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Standard Guide for Forensic Examination of Fabrics and Cordage¹

This standard is issued under the fixed designation E2225; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 ~~The intent of this~~ This guide is intended to assist individuals and laboratories ~~conducting that~~ conduct examinations of fabrics and cordage. It is not designed as a detailed methods description or protocol for the analysis and comparison of fabric and cordage evidence, but as a guide to an acceptable procedure to strengthen the usefulness of the analytical method cordage for the purposes of identifying and comparing types of fabric, cordage and damage. A complete characterization of the fabrics, including their construction and other materials used in the assemblage of a textile (for example, sewing thread), is a critical component of a comprehensive forensic fabric or cordage examination.

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 cannot replace knowledge, skills, or abilities acquired through education, training, and experience and is to be used in conjunction with professional judgment by individuals with such discipline-specific knowledge, skills, and abilities.*

1.4 *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.*

1.5 *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

[D123 Terminology Relating to Textiles](#)

[E1459 Guide for Physical Evidence Labeling and Related Documentation](#)

[E1492 Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory](#) 25-18

[E2224 Guide for Forensic Analysis of Fibers by Infrared Spectroscopy](#)

[E2227 Guide for Forensic Examination of Non-Reactive Dyes in Textile Fibers by Thin-Layer Chromatography](#)

[E2228 Guide for Microscopical Examination of Textile Fibers](#)

2.2 AATCC Standards:³

[AATCC Test Method 20: Qualitative 20: Qualitative Test Method 20–2007 Fiber Analysis: Qualitative](#)

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology [D123](#).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *braid, n*—the intertwining of strands in a braiding process to produce a rope structure.

(1)⁴

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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 American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709/27709-2215, <http://www.aatcc.org>.

⁴ The boldface numbers in parentheses refer to the list of references at the end of this standard.

3.2.2 *cord, n*—a twisted or formed structure composed of one or more single or plied filaments, strands, or yarns of organic polymer or inorganic materials. D123

3.2.2.1 *Discussion*—

Generally, cords have a diameter less than $\frac{3}{16}$ in.

3.2.3 *cordage*—*cordage, n*—~~twine, ropes, and cords, collectively~~—a collective term for twines, cords and ropes made from textile fibers and yarns. (1)

3.2.4 *core*—*core, n*—~~fibers or other textile materials running lengthwise through a textile product (yarn, strand, small diameter rope, etc.) placed in the center of a cordage~~—rope and serving as a support for the strands around it. (1)

3.2.4.1 *Discussion*—

Core can be of any continuous construction including parallel strands, twisted strands or braided strands.

3.2.5 *course*—*course, n*—*in knitted fabrics*, a row of successive loops in the width direction of the fabric. D123

3.2.6 *erown*—*crown, n*—the raised portion of a strand in a twisted cordage.

3.2.5 *fabric*—a planar textile structure produced by interlacing yarns, fibers, or filaments.

3.2.7 *fiber*—*fiber, n*—*in textiles*, a generic term for any one of the various types of matter that form the basic elements of a textile and that is characterized by having a length at least 100 times its diameter. D123

3.2.8 *filament*—*filament, n*—*in textiles*, a continuous fiber of extremely long length. D123

3.2.9 *knitted fabric*—*fabric, n*—a structure produced by interlooping one or more ends of yarn or comparable material. D123

3.2.10 *meaningful difference, n*—a feature or property of a sample that does not fall within the variation exhibited by the comparison sample, considering the limitations of the sample or technique, and therefore indicates the two samples do not share a common origin. The use of this term does not imply the formal application of statistical tests. 453afe/astm-e2225-18

3.2.10.1 *Discussion*—

The variation can be based on visual or microscopical comparison of physical and chemical data.

3.2.11 *nonwoven fabric*—*fabric, n*—a textile structure produced by bonding or interlocking of fibers, or both, accomplished by mechanical, chemical, thermal, or solvent means, or means and combinations thereof. D123

3.2.10 *pitch*—the number of crowns per inch of the same strand.

3.2.12 *ply*—*ply, n*—(1) the number of single yarns twisted together to form a plied cord; yarn, or the number of plied yarns twisted together to form cord; (2) an individual yarn in a plied yarn or cord; (3) one of a number of layers of fabric; (4) the number of layers of fabric as a shirt collar, or of cord in a tire. (2)

3.2.13 *rope, n*—a compact and flexible, torsionally balanced structure produced from strands which are laid, plaited, or braided together to produce a product which serves to transmit a tensile force between two points.

3.2.13.1 *Discussion*—

Generally greater than $\frac{3}{16}$ in. diameter (1); a rope is made up of three or more strands.

3.2.14 *selvage*—*selvage, n*—the narrowwoven edge portion of woven fabric that runs parallel to the warp; it is made with stronger yarns in a tighter construction than the body of the fabric to prevent raveling. D123

3.2.15 *staple, fiber*—*n*—natural fibers or cut lengths from filaments. _____ **D123**

3.2.16 *strand, n*—(1) a single fiber, filament, or monofilament; (2) an ordered assemblage of textile fibers having a high ratio of length to diameter and normally used as a unit; includes slivers, roving, single yarns, plied yarns, cords, braids, ropes, etc. _____ **(2)**

3.2.16.1 *Discussion*—

A strand is often multiple plies joined together. The terms “ply” and “strand” are not synonymous; cordage can have a single-ply strand, but not a stranded ply.

3.2.17 *thermoplastic, n*—a synthetic material that softens or melts at high temperatures.

3.2.18 *thread, n*—a slender strong strand or cord made by plying or twisting yarns, typically used for stitching.

3.2.19 *strand*—*tracer, n*—filaments or yarns twisted together or laid parallel to form a unit for further twisting or plaiting into cordage. A means of distinguishing one rope from another or one manufacturer from another by the use of yarns, tapes or other markers in a rope, either externally, internally or both. Also referred to as a marker. _____ **(1)**

3.2.19.1 *Discussion*—

This marker can be different in color, size, or composition, or combination thereof, from that of the basic cordage. It can be found in the core or alongside a ply or strand.

3.2.15 *tracer*—a marker (such as color-coded yarns or labels) integrated into the manufacture of a cord that assists in identifying the manufacturer.

3.2.20 *twist, direction n*—(*lay*)—the direction of twist in yarns is indicated by the capital letters S and Z; yarn with an S-twist is seen when a yarn is held vertically and the plies spiral around its central axis slope in the same direction as the middle portion of the letter S, and Z-twist is seen when the plies slope in the same direction as the middle portion of the letter Z. number of turns about the axis applied to a fiber, yarn, strand or rope over a given length to combine the individual elements into a larger and stronger structure. _____ **(1)**

3.2.20.1 *Discussion*—

The direction of twist in yarns is indicated by the capital letters S and Z. A yarn has an S-twist if, when it is held vertically, the spirals around its central axis slope in the same direction as the middle portion of the letter S, and Z-twist if they slope in the same direction as the middle portion of the letter Z.

3.2.21 *wale*—*wale, n*—*in knitted fabrics*, a column of successive loops in the length direction of the fabric; *in woven fabrics*, one of a series of raised portions or ribs lying ~~warpwise~~ warp-wise in the fabric. _____ **D123**

3.2.22 *warp*—*warp, n*—the set of yarn in all woven fabrics that runs lengthwise and parallel to the selvage and is interwoven with the filling yarn running lengthwise in a woven fabric. _____ **D123**

3.2.23 *weft (filling)*—(*filling*), *n*—*in a woven fabric*, the yarn running from selvage to selvage at right angles to the warp. _____ **D123**

3.2.24 *woven fabric*—*fabric, n*—generally used to refer to fabric composed of a structure produced when at least two sets of yarns, warp and weft (filling), that is formed by weaving, which is the interlacing of these sets of yarns; strands are interlaced, usually at right angles to each other, according to a predetermined pattern of interlacing, and such that at least one set is parallel to the axis along the lengthwise direction of the fabric. _____ **D123**

3.2.25 *yarn*—*yarn, n*—a generic term for a continuous strand of textile fibers, filaments, or material in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric. _____ **D123**

4. Summary of Guide

4.1 Due to the general availability of fabric and cordage, they Because of their general availability, fabrics and cordage are often encountered by the forensic scientist. This guide assists the forensic scientist in determining and documenting the structural details

~~of fabric and cordage~~ forensic scientists who examine, identify, and compare these types of evidence. Structural details such as design, construction and composition. These structural details can often provide information of significant forensic value. construction, and composition provide information that may assist the examiner in reaching a conclusion as to the possible end use or source of an item.

5. Significance and Use

5.1 ~~The construction, composition, and color of textiles as evidence in crimes are useful comparison~~ contain useful comparative characteristics for forensic examinations. Textiles ~~may appear in a variety of weaves, knits, and nonwoven constructions; a combination of fabric types can occur in any one textile. There is a vast~~ constructions: woven, knit, nonwoven, or in combination. ~~The range of colors in which textiles are offered in the marketplace. Therefore, the construction, composition, and color of a textile can aid the Examiner in including or excluding a textile for consideration in a forensic examination.~~ marketplace is vast and constantly changing due to styles and seasons.

5.2 ~~A comprehensive forensic fabric or cordage examination should consist of a complete characterization of the construction and fabrics, including their construction, and other materials used in the composition of the item (such as sewing thread).~~ assemblage of a textile (for example, sewing thread) is a critical component of a comprehensive forensic fabric or cordage examination.

6. Sample Handling

6.1 The general handling and tracking of samples should meet or exceed the requirements of Practice E1492 and Guide E1459.

6.2 ~~Photographs may be taken~~ Photography of the item, prior to conducting any analyses ~~analyses, is recommended~~ in order to provide documentation of the original condition. ~~Document and remove other evidence (for example, hair, blood, paint, etc.) which may require additional analysis. Document condition (for example, shape, position, layers or relation of one yarn to another). Documentation should also include any physical damage (for example, worn, cut, broken, frayed, etc.). The following general macroscopic characteristics should be observed and documented: frayed) or the presence of other evidence. Other evidence (for example, hair, blood, paint) that may require additional examination should be collected prior to textile analysis.~~

6.2.1 Severed ends for possible physical matches;

6.2.2 Knots or ligatures, or both (1);⁴

6.2.3 Dimensions (size, length, diameter, etc.);

6.2.4 Components: number, type, and twist; and

6.2.5 Color (dyed/natural).

6.3 ~~Do not bring a questioned specimen~~ A questioned material (for example, a piece of fabric, yarn, tuft of fibers, etc.) in fibers) shall not be brought into contact with the known fabric from which it is suspected to have originated until you have performed a preliminary examination (see 6.2 and 7.1) of the questioned specimen. specimen has been performed.

6.4 ~~Do not alter the condition of a questioned specimen (for example, shape, position, layers or relation of one yarn to another) before a preliminary examination and before receiving a known sample for comparison.~~

6.4 ~~Do not cut a~~ A sample to be used for composition testing should not be cut from ends of yarn/cordage or edges of fabric if there is a possibility of physically matching a questioned specimen/item to a known specimen. Take item. It is recommended that the known sample be collected away from the existing edge(s) and mark the location as “known-taken.” marked.

6.6 Fabric and cordage may be a source of other types of physical evidence (for example, hairs, fibers, blood, etc.). In addition, cuts, tears, knots and severed ends may be of forensic value. Therefore, fabric and cordage evidence should be examined in a manner that preserves these types of evidence.

6.5 All pertinent data collected on questioned and standard/known samples should be placed into, or referenced within, the specific case file.

6.6 Reference samples should be maintained. These reference samples should be supplied by a reputable source. The information contained on tags in textiles should be recorded, especially the registered number (RN) and the woolen products label number (WPL) when applicable. These refer to the manufacturer of the textile and can assist the examiner with tracking a particular textile or garment (3, 4), and be verified before use as a reference. It should be noted that the fiber content listed in A searchable database of RN and WPL numbers can be found on the Federal Trade Commission’s website manufacturers’ (5)labeling .of commercially supplied items may not be accurate or complete.

7. Analysis

7.1 Preliminary examination of fibers composing textiles should include its general appearance under a properly aligned low power compound microscope. Any adhering debris or extraneous material should. Prior to any analysis of the fibers comprising a fabric or cordage, the fabric or cordage should be examined for physical matches, pattern evidence and damage (for example, thermoplastic fusions, cut/tear marks). Any adhesives or other material used in bonding fabrics, carpet backings, etc., should also be noted.