

Technical Procedure for the Examination of Cordage

1.0 Purpose – This technical procedure shall be followed for the examination of cordage samples, to include yarns, ropes and carpets.

2.0 Scope – This procedure applies to the analysis of cordage samples, to include yarns, ropes, and carpets, within the Trace Evidence Section. Cordage examinations shall be conducted by a Forensic Scientist trained in fiber analysis. Physical fit analyses involving cordage shall be conducted by a Forensic Scientist trained in cordage physical fit examinations.

3.0 Definitions – N/A

4.0 Equipment, Materials, and Reagents

4.1 Equipment

- Stereomicroscope
- Camera

4.2 Materials

- Forceps
- Probes
- Scalpel
- Razor blades
- Ruler or calipers

4.3 Reagents

- N/A

5.0 Procedure

5.1 Analytical Approach

5.1.1 Review the request for analysis and determine the type(s) of examination required based on the request made by the agency and/or the evidence submitted. Examination(s) that may be performed are the comparison of the questioned item to determine if it could have originated from the known item, comparing two samples to determine if they could have been constructed by the same manufacturer, and an identification of generic manufacturing characteristics.

5.1.1.1 There may be times when an agency requests a variation on the above listed types of analyses. If the request falls within the scope of the technical procedures, the analysis may be permitted.

5.1.2 Evaluate the case information and evidence submitted.

- 5.1.2.1** If necessary, contact the submitting agency to obtain additional evidence, case information, and/or contact the submitting agency to request known cordage standards following the Laboratory [Procedure for Obtaining Evidentiary Standards](#). If standards are not submitted, the examination may be limited or the evidence may be returned.
- 5.1.3** Most Trace cases involve some degree of evidence screening, either visually/microscopically or in combination with instrumental techniques. Preliminary evaluation of the known's characteristics is warranted when screening is performed in order that those questioned items suitable for further comparison can be selected. When proceeding to further comparison of questioned and known samples, beginning with the questioned items is required unless case constraints dictate otherwise.
- 5.1.3.1** The Forensic Scientist shall approach a cordage comparison by attempting to show that the samples are different. The questioned and known items are analyzed using the same techniques and are compared at every step throughout the process. The failure to detect any significant differences, after exhausting the methodology available to the Forensic Scientist, results in the conclusion that the questioned and known item could have had a common origin. If a difference is found, the analysis may be concluded at any step.
- 5.1.3.2** The order of the examination is based on the quantity, quality, type of the evidence and the Forensic Scientist's training and experience.
- 5.1.3.3** Some of the available tests are destructive. When sample size is limited, destructive testing, if necessary, shall be performed only after all non-destructive testing is complete.
- 5.1.4** Open the questioned evidence container and describe the evidence present. If necessary, process the item to remove any trace evidence adhering to the item following the Trace Evidence Section [Technical Procedure for the Collection and Preservation of Evidence](#).
- 5.1.4.1** If the questioned item is cordage and the entire sample will be deconstructed during analysis, photographs shall be taken prior to analysis.
- 5.1.4.2** If the questioned item is fibers and not cordage, proceed the Trace Evidence Section [Technical Procedure for the Examination of Fibers](#).
- 5.1.5** Begin the cordage examination by performing a preliminary evaluation of the questioned and/or known cordage standards and record the overall macroscopic characteristics.
- 5.1.5.1** The following is a list of macroscopic characteristics that may be used for classification and comparison of any cordage that may be suitable for further analysis. The characteristics listed below are not all-inclusive and may or may not be present in every fiber.
- Size (i.e., Length and Relative Longitudinal Diameter)
 - Construction (i.e., twisted, braided, or plastic)
 - Composition

- Color
- Other characteristics (e.g., stains, fraying, damage, cut or torn ends)

5.1.5.2 Any visible debris shall be removed and secured for possible further examination if the questioned and known items will be brought into direct contact.

5.1.5.3 No further analysis may be performed on cordage found to be macroscopically not consistent with the applicable known standard.

5.1.5.4 If the known standard is only being deconstructed to a fiber comparison level, then no additional information needs to be recorded.

5.1.6 A physical fit examination shall be conducted if necessary. Areas for possible physical fits include plastic ends, fabric/paper cores, long and short yarns, etc. See the Trace Evidence Section [Technical Procedure for Physical Fit Examinations](#).

5.1.7 If no physical fit is possible, or a physical fit cannot be made, the Forensic Scientist shall continue analyzing each item.

5.1.8 Perform a detailed examination of the cordage according to **Examination of Cordage**. If the item in question is a portion of carpet, proceed to **Examination of Carpet**.

5.1.9 Once the cordage analysis and comparison is complete, the yarns shall be broken down into their component fibers. Fibers shall be analyzed and compared following the Trace Evidence Section [Technical Procedure for Examination of Fibers](#).

5.1.10 If questioned and known cordage samples are found to be consistent with each other, a second Forensic Scientist, who is qualified in cordage comparisons, shall confirm these microscopic comparisons. Additional verifications may be completed by other available Forensic Scientists who are qualified in cordage comparisons. A verification review shall be completed in Forensic Advantage (FA) and the microscope slides shall be initialed and dated by the verifying Forensic Scientist(s).

5.1.11 Once all visual, microscopical, chemical, and instrumental examinations have been completed and the results compared, the Forensic Scientist shall issue a report stating his or her findings.

5.2 Examination of Cordage

5.2.1 Twisted cordage (including yarns and carpet)

5.2.1.1 Determine the overall number of plies and their direction of twist

5.2.1.2 If more than one ply is present, measure the length of the repeating unit and the number of crowns per unit length.

5.2.1.2.1 Break down each ply until the final unit is a single yarn composed of fibers or filaments. Record the twist direction in each step.

5.2.2 Braided cordage

- 5.2.2.1 Determine the number of braids in both the S and Z direction.
- 5.2.2.2 Describe the weave pattern.
- 5.2.2.3 Measure the length of the repeating unit and the number of braids per unit length.
- 5.2.2.4 Measure the thickness of each braid and determine the direction of twist.
 - 5.2.2.4.1 Break down each ply until the final unit is a single yarn composed of fibers or filaments. Record the twist direction in each step.

5.2.3 Plastic cordage

- 5.2.3.1 Examine the plastic sheath's ends for markings suitable for a physical fit or toolmark examination.
- 5.2.3.2 Measure the thickness of the sheath and record its color and/or composition.
- 5.2.4 Remove a sample for analysis, taping off and labeling the cut ends. Leave all knots intact, if possible, and cut from the center of the item, leaving the original ends undamaged.
- 5.2.5 Record whether a coating can be observed. Collect a sample for analysis.
- 5.2.6 If a core is present, analyze the size, color, twist, and coating for each type. Collect a sample for analysis.
- 5.2.7 If a tracer is present, analyze the size, color, twist, and location for each type. Collect a sample for analysis.
- 5.2.8 Compare all the above-listed color, construction, and compositional characteristics of the questioned and known items.
- 5.2.9 Once the cordage analysis and comparison is complete, the yarns shall be broken down into their component fibers. Fibers shall be analyzed and compared following the Trace Evidence Section [Technical Procedure for Examination of Fibers](#).

5.3 Examination of Carpet

- 5.3.1 For carpet samples, classify the type of carpet present in the sample (loop, cut-pile, etc.) if possible.
- 5.3.2 For carpet tufts, measure the length of the tuft and examine the yarns as detailed in **Examination of Cordage**.
- 5.3.3 If present, examine the layer structure and construction of any backing materials in

- 5.3.4 accordance with the Trace Evidence Section [Technical Procedure for Examination of Fabric](#).
- 5.3.5 Compare all the above-listed color, construction, and compositional characteristics of the questioned and known items.
- 5.3.6 Once the carpet analysis and comparison is complete, the yarns shall be broken down into their component fibers. Fibers shall be analyzed and compared following the Trace Evidence Technical [Procedure for Examination of Fibers](#).

5.4 Guidelines for Cordage Examination Result and Conclusion Statements

- 5.4.1 The reports shall read as listed below. The wording of the results shall accurately describe the evidence at hand.
- 5.4.2 **Association (Consistent)**
 - 5.4.2.1 This statement shall be used when the questioned and known samples are consistent in color, construction, and composition.
 - 5.4.2.1.1 Example: Item A was found to be consistent in color, construction, and composition with Item B. Therefore, Item A could have originated from [the same source as] Item B.
 - 5.4.2.2 Qualifying statements shall be added to the report where appropriate, based on the Forensic Scientist's training and experience (e.g., limited testing performed).
- 5.4.3 **Inconclusive**
 - 5.4.3.1 These statements shall be used when no conclusion could be reached based on the analysis.
 - 5.4.3.1.1 Example: Item A was found to be consistent in ___ to Item B; however, slight differences were noted in ____. Therefore, no conclusion could be reached as to whether or not Item A could have originated from [the same source as] Item B.
 - 5.4.3.1.2 Example: Due to the nature/condition of Item A, no conclusion could be reached as to whether or not Item A could have originated from [the same source as] Item B.
- 5.4.4 **No Association (Not Consistent)**
 - 5.4.4.1 These statements shall be used when one or more of the characteristics associated with the questioned and known samples are different.
 - 5.4.4.1.1 Example: Item A is not consistent with Item B. Therefore, Item A could not have originated from [the same source as] Item B.

5.4.4.1.2 Example: Item A was found to have different manufacturing characteristics from Item B. Therefore, Item A could not have originated from [the same source as] Item B.

5.4.5 No Analysis

5.4.5.1 No analysis is performed.

5.4.5.1.1 Example: Due to the nature/condition of the evidence, no analysis could be conducted.

5.4.5.1.2 Example: The above listed evidence is being returned unanalyzed. If you have any questions, please contact the Forensic Scientist who issued this report.

5.4.5.2 No analysis is performed due to the results of the DNA analysis.

5.4.5.2.1 Example: Based on the results of DNA analysis, the above listed evidence is being returned unanalyzed. If you have any questions, please contact the Forensic Scientist who issued this report.

5.5 Standards and Controls – N/A

5.6 Calibrations – N/A

5.7 Maintenance – No maintenance is required in this procedure. However, the procedure does utilize instruments that require maintenance. See the individual technical procedures for the operations of those instruments.

5.8 Sampling and Sample Selection

5.8.1 No sampling is performed. When sample selection occurs, it shall be based on the Forensic Scientist's training and experience.

5.8.2 If DNA analysis is being performed on the evidence in the case, based on the results of the DNA analysis, the cordage evidence may be returned unanalyzed.

5.9 Calculations – N/A

5.10 Uncertainty of Measurement – N/A

6.0 Limitations – Ropes, cordage, yarns and carpet are manufactured materials. In general, it shall not be possible to identify a questioned item as having come from a particular source to the exclusion of all others. One exception to this shall be a physical fit.

7.0 Safety

7.1 Items may have blood or other body fluids present. Use protective equipment when dealing with items that may contain biohazard material.

7.2 Glass pipettes, razor blades, and probes are sharp and can be dangerous.

8.0 References

8.1 ASTM / SWG Guidelines

ASTM Standard E1732, "Standard Terminology Relating to Forensic Science." ASTM International, West Conshohocken, PA, 2000.

SWGMA. "Forensic Fiber Examination Guidelines." *Forensic Science Communications* 1.1 (1999). Chapter 7.

ASTM Standard E2225, 2002, "Standard Guide for Forensic Examination of Fabrics and Cordage," ASTM International, West Conshohocken, PA, 2002.

8.2 Books

Joseph, M.L. *Introductory Textile Science*. USA: CBS College Publishing, 1981.

Robertson, J. and M. Grieve, eds. *Forensic Examination of Fibres*. 2nd Ed. London: Taylor and Francis, 1999.

8.3 Journal Articles

Wiggins, K.G. "Recognition, Identification and Comparison of Rope and Twine." *Science and Justice* 35.1 (1996): 53-58.

9.0 Records – N/A

10.0 Attachments – N/A

Revision History		
Effective Date	Version Number	Reason
06/21/2023	5	<ul style="list-style-type: none">• Updated header to Trace Evidence Section, issuing authority to Trace Evidence Section Forensic Scientist Manager.• Updated all references in procedure from Trace Unit to Trace Evidence Section• Updated all references in procedure from Physical Match to Physical Fit• 5.1 through 5.3 reorganized and updated to clarify ISO 17025 requirements to examine questioned before known.• 5.4.2 – Renamed Association (Consistent)• 5.4.4 – Renamed No Association (Not Consistent)• Removed 5.8.2 through 5.8.4• 7.0 – Updated and added 7.1 and 7.2• 8.1 – Added ASTM E1732 reference