

# **Standard Guide for Developing Discipline Specific Methodology for ACE-V**

*Virtual Subcommittee #3: ACE-V Process Map  
Chemistry/Instrumental Analysis, Digital/Multimedia, and Physics/Pattern  
Interpretation Scientific Area Committees  
Organization of Scientific Area Committees (OSAC) for Forensic Science*





# OSAC Proposed Standard

## Standard Guide for Developing Discipline Specific Methodology for ACE-V

Prepared by  
Virtual Subcommittee #3: ACE-V Process Map  
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### **Disclaimer:**

This document has been developed by the *Virtual Subcommittee #3: ACE-V Process Map* of the Organization of Scientific Area Committees (OSAC) for Forensic Science through a consensus process and is *proposed* for further development through a Standard Developing Organization (SDO). This document is being made available so that the forensic science community and interested parties can consider the recommendations of the OSAC pertaining to applicable forensic science practices. The document was developed with input from experts in a broad array of forensic science disciplines as well as scientific research, measurement science, statistics, law, and policy.

This document has not been published by a SDO. Its contents are subject to change during the standards development process. All interested groups or individuals are strongly encouraged to submit comments on this proposed document during the open comment period administered by the ASTM International, Committee E30 on Forensic Science.

**Date:** 03/22/2020

**Ballot Action:** New standard guide for consideration

**Rationale:** This document was developed at the request of the OSAC Physics/Pattern Interpretation SAC. The ACE-V Virtual Interdisciplinary subcommittee #3 was established that consisted of the Chemistry/Instrumental Analysis and Digital/Multimedia SAC's. Each of the following SC's were involved and provided comments that were adjudicated: Facial Identification, Fire Debris and Explosives, Firearms and Tool marks, Footwear and Tire, Friction Ridge, Video Imaging Technology and Analysis, and Materials. The document was selected to be further developed by ASTM. The intent of this guide is to establish a framework for developing a forensic discipline-specific methodology, to govern standardized methods used to conduct the various phases of ACE-V in the relevant disciplines. Each discipline could then develop their own standards that describe specific requirements unique to that discipline.

## **Standard Guide for Developing Discipline Specific Methodology for ACE-V<sup>1</sup>**

This standard is issued under the fixed designation X XXXX; 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 guide identifies and defines the various phases within the methodology of ACE-V.

**1.2** It specifies minimum general requirements that shall be adhered to for a methodology to be recognized as ACE-V

**1.3** This guide does not define any discipline specific test methods.

**1.4** *Units* - The values stated in SI units are to be regarded as the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

**1.6** *This standard cannot replace knowledge, skills, or abilities acquired through education, training, and experience (E2917), and is to be used in conjunction with professional judgment by individuals with such discipline-specific knowledge, skills, and abilities.*

### **2. Referenced Documents**

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

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<sup>1</sup> This practice is under the jurisdiction of ASTM Committee XXX and is the direct responsibility of Subcommittee XXX. Current edition approved XXX XX, XXXX. Published XXX XXXX. DOI: 10.1520/XXXXX-XX.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org) or contact ASTM Customer Service at [Service@astm.org](mailto:Service@astm.org). For the *Annual Book of ASTM standards* volume information, refer the standard's Document Summary page on the ASTM website.

2.1.1 ASTM E2917-19a, Standard Practice for Forensic Science Practitioner Training, Continuing Education, and Professional Development Programs, ASTM International, West Conshohocken, PA, 2019.

**2.2 ISO Standards<sup>3</sup>:**

2.2.1 ISO 21043-1:2018 (E), Forensic Sciences - Part 1: Terms and Definitions.

2.2.2 ISO 9000:2015 (E), Quality Management Systems - Fundamentals and Vocabulary.

2.2.3 ISO 9001: 2015 (E), Quality Management Systems - Requirements.

2.2.4 ISO/IEC 17025:2017 (E), General requirements for the competence of testing and calibration laboratories.

### **3. Terminology**

**3.1 Definitions:**

3.1.1 **item**, *n* - object, substance or material that is collected, derived or sampled as part of the forensic process as defined in ISO 21043-1:2018(E).

3.1.2 **reference specimen**, *n* - material from a known source (NOTE 1) used for comparison purposes in a forensic process as defined in ISO 21043-1:2018(E).

NOTE 1: Source may refer to a specific person (for example, an individual whose face appears in an image, a recorded voice, or a sample of handwriting); a specific part of the body of an individual (for example, the finger that produced a latent print); a specific object (for example, a firearm, a shoe, or a typewriter); or a location (for example, a building visible in the background of an image).

3.1.3 **Verification**, *n* - Confirmation, through the provision of objective evidence that specified requirements have been fulfilled as defined in ISO 9000:2015 (E).

### **4. Summary of Practice**

**4.1** Define the type of items and reference specimen

**4.2** Describe the Acceptance criteria

**4.3** Describe Requirements for Conducting Analysis

**4.4** Describe Requirements for Conducting Comparisons.

**4.5** Describe the requirements for conducting the Evaluation Phase.

**4.6** Describe the requirements for conducting Verification

**4.7** Specify the minimum requirements for Reporting of Results.

**4.8** Specify the minimum requirements for Technical Records to be retained.

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<sup>3</sup> For referenced ISO standards, visit the ANSI website, <https://webstore.ansi.org/>

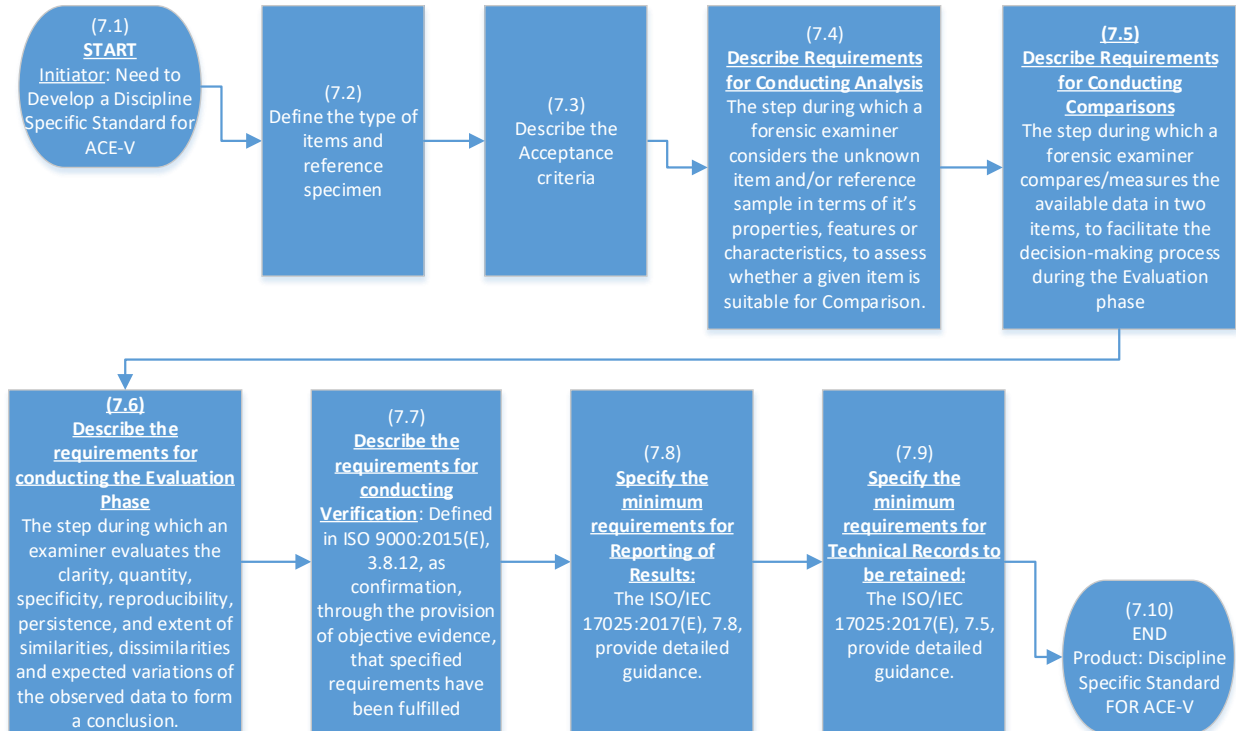


Fig. 1 High-Level Framework for Developing Discipline Specific Standards For ACE-V.

## 5. Significance and Use

**5.1** This guide impacts and applies to forensic disciplines that identify the need to develop discipline specific standards for the application of the methodology of ACE-V (Analyze, Compare, Evaluate and Verify).

**5.2** This guide provides a framework for developing a forensic discipline-specific methodology, to govern standardized methods used to conduct the various phases of ACE-V in the relevant discipline.

**5.3** Application of the requirements in this guide will lead to inter disciplinary standardized methodology which can then be validated through empirical studies within each of the various forensic disciplines involved in conducting feature comparisons.

## 6. General Requirements

**6.1** Develop discipline specific standards for ACE-V following the framework presented in this guide.

**6.2** Clearly define the methods used, and criteria applied in each step of ACE-V.

**6.3** Specify those steps in a procedure where the sequence of the steps is critical to the outcome of the test (NOTE 2) and specify the minimum requirements for documentation to be retained in the Technical record in this regard.

NOTE 2: For example, this is particularly relevant where the discipline applies bias reduction procedures such as "linear-ACE-V" or "linear sequential unmasking" to reduce bias.

**6.4** Provide information regarding the validation of methods selected for inclusion in the discipline specific standard. Those methods that will be used in Testing Laboratories, shall adhere to the method verification and validation requirements as per ISO/IEC 17025 and ISO 9001: 2015. These standards provide direction on the Quality management systems requirements for design and development of products and services, specifically with regards to design and development controls such as verification and validation.

## **7. Procedure**

**7.1 Initiator:** The procedure described in this guide is initiated when the need exists to Develop a Discipline Specific Standard for ACE-V.

**7.2 Define the type of items (NOTE 3) and reference specimens** that will be accepted for testing in the specific discipline.

NOTE 3: Examples of items are: Hinge lifters or digital images containing friction ridge impressions, recovered video or images that recorded a subject of interest, electrostatic dust lifts or three-dimensional casts containing footwear impressions.

**7.3 Describe the Acceptance criteria:** Each discipline specific standard shall describe the minimum acceptance criteria (NOTE 4) to which the items must adhere before being accepted for testing.

NOTE 4: Examples of acceptance criteria are clarity of digital images, minimum resolution requirements for digital images as applicable to the discipline, clarity and other variables of digital images and video, proper packaging to prevent contamination and cross contamination, minimum quality requirements for reference specimens.

**7.4 Describe Requirements for Conducting Analysis:** Analysis is a step in the ACE-V Methodology during which a forensic practitioner considers the unknown item and/or known reference specimen in terms of its properties, features, or characteristics, which may be directly observable, measurable, or otherwise perceptible qualities, to assess whether a given item is suitable for potential Comparison. Clearly define and describe the following aspects of the Analysis step for each discipline specific standard to include at a minimum:

7.4.1 Measurable, observable, demonstrable data, features (NOTE 5) or characteristics that will be considered to provide objective evidence that the specified requirement to reach a suitability decision has been met.

NOTE 5: Examples of features are class characteristics in footwear comparisons, facial features, different levels of detail in the friction ridge impressions or striations on cartridge casings that will be considered during comparisons.

7.4.2 The specific methods (NOTE 6) to be used during the Analysis step.

NOTE 6: Examples of methods for analysis are visual examination of items under different levels of magnification, microscopy, spectrometry, application of automated database searches to detect features and apply suitability values, and micrometry to detect features or characteristics that can be utilized for comparison.

7.4.3 The criteria necessary to determine that the specified requirement for a suitability decision is reached.

**7.5 Describe the Requirements for Conducting Comparisons:** Comparison is a step in the ACE-V Methodology during which a forensic practitioner compares or measures the available data (properties, features, or characteristics, which may be directly observable, measurable, or otherwise perceptible qualities) in two items, to facilitate the decision-making process during the Evaluation phase. Clearly define and describe the following aspects of the Comparison step for each discipline specific standard to include at a minimum:

7.5.1 The specific methods (NOTE 7) to be used during the Comparison step.

NOTE 7: Examples of methods of comparison include using a comparison microscope in firearms examination, visual side by side comparison in friction ridge examination and image analysis, mass spectrometry, creating overlays in footwear comparison. Also automated systems like “Case specific Biometric Databases” to conduct comparisons with small populations of known reference specimens.

7.5.2 The instruments used during the Comparison step, and where applicable, minimum manufacturing and calibration requirements for specific instruments.

**7.6 Describe the requirements for conducting the Evaluation Phase:** Evaluation is a step in the ACE-V Methodology during which the forensic practitioner evaluates the clarity, quantity, specificity, reproducibility, persistence, and extent of similarities, dissimilarities and expected variations of the observed data (properties, features, or characteristics, which may be directly observable, measurable, or otherwise perceptible qualities), taking into account any potential limitations of the items, to form a conclusion. Clearly define and describe the following aspects of the Evaluation step for each discipline specific standard, to include at a minimum:

7.6.1 The method (NOTE 8) to be used during the Evaluation step for interpreting the data or providing the weight of the observations.

NOTE 8: For example, for source conclusions, the examiner assesses the weight of observations by considering the prospect of finding the observed characteristics if the items came from the same source, as well as the prospect of finding the observed characteristics if the items came from different sources. This should include the application of statistical models where applicable.

7.6.2 The range of possible conclusions.

7.6.3 The criteria (NOTE 9) necessary to determine the specified requirement to reach each of the possible conclusions.

NOTE 9: It is important that standards specify not only the factors to be weighed, but also the threshold and criteria for reaching each possible conclusion.

7.6.4 Specify the circumstances (if any) under which it is appropriate to consider contextual information or investigative facts when drawing conclusions.

**7.7 Describe the requirements for conducting Verification:** Verification is defined in ISO 9000:2015(E), as the confirmation through the provision of objective evidence, that specified requirements have been fulfilled. It is further defined in ISO/IEC 17025:2017(E), for testing and calibration Laboratories as: “provision of objective evidence that a given item fulfils specified requirements. “Item” is further described as: “The item may be, for example, a process, measurement procedure, material, compound, or measuring system”. Clearly define and describe the following aspects of the Verification Step for each discipline specific standard, to include at a minimum:

7.7.1 The various methods (NOTE 10) through which confirmation is obtained.

NOTE 10: ISO 9000:2015(E) describes the process of confirmation as follows: “The objective evidence needed for a verification can be the result of an inspection or of other forms of determination such as performing alternative calculations or reviewing documents”. Documents are further defined as: “information and the medium on which it is contained”.

7.7.2 The objective evidence (NOTE 11) that the specified requirements have been met.

NOTE 11: ISO 9000:2015(E) defines objective evidence as: “data supporting the existence or verity of something” and indicates that: “Objective evidence can be obtained through observation, measurement, test, or by other means”

7.7.3 The specified requirements (NOTE 12) to be met for each result or conclusion.

NOTE 12: ISO 9000:2015(E) defines “requirement” as: “need or expectation that is stated, generally implied or obligatory”. Also, that: “A specified requirement is one that is stated, for example in documented information”.

### **7.8 Specify the minimum requirements for Reporting of Results:**

7.8.1 ISO/IEC 17025:2017(E) provides detailed guidance on Reporting requirements.

### **7.9 Specify the minimum requirements for Technical Records to be retained:**

7.9.1 ISO/IEC 17025:2017(E) provide detailed guidance on requirements for Technical Records. At a minimum documentation should include in some manner, the features observed in each of the items to be compared.

7.9.2 Identify and include contextual information about matters other than the physical characteristics of the items being compared, that should be included in the documentation.

**7.10 End:** The procedure described in this guide ends when a Discipline Specific Standard for ACE-V is complete.

## **8. Keywords**

**8.1** ACE-V, analysis, comparison, evaluation, verification, methodology



## APPENDIX

### (Nonmandatory Information)

#### X1. RATIONALE

X1.1 Following are references to some publications which provide a condensed historical overview on the evolution of the ACE-V Methodology:

X1.1.1 Champod (1)<sup>4</sup> states that pioneers in forensic science, although not named that way, were already applying a protocol similar to ACE-V, citing (Heindl 1927 (2) and Locard 1931 (3)). He recognizes the Royal Canadian Mounted Police (RCMP) as "...the organization that developed and adopted the ACE-V protocol for forensic comparisons..." referencing Huber (4). Chief Supt. R.A. Huber primarily addressed forensic document examiners with this publication. He was the Assistant Director, Laboratories and Identification Directorate, R.C.M.P. in Ottawa at the time. He recognized that various disciplines are following a similar process even though mostly subconsciously, e.g. in handwriting and firearms examinations. He also mentioned fingerprint, physical matching and chemical examinations. He described the three distinct phases of the ACE methodology as follows:

X1.1.1.1 "Analysis – The unknown item must be reduced to a matter of its properties or characteristics, which may be directly observable, measurable, or otherwise perceptible qualities.

X1.1.1.2 Comparison – The properties or characteristics of the unknown determined through Analysis are now compared with the familiar or recorded properties of known items.

X1.1.1.3 Evaluation – Similarities or dissimilarities in properties or characteristics will each have a certain value for identification purposes determined by its likelihood of occurrence. The weight or significance of each must therefore be considered."

X1.1.2 Further on p.11 Huber (4) states: "*Scientific method provides a fundamental criterion for conclusions drawn from it: that conclusions must be restricted to what one may expect to be the conclusions of any other competent scientist*", inferring what later became known as the "Verification" phase of ACE-V.

X1.1.3 This methodology was also adopted by Cassidy (5) in the Footwear discipline in his publication in 1980. He added however that: "The inexperienced examiner should always have his identification work re-examined and confirmed by a qualified person", re-enforcing the Verification concept.

X1.1.4 David Ashbaugh published several articles in the early 1990's covering the methodology of ACE-V for friction ridge comparison, and extensively so in his publication in 1999 (6).

X1.1.5 ACE-V was adopted by the Scientific Working Group for Friction Ridge Analysis, Study, and Technology (7) in 2002 as the standard for friction ridge examination.

X1.1.6 John Vanderkolk discusses the application of ACE-V for Image Analysis, in great detail in his publication in 2009 (8).

X1.1.7 ACE-V was published in 2015 in the Best Practice Manual for Fingerprint Examination issued by the European Network of Forensic Science Institutes (ENFSI) (9).

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<sup>4</sup> The boldface numbers in parentheses refer to the list of references at the end of this guide.

X1.1.8 ACE-V was cited as a possible accepted protocol applied to photographic comparisons in the Scientific Working Group on Digital Evidence (SWGDE) guideline Documents (10), (11) and technical overview document (12).

X1.2 The process of developing a discipline specific ACE-V standard is discussed in this guide following the High-Level Framework for Developing Discipline Specific Standards For ACE-V depicted in fig. 1.

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