

Guide to Packaging for Small Parcel Shipments

(approved by IoPP Transport Packaging Committee- 3/1/02)

Scope

These guidelines are voluntary and intended to assist in designing packages and other shipping units that will perform satisfactorily as single entities in a domestic small parcel carrier environment. These guidelines are not to be considered approved carrier packaging specifications. Following part or all of these guidelines will not guarantee the automatic approval of a damage claim by any carrier.

Terminology

The following terms are specific to this guide:

Performance-based: Design criteria focused on achieving a satisfactory performance to specified elements, such as degree of hazard.

Shipping Unit: The smallest complete unit that will be subjected to the distribution environment, for example a box, bag, or bundle.

Single Package: A single shipping container, including any interior protective packaging, that provides a means of protecting and handling a product.

Small Parcel Carriers: Distribution carriers that transport packages weighing up to 150 pounds through ground and/or air transport networks.

Small Parcel: A shipping unit weighing no more than 150 pounds.

Transport Package: A shipping unit that provides containment and protection to goods during handling, storage, and transportation. The term includes all industrial packaging and the shipping containers for consumer products.

Significance and Use

The small parcel environment that this guide addresses includes mechanized sortation systems and multiple single package manual handlings.

These guidelines will assist users in design and development of packaging intended for protection of goods while they are in transit from point of origin through small parcel carrier systems until reaching their final destination. The focus of this guide is single shipping units weighing not more than 150 pounds each.

This guide includes domestic small parcel shipments only. It excludes overseas shipments that will be addressed later. Shipments of regulated hazardous materials are also excluded from this guide. If a powder, liquid or gas is to be packaged for shipment, seek guidance from the in-house hazardous materials specialist or the carrier. Additional information is available at the Department of Transportation website, <http://hazmat.dot.gov>, or phone 800-467-4922.

Rather than a set of detailed material specifications and design procedures, this guide is a listing of desired performance criteria for the transport package. Generally, the transport package addressed by the guide will be secondary packaging, although for some goods the transport package will be primary packaging. The following section on “The Shipping Environment” also applies to *unpacked* products (tires, spools of wire, castings, etc.) since small parcel carriers transport many types of unpackaged goods.

So proper packaging can be developed, users of this guide should be aware of the characteristics of package contents, including:

- Ability of the contents to withstand the effects of shock and vibration during handling and transportation;
- Ability to hold a load in compression
- Susceptibility to abrasion, corrosion, temperature, static electricity and magnetic fields.

The Shipping Environment

In addition to normal shipping hazards found in truckload, LTL truck, railcar, and air freight, the small parcel shipping environment typically includes hazards that are unique to them as well as common hazards that may be of greater severity than by other modes. Many of the more severe hazards are due to automated sorting and handling equipment used by larger ground and air express carriers.

Typical Carrier Systems: Small parcel carriers rely on a “hub-and-spoke” network to cover large areas and offer fast, predictable transit times for single package shipments. The hub-and-spoke system uses major sorting facilities, often called “hubs” or “depots”, acting as exchange points for packages moving long distances. Hubs are designed to sort tens of thousands of packages an hour, permitting the quick exchange and redirection of parcels.

Each hub is connected to a number of operating centers, which serve as home base for the package delivery vehicles and where the pickup and delivery service within specific geographic areas are provided. Operating center boundaries are contiguous so that every address is covered. This system allows next-day ground service to destinations where such is possible; just because the package is shipped via “next-day air” does not necessarily mean it will travel in an aircraft.

Within each hub or operating center, the package may travel through the system in one of three ways, depending on the characteristics of the packaging. Packages can be classified as a *small*, *regular* or as an *irregular* shipping unit.

Smalls are classified by some carriers as packages less than 450 cubic inches and less than 10 pounds. Due to the small size of the package, some carriers find it is more efficient to handle them consolidated in bags. Therefore, their *smalls* go through a *smalls-sort* that consolidates them into a bag containing approximately 10 – 20 packages destined for the same geographic location. The bag of *smalls* is then sorted through the hub or operating center and loaded into a truck or aircraft for transport to the destination.

(It should be noted, however, that some carriers do not use bags to consolidate multiple packages.)

Regular shipping units are filled corrugated shipping containers typically larger than 450 cubic inches and between 10 to 70-75 pounds. *Regular* packages will be handled and sorted on the carrier's conveyor network systems. Package designers should check their carrier to determine the carrier's specific size and weight limits.

Irregular shipping units are units that may:

- Not be fully encased in corrugated fiberboard
- Be packaged in plastic, metal or wood on its exterior surface
- Be tubular or round in shape
- Have no shipping container
- Be oversize, or weigh more than 70-75 pounds.

Due to the characteristics of these types of shipping units, they are not handled on high volume conveyor systems. They may be placed on slower moving conveyors, on carts, or on pallets for sorting and movement through the hub and onto outbound trucks or aircraft.

During relatively short distance shipments (300 miles), some carriers may load/reload packages as many as five times and send them through three different sorts that could include manual, mechanical, or automatic handling on high speed belts, slides, chutes and rollers. Longer distances will likely result in more loading, unloading, and sorting. These operations present a number of hazards that could cause damage if the packaging does not provide adequate protection.

Shipping Hazards: There are many possible hazards in this environment, but the five principal ones are: shock; vibration; compression; extreme climate conditions; and altitude.

Shock - will occur during handling when packages are dropped, are struck by (or strike) other packages or objects during the sorting operation, or when they shift or fall during transit. The impacts create shock, which may cause fatigue or damage to the packages and their contents. Recent studies of the handling environment of small parcel carriers have shown that the majority of shocks result from non free-fall impacts and that most impacts are equivalent to drops from a relatively low height. Impacts equivalent to a high drop height do occur, but generally not more than once during any one shipping cycle. About 5% of all shipments receive at least one impact above an equivalent drop height of 30 inches.

Recent studies also indicate that impacts to packages are mostly rotational drops on edges, somewhat less on corners. Few perfect flat or perfect edge/corner drops are encountered. Most impacts occur on the bottom surface, corners or edges of the package. From the package engineering standpoint, packages should be designed to withstand shock from any direction. Due to the automated sorting systems, small parcel carriers cannot honor orientation or shock labels, or "keep upright" arrows. Therefore, transit orientation may be different than the intended orientation. More likely, packages will travel in the most stable orientation, usually the package's lowest center of gravity. This

helps prevent packages from tumbling down chutes and slides, or from falling over during the normal loading or sorting process. It also keeps the sortation-scanning label facing up so overhead scanners may scan it. For example, a package that is 16 inches x 12 inches x 24 inches high is taller than it is long or wide and will likely travel on its side.

If irregulars are sorted mechanically with forklift trucks, package impacts are most often the result of the package falling from the forklift during handling. (It should be noted, however, that some small parcel carriers do not use forklift trucks for handling or sorting). The drop distance will depend on the height of the load and the distance of the forklift blades from the ground, distances typically ranging from 4 to 48 inches. (These types of drops do not occur as frequently as impacts during other types of sorting operations.) Other types of impacts that occur during forklift handling include: impacts with pallets and other shipments; impacts with fork lift blades as packages bounce during handling; and impacts as packages are loaded into or unloaded from trailers, trucks, freight containers, racks or carts during sorting or transportation.

Vibration- occurs when a package is mechanically moved or transported. Automated sorting induces a low level of vibration at constant frequency into packages as they move on conveyor systems. Frequency changes as a conveyor belt passes over drive rollers and carrier rollers. Mechanical sorting with forklifts will induce vibration but usually very low frequency as packages bounce on the pallet or directly on the forklift blades during transit. Manual sorting induces virtually no notable vibration.

In-transit motions subject packages to many levels of vibration over different durations of time. Aircraft induced vibration typically is very high frequency and low amplitude for 30 minutes to 12 hours on domestic shipments, depending on origin, destination, and the carrier's network. Truckload and trailer on flatbed railcar (TOFC) will subject the packages to lower frequencies but at much higher amplitudes than aircraft. The duration can range from 5 minutes to several days, which can result in damage including scuffing, abrasion, loosening of fasteners and closures, and package fatigue.

Compression- may be a static condition, as in a trailer or aircraft when the package is under load from other packages and the vehicle is not moving. Or it may be a dynamic condition, when the trailer or aircraft is in motion. The dynamic compression will impose both vertical and lateral compressive forces. Stacking is unavoidable due to space and time constraints so, as with orientation labels, "Do Not Stack" and "Top Load Only" labels cannot always be honored.

Handlers use an interlocking method rather than column stacking when loading packages into trailers or aircraft containers, usually building a "wall" across the trailer or container. (Interlocking reduces corrugated box stacking strength up to 50%, compared to column stacking. However, interlocking patterns are more stable and better suited for random size boxes). Although heaviest packages may often be placed in the bottom half of the wall with lightest packages toward the top, there is no guarantee of this since packages arrive in a random fashion to the build-up or loading area and must be loaded as received.

Average density of small parcel freight is approximately ten (10) pounds per cubic foot. Sorting operations result in lower levels of compressive forces than in-transit movement. One exception to this is when jam-ups occur in automated sorting systems. This can create a large dynamic compressive force as heavier packages slide into, and build up behind, other packages. Other instances of high compressive force can occur when pallets and forklifts are used to sort or load and unload packages. This is especially true when packages overhang the pallet or are pushed into another pallet or against a vehicle or container wall. Compression damage can also occur when pallet loads are stacked on top of each other. A loaded pallet with bottom deckboards will cause less damage, if any, to a load below it compared to a pallet with no bottom deckboards. A pallet with full bottom deck provides the best load support.

Climatic conditions- climatic conditions that may cause damage are high or low temperatures and high humidity. In small parcel carrier systems the feeder-aircraft and package delivery vehicles are not conditioned, therefore packages will be exposed to the same temperature and humidity extremes in the vehicle as outside. As such, it is not unrealistic for packages to be exposed to temperatures as high as 140°F or as low as -50°F inside the vehicle, and relative humidity as high as 100%. The only exception is when a package is inside large cargo aircraft that are conditioned to approximately 68 – 74°F (refer to carriers for their specific aircraft information).

Altitude- Packaged products may be exposed to altitudes as high as 20,000 feet in air shipments. This will only occur if the package is traveling to a remote rural area on a non-pressurized feeder-aircraft. Large cargo jets are pressurized to approximately 8,000 feet. Over-the-road altitudes should not exceed 12,000 feet at the extreme.

Other conditions- Several other conditions encountered in most small parcel delivery systems are different than those in other modes of transport. These include the orientation of packages when tilted on inclines and in flight, and the “bridging” of long packages in automatic sorting systems.

Automated sorting does not maintain a single orientation and inclines and slopes are inevitable. Conveyor angles may range from a 12 to 37 degrees depending on carrier and sorting facility, and slides may range from 17 to 30 degrees. Packages must be able to maintain these angles during movement or they will roll back down and possibly be damaged or get caught in the junction where the flat belt meets the incline belt.

Loading of vehicles is relatively free of inclines but orientation cannot always be maintained. This is more evident with shipments moving by aircraft than by truck since space is much more limited in aircraft containers. Pallet loaded shipments are normally kept upright but unpalletized packages can be loaded in any orientation that allows them to fit.

In-transit inclines vary greatly between modes of transportation. Compared to trucks, aircraft are unique because they can move quickly and sharply in all three directions at

the same time. The maximum operation angles for two common all-cargo aircraft are listed below:

DC-8: 30-degree bank max, 10-degree decent max, 15-degree climb max.

DC-10: 30-degree bank max, 10-degree decent max, 20-degree climb max.

These angles in flight, in addition to load shifting and vibration, cause packages to be moved in virtually any orientation and angle.

Bridging occurs when a long package is supported near its ends, as in jamming on a conveyor or chute during the sorting operation. Damage can occur if the bridged package is struck near its center by another fast moving package. In transit, long packages may be oriented such that they are not supported along their entire face (bridged), thereby incurring both dynamic and static forces.

Carrier Requirements/Restrictions: Each carrier has its own Terms and Conditions (T&C) that affect packaging; it is the shipper's responsibility to determine if their shipments meet those T&C. Among the requirements or restrictions commonly listed are: Size Limits; Weight Limits; Perishables; Labeling; Special Commodity packaging instructions; Shipments requiring advanced arrangements; Not Acceptable Items; Limitation of Liability; and Maximum Declared Values. To find a carrier's T&C go to the carrier's Tariff that is posted on its website. Some website sources are:

- DHL- www.dhl-usa.com/bs/carriagedoc/
- Emery Forwarding- www.emeryworldwide.com
- FedEx- www.fedex.com
- UPS- www.ups.com
- US Postal Service- www.usps.gov

General Design Recommendations (by package type)

The following general design recommendations are presented in three categories of package types:

- Type 1- factory packed, pre-engineered custom package design, dedicated to one product,
- Type 2- miscellaneous items packed in random order at fulfillment centers, catalog houses, and pick & pack operations,
- Type 3- occasional packages prepared for miscellaneous items.

Type 1- Factory packed in pre-engineered custom packages: To assure adequate protection from shock and vibration, the package designer should determine the product's level of fragility. Fragility level identifies how much force is required to cause an unacceptable level of damage to the product. The most accurate way to do this is fragility assessment using laboratory shock and vibration equipment, testing to ASTM Test Methods D 3332 and D 3580. If that is not available, a reasonable estimate should be made based on similar products or by working with the product designer to develop an estimate.

Generally, the product should be positioned in the center of the package unless either the fragility is known to differ by orientation, or it is critical to move the package center of gravity. Style of corrugated shipping container will depend largely on the method of packing to be used and shape and orientation of the package contents. Container strength and protective packaging within the container should be cost effective, consistent with product protection, packing labor, and any customer requirements.

Products of higher value should be packaged using higher strength and level of product protection than that used with moderate value products. Establishing a benchmark of percent cost of packaging to total product manufacturing cost will assist in determining if packaging costs are equitable within a shipper's product line.

Customer preferences regarding package aesthetics, design features, and environmental impact may affect interior packaging choices, but must be balanced against the need to minimize costs.

Type 2- Miscellaneous items packed in random order: In this situation, one or more items are packed within a shipping container of adequate size, selected from a range of available stock sizes. Contents should always be centered within the container. Many companies have successfully developed packaging guidelines that define relative product fragility and the amount/thickness of protective packaging required. In the absence of these, a minimum of two (2) inches thickness of protective or space between contents and container walls should be provided. Product fragility is generally considered by the worker during packing. Items deemed more fragile should have greater clearance from container walls and more separation from other items in the container. The same rationale should be applied to products of higher than average value, i.e. products having much higher value than the shipper's average value for the same cubic volume should be packed in larger and stronger boxes with more cushioning materials.

If the shipping container is a corrugated fiberboard box, use a style that is easily filled by the packer (usually an RSC style). Container contents should not weigh more than 50% of the maximum allowable weight listed on the box manufacturer's certificate, usually located on the bottom flaps. Interior packaging materials should provide adequate protection based on the fragility of package contents and be of sufficient strength to maintain any required clearance between contents and all six container walls (top, bottom, and four sides), and also to prevent contents from puncturing through the container walls. Hourly rate of packing will also be an important factor in selecting packaging materials, as higher rates may show that costlier materials are more effective in total cost when labor is included.

Unpacking and disposal of packaging materials are important to most customers receiving these types of packages. Some types of void fill materials may not be acceptable for that reason. Environmental impact of packaging materials is also important and some customers may require that containers and interior packaging be made of the same material for co-mingling by recyclers.

Type 3- Occasional packaging of miscellaneous items: These are packages prepared infrequently on an occasional basis by factories, warehouses, mailing stores, or individuals. The contents vary each time and may be any item acceptable for shipment by carriers.

Although fragility levels of these types of items are important, fragility is often not known or easily estimated and the most important factor in determining amount of packaging becomes the intrinsic value of the item. Greater value items should be packed in stronger containers with more cushioning protection than average value items. Contents of corrugated containers should never exceed 50% of the allowable gross weight as printed on the box manufacturer's certificate. At least three (3) inches of cushioning material of sufficient strength for item weight should be used on all six sides of the item.

Because these items are shipped to customers sporadically and in low volume, environmental impact and related issues are generally not a factor.

Shipping Containers

As pointed out in the Shipping Environment section, carriers' conveyor sort systems are designed specifically to handle corrugated boxes since that is by far the most predominant type of shipping container moving through the systems. Other types of containers such as bags, tubes or wood boxes are sorted on auxiliary systems such as carts, pallets, or slower moving conveyors.

Defining Types of Loads: A general terminology of the packaging and transportation industry is used to describe three types of loads- easy, average, or difficult.

- Easy loads are items of moderate density (up to 15 pounds per cubic foot) that may completely fill the container or be packaged in interior receptacles. They are not readily damaged by puncture or shock, do not shift or move in the package, nor present a hazard to other parcels.
- Average loads are moderately concentrated items that provide partial support to all surfaces of the container. Average loads may be placed directly in the shipping container or employ intermediate packaging.
- Difficult loads are items that require a high degree of protection to prevent puncture or distortion, or reduce transmitted shock, and do not support the container. Fragile objects and delicate instruments (having a fragility of 50 G's or less), high density items, and small bulk items are in this category.

Corrugated Fiberboard Boxes: To adequately protect contents in high speed sorting systems, corrugated fiberboard boxes must be durable and strong enough to resist repeated impacts. Experience has shown that best results are obtained when contents of the box are limited to about 50% of the maximum gross weight specified on the box manufacturer's certificate (BMC), usually located on a bottom flap. For instance, a box certified as minimum 200 burst or 32 ECT strength has a maximum allowable gross weight limit of 65 pounds for common carrier truck or rail shipments. However, in small

parcel shipping the maximum gross weight for average and difficult loads should not exceed about 30 pounds for best performance in product protection. Easy loads may be packed somewhat heavier.

The BMC is required by trucking companies that subscribe to the National Motor Freight Classification and by railroads as an indication of certified minimum strength of corrugated fiberboard for a maximum allowable gross weight and overall box dimensions. The BMC is not a requirement of small parcel carriers and does not indicate that the maximum load shown on the BMC is permissible nor that the box will adequately perform in a small parcel system.

Both burst (Mullen) and ECT grades of fiberboard are acceptable for corrugated fiberboard boxes in small parcel systems, however the two grades have different properties that may reflect in their performance during shipment. Burst grade fiberboard is manufactured to attain certain minimum levels of tensile and tear strength, collectively measured by the Mullen burst test. ECT grade fiberboard is manufactured to attain a minimum level of crush resistance that relates to good stacking strength in the finished box and this is measured by the Edgewise Crush Test. Although sufficient stacking strength is an important attribute needed in small parcel systems, durability is even more important as the corrugated fiberboard box must retain and protect its contents in manual and automated handling. Durability is closely related to tensile and tear properties. To help control the grade of ECT fiberboard, it is encouraged to specify basis weight (minimum combined weight of facings) when procuring corrugated fiberboard boxes.

Several other properties of corrugated fiberboard boxes are useful to know as they relate to performance of boxes in small parcel systems:

- Corrugated fiberboard is approximately one-half as strong in stacking strength at 85% relative humidity (RH) as in normal testing conditions of 50% RH.
- Corrugated fiberboard boxes under compressive load for approximately one week retain about 2/3 of their original machine-measured compression strength. Boxes in storage for a long period (approximately one year) retain about one-half of their original compression strength.
- Interlocked stacking of boxes reduces their compressive strength by up to 50%. Column stacking is preferable for good stacking performance.
- Misalignment of boxes in a column stack reduces stacking strength, ½ inch misalignment could reduce strength by 30%.
- Stacks of loaded boxes reach their maximum level of motion (natural frequency) during vertical vibration somewhere in the range of 6 to 12 Hz (cycles/second), no matter what they contain. This range of vibration frequency is common within both truck and rail transport.

The regular slotted container (RSC) style of box works well with most items and packing operations. For heavy loads over 50 pounds, a full overlap style (FOL) will prevent breakouts better than the RSC style. When the shape of the article or the method of packing are not well suited to the RSC style, most other box styles are acceptable for subsequent shipment through high speed sorting systems. However, any style box having

non-uniform surfaces or faces should be avoided if at all possible, including interlocking cover (IC), partial overlap (OSC), partial telescoping (PTD or PTHS), and recessed-end styles.

Box closure is very important for single shipments. Closure methods suited to shipment of palletized boxes may not be acceptable for the extra stress of individual shipments. Higher grades of closure materials and larger amounts of them are often required. Many standard methods of box closure may be considered, including tape, adhesive, staples and banding (strapping or tape). For detailed discussion, refer to ASTM D 1974 as a standard practice of closing, sealing and reinforcing fiberboard boxes. Single strip closure of tape is often acceptable when using premium grades of pressure sensitive tape or premium reinforced gummed paper tape. With lower grades of tape, or with large or “difficult” boxes, a more durable closure can be obtained by also using strips at right angles across flap joints at the ends of the box (six strip or H method). Packages weighing over 60 pounds may require reinforcement with bands of non-metallic strapping or reinforced tape.

Other Shipping Containers: Bags, bundles and wraps should not be used with difficult loads. For easy loads up to five (5) pounds paper bags and wraps are acceptable when the paper is at least 50-pound basis weight and items must be immune from impact or pressure damage. For easy and average loads up to 20 pounds, reinforced paper bags and padded bags with at least 60-pound basis weight paper exteriors are acceptable. For easy loads up to five (5) pounds, plastic bags should be at least 2-mil thick polyethylene or equivalent. For easy loads up to 10 pounds, bags should be at least 4-mil thick. Cloth bags are acceptable for easy and average loads up to 10 pounds provided their seams are as strong as the material. Bundles should be adequately compressed and reinforced to contain the article. Unitized packages should be adequately strapped together with either nonmetallic banding or pressure sensitive filament tape.

Flat non-gusseted envelopes may be used for non-rigid stationary and similar materials up to one (1) pound in weight and one (1) inch in thickness. Other styles of envelopes may be used for easy loads up to five (5) pounds, providing the paper is at least 28-pound basis weight or 90 psi burst strength.

Fiberboard tubes and similar long packages are acceptable but some carriers limit length. Check with the specific carrier before shipping. The inside tube length, with ends installed, should not be any longer than the product inside. (Only exception is when cushioning must fill end voids and prevent product movement.) Tube ends should be equal to the tube sidewall in strength and sidewalls should have equivalent strength of solid fiberboard 1/8 inch thick for tubes under 18 inches long, 5/32 inch thick for tubes 18 to 32 inches long, 3/16 inch thick for tubes over 32 to 60 inches long, and 1/4 inch thick for tubes over 60 inches long. Crimped or taped end closures are not recommended for other than lightweight rolled items. Tape should completely encircle the seams on friction slide closures of mailing tubes.

Cans, pails and drums are acceptable with positive closures. Generally, friction closures by themselves are not acceptable. Protruding devices, such as locking rings, should be shielded with padding to prevent injury to handlers, equipment and other parcels.

Wood boxes and crates, EPS coolers, spools, reusable containers, and stretch/shrink wrapped items are also acceptable providing they are adequately closed and reinforced. Any protruding handles, hinges, latches, wheels/castors or other devices may cause containers to “hang up” in sorting operations and should therefore be padded or recessed to prevent that possibility.

Interior Protective Packaging

To properly prepare a package for shipment via small parcel carriers, packers should use some type of interior protective packaging materials or forms within the shipping container. These materials or forms are utilized for one or more of the following functions:

- cushioning the item from shock and vibration;
- bracing or blocking the item in position to eliminate movement within the container;
- filling any voids remaining in the container after the item is placed within it;
- protecting the item’s surface from abrasion, scratching, corrosion, etc.
- protecting from ESD (electro-static discharge);
- protecting from the environment (temperature extremes, moisture, etc.)

A wide variety of materials and forms are available for interior packaging and most of them will perform more than one of the above functions. Use of reliable engineering data is preferred to assure optimum material performance. When selecting cushioning, bracing, or void fills the packer should use care to avoid over-loading as that may adversely affect its protection capabilities. For Type 2 or 3 packages, overfilling the container slightly with void fill material before closing will assure the item is held in place; excessive overfill should be avoided to prevent container distortion and/or damage. Use industry approved lab test procedures to determine how well a Type 1 package will perform in distribution.

When enclosing several items within a package, special care should be taken to protect them from contact with each other as well as external forces. Heavy items should not be packaged with fragile items unless extreme care is taken to separate items from each other.

Some items may require specialized interior packaging materials, such as absorptive materials for liquids in case of spill, or dry ice for temperature control. Other special requirements such as shielding from electromagnetic forces should be implemented inside a primary container within the shipping container.

Testing in the Laboratory prior to Shipment

Pre-shipment testing in a laboratory is the best way to determine if a package item is adequately protected against hazards encountered during shipping and handling. Such testing is particularly appropriate for pre-engineered Type 1 packages.

Lab testing can also be useful in developing a general approach to Type 2 packaging. However, due to the random nature of Type 2 packaging, testing will not provide the same positive assurance as seen with Type 1 package testing.

Shock, vibration and compression are major reoccurring forces present in all shipping modes, including the small parcel environment; damage will occur unless items are properly packaged to protect against these forces. Temperature and humidity extremes are naturally occurring conditions that will also contribute to package failure in the small parcel environment. At a minimum, lab tests should assess all of these potential causes of damage.

ASTM International (American Society for Testing and Materials) and the International Safe Transit Association (ISTA) are the principal sources for methods of laboratory testing, including minimum equipment requirements. Among the test methods recommended for small parcels are free-fall drop, incline impact, random vibration, repetitive shock (loose load) vibration, machine compression and constant load compression. ASTM International and ISTA also provide conditioning practices for temperature and humidity.

When tests are conducted in a sequence similar to that expected in actual shipments, the practice is called performance testing or general simulation. Copies of testing methods and performance test procedures are available from ASTM International and ISTA. Some small parcel carriers specify ISTA procedures as the minimum requirements for packaging.

It is strongly recommended that Type 1 packages should be pre-shipment tested using one of the following procedures:

ISTA 3C- atmospheric preconditioning, drop test, compression test, random vibration test, drop test;

ASTM D4169 Distribution Cycle 3- atmospheric conditioning, drop test, compression test, loose-load vibration test, random vibration test, drop test.

ISTA 1A- vibration test, drop test. In addition a compression test is conducted prior to the vibration and drop tests. Conduct either a constant load test or a compression machine test to simulate floor loading of the package with a load density of about 10 lb/cu.ft. on top of the box, measured to a 9 foot high roof. The constant load test should be conducted for one hour on each of three mutually perpendicular faces, with a constant static load of approximately 400 pounds per square foot (based on a design factor of 5 to compensate for time, humidity, and handling effects). The compression machine test should also be conducted on each of three mutually perpendicular faces, loading each briefly to a maximum

load that is equivalent to approximately 550 pounds per square foot of package face (based on a design factor of 7 to compensate for time, humidity, and handling effects).

It is also encouraged to test packages having unique properties or characteristics, using one of the following procedures:

ISTA 3D: for packages that are classified as *small*s

ISTA 2D (formerly ISTA 1J): for packages that are large and flat

ISTA 2E (formerly ISTA 1K): for packages that are long and narrow

Trial shipments via the small parcel carrier(s) of choice are strongly recommended following successful laboratory testing. Ideally, tests should include multiple shipments to each of several destinations. Packages may be opened and inspected on arrival or they may be returned unopened to the point of origin for inspection. If damage occurs, an analysis of results compared to lab test results may be necessary to determine the cause of the damage. Such damage in trial shipments may indicate a need to increase intensity of one or more lab tests, depending on type of damage incurred, and/or the addition of different types of tests.

ISTA will provide certification of successful laboratory testing if the tests are performed in an ISTA certified laboratory using ISTA or ASTM procedures. In order to determine pass/fail, documented acceptance criteria for both package and contents must be provided to the laboratory prior to testing.

Labeling and Marking

All shipping containers must be labeled or marked with routing information, including consignee and consignor addresses. This information must be legible, easily understood, and durable to better ensure that the package ultimately reaches the intended consignee. Other routing labels may also be required by the carrier. The ideal placement of shipping labels is on the top flaps of the shipping container.

Identification of contents on the exterior of the container is not required by carriers, however such identification may be a requirement of the consignee for subsequent identification in storage. When marking content's identification on containers, use a coded system to preclude theft or pilferage of valuable or highly desirable items.

If package contents require a warning such as *Electromagnetic* or *ESD sensitive*, a label or marking should be placed on at least the two largest faces of the shipping container. If the container requires special considerations in handling, consult industry standards "Pictorial Markings for the Handling of Goods" published by ASTM (D5445) and ISO (780). Keep in mind that small parcel carriers cannot honor orientation labels.

References and Resources

Published articles

- “Box Strength Guidelines for Small Parcel Shipments”, Chad Thompson, UPS, DIMENSIONS.01 proceedings, ISTA
- “Package Testing for E-commerce: basics you need to know to meet your customer’s expectations”, Joe Franklin, QVC Inc., DIMENSIONS.01 proceedings, ISTA
- “United Parcel Service’s Perspective on E-Commerce”, Chad Thompson, UPS, DIMENSIONS.01 proceedings, ISTA
- “Measurement of UPS Ground Shipping Environment for Large & Heavy Packages”, Paul Singh, Michigan State University, ISTACON 2000 proceedings, ISTA
- “Handling Drops in the USPS”, Thomas Kausch, Eastman Kodak Co., ISTACON 2000 proceedings, ISTA
- “Internet Direct Sales Pose New Challenges to Packaging”, Al McKinlay, Consultant, TRANSPACK 2000 proceedings, IoPP

Books

- “Corrugated Shipping Containers: An Engineering Approach”, George G. Maltenfort, IoPP Bookstore, www.iopp.org
- “Transport Packaging”, Alfred H. McKinlay, IoPP Bookstore

Standards

- “Annual Book of ASTM Standards”, Volume 15.09, ASTM International, 100 Barr Harbor Drive, W. Conshohocken, PA 19428-2959, tel. 610-832-9585, www.astm.org
- “Preshipment Test Procedures and Projects”, ISTA, 1400 Abbott Road, Suite 310, East Lansing, MI 48823-1900, tel. 517-333-3437, www.ista.org
- ISO Standards, available from American National Standards Institute (ANSI), 25 West 43rd Street, New York, NY 10036, tel. 212-642-4900, www.ansi.org

Testing Laboratories

“Certified Testing Laboratories”, ISTA

Consultants

“Directory of Packaging Consultants”, IoPP