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**Technical Report on the Articulation of the Reasoning
and Foundational Principles Behind Friction Ridge
Examinations**

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Technical Report on the Articulation of the Reasoning and Foundational Principles Behind Friction Ridge Examinations

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Foreword

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This document was revised, prepared, and finalized as a standard by the Friction Ridge Consensus Body of the AAFS Standards Board. The draft of this standard was developed by the Friction Ridge Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science.

Questions, comments, and suggestions for the improvement of this document can be sent to AAFS-ASB Secretariat, asb@aafs.org or 401 N 21st Street, Colorado Springs, CO 80904.

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1 Technical Report on the Articulation of the Reasoning and Foundational 2 Principles Behind Friction Ridge Examinations

3 1 Scope

4 This document provides reference information to aid in articulating the reasoning and foundational
5 principles behind the examination of friction ridge evidence. It provides additional explanations
6 and references in support of fundamental statements made within the friction ridge discipline. The
7 statements in the document include basic premises of friction ridge examination, the execution of
8 the examination process, and the communication of the results of examinations. This document
9 does not address the specific friction ridge examination conclusions or wording of those
10 conclusions which are the subject of a separate document.

11 2 Normative References

12 There are no normative reference documents. Annex A contains bibliographical references.

13 3 Terms and Definitions

14 For purposes of this document, the following definitions apply.

15 3.1

16 **agreement (synonym of correspondence and corresponding friction ridge detail)**

17 Observed similarities in pattern type, ridge flow, and friction ridge features in sequence, of the
18 same or similar type, in the same relative position to each other, with associated intervening ridge
19 counts. An accumulation of similarities between two impressions resulting in overall conformity
20 that supports a conclusion of source identification.

21 3.2

22 **analysis (phase of the examination process)**

23 The interpretation of observed data in a friction ridge impression in order to categorize its
24 suitability/utility.

25 3.3

26 **clarity**

27 The fidelity and coherence with which the anatomical details of friction ridge skin are reproduced
28 in a friction ridge impression, and are able to be visualized.^a

29 3.4

30 **comparison (phase of the examination process)**

31 The search for and detection of similarities and dissimilarities in observed data between friction
32 ridge impressions.

^a Kalka, N.D., M. Beachler, R.A. Hicklin. "LQMetric: A Latent Fingerprint Quality Metric for Predicting AFIS Performance and Assessing the Value of Latent Fingerprints", *JFI* 70(4): 443-463. 2020.

- 33 **3.5**
 34 **complexity (of a comparison)**
 35 A characteristic of a comparison in which the attributes of one or both impressions may require
 36 additional consideration and quality assurance measures relating to the evaluation of a source
 37 conclusion. Usually refers to the quality and clarity of at least one of the impressions in the
 38 comparison set, affecting the difficulty of the comparison.
- 39 **3.6**
 40 **complexity (of an impression)**
 41 A characteristic of an impression whose attributes may require additional consideration and
 42 quality assurance measures. Usually refers to the quality and clarity of the impression being
 43 analyzed, having the potential to affect the difficulty of a subsequent comparison.
- 44 **3.7**
 45 **conclusion (synonym of source conclusion)**
 46 Opinion stated by an examiner after interpretation of observed data. The opinion is the professional
 47 judgment that the observed data can offer support for one proposition over another. A conclusion is
 48 distinct from a "*proposition*."
- 49 **3.8**
 50 **disagreement**
 51 A dissimilarity, or an accumulation of dissimilarities, that is deemed to be outside of expected
 52 variations in the appearance of impressions from the same source, resulting in overall
 53 nonconformity.
- 54 **3.9**
 55 **discriminability**
 56 The degree to which information in an impression can be used to distinguish it from impressions
 57 made by different sources. The discriminability of an impression is a combination of the quantity,
 58 spatial arrangement, clarity, and rarity of features observed.
- 59 **3.10**
 60 **dissimilarity**
 61 An observation that two impressions have a general difference of appearance when comparing an
 62 individual feature or detail. Not to be confused with "*disagreement*".
- 63 **3.11**
 64 **evaluation (phase of the examination process)**
 65 The weighting of the aggregate strength of the evidence (observed similarities and dissimilarities
 66 when considering two competing propositions) between the observed data in the friction ridge
 67 impressions being compared in order to formulate a source conclusion.
- 68 **3.12**
 69 **exemplar impression (synonym of exemplar or known and exemplar prints)**
 70 **exemplar or known (synonym of exemplar impression and exemplar prints)**
 71 **exemplar prints (synonym of exemplar impression and exemplar or known)**
 72 The deliberately recorded images or impressions from the friction ridge skin of an individual.
- 73 NOTE Examples may include, but are not limited to, inked tenprints, inked palm prints, Livescan prints,
 74 powder and lift prints, casted/molded prints, or photographs of friction ridge skin.

75 **3.13**76 **observed data**

77 Any information seen within an impression that an examiner may rely upon to reach a decision,
78 conclusion, or opinion. This not only includes minutiae, but attributes such as clarity, scars, creases,
79 edge shapes, pore structure, and other friction ridge features.

80 **3.14**81 **pattern force area**

82 A region of friction ridge skin which in theory, minutiae were forced to form due to pattern type
83 and existing ridge fields during friction ridge formation. As these minutiae form more predictably,
84 their configurations are more common and less random.

85 NOTE For example, in the outflow of a loop, many ridges converged during formation, which forced many
86 ridge endings to form as space ran out.

87 **3.15**88 **probability**

89 An expression of the chance that a particular event occurs.

90 **3.16**91 **propositions**

92 Statements about the actual state of nature or an event, which is unknown or unknowable. Not to
93 be confused with "*conclusions*," nor "*source conclusions*" (refer to those definitions for further
94 clarification).

95 **3.17**96 **questioned impression (synonym of questioned image or questioned item)**97 **questioned image (synonym of questioned impression and questioned image)**98 **questioned item (synonym of questioned impression and questioned image)**

99 An impression or image of friction ridge skin whose source or identity is unknown; it can include
100 latent impressions, impressions from an unknown source or a known source.

101 NOTE For example the questioned impression may be a "known impression" in tenprint to tenprint
102 examinations.

103 **3.18**104 **rarity (of a feature type)**

105 The frequency or prevalence of a friction ridge feature, either in isolation or in conjunction with
106 other information about its local context.

107
108 NOTE For example, the prevalence of a type of feature could be affected by its proximity to a pattern force
109 area, the finger number or palmar region on which it is located, or the pattern type in which it is located.

110 **3.19**111 **similarity**

112 An observation that two impressions share a general likeness when comparing an individual
113 feature or detail. Not to be confused with "*agreement*."

114 **3.20**
115 **source**

116 An area of friction ridge skin of an individual from which an impression originated.^b

117 **3.21**
118 **strength of the evidence**

119 The relative support the evidence lends to one proposition over another. It may be described
120 verbally or numerically.

121 **3.22**
122 **suitability (synonym of utility)**

123 The usefulness of an impression for a further step in the examination process, such as comparison
124 or Automated Biometric Identification System (ABIS) entry.

125 **4 General**

126 This document presents a series of statements, in sequence, that build upon one another. Together
127 these provide a roadmap for articulation of the foundational principles and reasoning for current
128 friction ridge examination practices. This document does not provide a script for examiners; rather,
129 this series of statements taken together provides a high-level overview of the main concepts behind
130 the current practice of friction ridge examination. Each brief statement is followed by a more in-
131 depth explanation of the theory behind the statement.

132 Supporting references are provided in each section. The references cited are meant to be
133 representative, not all-inclusive.

134 **5 Discriminating and Persistent Nature of Friction Ridge Skin**

135 **5.1 Statement**

136 Friction ridge skin contains persistent morphological structures that can be highly discriminating.

137 **5.2 Further Explanation**

138 **5.2.1** Research and practical application have shown that the combination of the features present
139 in friction ridge skin can be highly variable between different sources. Research and practice have
140 also shown that, barring injury, disease, or other conditions damaging to the skin the essential
141 structure and ridge arrangements of these features remain unchanged (except for growth) over the
142 life of an individual.

143 **5.2.2** An entire complement of a particular anatomical source of friction ridge skin is highly
144 discriminating. However, it is less certain at what point a subset of the skin's features, imperfectly
145 reproduced as an impression, are no longer discriminating enough to distinguish between similar
146 sources. Furthermore, while research has demonstrated that some configurations of friction ridge
147 features are highly discriminating, others, particularly in pattern force areas, are less so. Since

^b National Institute of Justice (U.S.). *The Fingerprint Sourcebook*. Washington DC: U.S. Dept. of Justice Office of Justice Programs National Institute of Justice; 2011. <http://purl.fdlp.gov/GPO/gpo18039>. Accessed November 11 2022.

148 impressions are often incomplete or indiscernible in part, their degree of discriminability is
 149 considered at all stages of the examination.

150 **5.3 References Supporting Statement and Explanations**

151 The following references support the statement and explanations for the discriminating and
 152 persistent nature of friction ridge skin.

153 a) *Discriminability, persistence, and morphology*. Wilder and Wentworth (1932), Cummins and
 154 Midlo (1943), Hale (1952), Babler (1979), Maceo (2011), Wertheim (2011), Kücken and
 155 Champod (2013), Yoon and Jain (2015)

156 b) *Historical use of friction ridge skin for personal identification*. Barnes (2011)

157 c) *Recent scientific studies of friction ridge discriminability*. Neumann et al. (2007), Neumann et al.
 158 (2012)

159 d) *Features in pattern force areas (e.g., deltas, outflows of a loop) tend to be more common*.
 160 Champod and Margot (1997)

161 **6 Transfer of Friction Ridge Features to Impressions**

162 **6.1 Statement**

163 An impression, or recording, of the features of friction ridge skin can result when contact is made
 164 with a receptive surface.

165 **6.2 Further Explanation**

166 Contact with a surface can result in an impression, or recording, of the friction ridge skin. The
 167 resulting impression is not a perfect recording of the skin, as it is subject to distortions, differences
 168 in composition and substrate, and environmental effects. Each impression from the same area of
 169 friction ridge skin will record a subset of that skin's features that will vary in appearance from other
 170 impressions of the same source skin. This is true of both questioned and exemplar impressions.

171 **6.3 References Supporting Statement and Explanation**

172 The following references support the statement and explanations for the transfer of friction ridge
 173 features to impressions.

174 a) *Ridgeology*. Ashbaugh (1999)

175 b) *Distortions*. Maceo (2009)

176 c) *Reproducibility of friction ridge skin features in an impression*. Monson et al. (2019)

177 7 Analysis of Impression to Observe Data for Suitability Assessment

178 7.1 Statement

179 During analysis of a friction ridge skin impression, the data present in the impression is observed
180 and its discriminability is assessed in order to categorize its suitability for comparison. Analysis is
181 applied both to questioned and exemplar impressions.

182 7.2 Further Explanation

183 Examiners have demonstrated an ability to observe data such as ridge events, creases, and scars in
184 friction ridge impressions that surpasses that of untrained individuals. Examiners are capable of
185 observing data even in highly distorted impressions. Confidence in the existence and type of
186 observed data increases with the clarity of the data observed in an impression.

187 7.3 References Supporting Statement and Explanation

188 The following references support the statement and explanations for the analysis of impression to
189 observe data for suitability assessment.

- 190 a) *Effects of expertise and human factors on analysis and comparison*. Busey and Parada (2010),
191 Busey and Vanderkolk (2005)
- 192 b) *Expertise/novice ability*. Tangen, Thompson, and McCarthy (2011)
- 193 c) *Qualitative analysis and comparison*. Hicklin et al. (2013), Langenburg (2012), Maceo (2009)
- 194 d) ANSI/ASB Best Practice Recommendation 165, *Best Practice Recommendation for Analysis of*
195 *Friction Ridge Impressions*, 1st Ed., 2024

196 8 Comparison of Observed Data to Assess Similarity and Dissimilarity

197 8.1 Statement

198 During comparison, the observed data in comparable areas of two friction ridge impressions are
199 assessed for similarity and dissimilarity.

200 8.2 Further Explanation

201 A ridge-to-ridge comparison between two side-by-side impressions assesses whether there is
202 similarity or dissimilarity in the observed data in comparable areas of the two impressions.
203 Similarity and dissimilarity are assessed with respect to both the observed data and its spatial
204 relationships. Every recording of the same area of friction ridge skin is different. As a result, the
205 assessment of similarity and dissimilarity takes into account tolerances for distortion and other
206 environmental effects.

207 8.3 References Supporting Statement and Explanation

208 The following references support the statement and explanations for the comparison of observed
209 data to assess similarity and dissimilarity.

210 a) *Quantitative comparison and evaluation*. Ashbaugh (1999), Fagert and Morris (2015), Ulery et
211 al. (2014)

212 b) ANSI/ASB Best Practice Recommendation 166, *Best Practice Recommendation for Comparison*
213 *and Evaluation of Friction Ridge Impressions*, 1st Ed., 2024

214 **9 Accumulated Similarity Decreases Probability of Repetition in a Different Source**

215 **9.1 Statement**

216 The larger the set of similarities observed between two impressions the greater the likelihood of
217 those observations if the impressions originated from the same source versus if they originated
218 from different sources. Furthermore, the greater the clarity and/or rarity of those similarities, the
219 greater the likelihood of those observations if the impressions originated from the same source
220 versus if they originated from different sources.

221 **9.2 Further Explanation**

222 **9.2.1** In general, the variability in appearance of observed data is greater for impressions that
223 originated from different sources than for multiple impressions that originated from the same
224 source.

225 **9.2.2** Not all observed data carry the same weight. Observed data with higher clarity generally
226 indicate more accurate representations of the source friction ridge skin. Observed data that are
227 rarer allow the examiner to better discriminate between two sources.

228 **9.2.3** Quantity, spatial arrangement, clarity, and rarity combined make up the discriminability of
229 the impression. A more discriminating impression is less likely to have similar observed data in
230 impressions originating from different sources.

231 **9.2.4** Conversely, the stronger the dissimilarity, or larger the set of dissimilarities, observed
232 between two impressions the greater the likelihood of those observations if the impressions
233 originated from different sources versus if they originated from the same source.

234 **9.2.5** Likelihoods, probabilities, and rarity may be empirically derived (e.g., from validated
235 statistical models) and/or subjectively assigned by the examiner based on their professional
236 judgment.

237 **9.3 References Supporting Statement and Explanations**

238 The following reference supports the statement and explanations for the accumulated similarity
239 decreases probability of repetition in a different source.

240 a) *Quantifying variability and weight of evidence*. Egli et al. (2007), Gutiérrez et al. (2007),
241 Neumann et al. (2007), Neumann et al. (2012), Stoney and Thornton (1986)

242 **10 Evaluation of the Observed Data Under Two Competing Propositions**

243 **10.1 Statement**

244 During evaluation, the examiner assesses observed similarities and dissimilarities to determine
 245 whether there is agreement or disagreement in the observed data. Within this assessment, two
 246 competing propositions are considered: 1) that the two impressions originated from the same
 247 source, and 2) that the two impressions originated from different sources.

248 **10.2 Further Explanation**

249 **10.2.1** The examiner considers the support for each proposition and if the support for one
 250 proposition outweighs the other.

251 **10.2.2** The relative weighing of propositions determines the direction, if any, the examiner
 252 moves from the neutral position (i.e., Inconclusive).

253 **10.2.3** To determine the strength of the evidence, the examiner weighs the probability of
 254 observing the similarities and dissimilarities in two impressions assuming they were made by the
 255 same source against the probability of observing the similarities and dissimilarities assuming they
 256 were made by different sources. The strength of the evidence is the degree to which the probability
 257 of one proposition outweighs the probability of the other proposition.

258 **10.2.4** The combination of the direction and the strength of evidence is recorded as one of the
 259 conclusions documented in ASB Standard 013, *Standard for Friction Ridge Examination Conclusions*
 260 (*Draft available from asb@aafs.org*).

261 **10.3 References Supporting Statement and Explanations**

262 The following references support the statement and explanations for the evaluation of the observed
 263 data under two competing propositions.

- 264 a) *Two competing propositions are considered.* Aitken et al (2010), Neumann et al. (2012),
 265 Robertson et al. (2016)
- 266 b) *Using likelihoods to indicate support for propositions.* Champod (2015), Cole (2009), Cole (2014),
 267 Swofford (2015)
- 268 c) *Probability can be an expression of your degree of belief in the truth of an event.* Lindley (2014)
- 269 d) ASB Standard 013, *Standard for Friction Ridge Examination Conclusions* (*Draft available from*
 270 *asb@aafs.org*)

271 **11 Articulation of Error Rates from Examiner Performance Studies**

272 **11.1 Statement**

273 Examiner performance studies have shown that friction ridge examiners (when taken as a whole)
 274 can reach accurate and reliable conclusions under specific testing conditions.

275 **11.2 Further Explanation**

276 **11.2.1** A number of friction ridge examiner performance studies have been conducted in recent
 277 years. These studies varied in design, participation, subject matter, and limitations. These studies
 278 have reported relatively low instances of false negative errors and even lower (albeit non-zero)
 279 instances of false positive errors by study participants.

280 **11.2.2** The error rates from performance studies do not represent the probability of error in any
 281 specific situation (i.e., the probability of error associated with a specific examiner, FSP, case, or
 282 examination) as all measured error rates are only directly applicable to the specific study and its
 283 participants.

284 **11.2.3** The chance of error in a specific examination is generally dependent on a number of
 285 factors including, but not necessarily limited to: the quality and quantity of information in the
 286 impression, the complexity of the impression/comparison, the conclusion effected, the “skill” of the
 287 examiner, and whether or not the comparison was a result of a large database search (i.e., the
 288 exemplar impression already has some amount of similarity to the questioned impression).

289 **11.2.4** Error rates may be presented in differing ways with differing values depending on how the
 290 data was analyzed. Regardless of how an error rate is calculated, the underlying data (i.e., the
 291 performance of the participants) does not change.

292 **11.3 References Supporting Statement and Explanations**

293 The following reference supports the statement and explanations for the articulation of error rates
 294 from examiner performance studies

295 a) *Examiner Performance Studies*. Ulery, Hicklin et al. (2011), Pacheco, Cerchiai et al. (2014),
 296 Eldridge, De Donno et al. (2021)

297 b) *Error Rate and Impression Complexity*. Kellman, Mnookin et al. (2014)

298 **12 Communication of Results of Examinations**

299 **12.1 Statements**

300 Because target audiences for the results of friction ridge examinations vary, the specific wording
 301 used to convey the reasoning and foundational principles behind friction ridge examinations can
 302 vary.

303 Some statements made by examiners, while wholly understandable to a subject matter expert, can
 304 be prone to misinterpretation by the layperson.

305 **12.2 Further Explanation**

306 **12.2.1** Historically, when articulating the results of friction ridge examinations, examiners have
 307 used words and phrases that are now considered inappropriate or misleading (including their
 308 usage under the caveat that it is an examiner’s “opinion”). A prohibition against the use of such
 309 problematic phrases is documented in ASB Standard 013, *Standard for Friction Ridge Examination*
 310 *Conclusions* (*Draft available from asb@aaafs.org*). The documented prohibited language includes the
 311 following:

- 312 a) *Individualization, Made by, Originated from the same source, Exclusion of all others.*
 313 Use of the term “individualization” or phrases such as “originated from the same source”
 314 (outside of the presentation of propositions), “made by”, “matched to”, and “exclusion of all
 315 others” imply the reduction of an open population (i.e., the world’s population) to a single
 316 source. These terms and phrases de facto exclude all other possibilities. Unless case related
 317 contextual information is considered when making this determination, such as a closed-set
 318 population, this claim is not supportable by the current research and empirical testing.
- 319 b) *Zero error rate, Infallible.*
 320 A claim of a zero error rate for the examination of friction ridge impressions is demonstrably
 321 false; errors have occurred in practice, proficiency testing, and performance studies.
 322 Furthermore, the concept of a zero error rate is incompatible with the practice of science.
- 323 c) *Citing a personal degree of confidence as a measure of accuracy*
 324 While an examiner may express confidence in their conclusion, there is no established metric by
 325 which to measure a degree of confidence in a specific conclusion (e.g., 100% confident,
 326 extremely confident, etc.). Even a documented personal error rate does not account for the
 327 variability in the chance of error due to the specific circumstances of the comparison at hand.
- 328 Examiners may erroneously conflate confidence with accuracy by asserting or implying that
 329 because an examiner has confidence in the conclusion it is therefore accurate. Examiners can be
 330 both confident and inaccurate in their conclusions as is evidenced by documented errors both
 331 in practice and performance studies.
- 332 d) *Certainty, Practical impossibility, Reasonable degree of scientific certainty, and equivalents.*
 333 The concept of certainty is incompatible with the practice of science. Science is inherently an
 334 endeavor to generate the best possible answers to questions that are never knowable with
 335 certainty. Arguments such as “I would not have signed the report unless I was certain” are not
 336 sufficient support for a claim of certainty. Furthermore, statements that include a measure of
 337 certainty are similarly inappropriate because certainty is generally perceived as a categorical
 338 statement as opposed to a scalable measure.
- 339 In practice, the concept of certainty is often inappropriately conflated with confidence. Whereas
 340 certainty is associated with the accuracy of a result, confidence is associated with a person’s
 341 conviction in that result.
- 342 e) *Citing a number of friction ridge comparisons as a measure of accuracy*
 343 Performance studies have demonstrated that an examiner’s years of experience is not
 344 correlated with reduced error rates. Given this lack of correlation, the number of comparisons
 345 performed by an examiner is not a reliable measure of the accuracy of the proffered conclusion.
 346 Research has shown that the chance of error in a given comparison is most heavily influenced
 347 by the attributes of the impressions examined as opposed to the examiner performing the
 348 comparison.
- 349 f) *The concept of the uniqueness of friction ridge skin alone is sufficient to justify a conclusion*
 350 While the friction ridge skin can be considered highly discriminable, and is essential for the
 351 reliable practice of friction ridge examination, the examination of friction ridge impressions
 352 does not involve the direct comparison of the friction ridge skin. Instead, friction ridge
 353 examiners perform comparisons on reproductions of that skin.

354 Within the process of reproduction (e.g., deposition), discriminating information is lost. The
 355 amount of loss is variable, but loss always occurs. Furthermore, distortion, composition,
 356 substrate, and environmental effects may influence the appearance of the resulting subset of
 357 information recorded.

358 Examiners and lay audiences alike are vulnerable to reasoning incorrectly that the
 359 discriminability of friction ridge skin vouches for the accuracy of friction ridge conclusions. The
 360 skin's discriminability is not a guarantor of the accuracy of the conclusion.

361 **12.3 References Supporting Statement and Explanations**

362 The following references support the statement and explanations for the communication of results
 363 of examinations.

364 a) *Use of these phrases is inappropriate and unsupported.* Campbell (2011), Champod (2013), Cole
 365 (2014), Garrett (2009), National Research Council (2009), NIST (2012)

366 b) *Studies on the accuracy of experienced friction ridge examiners.* Langenburg (2009), Ulery,
 367 Hicklin et al. (2011), Tangen, Thompson et al. (2011)

368 c) *Forensic statistics.* Robertston et al. (2016), Aitken and Taroni (2004)

369 d) *Decision-making in forensic identification.* Biedermann et al. (2008)

370 **13 Limitations**

371 **13.1 Statement**

372 Friction ridge examinations and conclusions are subject to limitations both fundamental and
 373 practical

374 **13.2 Further Explanation**

375 **13.2.1** Friction ridge examination is subjective in nature.

376 While performance studies have demonstrated that friction ridge examiners in the aggregate can
 377 reach accurate conclusions (under specific test conditions), friction ridge examination is
 378 fundamentally an exercise in personal (professional) judgment. Decisions are made based on
 379 human observations. Examiners also apply personally-derived thresholds to effect examination
 380 decisions. While these personal observations and thresholds are not arbitrarily derived or applied
 381 they can vary from examiner to examiner.

382 Studies have demonstrated that individuals can develop expertise in friction ridge examination by
 383 acquisition of relevant knowledge, experience, and training. Furthermore, studies have shown that
 384 examiners often reach consensus and that variability amongst examiners was most strongly
 385 associated with high complexity impressions and with decisions at or near sufficiency thresholds.

386 The subjective nature of friction ridge examination means that examiners will not always agree
 387 with each other, necessitating the application of strong and transparent quality assurance practices.

388 **13.2.2** The age of a friction ridge impression cannot be determined from the appearance of the
389 impression.

390 Absent exceptional circumstances, friction ridge impressions do not provide information indicative
391 of when the deposition of a print took place. Numerous factors affect the appearance of an
392 impression both at the time of deposition and over time. The influence of these factors is variable
393 and not an indicator of age.

394 **13.2.3** The presence of a friction ridge impression generally indicates contact was made but not
395 the specific activity resulting in the deposition.

396 In general, the presence of a friction ridge impression on an item of evidence indicates that a
397 contact was made between a source and an item. The anatomical source of an impression along
398 with its orientation and location on an item may also reveal information about how that item was
399 handled. Absent exceptional circumstances, an impression cannot be directly associated with a
400 specific event or activity. For example, the presence of a friction ridge impression on a firearm does
401 not necessarily indicate that the impression was deposited during the firing of that firearm.

402 Under specific circumstances, an impression may not directly originate from a source contact but
403 instead be a result of a transfer from one item to another (e.g., lifted by an adhesive surface).

404 **13.2.4** The absence of, or failure to detect, a friction ridge impression does not indicate that
405 contact did not occur.

406 The deposition of a friction ridge impression is a chance event. A variety of factors may impede the
407 deposition of an impression (e.g., absence of a matrix to deposit, non-receptive surfaces, etc.) or the
408 longevity of a deposited print (e.g., wiping a surface, exposure to the elements), and the detection of
409 friction ridge impressions on items of evidence is not always successful. As such, a lack of friction
410 ridge impressions on an item of evidence does not indicate that the item was not contacted.
411 Furthermore, the exclusion of a source to a detected impression does not indicate that that source
412 did not contact the item.

413 Conversely, the absence of, or failure to detect, a friction ridge impression can also result from an
414 item not being handled. As such, this observation provides no evidentiary support for either
415 proposition (i.e., that the item was handled but no impression was deposited or detected or that the
416 item was not handled).

417 **13.2.5** Ground truth is unknown.

418 In case work, the examiner cannot truly know whether any particular person is the source of an
419 unknown impression since they did not observe the deposition of the impression. It is for this
420 reason that the expression of professional judgment of the source of the unknown impression,
421 along with a description of the strength of the evidence supporting that professional judgment, be
422 limited. It is inappropriate to give the impression that any conclusion is a known fact.

423 **13.2.6** The strength of the evidence supporting the examiner's professional judgment is variable.

424 All conclusions are not equal in strength. When presenting a conclusion, it is important to be
425 transparent about the quality, quantity, and complexity of the data that were used to reach the
426 conclusion and how that quality, quantity, and complexity affect the strength of the evidence
427 supporting the conclusion.

428 **13.2.7** Reproducibility is not a guarantee of accuracy.

429 It is inappropriate to assert that because a conclusion has been reproduced by others (through
430 verification or other means) it is therefore accurate. In both practice and performance studies,
431 errors have occurred that have been reproduced by other examiners. The only way to be certain of
432 accuracy is to know ground truth. In the absence of ground truth, the most appropriate way to
433 support the accuracy of a conclusion is by clearly demonstrating the support the data provide for
434 the conclusion.

435 **13.2.8** Case type can be relevant to whether a comparison is performed, but is not relevant as
436 support for a conclusion.

437 Agencies have different policies regarding the prioritization of cases based upon crime type.
438 However, crime type is not an appropriate basis for adjusting the threshold for a conclusion. For
439 example, it is not appropriate to reach a conclusion using less supporting data for a homicide than
440 one would consider sufficient for a burglary.

441 **13.2.9** Friction ridge examiners and their conclusions can be influenced by cognitive biases.

442 Cognitive bias is pervasive in and a fundamental component of human decision making.

443 Studies have demonstrated that examiners and their conclusions can be influenced by the
444 introduction of biasing information. However, studies have also shown that, in general, examiners
445 are resistant to the effects of biasing information or, when influenced, generally default to more
446 conservative conclusions.

447 The presence of biasing information alone does not necessarily indicate that an examiner or their
448 conclusion is inaccurate or unreliable. The vulnerability of an examiner/conclusion to be impacted
449 by bias is dependent on the nature of the impression and/or comparison being performed. Friction
450 ridge impressions/comparisons that are highly complex and/or closest to decision thresholds
451 require the examiner to apply greater levels of personal judgment and as a result tend to be the
452 more vulnerable to the effects of bias. Conversely, lower complexity/non-complex
453 impressions/comparisons require less personal judgment and as a result tend to be more resistant
454 to the effects of bias.

455 Awareness of bias does not make an examiner immune from its effects. The influence of bias may be
456 mitigated by the application of appropriate quality assurance measures (e.g., blinding or masking).

457 **13.3 References Supporting Statement and Explanations**

458 The following references support the statement and explanations for limitations.

459 a) *Examiner variability*. Ulery, Hicklin et al. (2015, 2016)

460 b) *Examiner expertise*. Busey and Vanderkolk (2005), Busey and Parada (2010), Tangen,
461 Thompson, and McCarthy (2011)

462 c) *Age determination of friction ridge impressions*. Girod et al. (2016)

463 d) *Reproducibility of friction ridge conclusions*. Ulery, Hicklin et al. (2012), Tangen, Kent, and
464 Searston (2020)

465 e) *Bias*. Busey and Dror (2011), Pena, Stoiloff et al. (2024)

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Annex A (informative)

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470 The following bibliography is not intended to be an all-inclusive list, review, or endorsement of
471 literature on this topic. The goal of the bibliography is to provide examples of publications
472 addressed in the standard.

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