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# Standard Guide for Forensic Examination of Fabrics and Cordage[1]

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## 1. Scope

1.1 The intent of this guide is to assist individuals and laboratories conducting 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.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1459 Guide for Physical Evidence Labeling and Related Documentation

E1492 Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory

E2228 Guide for Microscopic Examination of Textile Fibers

## 3. Terminology

3.1 *cordage*—twine, ropes, and cords, collectively.

3.2 *core*—fibers or other textile materials running lengthwise through the center of a cordage.

3.3 *course*—the row of loops or stitches running across a knit fabric, corresponding to the filling in woven fabrics.

3.4 *crown*—the raised portion of a strand in a twisted cordage.

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

3.6 *knit fabric*—a structure produced by interlocking one or more loops of yarn or comparable material.

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

3.8 *ply*—the number of single yarns twisted together to form a plied cord; an individual yarn in a plied yarn or cord.

3.9 *selvage*—the narrow edge 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.

3.10 *staple fiber*—natural fibers or cut lengths from filaments.

3.11 *strand*—filaments or yarns twisted together or laid parallel to form a unit for further twisting or plaiting into cordage.

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

3.13 *twist direction (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.

3.14 *wale*—a column of loops lying lengthwise in a knit fabric.

3.15 *warp*—the set of yarn in all woven fabrics that runs lengthwise and parallel to the selvage and is interwoven with the filling.

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

3.17 *woven fabric*—generally used to refer to fabric composed of two sets of yarns, warp and weft (filling), that is formed by weaving, which is the interlacing of these sets of yarns.

3.18 *yarn*—filaments (fibers) with or without a twist used to form a strand.

## 4. Summary of Guide

4.1 Due to the general availability of fabric and cordage, they are often encountered by the forensic scientist. This guide assists the forensic scientist in determining and documenting the structural details of fabric and cordage such as design, construction and composition. These structural details can often provide information of significant forensic value.

## 5. Significance and Use

5.1 The construction, composition and color of textiles as evidence in crimes are useful comparison characteristics for forensic examinations. Textiles 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 range of colors in which textiles are offered in the marketplace. Therefore, the construction, composition, and color of a textile can

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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.

aid the Examiner in including or excluding a textile for consideration in a forensic examination.

5.2 A comprehensive forensic fabric or cordage examination should consist of a complete characterization of the construction and materials used in the composition of the item (such as sewing thread).

## 6. Sample Handling

6.1 Photographs may be taken of the item prior to conducting any analyses 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 any physical damage (for example, worn, cut, broken, frayed, etc.). The following general macroscopic characteristics should be observed and documented:

6.1.1 Severed ends for possible physical matches,

6.1.2 Knots or ligatures, or both,

6.1.3 Dimensions (size, length, diameter, etc.),

6.1.4 Components: number, type, and twist, and

6.1.5 Color (dyed/natural).

6.2 Do not bring a questioned specimen (for example, a piece of fabric, yarn, tuft of fibers, etc.) in contact with the known fabric from which it is suspected to have originated until you have performed a preliminary examination (see 6.1 and 7.1) of the questioned specimen.

6.3 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 sample to be used for composition testing from ends of yarn or edges of fabric if there is a possibility of physically matching a questioned specimen to a known specimen. Take the known sample away from the existing edge(s) and mark the location as "known taken."

6.5 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.

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

6.7 Reference samples should be maintained. These reference samples should be supplied by a reputable source and be verified before use as a reference. It should be noted that the fiber content listed in manufacturers' 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 be noted.

7.2 Physical matches should always be considered if the pieces of fabric or cordage to be compared have been cut or torn. A physical match must be documented photographically or by another comparable documentation method. Additionally, describing the condition of corresponding threads and their relative positions in the damaged area on the questioned and known pieces (so-called "longs and shorts") provides a detailed corroborative description.

7.2.1 If a physical match is not possible, comparison of the parameters determined in the checklist will assist the Examiner in determining if the two items could have originated from the same source.

7.3 *Fabric*:

7.3.1 Fabric examinations are primarily a process of deconstructing the fabric by dissecting its constituent elements. Each of these elements can have a number of sub-elements, all of which must be characterized to complete the examination. These elements include:

7.3.1.1 Construction (woven, knit, nonwoven),

7.3.1.2 Threads per inch in warp and weft direction,

7.3.1.3 Staple or continuous fibers in yarns,

7.3.1.4 Yarn twist,

7.3.1.5 Number of plies,

7.3.1.6 Direction of twist of plies,

7.3.1.7 Number of filaments in each ply,

7.3.1.8 Composition of yarn,

7.3.1.9 All fiber types composing the fabric,

7.3.1.10 Color(s) and design,

7.3.1.11 Blend of two or more types of fibers within each ply, and

7.3.1.12 Sewing threads, buttons, decorations, etc. detailed as above.

7.3.2 The information contained on tags in textiles should also be recorded, especially the Registered Number (RN) and the Woolen Products Label number (WPL). These refer to the manufacturer of the textile and can assist the examiner with tracking a particular textile or garment (**1**,**2**).[3]

7.4 *Cordage*:

7.4.1 The initial step in the identification of rope and cordage is to determine its construction and assembly. It is recommended that a laboratory checklist be developed for this purpose (**3**). The checklist should include, but not be limited to, the following characteristics (see Fig. 1):

7.4.1.1 Diameter,

7.4.1.2 Staple or filament fibers,

7.4.1.3 Twisted, braided, or non-twisted,

7.4.1.4 Direction of twist,

7.4.1.5 Crowns or turns per inch,

7.4.1.6 Number of plies or braids,

7.4.1.7 Twist of each ply or braid,

7.4.1.8 Crowns or turns per inch, and

7.4.1.9 Number of filaments in each ply or braid, that are evaluated for the following characteristics:

*(1)* Core, if any,

*(2)* Twist,

*(3)* Crowns or turns per inch,

*(4)* Number of filaments,

*(5)* Color(s),

*(6)* Coatings, if any, and

*(7)* Tracers, if any.

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