Designation: D3951 – 15

Standard Practice for Commercial Packaging[1]

This standard is issued under the fixed designation D3951; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice establishes minimum requirements for packaging of supplies and equipment, exclusive of ammunition, explosives, or hazardous materials, as covered in Title 49 of the Code of Federal Regulations.

1.2 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *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:*[2]

D996 Terminology of Packaging and Distribution Environments

D1974/D1974M Practice for Methods of Closing, Sealing, and Reinforcing Fiberboard Boxes

D4169 Practice for Performance Testing of Shipping Containers and Systems

D4727/D4727M Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes

D5118/D5118M Practice for Fabrication of Fiberboard Shipping Boxes

D5168 Practice for Fabrication and Closure of Triple-Wall Corrugated Fiberboard Containers

D5445 Practice for Pictorial Markings for Handling of Goods

D6039/D6039M Specification for Open and Covered Wood Crates

D6251/D6251M Specification for Wood-Cleated Panelboard Shipping Boxes

D6254/D6254M Specification for Wirebound Pallet-Type Wood Boxes

D6255/D6255M Specification for Steel or Aluminum Slotted Angle Crates

D6256/D6256M Specification for Wood-Cleated Shipping Boxes with Skidded, Load-Bearing Bases

D6880/D6880M Specification for Wood Boxes

D7478/D7478M Specification for Heavy Duty Sheathed Wood Crates

2.2 *Code of Federal Regulations:*[3]

Title 49 Transportation (Parts 100 to 199)

2.3 *Military and Federal Standards:*[4]

MIL-STD-129 Military Marking for Shipment and Storage

MIL-STD-2073–1 Standard Practice for Military Packaging

FED-STD-123 Marking for Shipment (Civil Agencies)

2.4 *International Standards:*[5]

ISPM Publication No. 15 Regulation of Wood Packaging Material in International Trade (International Standards for Phytosanitary Measures (ISPM))

3. Terminology

3.1 Terminology found in Terminology D996 shall apply.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *CONUS*—Continental United States (excluding Hawaii and Alaska).

3.2.2 *immediate use*—used or consumed within seven days of receipt.

3.2.3 *safe delivery—in packaging*—delivery of a shipment to its destination with minimal damage to the package and no damage to the contents.

[1] This practice is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.27 on Fiberboard Shipping Containers, Containerboard and Related Structures and Materials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

[4] Available from Document Automation and Production Service, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094,. http://assist.daps.dla.mil/quicksearch..

[5] Available from the International Plant Protection Convention at http://www.aphis.usda.gov/import_export/plants/plant_exports/wpm/index.shtml.

4. Significance and Use

4.1 This practice covers the requirements for the commercial preservation, packaging, packing (exterior container), unitization, and marking for supplies and equipment. It provides for multiple handling and shipment by any mode, and storage periods of a minimum of one year in enclosed facilities without damage to the product. It also provides for package quantities suitable for redistribution without additional repackaging or marking. Planned storage that exceeds one year requires more than minimum requirements for physical and mechanical protection.

4.2 This practice is applicable to Department of Defense shipments for:

4.2.1 Items intended for immediate use;

4.2.2 Items for not-mission-capable supply;

4.2.3 Items intended for depot operational consumption;

4.2.4 Small parcel shipments (CONUS), not-for-stock; and

4.2.5 Direct vendor deliveries (CONUS ONLY).

4.3 All other Department of Defense shipments shall be in accordance with MIL-STD-2073–1.

5. Requirements

5.1 *General*—The following requirements, unless specifically changed by the contract or order, shall apply. Suppliers are encouraged to use advanced packaging technology.

5.1.1 *Packaging*—Preservation, packaging, packing, and marking furnished by the suppliers shall meet or exceed the following minimum requirements:

5.1.1.1 *Cleanliness*—Items shall be free of dirt and other contaminants which would contribute to deterioration of the item or which would require cleaning by the customer prior to use. Coatings and preservatives applied to the item for protection are not considered contaminants.

5.1.1.2 *Preservation*—Items susceptible to corrosion or deterioration shall be provided protection such as preservative coatings, barrier protection, volatile corrosion inhibitors, or desiccated unit packs.

5.1.1.3 *Cushioning*—Items requiring protection from physical and mechanical damage or which are fragile shall be protected by wrapping, cushioning, pack compartmentization, cartonizing, or other means to mitigate shock and vibration to prevent damage during handling and shipment.

5.1.1.4 *Loose-fill Cushioning/Dunnage* —Loose-fill material shall be prohibited for all Department of Defense (DoD) and/or General Services Administration (GSA) shipments and shipments to aerospace facilities.

5.1.2 *Unit Package:*

5.1.2.1 *Unit Package*— A unit package shall be so designed and constructed that it will contain the contents with no damage to them, and with minimal damage to the unit pack during shipment and storage in the shipping container configuration, and shall allow subsequent handling.

5.1.2.2 *Unit Package Quantity*—Unless otherwise specified in the contract or purchase order, the unit package quantity shall be one each part, set, or assembly, except for small lightweight items, for example, industrial hardware, which will be unit packaged in quantities that are standard in the trade and suitable for retail sales. Single items weighing over 5 lb shall be individually packaged.

5.1.2.3 Bulk packaging shall be specifically excluded unless specified in the contract or purchase order.

5.1.3 *Intermediate Package:*

5.1.3.1 The use of intermediate packaging is encouraged particularly when such use enhances handling and storage.

5.1.4 *Packing:*

5.1.4.1 Unit packages and intermediate packages not meeting the requirements for a shipping container shall be packed in shipping containers.

5.1.4.2 *Shipping Containers*—The shipping container (including any necessary blocking, bracing, cushioning, or water resistance) shall comply with the regulations of the carrier used and shall provide safe delivery to the destination. The shipping container shall be capable of multiple handling and storage periods at a minimum of one year in enclosed facilities without damage to the product. Table 1 provides suggested size and weight limits for shipping containers and may be used for unit and intermediate packages when specifying a fiberboard container, wood box, or crate.

5.1.4.3 All containers shall be tested to meet Practice D4169 test standards when specified in the contract or purchase order.

5.1.5 *Unitization*—Shipments should be considered for unitization where appropriate or as specified in the contract or purchase order. Unitization encompasses, but is not limited to, bundling, consolidation in a container, or placement on a pallet.

5.1.6 *Marking:*

TABLE 1 Weight and Size Limits of Shipping Containers

Container Standard	Maximum Outside Dimensions, length + width + depth	Maximum Weight of Boxes and Contents (lb)
Practice D5118/D5118M	SW Corrugated ≥40 and ≤105 in.	≤120
	DW Corrugated ≥85 and ≤120 in.	≤180
Practice D5168	TW Corrugated ≥110 and ≤125 in.	≤300
Specification D6251/D6251M[A]	As required	≤1000
Specification D6880/D6880M[A]	As required	≤1000
Specification D6256/D6256M[A]	≤16 ft	≤2500
Specification D6254/D6254M[A]	As required	≤2500
Specification D6255/D6255M[A]	As required	≤3000
Specification D6039/D6039M[A]	As required	≤4000
Specification D7478/D7478M[A]	30 ft L × 9 ft W × 10 ft H	≤30 000

[A] Containers with length and width greater than 48 in. shall be designed with four-way entry lift capability. Containers with gross weight over 100 lb shall have 2-way forklift entry at a minimum.

5.1.6.1 *Unit and Intermediate Marking*—Marking for the unit and intermediate container shall mean those used in the commercial distribution or over-the-counter retail sales. The markings shall be sufficient to clearly and visibly identify the contents of the package. When the unit or intermediate container is also the shipping container the requirements of 5.1.6.2 shall apply. Unless otherwise specified in the contract/purchase order, the following are the minimum requirements:

(1) Part number and/or UPC barcode part number,

(2) Product name or nomenclature,

(3) Quantity and unit of issue,

(4) Manufacture retail markings,

(5) Shelf-life markings (expiration date/inspection date/date of manufacture), if applicable,

(6) Storage legends, if applicable, and

(7) Precautionary markings, if applicable.

5.1.6.2 *Shipping Container Markings*—All markings shall be legible, durable, and identify the contents of the package, and if required, include pictorial markings as identified in Practice D5445. Unless otherwise specified in the contract /purchase order, the following are the minimum requirements:

(1) Consignee and consignor address,

(2) Applicable precautionary markings,

(3) Part number and/or UPC barcode part number,

(4) Product name or nomenclature,

(5) Quantity and unit of issue,

(6) Manufacturer retail markings,

(7) Contract number/purchase order number,

(8) Shelf-life marking (expiration date/inspection date/date of manufacture), if applicable,

(9) Storage legends, if applicable, and

(10) Precautionary markings, if applicable.

5.1.6.3 *Unitization Markings*—All desired markings shall be as specified in the contract /purchase order. All markings shall be legible, durable, and identify the contents of the shipment unit, and if required, include pictorial markings as identified in Practice D5445.

5.1.6.4 *Wood Packaging Material (WPM)*—If wood packaging material is used for export from or import to the United States, the supplier shall comply with the requirements of ISPM Publication No. 15.

5.1.6.5 *Container Markings for DoD*—For all shipments to the Department of Defense, the marking shall be in accordance with MIL-STD-129. Any additional marking requirements shall be specified in the contract or purchase order.

5.1.6.6 *Container Markings for Government Civil Agencies*—For all shipments to government civil agencies, such as the General Services Administration (GSA), the marking shall be in accordance with FED-STD-123. Any additional marking requirements shall be specified in the contract or purchase order.

5.1.6.7 *Items without Adequate Surface for Labels*—Items without adequate surface for labels shall be marked in accordance with 5.1.6.1 by means of a tag securely affixed to the item.

6. Options

6.1 *Export Shipments*—When permitted by the contract or purchase order, this practice may be used for export shipments when favorable conditions are provided, such as containerization media and enclosed areas of receiving. Additional preservation methods and the use of weather-resistant grades may be required to ensure the packaging successfully protects the item in the export shipping environment. Ensure unit, intermediate and shipping containers are weather-resistant grades when shipping overseas. Containers should be sealed as opposed to closed (see Practice D1974/D1974M).

7. Performance Testing

7.1 The use of Practice D4169 shall be required when determining the performance level of a shipping unit.

7.2 The supplier shall be responsible for requirements specified herein and in the contract or purchase order. The purchaser reserves the right to perform any or all of the tests.

7.2.1 Packaging used shall successfully pass the test levels of Practice D4169, Distribution Cycle 1. Export shipments shall also pass the test levels of Distribution Cycles 15, 16, or 17 as appropriate. Assurance Level II shall be used. Acceptance shall be criterion I, no product damage.

7.3 Packaging shall be capable of successfully passing the test levels of Practice D4169 Distribution Cycle 18 for shipments destined for delivery to the Department of Defense.

7.3.1 Shipments destined for delivery to an overseas location as defined in the contract shall meet Assurance Level I.

7.3.2 Shipments destined for delivery to customers within the continental United States shall meet Assurance Level II.

8. Keywords

8.1 commercial packaging; intermediate; packaging; preservation; unit package

APPENDIX

(Nonmandatory Information)

X1. SELECTION AND USE OF INTERNAL CUSHIONING AND DUNNAGE MATERIALS

X1.1 Scope

X1.1.1 This appendix covers guidelines for the selection and use of cushioning and dunnage material for the protection of goods during handling and transportation. These packaging materials must be selected appropriately for known handling and transportation conditions, end use, and the product characteristics being packaged. It is common for a transport package to be dropped and otherwise impacted. These events may produce potentially damaging shocks. Transportation vibration from conveyors, trucks, railroads, or aircraft can also damage some items. Shock and vibration to the item are controlled by cushioning so that the chance of product damage is greatly reduced throughout the supply chain. Cushioning is material used to reduce the effect of externally applied shock or vibration forces, or both. In this appendix, dunnage is used to prevent or control movement of the unit or load or to facilitate handling (often referred to as void-fill material). See Terminology D996 for definitions.

X1.2 Applicability

X1.2.1 The users of this appendix 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).

X1.2.2 This appendix is not intended to replace those packaging designs that have been developed and tested for unique/specific products requiring detailed specifications (such as reusable containers with internal cushioning design configurations).

X1.2.3 This appendix does not purport to address all of the packaging and dunnage materials available for use, but as a guide using the selection criteria provided.

X1.3 Mode of Action of Cushioning Materials

X1.3.1 Most cushioning materials have quantified shock and vibration mitigation capabilities and are used to cushion items with specific known requirements. Cushioning materials absorb and dissipate a portion of the resultant shock when a packaged item receives an impact. Correct selection and sizing of the cushioning material thus ensures that the packaged contents sustain no damage.

X1.4 Required Characteristics of Cushioning Materials

X1.4.1 Cushioning materials must fulfill the following four main requirements:

X1.4.1.1 To reduce levels of shock and vibration, concentrated forces, and abrasion during handling and shipment.

X1.4.1.2 Resistance to expected climatic conditions, such as moisture due to elevated relative humidity, direct solar radiation, and variations in temperature, pressure and static loading.

X1.4.1.3 Cushioning materials will not adversely affect the package contents because of incompatibility of chemical and/or hygroscopic properties. If cushioning materials are placed in direct contact with the package contents, the design will provide adequate protection to the contact surface(s) of the contents.

X1.4.1.4 The cushioning materials used should be reusable, recyclable, and recoverable to the maximum extent practical, while still meeting an item's cushioning and compatibility requirements, and promoting economically advantageous life cycle costs.

X1.5 Description of Various Kinds of Cushioning Materials and Typical Uses

X1.5.1 *Flexible Closed-Cell Plastic Film*—Flexible closed-cell plastic film is constructed of a composite of two or more layers of plastic film with uniformly distributed closed cells filled with air. This material is intended for use within packages to protect items from damage due to shock, vibration, concentrated forces, and abrasion during handling and shipment. The flexibility of the material permits it to be used as pads, bags, wraps, dunnage, or filler. When used as a sealed bag, it may reduce contamination. Some film types have static dissipative properties and are excellent for protecting electrostatic discharge sensitive items.

X1.5.2 *Plastic Foam Cushioning Materials*—Plastic foam cushioning materials are mainly made from polystyrene (PS), polyurethane (PU), and polyethylene (PE). Plastic foams are available in flexible, semirigid, and rigid forms. Their cushioning characteristics are determined not only by their varying densities, but also by their cell structure. The particular characteristics of the various starting materials are briefly described as follows:

X1.5.2.1 *Polystyrene (PS)*—Polystyrene is commonly injection molded, vacuum formed, or extruded, while expanded polystyrene is either extruded or molded in a special process. It should be noted that, due to its structure (enclosed capillaries), PS cushioning material may have a tendency to absorb or release water vapor. Polystyrene cushioning material is produced as relatively large moldings, such as planks, cushioning frames, and edge or corner pads.

(1) Expanded Polystyrene (EPS)—Expanded polystyrene is a rigid closed-cell foam. It is usually white and made of pre-expanded polystyrene beads. Uses include molded sheets of expanded bead PS (known as "bead-board") for cushioning fragile items.

(2) Extruded Polystyrene Foam (XPS)—Extruded polystyrene foam consists of closed cells and has a higher stiffness and reduced thermal conductivity.

X1.5.2.2 *Polyurethane (PU)*—Polyurethanes are produced in flexible, semi-rigid and rigid foams with an open cell structure. Flexible and semi-rigid polyurethanes are primarily

used in cushioning applications. The shock absorbing properties of PU foams, for any one static stress, depend on the density of the foam. The shock absorbing properties of PU foams depends on factors such as foam density and cell structure. Polyurethane foams are usually produced as relatively large moldings, either by direct foaming around the item to be packaged or in pre-formed shapes.

X1.5.2.3 *Polyethylene (PE)*—Polyethylene is polymerized ethylene resin, used in plank form or thin sheets as cushioning foams in packaging applications. Polyethylene is classified into several different categories usually based on its density. Its mechanical properties depend significantly on variables such as density and the extent and type of cross-linking present.

X1.5.3 *Cellulosic*—Cellulosic cushioning consists of multilayers of lightweight, absorbent wadding (“paper”) used to protect fragile or sensitive items. It conforms to any shape and fills excess space to prevent items from shifting during transport. This material is used to protect a variety of items that require different densities of cushioning. As this highly compressed wadding expands, its density decreases.

X1.5.4 *Bound Fiber*—(also known as *rubberized hair*), consists of fibrous organic filler material (vegetable or synthetic fiber) and a material (e.g., natural latex rubber) that binds the fibers into a cushioning matrix. It may be form fitted to a broad range of parts and due to density variability it can be used for both lighter and heavier weight items. Bound fiber holds its shape through broad temperature ranges and is a good substitute for foamed cushioning materials. Like foam cushioning, softer or harder forms are available depending on requirements.

X1.5.5 *Solid/Corrugated Fiberboard*—For the purposes of this appendix, fiberboard is primarily used for the fabrication of boxes and interior details (such as pads, sleeves, liners, partitions, die-cut sheets, etc.) although fiberboard pads are also sometimes used as cushioning for heavy items, and for blocking and bracing. The various types, grades, and classes may be obtained from Specification D4727/D4727M.

X1.6 Required Characteristics of Dunnage Materials

X1.6.1 Dunnage is any general packing material used as void-fill for blocking or bracing. Dunnage commonly consists of wood boards, blocks, or planks, the metal or plastic bracing used in supporting and securing packages for shipping and handling, or any other material used as void fill (flexible closed-cell plastic film, cellulosic wadding, loosefill or “peanuts,” etc.).