OSAC 2023-N-0011 Standard Practice for a Physical Fit Analysis Training Program

Trace Materials Subcommittee
Chemistry: Trace Evidence Scientific Area Committee
Organization of Scientific Area Committees (OSAC) for Forensic Science

OSAC Proposed Standard

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Keywords: *forensic science; training; physical fit; physical fit analysis; trace; materials*

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Standard Practice for a Physical Fit Analysis Training Program

1 Scope

1.1 This practice is for use by laboratory personnel responsible for designing a training program for forensic science practitioners (FSPs) who will perform physical fit examinations on various materials.

1.1.1 The trainees and training program shall meet or exceed the minimum training requirements set forth in E2917, WK84047, and WK84882.

1.1.2 Additional training could be required for a particular technique or equipment (e.g. photography) referred to herein as technique. The application of analytical techniques to physical fit analysis assumes the trainee is already competent in the use of each particular analytical technique.

1.1.3 Other sources of information on physical fit examination not specifically mentioned in this document can be considered and added.

1.1.4 Additional physical fit analysis training beyond that which is listed here should be made available to the trainee. Such training could include off-site courses, internships, and specialized training by experienced FSPs.

1.1.5 Continuing education and training is recommended. Additional training provides a FSP with the opportunity to remain current in the field.

1.2 This practice is in a modular format for easy adaptation to an individual laboratory's training program. Recommendations as to lessons, practical exercises, progress monitoring, and trainee evaluations are included. Reading assignments with full citations are listed for each subsequent section in the appendix of this document.

1.3 *This standard practice 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2 Referenced Documents

2.1 ASTM Standards

2.1.1 E620 Practice for Reporting Opinions of Scientific of Technical Experts

2.1.2 E2917 Practice for Forensic Scientist Practitioner Training, Continuing Education, and Professional Development Programs

2.1.3 E1459 Guide for Physical Evidence Labeling and Related Documentation

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

2.1.5 WK84047 Guide for Physical Fit Examination

2.1.6 WK84882 Guide for Testimony for Forensic Science Practitioners

3 Significance and Use

3.1 The procedures outlined herein are grounded in the generally accepted body of knowledge and experience in the field of forensic physical fit examination and comparison.

3.2 A physical fit analysis training program provides a theoretical foundation and basic practical skills necessary to prepare a trainee to become a qualified physical fit FSP. Upon successful completion of the physical fit analysis training program, the trainee is able to form opinions based upon sound scientific knowledge, appropriate examinations, and practical experience with various materials. The trainee also is able to independently work cases, write reports, testify in court, and technically review cases. Upon completion of the program by a trainee

or at some regular interval (e.g., once per accreditation cycle), the training program should be evaluated for its efficacy and relevance according to the guidance set forth in E2917.

3.3 This training practice covers the use of a variety of microscopes and photography techniques which can be utilized in the analysis of physical fits. A laboratory may not have access to all of the listed equipment. It is expected that a physical fit analysis training program will include all of the techniques that are found within a laboratory's procedures for the examination of physical fits.

4 Responsibilities

4.1 Each trainee is trained by, and works under the guidance of, one or more qualified physical fit FSPs.

4.2 The trainer(s) shall be technically qualified in physical fit examination and comparison. Other members of the laboratory are encouraged to offer relevant information regarding their specialties to the trainee. The trainer(s) is responsible for:

4.2.1 Introducing the trainee to the relevant scientific literature, appropriate procedures, training material, and reference collections.

4.2.2 Discussing readings and theory with the trainee.

4.2.3 Teaching basic microscopy and photography for physical fit examinations.

4.2.4 Teaching case management.

4.2.5 Fostering ethical professional conduct.

4.2.6 Reviewing how the different types of human factors (e.g., bias, visual perception issues, logical inferential reasoning, stress and cognitive loads) can influence physical fit examinations, by providing examples to illustrate the concepts.

4.2.7 Teaching appropriate quality assurance and quality control procedures.

4.2.8 Reviewing test, practical exercises, and casework samples with trainee.

4.2.9 Teaching expert testimony skills through mock court and/or observation.

4.2.10 Monitoring and evaluating the trainee's progress.

4.3 Each laboratory is required to maintain:

4.3.1 An up-to-date training program which is reviewed and assessed for efficacy and relevance as described in E2917.

4.3.2 Documentation of training according to E2917.

4.3.3 Documentation of competency tests and proficiency tests.

5 Syllabus

5.1 A physical fit analysis training program provides the trainee theoretical knowledge and practical skills in examining, interpreting, reporting, verifying, testifying, and technically reviewing forensic physical fit cases. This is accomplished through a combination of the following training methods:

5.1.1 Reading of relevant literature

5.1.1.1 The reading assignments listed are suggestions. Newer versions can be used. Other relevant literature can be used or substituted.

5.1.2 Instruction by, and observation of, physical fit FSP

5.1.2.1 Lectures and discussions

5.1.2.2 Practical demonstration of basic skills

5.1.2.3 Casework, including report writing and technical review

5.1.2.4 Court testimony

5.1.3 Practical skills

5.1.3.1 Practical exercises which include analysis of reference materials and known samples

5.1.4 Final competency evaluations

5.1.4.1 Written or oral tests

5.1.4.2 Practical laboratory tests

5.1.4.3 Mock cases

5.1.4.4 Mock court or oral exam

5.1.5 Performing supervised casework

5.2 The recommended training period is between one and three months, full time, for a FSP that has been previously trained and is competent in the analytical techniques utilized in the analysis of physical fits. For a new FSP with no previous training in microscopical techniques or photography, the expected training period is between three and six months.

5.3 Successful completion of each milestone in the training program will be recorded using the guidance set forth in E2917.

6 Physical Fit Training Program Objectives

6.1 Encouraging Physical Fit Evidence

6.1.1 This section introduces the trainee to the types of cases and the various conditions in which evidence can be encountered for a physical fit examination.

6.1.1.1 There is no limit as to the type of material that can be encountered for a physical fit examination. Physical fits have been completed on many different types of materials, including, but not limited to, matches, metal, paint, paper, plastic, skeletal material, tape, textiles, and wood. This training document provides an overall training procedure for physical fit examination. Special considerations for specific materials are addressed in WK84047 and in the Appendix.

6.1.1.2 The trainee should observe an experienced FSP perform physical fit casework throughout the training program.

6.1.2 This section also introduces the trainee to sample handling and general considerations when examining evidence for physical fit.

6.1.3 Reading Assignments – *see Appendix*

6.1.4 Practical Exercise

6.1.4.1 Demonstrate knowledge of the types of cases in which a physical fit examination could be warranted.

6.1.4.2 Demonstrate knowledge of the precautions necessary when dealing with evidence for physical fit examinations.

6.1.4.3 Discuss how evidence relates to other sections within the laboratory (e.g., DNA, friction ridge).

6.1.5 The methods of instruction for this unit are reading and research by the trainee and discussions with the trainer(s).

6.1.6 The method of evaluation for this unit is an assessment of the trainee's completed exercises by the trainer.

6.2 Physical Fit Terminology

6.2.1 This section introduces the trainee to the following terms:

6.2.1.1 amorphous
6.2.1.2 brittle
6.2.1.3 class characteristic
6.2.1.4 contour
6.2.1.5 crystalline
6.2.1.6 cut
6.2.1.7 deformation
6.2.1.8 ductile
6.2.1.9 elastic
6.2.1.10 fibrous
6.2.1.11 fracture
6.2.1.12 individual characteristic

6.2.1.13 macroscopic
6.2.1.14 malleable
6.2.1.15 microscopic
6.2.1.16 morphology
6.2.1.17 physical fit
6.2.1.18 pliable
6.2.1.19 polymeric
6.2.1.20 rigid
6.2.1.21 stress
6.2.1.22 strain
6.2.1.23 torn

6.2.2 Reading Assignments – *see Appendix*

6.2.3 Practical Exercise

6.2.3.1 Define the terms listed in this section in the context of physical fit examinations.

6.2.4 The methods of instruction for this unit are reading and research by the trainee.

6.2.5 The method of evaluation for this unit is an oral or written quiz.

6.3 Characteristics of Materials and Suitability for Physical Fit Examinations

6.3.1 This section introduces the trainee to the evaluation of physical fit evidence using the laboratory's standard methods and protocols.

6.3.2 The methods of instruction for this unit are reading by the trainee, lecture from the trainer, and practical exercises.

6.3.3 Reading Assignments – *see Appendix*

6.3.4 Lecture and Practical Exercise

6.3.4.1 Discuss class and individual characteristics for various materials.

6.3.4.2 Discuss suitability (i.e., what makes an item(s) suitable for physical fit examination).

6.3.4.3 Review the use of available laboratory equipment (e.g., lighted magnifier, stereomicroscope, comparison microscope) and application to physical fit analysis.

6.3.4.4 Review the different observation and detail reproduction techniques (e.g., reverse lighting, polarizing films, casting) as they apply to physical fit analysis.

6.3.4.5 Collect different types of materials that possess different physical qualities (e.g., crystalline, amorphous, fibrous, composite, rigid, pliable). Separate these samples into two or more pieces using various techniques (e.g., cutting, tearing, breaking). The trainer should include materials that are both suitable and not suitable for physical fit examination.

- Observe the edge features of the different materials to include class characteristics (e.g., size, color, pattern, surface texture, dimension, composition) and individual characteristics that could be visible macroscopically (e.g., large incidental striations/scratches; irregular fracture edges; unusual identifiers such as dirt, marker, paint, smudge, or smear traversing a separation boundary; a break through the design or wording imprinted on the object).
- Examine the items for the presence of individual characteristics that could be visible microscopically (e.g., cross-sectional topography; small incidental striations/scratches; irregular fracture edges; inclusions; stress fracture lines; extrusion markings; conchoidal stress lines; hackle marks; and unusual identifiers such as dirt, marker, paint, smudges, or smears traversing a separation boundary; a break through the design or wording imprinted in the object) in the previously separated materials.
- For each type of material, assess its suitability to form a physical fit evaluating class characteristics and edge features including distortion.

6.3.4.6 Separate or break multiple similar objects (e.g., tape, pencils) to observe how each individual unit separates/breaks differently. Attempt physical fits among the separated pieces.

6.3.4.7 Reconstruct a broken object that has been separated into multiple pieces (e.g., tail light lens).

6.3.5 The method of evaluation for this unit is an assessment during the oral discussions of the practical exercises.

6.4 Documentation

6.4.1 This section introduces the trainee to documenting a physical fit, including note taking and photography.

6.4.2 Reading Assignment – *see Appendix*

6.4.3 Practical Exercise

6.4.3.1 Photograph numerous physical fits, including items with features that can only be viewed under a microscope.

6.4.3.2 Photograph case materials.

6.4.3.3 Review previous case notes, verifications, and documentation provided by the trainer.

6.4.3.4 Take notes on a mock case(s).

6.4.4 The methods of instruction for this unit are reading by the trainee, lecture from the trainer, and practical exercises.

6.4.5 The method of evaluation for this unit is an assessment of the practical exercises.

6.5 Examination and Comparison of Evidence for Physical Fit

6.5.1 This section introduces the trainee to the observation and comparison of separated materials.

6.5.2 The methods of instruction for this unit are reading by the trainee, lecture from the trainer, and practical exercises.

6.5.3 Reading Assignment – *see Appendix*

6.5.4 Lecture and Practical Exercises

6.5.4.1 Discuss the scientific basis of current guidelines for interpretation and results of a physical fit examination.

6.5.4.2 Discuss error rates and existing validation studies.

6.5.4.3 Discuss how different types of human factors (e.g., bias, visual perception issues, logical inferential reasoning, stress, and cognitive loads) can influence physical fit examinations and what tools can be used to mitigate or resolve human factors issues.

6.5.4.4 Complete mock cases that encompass a variety of materials that could be encountered in casework.

6.5.4.5 Complete mock cases that have physical fit and no physical fit results.

6.5.4.6 Discuss the verification process.

6.5.4.7 Complete several of these mock cases with full documentation including photography. See section 6.4 regarding documentation.

6.5.5 The method of evaluation for this unit is an assessment of the practical exercises.

6.6 Report Writing

6.6.1 This section introduces the trainee to writing technically and administratively accurate reports for physical fit examinations.

6.6.2 Reading Assignments – *see Appendix*

6.6.3 Practical Exercise

6.6.3.1 Write reports for the previously completed mock cases in 6.5.

6.6.4 The methods of instruction for this unit are a lecture from the trainer and reading completed technically reviewed reports.

6.6.5 The method of evaluation for this unit is a review of the reports written by the trainee.

6.7 Testimony

6.7.1 This section introduces the trainee to testimony in forensic physical fit analysis.

6.7.2 Reading Assignments – *see Appendix*

6.7.3 Practical Exercises

6.7.3.1 Review and discuss with trainer summaries of prominent court rulings dealing with forensic science including ethics, Brady issues, confrontation clause, admissibility, and discovery.

6.7.3.2 Prepare lists of suggested qualifying and educational questions, with related answers, for the court.

6.7.3.3 Review the relevant materials for an admissibility hearing to include research, theory, and legal decisions regarding physical fit casework.

6.7.4 The methods of instruction for this unit are a lecture from the trainer and witnessing or reviewing transcripts of court testimony given by a FSP (if available).

6.7.5 The method of evaluation for this unit is a review of the court documents prepared by the trainee.

6.8 Final Training Evaluations

6.8.1 This section evaluates the knowledge, skills, and abilities of the trainee through a combination of the following assessment elements:

6.8.1.1 Complete a final comprehensive written or oral examination on physical fit examinations.

6.8.1.2 Conduct mock case(s) for competency evaluation.

6.8.1.3 Participate in a mock trial using one of the mock cases completed during training. If the trainee has previous mock trial or court experience, an oral review could replace the mock trial.

6.8.2 The method of evaluation for this unit is successful completion of the selected elements of assessment.

6.9 Technical Reviews and Verification

6.9.1 This section introduces the trainee to technical and administrative reviews.

6.9.2 Practical Exercises:

6.9.2.1 Observe an experienced FSP's casework that has been technically reviewed.

6.9.2.2 Complete mock technical review and mock verification exercises.

6.9.3 The methods of instruction for this unit are demonstrations by the trainer and discussions with the trainee.

6.9.4 The method of evaluation for this unit is successful completed of the practical exercises.

6.10 Supervised Casework

6.10.1 This section introduces the trainee to performing casework.

6.10.2 Practical Exercises:

6.10.2.1 Perform actual casework under the supervision of a qualified FSP before performing independent casework.

6.10.3 The methods of instruction for this unit are demonstrations by the trainer and discussions with the trainee.

6.10.4 The methods of evaluation for this unit are assessment of the casework completed by the trainee.

Appendix: Reading Assignments

1. Section 6.1 Encountering Physical Fit Evidence

1.1. WK84047 Standard Guide for Physical Fit Examination

1.2. Brooks et al. Forensic physical fits in the trace evidence discipline: A review. *Forensic Science International* 313 (2020).

1.3. Cortner G, Hammam J. Physical Match: A Focus on its Forensic Use. *Tieline*. 1996, 32 - 49.

1.4. Jayaprakash P. Practical relevance of pattern uniqueness in Forensic Science, *Forensic Science International* 231, 2013.

2. Section 6.2 Physical Fit Terminology

2.1. Kirk PL. Crime Scene Investigation, 2nd ed. John Wiley and Sons: New York, 1974, pp. 240-243, 260-263, 269-271.

2.2. DeForest PR, Gaensslen RE, Lee HC. *Forensic Science: An Introduction to Criminalistics*. New York: McGraw-Hill, Inc., 1983. pp. 51-52, 162-164, 173-174, 215-218, 280-289, 292-293.

2.3. Saferstein R, Ed., Forensic Science Handbook, Prentice-Hall, Inc., New York, NY, 1982, pp. 151, 547.

2.4. Saferstein R. Criminalistics: An Introduction to Forensic Science, 5th ed., Prentice-Hall, Inc., Englewood Cliffs, NJ, 1977, pp. 61-71.

3. Section 6.3 Characteristics of materials and suitability for physical fit examinations (General)

3.1. Laboratory specific procedures

3.2. Bentley S. The Use of Mikrosil as an Aid in Confirming a Physical Match Between Two Pieces of Glass, *Tieline*, 12, No. 1 (Summer 1987).

3.3. Claytor LK, Davis AL. A Validation of Fracture Matching Through the Microscopic Examination of the Fractured Surfaces of Hacksaw Blades. *AFTE Journal* 2010, Vol 42 (4), pp 323 - 334.

3.4. Dawood B, et al. Quantitative matching of forensic evidence fragments utilizing 3D microscopy analysis of fracture surface replicas. *J For Sci* 2022, Vol 67 (3), pp 899 - 910.

3.5. Finkelstein NS, Levy O, Levi A. Photographic comparison of surface topography as a viable solution when physical match is challenging. *J For Sci* Vol 66, No 1, pp 295-302.

3.6. Orench JA. *A Validation Study of Fracture Matching Metal Specimens Failed in Tension.* AFTE Journal 2005; 37 (2)pp 142 - 145.

3.7. Prusinowski M, Brooks E, Neumann C, Trejos T. Forensic interlaboratory evaluations of a systematic method for examining, documenting, and interpreting duct tape physical fits. Forensic Chemistry. 2023. 34, 100407.

3.8. van Dijk CD, van Someren A, Visser R, Sjerps M. Evidential value of duct tape comparison using loopbreaking patterns. Forensic Sci Int. 2022 Mar; 332:111178. https://doi.org/10.1016/j.forsciint.2022.111178

4. Section 6.3 Characteristics of materials and suitability for physical fit examinations (Glass)

4.1. ASTM C1256-93(2019), Standard Practice for Interpreting Glass Fracture Surface Features, ASTM International, West Conshohocken, PA, 2019, www.astm.org
4.2. Baca AC, Thornton JI, and Tulleners FA. Determination of Fracture Patterns in Glass and Glassy Polymers, *J For Sci*, 2016, 61, pp 92-101
4.3. McJunkins S, Thornton J. Glass Fracture Analysis. A Review. *Forensic Science*, 2 (1973) pp 1 – 27.
4.4. Miller ET. Forensic Glass Comparisons in Saferstein R, editor. *Forensic Science Handbook* Vol 1 1st ed. pp 151-153.
4.5. Nelson DF. Illustrating the Fit of Glass Fragments. *Journal of Criminal Law*, Criminology and Police Science 1959. pp 312-314.
4.6. Quinn GD. Fractography of Ceramics and Glasses. National Institute of Standards and Technology. (2020). https://doi.org/10.6028/NIST.SP.960-16e3
4.7. Tulleners F, Thornton J, Baca, A. Determination of Unique Fracture Patterns in Glass and Glassy Polymers. Department of Justice, March 2013. pp. 2-13. *https://www.ncjrs.gov/pdffiles1/nij/grants/241445.pdf*
4.8. Watch video on how flat glass is made such as https://www.youtube.com/watch?v=OVokYKqWRZE

5. Section 6.3 Characteristics of materials and suitability for physical fit examinations (Matches)

5.1. Dixon K. Positive Identification of Torn Burned Matches with Emphasis on Crosscut and Torn Fiber Comparisons. *J For Sci* 1983; 28 (2) pp 351-359.
5.2. Funk HJ. Comparison of Paper Matches. *J For Sci* 1967; 13 (1) pp 137 – 143.
5.3. Gerhart FJ, Ward DC. Paper Match Comparisons by Submersion. *J For Sci* 1986; 31 (4) pp 1450 – 1454.
5.4. Von Bremen UG. Laser Excited Luminescence of Inclusions and Fibers in Paper Matches. *J For Sci* 1986; 31 (2) pp 455-463.

6. Section 6.3 Characteristics of materials and suitability for physical fit examinations (Miscellaneous)

6.1. Bisbing R, et al. A Fingernail Identification. *AFTE Journal* 1980; 12(1) pp. 27- 28.
6.2. Christophe DP, Daniels C. An Unusual Technique for Physical Match Comparison. AFTE Journal 2008, Vol 40 (4), pp 396 - 398.
6.3. Gerber KA. A Sawed-off Shotgun Barrel Identified by Random Marks Produced from Usage. *ATF Journal 2005.* Vol 37 (2) pp 123 - 126.

6.4. Matricardi VR, et al. The Comparison of Broken Surfaces: A Scanning Electron Microscopy Study. *J For Sci* 1975: 20 (3) pp 507.
6.5. Miller J, Kong H. Metal Fractures: Matching and Non-matching Patterns. *AFTE Journal* 2006; 38(2).
6.6. Perper J, Prichard W, McCommons P. Matching the Lost Skin of Homicide Suspect. *For Sci International* 1985; 29 pp 77-82.
6.7. Shor Y, et al. Physical Match: Insole and Shoe. J For Sci July 2003, Vol 48, No 4.
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7. Section 6.3 Characteristics of materials and suitability for physical fit examinations (Synthetic polymers)

7.1. Castle DA, Gibbons B, Hamer PS. Physical Methods for Examining and Comparing Transparent Plastic Bags and Cling Films, *J For Sci Society*, 1994, 34 (1): 61-68.
7.2. Ford KN. The Physical Comparison of Polyethylene Film. *J For Sci Society* 1975; 15 pp 107-113.
7.3. Kopec R, Meyers C. Comparative Analysis of Trash Bags – A Case History. *AFTE Journal* 1980; 12(1) pp 23 - 25.
7.4. Pierce DS. Identifiable Markings on Plastics. *J For Identification* 1990; 40 (2) pp 51-59.
7.5. Vanderkolk JR. Identifying Consecutively Made Garbage Bags Through Manufactured Characteristics. *J For Ident* 1995; 45(1) pp 38 – 50.
7.6. Von Bremen UG, Blunt LKR. Physical Comparison of Plastic Garbage Bags and Sandwich Bags. *J For Sci* 1983; 28 (3) pp 644-654.
7.7. Van Hoven HA, Fraysier HD. The Matching of Automotive Paint Chips by Surface Striation Alignment. *J For Sci* 28.2 (1983): 463-67.
7.8. Walsh K, Gordon A. Pattern matching of a paint flake to its source. *AFTE Journal* 2001; 33(2) pp.143-5.
7.9. Zugibe F, Costello J. The Jigsaw Puzzle Identification of a Hit and Run Automobile, *J For* Sci 31.1 (1986) 329 – 32.
7.10. Watch videos on how different synthetic polymer objects are made such as: https://www.youtube.com/watch?v=7O29V_fDdbQ

8. Section 6.3 Characteristics of materials and suitability for physical fit examinations (Skeletal materials)

8.1. Christensen AM, Isa MI, Smith MA, Hefner JT, Berryman HE, Saginor IS, NS and Webb JB. (2022). A Guide to Forensic Fractography of Bone (1.0). Zenodo. https://doi.org/10.5281/zenodo.6013748.
8.2. Christensen A, Sylvester A. Physical Matches of Bone, Shell and Tooth Fragments: A Validation Study. *J For Sci* 2008; 53(3) pp. 694 – 698.
8.3. Villa P, Mahieu E. Breakage patterns of human long bones. J Hum Evol 1991; 21 pp. 27–48.

9. Section 6.3 Characteristics of materials and suitability for physical fit examinations (Tape)

9.1. Agron N, Schecter B. Physical Comparisons and Some Characteristics of Electrical Tape. *AFTE Journal* 1986; 18 (3) pp 53 – 59.

9.2. Bradley M. A Validation Study for Duct Tape End Matches. *J For Sci* 2006;51(3) pp 504-508.

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9.10. Weimar B. Physical match examination of the joint faces of adhesive PVC-tapes. *AFTE Journal* 2010;42(3) pp. 271-7.

9.11. Weimar B. Physical Match Examination of Adhesive PVC-Tapes: Improvement of the Conclusiveness by Heat Treatment. *AFTE Journal* 2008; 40(3) pp. 300-302.

9.12. Watch videos on how tape is made such as:

9.12.1. https://electrictv.net/videos/3m-tape-manufacturer-how-its-made-necaibew-team/

9.12.2. https://www.youtube.com/watch?v=fVpNteozrO0

10. Section 6.3 Characteristics of materials and suitability for physical fit examinations (Textiles)

10.1. Fisher BAJ, Svensson A, Wendel O. Techniques of Crime Scene Investigation, 4th ed., Elsevier Science Publishing Co., Inc., New York, NY, 1987.

10.2. Kirk PL. *Crime Investigation*. New York: Interscience Publishers, Inc., 1966. pp. 116-125.

10.3. Laux D. Identification of a Rope by Means of a Physical Match Between the Cut Ends. *J For Sci* 1984; 29 (4) pp.1247 – 1248.

11. Section 6.4 Documentation

11.1. E1459 Standard Guide for Physical Evidence Labeling and Related Documentation

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

11.3. Digital camera manual appropriate to camera

11.4. Laboratory specific procedure(s) on documentation

12. Section 6.5 Examination and comparison of evidence for physical fit

12.1. WK84047 Standard Guide for Physical Fit Examination

12.2. Budowle B et al. A Perspective on Errors, Bias, and Interpretation in the Forensic Sciences and Direction for Continuing Advancement. J For Sci, July 2009, Vol. 54, No. 4, pp. 798 - 809.

12.3. Dror IE. Cognitive and Human Factors in Expert Decision Making: Six Fallacies and the Eight Sources of Bias. Anal Chem, 2020, 92, pp. 7998 - 8004.

12.4. Katterwe H. Fracture Matching and Repetitive Experiments: A Contribution of Validation. *AFTE Journal* 2005; 37 (3) pp. 229 – 241.

12.5. Quigley-McBride A et al. A practical tool for information management in forensic decisions: User Linear Sequential Unmasking - Expanded (LSU-E) in casework. Forensic Science International: Synergy, 4, e100216. https://doi.org/10.1016/j.fsisyn.2022.100216.

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12.7. Stone R. A Probabilistic Model of Fractures in Brittle Metals. *AFTE Journal* 2004; 36 (4) pp. 297- 301.

12.8. Tsach T, Wiesner S, Shor Y. Empirical Proof of Physical Match: Systematic Research with Tensile Machine. *For Sci Int* 2007; 166 pp.77-83.

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

13. Section 6.6 Report Writing

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

13.2. Laboratory specific physical fit analysis procedure(s) on reporting.

14. Section 6.7 Testimony

14.1. Daubert v. Merrell Dow Pharmaceuticals (92-102), 509 U.S. 579 (1993)

14.2. Frye v. United States 293 F. 1013 (D.C. Cir. 1923)

14.3. Kumho Tire Co. v. Carmichael 526 US 137 (1999)

14.4. Melendez-Diaz v. Massachusetts 557 US 305 (2009)
14.5. Bullcoming v. New Mexico 564 US 647 (2011)
14.6. Williams v. Illinois 567 US 50 (2012)
14.7. Brady vs Maryland 373 US 83 (1963)