



# Standard Practice for Forensic Tape Analysis Training Program<sup>1</sup>

This standard is issued under the fixed designation E3233; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This standard is intended as a practice for use by laboratory personnel responsible for training examiners to perform forensic examinations and comparisons on pressure sensitive tapes and adhesives. It contains a list of training objectives with recommended methods of instruction, reading assignments and structured exercises to provide practical experience for the trainee.

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

1.1.2 Additional training could be required for a particular method or instrument referred to herein. The application of analytical techniques to tape analysis assumes the trainee is already competent in the use of each particular analytical technique or instrumental method.

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

1.1.4 Additional tape 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 examiners.

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

1.1.6 Tape samples are evaluated for physical matches of the cut or torn end pieces. This practice does not provide training requirements for physical match comparisons. Additional training is required to conduct this type of analysis.

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 are listed in each subsequent section of this practice; full citations are available in the References section.

1.3 A tape analysis training program provides a theoretical foundation and basic practical skills necessary to prepare a

trainee to become a qualified forensic tape examiner. At the end of the tape analysis training program, the trainee is capable of forming opinions based upon sound scientific knowledge, appropriate examinations, and practical experience. The trainee also is able to independently work cases, write reports, testify in court, and peer review cases. Upon completion of the program by a trainee or at some regular interval (for example, once per accreditation cycle), the training program should be evaluated for its efficacy and relevance according to the guidance set forth in Practice E2917.

1.4 This practice does not address human factors (for example, cognitive bias). It is the responsibility of the user of this practice to address human factors during the initial or general training of a forensic scientist.

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 on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

E2224 Guide for Forensic Analysis of Fibers by Infrared Spectroscopy

E2228 Guide for Microscopical Examination of Textile Fibers

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

E3085 Guide for Fourier Transform Infrared Spectroscopy in Forensic Tape Examinations

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

### 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 tape examination and comparison.

3.2 With successful completion of this tape analysis training program, the trainee gains the theoretical knowledge and practical skills necessary to perform, document, and evaluate forensic tape examinations and comparisons.

3.3 This training practice covers a variety of instrumental methods which can be used in the analysis of tape. Not all laboratories will have access to all of the instrumentation. It is expected that a tape analysis training program will include all the techniques that are found within a laboratory's procedures for the forensic examination of tape.

3.3.1 Instrumental methods that provide organic and inorganic analysis capabilities are utilized in the laboratory training program. Examples include Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, pyrolysis gas chromatography (PGC), scanning electron microscopy-energy dispersive X-ray spectroscopy (SEM/EDS), X-ray fluorescence (XRF), or X-ray diffraction (XRD).

### 4. Responsibilities

4.1 Each trainee is trained by and works under the guidance of one or more qualified forensic tape examiners.

4.1.1 The trainee shall meet or exceed the minimum training criteria set forth in Practice E2917 and the objectives set forth in the training program.

4.2 A trainer(s) shall be technically qualified in forensic tape examination and comparison or associated techniques. 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 instrumental methods for the analysis and comparison of tape evidence;

4.2.4 Teaching case management;

4.2.5 Fostering ethical professional conduct;

4.2.6 Reviewing ways in which bias can influence tape examinations;

4.2.7 Teaching appropriate quality assurance and quality control procedures;

4.2.8 Reviewing tests, practical exercises, and casework samples with trainee;

4.2.9 Teaching expert testimony skills through moot court or observation, or both; and

4.2.10 Monitoring 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 Practice E2917,

4.3.2 Documentation of training according to Practice E2917, and

4.3.3 Documentation of competency tests and proficiency tests.

### 5. Syllabus

5.1 A tape analysis training program provides the trainee theoretical knowledge and practical skills in examining, interpreting, reporting, testifying, and reviewing forensic tape 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 and Observation of Forensic Tape Examiners:*

5.1.2.1 Lectures and discussions,

5.1.2.2 Practical demonstration of basic skills,

5.1.2.3 Casework, and

5.1.2.4 Court testimony.

5.1.3 *Practical Skills:*

5.1.3.1 Practical exercises which includes 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, and

5.1.4.4 Moot court or oral exam.

5.1.5 *Performing Supervised Casework.*

5.2 The recommended training period is between three to six months, full time, for a forensic examiner that has been previously trained and is competent in the analytical techniques utilized in the analysis of tape evidence. For new examiners with no previous training in microscopical or instrumental techniques, the expected training period is between twelve to eighteen months.

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

### 6. Tape Analysis Training Program Objectives

6.1 *Encountering Tape Evidence:*

6.1.1 This section introduces the trainee to the types of cases and the various conditions (intact, partial, backing only, scrim only, adhesive only, etc.) in which tapes are encountered as physical evidence.

6.1.2 Types of tapes which could be encountered as evidence include duct tape, electrical tape, strapping tape, packaging tape, office tape, paper (masking) tape, medical tape, gaffer's tape, and other specialty pressure sensitive adhesive tapes.

6.1.3 *Reading Assignments:*

6.1.3.1 Scientific Working Group for Materials Analysis (SWGMA), "Guideline for Forensic Examination of Pressure Sensitive Tapes," pp. 2–20 (1).<sup>3</sup>

<sup>3</sup> The boldface numbers in parentheses refer to a list of references at the end of this standard.

6.1.3.2 Choudhry and Whritenour, “A New Approach to Unraveling Tangled Adhesive Tape for Potential Detection of Latent Prints and Recovery of Trace Evidence” (2).

6.1.3.3 Neel and McIntyre, “The Effects of Cyanoacrylate Fuming and Fluorescent Dye Staining on Forensic Tape Analysis” (3).

6.1.3.4 Campbell, “Separation of Adhesive Tapes” (4).

6.1.4 *Practical Exercises:*

6.1.4.1 Demonstrate knowledge of the types of cases and the various conditions in which tapes are encountered as physical evidence through an oral or written exercise.

6.1.4.2 Demonstrate the ability to separate tape by different methods.

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 a review of the trainee’s completed exercises by the trainer.

6.2 *Tape Terminology:*

6.2.1 This section introduces the trainee to the following terms:

- 6.2.1.1 Adhesive,
- 6.2.1.2 Additives,
- 6.2.1.3 Backing,
- 6.2.1.4 Backsizing,
- 6.2.1.5 Calendering,
- 6.2.1.6 Cellophane,
- 6.2.1.7 Cellulose acetate,
- 6.2.1.8 Crepe,
- 6.2.1.9 Duct tape,
- 6.2.1.10 Elastomer,
- 6.2.1.11 Electrical tape,
- 6.2.1.12 Fill yarns,
- 6.2.1.13 Filament tape,
- 6.2.1.14 Flatback,
- 6.2.1.15 Machine direction,
- 6.2.1.16 Masking tape,
- 6.2.1.17 Migration,
- 6.2.1.18 Nominal width,
- 6.2.1.19 Packaging tape,
- 6.2.1.20 Physical end match,
- 6.2.1.21 Plain (simple) weave,
- 6.2.1.22 Plasticizers,
- 6.2.1.23 Polymer,
- 6.2.1.24 Pressure sensitive adhesives (PSA),
- 6.2.1.25 Pressure sensitive tape (PST),
- 6.2.1.26 Prime coat,
- 6.2.1.27 Reinforcement,
- 6.2.1.28 Release coat,
- 6.2.1.29 Scrim,
- 6.2.1.30 Scrim Count,
- 6.2.1.31 Strapping tape,
- 6.2.1.32 Tack,
- 6.2.1.33 Tackifier,
- 6.2.1.34 Texturized yarn,
- 6.2.1.35 Twisted yarn,
- 6.2.1.36 Thickness,
- 6.2.1.37 Warp yarns,
- 6.2.1.38 Weft insertion,

6.2.1.39 Weft yarns, and

6.2.1.40 Yarns.

6.2.2 *Reading Assignments:*

6.2.2.1 SWGMAT, “Guideline for Forensic Examination of Pressure Sensitive Tapes,” pp. 88–89 (1).

6.2.2.2 SWGMAT, “Guideline for Assessing Physical Characteristics in Forensic Tape Examinations,” pp. 98–99 (5).

6.2.2.3 Johnston, *Pressure Sensitive Adhesive Tapes — A Guide to Their Function, Design, Manufacture, and Use*(6).

6.2.3 *Practical Exercises:*

6.2.3.1 Define the terms listed in this section.

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 *Manufacturing Processes:*

6.3.1 This section introduces the trainee to tape manufacturing processes.

6.3.2 *Reading and Viewing Assignments:*

6.3.2.1 Johnston, *Pressure Sensitive Adhesive Tapes — A Guide to Their Function, Design, Manufacture, and Use* (6).

6.3.2.2 Johnston, *Manufacturing Methods* (7).

6.3.2.3 Internet video search “How Duct Tape is Made.”

6.3.2.4 Internet video search “How Adhesive Tape is Made.”

6.3.3 The trainee is encouraged to visit tape manufacturing facilities.

6.3.4 The methods of instruction for this unit are reading and viewing relevant videos by the trainee.

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

6.4 *Overview of Forensic Tape Examinations:*

6.4.1 This section introduces the trainee to the basic steps in forensic tape examinations.

6.4.2 *Reading Assignments:*

6.4.2.1 Laboratory specific tape analysis procedure(s).

6.4.2.2 Bradley, et al., “A Validation Study for Duct Tape End Matches” (8).

6.4.2.3 Bradley, et al., “A Validation Study for Vinyl Electrical Tape End Matches” (9).

6.4.2.4 Mehlretter and Bradley, “Forensic Analysis and Discrimination of Duct Tapes” (10).

6.4.2.5 Smith, “Forensic Examinations of Pressure Sensitive Tape” (11).

6.4.3 The methods of instruction for this unit are reading by the trainee and lecture from the trainer.

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

6.5 *Examination of Physical Properties:*

6.5.1 This section introduces the trainee to the physical properties of a variety of tapes to include the following:

6.5.1.1 Backing type (for example, paper, polymer);

6.5.1.2 Backing properties such as color, texture, gloss, edge features, calendering marks, striations, pores/pits, and inclusions;

6.5.1.3 Adhesive properties such as color, texture, and appearance;

6.5.1.4 Width measurements;

6.5.1.5 Overall thickness;

6.5.1.6 Backing thickness;

6.5.1.7 Scrim/yarn count; and

6.5.1.8 Backing construction (number of layers).

6.5.2 *Reading Assignments:*

6.5.2.1 SWGMAT, “Guideline for Assessing Physical Characteristics in Forensic Tape Examinations,” pp. 98–105 (5).

6.5.2.2 LaPorte and Weimer, “Evaluation of Duct Tape Physical Characteristics: Part I – Within-Roll Variability” (12).

6.5.3 *Practical Exercises:*

6.5.3.1 Perform a comparison of the physical properties of several known tape samples.

6.5.4 The methods of instruction for this unit are reading by the trainee and practical instruction from the trainer.

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

6.6 *Microscopical Examination of Tape Components:*

6.6.1 This section introduces the trainee to the microscopical characteristics of a variety of tapes.

6.6.2 Include the following points of instruction:

6.6.2.1 Determine backing and possible adhesive layer sequence using cross sectioning techniques.

6.6.2.2 Compare backings and adhesives using polarized light microscopy (PLM).

6.6.2.3 Classify clear backed tapes as biaxially oriented polypropylene (BOPP) or monoaxially oriented polypropylene (MOPP) using polarizing techniques.

6.6.3 *Reading Assignments:*

6.6.3.1 SWGMAT, “Guideline for Using Light Microscopy in Forensic Examinations of Tapes” (13).

6.6.3.2 Smith and Weaver, “PLM Examinations of Clear Polymer Films” (14).

6.6.3.3 Sakayanagi, et al., “Identification of Pressure Sensitive Adhesive Polypropylene Tape” (15).

6.6.3.4 Goodpaster, et al., “Identification and Comparison of Electrical Tapes Using Instrumental and Statistical Techniques: I. Microscopic Surface Texture and Elemental Composition” (16).

6.6.3.5 Hobbs, et al., “A New Approach for the Analysis of Duct Tape Backings” (17).

6.6.3.6 Stellmack, et al., “Hand-Sectioning and Identification of Pressure-Sensitive Tapes” (18).

6.6.3.7 Rappe, “Measurement of Principle Refractive Indices of Oriented Polymer Films” (19).

6.6.4 *Practical Exercises:*

6.6.4.1 Compare the microscopical characteristics of a variety of types of tape (for example, duct, electrical, packaging, office).

6.6.5 The methods of instruction for this unit are reading by the trainee and practical instruction from the trainer.

6.6.6 The method of evaluation for this unit is an evaluation of the practical exercise.

6.7 *Examination of Reinforcing Materials:*

6.7.1 This section introduces the trainee to the reinforcing materials encountered in a variety of tapes.

6.7.2 Training for strapping (filament) tapes includes characterizing the general fiber types using PLM.

6.7.3 Training for fabric reinforced tapes (duct and gaffers) includes:

6.7.3.1 Performing scrim/yarn counts

6.7.3.2 Determining the weave of the scrim fabrics (for example, weft insertion, plain weave)

6.7.3.3 Characterizing the yarns in the warp and fill directions (for example, untwisted bundles, texturized groups, twisted bundles)

6.7.3.4 Determining yarn twist direction (for example, Z, S, zero)

6.7.3.5 Observing the fluorescence of the fabric using long and short wave ultraviolet light and recording the fluorescence of the fibers composing the warp or fill yarns

6.7.3.6 Determining general fiber type(s) comprising warp and fill yarns using PLM or FTIR or both

6.7.4 If the trainee is not a fiber examiner, additional fiber identification training focusing on fibers encountered in tape reinforcement materials could be needed.

6.7.5 *Reading Assignments:*

6.7.5.1 Guide E2224.

6.7.5.2 Guide E2228.

6.7.5.3 Palenik, “Microscopical Examination of Fibres” (20).

6.7.6 *Practical Exercises:*

6.7.6.1 Compare the features of a variety of reinforcing materials in duct tape and strapping tape.

6.7.7 The methods of instruction for this unit are reading by the trainee and practical instruction from the trainer.

6.7.8 The method of evaluation for this unit is an evaluation of the practical exercise.

6.8 *Fourier Transform Infrared Spectroscopy (FTIR):*

6.8.1 This section introduces the trainee to the classification and comparison of a variety of tapes based on their chemical composition using FTIR.

6.8.2 Include the following points of instruction:

6.8.2.1 Understanding the theory of FTIR analysis (unless previously authorized to use the instrument).

6.8.2.2 Preparing samples for analysis by FTIR.

6.8.2.3 Performing computer searches of spectral libraries, if available.

6.8.2.4 Classifying and comparing a variety of tape backings (classify polymer types).

6.8.2.5 Classifying and comparing a variety of tape adhesives (classify elastomer types).

6.8.2.6 Demonstrating familiarity with classes of adhesive tackifiers.

6.8.2.7 Demonstrating familiarity with extenders used in tape backings and adhesives.

6.8.2.8 Classifying general fiber types used in reinforcing fabrics.

6.8.2.9 Extracting and classifying plasticizers from PVC tape backings.

6.8.2.10 Understanding the strengths and limitations of the technique.

6.8.3 *Reading Assignments:*

6.8.3.1 Guide E3085.