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Standard Guide for Use of Stretch Films and Wrapping Application[1]

This standard is issued under the fixed designation D4649; 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 for the selection, specification, and use of stretch 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.

1.1.1 Performance characteristics of stretch film may be negatively affected by extreme temperatures.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

D907 Terminology of Adhesives

D996 Terminology of Packaging and Distribution Environments

D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

D1505 Test Method for Density of Plastics by the Density-Gradient Technique

D1746 Test Method for Transparency of Plastic Sheeting

D1894 Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheeting

D1922 Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method

D2103 Specification for Polyethylene Film and Sheeting

D2457 Test Method for Specular Gloss of Plastic Films and Solid Plastics

D2578 Test Method for Wetting Tension of Polyethylene and Polypropylene Films

D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

D3951 Practice for Commercial Packaging

D4321 Test Method for Package Yield of Plastic Film

D4470 Test Method for Static Electrification

D5331 Test Method for Evaluation of Mechanical Handling of Unitized Loads Secured with Stretch Wrap Films

D5414 Test Method for Evaluation of Horizontal Impact Performance of Load Unitizing Stretch Wrap Films

D5415 Test Method for Evaluating Load Containment Performance of Stretch Wrap Films by Vibration Testing

D5416 Test Method for Evaluating Abrasion Resistance of Stretch Wrap Films by Vibration Testing

D5458 Test Method for Peel Cling of Stretch Wrap Film

D5459 Test Method for Machine Direction Elastic Recovery and Permanent Deformation and Stress Retention of Stretch Wrap Film

D5748 Test Method for Protrusion Puncture Resistance of Stretch Wrap Film

D8314 Guide for Performance Testing of Applied Stretch Films and Stretch Wrapping

E96/E96M Test Methods for Water Vapor Transmission of Materials

E284 Terminology of Appearance

3. Terminology

3.1 *Definitions*—Terminology found in Terminology D996 shall apply.

[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.

4. Significance and Use

4.1 This guide is for user selection, specification, and application of stretch film materials. It may be used between the buyer and seller to arrive at purchase specifications.

5. Stretch Film Classification

5.1 *Stretch Film Uses*—The following are general uses of stretch films.

5.1.1 Used to bundle multiple smaller goods into a single larger entity.

5.1.2 Used to secure a handling base (skids, platforms, pallets, slip sheets, etc.) to a load to expedite handling.

5.1.3 Used to secure cushioning, edge protection, or other package components to an individual item (office furniture, windows, etc.).

5.1.4 Used as an environmental protection and tamper evidence for a load.

5.1.5 Used as a primary protective wrap for individual products (rolled products, metal coils, metal extrusions, wood molding, etc.).

5.2 *Stretch Film Types*—The following are general types of stretch film.

5.2.1 *Machine Stretch Film*—Typically sold in widths ranging from 20 in. to 30 in. and in a variety of thicknesses. It is typically sold on a 3-in. core and can be purchased in any length, although 3000 ft to 10 000 ft is most common.

5.2.2 *Hand Stretch Film*—Typically sold in widths ranging from 10 in. to 20 in. and in a variety of thicknesses. It is typically sold on a 3-in. core and can be purchased in any length, although 1000 ft to 2000 ft is common.

5.2.3 *Prestretched (oriented) Stretch Film*—Hand films that are stretched during the manufacturing process either in-line (oriented) or in a secondary operation (prestretched).

5.2.4 *Stretch Tape*—Typically sold in width ranging from 3 in. to 5 in. and comes in a variety of thicknesses. It can be used to bundle a series of objects, wrap a load that requires airflow or to handle goods temporarily for internal transport. It is generally applied by hand and the devices for application vary widely from grabbing an extended core to apparatuses that aid in the application of the film.

5.2.5 *Ventilated Stretch Film*—A film that has holes formed into it that allow airflow to enter and exit the load. It can be applied with all application methods discussed in Section 12.

5.3 *Stretch Film Classifications*—The following are general classifications of stretch films.

5.3.1 *Application Methods:*

5.3.1.1 *Hand Film*—For use in hand application of stretch film.

5.3.1.2 *Machine Film*—For use in powered stretch film application.

5.3.2 *Fabrication Methods:*

5.3.2.1 *Blown Extrusion*—Implies the bubble forming extrusion process used to manufacture the film.

5.3.2.2 *Cast Extrusion*—Implies the flat die extrusion method of manufacturing the film.

5.3.3 *Cling Mechanisms*—The cling should be facing inward on the load to prevent different loads from sticking to each other. If the cling side is not known, fold the film over on its self in either direction to determine which side has more cling.

5.3.3.1 *Two Sided*—Similar cling properties are found on both sides of the film.

5.3.3.2 *Differential Cling*—Superior cling properties are found on one side of the film and lower cling on the other.

5.3.3.3 *One Sided*—Cling properties are found on one side and no cling is found on the other side. Some one sided cling films have a slippery, non-cling side.

5.3.3.4 *No Cling*—No cling is found on either side of the film. These films' tails typically have to be tucked under a layer of film in the wrap pattern or heat sealed to ensure the film does not come unraveled in the transportation process.

5.3.4 *Layering During Extrusion:*

5.3.4.1 *Monolayer*—Single layer of material.

5.3.4.2 *Co-Extruded*—Multiple layers of material where used during extrusion.

5.3.5 *Ultraviolet Protective Film*—Protects the film from breaking down in the presence of the sun's ultraviolet rays.

5.3.6 *Anti-corrosive Films*—Works to prevent corrosion on metal products.

5.3.7 *Opaque/Tinted Films*—Colorants are an option as a load identification alternative or as a method to hide the product being transported.

6. Raw Materials

6.1 The following are typical materials included in the extrusion process of stretch film:

6.1.1 Linear low-density polyethylene (LLDPE),

6.1.2 Metallocene linear low density polyethylene (mLLDPE),

6.1.3 Polypropylene (PP),

6.1.4 Polyisobutylene (PIB) (tackifier),

6.1.5 Ethylene Vinyl Acetate (EVA).

7. Stretch Film and Additives' Characteristics

7.1 *Physical and Mechanical Properties:*

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

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

7.1.3 Some of the test methods described in Table 2 may be applied to multiple wraps or stretched specimens, or both, to aid in assessing their performance characteristics.

7.1.4 Other tests that may be of value for evaluating actual performance are given in Guide D8314.

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

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

7.4 *Static Discharge*—Some stretch films may build up static electrical charge. Care should be exercised in using these

TABLE 1 Physical and Mechanical Properties of Materials

Property	Common Unit	SI Unit	ASTM Test Method
Breaking factor	lbf/in.	kN/m	D882
Clarity	%	%	D1746
Cling (peel)	gm	N	D5458
Coefficient of friction at approximately 72 and 100°F (22 and 38°C)	...	...	D1894
Density	lbf/in.^{3}	g/cm^3	D1505
Elastic recovery	%	%	D5459
Elongation at break	%	%	D882
Flammability	% 0	% 0	D2863
Force at elongation (50, 100, 150, 200 %)	lbf/in.	kN/m	D5459
Gloss	...	...	D2457
Haze	%	%	D1003
Protrusion puncture	in./lbf	Nm	D5748
Static electrification	V	V	D4470
Stress retention	%	%	D5459
Tear resistance (Elmendorf)	gm	N	D1922
Ultimate tensile strength	lbf/in.^{2}	Pa	D882
Water vapor transmission rate	g/24 h-100 in.^{2}	g/h-m^2	E96/E96M, Procedure E
Yield (coverage)	in.^{2}/lb	m^2/Kg	D4321

TABLE 2 Test Methods Related to Performance

Procedure	ASTM Test Method
Test Method for Evaluating Abrasion Resistance of Stretch Wrap Material	D5416
Test Method for Evaluating Load Containment Performance of Stretch Wrap Material by Vibration Testing	D5415
Test Method for Evaluation of Horizontal Impact Performance of Stretch Wrap Materials	D5414
Test Method for Evaluation of Mechanical Handling of Unitized Loads Secured with Stretch Wrap Materials	D5331

materials especially where potential flammable air vapor or air dust mixtures can exist.

7.5 *Unwind Noise*—Some stretch films are noisier than others during the application process. This may be a characteristic that needs to be considered for some applications.

8. Dimensions, Mass, and Permissible Variations

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

8.1.1 Thickness (gauge, microns, inches) is expressed in decimal form. For example, 80-gauge is also equal to 0.0008 inches. The 80-gauge film multiplied by 0.254 to equal 20.3 micron.

8.1.1.1 The actual wrap material thickness shall not vary more than ±10 % of the nominal thickness in any one point across the width.

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

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

8.1.3.1 Roll width tolerance is ±⅛ in. (3 mm) of the width as marked unless otherwise agreed upon between the buyer and the seller.

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

TABLE 3 Average Weight/Yield Tolerances for Stretch Wrap Material

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

TABLE 4 Unit Conversion Factors

Unit Conversion	
Gauge * 0.254 = Micron	Inch * 25.4 = Millimetres
Micron * 3.937 = Gauge	Millimeter * 0.0394 = Inches
Feet * 0.3048 = Metres	Pound / 2.2 = Kilograms
Meter * 3.2808 = Feet	Kilogram * 2.2 = Pounds
Pound Force * 4.44822 = Newtons	Newton /4.44822 = Pounds Force
Pound/in^3 * 27.6799 = g/cm^3	Pound/ft^3 * 0.0160184 = g/cm^3
Mil * 25.4 = Micron	Mil = 100 Gauge
Pound Force/in^2 * 6.895 = kPa	

8.1.5 The length per roll of film wrap materials shall be within ±5 % of the length as marked, or as otherwise agreed between the buyer and the seller as measured by a wheel counter that presses on the film roll as it is being unwound from the roll but before the film is pulled off the roll. (Films may extend or contract after the film is removed from the roll. This may produce an inaccurate length measurement.)

8.1.6 A unit conversion table is found in Table 4.

9. Workmanship, Finish, and Appearance

9.1 Films shall be generally free from imperfections that may affect the performance such as wrinkles, creases, soft spongy areas, damaged edges, and inconsistent thicknesses.

9.1.1 No splices are allowed.

10. Sampling

10.1 Samples should not be taken within the initial 2 % or the last 2 % of the length of the roll; regardless remove enough film to ensure that damaged or poorly wound film is not used for test samples.

11. Ordering and Shipping Information

11.1 The following should be included when ordering stretch film.

11.1.1 Film thickness.

11.1.2 Film width.

11.1.3 Film length per roll.

11.1.4 Core dimensions (inside diameter and extension).

11.1.5 Identification of machine or hand film.

11.1.6 Identification of any other classifications found under Section 5.

11.1.7 Quantity.

11.1.8 Delivery locations.

11.1.9 Where necessary, ordering information may be expanded per customer request.

11.2 Shipping container or individual rolls, or both, shall be labeled in accordance with Practice D3951 with the following additional markings:

11.2.1 Product name.

11.2.2 Thickness.

11.2.3 Material width.

11.2.4 Material length per roll.

11.2.5 Material weight per roll.

11.2.6 Manufacturer's or seller's name.

11.2.7 Lot or serial number on the individual roll, pallet, or case.

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

12. Considerations for Application

12.1 *Wrap Patterns*—Infinitely variable but typically consist of:

12.1.1 *One-Way Spiral*—Typically started on the bottom or the top of the load. The stretch wrapper makes a single spiral pass over the load with overlap varying from 20 % to 80 %.

12.1.2 *Two-Way Spiral*—Typically started on the top or bottom of the load. The stretch wrapper makes two complete spiral passes (for example, up and down) over the load without breaking the film web. Overlap is between 20 % and 80 %.

12.1.3 *Additional Top and Bottom Wraps*—Multiple layers of overlap on the top and bottom of the load are applied in addition to a cross spiral pattern (12.1.2) base.

12.1.4 *Top Overwrap*—The amount that the film is allowed to wrap over the top surface of the load.

12.2 *Stretch Roping*—Roping is achieved by taking either part or the entire film web and curling or bunching into a single "strand" of film. This technique is used for stabilizing heavy loads and to better connect the contents on the load to the pallet. Note that by using roped stretch film it is very easy to create a high point load on corners of a load, potentially damaging delicate goods during the wrapping process.

12.2.1 *Hand Application of Rope*—The film roll is held sideways (roll is parallel to the floor) as the film is applied to the load.

12.3 *Percent Prestretch and Post-Stretch*—In general, the more stretch imparted on a given film, the more stiff (harder to stretch further) the film will become. As the film is stretched generally the film stiffness, cling levels, load containment, and puncture resistance may change. This is due to the aligning of the polymer chains during the stretching process.

12.4 *Shelf Life of Film*—Depending on storage conditions the quality of the film or the core can degrade over time, utilize first-in-first-out inventory management when possible. Exposure to extreme temperatures, sunlight, and humidity can significantly affect the length of this period.

12.5 *Securing the Pallet*—Securing the pallet and the load together with stretch film helps to keep the load together, reducing the potential for load shift during transit.

12.6 *Wrapping Consistency Evaluation*—Film stretch and containment force should be reevaluated on a minimum quarterly basis to ensure machine operation is consistent with the standard operating procedure.

12.7 *Methods of Securing the Film Tail:*

12.7.1 The cling properties of the film are used to secure the tail in place, recommended length is ½ to ¾ the width of a load.

NOTE 1—Clockwise from left, Pole applicator, end plugs to protect hands during application, and film applicator with tensioner.

FIG. 1 Hand Wrap Film Dispensers (see 13.3)

12.7.1.1 The film tail can be tucked under a previous wrap(s).

12.7.1.2 The film tail can be heat sealed to the wrap(s).

13. Application Devices

13.1 Stretch film may be applied either by machine or by hand. Machine application provides more consistency and control for wrapping of a load. Hand application is more variable due to operator control of film coverage, placement of the film, and the amount of tension applied. Any method of application can be used in conjunction with a conveyor.

13.2 *Types of Stretch Devices*

13.2.1 *Brake Devices*—A brake device stretches film using only tension between the film roll (or application device) and the load to be wrapped on more basic wrappers.

13.2.2 *Non-Powered Prestretch*—A set of fixed gears is used to stretch film to a percentage of its original length. The levels of stretch that can be selected are limited to the ratios which can be achieved by changing out machine parts in the film carriage.

13.2.3 *Powered Prestretch*—A power assisted version of non-powered prestretch, again using fixed gears.

13.2.4 *Variable Prestretch*—An adjustable stretch version of the powered prestretch where the percent stretch can be changed by the operator either between wraps or mid wrap pattern.

13.3 *Hand Wrap Dispenser* (see Fig. 1). Will range from handling the core directly to an apparatus that holds the film and can control tension during application. For the safety of both handlers and load contents, a clear Standard Operating Procedure should be composed and followed. Film is typically stretched between 0 % and 50 % during application. When applying film by hand, attempt to emulate the wrap patterns stated in Section 12.

FIG. 2 Turntable Stretch Wrap System (see 13.4.1)

FIG. 3 Rotating Arm Stretch Film System (see 13.5)

13.3.1 *Optional Techniques beyond the standard wrap patterns include:*

13.3.1.1 *Butterflying*—Rotating the roll on its vertical axis during the application process. If this is part of the SOP, it is not recommended that single sided cling film is used as the cling will only be on the inside 50 % of the time.

13.3.1.2 *Over the Corner*—Pulling the film over the corner during the application process to help secure the corner of the load.

13.3.1.3 *Band Wrap*—Wrapping around the top of the unit load to temporarily secure the load.

13.4 *Machine Application*—Can be manual, semiautomatic, and automatic and offer a wide variety of features.

13.4.1 *Turntable Wrapper* (see Fig. 2).

13.4.1.1 Load turns on a spinning table as the film is applied therefore the load must be stable enough to handle the force from the film and the centrifugal forces.

13.4.1.2 The film carriage travels up and down as the film is applied.

13.4.1.3 The film carriage is available in prestretching and brake device variants.

13.4.1.4 *Turntable Height*—Turntables are available in two different heights, low and high.

(1) Low Turntables—The turntables are close to the ground, typically less than 4 inches in height. Can be loaded with both hand jack and fork truck.

(2) High Turntables—The tables are higher than 4 inches off the ground. They allow for more pallet coverage when applying film and easier loading for fork truck drivers.

13.4.1.5 Consider the size (tower clearance) and weight (max table weight) of the load to be wrapped.

13.5 *Rotating Arm/Straddle Wrapper* (see Fig. 3).

13.5.1 The load is placed on the floor under the arm or it is brought to the wrapping station on a conveyor and the film carriage travels around the load to be wrapped.

13.5.2 The film carriage travels up and down as the film is applied.

13.5.3 Consider the size of the load to be wrapped versus the diameter of the available wrapping area.

13.5.4 Used for unstable loads that cannot be rotated.

13.5.5 Used for very heavy loads that cannot be put on a turntable or conveyor.

13.5.6 Better suited for high speed application because the load is not exposed to centrifugal forces during wrapping.

13.6 *Self-Propelled Robotic Stretch Wrapper* (see Fig. 4).

13.6.1 The pallet load is placed on the floor, typically at the same location it was loaded with product, and the stretch wrapper is brought to it for stretch wrapping.

13.6.2 The stretch wrapper travels around the pallet load to apply stretch film.

13.6.3 A guide wheel maintains contact with the pallet load to guide the stretch wrapper around differing pallet sizes.

13.6.4 The film carriage travels up and down as the film is applied.

13.6.5 Used for unstable loads that cannot be transported prior to stretch wrapping.

13.6.6 Used for facilities with space constraints that must store the stretch wrapper out of the way when not in use.

13.6.7 Used for very large loads which would otherwise require very large turntable or rotary arms.

13.6.8 Used for very heavy loads that cannot be put on a turntable or conveyor.

13.7 *Vertical Ring Wrapper* (see Fig. 5).

13.7.1 The film carriage travels on a circular track that travels up and down.

13.7.2 Multiple film heads can be added.

13.7.3 Consider the diameter of the wrapping area versus the diameter of the load to be wrapped.

13.7.4 Used for unstable loads that cannot be rotated.