

Fabric and Cordage Examinations

1 Scope

This document describes procedures used by Fiber Examiners in the examination of fabric and cordage characterization, identification, and comparison in the Trace Evidence Unit (TEU) and Scientific and Biometrics Analysis Unit-Trace (SBAU-Trace). Examination of fabric damage, fabric impressions, and the fabric portion of tape are included in these procedures. The nature and extent of the evidence will determine the techniques used.

2 Equipment/Materials/Reagents

- Comparison microscope, magnification range from approximately 40x to approximately 600x
- Stereobinocular microscope, magnification range from approximately 2x to approximately 40x
- Keyence digital microscope, magnification range from approximately 5x to approximately 1000x (SBAU-Trace)
- Forceps
- Spatula
- Scissors
- Probes
- Digital Camera
- Lux-o-lamp[®]
- Substrate for producing test damage *e.g.*, Cardboard box or Styrofoam
- Iron
- Sonicator

3 Standards and Controls

Not applicable.

4 Sampling

Known fiber sample selections will represent the range of fibers of different colors, shapes, and sizes comprising the fabric and/or cordage. The comparison of the composition of the fabric and/or cordage will be based on these sample selections.

5 Procedure

5.1 Fabric Examinations

5.1.1 Prior to a fabric analysis, specimens may be processed utilizing the procedures outlined in the respective unit's *Evidence Processing Procedures*.

5.1.2 The general appearance, stains, size, shape, color, and condition of the pieces of fabric will be documented. The documentation will also include any cut, torn, crushed, or burned edges. After the condition of the fabric is documented, it may be necessary to clean and/or iron the fabric in order to accurately examine it.

5.1.2.1 Cleaning may be conducted with water and soap and may involve sonicating the fabric. The fabric will be allowed to air dry and then ironed if necessary to allow for accurate thread counts and comparison of edges. Care will be taken to ensure the integrity of the fabric.

5.1.3 The type of fabric (*e.g.*, woven, knit, or non-woven) will be documented.

5.1.4 Any identifying characteristics which may help identify the possible end use of the textile (*e.g.*, trousers, jacket) will be documented.

5.1.5 An examination should be conducted for obvious macroscopic characteristics, such as repeats or manufacturer's flaws, a missing portion of a printed design, a thicker yarn, stains, etc. Dimensions (*e.g.*, selvedge edge to selvedge edge, if present) may be determined to calculate a maximum width.

5.1.6 The size and shape of any missing portion(s) from each piece of fabric should be determined, if possible, and documented.

5.1.7 The thread count, color, and construction of yarns in the fabric will be determined and documented.

5.1.8 A known fiber sample(s) representative of the fabric may be taken and mounted on a glass microscope slide.

5.2 Fabric Comparisons

5.2.1 Any obvious macroscopic characteristics that may serve to quickly eliminate the pieces of fabric as having come from a common source will be compared. These characteristics may include repeats, manufacturer's flaws, differing maximum widths, a missing portion of a printed design, a thicker yarn, stains, etc.

5.2.2 The corresponding "side" or "face" of the fabric will be determined, if possible, and the warp and weft yarns (or courses and wales) will be oriented in the same direction for comparison.

5.2.3 Using macroscopic characteristics such as irregular contours from cuts and/or tears, different types, sizes, and colors of yarns, design patterns, and stain patterns, an attempt to orient the pieces of fabric to one another will be made and a determination will be made as to whether the two pieces appear to physically fit together. The size of the area missing from one piece of fabric should be equal to or greater than that of the other fabric.

5.2.3.1 Once the pieces of fabric are oriented using macroscopic characteristics, individual yarns should be compared to one another, ensuring that the “long” yarns in one fabric coincide with the “short” yarns in the other piece of fabric. Comparisons of yarns should continue along the entire cut or torn edge.

5.2.3.2 If all of the gross characteristics and all of the “long and short” yarns along the entire cut or torn edge of one piece of fabric can be associated to the second piece of fabric, it can be concluded that the two pieces of fabric physically match one another and at one time were a contiguous piece of fabric.

5.2.3.3 Diagrams and/or photographs of the two pieces of fabric together will be taken, marked with the laboratory number(s) and item numbers, and retained in the notes.

5.2.3.4 If the two pieces of fabric physically fit together, they must also be alike in color, construction, and composition. Therefore, no additional fabric comparisons between the two physically matched pieces of fabric are necessary.

5.2.4 If two pieces of fabric do not physically match to one another, an examination to determine if the two pieces of fabric exhibit the same color, construction, and composition will be conducted.

5.2.4.1 The thread count, color, and construction of yarns in each direction for each piece of fabric will be documented and compared.

5.2.4.2 If no difference are observed in the construction of the fabric, the fibers comprising the fabric will be identified and compared utilizing the procedures outlined in the *Forensic Fiber Examinations* protocol.

5.2.4.3 If no differences are observed between the fibers comprising the pieces of fabric and the appropriate techniques outlined above, it can be concluded that the pieces of fabric are consistent with originating from the same item or from two different items exhibiting the same color, construction, and composition.

5.3 Fabric Impression Examinations

5.3.1 Examination may be of the questioned item bearing the actual impression, a “lift” of an impression, a “cast” of an impression from various types of surfaces (*e.g.*, mud, glass, fender) or a photograph of an impression. If the actual item bearing the impression is submitted and hair

and fiber examinations have been requested, the item will first be examined for the presence of trace evidence utilizing the procedures outlined in the respective unit's *Evidence Processing Procedures*, if appropriate.

5.3.1 Identifying features that may help in the identification of the fabric type (*e.g.*, twill, plain weave, knit, etc.) of the potential donor will be studied and documented.

5.3.2 Damaged areas on the fabric item (*e.g.*, cuts, tears, snags) that may aid in orientation of the fabric and may add significance to the association will be identified and evaluated.

5.3.3 Multiple impressions of the potential fabric donor on a suitable substrate such as ink or modeling clay may be created, using different amounts of force or pressure.

5.3.4 The number of yarns or loops per inch in each direction for both the known fabric impression and the questioned impression will be compared. Results will be documented in the case notes.

5.3.5 If no differences are observed between the known fabric impression and the questioned impression, it can be concluded that the fabric or another fabric of similar construction could have made the impression. The presence of characteristics such as cuts, tears, snags, etc., may allow for added significance to the conclusion.

5.4 Fabric Damage Examination

5.4.1 Prior to a fabric damage analysis, specimens are typically processed utilizing the procedures outlined in the respective unit's *Evidence Processing Procedures*. Fabric damage (*e.g.*, length of cut/tears), any identifying features (*e.g.*, single edged blade characteristic "V" shaped notch from the flat edge tearing the fabric), the shape of the cut/tear, and any other characteristics observed will be documented.

5.4.2 When possible, test damage will be created after all other appropriate laboratory examinations (*e.g.*, trace evidence, DNA, latent print) have been completed.

5.4.2.1 Test damage will be made in an undamaged portion of the garment utilizing the questioned implement(s).

5.4.2.2 The length, shape and overall pattern produced by the test damage will be compared to previously identified fabric damage.

5.4.2.3 Photographs will be taken and maintained with the notes.

5.4.2.4 If no differences are observed between the test damage and the questioned fabric damage, it can be concluded that the identified fabric damage is consistent with having been made by the questioned implement or another similar implement.

5.5 Tape with Fabric Components Examinations

5.5.1 Prior to the analysis of the fabric component of tape, to include duct tape, specimens are typically processed utilizing the procedures outlined in the respective unit's *Evidence Processing Procedures*, if appropriate.

5.5.2 The fabric component of tape is examined, and if necessary compared, by fiber examiners to determine its color, construction, and composition. The fabric portion of the duct tape or fabric backing of fabric tape is examined by fiber examiners to determine color, construction and composition. The Chemistry Unit is responsible for the analysis of the remainder of the duct tape or fabric tape.

5.5.3 The thread count, color, and construction of yarns (warp and weft) for the fabric component of each piece of tape will be documented and compared.

5.5.4 The fibers present in the warp and weft yarns will be analyzed and identified utilizing the procedures outlined in the *Forensic Fiber Examinations* protocol.

5.5.5 If the item received for analysis encompasses the entire width of the tape and at least 1 inch of the length of the tape, and if no differences are observed between the pieces of fabric utilizing the appropriate techniques outlined above, it can be concluded that the fabric components of the tape are consistent with originating from the same source or from two different sources exhibiting the same color, construction, and composition.

5.5.5.1 If the item received for analysis does not encompass the entire width of the tape and at least 1 inch of the length of the tape, and if no differences are observed between the pieces of fabric utilizing the appropriate techniques outlined above, it can be concluded that the fabric components of the tape exhibit the same color, construction and composition as one another, and therefore are consistent with originating from the same source or from two different sources exhibiting the same color, construction, and composition. However, a statement will be added to the results identifying that the piece of tape received for analysis was not sufficient to fully characterize the tape.

5.6 Cordage Examinations

5.6.1 Prior to a cordage analysis, specimens are typically processed utilizing the procedures outlined in the respective unit's *Evidence Processing Procedures*, if appropriate.

5.6.2 The general appearance, stains, size, shape, color and condition of the pieces of cordage will be analyzed and documented paying special attention to cut, torn, crushed or burned edges.

5.6.3 The ends of the pieces of cordage will be examined to determine how the cordage was severed (*e.g.*, cut, burned, torn), if appropriate.

5.6.4 After the condition of the cordage is documented, it may be necessary to clean the cordage in order to accurately examine it.

5.6.4.1 Cleaning may be conducted with water and soap and may involve sonicating the cordage. The cordage will be allowed to air dry. Care will be taken to ensure the integrity of the cordage.

5.6.5 The diameter (and length, if pertinent), type of cordage (twisted or braided) will be documented and any knots that are present noted, if pertinent.

5.6.6 The number of crowns or turns per inch, the number of plies and braids, and the direction of twist (“S” or “Z”) for the entire piece of cordage and for each ply or braid will be documented.

5.6.7 A known fiber sample(s) representative of the cordage may be taken and mounted on a glass microscope slide.

5.7 Cordage Comparisons

5.7.1 Any obvious macroscopic characteristics that may serve to quickly eliminate the pieces of cordage as having come from a common source will be compared. These characteristics may include repeats, manufacturer’s flaws, differing widths, a missing portion of a design, a thicker ply, etc.

5.7.2 A determination will be made as to the suitability of the ends of the cordage for physical matching. Individualizing characteristics on the ends of the cordage such as a paper core or jagged plastic edges will be examined.

5.7.2.1 If the cordage has a paper or fabric core, the core will be opened so that it lays flat on the workspace.

5.7.2.2 Using macroscopic characteristics such as irregular contours, different types, sizes and colors of yarns, design patterns and stain patterns, orientation of the cores to one another will be attempted.

5.7.2.3 Once the cores are oriented using macroscopic characteristics, comparisons of the individual components of the cores to one another will be conducted. If the core is fabric, the comparisons will follow the fabric comparison procedures above. If the core is paper, comparison of the cut and/or torn edges to one another will be conducted along the entire length of the core.

5.7.2.4 If no differences can be found between the two pieces of core, then it can be concluded that the two pieces of core physically match one another and were once joined across their severed ends.

5.7.2.5 Diagrams and/or photographs of the two pieces of cordage together will be made, marked with the laboratory number(s) and item numbers, and retained in the notes.

5.7.2.6 If two pieces of cordage physically match one another, then they must also be alike with respect to color, construction and composition. Therefore, no additional cordage comparisons between the two physically matched pieces of cordage are necessary.

5.7.3 If two pieces of cordage cannot be physically matched to one another, examinations will be conducted determine if the two pieces of cordage exhibit the same color, construction and composition.

5.7.3.1 A measured section may be removed (*e.g.*, one inch) from a logical area (not near the end, a knot, etc.), and the remaining cut ends taped together and marked appropriately. This “section” may be used for determination of construction and composition.

5.7.3.2 The color and construction (*e.g.*, crowns per inch, number of plies/braids, twist of plies/braids) for each piece of cordage will be documented.

5.7.3.3 Each piece of cordage will be examined for a core or a tracer. If so, the construction of the core or tracer will be documented in the case notes.

5.7.3.4 The fibers comprising each piece of cordage will be analyzed and identified utilizing the procedures in *Forensic Fiber Examinations* protocol.

5.7.3.5 If no differences are observed between the pieces of cordage utilizing the appropriate techniques outlined above, it can be concluded that the pieces of cordage are consistent with originating from the same item or from two different items exhibiting the same color, construction, and composition.

5.8 Fabric, Fabric Damage, Fabric Impression, Tape with Fabric Components, and Cordage Verifications

Fabric, fabric damage, fabric impressions, tape with fabric components, and cordage associations are verified by a second qualified Examiner. These verifications are documented by the signature of the verifying Examiner and the date of the verification on the Verification Form for Legacy cases or documented in Forensic Advantage (FA).

6 Calculations

Not applicable.

7 Measurement Uncertainty

Not applicable.

8 Limitations

The type of information which can be developed as a result of fabric, fabric impression, fabric damage, and cordage examinations is dependent on the type of evidence received and the condition of the evidence.

9 Safety

9.1 While working with physical evidence, laboratory personnel will wear appropriate protective attire (at a minimum, laboratory coat and gloves).

9.2 Universal precautions will be followed.

9.3 No specific hazards are associated with the examination techniques performed.

10 References

- Hatch, Kathryn L., Textile Science, West Publishing Company, Minneapolis/SaintPaul, New York, Los Angeles, San Francisco, 1993.
- Reader's Digest Complete Guide to Sewing, The Reader's Digest Association, Inc. Pleasantville, New York, 1976.
- Cordage Directory, Published by the Cordage Institute, Hingham, Massachusetts, 1989.
- Registered Numbers & Wool Products Label Encyclopedia, The Salesman's Guide, A Unit of the Cahners Business Information, New Providence, New Jersey, 1998.

Rev. #	Issue Date	History
3	10/02/2017	<p>Removed Unit references throughout document, except where still needed to denote that TEU and SAU-Trace have separate Evidence Processing Procedures.</p> <p>Section 2 Updated equipment used.</p> <p>Section 4 Deleted and renumbered subsequent sections.</p> <p>Sections 5.1.2 and 5.1.2.1 Indicated that fabric may be cleaned and added section about cleaning fabric if necessary prior to examinations.</p> <p>Section 5.1.5 Reworded section for clarity.</p> <p>Section 5.1.6 Reworded section for clarity.</p> <p>Sections 5.1.7 and 5.1.8 Added sections to have information about the yarns recorded and to potentially mount a known fiber sample.</p> <p>Section 5.2 Added Fabric Comparison title.</p> <p>Sections 5.2.1 and 5.2.3 Added sections.</p> <p>Section 5.2.2 Reworded section for clarity.</p> <p>Section 5.2.3.4 Reworded section to indicate that no further examinations need to be performed between two pieces of fabric that physically match.</p> <p>Section 5.2.4.1 Updated section to document thread count, color and construction of fabric.</p> <p>Section 5.2.4.2 Updated section to indicate procedures used to compare fibers.</p> <p>Section 5.2.4.3 Updated section for clarity in conclusion.</p> <p>Section 5.3.1 Updated section to clarify when the items need to be processed for the presence of trace evidence.</p> <p>Section 5.5.2 Updated section for clarity.</p> <p>Section 5.5.3 Updated section to clarify that what characteristics of the fabric will be documented.</p> <p>Sections 5.6.4 and 5.6.4.1 Added sections indicating that cordage may be cleaned and added section about cleaning cordage if necessary prior to examinations.</p> <p>Section 5.6.7 Added section regarding collection of known fiber sample from cordage.</p> <p>Section 5.7.1 Added section regarding macroscopic observations of cordage.</p> <p>Section 5.7.2 Added section regarding assessment of the ends of cordage for physical matching.</p> <p>Section 5.7.2.6 Reworded section to indicate that no further examinations need to be performed between two pieces of cordage that physically match.</p> <p>Sections 5.7.3.2, 5.7.3.3, and 5.7.3.4 Added and updated sections to clarify characteristics to be documented in notes during examination.</p> <p>Section 5.7.3.5 Updated section for clarity in conclusion.</p>

- 4 02/10/2020 Changed confirmation to verification throughout document.
Removed fabric damage, fabric impressions, and duct tape from title.
Updated SBAU-Trace group name throughout.
Changed all references to duct tape to tape with fabric components.
Added sampling information into Section 4.
Updated language in Section 5.2.2, 5.2.3, 5.2.4, 5.2.4.2, 5.2.4.3, 5.3.4, 5.3.5, 5.7.2.3, 5.7.2.4 for clarity.
Updated wording in Sections 5.5 and 5.8 for clarity and to be more general about tape containing a fabric component.
Changed language in 5.3.5 removing the ability to ability to make a positive identification.
Updated document title in Section 5.7.3.4.
Updated QA document titles throughout.

Approval

Redacted - Signatures on File

Trace Evidence Unit Chief:

Date: 02/07/2020

Scientific and Biometrics Unit
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