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Standard Guide for Selection and Use of Stretch Wrap Films[1]

This standard is issued under the fixed designation D 4649; 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.

1. Scope

1.1 This guide covers recommended guidelines and test methods for the selection, specification, and use of stretch wrap films for unitizing, reinforcing, and palletizing for indoor environments. This can include storage or transport, or both, in warehouses, closed containers such as truck trailers or rail boxcars, and associated transfer terminals. This guide does not cover the performance issues associated with outdoor exposure.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

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]

D 882 Test Methods for Tensile Properties of Thin Plastic Sheeting
D 907 Terminology of Adhesives
D 996 Terminology of Packaging and Distribution Environments
D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
D 1746 Test Method for Transparency of Plastic Sheeting
D 1894 Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting
D 1898 Practice for Sampling of Plastics
D 1922 Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method
D 2103 Specification for Polyethylene Film and Sheeting
D 2457 Test Method for Specular Gloss of Plastic Films and Solid Plastics
D 2578 Test Method for Wetting Tension of Polyethylene and Polypropylene Films
D 2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
D 3951 Practice for Commercial Packaging
D 4321 Test Method for Package Yield of Plastic Film
D 4470 Test Method for Static Electrification
D 5331 Test Method for Mechanical Handling of Unitized Loads Secured With Stretch-Wrap Films
D 5414 Test Method for Evaluation of Horizontal Impact Performance of Load Unitizing Stretch Wrap Materials
D 5415 Test Method for Evaluating Load Containment Performance of Stretch Wrap Materials by Vibration Testing
D 5416 Test Method for Evaluating Abrasion Resistance of Stretch Wrap Materials by Vibration Testing
D 5458 Test Method for Peel Cling of Stretch Wrap Film
D 5459 Test Method for Machine Direction Elastic Recovery and Permanent Deformation and Stress Retention of Stretch Wrap Materials
E 96 Test Methods for Water Vapor Transmission of Materials
E 284 Terminology of Appearance

3. Terminology

3.1 *Definitions*—Terminology found in Terminology D 996 shall apply.

3.2 *Definitions of Terms:*

3.2.1 *blocking*—an undesirable adhesion between touching layers of a material, such as occurs under moderate pressure during storage or use. (See Terminology D 907.)

3.2.2 *clarity*—the characteristic of a transparent body whereby distinct high-contrast images or high-contrast objects (separated by some distance from the body) are observable through the body. (See Terminology E 284.)

3.2.3 *cling*—the ability of one surface of a material to adhere to itself or another surface.

[1] This guide is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.25 on Palletizing and Unitizing of Loads.

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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.

3.2.4 *elastic recovery*—the extent that a material returns to its original length after being subjected to an extension.

3.2.5 *elongation*—increase in length (expressed as a percent of original length).

3.2.6 *thickness (caliper, gage)*— the perpendicular distance between opposite surface of a material.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *conventional braking*—a mode of stretch wrap machinery operation in which wrap material elongation is achieved by relative load motion and supply roll tension.

3.3.2 *core extension*—the length to which the core extends beyond the edge of the wrap material.

3.3.3 *cut growth resistance*—the ability of a wrap material to resist nick or cut propagation.

3.3.4 *film force to load*—the amount of force applied by the film to a load in providing load containment.

3.3.5 *film tail*—that portion of wrap material that is applied to the load after relative load motion ceases.

3.3.6 *food wrap material*—a material designed for use in direct food contact.

3.3.7 *load containment*—the utilization and protection, or both, of product(s) for distribution and storage or both.

3.3.8 *marking wheel*—a device that makes repetitive marks indicating a known distance.

3.3.9 *measured stretch*—see *elongation*.

3.3.10 *mechanical prestretch*—a mode of stretch wrap machinery operation in which wrap material elongation is achieved through the use of a prestretch device and relative load motion.

3.3.11 *nonfood wrap material*—a material not for direct food contact.

3.3.12 *overlap*—the width of wrap material that covers a previous layer of wrap material.

3.3.13 *powered prestretch*—a mode of stretch wrap machinery operation in which wrap material elongation is achieved through use of a power assist prestretch device and relative load motion.

3.3.14 *protrusion puncture resistance*—the ability of a wrap material to withstand the force exerted by a protrusion.

3.3.15 *stretch wrap material*—a material used for overwrapping that elongates when applied under tension and, through elastic recovery conforms to the item(s) packaged.

3.3.16 *wrap cycle*—the series of operations used to wrap a load.

3.3.17 *yield (coverage)*—area per unit weight.

3.3.18 *zipper (tear)*—a self-propagating tear.

4. Significance and Use

4.1 This guide is for user evaluation, selection, specification, and application of stretch wrap materials. It may be used between the buyer and seller to arrive at purchase specifications. Specific methods are contained within the body of the guide for material evaluation, user performance, and quality assurance testing.

4.2 Care must be exercised in extrapolating test values obtained by use of the test methods outlined in this guide, to actual field performance.

5. Stretch Film Classification

5.1 Stretch wrap films may have the following types:

5.1.1 Hand applied film versus machine applied film,

5.1.2 Fabrication (blown, cast),

5.1.3 Cling Mechanism (two side, one side, no cling, migratory, non-migratory, one side slip, differentiated), and

5.1.4 Layer (monolayer, co-extruded).

5.2 Grade:

5.2.1 Colors, (clear, tints, opaque).

5.3 Class:

5.3.1 Food Contact, and

5.3.2 Non-food Contact.

6. Raw Materials and Fabrication

6.1 Typical materials covered by this guide are as follows:

6.1.1 Low-density polyethylene (LDPE),

6.1.2 Medium-density polyethylene (MDPE),

6.1.3 Linear low-density polyethylene (LLDPE),

6.1.4 Metallocene/m linear low density polyethylene (mLLDPE):

6.1.5 Ethylene vinyl acetate copolymer (EVA),

6.1.6 Poly(vinyl chloride) (PVC),

6.1.7 Polypropylene (PP),

6.1.8 Other polymeric materials or blends that meet the requirements of this guide. High density polyethylene (HDPE),

6.1.9 Ethylene methyl acrylate copolymer (EMA),

6.1.10 Very low density polyethylene (VLDPE),

6.1.11 Ethylene metallocene plastomers, and

6.1.12 Additives, modifiers and pigments.

7. Ordering Information

7.1 The inquiry and order for materials shall indicate the following where applicable:

7.1.1 Grade and class required,

7.1.2 Thickness,

7.1.3 Material length per roll,

7.1.4 Outside roll diameter,

7.1.5 Material width,

7.1.6 Core dimension (inside diameter and extension), and

7.1.7 ASTM designation, including revision date.

7.2 Where necessary, ordering information may be expanded or modified for special uses or materials, such as method of stretch and stretch percentage expected.

8. Stretch Film and Additives' Characteristics

8.1 *Physical and Mechanical Properties*:

8.1.1 The properties and test methods in Table 1 shall be used when describing the physical and mechanical characteristics of wrap materials as manufactured.

8.1.2 The practices listed in Table 2 can be an aid when describing performance characteristics of wrap materials, as used for unitizing, reinforcing, and palletizing.

8.1.3 Some of the test methods described in Table 1 may be applied to multiple wraps or stretched specimens, or both, to aid in assessing their performance characteristics.

8.1.4 Other tests that may be of value for evaluating actual performance are given in Annex A1.

TABLE 1 Physical and Mechanical Properties of Materials

Property	Common Unit	SI Unit	ASTM Test Method
Breaking factor	1 lbf/in.	kN/m	D 882
Clarity	%	%	D 1746
Cling (peel)	gm	N	D 5458
Coefficient of friction at approximately 72 and 100°F (22 and 38°C)	...	...	D 1894
Density	lb/in.^{3}	g/cm^3	D 1505
Elastic recovery	%	%	D 5459
Elongation at break	%	%	D 882
Flammability	% 0	% 0	D 2863
Force at elongation (50, 100, 150, 200 %)	lbf/in.	kN/m	D 882
Gloss	...	...	D 2457
Haze	%	%	D 1003
Protrusion puncture	in./lb	M/kg	[A]
Static electrification	V	V	D 4470
Stress retention	%	%	D 5459
Tear resistance (Elmendorf)	gm	N	D 1922
Ultimate tensile strength	lb/in.^{2}	Pa	D 882
Water vapor transmission rate	g/24 h-100 in.^{2}	g/h-m^2	E 96, Procedure E
Wetting tension	dyne/cm	dyne/cm	D 2578
Yield (coverage)	in.^{2}/lb	m^2/Kg	D 4321

[A] New Standard Test Method for Protrusion Puncture Resistance of Stretch-Wrap Materials is under development.

TABLE 2 Test Methods Related to Performance

Procedure	ASTM Test Method
Test Method for Evaluating Abrasion Resistance of Stretch Wrap Material	D 5416
Test Method for Evaluating Load Containment Performance of Stretch Wrap Material by Vibration Testing	D 5415
Test Method for Evaluation of Horizontal Impact Performance of Stretch Wrap Materials	D 5414
Test Method for Evaluation of Mechanical Handling of Unitized Loads Secured with Stretch Wrap Materials	D 5331

8.2 *Other Properties*—Food contact stretch films must conform to FDA or other governmental regulations, or both, as applicable.

8.3 *Recyclability/Disposability*—Stretch film should be recycled whenever possible. Disposability shall be in accordance with local, state, and federal regulations.

8.4 *Static Discharge*— Some plastic packaging wrap materials may build up static electrical charge. Care should be exercised in using these materials especially where potential flammable air vapor or air dust mixtures can exist.

9. Dimensions, Mass, and Permissible Variations

9.1 The material dimensions and their permissible variations shall conform to the following, unless otherwise specified by the user:

9.1.1 Thickness (caliper, gage) is expressed in fractions of an inch or mils. For example, the nominal thickness of 80-gage wrap material is 80/100 000, 0.00080 in., or 0.8 mils,

9.1.1.1 As determined by Specification D 2103, and

9.1.1.2 The actual wrap material thickness shall not vary more than ±25 % of the nominal gage thickness in any one point across the width nor 20 % from the nominal thickness for the average of five consecutive points across the web, measured in a minimum of 1-in. or 25-mm increments.

9.1.2 *Roll Weight or Yield*—See Table 3.

9.1.2.1 Gross weight of hand wrap films generally under 12 lb.

9.1.3 The film roll width tolerance for wrap materials is ±¼ in. (6 mm) unless otherwise agreed upon between the buyer and the seller.

9.1.3.1 Standard widths are 10 to 80 in. (254 to 2032 mm) plus 10 to 20 in. (254 to 508 mm) on hand wrap applications. Nonstandard widths are also available.

9.1.3.2 Roll width, measured by a steel tape having an accuracy of ±⅛ in. (3 mm).

9.1.4 The roll diameter tolerance is ±5 % of nominal outside diameter.

9.1.5 The length per roll of film wrap materials shall be within + 4 – 0 % of the length as marked, or as otherwise agreed between the buyer and the seller, as measured by a tapeless measure.

10. Workmanship, Finish, and Appearance

10.1 Wrap materials shall be generally free from defects that may affect the serviceability such as wrinkles, fold-over creases, soft spongy areas, and gels.

10.1.1 No splices are allowed.

11. Sampling

11.1 Sampling shall be in accordance with Practice D 1898.

12. Test Methods

12.1 The test methods in Annex A1 are not ASTM standards, however these procedures are a necessary part of this guide.

13. Preparation for Delivery

13.1 Lot or serial number must appear on the individual roll, pallet or case.

13.2 Shipping container or individual rolls, or both, shall be labeled in accordance with Practice D 3951 with the following additional markings:

13.2.1 Product name,

13.2.2 Thickness,

13.2.3 Material width in inches or millimetres,

13.2.4 Material length per roll in feet or meters,

13.2.5 Material weight per roll in pounds or kilograms, and

13.2.6 Manufacturer's or seller's name.

13.3 Where necessary, labeling information may be expanded or modified for special uses or materials.

14. General Uses

14.1 Tensioned stretch film may be used to secure a handling base (skids, platforms, pallets, slip sheets, etc.) to a unit load to expedite handling (tertiary package).

TABLE 3 Average Weight/Yield Tolerances for Stretch Wrap Material

Number of Rolls	Tolerance, %
Any one roll	±7
Lots over 25	±5

14.2 Stretch film may be used to secure cushioning, edge protection, or other package components to an individual item (office furniture, windows, etc.) (primary/secondary package).

14.3 Stretch film may be used as a primary protective wrap for individual products (rolled products, metal coils, etc.) (primary package).

14.4 Stretch film may be used to bundle multiple products and provide surface protection (metal extrusions, wood molding) (primary package).

14.5 Stretch film may be applied to rolled forage crops to facilitate the decomposition into silage (primary package)

15. Film Force Applied to the Load

15.1 *Concept of Load Containment*—Proper load containment allows the film to securely hold a load in place, so the load safely arrives intact at a customer's location. Stretch film is properly applied when: film is elongated; applied under tension; and the elastic recovery conforms to the load. Load containment can be increased with additional wraps of stretch film, heavier gauge film, or increased post-stretch.

15.2 *Film Load Containment Properties*—Films can differ in stretch retention and elastic recovery characteristics.

15.3 Film force to load is usually measured by determining the force required to pull the film a certain distance away from the load.

15.4 Film elongation is achieved with pre-stretch and post-stretch. In a typical application, the majority of film elongation is achieved in a pre-stretch mode of operation.

15.4.1 Pre-stretch is a mode of operation in which stretch film elongation is achieved between a pre-stretch device, typically between two rollers rotating at different speeds.

15.4.2 Post-stretch is a mode of stretch film machinery operation in which film elongation is achieved after leaving the pre-stretch device and before reaching the load. Generally this is achieved by an adjustment to the film force to load machine setting.

15.5 *Wrapping Techniques*:

15.5.1 Each application may require different load containment properties based on the product and methods of distribution. These properties can be obtained with different film properties and machine settings.

15.6 *Film Force Measurement Procedures*:

15.6.1 *Pull-Plate Method*—A fish type scale is attached to a non-yielding round plate and the film is pulled away from the load. At a measured distance the pounds (kilograms) of force applied to the plate by the film is recorded.

15.6.2 *Wrap-Scale-In Method*—A strain gauge such as a bathroom type scale is attached to the load and the stretch film is applied to the load. The strain gauge is used to record the pounds (kilograms) of force applied to the gauge by the film and is recorded.

15.6.3 *Effects of Time and Temperature on the Film Forces Applied to the Load*—It is important to conduct the film test at the same amount of time after the load is wrapped, and at the same temperature and the same stretch percentages, to obtain the most reproducible results.

16. Application Devices

16.1 Stretch film may be applied either by machine or by hand. Machine application provides more consistency and control for wrapping and unitizing a load. Hand application is more variable due to operator control of film coverage, placement of the film, and the amount of tension applied. For the safety of both handlers and load contents, when hand wrapping there should be a careful inspection of the finished unitized load for the placement, tension and coverage of film so that the load is securely held to the pallet.

16.2 *Machine Application*

16.2.1 *Turntable*:

16.2.1.1 Semi-Automatic or automatic (see Fig. 1),

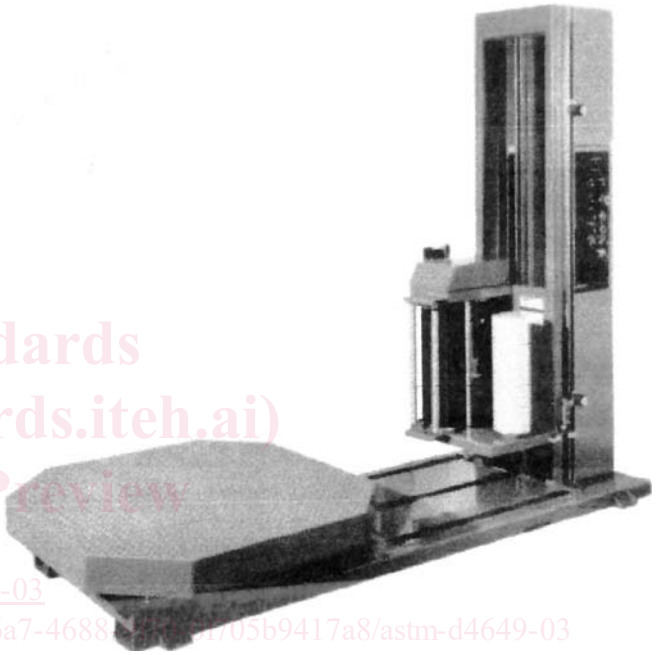

FIG. 1 Turntable Stretch Wrap System (shown as defined in 16.2.1 - semi-automatic)

16.2.1.2 Load turns on a spinning table,

16.2.1.3 Machine does stretching and wrapping,

16.2.1.4 Film elongation as measured on load typically range from 100 to 300 %,

16.2.1.5 Post Stretch/Force to Load controlled by machine setting, and

16.2.1.6 Products are typically wrapped at speeds of 10 to 20 loads per hour (semi-automatic) and 20 to 60 loads per hour (automatic).

16.2.2 *Orbital/Bundling* (see Fig. 2):

16.2.2.1 Semi-Automatic or automatic,

16.2.2.2 Film is stretched and applied in a vertical circle around a horizontal load,

16.2.2.3 Film elongation as measured on load typically range from 50 to 200 %,

16.2.2.4 Post Stretch/Force to Load controlled by machine setting, and

16.2.2.5 Products wrapped typically range from 20 to 100 loads per hour.

16.2.3 *Rotating Arm* (see Fig. 3):

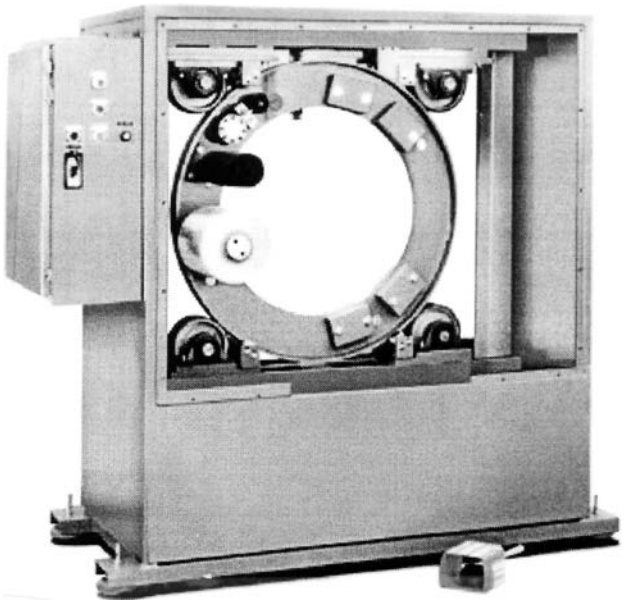

FIG. 2 Horizontal Stretch Bundling System (as defined in 16.2.2)

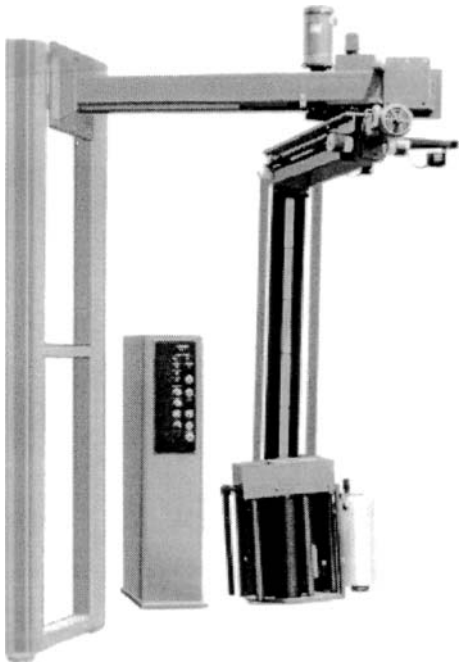

FIG. 3 Rotating Arm Stretch Film System (as defined in 16.2.3)

16.2.3.1 Semi-automatic and automatic,

16.2.3.2 Film is stretched and applied in a horizontal circle around a stationary load,

16.2.3.3 Film elongation as measured on load typically range from 100 to 300 %,

16.2.3.4 Post Stretch/Force to Load controlled by machine setting, and

16.2.3.5 Products are typically wrapped at speeds of 25 to 35 loads per hour (semi-automatic) and 35 to 70 loads per hour (automatic).

16.3 *Hand Application*

16.3.1 *Extended Core* (see Fig. 4):

16.3.1.1 Core typically extends 5 in. from film edge,

16.3.1.2 An operator manually grips core extensions, and

16.3.1.3 Film elongation as measured on load typically range from 20 to 80 %.

16.3.2 *Hand Wrap Dispenser* (see Fig. 5):

16.3.2.1 Tension controlled by adjusting knob for resistance of roll turning, and

16.3.2.2 Film elongation as measured on load typically range from 20 to 150 %.

16.3.3 *Manual Hand Application* (see Fig. 6):

16.3.3.1 No handles or machines used, and

16.3.3.2 Tension and stretch controlled with pressure from the hand on core or film edge.

16.3.4 *Hand Bundling Film* (see Fig. 7):

16.3.4.1 Extended core or handle insert typically used to apply film,

16.3.4.2 Tension and stretch controlled by grip on core or handle, and

16.3.4.3 Film elongation as measured on load typically range from 20 to 150 %.

17. Keywords

17.1 stretch wrap materials

FIG. 4 Extended Core Hand Film (as defined in 16.3.1)

FIG. 5 Hand Wrap Film Dispenser (as defined in 16.3.2)