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Cotton Module Cover Material Performance

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Cotton Module Cover Material Performance

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1 Scope

1.1 This standard was developed for and applies to material covers for rectangular-shaped and cylindrical cotton modules.

1.2 This performance standard applies to materials used to manufacture covers intended to protect cotton modules after harvest from rain and wind exposure during outdoor storage, minimizing the fiber quality damage and fiber loss that can occur under poor storage conditions.

1.3 Rectangular module covers are typically used over multiple harvest seasons where they experience exposure to wind and ultraviolet (UV) radiation (sunlight). For rectangular module covers, mechanical motion from wind and other sources has been found to be the dominant factor contributing to material degradation. This standard specifies a minimum ability to maintain water penetration resistance following mechanical flexing for rectangular module covers.

1.4 Rectangular module cover materials may be constructed of natural or man-made fibers, tapes, film (woven or extruded) or a combination of fibers that may be coated and have UV inhibitors added. Although some covers will include sections of materials that are connected by seams, reinforcements, and/or have fused intersections and have grommets inserted to tie down or secure the cover onto a cotton module with ropes or cords, this performance standard only applies to the material used to form the top surface of the rectangular module cover. For cylindrical module covers, this performance standard applies to single layer and combined layer, natural or man-made materials as specified.

1.5 The physical test requirements for materials used in rectangular module covers are those that can predict functional protection and reasonable durability for extended periods of use. The tests for rectangular covers are intended to evaluate the degradation of resistance to water penetration after repeated mechanical flexing (similar to wind motion).

1.6 Plastic film covers used on cylindrical modules are single use covers that are applied under tension to protect and restrain the cotton in cylindrical form. Unlike rectangular module covers, degradation due to wind exposure is not a primary concern for cylindrical module covers. For cylindrical module covers, the primary focus is on puncture, tear, impact resistance, and the ability to provide structural stability to the module. Compromised cylindrical module covers not only risk loss of quality and quantity of lint and seed, but also increase the likelihood of plastic contamination in lint bales.

1.7 For cylindrical module covers, this performance standard is focused on single use plastic film covers. The use of other materials is not prohibited; however, the testing protocols in this standard may not be appropriate for other materials.

1.8 The laboratory testing methods specified for cylindrical module covers are intended to evaluate tear, puncture, and impact resistance of the material in multi-layer combinations as applied to a cylindrical module, as these have been common modes of failure for the multi-layer film materials in current use. In-field testing of

module cover materials applied to cylindrical cotton modules is intended to evaluate the ability for the cover material system to protect and restrain the cotton under prolonged exposure to environmental effects.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies unless noted. For undated references, the latest approved edition of the referenced document (including any amendments) applies.

2.1 ANSI/ASAE/ASABE

ANSI/ASAE S392, Cotton Module Builder and Transporter Standard

ANSI/ASABE S647, Seed Cotton Module Identification System

2.2 AATCC Test Methods

AATCC TM20, Fiber Analysis: Qualitative

AATCC TM42, Water Resistance: Impact Penetration Test

2.3 ASTM International Standards

ASTM D3775, Test Method for Warp (End) and Filling (Pick) Count of Woven Fabrics

ASTM D3776, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric

ASTM D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting

ASTM D1938, Standard Test Method for Tear-Propagation Resistance (Trouser Tear) of Plastic Film and Thin Sheeting by a Single-Tear Method

ASTM D2582, Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting

ASTM D3420, Standard Test Method for Pendulum Impact Resistance of Plastic Film

ASTM D6988, Standard Guide for Determination of Thickness of Plastic Film Test Specimens

ASTM F392, Standard Practice for Conditioning Flexible Barrier Materials for Flex Durability

2.4 National Cotton Council: “Just Tarp It: Selecting a Module Cover” brochure, 2004

2.5 Cotton Incorporated: “Seed Cotton Module Handling and Storage,” 2010

2.6 ISO/CIE (International Commission on Illumination)

ISO/CIE 11664-4:2019, Colorimetry — Part 4: CIE 1976 L* a* b* colour space

ISO/CIE 11664-6:2014, Colorimetry — Part 6: CIEDE2000 colour-difference formula

3 Terminology

3.1 cotton module, n.: a compressed bundle of seed cotton removed from plants at harvest that form a unit of a specific dimension for storage in fields prior to transportation to a cotton ginning facility

3.2 cover, n.: *for rectangular or cylindrical cotton modules,* protective material or combinations of materials sufficient in dimensions and form to protect a cotton module from exposure to rain and wind, and thus minimize fiber and seed quality degradation or loss prior to the ginning process

3.3 cover model, n.: *of a module cover,* a uniquely designed module cover described by a manufacturer, wholesaler or retailer as a marketable product identified by a model designation that is included on the label attached to the cover

3.4 cover top material, n.: *for a rectangular module cover model,* the material (film, coated woven, etc.) selected by the manufacturer to form the portion of the cover intended to resist water penetration into the cotton module during precipitation events

3.5 cylindrical module, n.: A cylinder with circular end diameters of approximately 2.4 m (7.8 ft) and length of 2.4 m (7.8 ft). The cylindrical module relies on the cover for both protection of the seed cotton from weathering and structural stability for the seed cotton to maintain a cylindrical shape.

3.6 module axis, n.: direction parallel to the cylindrical axis of a cylindrical module

3.7 module circumference, n.: direction parallel to the circumference of a cylindrical module and perpendicular to the module axis

3.8 rectangular module, n.: A rectangular profile module typically 9.75 m (32.0 ft) or 4.88 m (16.0 ft) in length and with a ground level width of 2.3 m (7.5 ft) and height of 2.4 m (8.0 ft). A rectangular module is composed of free-standing seed cotton, and a cover is primarily for the protection of seed cotton from wind and precipitation.

4 Uses and Significance

4.1 This standard specifies minimum physical testing criteria for two levels (acceptable and superior) of performance for rectangular module cover materials in providing resistance to moisture penetration. This standard also specifies the minimum physical testing and in-field system performance criteria of cylindrical module covers to maintain module structural integrity and to provide resistance to quality losses. This standard offers manufacturers and distributors of module covers a guideline for the development and selection of candidate materials for use in the cotton industry and is intended to discourage the marketing of covers manufactured with inferior quality material, which may lead to quality losses and increased risk of lint bale contamination.

4.2 The performance criteria for cylindrical module covers include laboratory testing of the cover materials in addition to field testing to ensure that the cover adequately restrains and protects the cotton through prolonged exposure to environmental effects. Laboratory tests that mimic use situations for rectangular module covers are an accepted practice that allows for comparable materials or products to be evaluated on the same basis.

4.3 Length of use

4.3.1 Rectangular module covers typically are used in field application for a season lasting for weeks or months and then stored for use again during a subsequent harvest season. Workers apply module covers to the cotton after it is compressed into rectangular module form by a module builder. Rectangular module covers typically are used for two or more seasons, and degradation of the water penetration resistance by ambient exposure can result in loss of cotton fiber and seed quality and associated market value. Therefore, the prediction of satisfactory performance is related to the durability of module covers and the cover top materials from which they are manufactured. Other factors, including storage conditions, age, and handling can affect the performance of covers. See information in Referenced Document 2.4 for proper care guidelines.

4.3.2 Cylindrical module covers are typically single use materials and can remain applied to cylindrical modules for weeks or months prior to being cut from the module and removed at the gin. Cylindrical module covers are applied to cotton modules automatically by the harvester just after the point of harvest. The cylindrical module shape and cover provide resistance to water penetration. Tear, puncture, and impact resistance are critical cover material characteristics that preserve the integrity of the cover, allowing it to protect the cotton and maintain the cylindrical shape. Compromised cover integrity can not only result in a loss of cotton fiber and seed quality but also provide a source of plastic contamination in the seed cotton presented at the gin.

4.4 It should be recognized that rectangular module cover materials can be produced with an almost infinite number of combinations of construction variables (types of fibers, percentage of fibers, fabric count per unit distance, and chemicals). The user of module covers may find acceptable products that do not conform to all of the requirements in Section 9. Hence, no single performance specification can apply to all the various module cover materials that could be utilized for this end use.

4.5 Rectangular module covers are intermittent use products, and manufacturers may only produce or purchase materials from their suppliers annually. As a result, production lots of cover top material with identical specifications will be produced, manufactured, or purchased at different times. Results of performance testing in accordance with this standard will be considered valid for a period of four years, providing none of the material characteristics or suppliers have been changed.

4.6 Each rectangular cover will have the protective top manufactured from a base material with specific characteristics (see Table 1). For the purposes of this standard, changes in the specified characteristics of the primary material of the top will constitute a different material. Modification or any change of the material characteristics or supplier will require testing to this standard performance specification. Testing results obtained from this standard can be applied to any rectangular module cover model that uses the identical top material.

4.7 Results of performance testing on cylindrical module covers will be considered valid for a period of five years, providing none of the material characteristics or cover system design specifications have been changed.

4.8 Rectangular module cover materials that meet or exceed the performance specifications given in Section 9 can be described with the statement, “When manufactured, the material forming the top of this cover met the requirements for acceptable/superior performance under ASABE Standard S615.” Either the word “acceptable” or “superior” should be included based upon meeting the performance criteria specified in Section 9. This statement may be included in the product label attached to the module cover and in advertising materials.

4.9 Cylindrical module cover materials that meet or exceed the performance specifications given in Section 9 can be described with the statement, “The material system forming this module cover met the requirements for acceptable performance under ASABE Standard S615 for cold to moderate / moderate to warm / all intended use environments.” Either the words “cold to moderate”, “moderate to warm”, or “all” should be included based upon field testing environmental conditions (see section 8.4). This statement may be included in the product label attached to the module cover and in advertising materials.

5 Module Cover Description

5.1 Rectangular module covers

5.1.1 For rectangular module covers, the top material may be constructed of any composition that meets the “acceptable” performance specifications stated in Section 9.

5.1.2 For rectangular modules, the side materials may be the same or different materials as the top piece of a module cover.

5.1.3 The top and sides pieces of a rectangular module cover may have sewn or fused seams, tape or metal reinforcements, and have metal grommets. Acceptable seams, whether sewn with thread or fused, are those that provide both strength and water penetration resistance.

5.2 Cylindrical module overs

5.2.1 The testing protocols in this standard are specific to plastic film materials.

5.2.2 Other materials may be appropriate for cylindrical module covers; however, many of the testing protocols in this standard are only appropriate for plastic films.

5.2.3 Cylindrical module covers should be constructed such that they do not interfere with the continuous operation of the cotton harvester. Adhesive materials used on cylindrical module covers shall not be deposited

on any part of the harvester. Cylindrical module covers shall be manufactured to proper width dimensions to prevent tearing of the sides of the film during the application of a cover to a module on the harvester. The cover should form a taught, well-defined shoulder around the edge of both flat faces of a cylindrical module so that the film is not loosely exposed. Loose cover material around the shoulders of a cylindrical module increases the likelihood of the cover being damaged during handling in the field and at the gin. Cylindrical module covers shall be constructed so that they are able to withstand normal wear experienced during handling and transportation from the field to the gin.

5.2.4 In efforts to detect and remove contaminants from seed cotton, the color of cylindrical module covers is critical to facilitating efficient detection using digital color imaging technology, and for employees to visually detect loose cover material when covers are removed prior to ginning. Material colors that do not overlap the typical cotton color space and that are easily detected by color imagers are ideal for use (e.g. cyan or blue with high color saturation). Other technologies may be included in the base film construction to facilitate detection of cover material in flowing seed cotton but should not hinder cover performance or detection by color imager-based systems. UV inhibitors should be included in the base film material to help prevent color change and material degradation over time.

5.2.5 Cylindrical module covers shall contain radio frequency identification (RFID) tags that conform to ASABE S647. A minimum of four RFID tags should be affixed to each module cover to aid in remote identification of cylindrical seed cotton modules and allow for the use of automated positioning systems that sense the position of modules based on RFID tag position.

6 General Module Cover Material Identification

6.1 Table 1 identifies the material characteristics and standard test methods rectangular module cover manufacturers and suppliers should use to select module cover materials and minimum documentation of the product and its manufacturing history.

6.2 Rectangular module cover identification should be relevant to understanding and interpreting required performance test results between module cover suppliers, ginners, cotton producers and agricultural researchers, who may supply, purchase, or use module covers.

6.3 Related to both rectangular and cylindrical module covers, chemicals used in the production of textile fabrics are subject to approval for use under restricted substances lists (RSL) in the U.S. and international markets. Information about chemical usage can be found at the Environmental Protection Agency (EPA) (see 11.1). The American Apparel and Footwear Association (AAFA) publishes a guideline list of restricted chemicals, which is updated periodically (see 11.2).

6.4 The manufacturer and its supplier shall declare and retain documentation that the chemicals used are not on the EPA or AAFA controlled or restricted substance lists (see 11.1 and 11.2).

6.5 The characteristics of the cover materials being tested should be described in detail. The following characteristics should be provided and attached to each rectangular module cover, as appropriate for the formulation/construction of the material. These characteristics should be in addition to the identifying information typically included on module cover labels (manufacturer, model number, year of manufacture, etc.).

6.5.1 Fabric count: tapes or threads per cm (in.), length and width directions

6.5.2 Coating type or composition

Table 1 – Rectangular module cover material and product identification

Material Characteristic	Standard Test Method	Other Source of Information
Fabric count, /cm (in.), warp × filling[a]	ASTM D3775	
Fiber content[a]	AATCC TM20	
Total material thickness[b]	ASTM D6988	
Coating or film, composition		supplier declaration
UV Inhibitor, chemical component		supplier declaration
Material supplier identifier		supplier
Production lot number		supplier

[a] Does not apply to film materials.
[b] Does not apply to woven or knit materials. If multiple layer product for cylindrical modules, report combined thickness of all layers that surround the cotton.

7 Rectangular Module Cover Material Testing Protocols

7.1 The material testing protocols described below prescribe the level of mechanical flexure and the method of determining moisture penetration following exposure. While module covers may experience simultaneous UV radiation and mechanical flexing, this standard is focused on mechanical degradation due to flexing.

7.1.1 Water penetration testing (section 7.4) should be performed on samples taken from the top cover material before and after flexure to document the change in performance of the product.

7.1.2 Manufacturers may use any qualified testing service providers to perform these tests.

7.2 Sampling cover material

7.2.1 All samples are to be taken from material intended to form the top of the module cover. Those samples may be selected from rolls of material prior to manufacturing or from the non-seamed regions of the top of a manufactured cover. For the purposes of the following description, the term “module cover” will be used, but it should be understood that a section (see 7.2.2) of material from a raw material roll is considered equivalent.

7.2.2 A minimum of three manufactured covers with an identical top material (as defined in section 3.3) should be selected to be evaluated under this standard. Preferably, each individual cover should be selected from different production lots or shipments. As an alternative, a 2.42 × 9.70 m (8 × 32 ft) section of the material can be taken from a roll intended for use as the top of a cover and substituted for a manufactured cover. If the roll of raw material is not at least 2.42 m in width, the full width of the roll should be used.

7.2.3 From each cover, cut a minimum of six (6) specimens (three (3) for “as manufactured” and three (3) for the mechanical flexure test) in pairings with one (1) specimen of each type. The specimens should be cut of the size required for the flexure testing (see 7.3.2). The three (3) pairs of specimens should be located near the opposite ends of the cover and near the middle of the cover, respectively. See Figure 1 for the approximate layout of the specimen sets. Individual specimens should be located to avoid seams or welds.

7.2.4 Sufficient material to obtain samples (as specified in 7.2.3) from each of the three (3) covers selected for specimen extraction should be retained under optimum storage conditions (as specified by the material manufacturer) for a period of four (4) years. Retention of these materials is intended to provide the opportunity for confirming tests if the initial test results are disputed during those four (4) years. Following the period of four (4) years after the official date of performance evaluation, the materials may be discarded.

7.2.5 The sampling instructions provided in this section may not be satisfactory for the establishment of statistical confidence in the comparison of different module covers.

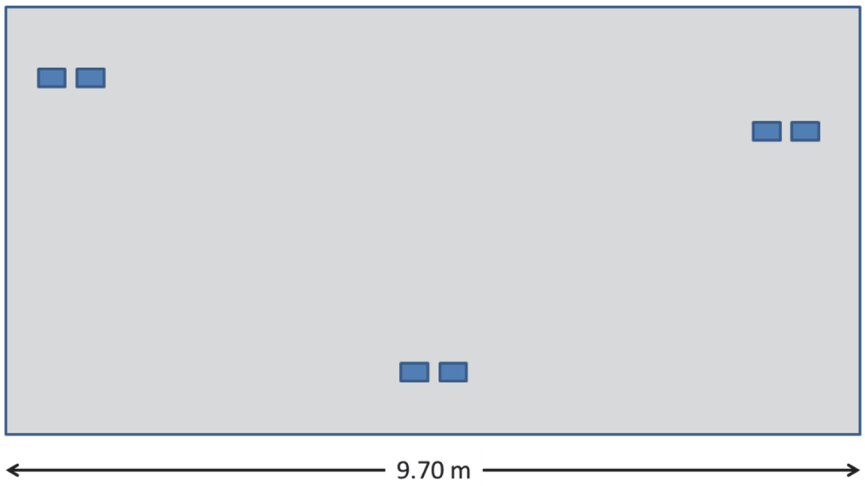

Figure 1 – Graphic shows desired layout of specimen collection sites on a cover top. Specimen collection sites are approximate and should be located to avoid seams or welds. Each specimen of the pair should be uniquely marked.

7.3 Mechanical flexure exposure protocol

7.3.1 Follow the ASTM F392, Test Method for Flex Durability of Flexible Barrier Materials, that uses a Gelbo Flex Tester with modifications as noted below.

7.3.2 From each of the three (3) module covers tested, cut three (3) 28 × 21 cm (11 × 8.5 in.) specimens with the long dimension in the length direction of the module cover material from location (as specified in 7.2.3). Mark each specimen with its sample identification on the top side (side intended to be exposed).

7.3.3 Mount a specimen on the test instrument's mandrel and tighten the pipe clamp according to the test method and instrument manufacturer's instruction with the specimen's top side oriented to the outside of the mandrel. Set the instrument for its long-stroke flex motion and 3,000 cycles.

7.3.4 Following the initial 3,000 cycles, remove the test specimen and invert it so that the top surface is to the inside of the mandrel. Reversing the orientation is intended to prevent possible bias from one-directional flexing.

7.3.5 Subject the specimen to another 3,000 cycles.

7.3.6 Continue alternating flexing until the specimen has experienced 12,000 cycles of flexure.

7.3.7 Assess the level of water resistance degradation (as specified in Section 7.4).

7.4 Water resistance protocol

7.4.1 Perform AATCC TM42, Water Resistance: Impact Penetration Test, on test specimens according to the standard with the following test procedure modification. This test should be performed identically for the unexposed specimens and those exposed to the flexure protocols.

7.4.1.1 Use a 15° angle set up rather than the prescribed 45° water impact angle. The reduced angle is used to better match the operating conditions for the module cover materials.

7.4.1.2 The specimen size is 28 × 21 cm (11 x 8.25 in), as required for the flexure exposure protocol. Although this is larger than the size specified in TM42 the specified procedures can be followed.

7.4.1.3 Attach a 2.27 kg (5 lbs.) weight to the clamp at the lower end of the test specimen to keep the specimen under tension.

7.4.2 The water resistance test should be conducted on each specimen four times. For each test, the orientation of the specimen should be reversed. Pinholes or cracks in the material can have an orientation, and having the specimen alternating direction will allow two tests at each orientation. Between each test, the specimen should be thoroughly dried and allowed to be exposed to air on both sides for at least 15 minutes before subsequent tests.

7.4.3 The mass of water passing through the specimen should be averaged for the four (4) tests, and that quantity compared to the allowable penetration water mass following exposure (see section 8.1).

8 Cylindrical Module Cover Material Testing Protocols

8.1 Cylindrical module cover material sampling

8.1.1 For covers that form multi-layer film zones when applied to a cylindrical module, testing should be conducted on samples of the zone containing the minimum number of film layers. For example, for a cover that encircles the outside of a cylindrical module multiple times such that it produces a zone containing three (3) layers and a zone containing four (4) layers of film, testing should be conducted on samples collected from the three-layer zone.

8.1.2 A minimum of five (5) manufactured covers (as defined in section 3.2) should be selected to be evaluated under the laboratory testing portion of this standard (as defined in section 8.2). Preferably, each cover should be selected from different production lots or shipments. New covers that have not experienced any applied tension other than that imparted during manufacturing should be selected for testing. The tension required to remove the cover from a roll of manufactured covers is considered negligible. Covers from the same rolls selected for laboratory testing should be used to cover cylindrical modules used in the field testing portion of this standard (as defined in section 8.4). It is recommended that laboratory testing of cover material be successfully completed prior to field testing. Upon successful completion of laboratory testing, one (1) hand-layered round module cover from a roll selected for laboratory testing and prepared as outlined in section 8.1.3 shall be shipped to the National Cotton Council offices at 7193 Goodlett Farms Pkwy, Cordova, TN 38088.

8.1.3 Prepare the material from each cover selected for testing by cutting and hand layering the appropriate material layer segments. The composite layer sampled for testing shall be of the film material combination representing the area of the cover expected to have the lowest strength and tear/puncture propagation resistance levels. With the multi-layer combinations prepared from each cover, cut a sample of the multi-layer composite material large enough to complete each of the tests outlined in section 8.2. Do not include areas used to secure the cover (e.g., areas of localized adhesive or special closure materials or devices) or areas of transition between different materials.

8.1.4 Sufficient material to obtain samples (as specified in sections 8.2.1 to 8.2.5) from each of the five (5) covers selected for specimen extraction should be retained under optimum storage conditions (as specified by the material manufacturer) for a period of three (3) years. Retention of these materials is intended to provide the opportunity for confirming tests if the initial test results are disputed during those three (3) years. Following the period of three (3) years after the official date of performance evaluation, the materials may be discarded.

8.1.5 The sampling instructions provided in this section may not be satisfactory for the establishment of statistical confidence in the comparison of different module covers.

8.2 Cylindrical module cover: laboratory testing

8.2.1 Tensile strength shall be determined in both directions (module circumference and module axis) according to ASTM D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting. Specimen width used in testing shall be 25.4 mm (1 in.). The testing instrument shall use an initial grip separation distance (gauge length) of 50 mm (2 in.) and the specimen length must be long enough to span the grip separation distance and allow for proper engagement by the grips. The rate of grip separation shall be 500 mm/min (20 in./min)

8.2.2 Tear-propagation resistance shall be determined in both directions (module circumference and module axis) according to ASTM D1938, Standard Test Method for Tear-Propagation Resistance (Trouser Tear) of Plastic Film and Thin Sheeting by a Single-Tear Method. Specimen size shall be 76.2 mm (3 in.) long by 25.4 mm (1 in.) wide.

8.2.3 Puncture-propagation tear resistance shall be determined in both directions (module circumference and module axis) according to ASTM D2582, Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting. Specimens shall be a minimum of 203 mm (8 in.) long in the direction of the tear and approximately 203 mm (8 in.) wide. The test instrument shall use a 1.36 kg (3 lb) carriage weight and a drop height of 508 mm (20 in.).

8.2.4 Resistance to impact-puncture penetration shall be determined according to ASTM D3420, Standard Test Method for Pendulum Impact Resistance of Plastic Film, Procedure A. Specimen should be approximately 102 mm (4 in) diameter or 102 by 102 mm (4 x 4 in) square as required to fit the test instrument aperture.

8.2.5 Thickness shall be determined according to ASTM D6988, Standard Guide for Determination of Thickness of Plastic Film Test Specimens.

8.2.6 Manufacturers shall use an independent qualified testing service provider to perform these tests.

8.2.7 Cylindrical module cover laboratory testing minimum acceptable performance levels shall be determined according to Table 4. Group and Single threshold values are listed in Table 4 for the tests specified in 8.2.1–8.2.5. The Group threshold is the value which must be met or exceeded by the mean of all covers tested (e.g. the overall mean of all covers tested). The Single threshold is the value which must be met or exceeded by the mean of the measurements conducted on an individual cover (e.g. the mean of 10 measurements conducted on one (1) cover). Both Group and Single threshold values must be met to meet minimum acceptable performance under this standard.

8.3 Cylindrical module cover: color

The color of plastic film used to construct cylindrical module covers shall not be of colors that are difficult to detect in seed cotton by color imager-based detection systems such as clear, white, tan, brown, or black. The recommended color of plastic film shall have lightness (L), chroma (C), hue (H), and delta E values according to the CIELCH color model (ISO/CIE 11664-4:2019) and CIEDE2000 standard (ISO/CIE 11664-6:2014) as specified in Table 4. Cover color shall be measured on the top half of the module cover at the beginning of the field testing period and again after six (6) months to ensure that the color does not fade or change more than delta E = 2.0 (CIEDE2000) as calculated from the initial and six (6) month color measurements.

8.4 Cylindrical module cover: field testing

8.4.1 Field testing of cylindrical module covers shall be conducted to confirm that the cover, when performing as an applied system, properly restrains and protects the stored cotton over prolonged exposure to environmental weathering effects. For field testing, a minimum of 24 cylindrical modules shall be formed and covered on a properly equipped cotton harvester, transported from the field to the storage location using common industry practices (module moving equipment and transport vehicles), and stored for a period of six (6) months. Average module diameter measured in the field (average diameter = vertical + horizontal diameters / 2, measured on both flat sides) shall be 239 ± 5 cm (94 ± 2 in.) for all test modules. The maximum module diameter setpoint on the harvester shall be used to form the test modules. The storage location shall be a well-drained prepared surface free from materials that may cut or puncture the wrap material (plant stalks, rocks, other debris) and have full sun/sky exposure. Only modules with undamaged covers after positioning on the storage area surface shall be used in field testing. The modules shall be placed on the storage surface with cylindrical axes parallel to the Earth's lines of latitude and with the modules rotated so that the outer tails of the covers (containing tail adhesive) receive maximum Sun exposure for the storage surface location in the northern or southern hemisphere. Adequate space is required between modules so that testing personnel can easily access the covered and exposed surfaces of each module. The cylindrical modules shall be evaluated weekly for the first two (2) months, then at least monthly thereafter for deficiencies in cover integrity. Cylindrical module covers shall be evaluated for cover tail adhesive separation (see sections 8.4.3 and 8.4.4), breaks in cover material (see section 8.4.5), tail adhesive slip (see section 8.4.6), cover system failure (see section 8.4.7), and module squat ratio (see section 8.4.8). Field testing of cylindrical module covers shall be conducted in an environment corresponding to the

intended use environment (Table 2). For example, cylindrical module covers intended for use in growing areas with low temperatures during harvesting and ginning season should be tested in environment A which is similar to the climate of Lubbock, TX. Those only intended for use in moderate/warm climates should be tested in environment B, which is similar to the climate of Corpus Christi, TX. If a cylindrical module cover is intended for use in all climates, then it should be field tested in environments A and B. Cylindrical module cover field testing performance levels for acceptable performance under this standard shall be determined according to Table 5.

8.4.2 Environmental conditions for field testing of cylindrical module covers are shown in Table 2.

Table 2 – Storage environments for field testing cylindrical module covers

Environment	Annual Temperature Range	Annual UV Index Range
A (cold to moderate)	–12°C to 38°C (10°F to 100°F)	3–8
B (moderate to warm)	0°C to 39°C (32°F to 102°F)	4-11+

8.4.3 Cover tail adhesive separation, minor: a layer separation between the outer tail section containing the tail adhesive and the next inner film layer that has length (along the module axis) less than 10 in. or depth (along the module circumference) less than two (2) in.. No more than three (3) minor separation zones shall occur on a module cover with minor tail adhesive separation.

8.4.4 Cover tail adhesive separation, major: a layer separation between the outer tail section containing the tail adhesive and the next inner film layer that has length (along the module axis) greater than 10 in. or depth (along the module circumference) greater than two (2) in.; or more than three (3) cover tail adhesive separation, minor zones.

8.4.5 Breaks in cover material: any single or multi-layer material breaks, splits, or other ruptures caused by weathering or material weakening during storage.

8.4.6 Adhesive slip: any displacement in the direction of the module circumference of the cover tail section (containing tail adhesive) relative to its initial position on the next film layer inside. Adhesive slip can occur with or without the occurrence of cover tail adhesive separation.

8.4.7 Cover system failure: any cover that has a complete separation of the outer tail section from the module and/or exposure of seed cotton in a cylindrical module around the module circumference along full or partial length of the module axis caused by any single or combination of factors experienced during storage.

8.4.8 Module squat ratio: module squat ratio is defined as the horizontal diameter divided by the average of the horizontal and vertical diameters of the flat face of a cylindrical module. The average ratio is to be determined for a cylindrical module from measurements taken on both flat faces. Module squat shall be measured after ejection from the harvester and again after two (2) months of storage.

9 Cover Material Performance Requirements

9.1 Table 3 shows pertinent physical characteristics and acceptable levels of performance for rectangular module covers. Manufacturers and suppliers may have different (higher) performance requirements for manufacturing product material specifications.

Table 3 – Rectangular module cover material specification requirements

Characteristic	Requirements, Minimum	Section
Water resistance after flexure exposure	Acceptable: minimum of 6 of 9 specimens allow less than 1 g of water to penetrate at 12,000 cycles, and each specimen must retain its physical integrity (i.e. no rips, holes, delamination etc. that would affect performance in field applications) Superior: 9 of 9 specimens allow less than 1 g of water to penetrate at 12,000 cycles, and each specimen must retain its physical integrity (i.e. no rips, holes, delamination etc. that would affect performance in field applications)	7.4

9.2 The values included in Table 4 specify minimum physical characteristic and performance levels for cylindrical module covers to achieve compliance with this standard. Manufacturers and suppliers may have different (higher) performance requirements for manufacturing product material specifications.

Table 4 – Minimum cylindrical module cover material performance specifications for certification. Group threshold values are those which the mean of the cover sample group (minimum of 5 covers, see section 8.1.2) must meet or exceed for certification. Single threshold values are those which the mean of measurements on a single cover sample must meet or exceed for certification.

Characteristic			Module Circumference	Module Axis	Section
Tensile strength	Maximum load	Group	151 N (34.0 lbf)	162.4 N (36.5 lbf)	8.2.1
		Single	99.6 N (22.4 lbf)	131.2 N (29.5 lbf)	
	Elongation	Group	716%	835%	
		Single	603%	757%	
Tear-propagation resistance	Maximum load	Group	22.4 N (5.0 lbf)	25.5 N (5.7 lbf)	8.2.2
		Single	21.0 N (4.7 lbf)	23.3 N (5.2 lbf)	
Puncture-propagation tear resistance	Tear resistance	Group	120.0 N (27.0 lbf)	129.2 N (29.0 lbf)	8.2.3
		Single	117.8 N (26.5 lbf)	125.1 N (28.1 lbf)	
	Tear length[a]	Group	50.5 mm (1.99 in.)	47.3 mm (1.86 in.)	
		Single	51.3 mm (2.02 in.)	48.6 mm (1.91 in.)	
Impact-puncture penetration resistance		Group	4.23 J		8.2.4
		Single	3.91 J		
Thickness		Group	219 µm (8.62 mils)		8.2.5
		Single			
Color	Allowable: Any color film except for clear, white, tan, brown, or black. Recommended: L = 68.42, C = 40.14, H = 235.94°, delta E = 2.0				8.3

[a] Group and single values listed for tear length are maximum values that must not be exceeded for certification.

9.3 Cylindrical module cover field testing parameters are listed in Table 5. These parameters establish the levels of allowable performance acceptable for compliance with this standard.

Table 5 – Cylindrical module cover field testing performance levels for certification under this standard

Parameter	Requirements	Section
Cover tail adhesive separation, minor	No more than 10% of test modules	8.4.3
Cover tail adhesive separation, major	No more than 10% of test modules	8.4.4
Breaks in cover material	No more than 10% of test modules	8.4.5
Adhesive slip	No more than 10% of test modules	8.4.6
Cover system failure	Zero test modules	8.4.7
Module squat ratio	Maximum ratio of 1.07	8.4.8

10 Reporting

10.1 For rectangular module covers, report the following information, as appropriate for the material tested.

10.1.1 Supplier company name

10.1.2 Supplier cover model number

10.1.3 Cover material production lot number

10.1.4 Fiber content

10.1.5 Coating/composition

10.1.6 UV inhibitor, chemical component

10.1.7 Fabric weight, g/m^2 (oz/yd^2) (non-film materials only) (ASTM D3776)

10.1.8 Fabric count, tapes/cm (tapes/in.), warp × filling (non-film materials only)

10.1.9 Total material thickness for film materials

10.2 For cylindrical module covers, report the following information for the material tested.

10.2.1 Cover manufacturer name

10.2.2 Cover product name

10.2.3 Cover intended use environment

10.2.4 Serial or identifier numbers for the specific covers tested

10.2.5 Year of cover manufacture

10.3 Report the following information regarding the testing conducted for both rectangular and cylindrical module covers.

10.3.1 Date(s) of testing

10.3.2 Name of laboratory conducting test

10.3.3 Name of individual responsible for conducting test

10.3.4 Manufacturer, model and settings of machines used to test material samples

10.4 Report the following test results for rectangular module covers:

10.4.1 The number of the “as manufactured” specimens (not exposed to flexure) that prevented more than one (1) gram of water to penetrate the specimen and the total number tested.

10.4.2 The number of the specimens exposed to flexure that prevented more than one (1) gram of water to penetrate the specimen and the total number tested.

10.5 Report the following for cylindrical module covers:

10.5.1 The tensile strength maximum load and elongation values for each of the five (5) samples measured in both the circumference and axial directions. Report the five-sample group average and standard deviation for maximum load and elongation.

10.5.2 The tear propagation resistance in the circumference and axial directions for each sample and the average and standard deviation of the five-sample groups.

10.5.3 The puncture propagation tear resistance and tear length in the circumference and axial directions for each sample and the average and standard deviation of the five-sample groups.

10.5.4 The impact-puncture penetration resistance recorded for each of the five samples tested and the average and standard deviation of the five-sample group.

10.5.5 The thickness of each sample measured and the average and standard deviation of the five-sample group.

10.5.6 Report the following climate data measured at the storage site for each month during field testing of cylindrical modules: mean maximum daily air temperature, mean minimum daily air temperature, monthly rainfall/snow depth, and mean wind speed.

10.5.7 The percent of test modules with cover tail adhesive separation, minor/major.

10.5.8 The percent of test modules with breaks in cover material.

10.5.9 The percent of test modules with adhesive slip.

10.5.10 The percent of test modules with cover system failure.

10.5.11 The module squat ratio for each module in the test group and the average and standard deviation for the module test group as measured just after ejection from the harvester and after two (2) months of storage.

10.5.12 Photos of modules in field testing will be provided to the National Cotton Council staff on a monthly basis. A minimum of four (4) photos should be submitted for each module. The four (4) photos should include a view across the full width of the module showing the outer tail of the module wrap, a view of the side of the module opposite from the outer tail, and views of both flat faces of the module. A photo(s) showing the entire group of modules at the storage location should also be submitted.

11 Notes

11.1 EPA information on toxic substances can be accessed at http://www.epa.gov/lawsregs/topics/toxic.html

11.2 AAFA Restricted Substance List can be accessed at https://www.wewear.org/industry-resources/ restricted-substances-list/english/

12 Information and Reference Sources

12.1 ASTM, http://www.astm.org/

12.2 AATCC, http://www.aatcc.org/

12.3 “Just Tarp It: Selecting a Module Cover” brochure, 2004 available at http://www.cotton.org/tech/quality/just-tarp-it.cfm

12.4 “Seed Cotton Module Handling and Storage,” 2010 available at http://www.cottoninc.com/fiber/AgriculturalDisciplines/Engineering/Cotton-Harvest-Systems/Cotton-Storage/SeedCottonHandlingStorage.pdf.

12.5 ANSI/ASAE S392, Cotton Module Builder and Transporter Standard available from the American Society of Agricultural and Biological Engineers, http://www.asabe.org or the American National Standards Institute, http:/www.ansi.org

12.6 ANSI/ASABE S647, Seed Cotton Module Identification System available from the American Society of Agricultural and Biological Engineers, http://www.asabe.org or the American National Standards Institute, http:/www.ansi.org

12.7 Luo, M.R., G. Cui, and B. Rigg. 2001. The Development of the CIE 2000 Colour-Difference Formula: CIEDE2000. *Color Research and Application* 26(5): 340-350.