OSAC 2022-S-0015 Standard Guide for Forensic Physical Fit Examination

Trace Materials
Chemistry: Trace Evidence Scientific Area Committee
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OSAC 2022-S-0015 Standard Guide for Forensic Physical Fit Examination

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Standard Guide for Forensic Physical Fit Examination

1. Scope

1.1 This guide covers the forensic physical fit examinations for the macroscopical and microscopical examinations of broken, torn, or separated materials for the purpose of determining whether or not they at one time formed a single item. This guide is intended as an overview of the physical fit examination of these materials and to assist individuals in the evaluation and documentation of their physical comparisons.

1.2 The forensic examiner considers sample composition, condition (e.g., size, environmental effects, wear, complexity of separated edge features) when selecting procedures that are suitable for each specific case.

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

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision of Principles for the Development of International Standards issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*

C1256 Practice for Interpreting Glass Fracture Surface
E1459 Guide for Physical Evidence Labeling and Related Documentation
E1492 Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Laboratory
E1610 Guide for Forensic Paint Analysis and Comparison
E1732 Terminology Relating to Forensic Science
E2225 Guide for Forensic Examination of Fabrics and Cordage
E2917 Practice for Forensic Science Practitioner Training, Continuing Education, and Professional Development Programs
E3260 Guide for Forensic Examination and Comparison of Pressure Sensitive Tapes

2.2 *Other Documents:*

ISO/IEC 17025 (2017) General Requirements for the Competence of Testing and Calibration Laboratories
OSAC Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials

3. Terminology

3.1 Definitions – For additional terms commonly employed for general forensic examinations see **E1732** and for fractography see **C1256**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *arrest lines, n* – a sharp line on the fracture surface defining the crack front shape of an arrested or momentarily-hesitated crack. (**1**)

3.2.2 *fractography, n* – the means and methods for characterizing fractured specimens or compounds (**1**)

3.2.3 *individual characteristics, n* – the attribute(s) that establish(es) a single source.

3.2.3.1 *Discussion:* other terms used include random accidental characteristics, randomly acquired characteristics, distinguishing characteristics.

3.2.4 *physical fit, n* – an association based upon the realignment of two or more fragments or pieces that demonstrate they were once joined together to form a single object.

3.2.4.1 *Discussion* - The term match (e.g., physical match, fracture match) is not recommended to be used as it can be misleading to the layperson.

3.2.5 *scarp, n* -A line on the crack surface, which is the locus of intersection of a liquid-filled part of a running crack front with an unwetted part, or a moist part with a dry part (**2**).

3.2.6 *technical review* – a qualified second party's evaluation of reports, notes, data, and other documentation to ensure there is appropriate and sufficient support for the actions, results, conclusions, opinions, and interpretations (**OSAC Preferred Term – Lexicon**).

3.2.7 *verification***,** *n—provision of objective evidence that a given item fulfils specified requirements.* **ISO 9000:2017(E)**

4. Summary of Guide

4.1 Physical fit examination is the process of evaluating two or more samples to determine if they were at one time a single unit. It is based on the premise that separation events (e.g., breaks, cuts, tears) are not reproducible because of the combination of applied forces, construction features, and material properties.. When something is broken, torn, or separated, the surfaces or edges of adjacent fragments often have observable features that correspond with one another. These complementary features, patterns, and edges produced during separation allow an examiner to recognize and reconstruct samples that were at one time a single unit or attached to one another.

4.2 Physical fit examinations can involve the assessment or reassembly of multiple pieces prior to the comparison of a questioned sample to a possible known source.

4.3 Separation occurs in a variety of ways (e.g., broken, cut, torn). Separated materials that possess irregular edges and individual characteristics on their complementary surfaces can be realigned to demonstrate they were at one time a single unit. The physical fit can be viewed in two or three dimensions.

4.4 The absence of edge detail or material loss does not always rule out the possibility of a physical fit. A physical fit could result when physical features align across the separation boundary (e.g., striations, wood grain).

4.5 Different types of materials exhibit differing types of individual characteristics based on their construction, chemical structure, and physical properties. The recognition and distinction between class and individual characteristics for differing types of materials allows the use of the same general procedures for the physical fit examinations of all materials.

4.6 This guide contains a general procedure to perform physical fit examinations as well as a summary of considerations and limitations for an examiner to evaluate when conducting these examinations.

5. Significance and Use

5.1 This guide can assist the examiner in selecting and organizing a general analytical scheme for the evaluation and documentation of physical comparisons of materials for a potential physical fit. The type and size of material influences the exact steps and equipment needed to assess the physical fit. The evaluation, documentation, and interpretation are all important parts of a physical fit examination.

5.2 This guide addresses special considerations for physical fit analysis for glass, skeletal material, polymers, tapes and textiles.

5.3 Physical fit examinations have a long history of use in forensic science as described in Brooks et al (**3**). This reference and Section 18 include studies on the fractography of different materials and the use of physical fit examinations in forensic casework..

5.4 It is not the intention of this guide to present comprehensive theories regarding the mechanism of fractures, tearing, cutting, or other methods of separation. This information is available from training courses and reference materials such as ASTM Guide C1256 and others (**2, 4 – 8**).

6. Quality Assurance Considerations

6.1 A quality assurance program is used to assess and verify that analytical testing procedures and reporting of results are monitored by means that include, but are not limited to, proficiency tests and technical audits. General quality assurance guidelines are available in ISO/IEC 17025.

7. Apparatus and Materials

7.1 Different equipment is used depending on the material being examined and the case specifics.

7.2 General list of common materials utilized:

- 7.2.1 Camera
- 7.2.2 Stereomicroscope
- 7.2.3 Comparison microscope
- 7.2.4 Magnifier
- 7.2.5 Polarizing filters
- 7.2.6 Light box
- 7.2.7 Oblique lighting
- 7.2.8 UV lighting
- 7.2.9 Clay
- 7.2.10 Casting material
- 7.2.11 Plastic sheets
- 7.2.12 Solvents
- 7.2.13 Ruler
- 7.2.14 Micrometer
- 7.2.15 Sample handling tools (e.g., probe, forceps)
- 7.2.16 Packaging and documentation materials (e.g., labels, markers)

8. Sample Handling

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

8.2 The need for multiple types of examinations (e.g., other trace, DNA, latent prints, firearms) is considered before initiating a physical fit examination. Communicate with examiners from other disciplines to coordinate the order of examination or evidence preservation and recovery methods.

8.3 Physical fit examinations typically require that samples from more than one item of evidence be examined together. Documentation practices provide records of where samples came from and their condition as received in the laboratory. Document physical damage or the presence of other evidence. Documentation includes images, diagrams, non-destructive marking/labeling of the individual samples, or other methods deemed appropriate for the evidence in question.

8.3.1 Samples should each be uniquely identified prior to analysis.

8.4 A preliminary examination of the samples is performed prior to bringing them into contact with each other to prevent cross-contamination.

8.5 The areas to be compared are carefully handled to protect them from damage or alteration.

8.6 Alterations made to the evidence during the examination are documented.

8.7 All tools used are cleaned prior to contact with the evidence.

8.8 WARNING: Some samples have sharp edges and caution is warranted when handling these samples.

8.9 Following the examination, evidence is repackaged in a manner as to protect the evidence against damage.

9. General Considerations and Limitations

9.1 General Considerations:

9.1.1 The plasticity of the object should be taken into consideration, especially in areas where stretching caused by the separation could cause distortion in a physical fit. Notes should include a discussion of apparent missing material and deformation of material that could impact results.

9.1.2 Features that carry across the separation boundary (e.g., scratches, stains, manufacturing defects) can serve to demonstrate the physical fit.

9.1.3 The separation method (e.g., cut, torn) can be assessed during the physical fit assessment; however, that is outside the scope of this guide.

9.1.4 Physical fit examination is a visual technique and therefore bias could occur. Precautions to minimize bias include:

- 9.1.4.1 Receiving adequate training
- 9.1.4.2 Avoiding contextual bias (e.g., suspect's confession, investigator's opinions)
- 9.1.4.3 Assessing questioned samples prior to comparison to known samples
- 9.1.4.4 Employing a quality assurance program
- 9.1.4.5 Conducting technical review and verification

9.1.5 An error rate has not yet been established for physical fit examinations due to the complexity of the associated variables (e.g., variety of materials, different breaking mechanisms).

9.1.6 In the absence of a physical fit, a sample cannot be associated with an individual source. A class association can be determined but that is outside the scope of this guide.

9.2 Limitations

9.2.1 Sample composition or condition could limit the evaluation of a physical fit examination. Examples include but are not limited to:

9.2.1.1 Size

9.2.1.2 Environmental effects

9.2.1.3 Wear

9.2.1.4 Deformation or stretching before separation

9.2.1.5 Lack of features to compare along the separated edge(s)

9.2.1.6 Improper collection, preservation, or handling

10. General Procedure

10.1 Refer to Section 8 for sample handling considerations prior to and during physical fit examinations.

10.2 A typical scheme for physical fit examinations is outlined in Figure 1.

10.3 During the examination, questioned samples should be assessed prior to comparison to known samples.

10.4 When exclusionary differences are observed at any point during the examination, no further examinations are required. Exclusionary differences can include differences in class characteristics (e.g., two pieces of tape with different construction or a red shirt with a piece missing compared to a blue piece of fabric).

10.5 When the general contours do not align and there are no corresponding features on the separated surfaces or no traversing surface features, no further physical fit examinations are required. Additional physical and chemical analysis could be completed and are outside the scope of this guide.

10.6 Imaging, sketching, or written notes, or any combination thereof, is used to document features. See Section 12 for additional detail on Examination Documentation.

10.7 A macroscopic assessment is conducted of the samples of interest.

10.7.1 The condition, general features, and properties of the samples are examined. Features such as material type, color, shape, construction features, curvature, fluorescence, surface features, texture, grain, weave, orientation, and degree of gloss are observed and documented. These features can be examined with various light sources at varying angles of illumination. The material of interest dictates what properties are present and relevant during the physical assessment.

10.7.1.1 Samples that are suitable for physical fit examination have features that are not noticeably obstructed by extensive distortion, wear, weathering, or loss of material.

10.7.1.2 If the samples are deemed suitable for fit comparison, the samples are compared side by side and the macroscopic edge features are observed.

10.7.2 The macroscopic features on the separated edges, such as the presence of layers, continuous construction or manufacturing marks, fracture marks, alignment of the fracture pattern, color, dimensions, stains, or pattern continuation are observed and documented.

10.7.3 The dimensions of the questioned and known samples, in addition to the area of the alignment, can be measured (e.g., using a ruler, caliper, micrometer) and documented.

10.8 When individual characteristics are not visible at the macroscopic level to determine and demonstrate a physical fit, detailed observation at the microscopical level follows.

10.9 A microscopical examination is conducted on the samples of interest.

10.9.1 The microscopic edge features are observed using a simple magnifier, stereomicroscope, comparison microscope, or a combination of magnification types. Different light sources could be used depending on the type of material being examined (e.g., annular ring light, fiber optic light, transmitted, reflected). The size and physical properties of the examined samples determine which magnification type should be used.

10.9.2 The questioned and known edges are compared microscopically for the observation and documentation of similarities and differences in features such as alignment, fracture pattern features, stretching, distortion, fracture marks, pigmentation, grain, texture, weave, twist, fluorescence, and missing material. Minimizing contact between the sample edges can prevent damage or contamination during alignment.

10.9.3 Optional: The portions of the edges that align across the samples (e.g., duct tape scrim edges) are measured and documented.

10.10 A physical fit occurs when the samples share class and individual macroscopic and microscopic features across the edges and surfaces, including the cross section.

10.11 The samples or documentation of features are submitted for verification, technical review or both.

10.12 The correspondence of observed class characteristics between the compared items during a physical fit examination could warrant additional testing to evaluate the possibility of an association of the evidence with class characteristics or an exclusion (elimination). When further examinations are conducted, refer to appropriate ASTM standards (e.g., E1610, E2225) as well as the OSAC Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials.

11. Special Considerations

11.1 The types of materials listed below are commonly encountered for physical fit; however, this does not preclude other materials from being examined and compared for physical fit. For each material, class characteristics including composition or construction, the manner of separation, relevant features, and limitations inherent to that material are considered. Different materials will exhibit varied individual characteristics based on their construction and chemical structure (amorphous, crystalline, fibrous or combinations thereof) or their properties (brittle or ductile). The recognition and distinction between class and individual characteristics for different materials allows the use of the same general procedures for the physical fit examinations of all materials.

11.2 **Glass**

11.2.1 Background: Glass exhibits brittle behavior at room temperature. Therefore, broken glass is particularly well suited to reassembly to its original configuration because there is usually no distortion caused by the breaking event (**1**). Objects broken by brittle failure such as glass could be distinguished by ductile or viscous failure in that its fragments could fit together exactly. The reassembled object will have the same shape as before the breaking event. For a more detailed description of glass fractography, see ASTM C1256, (**1**) and (**2**).

11.2.2 Separation methods: The breaking of glass objects deforms elastically (i.e., reversibly) under an applied load until the onset of cracking, at which time the deformation is permanent (**2**). In every case, the fracture begins at a particular site (i.e., origin of impact) and grows from there. Cracks could develop slowly over a period of time or rapidly. Crack development is dependent upon numerous factors including glass type, loading pressure, impact type (i.e., high velocity or low velocity), humidity. (**2**).

11.2.3 Relevant features: A glass physical fit examination involves conducting an examination of fracture surfaces for features such as rib marks, including arrest lines, Wallner lines, hackle, and scarps. Surface features, curvature, material type, color, thickness, and fluorescence are observed to determine if all pieces could be from a single object. Surface features are used to place all the fragments in the same orientation (e.g., fluorescent side facing up, surface scratches).

11.2.4 Other considerations: There are no published studies addressing minimum lengths of fractured edges suitable for physical fit determinations. However, successful results from proficiency testing have been documented for glass fragments as small as approximately 5mm **(9)**.

11.2.5 Other limitations:

11.2.5.1 Brittle fracture examinations could be severely restricted due to improper collection and preservation at the scene or during shipping.

11.2.5.2 Glass could shatter into multiple pieces rather than separating into only two pieces. In this case, reconstruction of pieces from a single evidentiary sample could be performed prior to a physical fit examination

11.2.5.3 Tempered glass objects could leave fewer discriminating fracture features to conduct a physical fit examination due to the breaking mechanism. However, the fit becomes more distinctive when multiple pieces of tempered glass fit together.

11.3 Skeletal Material

11.3.1 Background: Physical fit examinations for skeletal material are generally conducted to reconstruct fragments in order to identify the origin of bone fragments, to conduct trauma examination, or to conduct morphological or metric assessment for biological profile estimations. In rare cases, however, a comparison between two items is conducted, such as in cases where material is recovered from distinct spatial locations, or at distinct temporal periods. In these cases, application of the results and interpretation terminology in this guideline could be appropriate.

11.3.2 Separation methods: The pattern of alterations to fresh bone depends upon the type of stress applied to the material. Application of a low-velocity impact could lead to permanent plastic deformation of the material prior to material failure (fracture), leading to warping of the material. Higher velocity impact (e.g., gunshots) could cause material failure without prior plastic deformation. For dry bone (postmortem alterations), plastic deformation generally does not occur prior to breakage, potentially allowing easier reconstruction.

11.3.3 Relevant features: Physical features of skeletal material are assessed at a macroscopical level and microscopical level, as appropriate. Relevant features include alignment of separated edges, and consistency of both external compact bone and internal trabecular bone patterns.

11.3.4 Other considerations: Consideration should be given to the possibility that separated portions of skeletal material could undergo differing taphonomic processes after separation (e.g., differential weathering, burning).

11.3.5 Other limitations: Limitations include edge wear from mishandling or taphonomic processes, plastic deformation of fresh bone, and non-distinctive fracture or breakage patterns.

11.4 Synthetic Polymers

11.4.1 Background: Synthetic polymers are manufactured materials that are found in a variety of consumer and industrial products and are commonly encountered as items of evidence. For purposes of physical fit examination, synthetic polymers are classified as either “rigid” or “flexible”.

11.4.1.1 Examples of rigid polymers include plastic vehicle parts, automotive paint chips, closed-cell foams, and other rigid polymeric materials excluding glass (See Glass section above).

11.4.1.2 Examples of flexible polymers include plastic bags, garbage bags, cling film, some architectural paint, open cell foams, and other flexible polymeric materials excluding tape (See Tape section below).

11.4.2 Separation methods: The fracture behavior of a polymer is determined by the absence of appreciable plastic deformation prior to failure (i.e., brittle fracture) or the presence of plastic deformation prior to failure (i.e., ductile fracture). Rigid polymers most often experience “brittle” fracture, while flexible polymers most often experience “ductile” fracture. This is due to their intrinsic properties (e.g., size, shape, composition, and degree of crystallinity). However, external factors (e.g., temperature, state of wear, presence of existing damage, and amount, type, and orientation of applied stress) could cause variation in the brittle/ductile fracture behavior of a polymeric material.

11.4.2.1 Examples of the external factors that commonly cause fracture in rigid polymers include motor vehicle collision, bullet penetration, and blunt impact of a weapon/tool.

11.4.2.2 Examples of the external factors that commonly cause fracture in flexible polymers include cutting, tearing, shearing with a dispenser, or a combination of these.

11.4.3 Relevant features: Physical features of rigid and flexible synthetic polymers are assessed at a macroscopical level and microscopical level, as appropriate.

11.4.3.1 Relevant features in rigid polymer physical fit examinations include layer structure (including the substrate when present), hackle marks, pre-existing scratches or cracks across the separation boundary, contour, curvature, and texture. The three-dimensional structure of a fractured polymer is valuable in a physical fit comparison.

11.4.3.2 Relevant features in flexible polymer physical fit examinations include color, size, perforation pattern, construction (if applicable), texture, print, and contour. Class characteristics imparted during manufacturing (e.g., striations, pigment bands, and interference colored bands), individual characteristics (e.g., fisheyes, arrowheads, streaks, tiger stripes, and surface scratches) or both which cross the separation boundary could demonstrate a physical fit **(10)**.

11.4.4 Other considerations:

11.4.4.1 Rigid polymers could shatter into multiple pieces rather than separating into only two pieces. In this case, reconstruction of pieces from a single evidentiary sample could be performed prior to a physical fit examination.

11.4.4.2 Coatings or other materials with multiple layers could separate along the physical boundary between layers.

11.4.4.3 Rigid polymers fatigue over time due to exposure to physical stressors, environmental conditions, or both. Cracks could form in a polymer due to fatigue and could alter how easily the polymer fractures, the location of a future fracture, or both.

11.4.4.4 The use of a light box as well as polarizing films could assist with visualization of some of the relevant features in flexible polymer physical fit examinations, including interference colors.

11.4.5 Other limitations:

11.4.5.1 Flexible polymers can easily deform when they are rolled, stretched, or twisted. When performing a physical fit examination, the amount of deformation could negatively impact the ability to align two or more pieces.

11.4.5.2 Sometimes when flexible polymers are cut, there are insufficient individual characteristics visible to determine a physical fit.

11.5 **Tape**

11.5.1 Background: There are a variety of tape products available in the market, and tape evidence could include one or more classes of tape. Tapes have at least two layers, a backing and a pressure-sensitive adhesive (PSA), formulated to meet the tape's specific end-use. Some tapes, such as duct tapes, also contain a fabric reinforcement layer. The physical structure and chemical composition of tape influences the relevant features of the material for physical fit examinations; however, a more detailed discussion of the classes of tape and their components is found elsewhere (ASTM E3260) and is outside the scope of this guide.

11.5.2 Separation Methods: Tapes are typically separated from the main source either by tearing sections by hand or using teeth, or cutting the tape with scissors, knife, tape dispenser, or other sharp tool. However, fragments of tape could also be separated during an explosion or other high impact event.

11.5.3 Relevant features for physical fit examinations of tapes:

11.5.3.1 The relevant features for physical fit examinations are dependent on the class of tape involved. Generally, the presence of letters or patterns or other manufacturing marks on tape samples could be relevant in the side-by-side comparison of tape evidence for physical fits.

11.5.3.2 Macroscopic features to observe include color, shape, construction features, surface features, external marks or debris, texture, weave, orientation, and degree of gloss. The general torn edge appearance is also a relevant feature, and could include straight, angled, wavy, or patterned edges.

11.5.3.3 Microscopic features of the separated edges include manufacturing marks or calendaring striations in alignment across the edges, areas where there is alignment in the respective tape layers, and areas of parallel protrusions or indentations across edges. Protruding scrim fibers could be observed in tapes that possess them.

11.5.3.4 To facilitate verification, the portion of the edge that aligns across the items should be measured (e.g., relative length, qualitative or quantitative descriptors, photographs with scale) and documented (**11, 12**).

11.5.4 Other considerations:

11.5.4.1 When used in the commission of a crime, tape is typically placed down on various substrates such as paper, wood, metal, or skin. There is also potential for the tape to adhere to itself. When collected, residues, leftover material, or additional forms of trace evidence (fibers, soil, etc.) from the original substrate could remain on the adhesive side of the tape. These residues could obstruct or interfere with the examination and documentation of features. In those situations, the examiner could attempt to separate the tape from the extraneous material using warm air, liquid nitrogen, a freezer, or solvents. However, the examiner should be careful to gently separate the tape under magnification to avoid damaging the ends or destroying features needed for physical examination.

11.5.4.2 The presence and orientation of reinforcing material (such as in duct, cloth, or filament tapes) could be used to orient and compare similar items.

11.5.4.3 Some kinds of tape could feather at the edges, where only portions of the layers can separate, leaving microscopic features that are unlikely to be randomly reproduced.

11.5.4.4 Physical fit determinations of some tapes (e.g., duct tapes with thicker adhesives) can be facilitated by removing some of the adhesive layer. To prevent the distortion of the edge features and scrim alignment, part of the adhesive is carefully removed until the scrim fibers are visible.

11.5.5 Other limitations:

11.5.5.1 Some classes of tape are more likely than others to deform from stretching (electrical tape) or to have loss of material (masking tape). In addition, tapes with fewer layers do not have as many potential features to observe for physical fit comparisons.

11.5.5.2 In an explosion, fire, or high-impact event, fragments of tape could be lost, preventing a full comparison for physical fits.

11.5.5.3 Tape samples without the full width of tape present could limit physical fit evaluations.

11.6 **Textiles**

11.6.1 Background: Textiles are comprised of natural or manufactured fibers subjected to a variety of manufacturing processes (e.g., spinning, weaving, knitting) to produce complex materials such as cordage and fabric. Although on a basic level all textiles are formed from fibers, the final product can vary in color, construction, and composition. Physical fit assessments could be performed in cases where pieces of damaged cordage or fabric are recovered from various locations.

11.6.2 Separation Methods: Textile physical fits occur when cordage or fabric has been mechanically damaged through cutting, tearing, or a combination of both, and the resulting pieces/edges are realigned. The separation process is dependent on the mechanical properties as well as the type and orientation of stress being applied. Distinct characteristics such as a neat and straight severance (typically associated with cutting damage) or a ragged/irregular severance (typically associated with tearing damage) could assist with physical fit examination.

11.6.3 Relevant features: Physical features of a textile are assessed at the fabric/cordage level, yarn level and fiber level, as appropriate. Textile features include size, shape, construction, yarn and fiber characteristics, stitched edges, selvedges, color, patterns, stains, unusual stretching or contours, and damage. In addition to general features such as pattern and color, mechanical separation of textiles typically results in a series of long and short yarns/fibers which could be used to orient and physically align the textiles of interest. Following the physical alignment, these “longs and shorts” are examined to ensure that their relative positions along the damaged edges of two or more textile pieces correspond.

11.6.4 Other Considerations: Textiles are flexible materials that can be rolled, stretched, and twisted. Orientation of the textile at the time of damage could impact the location, pattern and type of mechanical separation incurred. Additionally, when the elasticity limit of the textile is exceeded, permanent deformation could occur. When performing a textile physical fit examination, these deformations could impact the ability to align two or more damaged textile pieces.

11.6.5 Other Limitations: Sometimes the ability to perform textile physical fit assessments on damaged textiles is limited by laundering/handling/distorted threads, contaminants such as blood, stretching or distortion of the textile during damage, and general wear effects.

12. Examination Documentation

12.1 Documentation includes written notes, photography, diagrams, non-destructive marking/labeling of the individual items, or other methods deemed appropriate for the evidence in question.

12.2 Documentation should include observations of physical damage and the presence of other evidence.

12.3 Written descriptions, sketches, photographs, or other images are used to document each sample's features. Close-up images or photomicrographs are used to document the microscopic features.

12.4 Physical fits of evidential value require documentation of a sufficient quality for technical review, verification, court presentations, or other visual demonstrations. This includes images of pertinent edges and observed features as well as the correspondence between the edges of the pieces showing the physical fit.

12.5 At minimum, written documentation of no physical fits are also required.

12.6 Additional documentation (e.g., sketches) or images should be taken to facilitate note taking.

12.7 Images should contain a scale. If not practicable, the image is annotated with the magnification used.

12.8 The examination notes shall contain sufficient detail to support the interpretations and opinions such that another qualified practitioner could fully evaluate the details of the examination and consideration of limitations, and thus be able to evaluate the quality of the interpretation and opinion based on those notes or documentation.

12.9 Verification of the actual evidence by a second, qualified examiner is completed when sufficient documentation of the physical fit is not possible. The verification is documented in the case record.

13. Results and Interpretations

The following results and interpretations can be reached with regards to physical fit evaluations:

13.1 Physical Fit

13.1.1 The items that have been broken, torn, separated, or cut exhibit physical features that realign in a manner that is not expected to be replicated. A physical fit can result when features realign along the compared edges or when features do not realign along the compared edges but there are physical features present (e.g., striations, wood grain) which carry across the separation boundary and can themselves be realigned.

13.1.1.1 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 originated from the same source as opposed to the proposition they originated from different sources.

13.1.1.2 A Physical Fit is not currently based upon statistically-derived measurements; it is also not based upon exhaustive comparisons to all potential sources.

13.2 No Physical Fit

13.2.1 The items correspond in observed class characteristics, but exhibit physical features that do not realign, or they realign in a manner that could be replicated.

13.2.2 Alternatively, the items can exhibit physical features that partially realign, display simultaneous similarities and differences, show areas of discrepancy (e.g., warped areas, burned areas, missing pieces), or have insufficient individual characteristics that hinder the ability to determine the presence or absence of a physical fit.

13.2.3 The absence of a physical fit does not imply that the compared items did not originate from the same source.

13.2.4 The presence of partial fit features can increase the significance of the finding in cases where the items are associated with class characteristics during additional testing.

13.2.5 When no physical fit is observed and additional trace material examinations are completed, refer to OSAC Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials.

13.2.6 When the physical fit examination is the terminal examination step, a statement is included explaining the reasons for not completing further examinations.

13.2.7 The two items did not originate from the same source (exclusion) when the items exhibit differences in their class characteristics.

14. Report wording examples

Additional examples of report wording can also be found in the OSAC Guide for Interpretation and Reporting in Forensic Comparisons of Trace Materials.

14.1 Physical Fit

14.1.1 *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).***

14.1.2 *The Item 1 piece of tape and the free end of the Item 2 roll of tape physically corresponded with distinct features of the torn edges. This serves as the basis for the opinion that Item 1 and Item 2 were once part of a single unit **(Physical Fit).***

14.2 No Physical Fit

14.2.1 *The Item 1 car piece from the scene was examined and compared to the Item 2 bumper. The Item 1 car piece and the Item 2 bumper were similar in general appearance but did not physically fit back together (**No Physical Fit**). They do however share sufficient class characteristics to warrant additional comparison examinations to evaluate the possibility of an association with class characteristics or an exclusion.*

14.2.2 *The Item 1 and Item 2 pieces of plastic do not realign to form one larger piece (**No Physical Fit**). However, they do share sufficient class characteristics to warrant additional comparison examinations to evaluate the possibility of an association of evidence with class characteristics or an exclusion. The results of those examinations will be reported separately.*

14.2.3 *The Item 1 metal tip exhibited physical features that generally align with the Item 2 broken knife, however, there were also areas of discrepancy. Due to these similarities and differences, no physical fit was determined (**No Physical Fit)**. They do however share sufficient class characteristics to warrant additional comparison examinations to evaluate the possibility of an association with class characteristics or an exclusion.*

15. Verifications/Technical review

15.1 Physical fits are verified by another qualified examiner. Unless deemed necessary based on case details, a second examiner does not need to verify physical fits that are observed within an item or between items from the same location. Other results (e.g., inconclusive, exclusion) may also be verified.

15.2 Verification can be in the form of review and independent examination of the actual evidentiary material or by reviewing the photographs or images taken of the evidence.

15.3 Verification documentation includes the specific items examined, the result, verifier's initials, and the date.

15.4 Verification can be completed during the technical review process.

16. Additional Considerations

16.1 During a physical fit examination, it is possible to encounter items with features that join or realign in a manner that could be replicated.

16.1.1 Examples of this type of evidence include vehicle parts that snap together (e.g., mirror and mirror assembly), electrical components (e.g., USB drive and port), a pen and cap, or clothing items separated at the seam (e.g., coat and sleeve without tearing of the fabric).

16.1.2 Items which join or realign in this manner demonstrate class characteristics which are alike, but do not have a separation boundary and edge features to compare and evaluate as with physical fit determinations

16.1.3 Report wording example.

16.1.3.1 *The Item 1 mirror from the scene was examined and compared to the Item 2 mirror housing to determine whether at one time they could have been connected. Based on the examinations conducted, they are able to be joined; however, there are no individual characteristics present. Therefore, these items could have been at one time connected, or they each could have been connected to other similar objects.*

16.1.4 Additional examinations could be conducted on items that join or realign in this manner; however, these examinations are specific to the material and are beyond the scope of this guide.

17. Keywords

Physical fit, physical match, fracture match, fracture fit

18. References

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