additionally, additives or coatings almost always will be required to achieve certain performance requirements when working with recycled content in some packaging applications. However, the number and amount of treatments such as clay coating, sizing, wet strength polymers, adhesives, foils, and others can make it more difficult to recycle the package again. Therefore, an understanding of the total system is important to making appropriate impact reduction and cost trade-off decisions.

**THINGS TO CONSIDER**

The use of recycled content must not increase the potential for product damage. The loss of products and their embodied energy and resources would more than offset the benefits of using recycled content in the packaging.

In some instances, the use of recycled content may require additional processes or increase manufacturing cycle times, which could increase energy use. Water systems used during the paper making process can become more polluted when processing recycled paper and paperboard due to the need for cleaning and contamination removal, and/or the need to use higher volumes or stronger formulations of additives or coatings. When this happens, the need for additional water treatment to allow the water to be captured and reused or properly released as an effluent can increase cost. Additionally, additives or coatings almost always will be required to achieve certain performance requirements when working with recycled content in some packaging applications. However, the number and amount of treatments such as clay coating, sizing, wet strength polymers, adhesives, foils, and others can make it more difficult to recycle the package again. Therefore, an understanding of the total system is important to making appropriate impact reduction and cost trade-off decisions.

**BEST PRACTICE TIPS**

According to the 100% Recycled Paperboard Alliance’s website, recycled paperboard has the ability to be completely customized. It can be polycoated where needed or designed to be fully recyclable without polycoating within the production process to meet requirements for moisture vapor transfer, moisture transfer resistance, mold resistance, anti-tarnish, oil/grease resistance, opacity, customized colors, and coefficient of friction (COF). These attributes are built into the paperboard during production, and become a specified inherent part of the paperboard grade, which eliminates or minimizes costly third- and fourth-party conversion processes. Several 100 percent recycled paperboard manufacturers currently have grades available with a “white back” or white-inside surface. This is achieved by using a high percentage of a variety of white recovered papers as furnish (raw material) for the inside ply of the paperboard.

The best way to ensure the use of recycled content, particularly 100 percent recycled content, will meet specific packaging performance, regulatory, technical/operational, aesthetic, availability, and cost requirements is to build good, collaborative working relationships with suppliers. Other best practice tips for the successful use of recycled content in the design and manufacture of paper and paperboard packaging applications include:

- Source post consumer recycled content from a reputable recycler who can provide consistent quality, backed up by inspection sheets, and good customer support.
- Engage your suppliers in the design process and be sure to design the recycled content package so it can be recycled again.
- Support investments in end-of-life collection infrastructure to increase availability of recovered fiber.
- Communicate about the recyclability of the packaging to consumers.

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3 100% Recycled Paperboard Alliance website: http://www.rpa100.com/recycled/convert-to-recycled-paperboard/using-100-recycled-paperboard-the-conversion-guide
GENERAL
Understanding how paper and paperboard is produced is a good place to start in exploring opportunities to use recycled content in fiber-based packaging. The main steps in pulp and paper manufacturing are 1) raw material preparation, such as wood debarking and chip making; 2) pulp manufacturing; 3) pulp bleaching; 4) paper and paperboard manufacturing; and 5) fiber recycling. Pulp and paper mills may exist separately or as integrated operations. Integrated mills produce both pulp and paper or paperboard. Non-integrated mills produce paper or paperboard from pulp they purchase from a supplier. Additionally, some mills are set up—in terms of equipment, technology, and process flow—to work primarily with virgin fiber, some number with primarily recycled fiber, and an increasing number, known as swing mills, can accommodate both virgin and recycled fiber.

There are currently 85 mills operating across the US that have the capacity to produce packaging grade paper and paperboard as shown in Table 1.4 Note that the mill count will total 89 vs. 85 because four mills have capacity to produce packaging materials for multiple categories.

The ability to introduce or increase the use of recycled content in most packaging applications is largely controlled by mill equipment and technology upgrades, process-flow adjustments, and company or mill-specific “recipes.” Other factors that affect the use of recycled content—particularly post consumer content—include the type of treatments added to the paper or paperboard to meet packaging performance requirements. These treatments include adhesives, clay and other coatings, dyes, foils and other metallization materials, inks, laminate, overprint varnishes, starch, waxes, and wet strength and other polymers. Removing and filtering these materials before or during the repulping process can require extra steps, including the need for special screens to eliminate impurities such as “stickies” from the pulp, and the costly disposal of unusable contaminants that get into the system.

For more details on paper and paperboard production, see Appendix A.

4 Information on mills provided in an e-mail exchange with the American Forest and Paper Association.

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<th>TABLE 1. US PAPERBOARD MILL CAPACITY</th>
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Performance Requirements

Performance requirements will vary according to packaging format and application, as well as required conversion and distribution processes. Many packages need to provide critical environmental barriers such as moisture, grease, odor, and bacteria protection. Many paperboard packages must be able to be scored, folded, laminated, or sealed.

The physical properties of recycled fiber are lower than virgin fibers because each time a fiber is recycled it is shortened. As a result, recycled fibers have less strength and less cross-direction stiffness than virgin fibers. Recycling also degrades the inherent bonding capabilities of the fibers. Material properties can be further impacted by incomplete removal of contaminants such as residual product, adhesive backed-labels, closures such as staples, and other debris. Therefore, introducing recycled content into paper and paperboard packaging applications that have critical structural requirements may not be appropriate in conjunction with weight or caliper reduction measures.

**STRENGTH**

One of the most critical performance requirements for folding cartons and other paper and paperboard packaging is strength. There are six specific measures of strength that must be seriously considered when incorporating recycled content. These are compression strength, edge crush strength, burst strength, tensile strength, score bend strength, and drop impact strength, and they are defined as follows:

- **Compression Strength**: The capacity of the material or package to withstand axially directed pushing forces. When the limit of compressive strength is reached, materials are crushed. Compression strength is generally expressed in pounds per square inch (PSI).
- **Edge Crush Strength**: The amount of force that is needed to crush a box when standing on its edge. Closely related to compression strength and also measured in PSI, edge crush strength is an important consideration for box stacking.
- **Burst Strength**: The force of PSI required to rupture or burst a side of a package. Burst strength determines the package’s ability to withstand external or internal forces and how well the package will contain and protect its contents during rough handling.
- **Tensile Strength**: The resistance to lengthwise stress, measured as the load pulling in the direction of length that a material or package can bear without tearing apart. Tensile strength is also measured in PSI. Bond strength is related to tensile strength and may also be referred to as “z axis direction tensile” strength.
- **Score Bend Strength**: The ability of the sheet to remain intact during the automated folding/setup process. Paperboard with good score bend strength should not show any evidence of ply separation or delamination (if laminated), and any coating used should not crack along the score.
- **Drop Impact Strength**: A package’s ability to withstand impact stresses and the ability of the package to protect the content when subjected to such stresses.

Properties of recycled fibers change with each reuse cycle in ways that affect their strength. For example, the fibers shorten, and during the drying process, their cell walls collapse. These changes alter the fibers’ ability to swell, which in turn affects the natural bonding capacity and flexibility of the fibers. However, mill technology can go a long way to compensate for these affects and can determine the capability to increase recycled content levels in board types without affecting performance. The industry representatives interviewed for this report unanimously agreed that differences in board performance are more a matter of the technology installed at the individual mill than the fiber type. Experts also agree that paperboard quality cannot be attributed to one specific mill technology, but is rather a result of the overall process sequence in the mill and how it is managed. These views are consistent with research done by GreenBlue for its 2011 report Design for Recovery Guidelines for Paper Packaging, as well.

Two major paperboard mill/packaging converters and representatives from the 100% Recycled Paperboard Alliance, interviewed during the development of these guidelines, agreed that mill technology and operational management are primary factors in recycled board quality. They suggested that overall strength depends on the quality of the recycled fiber used in the “recipe” and how it is blended in the wet end of the machines. For example, since recycled fiber comes in many grades, it may be necessary to blend various grades to achieve the grade of paperboard and performance parameters required for a packaging application. Higher strength boards can be produced by using more recycled kraft in the blend, but some virgin content is almost always required to meet stringent strength requirements.

It is generally believed that recycled paperboard will have lower corner stacking and panel strength than solid bleached sulfate (SBS) and coated unbleached kraft (CUK) board, and regardless of the mill technology, it may be necessary to increase the caliper (cross-sectional width) of a recycled paperboard. Even with the addition of bulkers (agents or additives that enhance strength and stiffness) and squeezing the board to enhance the cross-linking of fibers, it may not be possible to produce a recycled board of equal strength as a virgin board without increasing the caliper thickness. Increasing caliper thickness generally increases weight, which should be recognized and considered when seeking to introduce or increase recycled content in a package. However, conversations with some recycled board manufacturers indicate that some mills have been able to change the basis weight of the board to minimize the packaging weight increase even while using a higher caliper recycled board. Other manufacturers suggested that it is possible to increase fiber and fiber strength in carton corners while reducing fiber used in the carton walls to achieve compression strength specifications without increasing overall packaging weight. For example, using various flute technology (wavy folds of paper sandwiched between sheets of liner board) in folding carton applications can achieve required strength without increasing material use, weight, or packaging to product ratio.

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The development of the extended nip press (ENP) is a technology that can facilitate an increased use in recycled content while meeting rigorous strength specifications. ENPs consist of a single press roll pushing against a pressurized belt that hugs the roll across a wider section of the press roll cylinder. Paper can pass through the ENP at loadings up to 6,000 pounds per linear inch (PLI) for longer periods of time. As a result, more water is removed from the sheet, and less drying time is required, which helps minimize loss of fiber strength. As explained, because recovered fibers have been dried and pressed before, they are harder and stiffer and do not bond as well as virgin fibers. Therefore, using an ENP can compensate for losses in fiber strength, and also allow the use of less fiber to achieve the same compression and drop impact strength levels. In summary, the use of specific technologies can make significant differences in the performance of recycled board. And the technologies employed at recycled mills can vary widely.

There are four possible ways to recover the loss of natural bonding of recycled fibers which can affect tensile and bond strength: 1) beating and refining, 2) chemical treatment, 3) blending with virgin fibers, and 4) fiber fractionization. Alkaline-based solutions are the most common chemicals used to improve the natural bonding properties of recycled pulps. Bond strength can also be enhanced by the addition of starch. Manufacturers can use internal sizing to reduce water absorption. Poor score bend strength can reduce the “machinability” of the board. In order to run smoothly and consistently on packaging lines, folding cartons must erect well, accept the product without changing shape, and maintain their shape when sealed without flaps popping open. The stiffness of the paperboard is an important property affecting score bend strength, and it may increase or decrease the board’s resistance to folding. The ratio of the stiffness of the board and the stiffness of the crease after it has been bent 90 degrees must lie within certain parameters for the sealing machine to work properly. Exploiting the greater machine-direction to cross direction stiffness ratio of recycled paperboard can compensate for some loss of score bend strength and/or stiffness, which should reduce machinability issues associated with recycled paperboard. This is because the carton feeding mechanism will be better able to accurately and positively control the carton, and will likely have features that 1) force the carton to pre-open, 2) hold the carton in a pre-opened state, and 3) control the carton in all directions once the carton is fully opened.

Additives can help address a variety of strength issues. If fiber is deficient in tear strength, introducing a dry strength additive can help. As a rule of thumb, the additives used to ensure that virgin board meets strength requirements will similarly increase recycled board strength. The only difference is that the combination or formulation of the additives may need to be adjusted slightly or a larger volume of an additive may need to be used.

**COEFFICIENT OF FRICTION**

Coefficient of friction (COF) is a measurement of how smooth or rough the carton finish is or how much drag or friction is created when a carton moves against another carton or other surface. The COF indicates how a package will perform in many critical applications. A high coefficient of one surface of paperboard to itself means the carton will tend to resist sliding in unit loads. A low coefficient may allow packages to slip from a unit load. COF is also an important factor for proper movement through carton folding equipment, separation of the carton at pick point, and flap folding and sealing.

Changes in the surface energy of secondary fibers and the presence of contaminants can significantly affect the friction properties of paper or paperboard. Recycled content boxes and cartons can be “more slippery” and can exhibit reduced COF or slide resistance. Anti-skid materials such as silica sprays can be applied to the paperboard or to the finished box to increase slide resistance. There are also a variety of control coatings that can improve the coefficient of friction of both virgin and recycled board. Most of these are proprietary formulations and their use, effectiveness, and environmental profile should be discussed with suppliers.

**BACTERIA CONTROL**

There are no special requirements for controlling bacteria in recycled board. The same processes used for virgin board apply. These include applying bacterial control agents during the paper machining process. Additionally, the steam heater drums in the dryer section of the production machines tend to run at a temperature of 300 to 350 degrees Fahrenheit, acting, therefore, as sanitizers. Bacterial control agents can also be added to a variety of coatings used on both virgin and recycled board.8

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17. Conversations with technical staff at Graphic Packaging and RockTenn.
Performance Requirements

**BARRIER PROTECTION**
Barrier protection may be needed to control light, humidity, moisture, oxygen, oil and grease, odors, microbes, and more. Achieving barrier protection is similar for both virgin and recycled boards and is achieved by the application of coatings. Barrier coatings typically form a tight bond on the paperboard in order to achieve the proper barrier. In some cases a slightly heavier or thicker application of coating may be required on recycled boards.

Polymer extrusion coatings are particularly effective in providing barrier protection. The most common polymers used as barrier coatings are polyethylene, polypropylene, and other polyolefins. Ethylene vinyl alcohol and polyamide are typically used as high-barrier, multilayer coatings, and provide good light, oxygen, humidity, and odor barriers. Polyethylene terephthalates and polybutylene terephthalates also may be used, particularly for high heat resistance and grease barrier features. Biopolymer coatings can be found increasingly in the marketplace, and may be considered by some a more environmentally friendly or more sustainable option for use with recycled content board. However, as these coatings are relatively new to the market, close collaboration with suppliers and appropriate performance testing are advisable.

White coatings employing titanium dioxide can be modified to create an effective oil and grease barrier. Emulsions and wax coatings can also provide required barrier protection, but will reduce the recyclability of the package. Generally speaking, barrier coatings can be applied on the inside or outside of packaging.

**WET STRENGTH**
Wet strength is the mechanical strength of paper remaining after submersion and soaking in water. Most paper or paperboard used for packaging that will be exposed or subjected to any level of moisture, and especially packaging that may be subjected to freeze/thaw conditions, will require treatment with a wet strength agent (WSA) or coating. WSAs are synthetic resins. Polyamide epichlorohydrin resins account for 90 percent of the wet strength market. These resins meet the needs of most recycled content paper and paperboard packaging applications. As a rule of thumb, applications of two to eight percent are required to achieve desired wet strength for most types of packaging. Applications of greater than eight percent are required for most laminates and labels. The use of polyamide epichlorohydrin resins can contribute to the presence of AOX in mill effluents. This is true, whether these wet strength agents are used on recycled, virgin paper, or paperboard.

**TESTING**
Mechanical tests and industry standards to evaluate a full variety of paperboard packaging performance requirements are well established. These tests are appropriate for both virgin and recycled content paperboard packaging. To be sure recycled content packaging will meet all performance requirements, various strength, glueability, and barrier property testing should be routine.

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18 Conversations with technical staff at Graphic Packaging and RockTenn, Aug. and Sept. 2011.
According to Keller and Heckman LLP, a law firm with a well respected food and drug practice that also specializes in packaging law, there is no legal requirement to obtain FDA’s explicit approval for the use of recycled content in paper and paperboard food or drug contact packaging. Rather, users of recycled content in paper and paperboard packaging must be able to demonstrate that all manufacturing processes associated with production of the recycled content packaging comply applicable sections of 21CFR170 to 21CFR180. Current guidance from the FDA for recycled content in fiber follows their guidelines for recycled plastics content, calling for proof that the paper and paperboard recycling process sufficiently removes potential contaminants.

Section 176.260 of the Food Additive Regulations permits pulp from reclaimed fiber to be used in food-contact articles if certain conditions are met. The regulation provides that recycled paper must not contain deleterious substances that may migrate to food so as to be potentially injurious to the health of consumers. Current guidance from the FDA indicates that they expect a manufacturer to “spike known quantities of the surrogates (i.e., potential contaminants) into pulp and demonstrate that the recycling process sufficiently reduces the levels of these contaminants.” Examples of the unwanted substances that may be in paper include polychlorinated biphenyls (PCBs), heavy metals, semi-volatile organic compounds, volatile organic compounds, polynuclear aromatic hydrocarbons (PAHs), dioxins, fluorescent whitening agents, inks, photoinitiators, defoamers, slimicides, coating materials, adhesives, and microbial contaminants.

Given these arguments, the law firm recommends an alternative approach to meeting FDA requirements. They suggest testing samples of virgin and recycled fiber that have been processed in a manner typical for finished food packaging by forming hand sheets of 100 percent recycled fiber and 100 percent virgin fiber using rolling, heating, and drying conditions typical of the finished paper products that will contact food; then comparing the samples to prove that there is no discernible difference in potential contaminants between the recycled paper and the virgin paper. It should be noted, however, that although Keller and Heckman LLP has issued a number of opinion letters on the basis of their sampling approach, the FDA is still committed to the surrogate contaminant challenge testing approach.

AN ALTERNATIVE

One way to introduce or increase recycled content in direct food-contact packaging without having to consider FDA compliance is to limit recycled content to middle layers in multi-layer package construction where a virgin outer layer serves as an effective “functional barrier.” While limiting recycled content to middle layers may make sense in various applications, it is impractical to go to a multi-ply construction simply to utilize recycled content, because the impacts associated with the additional virgin material use, the energy required for the additional processing, and the associated greenhouse gas and other emissions would likely far outweigh any benefit.

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Technical/Processing Considerations

MILL PRODUCTION

While working with recycled content can pose challenges for mill operators, a number of technological advances in multi-ply recycled paperboard manufacturing have made better and faster sheet formation possible. Most of these involve a different means of applying pulp to the rotating cylinders of a conventional multi-ply machine. Improvements in press section and coating technology are also common. Multiformers, for example, use pressurized chambers mounted on the cylinder mold to disperse the pulp evenly onto the cylinder. Ultraformers, a technology developed in Japan in the 1960s, use a fourdrinier-type headbox at the top of the cylinder to apply the pulp. More recently multi-fourdrinier technology has been adapted for use in manufacturing recycled paperboard. These machines use two or three top-former fourdrinier sections arrayed above a longer bottom fourdrinier to produce a multi-ply sheet at relatively high speeds. Fourdrinier machines dewater the web more quickly and evenly than cylinder-based formers alone, and are sometimes used for the top liner or inner liner of the paperboard. Which equipment works best depends on the desired thickness of the board. Fourdriniers perform better for lighter weight boards while former-type or cylinder machines perform better for thicker boards. It also should be noted that use of the fourdrinier technology allows recycled mills to reach cycle processing time similar to virgin mills, i.e., producing 2,000 to 3,000 feet per minute vs. the 600 feet per minute typical of older cylinder machines.

In the 1980s, distributed control systems (DCS) (i.e., that eliminate manual control of paperboard production) have improved the ability to produce recycled content board. DCSs comprise an array of scanners, measurements, profilers, control software, and high-speed communication interfaces with operators to deliver both optimum sheet characteristics and maximum production. These systems can also help monitor overall energy consumption.

Advances in cleaning technologies and methods have also allowed mills to better integrate recycled content into paper and paperboard. Advances in alloys and other materials have led to the development of more sophisticated screening equipment. A 12,000-slot screen used to be required for fine screening. Today, a 6,000-slot screen provides optimum performance. These screen improvements allow for the use of more contaminated furnish in the mix, an important consideration given the trend toward single stream recycling.

CONVERTER CHALLENGES

Although a paperboard manufacturer may say that it is “no problem” to run recycled paperboard, the converter may have trouble using it. Converters may be very particular about their raw materials because they typically tune their machines for a specific type of paperboard, often from a specific manufacturer. For this reason, the less predictable properties of recycled paperboard can disrupt the die-cutting, folding, box setup, and gluing processes. However, many converters, typically those that are subsidiaries of recycled paperboard manufacturers, routinely run two or three different types of paperboard in their plants and have learned to adapt to the different qualities of recycled board.

Moisture Control

Moisture uptake is one of the properties of greatest concern to the converter. Proper conditioning of the paper to ensure that the paper has flat edges is critical to the converting process. Recycled paperboard absorbs moisture more readily than SBS or CUK. If recycled paperboard is improperly conditioned, it may develop wavy or tight edges, which makes it more difficult to put through various automated conversion processes.

In addition to advances in machine technology discussed, moisture can be controlled by adding starch during the pulping process. There are also a host of additives that can be used in the recipe or applied to the paperboard. However, using more additives can result in more effluents released to water, which can offset the desired environmental gains of using recycled content.

Die-Cutting

Moisture is also a critical factor for die-cutting. Moisture control during the production of recycled content paperboard, as well as during transport to and storage at the conversion facility, is essential. High moisture content board may be tougher and more difficult to cut, while low moisture content board may be brittle and create excessive dust, which can be problematic for other steps in the conversion and finishing processes. Sophisticated temperature and moisture control in the cutting room can adjust for most moisture inconsistencies in recycled content paperboard.

Recycled content paperboard can be die-cut using either rotary or flat bed die-cutting machines. Maintaining the sharpness of the cutting blades to ensure they meet the counter die correctly is also important. Dull, worn, or blunt cutting blades can lead to tears along the cut line and also may result in dusty edges. Polymer coated or laminated recycled (or virgin) paperboard should be die cut from the plastic coated side.

Folding and Box Setup

Folding and box setup were issues of concern when using recycled content, but most of the issues have been resolved with advancements in equipment technology. Grain ratio and machine directional stiffness are the two critical parameters. Older cylinder machines create higher directional stiffness and tend to create setup issues. Newer fourdrinier machines allow for better machine directional to cross directional ratio, which makes the paperboard squarer and easier to score and run on setup equipment.

Higher caliper recycled sheets or boards will score easier and therefore fold and setup more easily. Setup equipment can be easily tuned to handle the higher caliber board. Another rule of thumb to ensure clean scoring and folding is to avoid old or aged recycled inventory. Many potential problems can be avoided simply by selecting and combining the best furnish for the job and formulating pigment coatings (clay, latex, titanium dioxide, or flow enhancers) to increase board flexibility.

Gluability

There are two primary types of glues used in folding cartons and bags – hot melt glues and water-based resin adhesives, also referred to as cold glues. Hot melts are typically used when the complexity of the style of the package necessitates the immediate adherence of the panels or openings. Cold glues require more time to tack panels together and the package has to be held under compression rollers and belts until that bond is initiated.

26 Conversation with technical staff at RockTenn, Sept. 2011.
Technical/Processing Considerations

Low surface strength, which may be a characteristic of high recycled content, can alter the natural bonding capacity of fibers and cause adhesion failures when glue seams are stressed. Therefore, use of cold glues is generally preferable for recycled folding cartons.

Coatings—for example, aqueous coatings—that may be used on a folding carton or bag can also affect gluability. However, coatings that are used on recycled content board are generally the same or very similar to coatings used on virgin board. Therefore, best practices used in gluing coated virgin board will address gluability requirements for coated recycled board.

One of those best practices is to simply keep coatings off the glue flaps. It is worth noting that whether applied to virgin or recycled board, coatings that contain high percentages of waxes, especially PTFE (“Teflon”) wax, and/or silicones, which are usually used to provide a low COF, will cause challenges. Other aqueous coatings that are challenging to the glue process are those with one and two part systems that are cross-linked to produce a tough hard cured coated surface, and offer few bond sites for gluing. Co-polymer white cold glue formulated to adhere to foil or polyvinyl chloride will work on all but a few very high wax or silicone-containing coatings. However, when facing a gluability question, the best course of action is to request answers and recommendations from your adhesive/glue, substrate, ink, and aqueous coating suppliers.

Moisture content is another concern for effective adhesion. Since recycled paperboard is generally produced with five to seven percent moisture content, it may be more sensitive to moist environments. Therefore, recycled paperboard cartons should be stored in a humidity-controlled environment, ideally with about a 50 percent relative humidity level. Additionally, for optimal use and efficiency, any folding carton, but particularly cartons with recycled content, should be converted within 90 days or less.

POST CONSUMER RECYCLED (PCR) PAPER SOURCING AND QUALITY CONTROL

Managing the sourcing of PCR materials is very important. Successful paper and paperboard recycling depends largely on the quality of recovered paper and when recovery rates increase, there is a tendency for the quality of the collected material to deteriorate. Waste management companies and municipalities have increasingly introduced single stream recycling collection programs. Single stream programs collect all materials in one container, with bottles, cans, and other materials often mixed with the paper. Benefits include increased volumes of recyclable materials, improved consumer convenience, and reduced municipal program costs. However, challenges include problems with the quality of recovered materials. The majority of material recovery facilities (MRFs) do not yet have adequate technology or capacity to effectively sort materials recovered in single stream collection systems, and as a consequence paper mills face increasing costs when processing and repulping recovered fiber contaminated with glass, plastics, metals, and inappropriate mixes of fiber. For this reason, a good working relationship between mills, merchants, and other involved parties is essential.


While aesthetics have little or no affect on a package's technical performance requirements or processability, color and appearance may be a major consideration for companies when using recycled paper and paperboard in certain packaging applications. For example, some consumers may hesitate to buy pharmaceuticals in dull, unbleached boxes. Brand marketing managers may insist on SBS high-gloss, hang tags for luxury apparel items, believing a dull, brown, uncoated hang tag may belie the brand value of the garment. On the other hand, utilitarian products such as trash bags can be easily packaged in recycled paperboard since there is little expectation for high-end graphics or printability on these boxes.

As these guidelines point out, additives and coatings can solve a host of challenges and make recycled content paper and paperboard perform, function, and look more like virgin paperboard for many applications. While it is simple to state that additives or coatings may provide the right solution, working with additives and coatings may not be entirely straightforward. Formulation matters as does when and how the additives are introduced or processable, color and appearance may not be entirely straightforward. Formulation matters as does when and how the additives are introduced or coatings applied, and as is true of all chemical formulations, some chemical categories should not be used in the presence of others. Additionally, whenever additives or coatings are introduced or their use increased, there is an increased risk of effluents, some of which may be toxic. Therefore, if aesthetics is the only reason for introducing or increasing the use of chemical additives and coatings, it will be important to look at many factors and perform a true benefits analysis to determine if certain aesthetic attributes are really essential.

WHITENESS AND BRIGHTNESS
An important factor in achieving the desired level of whiteness and brightness of recycled paper and paperboard used in packaging applications is the selection and blending of the recycled furnish. Keeping newsprint out of the furnish helps with coloration. Using multi-stage cleansing processes that utilize elemental chlorine-free and chlorine-free bleaching agents, such as hydrogen peroxide and other biodegradable cleaners, organic chelants, and/or optical brightening agents, also can help achieve desired results. Another solution is the use of white pigmented coatings that have been specifically formulated for whiteness and brightness, for example, coatings with titanium dioxide. These are often based on china clay or calcium carbonate and can be applied in one, two, or three layers.

PRINTABILITY
Too high a moisture content may adversely affect the printability of recycled board. Proper climate controls and inventory management are part of the solution to this issue. Acclimatizing the paperboard to the print room is also important. Mills will generally print the required time for acclimatization or “settling” on the pallet label. For example, if the volume of the pallet is 1m³ and the temperature difference between the pallet and the pressroom is 20 degrees Centigrade, the settling time should be 46 hours. Removing the paperboard wrapping just before printing can also help control moisture levels. Coatings offer another solution and there are a number of formulations available that will improve ink absorption and holdout. The best way to achieve the required or desired print quality is to ensure there are clear lines of communication between the end user (brand owner or retailer), the converter, the paper mill, and the printer, particularly if these functions are not integrated or controlled by a single supplier.

Another factor affecting printability is dust. Recycled paperboard is dustier than SBS or CUK, in part because the die-cutting process exposes the inner ply or plies of the recycled paperboard, which can dislodge small amounts of fiber. Part of the conditioning process is to remove the dust using a vacuum or a static charge system. Many converters of recycled paperboard use a piece of equipment that takes stacks of paperboard sheets and blows pressurized air along the edges (something akin to running one’s thumb along the edge of a ream of photocopy paper before feeding it into the copier). The effect of this step is to make the paperboard easier to feed through the printing process. Maintaining sharp cutting blades is another means of reducing this problem.

If the converter does not have a dust removal system, the dust collects on the press blankets and causes white spots with dark centers to form during printing. The result is that the converter must use costly downtime to clean the printing press blankets. Dust is incompatible with gravure printing because it fills the wells on the gravure cylinders. Nonetheless, experience at some gravure plants suggests that press operators prefer using recycled paperboard because of superior compressibility, which produces sharper printed images.

To reduce the impact of dust and debris associated with recycled paperboard on offset printing operations, web cleaners can be attached to presses, operating on the infeed side of the press. Automatic blanket washers, plate washers, and the filtration of ink and fountain solution have been incorporated increasingly into the newest offset printing presses, and some retrofits are available for existing presses.

SCUFF RESISTANCE
Similar to whiteness, brightness, and printability, coatings are a primary solution. Generally the same coatings used to achieve scuff resistance in virgin paper or paperboard will work on recycled content paper or paperboard, but the formula may need to be strengthened or the application volume increased.

An increasingly effective method for controlling scuffing is the application of an overprint varnish or post printing aqueous coating. Either of these applications can also reduce the slipperiness of the paperboard and improve the COF. Less friction will result in less scuffing or scratching and decrease the potential for mar graphics.
Market Availability and Cost

Market availability and cost are not typically considered significant barriers to the use of recycled content in paper and paperboard packaging as recovered paper, paperboard, and corrugated board is widely available in most markets. According to the latest available US EPA recycling data, 71.8 percent of paper and paperboard packaging was recycled in 2009—more than any other packaging material, and the majority accounted for by corrugated. Some analysts suggest, however, that this high recovery rate points to less opportunity for growth in recovery, which could make it difficult to increase the average recycled content use in many applications. Whether this proves true or not will depend on recovered and export materials market trends. New growth or a strengthening of offshore-recovered fiber markets could create a challenging supply and demand dynamic. As an indication of current trends, the AF&PA reports that the US exported 3 percent more recovered paper in April than in March 2011 and by August 2011, year-to-date exports of recovered paper were up 13 percent.

Likewise, cost of material is not generally considered a barrier to the use of recycled content in paperboard packaging applications. As is true of virgin fiber, cost of recycled paper and paperboard fluctuates, so at any given time recycled paperboard may cost less than virgin or vice versa.

Some high grades or specially treated recycled paperboard may typically cost more than virgin, but competitively priced recycled content paperboard can generally be found. Cost associated with equipment and process upgrades can be significant and may be more of a factor in the pricing of recycled content paperboard packaging. Mills converting to new technology may need to pass improvement costs on to their customers.

Some tips for dealing with market volatility are:
- Get informed and understand the market indicators that affect pricing such as demand, inventory levels, volume of sales, virgin pricing, etc.
- Collaborate with suppliers to identify mutually agreeable minimum and maximum values and volumes.
- Do not get locked into a fixed multi-year purchasing agreement: negotiate 30-, 60- or 90 day plans or agree to a volume-based contract that allows for monthly price negotiation.

# Guidelines for Recycled Content in Paper and Paperboard Packaging

## Apparel

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<thead>
<tr>
<th>APPLICATIONS</th>
<th>OPTIONAL WORK AROUNDS</th>
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<tr>
<td>Hang Tags</td>
<td></td>
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<tr>
<td>Current average recycled content use</td>
<td>10 %</td>
</tr>
<tr>
<td>Opportunity for increased recycled content use</td>
<td>High</td>
</tr>
</tbody>
</table>

### PERFORMANCE REQUIREMENTS

- **Stiffness**: Use slightly higher basis weight paper. Increase use of starch during pulping. Use cylinder forming machines, which yield stiffer board than fourdrinier machines.

### FDA REQUIREMENTS

- **Requirements**: None

### TECHNICAL CONSIDERATIONS

- **Quality of post consumer recycled content varies**: Partner with reliable suppliers. Carefully select and blend various grades of furnish.
- **Stickies or other contaminants**: Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed.
- **Brand restricted substances list**: No work around. Restricted substances should not be used.

### AESTHETIC CONSIDERATIONS

- **Creasing or cracking**: Use slightly higher basis weight paper. Increase use of starch during pulping. Use cylinder forming machines, which yield stiffer board than fourdrinier machines.
- **Whiteness and brightness**: Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating.
- **Yellowing or flecks**: Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating.
- **Ink holdout**: Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish.

### AVAILABILITY/MARKET LIMITATIONS

- **Supply may be limited on a regional basis**: Develop long-term negotiable contracts with preferred suppliers to ensure greater access to limited supply.
- **Price fluctuations**: Develop long-term negotiable contracts with preferred suppliers to help control costs.
# Bakery

<table>
<thead>
<tr>
<th>APPLICATIONS</th>
<th>OPTIONAL WORK AROUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artisanal Bread Bag</td>
<td></td>
</tr>
</tbody>
</table>

## Current average recycled content use
0%

## Opportunity for increased recycled content use
Low

### PERFORMANCE REQUIREMENTS

- **Tensile strength**: Loss of natural bonding capacity of the fibers affects tensile strength. Use alkaline-based solutions to improve the bonding potential of recycled pulps. Use more recycled kraft paper in the furnish mix.
- **Moisture barrier**: Use barrier coatings as per virgin content bags. A heavier or thicker coating may be required. Perform moisture vapor transmission rate (MVTR) test.

### FDA REQUIREMENTS

- **FDA 21CFR176.260**: Test samples of virgin and recycled fiber that have been processed in a manner typical for finished food packaging by forming hand sheets of 100 percent recycled fiber and 100 percent virgin fiber using rolling, heating, and drying conditions typical of the finished paper products that will contact food, and then compare samples to prove that there is no discernible difference in potential contaminants between the recycled paper and the virgin paper.

### TECHNICAL CONSIDERATIONS

- **Quality of post consumer recycled content varies**: Partner with reliable suppliers. Carefully select and blend various grades of furnish.
- **Stickies or other contaminants**: Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed.
- **Glueability**: Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off glue flaps.

### AESTHETIC CONSIDERATIONS

- **Color consistency**: Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating.
- **Printability**: Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish.

### AVAILABILITY/MARKET LIMITATIONS

- Furnish recovered from municipal solid waste stream may not be suitable for use in direct food contact packaging.
### Guidelines for Recycled Content in Paper and Paperboard Packaging

#### Applications

<table>
<thead>
<tr>
<th></th>
<th>Cereal Box</th>
<th>Pasta Box</th>
<th>Coffee Canister</th>
<th>Trash Bag Box</th>
<th>Flour Bag</th>
<th>Microwave Popcorn Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Average recycled content use</td>
<td>90-100%</td>
<td>90-100%</td>
<td>40-50%</td>
<td>90-100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Opportunity for increased recycled content use</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
</tbody>
</table>

#### Performance Requirements

- **Drop impact strength**: Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Carefully monitor blending on the "wet end" of production machines. Starch and bulkers added to the pulp may help.

- **Compression strength**: Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Carefully monitor blending on the "wet end" of production machines. Starch and bulkers added to the pulp may help.

- **Score bend strength**: Exploit the greater machine-direction to cross-direction stiffness ratio of recycled paperboard to achieve desired ratio of the stiffness of the board and the stiffness of the crease after it has been bent 90 degrees. Converters with equipment that is designed to be tolerant to variations in carton score are better able to work with recycled fiber content board.

- **Tensile strength**: Loss of natural bonding capacity of the fibers affects tensile strength. Use alkaline-based solutions to improve the bonding potential of recycled pulps. Use more recycled kraft paper in the furnish mix.

- **Stiffness**: Use slightly higher basis weight paper. Increase use of starch during pulping. Use cylinder forming machines, which yield stiffer board than fourdrinier machines.

- **Coefficient of friction**: Apply anti-skid materials such as silica sprays or other control coatings. Check with suppliers for best formulation.

- **Bacterial control**: Apply bacterial control agents as per virgin content during the paper machining process and/or add bacterial control agents to required coatings.

- **Moisture barrier**: Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Biopolymer coatings are increasingly available and should be considered. Perform moisture vapor transmission rate (MVTR) test.

- **Oder barrier**: Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Ethylene vinyl alcohol and polyamide provide good odor as well as light, oxygen and humidity barrier protection. Perform odor transmission rate (OTR) test.

- **Oil/grease barrier**: Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Polyethylene terephthalates and polybutylene terephthalates work well for high heat resistance and grease barrier protection. Perform oil/grease resistance (OGR) test.

- **Brand restricted substances list**: No work around. Restricted substances should not be used.

#### FDA Requirements

- **FDA 21CFR176.260**: In composite can construction, recycled content may be able to be used in middle layers to avoid direct food contact. If recycled content will have direct food contact, test samples of virgin and recycled fiber that have been processed in a manner typical for finished food packaging by forming hand sheets of 100 percent recycled fiber and 100 percent virgin fiber using rolling, heating, and drying conditions typical of the finished paper products that will contact food, and then compare samples to prove that there is no discernible difference in potential contaminants between the recycled paper and the virgin paper.

#### Technical Considerations

- **Quality of post consumer recycled content varies**: Partner with reliable suppliers. Carefully select and blend various grades of furnish.

- **Stickers or other contaminants**: Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed.

- **Folding and box setup**: Use newer fourdrinier equipment, which allows for better machine directional to cross directional ratio, making the board squarer and easier to run on setup equipment.

- **Clean die-cutability**: Use best moisture control processes. Maintain sharpness of cutting blades to avoid dusty edges. Cut polymer coated or laminated board from the plastic coated side.

- **Gluability**: Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings, off glue flaps.
### Aesthetic Considerations

<table>
<thead>
<tr>
<th>APPLICATIONS</th>
<th>OPTIONAL WORK AROUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scuff resistance</td>
<td>Use coatings as per virgin content. A heavier or thicker coating may be required. Try applying an overprint varnish or post printing aqueous coating.</td>
</tr>
<tr>
<td>Cracking along seams</td>
<td>Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help.</td>
</tr>
<tr>
<td>Whiteness and brightness</td>
<td>Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating.</td>
</tr>
<tr>
<td>Printability</td>
<td>Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish.</td>
</tr>
<tr>
<td>Ink holdout</td>
<td>Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish.</td>
</tr>
<tr>
<td>Color consistency</td>
<td>Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating.</td>
</tr>
<tr>
<td>Specks</td>
<td>Carefully select and blend various grades of furnish.</td>
</tr>
</tbody>
</table>

### Availability/Market Limitations

| Widely available | |
| Furnish recovered from municipal solid waste stream may not be suitable for use in direct food contact packaging | Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating. |
### Guidelines for Recycled Content in Paper and Paperboard Packaging

#### Applications

<table>
<thead>
<tr>
<th>Software Box</th>
</tr>
</thead>
</table>

#### Current average recycled content use

- Current average recycled content use: <5%
- Opportunity for increased recycled content use: Low

### Performance Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Workaround</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiffness</td>
<td>Use slightly higher basis weight paper. Increase use of starch during pulping. Use cylinder forming machines, which yield stiffer board than fourdrinier machines.</td>
</tr>
<tr>
<td>Co-efficient of friction</td>
<td>Apply anti-skid materials such as silica sprays or other control coatings. Check with suppliers for best formulation.</td>
</tr>
<tr>
<td>Score bend strength</td>
<td>Exploit the greater machine-direction to cross-direction stiffness ratio of recycled paperboard to achieve desired ratio of the stiffness of the board and the stiffness of the crease after it has been bent 90 degrees. Converters with equipment that is designed to be tolerant to variations in carton score are better able to work with recycled fiber content board.</td>
</tr>
<tr>
<td>Moisture barrier</td>
<td>Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Biopolymer coatings are increasingly available and should be considered. Perform moisture vapor transmission rate (MVTR) test.</td>
</tr>
</tbody>
</table>

### FDA Requirements

None

### Technical Considerations

| Quality of post consumer recycled content varies | Partner with reliable suppliers. Carefully select and blend various grades of furnish. |
| Stickies or other contaminants                 | Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed. |
| Clean die-cutability                           | Use best moisture control processes. Maintain sharpness of cutting blades to avoid dusty edges. Cut polymer coated or laminated board from the plastic coated side. |
| Folding and box setup                          | Use newer fourdrinier equipment, which allows for better machine directional to cross directional ratio, making the board squarer and easier to run on setup equipment. |
| Gluability                                    | Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off glue flaps. Try a co-polymer white cold glue that is formulated to adhere to foil or PVC. |

### Aesthetic Considerations

| Rub/scuff resistance                       | Use coatings as per virgin content. A heavier or thicker coating may be required. Try applying an overprint varnish or post printing aqueous coating. |
| Cracking along seams                       | Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help with strength. |
| Whiteness and brightness                   | Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating. |
| Printability                                | Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish. |
| Ink holdout                                 | Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish. |

### Availability/Market Limitations

| Very limited suitable quality               | Develop long-term negotiable contracts with preferred suppliers to ensure greater access to limited supply. |

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**Electronics**

### Applications

<table>
<thead>
<tr>
<th>Software Box</th>
</tr>
</thead>
</table>

#### Current average recycled content use

- Current average recycled content use: <5%
- Opportunity for increased recycled content use: Low

### Performance Requirements

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</table>

### FDA Requirements

None

### Technical Considerations

| Quality of post consumer recycled content varies | Partner with reliable suppliers. Carefully select and blend various grades of furnish. |
| Stickies or other contaminants                 | Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed. |
| Clean die-cutability                           | Use best moisture control processes. Maintain sharpness of cutting blades to avoid dusty edges. Cut polymer coated or laminated board from the plastic coated side. |
| Folding and box setup                          | Use newer fourdrinier equipment, which allows for better machine directional to cross directional ratio, making the board squarer and easier to run on setup equipment. |
| Gluability                                    | Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off glue flaps. Try a co-polymer white cold glue that is formulated to adhere to foil or PVC. |

### Aesthetic Considerations

| Rub/scuff resistance                       | Use coatings as per virgin content. A heavier or thicker coating may be required. Try applying an overprint varnish or post printing aqueous coating. |
| Cracking along seams                       | Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help with strength. |
| Whiteness and brightness                   | Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating. |
| Printability                                | Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish. |
| Ink holdout                                 | Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish. |

### Availability/Market Limitations

| Very limited suitable quality               | Develop long-term negotiable contracts with preferred suppliers to ensure greater access to limited supply. |

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**Guidelines for Recycled Content in Paper and Paperboard Packaging**
Food Service

APPLICATIONS

<table>
<thead>
<tr>
<th>Current average recycled content use</th>
<th>Pizza Box</th>
<th>Butcher Wrap</th>
<th>Take-out Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>43%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

Opportunity for increased recycled content use

High    Low     Medium

PERFORMANCE REQUIREMENTS

Drop impact strength

Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Carefully monitor blending on the “wet end” of production machines. Starch and bulkers added to the pulp may help.

Compression strength

Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Carefully monitor blending on the “wet end” of production machines. Starch and bulkers added to the pulp may help.

Edge crush strength

Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Use slightly higher basis weight paper. Exploit the greater machine-direction to cross-direction stiffness ratio of recycled paperboard to achieve desired ratio of the stiffness of the board and the stiffness of the crease after it has been bent 90 degrees.

Wet strength

Use a wet strength agent (WSA) or coating. WSA’s may result in greater AOX emissions.37, so choose formulation carefully and employ increased effluent control.

Stiffness

Use slightly higher basis weight paper. Increase use of starch during pulping. Use cylinder forming machines, which yield stiffer board than fourdrinier machines.

Co-efficient of friction

Apply anti-skid materials such as silica sprays or other control coatings. Check with suppliers for best formulation.

Bacterial control

Apply bacterial control agents as per virgin content during the paper machining process and/or add bacterial control agents to required coatings.

Moisture barrier

Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Biopolymer coatings are increasingly available and should be considered. Perform moisture vapor transmission rate (MVTR) test.

Odor barrier

Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Ethylene vinyl alcohol and polyamide provide good odor as well as light, oxygen and humidity barrier protection. Perform odor transmission rate (OTR) test.

Oil/grease barrier

Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Polyethylene terephthalates and polybutylene terephthalates work well for high heat resistance and grease barrier protection. Perform oil/grease resistance (OGR) test.

FDA REGULATIONS

FDA 21CFR176.260

If recycled content will have direct food contact, test samples of virgin and recycled fiber that have been processed in a manner typical for finished food packaging by forming hand sheets of 100 percent recycled fiber and 100 percent virgin fiber using rolling, heating, and drying conditions typical of the finished paper products that will contact food, and then compare samples to prove that there is no discernible difference in potential contaminants between the recycled paper and the virgin paper.

TECHNICAL CONSIDERATIONS

Quality of post consumer recycled content varies

Partner with reliable suppliers. Carefully select and blend various grades of furnish.

Stickies or other contaminants

Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed.

Folding and box setup

Use newer fourdrinier equipment, which allows for better machine directional to cross directional ratio, making the board squarer and easier to run on setup equipment.

Clean die-cutability

Use best moisture control processes. Maintain sharpness of cutting blades to avoid dusty edges. Cut polymer coated or laminated board from the plastic coated side.

Glueability

Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off glue flaps. Try a co-polymer white cold glue that is formulated to adhere to foil or PVC. Perform pin-adhesion test on mini-flute corrugated boxes.

AESTHETIC CONSIDERATIONS

Scruff resistance

Use coatings as per virgin content. A heavier or thicker coating may be required. Try applying an overprint varnish or post printing aqueous coating.

Cracking along seams

Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help.

Printability

Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish.

Color consistency

Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating.

Specks

Carefully select and blend various grades of furnish.

AVAILABILITY/MARKET LIMITATIONS

Widely available

Furnish recovered from municipal solid waste stream may not be suitable for use in direct food contact packaging.
**Guidelines for Recycled Content in Paper and Paperboard Packaging**

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<th>APPLICATIONS</th>
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<td>Current average recycled content use: 5%</td>
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<th>PERFORMANCE REQUIREMENTS</th>
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<td>Wet strength</td>
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<td>Freeze thaw strength</td>
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<td>Stiffness</td>
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<td>Co-efficient of friction</td>
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<td>Bacterial control</td>
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<td>Moisture barrier</td>
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<table>
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<th>FDA REGULATIONS</th>
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<td>If recycled content will have direct food contact, test samples of virgin and recycled fiber that have been processed in a manner typical for finished food packaging by forming hand sheets of 100 percent recycled fiber and 100 percent virgin fiber using rolling, heating, and drying conditions typical of the finished paper products that will contact food, and then compare samples to prove that there is no discernible difference in potential contaminants between the recycled paper and the virgin paper.</td>
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<th>TECHNICAL CONSIDERATIONS</th>
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<td>Quality of post consumer recycled content varies</td>
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<td>Stickies or other contaminants</td>
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<th>AESTHETIC CONSIDERATIONS</th>
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<td>Scuff resistance</td>
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<th>AVAILABILITY/MARKET LIMITATIONS</th>
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<tr>
<td>Very limited suitable quality</td>
</tr>
<tr>
<td>Furnish recovered from municipal solid waste stream may not be suitable for use in direct food contact packaging</td>
</tr>
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### Applications

<table>
<thead>
<tr>
<th>Applications</th>
<th>Optional Work Arousnds</th>
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</thead>
<tbody>
<tr>
<td>Medication Pill Box</td>
<td>Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Carefully monitor blending on the “wet end” of production machines. Starch and bulkers added to the pulp may help.</td>
</tr>
</tbody>
</table>

### Performance Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression strength</td>
<td>Exploit the greater machine-direction to cross-direction stiffness ratio of recycled paperboard to achieve desired ratio of the stiffness of the board and the stiffness of the crease after it has been bent 90 degrees. Converters with equipment that is designed to be tolerant to variations in carton score are better able to work with recycled fiber content board.</td>
</tr>
<tr>
<td>Score bend strength</td>
<td>Use slightly higher basis weight paper. Increase use of starch during pulping. Use cylinder forming machines, which yield stiffer board than fourdrinier machines.</td>
</tr>
<tr>
<td>Stiffness</td>
<td>Apply anti-skid materials such as silica sprays or other control coatings. Check with suppliers for best formulation.</td>
</tr>
<tr>
<td>Co-efficient of friction</td>
<td>Apply bacterial control agents as per virgin content during the paper machining process and/or add bacterial control agents to required coatings.</td>
</tr>
<tr>
<td>Moisture barrier</td>
<td>Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Biopolymer coatings are increasingly available and should be considered. Perform moisture vapor transmission rate (MVTR) test.</td>
</tr>
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</table>

### FDA Regulations

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
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<tbody>
<tr>
<td>None</td>
<td>None</td>
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### Technical Considerations

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Description</th>
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<tbody>
<tr>
<td>Quality of post consumer recycled content varies</td>
<td>Partner with reliable suppliers. Carefully select and blend various grades of furnish.</td>
</tr>
<tr>
<td>Stickies or other contaminants</td>
<td>Use newer fourdrinier equipment, which allows for better machine directional to cross directional ratio, making the board squarer and easier to run on setup equipment.</td>
</tr>
<tr>
<td>Folding and box setup</td>
<td>Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed.</td>
</tr>
<tr>
<td>Clean die-cutability</td>
<td>Use best moisture control processes. Maintain sharpness of cutting blades to avoid dusty edges. Cut polymer coated or laminated board from the plastic coated side.</td>
</tr>
<tr>
<td>Gluability</td>
<td>Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off glue flaps. Try a co-polymer white cold glue that is formulated to adhere to foil or PVC.</td>
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</table>

### Aesthetic Considerations

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cracking along seams</td>
<td>Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help with strength.</td>
</tr>
<tr>
<td>Printability</td>
<td>Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish.</td>
</tr>
<tr>
<td>Whiteness and brightness</td>
<td>Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating.</td>
</tr>
</tbody>
</table>

### Availability/Market Limitations

<table>
<thead>
<tr>
<th>Limitation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Very limited suitable quality</td>
<td>Develop long-term negotiable contracts with preferred suppliers to ensure greater access to limited supply.</td>
</tr>
</tbody>
</table>
# Personal Care Products

<table>
<thead>
<tr>
<th>APPLICATIONS</th>
<th>OPTIONAL WORK AROUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toothbrush Blister Pack Board</td>
<td></td>
</tr>
</tbody>
</table>

| Current average recycled content use | 30% |
| Opportunity for increased recycled content use | High |

## Performance Requirements

| Stiffness | Use slightly higher basis weight paper. Increase use of starch during pulping. Use cylinder forming machines, which yield stiffer board than fourdrinier machines. |
| Bacterial control | Apply bacterial control agents as per virgin content during the paper machining process and/or add bacterial control agents to required coatings |

## FDA Regulations

None

## Technical Considerations

| Quality of post consumer recycled content varies | Partner with reliable suppliers. Carefully select and blend various grades of furnish. |
| Stickies or other contaminants | Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed. |
| Heat sealability | Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off seal areas. Try a co-polymer white cold glue that is formulated to adhere to foil or PVC. |

## Aesthetic Considerations

| Printability | Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish. |
| Whiteness and brightness | Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating. |

## Availability/Market Limitations

| Availability varies | Develop long-term negotiable contracts with preferred suppliers to ensure greater access to limited supply. |
## Guidelines for Recycled Content in Paper and Paperboard Packaging

### Pet Products

<table>
<thead>
<tr>
<th>APPLICATIONS</th>
<th>OPTIONAL WORK AROUNDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pet Food Sacks</td>
<td>Cat Litter Box</td>
</tr>
</tbody>
</table>

| Current average recycled content use | <10% | <40% |
| Opportunity for increased recycled content use | Medium | High |

### PERFORMANCE REQUIREMENTS

- **Drop impact strength**
  - Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Carefully monitor blending on the “wet end” of production machines. Starch and bulkers added to the pulp may help.

- **Compression strength**
  - Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Carefully monitor blending on the “wet end” of production machines. Starch and bulkers added to the pulp may help.

- **Edge crush strength**
  - Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Use slightly higher basis weight paper. Exploit the machine-direction to cross-direction stiffness ratio of recycled paperboard to achieve desired ratio of the stiffness of the board and the stiffness of the crease after it has been bent 90 degrees.

- **Tensile strength**
  - Loss of natural bonding capacity of the fibers affects tensile strength. Use alkaline-based solutions to improve the bonding potential of recycled pulps. Use more recycled kraft paper in the furnish mix.

- **Co-efficient of friction**
  - Apply anti-skid materials such as silica sprays or other control coatings. Check with suppliers for best formulation.

- **Bacterial control**
  - Apply bacterial control agents as per virgin content during the paper machining process and/or add bacterial control agents to required coatings.

- **Moisture barrier**
  - Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Biopolymer coatings are increasingly available and should be considered. Perform moisture vapor transmission rate (MVTR) test.

- **Oil/Grease barrier**
  - Use barrier coatings as per virgin content. A heavier or thicker coating may be required. Polyethylene terephthalates and polybutylene terephthalates work well for high heat resistance and grease barrier protection. Perform oil/grease resistance (OGR) test.

### FDA REGULATIONS

- **FDA 21CFR176.260**
  - If recycled content will have direct food contact, test samples of virgin and recycled fiber that have been processed in a manner typical for finished food packaging by forming hand sheets of 100 percent recycled fiber and 100 percent virgin fiber using rolling, heating, and drying conditions typical of the finished paper products that will contact food, and then compare samples to prove that there is no discernible difference in potential contaminants between the recycled paper and the virgin paper.

### TECHNICAL CONSIDERATIONS

- **Quality of post consumer recycled content varies**
  - Partner with reliable suppliers. Carefully select and blend various grades of furnish.

- **Stickies or other contaminants**
  - Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed.

- **Folding and box setup**
  - Use newer fourdrinier equipment, which allows for better machine directional to cross directional ratio, making the board squarer and easier to run on setup equipment.

- **Glueability**
  - Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off glue flaps. Try a co-polymer white cold glue that is formulated to adhere to foil or PVC. Perform pin-adhesion test on mini-flute corrugated boxes.

### AESTHETIC CONSIDERATIONS

- **Scuff resistance**
  - Use coatings as per virgin content. A heavier or thicker coating may be required. Try applying an overprint varnish or post printing aqueous coating.

- **Cracking along seams**
  - Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help with strength.

- **Printability**
  - Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish.

### AVAILABILITY/MARKET LIMITATIONS

- **Furnish recovered from municipal solid waste stream may not be suitable for direct pet food contact packaging.**

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GUIDELINES for RECYCLED CONTENT in PAPER and PAPERBOARD PACKAGING
## Sporting Goods

<table>
<thead>
<tr>
<th>Applications</th>
<th>Optional Work Arou nds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golf Ball Box</td>
<td>Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help with strength.</td>
</tr>
</tbody>
</table>

### Performance Requirements

| Burst strength | Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help with strength. |
| Score bend strength | Exploit the greater machine-direction to cross-direction stiffness ratio of recycled paperboard to achieve desired ratio of the stiffness of the board and the stiffness of the crease after it has been bent 90 degrees. Converters with equipment that is designed to be tolerant to variations in carton score are better able to work with recycled fiber content board. |
| Rub/scuff resistance | Use an overprint varnish or post printing aqueous coating. |

### FDA Requirements

None

### Technical Considerations

| Quality of post consumer recycled content varies | Partner with reliable suppliers. Carefully select and blend various grades of furnish. |
| Sticks or other contaminants | Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed. |
| Clean die-cutability | Use best moisture control processes. Maintain sharpness of cutting blades to avoid dusty edges. Cut polymer coated or laminated board from the plastic coated side. |
| Folding and box setup | Use newer fourdrinier equipment, which allows for better machine directional to cross directional ratio, making the board squarer and easier to run on setup equipment. |
| Glueability | Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off glue flaps. Try a co-polymer white cold glue that is formulated to adhere to foil or PVC. |
| Brand restricted substances list | No work around. Restricted substances should not be used. |

### Aesthetic Considerations

| Cracking along seams | Use more recycled kraft paper in the furnish mix. Use an extended nip press (ENP) machine if available, which squeezes out more water and minimizes loss of fiber bond strength. Adding starch or bulkers to the pulp recipe can also help with strength. |
| Ink holdout | Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish. |
| Consumer acceptance | Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish. |

### Availability/Market Limitations

| Supply may be limited on a regional basis | Develop long-term negotiable contracts with preferred suppliers to help control costs. |
| Price fluctuations | Develop long-term negotiable contracts with preferred suppliers to help control costs. |
**APPLICATIONS**

<table>
<thead>
<tr>
<th></th>
<th>Grocery Bag</th>
<th>Shopping Bag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current average recycled content use</td>
<td>90-100%</td>
<td>&lt;20%</td>
</tr>
<tr>
<td>Opportunity for increased recycled content use</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

**OPTIONAL WORK AROUNDS**

- **Drop impact strength**: Carefully select and blend various grades of furnish, using more recycled kraft paper in the mix. Carefully monitor blending on the “wet end” of production machines. Starch and bulkers added to the pulp may help.

- **Tensile strength**: Loss of natural bonding capacity of the fibers affects tensile strength. Use alkaline-based solutions to improve the bonding potential of recycled pulps. Use more recycled kraft paper in the furnish mix.

**PERFORMANCE REQUIREMENTS**

**FDA REGULATIONS**

None

**TECHNICAL CONSIDERATIONS**

- **Quality of post consumer recycled content varies**: Partner with reliable suppliers. Carefully select and blend various grades of furnish.

- **Stickies or other contaminants**: Use advanced cleaning technologies. Try a drum pulper, which allows contaminants to remain larger, making it easier for them to be detected and removed.

- **Gluability**: Use best moisture control processes. Keep coatings, especially aqueous, wax, or silicone-based coatings off glue flaps. Try a co-polymer white cold glue that is formulated to adhere to foil or PVC. Perform pin-adhesion test on mini-flute corrugated boxes.

**AESTHETIC CONSIDERATIONS**

- **Printability**: Use best moisture control processes. Apply coatings that facilitate absorption. Use an overprint varnish.

- **Color consistency**: Carefully select and blend various grades of furnish. Use non-chlorine bleach in furnish cleaning processes. Use white-pigmented coating.

- **Specs**: Carefully select and blend various grades of furnish.

**AVAILABILITY/MARKET LIMITATIONS**

Widely available
Paper and Paperboard Production

 RAW MATERIALS

The vast majority of paper packaging produced and used in the US today is made from wood fiber. The ingredients for papermaking include hardwood and/or softwood woodchips, sawmill residues, water, and chemicals. Pre or post consumer fiber may also be included, as well as additives such as starch, sizing, pigments, and coatings. If the mill is producing 100 percent recycled paper, chemicals are not needed for the repulping, but may still be used in the process for deinking or defoaming.

Wood Type

The relative softness or hardness of the wood used in pulp also affects a paper substrate's printing surface and strength. Softer woods, such as pine, have longer fibers that produce stronger, more durable substrates than those produced from hard wood fibers. However, the shorter fibers from hardwoods, such as oak, produce smoother printing surfaces.

PULPING

There are three types of pulping processes—chemical, mechanical, and semi-chemical. The most common method of creating pulp from wood chips in the US is by chemical processes, either the kraft (also called sulfate) or the sulfite process. Of the two, the kraft process is more widely used. The chemicals, including caustic soda and sodium sulfide, along with defoaming agents, are added to wood chips and water and placed under high heat and pressure. They dissolve the lignin that holds the cellulose fibers in wood together, producing a fibrous pulp. Lignin is a natural adhesive that is non-fibrous in nature, making it unsuitable for inclusion in paper production.

Pulp can also be produced with a mechanical pulping process that uses grinders to extract cellulose from the wood by cutting or abrading it. This process is faster than chemical pulping, but also breaks the fibers, reducing their length and strength. The mechanical (or ground wood) pulp is typically of lesser quality than kraft pulp, and is primarily used in non-packaging applications, such as newsprint and writing paper. It may also be blended with higher-quality chemical pulp to reduce cost.

Finally, semi-chemical pulping combines both methods by combining a partial chemical digestion of hardwood chips with a pass through mechanical disc grinder to further break down the fibers. This type of pulp is frequently used to make paper for the fluted medium component of corrugated containerboard.

Bleaching

Bleaching is used to continue delignification that cannot be achieved in the cooking and oxygen stages of the pulping process, without sacrificing pulp yield or fiber properties. Bleaching is also used to remove color. Virgin pulp is usually a shade of tan or brown, depending on the wood type. Recycled pulp can be a range of colors including brown, gray, or dark cream, depending on the source of the recycled materials. Bleached fiber provides a clean, white appearance throughout the sheet for high quality printing.

The desired brightness may not be able to be achieved in only one bleaching step without sacrificing pulp strength. Therefore, pulp is typically bleached in several steps, and washed between each step. Multi-stage bleaching is generally considered to yield the best results, but it does change the fiber properties in ways that can be both positive and negative. Due to yield loss, the linear density of the fiber is reduced. Therefore, there are more fibers in the unit weight of bleached pulp. This has a favorable effect on tear strength for instance. Thanks to the removal of lignin, the fiber swells more easily and the pliability and flexibility of the fiber are increased. This facilitates the binding of the fiber network. Too great a loss of hemicellulose can, on the other hand, worsen the adhesive capacity of the points of contact so that the end result may also be weakened pulp strength. The bleaching process also adds cost to the production of the substrate.

TYPES OF PAPERBOARD

There are three major grades of paperboard used in packaging:

- Solid bleached sulfate (SBS)
- Coated unbleached kraft (CUK)
- Recycled (uncoated and coated)

Solid bleached sulfate and coated unbleached kraft are premium paperboard grades that are produced from a furnish containing at least 80 percent virgin wood pulp. Most bleached paperboard is coated with a thin layer of kaolin clay to improve its printing surface and may be also coated with polyethylene (PE) as a moisture barrier in food packaging. SBS is most popular in the US.

Recycled paperboard can be coated or uncoated. Uncoated recycled paperboard is a multi-ply material produced from 100 percent recovered fiber collected from manufacturing and converting plants and post consumer sources. It represents the single largest market for recovered fiber in the US. Some uncoated paperboard is produced with a top ply of white recovered fiber or is dyed for color. Basic grades of uncoated recycled paperboard include bending chip (BC), tan bending chip (TBC), double kraft lined (DKL), and white lined bending chip (WLBC). Coated recycled paperboard (CRB) is also a multi-ply material that is produced from 100 percent recovered fiber. However, it is typically coated with a thin layer of kaolin clay over a top ply of white recovered fiber to improve its printing surface.

Basic grades of coated recycled paperboard include clay coated news back (CCNB) and clay coated kraft back (CCKB).

49 KnowPulp website: http://www.knowpulp.com/english/demo/english/pulping/bleaching/1_general/frame.htm
51 Paperboard Packaging Alliance website: http://www.paperboardpackaging.org/about.html
52 Paperboard Packaging Alliance website: http://www.paperboardpackaging.org/about.html
Appendix A

It is worth noting that the US Environmental Protection Agency (EPA) differs with the International Standards Organization’s (ISO) definition of recycled content. According to ISO, pre and post consumer recycled materials are defined as follows:

- Pre consumer material: Material diverted from the waste stream during a manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.53
- Post consumer material: Material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose. This includes returns of material from the distribution chain.54

According to the US EPA, there are manufacturing wastes and post consumer recovered fiber, which are defined as follows:

- Manufacturing wastes: Dry paper and paperboard waste generated after completion of the papermaking process (that is, those manufacturing operations up to and including the cutting and trimming of the paper machine reel into smaller rolls or rough sheets) including: envelope cuttings, bindery trimmings, and other paper and paperboard waste resulting from printing, cutting, forming, and other converting operations; bag, box, and carton manufacturing wastes; and butt rolls, mill wrappers, and rejected unused stock; and repulped finished paper and paperboard from obsolete inventories of paper and paperboard manufacturers, merchants, wholesalers, dealers, printers, converters, or others.55
- Post consumer recovered fiber: Paper, paperboard, and fibrous wastes from retail stores, office buildings, homes, and so forth, after they have passed through their end usage as a consumer item, including: used corrugated boxes; old newspapers; old magazines; mixed waste paper; tabulating cards; and used cordage; and all paper, paperboard, and fibrous wastes that enter and are collected from municipal solid waste. Post consumer fiber does not include fiber derived from printers’ over runs, converters’ scrap, and over issue publications.56

The key difference is the inclusion of distribution returns and unsold finished product as post consumer material in the ISO definition.

COMMON USES OF THE DIFFERENT TYPES OF PAPERBOARD

Because SBS, CUK, and recycled paperboard differ in performance characteristics and price, each tends to be used to package a different set of goods.

SBS is generally used for items that are perishable or for which retailers believe that a highly printable or smooth, bright white appearance inside and outside helps differentiate the product. Products usually packed in SBS board include baked goods, cigarettes, fatty and aqueous foods, medicine, cosmetics, high-priced sporting goods, and PC software. SBS board coated with polyethylene as a moisture barrier is also used for packaging moist or oily food products including ice cream, quick serve restaurant sandwiches, and French fries.

Beverage carriers for beer and soda bottles use about 70 percent of the CUK produced. CUK is also used to package frozen foods, and to make large packages for detergents and other non food items. CUK paperboard works well for high-quality printing and foil or film laminating.

Recycled paperboard is used to package items such as dry foods, which may or may not be packaged with plastic inner liners (e.g., cereal, pasta, rice, cookies, crackers, and pet food), paper goods, hardware, and powdered laundry detergents. Uncoated recycled paperboard is commonly used in shoeboxes, composite cans and fiber drums.

PAPERBOARD MANUFACTURING

SBS and CUK Paperboard Manufacturing Process57

SBS and CUK paperboard are made on fourdrinier paper machines. A fourdrinier machine consists of a moving mesh screen (the “wire”) held horizontally by sets of rollers and four sections—the forming, press, drying, and calendaring sections. At the wet end of the fourdrinier in the forming section, pulp is held in the headbox and is released in a metered stream onto the wire. Gravity and mechanical suction drain water from the pulp. As the cellulose fibers interlock and form a mat, the web (paper sheet) leaves the end of the forming section and is carried through a series of presses and dryers, which continue to remove water. Near the end of the machine, the paper is coated and wound onto a large reel.

Some machines used to make SBS and CUK use headboxes that form two or three plies, which are joined together on the machine, allowing the production of multi-ply board. One of the advantages of a multi-ply board is that relatively more hardwood kraft pulp can be used on the outer liner of the board, for smoothness, while more softwood kraft pulp can be used to provide stiffness to the inner plies.

Recycled Paperboard Manufacturing Process58

Recycled paperboard is made from some percentage of recovered fiber and produced primarily on multi-ply machines. On a traditional cylinder machine, the forming cylinders are covered in wire mesh and sit in a vat filled with a recycled fiber pulp. As the cylinders turn, the fibers form a web (paper sheet) on the surface. The formed sheet is transferred off the cylinder onto a felt, and gets combined with other sheets that are pressed and dried to make a multi-ply board. Typical cylinder machines have six to nine cylinders.

53 ISO 14021
54 ISO 14021
55 US EPA website: http://www.epa.gov/osw/conserve/materials/paper/resources/glossary.htm#recoveredpaper
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Appendix A

An advantage of the multi-cylinder forming technology is that inexpensive, low-grade recovered fibers can be sandwiched into the middle of the board. It is also a very low-cost manufacturing method for grades of paperboard such as chipboard, core and tube stock, and construction board.

A main limitation of traditional cylinder machine technology is that it is expensive and difficult to run the large drums at high speeds. While running speeds on fourdrinier machines producing SBS and CUK can reach 2,000 to 3,000 feet per minute, cylinder machines typically produce only 600 feet per minute. Another drawback of cylinder technology is that non-uniform deposits of fiber can form on the wire cylinder, which requires high mechanical wet pressing and excessive heat to remove moisture in a dryer section.

More recently, multi-fourdrinier technology has been adapted for use in manufacturing recycled paperboard. These machines use two or three top-former fourdrinier sections arrayed above a longer bottom fourdrinier to produce a multi-ply sheet at relatively high speeds. Fourdrinier machines dewater the web more quickly and evenly than cylinder-based formers alone, and are most often used to produce the top ply or inner ply of the paperboard.