OSAC 2022-S-0029 Standard Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials

Trace Materials Subcommittee
Chemistry: Trace Evidence Scientific Area Committee
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Standard Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials

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Standard Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials

Designation

1 Scope

1.1 This guide covers recommendations for the overall interpretation and reporting of findings from an analytical scheme for trace material comparisons conducted by personnel in a forensic laboratory.

1.2 This guide provides guidance to forensic examiners to standardize the interpretation of comparative examinations of trace evidence. It highlights fibers, glass, hair, paint, and tape but can be applied to other trace materials.

1.3 This guide describes the information that is included in trace evidence written reports regarding interpretation of the overall results of comparative examinations and includes example report wording.

1.4 This standard is intended for use by competent forensic science practitioners with the requisite formal education, discipline-specific training (see Practices E2917, E3233, and E3234, WK56743), and demonstrated proficiency to perform forensic casework.

2 Referenced Documents

2.1 ASTM Standards:

E620 Practice for Reporting Opinions of Scientific or Technical Experts

E1610 Guide for Forensic Paint Analysis and Comparison

E1732 Terminology Relating to Forensic Science

E1967 Test Method for the Automated Determination of Refractive Index of Glass Samples Using the Oil Immersion Method and a Phase Contrast Microscope

E2224 Guide for Forensic Analysis of Fibers by Infrared Spectroscopy

E2225 Guide for Forensic Examination of Fabrics and Cordage

E2227 Guide for Forensic Examination of Non-Reactive Dyes in Textile Fibers by Thin-Layer Chromatography

E2228 Guide for Microscopical Examination of Textile Fibers

E2330 Test Method for Determination of Concentrations of Elements in Glass Samples Using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for Forensic Comparisons

E2808 Guide for Microspectrophotometry in Forensic Paint Analysis

E2809 Guide for Using Scanning Electron Microscopy/X-Ray Spectrometry in Forensic Paint Examinations

E2917 Practice for Forensic Science Practitioners Training, Continuing Education, and Professional Development Programs

E2926 Test Method for Forensic Comparison of Glass Using Micro X-ray Fluorescence (μ-XRF) Spectrometry

E2927 Test Method for Determination of Trace Elements in Soda-Lime Glass Samples Using Laser Ablation Inductively Coupled Plasma Mass Spectrometry for Forensic Comparisons

E2937 Guide for Using Infrared Spectroscopy in Forensic Paint Examinations

E3085 Guide for Fourier Transform Infrared Spectroscopy in Forensic Tape Examinations

E3233 Practice for Forensic Tape Analysis Training Program

E3234 Practice for Forensic Paint Analysis Training Program

E3260 Guide for Forensic Examination and Comparison of Pressure Sensitive Tapes

WK56743 New Practice for Training in the Forensic Examination of Human Hair by Microscopy

WK72597 New Guide for the Microscopical Examination of Human Hair

WK72932 New Guide for Forensic Glass Analysis and Comparison

WK74138 Guide for Using Micro X-ray Fluorescence (-XRF) in Forensic Polymer Examinations

WK75180 Guide for Using Pyrolysis Gas Chromatography and Pyrolysis Gas Chromatography-Mass Spectrometry in Forensic Polymer Examinations

WK78747 Standard Guide for Forensic Examination of Fibers

WK78749 Standard Guide for Microspectrophotometry in Forensic Fiber Analysis

2.2 Other Documents

ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

3 Terminology

3.1 Definitions - For additional terms commonly employed for general forensic examinations see E1732.

3.2 Definitions of terms specific to this standard:

3.2.1 For definitions of terms used in this guide, refer to Terminology E1732. Additional definitions follow.

Activity level: An aspect of comparative examination of evidence that considers factors such as transfer mechanisms and persistence.

> Discussion. Factors include the presence of the evidence in a particular location (i.e., glass found embedded in the sole of a shoe versus glass found on a shirt), quantity (i.e., multiple fragments versus single fragment), and condition (i.e., pulled hair versus shed hair).
>
> Discussion. Alternative hypotheses of alleged activities may also be part of the factors considered.

Association: The opinion that there is more support for the proposition that two items originated from the same source as opposed to the proposition they originated from different sources.

Comparative report: A written report that includes an assessment of the significance of the comparative results from the analysis of two or more items to determine whether the items could have originated from the same or different sources.

Cross-transfer: The two-way exchange of materials between objects that can occur when they come into contact with one another.

Relevant population: The pool of potential sources.

Significance: The weight or meaning of the evidence or results.

Source level: An aspect of comparative examinations of evidence that considers whether the items originated from the same or different sources.

> Discussion. Consideration is given to how discriminating and rare the characteristics of the evidence are (i.e., glass fragments originated from antique glass versus the glass fragments originated from modern glass; the paint originated from a single layer of white paint versus the paint originated from a multi-layered, multi-colored paint).

Trace material: Physical evidence that can occur from the transfer of generally small quantities of materials (e.g., fibers, glass, hairs, paint, tape).

4 Summary of Guide

4.1 This guide describes recommendations for the overall interpretation and reporting of findings from an analytical scheme for trace material comparisons, such as those involving fiber, glass, hair, paint, and tape.

4.2 This guide highlights the considerations associated with reaching an overall interpretation in trace material comparisons, including factors such as the properties of the items being analyzed, the analytical techniques applied in that analysis, and transfer and persistence considerations.

5 Significance and Use

5.1 This guide uses a qualitative approach to communicate the significance of an association or exclusion, based on a) the validated methodology used for the comparison of the items, b) discrimination capabilities of the analytical protocol, and c) existing knowledge of how discriminating the compared characteristics are based on survey studies, reference collections, or databases.

1. Note 3: The body of work supporting this guide is detailed in the 2020 trace evidence review article by Trejos, Koch, and Mehltretter [1].

5.2 This guide describes the use of an interpretation scale to assess relative significance of results in a comparison report of trace materials.

6 Comparative Report Contents

6.1 The general requirements for reporting opinions of scientific or technical procedures should meet or exceed the requirements of Practice E620.

6.2 The following information is recorded: a listing of analytical techniques, results, interpretation, and opinions. The opinions include an interpretation of the significance of the results as well as a basis for the opined significance. The basis should include factors that limit or increase the significance of the opinion.

6.3 Examiners from the same discipline should be capable of reaching the same results based upon the report information and supporting analytical data within the case file.

6.3.1 Raw analytical data are retained in the case file for review.

6.3.1.1 Raw analytical data can be included in a comparative report only if a statement appears with an explanation and interpretation of their significance, to avoid misunderstanding of the data by the reader of the report.

7 Interpretation and Opinion Process

7.1 In trace evidence comparisons, the examiner analyzes the evidence and resulting data, forms an opinion, and summarizes the findings in a written report. The examiner also interprets and reports the overall meaning of those findings. A three-step process can be used in forming the opinion. These steps can be conducted sequentially or simultaneously, depending on the methods used for the description and evaluation of the data.

7.1.1 Step one involves a binary decision to determine whether the compared samples can be discriminated based on the comparison of the data.

7.1.2 Step two is the evaluation of the results on a source level to determine and explain the significance of finding differences or lack of differences between the samples being compared.

7.1.3 Step three is the evaluation of these results on an activity level to determine and explain the relevance of the findings under given circumstances.

7.2 This guide emphasizes the second step of interpretation at the source level and, when applicable, the third step of interpretation at the activity level.

8 Significance Assessment

8.1 To reach an opinion, relevant data are acquired and evaluated using accepted scientific and logical principles and methodologies.

8.2 An assessment of the significance of the results is recorded in the report.

8.2.1 When associations are made, they are communicated clearly and qualified properly in the report. Simple opinion statements (e.g., consistent with, could have come from, indistinguishable) are not sufficient on their own.

8.2.2 An interpretation scale provides a framework for decision making for significance assessment and much of the rest of the document provides the framework for its application.

8.2.3 Results should include the factors that support the reported significance.

8.2.4 For an assessment that uses data based on a relevant population, the examiner should disclose what population is considered relevant and if it is narrower than all possible sources. This information can be assessed through published discrimination studies, product manufacturing and distribution information, and databases.

8.2.5 In cases where there are multiple comparisons or cross-transfers, a separate opinion statement should be reached for each individual transfer. Cross-transfers or multiple transfers, when they occur, are examples of factors that could further increase the significance of findings. If so, an additional opinion statement regarding the significance of the combined individual transfers can be added.

8.3 The interpretation scale should be included in the report in its entirety to provide context for a specific interpretation.

8.3.1 The following interpretation scale is an example for use in comparative examinations and uses a qualitative approach. However, when sufficient scientific data exist for a quantitative assessment of significance (e.g., error rates, frequencies of occurrence, likelihood ratios), such data can be used in conjunction with the qualitative assessment. The provenance of these data is provided either in the body of the report or included as an appendix to the report. When a database is used for this purpose, the use and limitations of the database are also included or made available upon request.

8.3.2 Some interpretation categories are not applicable in every case or for every material type. This does not preclude a laboratory from establishing similar systematic criteria as that presented here. Refer to Sections 9 through 13 of this document for additional specific guidance.

Physical Fit – *Physical Fit* is the highest degree of association between items. It is the opinion

that the observations provide the strongest support for the proposition that the items were once joined together to form a single object as opposed to originating from different sources. *Physical Fit* is reached when the items that have been broken, torn, or separated exhibit physical features that correspond or re-align in a manner that is not expected to be replicated. A Physical Fit is not currently based upon a statistical evaluation of data; it is also not based upon exhaustive comparisons to all potential sources.

Associations of Evidence with Class Characteristics:

Class characteristics are physical, optical, or chemical properties that establish membership in a class, category, or group. Associations based on class characteristics do not establish that the items came from the same source. Class associations can have varying degrees of significance. In general, the smaller the size of the group relative to the relevant population, the more significant the association. These types of associations are categorized as follows:

Association with Highly Discriminating Characteristics – An association in which items could not be differentiated based on the examinations conducted. Therefore, the possibility that the items came from the same source cannot be eliminated. Additionally, the items share unusual characteristics that would rarely occur in the relevant population. This type of association provides very strong to extremely strong support for the proposition that the items originated from the same source as opposed to different sources. This is the highest degree of association that can be determined in the absence of a *Physical Fit*.

Association with Discriminating Characteristics – An association in which items could not be differentiated based on the examinations conducted. Therefore, the possibility that the items came from the same source cannot be eliminated. Other items have been manufactured or could occur in nature that would also be indistinguishable from the submitted items and could be encountered in the relevant population. This type of association provides moderately strong to strong support for the proposition that the items originated from the same source as opposed to different sources. The analytical techniques used in the analysis of these items can provide high levels of discrimination among natural and manufactured materials and therefore this is considered a strong association.

Association with Limitations – An association in which items could not be differentiated based on the examinations conducted. Therefore, the possibility that the items came from the same source cannot be eliminated. This type of association provides slight to moderate support for the proposition that the items originated from the same source as opposed to different sources. As compared to the categories above, this type of association has decreased evidential value. The items are more commonly encountered in the relevant population, a complete analysis was not performed due to limited characteristics or a limited analytical scheme, or minor explainable variations were observed in the data. Minor variations could be due to factors such as having a sample of insufficient size to adequately assess heterogeneity of the entity from which it was derived.

Inconclusive – No opinion could be reached regarding an association or an exclusion between the items.

Exclusion with Limitations – The item exhibits differences from the comparison sample that support that it did not originate from the source, as represented by the comparison sample; however, limiting factors prevented an Exclusion (Elimination) from being reached. This provides more support for the proposition that the items originated from different sources as opposed to the same source.

Exclusion (Elimination) – The items exhibit differences that support an opinion that the two items did not originate from the same source.

9 Fiber Reporting

9.1 Fiber examination in forensic casework is typically a comparison of two or more fibers, usually from a questioned source and a known source, for the purpose of determining if the known source can be eliminated or included as a potential donor of the questioned fiber(s). Fiber analysis also involves the comparison of two or more questioned fibers to determine if they could share a common source.

9.2 Analytical methodologies used for fiber examination have a direct impact on significance assessments.

9.2.1 A Physical Fit can only be reported when there is alignment of textile products along damaged, torn, or cut edges.

9.2.2 A comprehensive analytical scheme (see Guide WK78747) for natural and manufactured fibers, fabric and cordage (see Guide E2225) starts with a visual and microscopical examination to compare physical and optical characteristics such as color, shape, diameter, surface features, inclusions or delustrants, fluorescence, and birefringence (see Guide E2228). Additional techniques are used to further compare color or colorant [e.g., microspectrophotometry (MSP) (see Guide WK78749), thin layer chromatography (TLC) (see Guide E2227)]. In the case of manufactured fibers, instrumental techniques (e.g., FTIR, see Guide E2224) are used to examine and compare chemical composition.

9.2.2.1 A statement of decreased significance should be reported if a reduced analytical scheme was used to assess the physical, optical, and chemical characteristics that are routinely evaluated for samples of a given fiber type (e.g., limitations of the sample size or condition, absence of equipment routinely used).

9.2.3 Increased or decreased significance is based on available information for the relevant population

9.3 Source factors that could increase the significance of an association

9.3.1 Unusual physical or optical properties (e.g., variegated coloring, electrostatic core, fading, discoloration)

9.3.2 Corresponding surface contamination or damage

9.3.3 Unusual fiber type (e.g., aramid), depending on the scenario

9.3.4 Conditions that limit the possible sources of the fibers (e.g., fibers found embedded in a deployed airbag in a vehicle with a limited number of passengers wearing known garments)

9.4 Source factors that could decrease the significance of an association

9.4.1 Limited number of relevant analytical techniques used in the comparison

9.4.2 Commonly observed fiber type, such as white cotton or blue denim cotton

9.4.3 Limited number of features available for comparison

9.4.4 Limited sample size

9.4.5 Condition of samples (e.g., degraded samples)

9.4.6 Minor physical or chemical differences between items being compared that could be a result of sample heterogeneity, contamination of the sample(s), or having a sample of insufficient size to adequately assess the homogeneity of the item from which it was derived

9.4.7 Circumstances where a narrow range of fiber type and color are likely to be encountered (e.g., same type of uniform worn by multiple people), which could lead to a random association

9.5 Example Scenarios for Each Interpretation Category

The following examples are provided to assist in reaching each interpretation category.

9.5.1 Physical Fit

9.5.1.1 This interpretation category can be reached for fibers only when there is a physical fit of a textile piece with another textile along its torn, cut, or damaged edge, or through corresponding individual characteristics (e.g., surface features that carry across the pieces).

9.5.2 Association with Highly Discriminating Characteristics

9.5.2.1 Post-manufacturing mark on the items (e.g., both known and questioned items exhibit similar damage, staining, craft paint on surface)

9.5.2.2 Questioned to known association in which an unusual combination of characteristics, such as damage and color alteration, is present on both items

9.5.3 Association with Discriminating Characteristics

9.5.3.1 Questioned to known association in which a typical analysis scheme was performed (e.g., questioned nylon fiber corresponding to a known carpet)

9.5.4 Association with Limitations

9.5.4.1 Ubiquitous fibers (e.g., white cotton, blue denim cotton)

9.5.4.2 Limited characteristics to differentiate among fibers, depending on scenario (e.g., an undyed natural fiber or a colorless polyester fiber on a tape lift of a vehicle seat compared to a white cotton and polyester blend t-shirt)

9.5.4.3 Reduced analytical scheme due to lack of characteristics of the fiber or lack of available equipment

9.5.4.4 Limited amount of material for a comprehensive characterization or to adequately assess heterogeneity of the source from which it was derived

9.5.4.5 Minor explainable or demonstrable variation in one of the comparison samples due to established causes such as damage (e.g., impact), alteration (e.g., heat or chemical exposure), or known contamination (e.g., biological fluids)

9.5.5 Inconclusive

9.5.5.1 The questioned fiber possesses similar characteristics to the known sample but also exhibits some differences. These differences could be attributed to a time differential between the date of the incident and the collection date of the known sample, post-depositional changes, the known sample not being truly representative, or because the questioned fiber is from a different source.

9.5.5.2 The questioned or known fibers are too damaged, degraded, or contaminated to conduct most examinations.

9.5.6 Exclusion with Limitations

9.5.6.1 The questioned fiber is dissimilar in physical properties or chemical composition in comparison to the known, suggesting the items did not originate from the same source; however, these dissimilarities are insufficient for a definitive exclusion due to limiting factors. Limiting factors include indications of change or damage that could be from exposure to heat, chemicals, or environmental effects; or limited amount of known sample of a suspected source that is highly variable (e.g., trunk liner).

9.5.7 Exclusion (Elimination)

9.5.7.1 Exclusionary differences in physical, optical, or chemical properties between the compared fibers

9.6 Example Wording for Interpretation Categories

9.6.1 Physical Fit

9.6.1.1 “The torn edge of the questioned fabric piece physically fits and aligns with the torn edges of the known shirt fabric. This provides extremely strong support for the proposition that the fabric piece originated from and was at one time part of the shirt, as opposed to the proposition it originated from and was a part of another torn fabric source (**Physical Fit**).”

9.6.1.2 "The cut end of the questioned cordage piece physically fits and aligns with the cut end of the known cordage. This provides extremely strong support for the proposition that the cordage piece originated from and was at one time part of the known cordage, as opposed to the proposition it originated from and was a part of another cut cordage source (**Physical Fit**).”

9.6.2 Association with Highly Discriminating Characteristics

9.6.2.1 “Questioned fibers were compared to the sample of fibers from the known textile using (*insert methods here*). A singed, purple polyester questioned fiber corresponds in (*insert characteristics here*) to the singed fibers that comprise the sample of known purple textile. Therefore, the questioned fibers either originated from the known textile or from another textile with the same manufactured and acquired characteristics (**Association with Highly Discriminating Characteristics**). This type of association was reached because no differences were observed between the fibers and because of the similar damage to both items.”

9.6.2.2 “Questioned fibers were compared to the fibers sampled from the known textile using (*insert methods here*). The multi-colored questioned fibers correspond in (*insert characteristics here*) along their length to the multi-colored fibers that comprise the sample from the known textile. Therefore, the questioned fibers either originated from the known textile or from another textile with the same manufactured characteristics (**Association with Highly Discriminating Characteristics**). This type of association was reached because no differences were observed between the fibers and because of the number and arrangement of colors in both items.”

9.6.2.3 "Questioned cordage was compared to the sample of the known cordage using (*insert methods here*). The questioned cordage corresponds in (*insert characteristics here*) to the sample of known cordage, and both items contain extensive fraying. Therefore, the questioned cordage either originated from the known cordage or from another source of cordage with the same manufactured and acquired characteristics (**Association with Highly Discriminating Characteristics**). This type of association was reached because no differences were observed between the cordage and because of the damage observed on both items."

9.6.3 Association with Discriminating Characteristics

9.6.3.1 "Questioned fibers were compared to the sample of fibers comprising the known textile using (*insert methods here*). Brown nylon fibers correspond in *(insert characteristics here)* to the sample of brown nylon fibers that comprise the known textile. Therefore, the questioned fibers either originated from the known textile or from another textile with the same characteristics (**Association with Discriminating Characteristics**). This type of association was reached because other textiles containing fibers made to the same specifications (type, color, microscopic characteristics, etc.) would also be indistinguishable from these fibers. The techniques utilized in this comparative analysis can readily distinguish different fibers."

9.6.3.2 "Questioned cordage was compared to the sample of known cordage using (*insert methods here*). Brown nylon yarns that comprise the questioned cordage correspond in (*insert characteristics here*) to the sample of brown nylon yarns that comprise the known cordage. Therefore, the questioned cordage either originated from the known cordage or from another source of cordage with the same characteristics (**Association with Discriminating Characteristics**). This type of association was reached because other cordage containing yarns made to the same specifications (type, color, microscopic characteristics, etc.) would also be indistinguishable from these yarns. The techniques utilized in this comparative analysis can readily distinguish different yarns."

9.6.4 Association with Limitations

9.6.4.1 "Questioned fibers were compared to fibers comprising the sample from the known textile using (*insert methods here*). Round, colorless polyester fibers correspond in (*insert characteristics here*) to the round, colorless polyester fibers that comprise the sample from the known textile. Therefore, the questioned fibers either originated from the known textile or from another textile with the same characteristics (**Association with Limitations**). This type of association was reached because of the limited number of distinguishing characteristics available for comparison between the known and the questioned fibers as well as the prevalence of this fiber type."

9.6.4.2 "Questioned fibers collected from the dashboard of the vehicle were compared to fibers comprising the sample from the known textile using (*insert methods here*). The impacted red nylon fibers from the dashboard correspond in (*insert characteristics here*) to the red nylon fibers that comprise the sample from the known textile. However, slight differences were noted in (*insert characteristics here*) of the questioned fibers in comparison to the fibers from the sample of the known textile. These slight differences are explainable due to observed damage. Therefore, the questioned fibers either originated from the known textile or from another textile with the same characteristics (**Association with Limitations**). This type of association was reached because of the minor variations observed in the characteristics between the known and the questioned fibers."

9.6.5 Inconclusive

9.6.5.1 "Questioned fibers were compared to fibers comprising the sample collected from the known textile using (*insert methods here*). The red nylon fibers correspond in (*insert characteristics here*) to the red nylon fibers that comprise the known textile. However, slight differences were noted in the (*insert characteristics here*) of the questioned fibers in comparison to the sample of the known textile. Because of the documented potential exposure of the questioned fibers to the environment (based on case information communicated by the submitting agency), no opinion can be reached as to whether the red fibers originated from the textile or from another source of red fibers (**Inconclusive**)."

9.6.6 Exclusion with Limitations

9.6.6.1 "Questioned fibers were compared to fibers composing the samples from the known trunk liner using (*insert methods here)*. The questioned fibers were different in (*insert characteristics here*) to the fiber samples from the known trunk liner, indicating the items did not originate from the same source; however, possible reasons for this difference include that the source is highly variable, and the questioned and known fiber samples provided are not fully representative of their source. Therefore, this difference is insufficient for a definitive exclusion (**Exclusion with Limitations**)."

9.6.6.2 "Questioned cordage was compared to the sample of known cordage using (*insert methods here*). The outer braided layer of the cordage is similar, but the core was different in (*insert characteristics here*), indicating the items did not originate from the same source; however, possible reasons for the difference include manufacturing variation or irregularities. Therefore, this difference is insufficient for a definitive exclusion (**Exclusion with Limitations**)."

9.6.7 Exclusion (Elimination)

9.6.7.1 "Questioned fibers were compared to the fibers comprising the known textile using (*insert methods here*). The fibers are different in (insert characteristics here) from the fibers comprising the textile. Therefore, the questioned fibers did not originate from the textile [**Exclusion (Elimination**)]."

9.6.7.2 "Questioned yarns were compared to the sample of known cordage using (*insert methods here*). The questioned yarns are different in construction from the yarns that comprise the reference sample of cordage. Therefore, the questioned yarns did not originate from the known cordage [**Exclusion (Elimination**)]."

9.7 Activity Level Considerations

9.7.1 Activity factors that could increase the overall significance of the association(s)

9.7.1.1 Large number of fibers or a portion of a textile transferred

9.7.1.2 Location where the fibers are found (e.g., under fingernail, in damaged area of vehicle)

1. Note 1: Be aware that fibers can move within packaging or during transport of evidence.

9.7.1.3 Cross-transfer of fibers between two sources

9.7.1.4 Fiber fusions (e.g., fiber embedded in or on a vehicle during an impact)

9.7.1.5 While certain fiber types are considered ubiquitous because they are commonly found in the environment (e.g., white cotton, blue denim cotton), activity factors should be considered to determine if the fibers are relevant and add significance.

9.7.2 Activity factors that could decrease the overall significance of the association(s)

9.7.2.1 Reasonable explanation as to why there was a transfer of fiber(s) (e.g., two individuals known to be in close or frequent contact)

9.7.3 Transfer and persistence

9.7.3.1 Transfer and persistence factors are considered when evaluating questions about alleged activities and the presence of fibers.

9.7.3.2 Textile fibers are transferred either by direct (primary) or indirect (secondary, tertiary) transfer. The possibility of transfer depends on the types of fabric or surface involved in the contact and the nature and duration of the contact.

9.7.3.3 The number of questioned fibers associated with a known source is important in estimating actual contact. The greater the number of fibers, the more likely that direct and potentially recent contact occurred between fiber sources. The converse is not necessarily true, however, and even one fiber association can have probative value. Additionally, finding no fibers does not necessarily mean that no contact occurred. Each case is different, and all of the relevant factors should be considered before determining the significance of the evidence.

9.7.3.4 The type of physical contact between two sources influences the number of fibers transferred and the value placed on their discovery. Physical contact of an extended duration or of a forceful nature can result in many fiber transfers. Brief contact is less likely to result in the transfer of multiple fibers.

9.7.3.5 Fabric construction affects the number and types of fibers that could transfer. For example, tightly woven or knitted fabrics shed fewer fibers than loosely knit or woven fabrics. Fabrics composed of filament fibers shed less than fabrics composed of staple fibers.

9.7.3.6 The condition and wear of the fabric also affects the degree of fiber transfers. Newer fabrics can have an abundance of loosely adhering fibers on the surface of the fabric. Well-worn fabrics typically do not have loosely adhering surface fibers but can have damaged areas that easily shed fibers. Damage to a fabric caused during physical contact increases the possibility of fiber transfer.

9.7.3.7 Transferred fibers are typically lost at an exponential rate. The rate of loss can vary depending on the types of fabrics involved, the activity of the individual or item (or lack thereof), and the environmental conditions (e.g., wind, rain) to which the evidence was exposed after contact. While it is impossible to precisely predict how many transferred fibers will remain after a given period of time, it is important for investigators to retrieve and protect evidence as soon as possible.

9.7.3.8 Background information regarding the sources involved (e.g., textiles, individuals) and possible prior contact between them can affect the significance of the association.

9.7.4 Cross-transfers or multiple transfers of fibers. If many different fibers are associated between known and questioned sources (e.g., two or more articles of clothing had fibers transfer from them, one shirt had two different fiber types transfer to it, fibers from multiple sources in a location transferred to a victim), then the possibility that contact occurred between these items could be increased. Multiple transfers or cross-transfers reduce the chance that the fibers were all deposited by coincidence.

9.7.4.1 When two or more associations are being reported, each association should be reported separately. Additional text can then be included describing whether and how the multiple reported associations could affect the overall significance assessment and opinions from the totality of the examination results.

9.7.5 Example Wording for Activity Level Considerations

9.7.5.1 "The large number of fibers recovered from Item 1 indicates direct contact occurred with a textile."

9.7.5.2 "The fibers embedded in the damaged area of the suspect vehicle indicates that the vehicle has been in forceful contact with a fabric-clad item."

9.7.5.3 Ubiquitous fibers. "Although the fibers were blue denim cotton, which are commonly found in the environment, finding blue denim cotton fibers embedded in the damaged area of the vehicle lends more significance to their evidentiary value."

9.7.5.4 Cross-transfer. "The presence of numerous fibers on the victim's shirt that could not be distinguished from the fibers comprising the known shirt from the subject and the presence of numerous fibers on the subject's shirt that could not be distinguished from the fibers comprising the known shirt from the victim provides stronger support for contact having occurred between the two shirts than either transfer alone. Cross-transfers reduce the chance that the fibers were all deposited by coincidence."

9.7.5.5 Multiple transfers. "The presence of fibers on the victim's shirt that could not be distinguished from the fibers comprising both the known shirt and the known pants from the subject provides stronger support for contact having occurred from the subject's shirt and pants to the victim's shirt than either transfer alone. Multiple transfers reduce the chance that the fibers were all deposited by coincidence."

10 Glass Reporting

10.1 Glass examination in forensic casework is typically a comparison of two or more glass fragments to determine if they can be discriminated by their physical, optical, or elemental composition. If the samples are distinguishable in one or more of these observed and measured properties, it is reported that they do not originate from the same broken glass object represented by the submitted known sample. If the samples are indistinguishable in all of these observed and measured properties, the possibility that they originated from the same broken glass object cannot be eliminated.

2. Note 2: It is important to note, however, that although there could be several objects with identical properties, glass fragments can originate only from broken and not intact objects.

10.2 Analytical methodologies used for glass comparisons have a direct impact on significance assessments.

10.2.1 A Physical Fit can only be reported when there is alignment of two glass fragments along their broken edges.

10.2.2 A comprehensive analytical scheme (see Guide WK72932), unless sample size or condition prohibits it, includes visual and microscopical examinations and characterization of the glass by its optical properties (see Test Method E1967) and elemental composition.

10.2.3 Increased or decreased significance is stated based on the techniques used for the examination and

respective discrimination capabilities and on frequency of occurrence or random match probabilities from glass populations.

10.2.3.1 Analytical sensitivity and precision of the methods used for elemental analysis, along with the observed variations within and between samples in the relevant population, allow for high discrimination between different sources. The use of Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) (see Test Method E2330), micro-X-Ray Fluorescence Spectroscopy (μXRF) (see Test Method E2926), or Laser Ablation-ICP-MS (LA-ICP-MS) (see Test Method E2927) is recommended for elemental analysis and comparison of glass when sufficient sample is available.

10.2.3.2 Due to the ability of the sensitive elemental techniques in 10.2.3.1 to differentiate glass manufactured in different plants, use of one of these techniques is required to report a potential association of increased significance. Since there are many manufacturing plants producing glass over many years, coincidental indistinguishable elemental composition can exist but are not frequent. Random match rates around 0.1% have been observed in different sample sets [2-4].

10.2.3.3 In reporting a potential association, a statement of decreased significance is reported if the analytical scheme does not include elemental analysis at all or if the elemental analysis is conducted by less sensitive methods such as scanning electron microscopy – energy dispersive x-ray spectroscopy (SEM-EDS).

1. Note 3 - The sensitivity of SEM-EDS is not suitable to detect those trace elements known to differentiate glass fragments, but SEM-EDS can detect differences between glasses based on major and, in some instances, minor elemental concentrations.

2. Note 4 - SEM-EDS analysis of glass can be conducted to characterize sources (i.e., float vs. container vs. leaded glass) or for comparative analysis when the small size of the sample prevents the analysis by more discriminating methods.

10.2.4 Glass examinations generate quantitative data (RI and elemental composition) that allow the application of statistical methods to make decisions about differences or similarities between samples. The laboratory or examiner selects a criterion that is appropriate to the analytical method used to generate the data and that has acceptable/known error rates.

10.2.4.1 Access to and use of databases is recommended to evaluate the rarity of measured features or to estimate a frequency of random match or a likelihood ratio (LR) to provide an objective measure of significance. Databases developed and validated in forensic laboratories or reported in the peer-reviewed literature can be used to estimate a quantitative measure of the significance through frequency of random match or LR estimations to describe the value of the glass evidence.

10.3 Source factors that could increase the significance of an association

10.3.1 Unusual physical features, such as unusual weathering markings, labeling (or partial labeling) of Department of Transportation (DOT) numbers, or manufacturer markings (e.g., headlamp)

10.3.2 Glass with a known limited population or rare characteristics (e.g., glass with unusual RI, custom made glass, glass with coatings, ultra-clear low Fe glass, sheet glass with unusually high concentrations of elements such as Er, Mo, Ce, Se)

10.3.3 Thermal history of the sample (if the compared glass fragments were both exposed to the same environmental temperature conditions, e.g., fire or explosion)

10.4 Source factors that could decrease the significance of an association

10.4.1 Analytical scheme does not include an assessment of both the optical and trace elemental composition of the glass

10.4.2 Condition of samples (e.g., small sample size)

10.4.3 Thermal history of the sample (if the compared glass fragments were exposed to different environmental temperature conditions, e.g., fire)

3. Note 5 - Exposure to heat (e.g., fire) could affect the optical properties prior to annealing but not the elemental profile.

10.4.4 Properties that are not very discriminating, such as a relatively common RI

10.5 Example Scenarios for Each Interpretation Category

The following examples are provided to assist in reaching each interpretation category.

10.5.1 Physical Fit

10.5.1.1 This interpretation category can be reached for glasses only when there is a physical fit (fracture fit) of two or more pieces of broken glass or through corresponding individual characteristics (e.g., surface features such as number, letter or a patterned label) that carry across the pieces.

10.5.2 Association with Highly Discriminating Characteristics

10.5.2.1 Association of glass fragments characterized by elemental analysis using ICP-based methods alone, or ICP-based methods in combination with physical or optical measurements (RI)

10.5.2.2 Association of glass fragments characterized by RI and elemental analysis using µXRF when elements with atomic number equal to or greater than 37 (Rb) are present above the limit of quantitation

10.5.2.3 Association of glass fragments for which the estimated random match probability of the measured properties is very small (e.g., smaller than 0.2%) [2-5]

10.5.2.4 Association of glass fragments for which the estimated calibrated likelihood ratios (LR) provide very strong to extremely strong support for the same-source hypothesis over the different-source hypothesis (e.g., LR greater than 1000) [1, 4]. Note that the example given (LR greater than 1000) is not meant as a strict cutoff to determine whether a calibrated LR provides very strong to extremely strong support for the same-source hypothesis. The calibrated LR, as well as the upper and lower limits of possible calibrated LRs, will depend on the background database and calibration procedure used for the LR calculations.

10.5.3 Association with Discriminating Characteristics

10.5.3.1 Association of glass fragments characterized by elemental analysis using µXRF alone, when elements with atomic number equal to or greater than 37 (Rb) are present above the limit of quantitation

10.5.3.2 Association of glass fragments characterized by elemental analysis using RI and µXRF, when elements with atomic number equal to or greater than 37 (Rb) are below the limit of quantitation

10.5.3.3 Association of glass fragments for which the estimated random match probability of the measured properties is small (e.g., between 0.2% and 2%) [1-5]

10.5.3.4 Association of glass fragments for which the estimated calibrated likelihood ratios provide moderately strong to strong support for the same-source hypothesis over the different-source hypothesis (e.g., LR between 100 and 1000) [4]. Note that the example given (LR between 100 and 1000) is not meant as a strict limited range to determine whether a calibrated LR provides moderately strong to strong support for the same-source hypothesis.

10.5.4 Association with Limitations

10.5.4.1 Reduced analytical schemes (e.g., only RI or RI and elemental analysis by SEM-EDS)

10.5.4.2 Limited sample or sample condition that prevents adequate characterization

10.5.4.3 Association of glass fragments for which the estimated random match probability of the measured properties is relatively high (e.g., greater than 2%) [2-5]

10.5.4.4 Association of glass fragments for which the estimated calibrated likelihood ratios provide weak to moderate support for the same-source hypothesis over the different-source hypothesis (e.g., LR between 1 and 100) [1, 4]. Note that the example given (LR between 1 and 100) is not meant as a strict limited range to determine whether a calibrated LR provides weak to moderate support for the same-source hypothesis.

10.5.5 Inconclusive

10.5.5.1 The questioned glass is insufficient to do most examinations (e.g., physical/optical examinations can identify the sample as glass, but the sample is too small for other comparison methods).

10.5.6 Exclusion with Limitations (not applicable)

10.5.7 Exclusion (Elimination)

10.5.7.1 Physical, chemical, or optical exclusionary differences between the compared glasses

10.6 Example Wording for Interpretation Categories

10.6.1 Physical Fit

10.6.1.1 "A physical/fracture fit was identified/observed based on corresponding random characteristics on the broken edges of the Item 1 piece of glass and the broken edges of Item 2, the known source. Therefore, this correspondence provides extremely strong support for the proposition that they were once part of the same broken glass object and extremely weak support for the proposition that the glass came from different broken glass objects (**Physical Fit**)."

10.6.2 Association with Highly Discriminating Characteristics

10.6.2.1 "The Item 1 known glass fragments and the Item 2 questioned glass fragment are colorless glass (*specify color when possible*) that show characteristics of tempered glass (*specify glass type when possible, e.g., flat, float, container glass).* Comparison of Items 1 and 2 by visual and microscopical techniques, refractive index, and elemental analysis by LA-ICP-MS (*specify sensitive technique here*) determined that they could not be differentiated based on their physical and optical characteristics or their elemental composition. These combined methods have shown to be highly discriminating between glass sources. Therefore, the questioned glass originated from the window (*specify the known source, e.g., sheet of glass, window, windshield*) as represented by the known sample or another source of broken glass indistinguishable in the measured properties (**Association with Highly Discriminating Characteristics**). This type of association was reached because coincidental associations of glass originating from different

sources could occur but are expected to be highly unusual."

10.6.3 Association with Discriminating Characteristics

10.6.3.1 "All glass fragments received as Item 1 (known) and the glass fragment received as Item 2 (questioned) are colorless glass (*specify color when possible*) that show characteristics of flat glass (*specify glass type when possible e.g., tempered, flat, float, container glass, etc.).* Comparison of Items 1 and 2 by visual and microscopical techniques, refractive index and elemental composition by µXRF (*specify sensitive technique here*) determined that they could not be differentiated based on their physical and optical characteristics and their elemental composition. These combined methods have shown to be discriminating between glass sources. Therefore, the questioned glass originated from the windshield (*specify the known source, e.g., sheet of glass, window, windshield*) submitted as a known sample or another source of broken glass indistinguishable in the measured properties (**Association with Discriminating Characteristics**). This type of association was reached because coincidental associations of glass originating from different sources could occur but are expected to be unusual."

10.6.4 Association with Limitations

10.6.4.1 "The glass fragment received as Item 1 (questioned glass) and the glass fragments received as Item 2 (known) are indistinguishable in their refractive indices. Therefore, the questioned glass originated from the known window or another source of glass with the same refractive index. (**Association with Limitations**). This type of association was reached due to the limited number of characteristics available for comparison between the known and questioned sample. In glass specimens where only refractive index data can be measured, the chance of finding coincidental associations is significantly greater. More discriminating techniques could not be applied due to the limited size of the questioned sample."

10.6.4.2 "The glass fragment received as Item 1 (questioned glass) and the glass fragments received as Item 2 (known) are indistinguishable by refractive index and elemental analysis with SEM-EDS. Therefore, the questioned glass originated from the known window or another source of glass with the same refractive index and elemental composition (**Association with Limitations**). This type of association was reached due to the limited number of characteristics available for comparison between the known and questioned sample. In glass specimens where only refractive index and SEM-EDS data can be measured, the chance of finding coincidental associations is significantly greater. SEM-EDS is limited to the detection of major and minor elements but not suitable for detection of trace elements. More discriminating techniques could not be applied due to the limited size of the questioned sample."

10.6.5 Inconclusive

10.6.5.1 "Although there are some similarities between the Item 1 questioned glass and the Item 2 container, the fragment size of Item 1 does not allow for the complete comparison of optical or chemical properties. Therefore, no opinion can be reached regarding an association or exclusion between items (**Inconclusive**)."

10.6.5.2 "Although there are some similarities between Item 1 and Item 2, the quantity of glass fragments received as the Item 2 known sample is insufficient to completely characterize the optical and elemental composition of the known broken source. Therefore, no opinion can be reached regarding an association or exclusion between items (**Inconclusive**)."

10.6.6 Exclusion with Limitations (not applicable)

10.6.7 Exclusion (Elimination)

10.6.7.1 "The Item 1 glass fragment differs in physical and optical properties from the Item 2 windshield, and therefore the known glass source represented as Item 2 is not the source of Item 1 [**Exclusion (Elimination**)].

10.6.7.2 "The Item 1 glass fragment differs in physical, optical, and chemical properties from the Item 2 bottle, and therefore Item 2 is not the source of Item 1 [**Exclusion (Elimination**)]."

10.6.7.3 "The Item 1 glass fragment differs in elemental composition from the Item 2 window, and therefore Item 2 is not the source of Item 1 [**Exclusion (Elimination**)]."

10.7 Activity Level considerations

10.7.1 Activity factors that could increase the overall significance of the association(s)

10.7.1.1 Large number of fragments transferred from a single source

10.7.1.2 Large number and size of fragments transferred and retained on the recipient

10.7.1.3 Location where the glass is found (e.g., upper surface of the shoe versus embedded in the sole of the shoe)

10.7.2 Activity factors that could decrease the overall significance of the association(s)

10.7.2.1 Location where the glass is found (e.g., embedded in the sole of the shoe versus on the upper surface of the shoe)

10.7.2.2 Inability to determine the location of fragments on a searched surface (e.g., fragments recovered in the evidence container or garment improperly wrapped)

10.7.3 Transfer and persistence

10.7.3.1 Transfer and persistence factors are considered when evaluating questions about alleged activities and the presence of glass.

10.7.3.2 The breaking of glass generates small fragments that can be transferred to a person or to other objects in the vicinity of the breaking glass. Transfer and persistence factors are considered in evaluation of the significance of the findings within a specific set of circumstances.

10.7.3.3 The understanding of the phenomena of transfer and persistence of glass fragments is fundamental for the interpretation and assessment of the significance of the evidence.

10.7.3.4 The number and size of fragments transferred and retained on the recipient is related to several factors such as type of clothes and garments, distance from the breaking window, wet versus dry clothing, type and thickness of glass, the breaking force, the number of blows, and the object that broke the glass item.

10.7.4 The value of evidence can be enhanced by the cross-transfer of evidence between victim and suspect, cross-transfer between objects, or the transfer of multiple items of evidence.

10.7.4.1 In instances in which two or more associations are being reported, each association should be reported separately. Additional text can be included describing whether and how the multiple reported associations can affect the overall significance assessment and opinions from the totality of the examination results.

10.7.5 Example Wording for Activity Level Considerations

10.7.5.1 "The large number of glass fragments recovered from item 1 indicates a recent exposure to broken glass."

10.7.5.2 "It is rare to find broken glass fragments in the head hair of persons not involved in glass-breaking activities."

11 Hair Reporting

11.1 Hair examination in forensic casework can consist of the microscopical comparison of questioned hairs to hairs from a known source to determine if the known source can be eliminated or included as a potential donor of the questioned hair

11.1.1 Hair comparisons typically consist of determining if a questioned hair is consistent in macroscopic and microscopic characteristics to the hairs submitted as a known sample.

11.2 A comprehensive analytical scheme (see Guide WK72597) includes visual and microscopical examination and comparison using a comparison microscope to assess and compare characteristics.

11.2.1 The presence, absence, and distribution of the macroscopic and microscopic characteristics present in a hair have a direct impact on its significance.

11.2.1.1 Hair from a single source is not homogeneous in microscopic characteristics and has a range of characteristics that could be present. These characteristics change over time.

11.2.1.2 A person can have hairs that have different macroscopic or microscopic characteristics from the majority of the hairs from the same somatic area.

11.2.1.3 If the macroscopic and microscopic characteristics of a questioned hair falls within the range of the characteristics of the hairs in known source, the known source can be included as a potential donor of the questioned hair. When the known source is included as a potential donor, the following statement or an equivalent statement is included in the report: "Microscopical hair comparisons are not a means of personal identification. The number of individuals that could be included as a possible source is unknown."

11.2.2 The result of a hair comparison could be affected if a known hair sample is very limited (e.g., contains one known hair), if the question hair is a fragment (i.e., cut or broken), if the questioned and known samples lack pigment, or if a significant amount of time has elapsed between the incident and known sample collection. Additional qualifying statements can be added to the report in situations where there are known circumstances that affect the examination.

11.2.3 The range of macroscopic and microscopic characteristics within the hairs from a single source could overlap with the range of characteristics of hairs from another source. Due to this overlap, it is possible that a questioned hair cannot be differentiated from multiple sources. In this case, a statement is added to the report that both sources of the known hair samples (persons A and B) can be included as possible sources of the questioned hair.

11.2.4 As a part of a microscopical comparison, hairs may be classified by ancestry. If ancestry classifications are reported, the following statement or an equivalent statement is included: "Ancestral classifications of hairs are based on the combination of macroscopic and microscopic characteristics which are typically observed in hairs from individuals of a given ancestral group, and these classifications may or may not correspond to an individual's ancestry origin or self-identification."

11.2.5 As a part of a microscopical comparison, hairs may be classified by body area. If body area classifications are reported, the following statement or an equivalent statement is included: "Body area classifications of hairs are based on the combination of macroscopic and microscopic characteristics which are typically observed in hairs from specific areas of the body."

11.2.6 DNA testing is considered after microscopical comparisons. When probative results are determined by a microscopical analysis of hairs, subsequent DNA analysis could provide additional information. Statements recommending subsequent DNA testing are included in the report, such as: "These results should be evaluated in conjunction with DNA analysis." Further discussion of DNA analysis of hairs is beyond the scope of this document.

11.2.7 Results presented in written reports cannot include statistical or numerical estimates of rarity or error rate because generally accepted estimates of these quantities have not yet been reliably established. This prohibition includes unfounded statistical statements (e.g., opinions based on years of experience, number of hairs or hair samples examined by examiner, or the number of examinations performed by the examiner) regarding a forensic hair examiner's potential error rate or the numerical likelihood that a questioned hair came from a specific individual.

11.3 Source factors that could increase the significance of an association

11.3.1 Dyed hair where both the natural color and the dyed color are present

11.3.2 Hair that has been dyed with different, distinctive colors multiple times

11.3.3 Disease, hereditary hair conditions, or unusual characteristics (e.g., head hairs with pilli annulati, a double medulla, hairs exhibiting characteristics from external causes)

11.3.4 Conditions that limit the possible sources of the hair (e.g, hairs found in a crack on the inside of a windshield with limited occupants.)

11.4 Source factors that could decrease the significance of an association

11.4.1 Featureless hairs that lack pigmentation

11.4.2 Very dense pigmentation or opaque hairs, which inhibits the observation of microscopic characteristics

11.4.3 Damaged or very short hairs, which limit the number of characteristics that can be used for comparison

11.4.4 Known sample that has a large intra-sample variation (e.g., includes both pigmented and unpigmented hairs, includes a wide variety of dyed hairs)

11.5 Example Scenarios for Each Interpretation Category

The following examples are provided to assist in reaching each interpretation category.

11.5.1 Physical Fit (not applicable)

11.5.2 Association with Highly Discriminating Characteristics

11.5.2.1 Behavioral factors and styling [e.g., a hair has been dyed several, distinctive colors multiple times and each color change is visible (at least on a microscopic level)]

11.5.2.2 Disease or hereditary condition that is manifest in hair

11.5.2.3 External environmental factors observed in both the questioned hair and the known sample (e.g., putrefied roots, burnt hairs)

11.5.2.4 Substances on the surface of the hair in both the questioned and the known sample (e.g., topical treatments, paint, lice)

11.5.3 Association with Discriminating Characteristics

11.5.3.1 A hair with a range of macroscopic and microscopic characteristics that are included in the representative known sample. This can include microscopic color variation that reflects natural environmental exposures and conditions over time.

11.5.4 Association with Limitations

11.5.4.1 A hair that possesses a limited number of macroscopic and microscopic characteristics such as:

(1) a hair that is very short (if it possesses a limited number of macroscopic and microscopic characteristics);

(2) a hair that has little to no pigmentation either naturally or through artificial means (i.e., has very little or no pigmentation, generally possess fewer characteristics for comparison); or

(3) a hair that is heavily pigmented or heavily dyed (i.e., the hair appears opaque and therefore a limited number of characteristics are available for comparison).

11.5.5 Inconclusive

11.5.5.1 A questioned hair possesses similar characteristics to the known sample but also exhibits some differences. These differences can be attributed to post-depositional changes, the known sample not being representative of the source (does not contain the full range of characteristics), or because the questioned hair is from a different source.

11.5.6 Exclusion with Limitations

11.5.6.1 The questioned and known hairs possess different characteristics (e.g., cross-section, thickness variation, color, distribution of pigment). Due to the range of characteristics possible within an individual, an Exclusion (Elimination) is not possible.

11.5.7 Exclusion (Elimination)

11.5.7.1 The questioned and known hairs are grossly different in their macroscopic or microscopic characteristics (e.g., known consists of tightly curled, dark brown head hairs 3-5 inches long; the questioned hair is a straight blonde head hair 18 inches long).

11.6 Example Wording for Interpretation Categories

11.6.1 Physical Fit (not applicable)

11.6.2 Association with Highly Discriminating Characteristics

11.6.2.1 “Based on a visual and microscopical comparison, the characteristics observed in the Item 1 questioned hair fall within the range of characteristics in the Item 2 known hairs. Items 1 and 2 also possess distinctive characteristics that are indicative of (*insert characteristic here, e.g., behavioral, disease/hereditary, or environmental characteristic*) that is not typically or routinely observed in human hairs. Therefore, the source of Item 2 (person A) is included as a potential

source of Item 1 (**Association with Highly Discriminating Characteristics**). Microscopical hair comparisons are not a means of personal identification. The number of individuals that could be included as a possible source is unknown. These results should be evaluated in conjunction with DNA analysis."

11.6.3 Association with Discriminating Characteristics

11.6.3.1 "Based on a visual and microscopical comparison, the characteristics observed in the Item 1 questioned hair fall within the range of characteristics in the Item 2 known hairs. Therefore, the source of Item 2 (person A) is included as a potential source of Item 1 (**Association with Discriminating Characteristics**). Microscopical hair comparisons are not a means of personal identification. The number of individuals that could be included as a possible source is unknown. These results should be evaluated in conjunction with DNA analysis."

11.6.4 Association with Limitations

11.6.4.1 "Based on a visual examination and microscopical comparison, the characteristics observed in the Item 1 questioned hair fall within the range of characteristics in the Item 2 known hairs. The source of Item 2 therefore cannot be eliminated as a potential source of Item 1; however, the characteristics for comparison are limited (**Association with Limitations**). The absence of a full range of physical and microscopic characteristics (*insert limitation, e.g., hair too short, too little or no pigmentation, hair appears opaque, no root structure present*) precludes a more definitive comparison result. Microscopical hair comparisons are not a means of personal identification. The number of individuals that could be included as a possible source is unknown. These results should be evaluated in conjunction with DNA analysis."

11.6.5 Inconclusive

11.6.5.1 "Based on a visual and microscopical comparison between the Item 1 questioned hair and the Item 2 submitted known hairs, some similarities and some dissimilarities in the macroscopic and microscopic characteristics were observed. Therefore, no opinion can be reached as to whether or not the source of Item 2 (person A) can be included as a potential source of Item 1 (**Inconclusive**). The comparison was limited due to (*list limiting factors if applicable*)."

11.6.6 Exclusion with Limitations

11.6.6.1 "Based on a visual and microscopical comparison between the Item 1 questioned hair and the Item 2 submitted known hairs, dissimilarities in the macroscopic and microscopic characteristics were observed. Based on the known sample submitted, Item 1 is not consistent with originating from the source of the Item 2 known hairs (**Exclusion with Limitations**). Assuming the known hair sample is representative, observations indicate that the hairs did not originate from the same source. Due to the natural variation that occurs in hairs, and the effect that time and environment can have upon a hair sample, these observed differences are insufficient for a definitive exclusion."

11.6.6.2 "The Item 1 questioned hair was microscopically dissimilar to the Item 2 known head hair sample and, therefore, based on the known sample, is not consistent with originating from the same source (**Exclusion with Limitations**). This exclusion is limited because there was a significant time lapse between the collection of the questioned hair and the known sample (over 1 year). Due to the effect that time and environment can have upon a hair sample, these observed differences are insufficient for a definitive exclusion."

11.6.6.3 "One hair from Item 1 was examined with a compound microscope and exhibited characteristics consistent with a head hair of European ancestry. Item 1 was found to be microscopically dissimilar by comparison microscopy to the Item 2 known sample, also of European ancestry. Therefore, based on the known sample submitted, the source of the Item 2 hair sample cannot be included as a source of the questioned hair in Item 1 (**Exclusion with Limitations**). This exclusion is limited because there may be variation within the source that may not be represented in the known sample."

11.6.7 Exclusion (Elimination)

11.6.7.1 "Based on a visual and microscopical comparison between the Item 1 questioned hair and the Item 2 submitted known hairs, gross dissimilarities in the macroscopic and microscopic characteristics (e.g., characteristics of ancestry) were observed. Therefore, the source of Item 2 (person A) can be excluded as a potential source of Item 1 based on the submitted sample [**Exclusion (Elimination)**]."

11.7 Activity Level Considerations

11.7.1 Activity factors that could increase the overall significance of the association(s)

11.7.1.1 Large number of loose hairs transferred from a single source

11.7.1.2 A clump of hairs transferred from a single source

11.7.1.3 Cross-transfer of hairs between two people

11.7.1.4 Conditions that limit the possible sources of the hair (e.g., numerous hairs embedded in the interior surface of a broken windshield of a motor vehicle with known passengers)

11.7.1.5 The presence of hairs with stretched/anagen roots (hairs in the active growing phase) indicates the forceful removal of the hairs (although the amount of force cannot be determined).

11.7.2 Activity factors that could decrease the overall significance of the association(s)

11.7.2.1 The recipient works in a hair salon and is exposed on a regular basis to hairs with a wide variety of physical characteristics, hairs that could be forcefully removed, hairs that could have been naturally shed, and cut hair fragments.

11.7.2.2 Reasonable explanation for a transfer of hair(s) (e.g., two individuals living together)

11.7.3 Transfer and persistence

11.7.3.1 Transfer and persistence factors are considered when evaluating questions about alleged activities and the presence of hair.

11.7.3.2 The retention of transferred hairs can depend upon the activity of the recipient object (e.g., person's clothing, furniture) after the transfer. For example, hair on the clothing of a person who is moving around can be lost (fall off or transferred to another object) over time, while hair on a chair can remain there for a long period of time or could be transferred to the clothing of another person who sat on the chair subsequent to the original deposition of the hair.

11.7.4 Cross-transfers or multiple transfers

11.7.4.1 When there is a cross-transfer of hairs and each transfer individually results in an association, a statement regarding the significance of the cross-transfer can be reported separately.

11.7.4.2 In instances in which two or more associations are being reported (e.g., head and pubic hair,

multiple hairs), each association should be reported separately. Additional text can then be included describing whether and how the multiple reported associations could affect the overall significance assessment and opinions from the totality of the examination results.

11.7.5 Example Wording for Activity Level Considerations

11.7.5.1 "A clump of hairs, similar in color, with stretched roots and adhering tissue/root sheath are indicative of the hairs having been forcibly removed."

11.7.5.2 "Due to cohabitation of the involved individuals, a transfer of hair between these individuals would not be uncommon."

11.7.5.3 Multiple transfers. "The presence of head and pubic hairs on the victim's shirt similar to the known head and pubic hairs from the subject provides stronger support for contact having occurred between the victim and subject than either transfer alone."

11.7.5.4 Cross-transfer. "The presence of hairs on the victim's shirt similar to the known hairs from the subject and the presence of hairs on the subject's shirt similar to the known hair from the victim provides stronger support for contact having occurred between the victim and subject than either transfer alone."

12 Paint Reporting

12.1 Paint examination in forensic casework is typically a comparison of two or more paints, usually from a questioned source and a known source for the purpose of determining if the known source can be eliminated as a potential donor of the questioned paint.

12.2 Analytical methodologies used for paint comparisons and discrimination studies have a direct impact on significance assessments.

12.2.1 A Physical Fit can only be reported when there is alignment of two paint fragments along the broken edges, with a substrate where it was previously in contact, or through surface scratches and features that carry across onto the questioned chip from the remaining finish.

12.2.2 A comprehensive analytical scheme (see Guide E1610), unless sample size or condition prohibits it, includes visual and microscopical examinations to assess physical characteristics and instrumental analysis (see Guides E2808, E2809, E2937, WK74138, WK75180) to compare the organic and inorganic components of the paint layers.

12.2.2.1 A statement of decreased significance should be reported if a reduced analytical scheme was used to assess the physical and chemical characteristics that are routinely evaluated for samples of a given paint type (e.g., limitations of the sample size or condition, absence of equipment routinely used).

12.2.3 Increased or decreased significance is based on available information for the relevant population.

12.3 Source factors that could increase the significance of an association

12.3.1 Unusual physical or chemical features (e.g., surface damage)

12.3.2 Paint formulation applied for other than its intended use (e.g., architectural paint applied to a vehicle)

12.3.3 Paint with a known limited population (e.g., customized finishes)

12.3.4 Increased number of layers

12.3.5 Unusual layer sequence where sequence order is typically controlled, mandated, or deliberate

12.3.6 For automotive paint, the following source factors could increase the significance of an association.

12.3.6.1 Repair during manufacture [original equipment manufacturer (OEM) repair]

12.3.6.2 Aftermarket refinish– number of layers and characteristics of the refinish affect association significance

12.3.6.3 Non-automotive paint layer within a layer system

12.3.6.4 Refinish layer(s) that change the topcoat color of the vehicle

12.3.7 For architectural paint, the following source factors could increase the significance of an association.

12.3.7.1 Multiple layers of various colors

12.3.7.2 Presence of inclusions, contaminants, or soil

12.3.7.3 Spray paint layer within a layer system

12.4 Source factors that could decrease the significance of an association

12.4.1 Limited number of analytical techniques used in the comparison

12.4.2 Limited number of features available for comparison

12.4.3 Condition of samples (e.g., mixed smears, contamination throughout the transferred material, minute sample amount)

12.4.4 Minor physical or chemical differences between items being compared that could be due to sample heterogeneity, contamination of the sample(s), or having a sample of insufficient size to adequately assess the homogeneity of the entity from which it was derived

12.4.5 Circumstances that increase the possibility of a random association (e.g., the suspect is a house painter and the material in question is an architectural paint)

12.5 Example Scenarios for Each Interpretation Category

The following examples are provided to assist in reaching each interpretation category.

12.5.1 Physical Fit

12.5.1.1 A Physical Fit is possible where there is alignment of a paint chip with another paint chip along its broken edge, with a substrate where it was previously in contact, or through corresponding individual characteristics (e.g., surface scratches) that carry across onto the questioned chip from the remaining finish.

12.5.2 Association with Highly Discriminating Characteristics

12.5.2.1 OEM automotive system with at least one aftermarket basecoat or primer layer above the original clear coat

12.5.2.2 OEM automotive system with two or more factory repairs (i.e., three or more total basecoat-clearcoat sequences)

12.5.2.3 Architectural paint system with two or more different layers

12.5.2.4 Automotive system with architectural paint present

12.5.3 Association with Discriminating Characteristics

12.5.3.1 Association of paint in which the typical analysis scheme was performed on mass-produced materials that have numerous features for evaluation (e.g., four-layered OEM automotive paint)

12.5.3.2 OEM automotive paint system with one factory repair of the same basecoat color and layer sequence (i.e., two total OEM basecoat-clearcoat sequences)

12.5.3.3 Single-layered paint for which there is knowledge of substantial discrimination power (e.g., red architectural paint) or product manufacturing distribution information that reduces the potential sources

12.5.3.4 Aftermarket refinish clearcoat and basecoat

12.5.4 Association with limitations

12.5.4.1 Smears with intermixing of layers that limit isolation of layers

12.5.4.2 Limited physical features available for evaluation and no elemental analysis performed

12.5.4.3 Chips of an OEM automotive paint system containing only a clearcoat and an unremarkable basecoat (e.g., white color, acrylic melamine binder system with primarily titanium dioxide as an extender pigment)

12.5.4.4 Single-layered paint for which there is limited knowledge of discrimination power and product manufacturing distribution information (e.g., yellow tool paint)

12.5.5 Inconclusive

12.5.5.1 The paints exhibit both similarities and differences such that no opinion can be reached regarding an association or exclusion between items.

12.5.5.2 Suspected clearcoat automotive layer transfer in which both vehicles have consistent (indistinguishable) clearcoat chemistries

12.5.5.3 Additional peaks or relative intensities variations of peaks in the questioned paint could be components of the paint or contamination from a foreign material. Analysis of the transfer cannot differentiate whether the peaks are exclusionary or due to contamination (e.g., architectural paint transfer on a pry tool is intermixed with non-paint material, such as drywall).

12.5.6 Exclusion with Limitations

12.5.6.1 Vehicles can have different paint systems on different panels of the same vehicle. Therefore, it is possible that one known vehicle part differs from the questioned sample (e.g., one sample has an anti-chip layer). No analytical differences were observed in the corresponding layers. The vehicle is no longer available to collect an additional known sample.

12.5.7 Exclusion (Elimination)

12.5.7.1 Exclusionary difference in physical characteristics (e.g., different color, different layer structure)

12.5.7.2 Exclusionary difference in chemical composition (e.g., different binders or fillers present, different ratios/amounts of components that exceed the variation observed in the sample)

12.6 Example Wording for Interpretation Categories

12.6.1 Physical Fit

12.6.1.1 "Examination and comparison of Items 1 and 2 revealed corresponding fracture contours, surface configurations, and layer structures. This provides extremely strong support for the proposition that the items originated from the same damaged source as opposed to the proposition they originated from different damaged sources (**Physical Fit**)."

12.6.2 Association with Highly Discriminating Characteristics

12.6.2.1 "Examination and comparison of the Item 1 questioned paint with Item 2 revealed they are consistent with respect to their observed and measured physical and chemical properties (e.g., layer sequence and chemical composition of corresponding layers) when analyzed using (insert analytical techniques here). It is therefore concluded that the Item 1 questioned paint recovered from the victim's clothing corresponds to the Item 2 paint and therefore originated either from that vehicle or from another source of automotive paint having the same distinct characteristics (**Association with Highly Discriminating Characteristics**). This type of association was reached because the questioned and known paints both exhibit characteristics that are atypical of original equipment manufacturer (OEM) paints. Due to the presence of (insert feature here) it is unlikely that other vehicles produced at the same manufacturing plant in approximately the same time frame would also be indistinguishable. Furthermore, other vehicles painted in the same distinctive manner would have to be damaged and missing paint to be considered viable sources of the questioned paint."

12.6.3 Association with Discriminating Characteristics

12.6.3.1 "Examination and comparison of the Item 1 questioned paint with Item 2 revealed they are consistent with respect to their observed and measured physical and chemical properties (e.g., layer sequence and chemical composition of corresponding layers) when analyzed using (insert analytical techniques here). It is therefore concluded that the Item 1 questioned paint recovered from the victim's clothing corresponds to the Item 2 paint and therefore originated either from that vehicle or from another source of automotive paint having the same distinct characteristics (**Association with Discriminating Characteristics**). This type of association was reached because other vehicles produced at the same manufacturing plant and painted with the same type of paint system would also be indistinguishable. The techniques utilized in this comparative analysis can typically distinguish different paint systems."

12.6.3.2 "Examination and comparison of the Item 1 green questioned paint recovered from the clothing with the Item 2 can of spray paint revealed the paints are consistent with respect to their observed and measured physical and chemical properties (e.g., color, texture, and chemical composition) when analyzed using (insert analytical techniques here). It is therefore concluded that Item 1 either originated from the Item 2 spray paint can or from another source of paint with the same distinct characteristics (**Association with Discriminating Characteristics**). This type of association was reached because spray paints are mass-produced, and other paint cans manufactured to the same specifications as Item 2 would also be indistinguishable from this paint. The techniques utilized in this comparative analysis can typically distinguish different spray paint products."

12.6.4 Association with Limitations

12.6.4.1 "The Item 1 questioned paint recovered from the scene consists of a smear of (*insert description*). Examination and comparison of Item 1 with Item 2 revealed they are consistent in (color, general

binder type, etc.). Due to the limited quantity and abraded nature of the questioned sample, limited comparisons were performed. It is therefore concluded that Item 2 cannot be eliminated as a possible source of the questioned paint recovered from Item 1 (**Association with Limitations**). This type of association was reached due to the limited characteristics available for comparison due to the sample size and poor condition of the questioned sample."

12.6.5 Inconclusive

12.6.5.1 "Examination and comparison of the Item 1 possible transfer on Vehicle 1 to the clearcoats of Vehicles 1 and 2 revealed that the vehicles have similar clearcoat chemical compositions to each other and to the possible transfer, and therefore, no opinion could be reached regarding an association or exclusion between the items (**Inconclusive**)."

12.6.6 Exclusion with Limitations

12.6.6.1 "Examination and comparison of the Item 1 questioned paint with Item 2 known paint from the left driver's side door revealed they are different with respect to (*insert characteristics here*). The questioned paint did not come from the area of the vehicle where the known sample was taken (**Exclusion with Limitations**). Vehicles can have different paint layer systems on different panels of the same vehicle. Further comparisons can be performed if additional known samples are submitted."

12.6.7 Exclusion (Elimination)

12.6.7.1 "Examination and comparison of the Item 1 questioned paint with Item 2 revealed they are different with respect to (*insert characteristics here*). It is therefore concluded that the questioned paint recovered from the scene did not originate from the reference area or panel of the vehicle represented by Item 2 [**Exclusion (Elimination**)]."

12.7 Activity Level Considerations

12.7.1 Activity factors that could increase the overall significance of the assessment(s)

12.7.1.1 The paint was applied wet to the surface (e.g., spray paint droplets) as opposed to being smeared on an item after the paint was dry.

12.7.1.2 Paint embedded in clothing rather than loosely adhered

12.7.1.3 Location or directionality of a transfer that assists in reconstruction of events (e.g., vehicle collision)

12.7.1.4 Cross-transfer of paints

12.7.2 Activity factors that could decrease the overall significance of the assessment(s)

12.7.2.1 Reasonable explanation as to why there was a transfer of paint(s) (e.g., individual was a painter with access to the location)

12.7.2.2 Environment with a high background of paint (e.g., busy intersection)

12.7.3 Transfer and persistence

12.7.3.1 Transfer and persistence factors are considered when evaluating questions about alleged activities and the presence of paint.

12.7.3.2 Transferred paint can occur in different forms such as multilayered fragments, chips, abrasion

smears, dried stains, powder, or aerosol droplets. Paint can be recovered in varying sizes and amounts.

12.7.3.3 Paint is typically transferred by direct (primary) transfer; however, paint chips can be transferred by indirect (secondary, tertiary) transfer. The possibility of transfer depends on a variety of factors including, but not limited to, the surfaces involved in the contact, the nature of the contact, the duration of the contact, the condition of the paint, and the chemical composition of the paint.

12.7.3.4 Environmental degradation can also affect the degree of paint transfer. Flaking and chalking of paint increases the possibility of paint transfer during a contact.

12.7.3.5 The nature, duration, and intensity of contact affect the transfer of paint. In the case of multilayered painted surfaces, these factors can influence the number of layers transferred.

12.7.3.6 The potential for transferred paint to be lost as well as the rate of loss are dependent upon a number of factors including, but not limited to the form of the transferred material, the manner of transfer, the nature of the material containing the transfer, and activities which happen after contact occurred. For example, paint smears that are the result of impacts or wet applications of paint to a surface have a lower rate of loss, even with activity, whereas loose chips adhering to a surface are anticipated to have a higher rate of loss when post-transfer activity occurs.

12.7.4 Cross-transfers or multiple transfers

12.7.4.1 In instances in which two or more associations are being reported (e.g., cross-transfers or multiple transfers), each association should be reported separately. Then additional text can be included describing whether and how the multiple reported associations could affect the overall significance assessment from the totality of the examination results.

12.7.5 Example Wording for Activity Level Considerations

12.7.5.1 "The physical characteristics of the paint on Item 1 establishes that the paint was dripped or splashed onto the surface rather than being brush-applied or transferred after it dried."

12.7.5.2 Cross-transfer. "The presence of a three-layered paint chip on Vehicle A that is indistinguishable from the known paint from Vehicle B and a four-layered paint chip on Vehicle B that is indistinguishable from the known paint from Vehicle A provides stronger support for the transfer of paints between the two vehicles than either transfer alone."

12.7.5.3 Multiple transfers. "The presence of a three-layered OEM paint chip on Vehicle A that is indistinguishable from the bumper paint from Vehicle B and a four-layered aftermarket paint chip on Vehicle A that is indistinguishable from the hood paint from Vehicle B provides stronger support for the transfer of paints from Vehicle B to Vehicle A than either transfer alone."

13 Tape Reporting

13.1 Tape examination in forensic casework is typically a comparison of two or more tape pieces/rolls in an attempt to determine if they originated from different sources. If the samples cannot be eliminated as having come from the same roll, tape analysis can provide an assessment as to the significance of that association.

13.1.1 For this guide, “tape” refers to pressure-sensitive tapes, primarily duct tape, electrical tape, and packaging tape, but this guide can also be applied to other types of tape.

13.2 Analytical methodologies used for tape comparisons have a direct impact on significance assessments.

13.2.1 A Physical Fit can only be reported when there is alignment of ends or edges between two pieces of tape.

13.2.2 A comprehensive analytical scheme (see Guide E3260), unless sample size or condition prohibits it, includes visual and microscopical examinations to assess physical characteristics and instrumental examinations (see Guide E3085, WK74138, WK75180) to assess organic composition and inorganic (elemental) composition of the backing, adhesive, and reinforcing fibers (if applicable).

13.2.3 A statement of decreased significance should be reported if a reduced analytical scheme was used to assess the physical and chemical characteristics that are routinely evaluated for samples of a given tape type (e.g., limitations of the sample size or condition, absence of equipment routinely used).

13.2.4 Increased or decreased significance is based on available information for the relevant population.

13.3 Source factors that could increase the significance of an association

13.3.1 Unusual physical features, such as a printed backing

13.3.2 Manufacturing defects

13.3.3 Unusual chemical features, such as an uncommon filler

13.3.4 Unusual or rare type of tape (e.g., limited amount manufactured or limited distribution)

13.3.5 Environmental factors (e.g., weathering or damage) that would affect both the questioned and known tape

13.3.6 Post-manufacturing modification of the tape observed on both samples being compared (e.g., handwriting on tape backing, paint overspray)

13.4 Source factors that could decrease the significance of an association

13.4.1 Common formulation of tape

13.4.2 Limited number of features available for comparison

13.4.3 Limited size

13.4.4 Contamination, degradation, or damaged condition of the sample(s)

13.4.5 Analytical scheme does not include an assessment of both the organic and inorganic/elemental composition of the tape

13.4.6 Analytical techniques do not include an assessment of all tape components

13.4.7 Minor physical or chemical differences between items being compared that could be due to sample heterogeneity, contamination of the sample(s), or having a sample of insufficient size to adequately assess the homogeneity of the entity from which it was derived

13.4.8 Circumstances that increase the possibility of a random association (e.g., limited number of

different products sold in a given area)

13.5 Example Scenarios for Each Interpretation Category

The following examples are provided to assist in reaching each interpretation category.

13.5.1 Physical Fit

13.5.1.1 A Physical Fit is possible where there is alignment of an end or edge of a piece of tape with another end or edge of a piece of tape or roll of tape, or through corresponding individual characteristics (e.g., surface scratches, fabric alignment) that carry across from one tape to the other.

13.5.2 Association with Highly Discriminating Characteristics

13.5.2.1 Post-manufacturing mark on the items (e.g., both known and questioned exhibit similar damage, handwriting on tape backing, paint overspray)

13.5.3 Association with Discriminating Characteristics

13.5.3.1 Association of tape in which the typical analysis scheme was performed on mass-produced materials that have numerous features for evaluation

13.5.3.2 A reduced analytical scheme was conducted, as long as the physical characteristics, organic composition, and inorganic/elemental composition of the tape were assessed to the extent possible (e.g., adhesives are too damaged to measure an accurate overall thickness).

13.5.4 Association with Limitations

13.5.4.1 Adhesive residue compared to a tape

13.5.4.2 No adhesive remaining on a tape backing

13.5.4.3 A reduced analytical scheme was conducted in which either the physical characteristics, organic composition, or inorganic/elemental composition of the tape were not satisfactorily assessed (e.g., no inorganic analysis of duct tape adhesives, no elemental analysis of electrical tape backings, no polarized light microscopy analysis of packaging tape backings)

13.5.4.4 Tape type for which there is limited knowledge of discrimination power and product manufacturing distribution information (e.g., office tape)

13.5.4.5 When the cause of minor physical or chemical differences between items being compared cannot be determined (i.e., the differences could be due to sample heterogeneity, contamination of the sample(s), or having a sample of insufficient size to adequately assess the homogeneity of the entity from which it was derived) but the samples are otherwise indistinguishable

13.5.5 Inconclusive

13.5.5.1 The questioned item is too damaged, degraded, or contaminated to conduct most examinations.

13.5.6 Exclusion with Limitations (not applicable)

13.5.7 Exclusion (Elimination)

13.5.7.1 Exclusionary difference in physical characteristics (e.g., different color, different layer structure)

13.5.7.2 Exclusionary difference in chemical composition (e.g., different elastomers or fillers present, different ratios/amounts of components that exceed the variation observed in the sample)

13.6 Example Wording for Interpretation Categories

13.6.1 Physical Fit

13.6.1.1 "Based on distinct features of the torn edge of one end of the Item 1 piece of tape and the free end of the Item 2 roll of tape, Item 1 was observed to physically correspond with the end of Item 2. This provides extremely strong support for the proposition that Item 1 originated from and was at one time a part of Item 2 as opposed to the proposition that it originated from and was a part of another used roll (**Physical Fit**).

13.6.2 Association with Highly Discriminating Characteristics

13.6.2.1 "Items 1 and 2 were found to be indistinguishable in physical features and chemical composition (*specify techniques*). Further, both items have similar environmental damage on their surfaces. Therefore, Item 1 originated from Item 2 or another roll of damaged tape manufactured in the same manner (**Association with Highly Discriminating Characteristics**). This type of association was reached because other rolls of tape produced at the same manufacturing plant and with the same specifications would also be indistinguishable, but these rolls would not be expected to be damaged."

13.6.3 Association with Discriminating Characteristics

13.6.3.1 "Items 1 and 2 were found to be indistinguishable in physical features and chemical composition (*specify techniques*). Therefore, Item 1 originated from Item 2 or another roll of tape manufactured in the same manner (**Association with Discriminating Characteristics**). This type of association was reached because other rolls of tape produced at the same manufacturing plant and with the same specifications would also be indistinguishable. Due to differences between tape products, the analytical techniques used in the analysis of these items allow for a high degree of discrimination."

13.6.4 Association with Limitations

13.6.4.1 "The Item 1 residue is chemically indistinguishable (*specify techniques*) from the adhesive used in the Item 2 roll of tape. Therefore, Item 2 cannot be eliminated as a possible source of Item 1 (**Association with Limitations**). This type of association was reached due to the limited number of characteristics available for comparison between the adhesive and the roll of tape, and because other rolls of tape have been manufactured (including rolls manufactured and distributed by other tape producers) that would have the same adhesive composition."

13.6.5 Inconclusive

13.6.5.1 "Although there are some similarities between the Item 1 debris and the adhesive from the Item 2 tape, severe contamination of Item 1 by biological fluids precludes a definitive assessment of the relationship between the debris and the tape. Therefore, no opinion can be reached regarding an association or exclusion between items (**Inconclusive**)."

13.6.6 Exclusion with Limitations (not applicable)

13.6.7 Exclusion (Elimination)

13.6.7.1 "Examination and comparison of the Item 1 piece of tape with the Item 2 roll of tape revealed they are different with respect to (*insert characteristics here*). It is therefore concluded that Item 1 did not originate from Item 2 [**Exclusion (Elimination)**]."

13.7 Activity Level Considerations

13.7.1 Multiple transfers

13.7.1.1 When two or more associations are being reported, each association should be reported separately. Additional text can then be included describing whether and how the multiple reported associations could affect the overall significance assessment from the totality of the examination results.

13.7.2 Example Wording for Activity Level Considerations

13.7.2.1 Multiple transfers. “Based on the reported results, more than one type of tape was recovered from and is indistinguishable between the various scenes. These findings could increase the significance of the reported results.”

14 Keywords

14.1 trace evidence; interpretation; reporting results; report wording; fiber; glass; hair; paint; tape

15 References

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