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STANDARDS FOR EXAMINING FRICTION RIDGE IMPRESSIONS AND RESULTING CONCLUSIONS

(To Replace: *Friction Ridge Examination Methodology for Latent Print Examiners*, ver. 1.01, and *Standards for Conclusions*, ver. 1.0)

Preamble

Friction ridge impression examinations are conducted by examiners using the Analysis, Comparison, Evaluation, and Verification (ACE-V) methodology, which includes both qualitative and quantitative aspects. ACE is not generally applied as a strictly linear process because it may include a return to any previous phase. Application of ACE includes observations, measurements, assessments, decision-making and documentation that is enabled by the training, skill and experience of the examiner.

The examination of friction ridge impressions and the resulting conclusions are based on ridge flow and ridge paths; the location, direction, and spatial relationships of minutiae; and ridge structure. The analysis phase leads to the determination of *suitability*. Following comparison, the evaluation phase leads to the following conclusions: *individualization*, *exclusion*, or *inconclusive*. These conclusions are based on the following premises [1]:

- Friction ridge skin bears an extremely complex, unique and persistent morphological structure.
- Notwithstanding the pliability of friction ridge skin, the contingencies of touching a surface, and the nature of the matrix, an impression of friction ridge skin structure may be left following contact with a surface.
- This impression may display features of varying quality (clarity of ridge features) and specificity (weighted values and rarity).
- Notwithstanding variations in clarity and specificity, the unique aspects of friction ridge skin may be represented as highly discriminative features in impressions.
- An impression that contains sufficient quality and quantity of friction ridge features can be individualized to, or excluded from, a source.
- No predetermined number of friction ridge features is required to establish an individualization.

1 Scope

1.1 The ACE-V methodology of friction ridge impression examination utilizes a qualitative and quantitative assessment of Level 1, Level 2, and Level 3 details.

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- 1.2 The ACE-V methodology is applied to any comparison between two friction ridge impressions. This document illustrates the case of unknown to known but is applicable to other comparisons (e.g., known to known).
- 1.3 The application of the ACE-V methodology requires examiner competency as established through training and testing [2].

2 Factors Affecting Examinations

- 2.1 The following factors affect the qualitative and quantitative aspects of friction ridge impressions. A competent examiner will understand these factors, recognize that they occur in friction ridge impressions, and understand how they influence friction ridge impression reproducibility. These factors may cause an apparent dissimilarity between impressions from the same source. Failure to properly assess the occurrence and influence of these factors could result in misinterpretation. When applicable, the following factors must be considered in all steps of the ACE-V methodology:
- 2.1.1 Anatomical aspects include the condition of the skin (e.g., scars and warts) and the morphology of the hand and foot relative to the shape and contour of the substrate.
- 2.1.2 Transfer conditions include pressure applied during transfer, slippage or twisting, sequence of deposition (i.e., double taps and overlays) and an understanding of the limitations of friction ridge pliability.
- 2.1.3 Transfer media include bodily secretions and contaminants (e.g., sweat, blood, paint, dirt, oil, grease).
- 2.1.4 Detection techniques that can be one or more of the following: optical (i.e., light sources and illumination techniques), physical, or chemical processing techniques.
- 2.1.5 Recording or preservation techniques, such as photography, lifting, live-scan, and ink.
- 2.1.6 Substrate (e.g., porous, non-porous, semi-porous, smooth, rough, corrugated, pliable, or textured surfaces).
- 2.1.7 Environmental conditions (e.g. protected, unprotected, wet, dry, cold, or hot).

3 Levels of Friction Ridge Impression Detail For Examinations

Level 1 detail refers to the overall ridge flow. Level 2 detail refers to individual friction ridge paths, friction ridge events (e.g., bifurcations, ending ridges, dots, and continuous ridges) and their relative arrangements. Level 3 detail refers to ridge structures (edge shapes, and pores) and their relative arrangements. Creases, scars, warts, incipient ridges, and other features may be reflected in all three levels of details¹.

4 Procedure for Friction Ridge Impression Examinations (ACE-V Methodology)

4.1 Analysis

- 4.1.1 Analysis includes the assessment of the impression to determine its value based on Level 1, 2, and 3 detail. This assessment is affected by other relevant information as described in section 2, as well as anatomical origin and orientation. Analysis determines if the impression is suitable for comparison. If the impression is not suitable the examination will

¹ For example, a crease could exhibit Level 1 crease flow, Level 2 crease path, and Level 3 crease shape.

stop at the analysis phase and will be reported as such². If the impression is suitable, the analysis further indicates the features and their tolerances to be used in the comparison.

4.1.2 In the analysis phase, the examiner assesses the friction ridge skin features and determines the tolerances assigned to the impressions (unknown and known). Tolerance is the allowance of variation in appearance of friction ridge features (due to the factors listed in section 2) that will be accepted during comparison, should the corresponding print be available.

4.1.3 The analysis will also provide anatomical information to prioritize the potential corresponding areas and limit unnecessary comparisons. Certain orientation indicators such as recurves, deltas, creases, and scars may provide specific guidance where to begin the comparison.

4.1.4 Determination of suitability

4.1.4.1 The determination of suitability is based on the assessment of the discriminating strengths of the features and their arrangements. Suitability is the determination that there is adequate quality and quantity of friction ridge features in an impression for some further process step. The assessment is made based on the quality of features (clarity of the observed features), the quantity of features (amount of features and area), the specificity of features, and their relationships (see section 5).

4.1.4.2 There are commonly two approaches to the determination of suitability as determined by agency policy:

- Approach #1: Only impressions of *value for individualization* are compared. *Value for individualization* indicates an impression that is deemed to be identifiable. When adopting this approach, impressions lacking value for individualization are not further compared.
- Approach #2: Impressions of value for individualization or exclusion are compared.
- Conclusions in the evaluation phase following both approaches are: individualization, exclusion, or inconclusive.

4.2 Comparison

4.2.1 If the analysis phase provides indicators as to the probable anatomical area, a side-by-side comparison with the appropriate area of the known print is conducted. In the absence of indicators, all areas of available known impressions must be compared.

4.2.2 Comparison is accomplished through the side-by-side observation of all levels of details to determine whether the two impressions are in agreement or disagreement based upon features, sequences, and spatial relationships within the tolerances of clarity and distortion.

4.2.3 Comparison begins with the determination of dissimilarity or similarity between two impressions at Level 1. If similarity is determined within tolerance at Level 1, a target group is selected from the features observed during the analysis phase and is then searched within the selected area of the other impression. When similarity with the target group exists, additional contiguous arrangements of features are compared between impressions in a cyclical or recurring process from the unknown to the known impression to evaluate disagreement or agreement between the impressions. The process can be extended to

² It will not be reported as inconclusive, but may be submitted to verification.

comparing features in the known with features in the unknown that were reanalyzed during the comparison phase. If the initial target group is not found, alternative target groups may be selected and compared.

4.2.4 Observation of agreement or disagreement between the impressions initiates the evaluation phase.

4.3 Evaluation

4.3.1 Once the examination progresses from the comparison phase into the evaluation phase, it is determined whether the information is sufficient (see section 5) to form one of the three conclusions or return to the analysis phase and reassess suitability.

4.3.2 In the evaluation phase, the examiner will ultimately decide whether the unknown impression is from a different source or the same source as the compared impression, or is inconclusive. These conclusions are defined below.

4.3.2.1 Exclusion

Exclusion is the decision by an examiner that there are sufficient features in disagreement to conclude that two areas of friction ridge impressions did not originate from the same source. Source refers to the area of friction skin. Exclusion of a subject can only be reached if all relevant comparable anatomical areas are represented and legible in the known exemplars. Notes and reports shall clearly state if the exclusion refers only to the source or the subject.

4.3.2.2 Individualization

Individualization is the decision by an examiner that there are sufficient features in agreement to conclude that two areas of friction ridge impressions originated from the same source. Individualization of an impression to one source is the decision that the likelihood the impression was made by another (different) source is so remote that it is considered as a practical impossibility.

4.3.2.3 Inconclusive

4.3.2.3.1 An inconclusive conclusion resulting from a suitability decision as described in approach #1 in section 4.1.4.2 occurs when an examiner is unable to individualize or exclude due to an absence of complete and legible known prints (e.g., poor quality fingerprints and lack of comparable areas). In such an instance, the inconclusive conclusion means that the impression needs to be reexamined using clearly and completely recorded known impressions.

4.3.2.3.2 An inconclusive conclusion resulting from a suitability decision as described in approach #2 in section 4.1.4.2 can occur either as in approach #1 or when corresponding features are observed but not sufficient to individualize. Likewise dissimilar features may be observed but not sufficient to exclude. In either case, the inconclusive conclusion means that the unknown impression was neither individualized nor excluded as originating from the same source.

4.3.2.3.3 There may be other instances where agencies have adopted procedures to report inconclusive decisions. These are left to the administrative policies and procedures of the individual agency. However, these policies and reporting procedures must be clearly defined by the agency.

4.3.3 Reporting conclusions

The conclusions of individualization and exclusion will be documented in notes and in reports; however, the determining factors need not be included in reports. Reasons for reaching inconclusive decisions must be documented in notes and included in reports.

4.4 Verification

4.4.1 The independent application of the ACE process is utilized by a subsequent examiner to either support or refute the conclusions of the original examiner.

4.4.2 Suitability determinations may be verified by another examiner trained to competency. A conclusion of individualization shall be verified. All other conclusions resulting from the evaluation phase should be verified.

4.4.3 Conflict resolution shall take place if the original conclusion is contested and cannot be resolved through consultation [4].

4.5 The flowchart in Appendix A details the major steps of ACE-V. The chart has been adapted from the NIST Expert Working Group on Human Factors in Latent Print Analysis. It is offered here as supporting documentation and applies to both ten print and latent print examination.

5 Sufficiency for Conclusion

Sufficiency is a product of the quality and quantity of the objective data under observation (e.g., friction ridge, crease, and scar features). As quality of an impression increases the need for quantity of friction ridge feature decreases, as well as the inverse.

5.1 Quality

5.1.1 Quality is the assessment of the clarity of ridge features. Generally as quality increases so does the discernability and reliability³ of the ridge features. It is recognized that quality is not necessarily constant throughout an impression. The assessment of quality may represent just the areas of highest quality, a range of qualities, or a map or rating system of quality of various regions in a single impression.

5.1.2 Table 1 shall be used for categorizing the levels of quality of the features in an impression (unknown or known). The level of quality determines the degree of tolerances that will be used during the comparison process. High quality will lead to low tolerances and conversely low quality will require high tolerances⁴.

³ Reliability refers to the confidence assigned by the examiner to the observed ridge features in terms of existence, location and shape he/she would expect to be reproduced on the corresponding print, should it be made available.

⁴ High tolerances: generous allowances for variations in appearance and spatial relationships.

Quality	
High	Level 1 is distinct; Level 2 details are distinct; There are abundant distinct Level 3 details.
Medium High	Level 1 is distinct; Most of the Level 2 details are distinct; There are minimal distinct Level 3 details.
Medium Low	Level 1 is distinct; Few of the Level 2 details are distinct; There are minimal distinct Level 3 details.
Low	Level 1 may not be distinct; Most of the Level 2 details are indistinct; There are no distinct Level 3 details.

Table 1: Categories of quality defined as a function of levels of details observed.

5.1.3 The quality metric was designed to allow for a range of quality assessment as opposed to a narrow categorization. Table 1 provides four ranked categories for the quality metric. There are subjective as well as objective elements to this categorization, but the descriptions provided in the table should allow a meaningful quality description to be made with reference to the categories.

5.2 Quantity

Quantity, as applied in this section, is the number of ridge endings, bifurcations, and dots (minutiae) in contiguous ridges, determined without any reference to known impressions. All minutiae are considered here including indistinct minutiae for which type and exact location cannot be established. Overall quantity of all features in the impression is not part of this measure.

It is recognized that this is an incomplete measure of the overall quantity of detail in a print. Level 2 detail encompasses more than minutia counts (including the ridge path, areas with open fields, and selectivity of minutiae). Minutia counts remain, however, as a discrete, measurable aspect of all prints and their enumeration is part of the systematic, formal consideration of quantity by all examiners.

The utility of the number of minutiae as applied in this section, is to assist in the analysis of suitability and the recognition of alternative levels of case complexity as they relate to sufficiency, evaluation, and verification. This use of the number of minutiae should not be considered as suggesting or endorsing the use of minutia counts as the sole criteria for a decision threshold.

5.3 Decision-making

5.3.1 Sufficiency graph

- 5.3.1.1** The sufficiency graph (Figure 1) reflects the interplay between quality (defined in Table 1) and quantity of minutiae (as discussed in section 5.2) and its relation to the decision thresholds and levels of complexity based on a consensus of collective experience. It broadly represents how the amount of available information in an impression directly impacts the decision-making process. The sufficiency graph was developed to illustrate the intellectual process involved with the examination of friction ridge detail and the ensuing decisions. It represents the examiner's understanding of the aggregate relationship of details. Its purpose is to illustrate a part of the process dealing with the analysis of the impression for sufficient quality and quantity of detail to proceed with the comparison effort. It also illustrates certain thresholds wherein examiners should recognize the need for, and provide, enhanced documentation supporting their conclusions.
- 5.3.1.2** The axes used to plot the decision of the examiner, the positions of the curves, and the underlying regions, were created based on a consensus of experienced examiners (SWGFAST). Considerations in establishing the graph are related to actual casework and include international practices, general awareness of longstanding, as well as current literature and trends in ongoing research.
- 5.3.1.3** Level 2 detail in this graph is represented on the horizontal axis by numbers of minutiae. The limitations and rationale for using this metric for quantity are discussed in section 5.2. It is re-emphasized here that this should not be considered as suggesting or endorsing the use of minutiae counts as the sole criteria for a decision threshold.
- 5.3.1.4** The four categories of quality represented on the vertical axis are given in Table 1 and discussed in section 5.1.2.
- 5.3.1.5** In Figure 1, the solid curve in the graph defines the lower limit of the sufficiency of friction ridge details below which, in area marked **A**, an individualization decision is not warranted. The dotted curve indicates the boundary between levels of complexity (complex versus non-complex). In area marked **B** in Figure 1, the examination is considered as complex and an individualization may be warranted. In area marked **C** in Figure 1, the examination is considered as non-complex and an individualization is warranted.
- 5.3.1.6** Quantity is meaningless in the absence of quality. Individualization cannot be achieved on quantitative considerations alone. It is recognized that in the absence of any minutiae, an individualization may be possible in such complex cases if the impression displays very high quality.

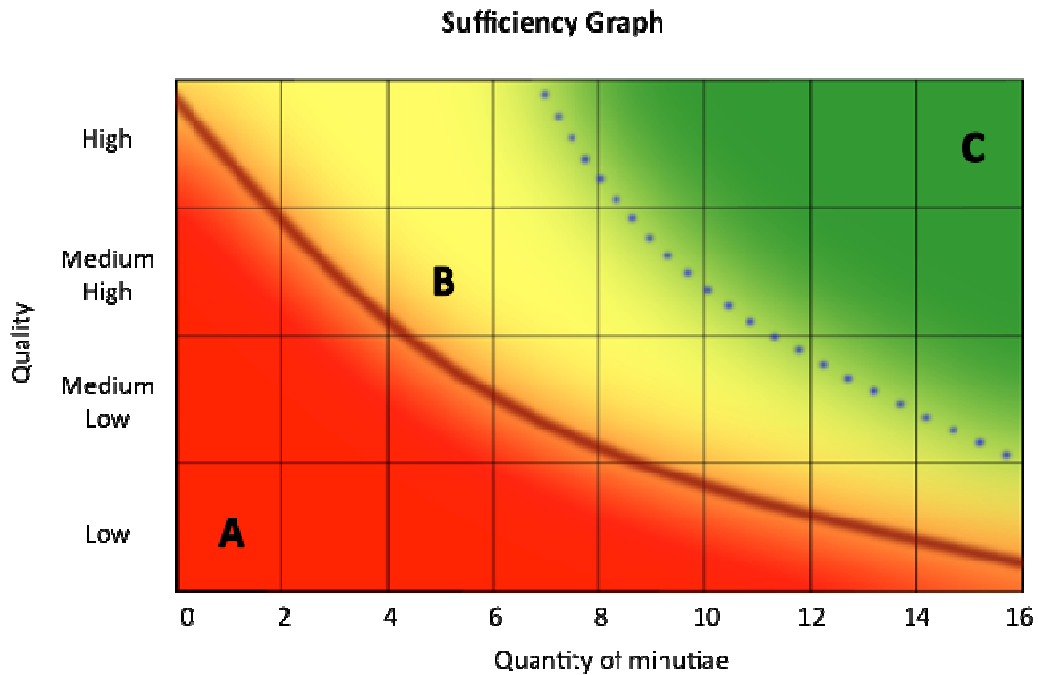


Figure 1: Sufficiency Graph (see section 5.3.1.5.). This graph does not suggest or endorse the use of minutiae counts as the sole criteria for a decision threshold.

5.3.2 Analysis phase

5.3.2.1 In the analysis phase, the assessment of the impression based on quality and quantity (as defined above) is positioned on the graph to determine its suitability for individualization. If the impression falls below the solid curve, then an individualization is not warranted. If positioned above the curve, then it may allow an individualization.

5.3.2.2 Minimum quality assurance measures are associated with each level of complexity according to the following table (Table 2):

Documentation and verification procedures	
Non-complex	Limited documentation of the relevant features used as a basis for a conclusion. Standard verification.
Complex	Extensive documentation of the relevant features used as a basis for a conclusion. Should consider the possibility of an enhanced verification and review procedure (e.g., a blind verification, multiple verifiers).

Table 2: Documentation and verification procedures.

5.3.2.3 A non-complex impression may be classified as complex if the following modifying factors are present: low specificity of features, significant distortion (e.g., multiple tap, superimposed impression, extreme pressure, and slippage), high tolerances, or the original conclusion is contested during verification.

5.3.2.4 An impression categorized initially as complex may be classified as non-complex if modifying factors are present such as high specificity of features, presence of creases, scars, and open fields.

5.3.2.5 Justification for reassignment of complexity shall be documented.

5.3.3 Evaluation phase

5.3.3.1 In the evaluation phase, the sufficiency graph is used as a guide that broadly delineates the boundaries between individualization and inconclusive decisions.

5.3.3.2 In the evaluation phase, the decision process starts with an attempt at exclusion followed by an assessment of the potential correspondence observed between the impressions.

5.3.3.3 Exclusion

5.3.3.3.1 An exclusion decision can be based solely on Level 1 when sufficient pattern area and orientation indicators (e.g., recurves, cores, deltas, and creases) are available and when disagreement has been observed absent any significant distortion such as: double tap, overlaid impressions, or twisting. If significant distortion is observed, an exclusion decision can only be reached by considering both Level 1 and Level 2 details. If available, Level 3 may also be considered in conjunction with Level 2.

5.3.3.3.2 An exclusion decision can be based on Level 2 when sufficient disagreement has been observed.

5.3.3.3.3 Level 3 details cannot be the sole factor in exclusion decisions. Level 3 details have to be considered in conjunction with Level 1 and Level 2 details.

5.3.3.4 Individualization

5.3.3.4.1 If the impressions originated from the same source, the examiner should observe correspondence, within tolerances, of all features. It is the degree of correspondence of features that is weighed.

5.3.3.4.2 For an individualization conclusion, sufficient agreement of information must exist so that the likelihood the impression was made by another (different) source is so remote that it is considered as a practical impossibility.

5.3.3.4.3 Level 3 details cannot be the sole factor in individualization decisions. Level 3 details have to be considered in conjunction with Level 1 and Level 2 details.

5.3.3.5 If the examiner did not reach a conclusion of individualization or exclusion, the conclusion will be reported as inconclusive.

6 References

- [1] IAI 2010-18 resolution (and supplemental report from the Standardization II Committee, to appear).
- [2] SWGFAST, *Standards for Minimum Qualifications and Training to Competency for Friction Ridge Examiner Trainees (Latent/Tenprint)*, 2/12/10, ver. 1.0.
- [3] SWGFAST, *Standard for the Documentation of Analysis, Comparison, Evaluation, and Verification (ACE-V) (Latent)*, 2/12/10, ver. 1.0.
- [4] SWGFAST, *Quality Assurance Guidelines for Latent Print Examiners*, 9/28/06, ver. 3.0.

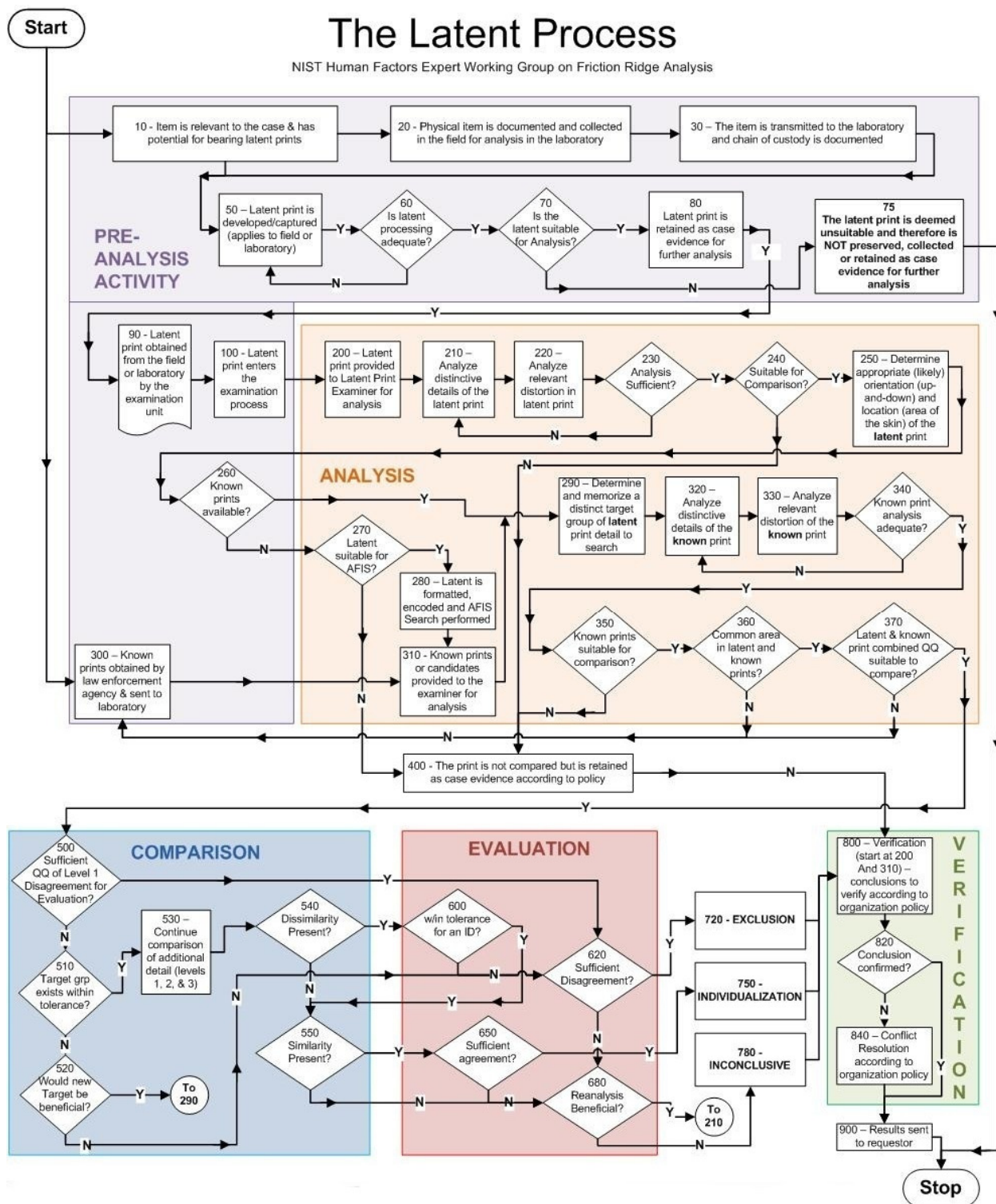
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Appendix A

The Latent Process

NIST Human Factors Expert Working Group on Friction Ridge Analysis



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