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Standard Guide for Transport Packaging Design[1]

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1. Scope

1.1 This guide covers an approach to design of packaging for distributing goods through the hazards of handling, storage, and transportation.

1.2 The principal content of this guide is the identification of the key steps involved in development of transport packages, including shipping containers, interior protective packaging, and unit loads. It is recognized that actual usage and application to individual design projects may vary appreciably without diminishing the value of the process. Consult with a packaging professional whenever needed.

1.3 This guide is not intended for design of primary packaging, if the primary package is not planned for use as a shipping container.

1.4 The user of this guide must be aware of the carrier rules regarding packaging for shipment via each mode of transportation in which the transport package may move, such as the National Motor Freight Classification (less-than truckload) and the Uniform Freight Classification (railroad). For hazardous materials packaging, the packaging must perform to the requirements of the applicable modal regulations listed in Section 2.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 642 Test Method for Determining Compressive Resistance of Shipping Containers, Components, and Unit Loads[2]

D 880 Test Method for Impact Testing of Shipping Containers and Systems[2]

D 996 Terminology of Packaging and Distribution Environments[2]

D 999 Test Methods for Vibration Testing of Shipping Containers[2]

D 1974 Practice for Methods of Closing, Sealing and Reinforcing Fiberboard Boxes[2]

D 3332 Test Methods for Mechanical-Shock Fragility of Products, Using Shock Machines[2]

D 3580 Test Method for Vibration (Vertical Linear Motion) Test of Products[2]

D 4003 Test Methods for Programmable Horizontal Impact Test for Shipping Containers and Systems[2]

D 4169 Practice for Performance Testing of Shipping Containers and Systems[2]

D 4728 Test Method for Random Vibration Testing of Shipping Containers[2]

D 4919 Specification for Testing of Hazardous Materials Packaging[2]

D 5276 Test Method for Drop Test of Loaded Containers by Free Fall[2]

D 5487 Test Method for Simulated Drop of Loaded Containers by Shock Machines[2]

D 6055 Test Methods for Mechanical Handling of Unitized Loads and Large Shipping Cases and Crates[2]

D 6179 Test Methods for Rough Handling of Unitized Loads and Large Shipping Cases and Crates[2]

D 6344 Test Method for Concentrated Impacts to Transport Packages[2]

2.2 *ISO Standard:*

ISO 4180 Complete Filled Transport Packages—General Rules for the Compilation of Performance Test Schedules[3]

2.3 *Other Documents:*

National Motor Freight Classification[4]

Uniform Freight Classification, Rail Publication Service[5]

International Civil Aviation Organization Technical Instructions for the Safe Transport of Dangerous Goods by Air[6]

IMDG Code, International Maritime Dangerous Goods Code[7]

IATA Dangerous Goods Regulations[8]

[1] This guide is under the jurisdiction of ASTM Committee D-10 on Packaging and is the direct responsibility of Subcommittee D10.21 on Application of Performance Test Methods.

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[2] *Annual Book of ASTM Standards*, Vol 15.09.

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[4] Available from National Motor Freight Traffic Association, Inc., American Trucking Associations, 2200 Mill Road, Alexandria, VA 22314.

[5] Available from 151 Ellis Street NE, Suite 200, Atlanta, GA, 33035-6021.

[6] Available from ICAO, Suite 400, 1000 Sherbrooke St. W., Montreal, Quebec, H3A 2R2 Canada.

[7] Available from International Marine Organization, 4 Albert Embankment, London, Ontario 5E1 7SR Canada.

[8] Available from IATA, Customer Service Rep., 2000 Peel St., Montreal, Quebec H3A 2R4.

United States Code of Federal Regulations Title 49, Transportation (CFR-49)[9]

International Safe Transit Association Procedures 1, 1A, 2, 2A[10]

3. Terminology

3.1 *Definitions*— General definitions for packaging and distribution environments are found in Terminology D 996.

4. Significance and Use

4.1 This guide assists users in design and development of packaging intended for the protection of goods while they are in transit from point of origin to final destination. By following the step by step approach, users will be assured that no important factors are overlooked in package design.

4.2 The design process focuses on protection from hazards of handling and shipping while recognizing the need to balance the economics of all facets in distribution, including packaging materials and labor, handling, storage, and transportation.

5. Procedure

5.1 *Introduction*:

5.1.1 Although no single procedure can be expected to meet all requirements for all design options, there are general areas of information that are necessary for the design process to be most useful. The more information in each of these areas that can be obtained accurately, the greater the probability of optimizing the final design for cost performance utility, timeliness, and environmental considerations. Other interested parties, such as customers or end users, should be contacted for any specific package design criteria.

5.1.2 The following sequence, listed in 5.2-5.11, may not always be applicable to every design process and may be changed to fit particular circumstances, products, markets, distribution methods, etc. Environmental hazards presented by the distribution environment (see 5.4) may be known long before a new product (see 5.2) is fully designed or ready for distribution (see 5.3). Such knowledge can in fact contribute to the design of the product to ultimately reduce the amount of packaging that will eventually be required. The user of this guide is encouraged to examine each particular situation and decide the best order in which to proceed, without omitting any of the basic steps that follow.

5.2 *Identify Physical Characteristics of the Package Contents*—It is important to know more about the package contents (goods) than simply its dimensions and weight. The package designer must be aware of physical and chemical characteristics and hazardous properties so proper packaging can be developed. These include: susceptibility to abrasion, corrosion, temperature, static electricity, or magnetic fields; the ability to hold a load in compression, the contents' ability to withstand the affects of shock and vibration during handling and transportation, and intended shelf life. See Test Methods D 3332 and D 3580 for methods of determining shock and vibration fragility of products.

5.3 *Determine Marketing and Distribution Requirements*:

5.3.1 Package design must include consideration of marketing and distribution requisites in addition to product characteristics. These requirements, in many cases, take the form of marketing graphics, product identification, and compliance labeling.

5.3.1.1 Compliance labeling can also take many forms. Some items to consider are identification of country of origin, hazardous materials transportation regulations, Truth in Packaging requirements, and bar coding. Besides the actual printed graphics, one may want to consider proper substrate for printing and any required coatings.

5.3.1.2 Distribution requirements can likewise take on many forms of consideration including: the number of units that will ship in a container; the composition and attributes of the primary package; the identity of customers and their handling and storage requirements; the package disposal criteria; total volume expected per shift/day/year; expected life cycle; the planned modes of transport; domestic and international rules or regulations for packaging via those transport modes; types of distribution channels; maximizing loads in carrier vehicles; freight classification; handling and storage requirements; production equipment; environmental issues; etc.

5.3.1.3 This listing is not all inclusive and other considerations than these also may be important to the total package design.

5.4 *Identify Environmental Hazards Your Packages May Encounter*—Knowledge of the distribution environment is key to designing an optimum transport package. Major hazards to be expected in the environment are: rough handling; vibration and shock in-transit; compression in storage or in-transit; high humidity and water; atmospheric pressure; salt/corrosion; static electricity; temperature extremes; and puncturing forces. Identifying these hazards and quantifying them may include observation, conducting measurements, or reading research reports (see the references listed in Practice D 4169).

5.5 *Consider All Available Alternatives*:

5.5.1 There are many alternatives available for shipping containers, interior protective packaging, and unit loads. All should be considered and reviewed before selecting the final types for further development. Trade-off analysis techniques such as make versus buy often help. Rather than considering only materials that one has experience with, comparing paper versus plastic versus wood versus metal is a good exercise at times to assure the optimum solution for a particular project.

5.5.2 Three major factors influencing selection of alternatives are: package performance, total system cost, and environmental impact of materials.

5.5.2.1 The final package design can have a profound effect on total costs. Cost considerations should include not only packaging materials and labor, but also capital, overhead, handling, freight (transportation), and damage.

5.5.2.2 The total environmental impact of a design may be extremely difficult to quantify, particularly since many environmentally associated elements (reuse, recycle, and so forth) may be significantly affected by the existence of available infrastructure or markets, or both. For the present and forseeable future, a general policy of following guidelines such as

[9] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9371.

[10] Available from ISTA, 1400 Abbott Road, #310, East Lansing, MI 48823-1900.