ANSI/NIST-ITL 1-2011

Data Format for the Interchange of Biometric and Forensic Information

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Foreword   (This foreword is not part of American National Standard ANSI/NIST ITL 1 2011)

Law enforcement and related criminal justice agencies as well as identity management organizations procure equipment and systems intended to facilitate the determination of the personal identity of a subject or verify the identity of a subject using biometric information. To effectively exchange identity data across jurisdictional lines or between dissimilar systems made by different manufacturers, a standard is needed to specify a common format for the data exchange.

Biometric data refers to a digital or analog representation of a behavioral or physical characteristic of an individual that can be used by an automated system to distinguish an individual as belonging to a subgroup of the entire population or in many cases, can be used to uniquely establish or verify the identity of a person (compared to a claimed or referenced identity). Biometric modalities specifically included in this standard are: fingerprints, plantars (footprints), palmprints, facial images, DNA, and iris images. Forensics, as used within the ANSI/NIST ITL standard, refers to identifying characteristics useful to law enforcement or identity management organizations that may be used manually to establish or verify the identity of an individual. This includes scars, marks, tattoos, and certain characteristics of facial photos and iris images. Latent friction ridge prints (fingerprint, palmprint and plantars) are included in this standard and may be used in either an automated system or forensically (or both).

- Some data may be stored and/or transmitted in image or processed versions.   The image may be 'raw' (as captured), compressed, cropped, or otherwise transformed. It is important, therefore that information associated with the image(s) be transmitted to the receiving organization that fully describes the biometric data. This standard also allows for the transmission of processed sample data, such as minutiae and other features from friction ridge biometrics.

The Information Technology Laboratory (ITL) of the National Institute of Standards and Technology (NIST) sponsored the development of this American National Standards Institute (ANSI) approved American National Standard using the NIST Canvass Method to demonstrate evidence of consensus. This updated standard replaces ANSI/NIST ITL 1 2007 and ANSI/NIST ITL 2 2008 standards.

Suggestions for the improvement of this standard are welcome. They should be sent to the attention of

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> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note that this change is to specifically reference forensics in the document.

Data Format for the Interchange of Biometric and Forensic Information

1 Introduction

1.1 Previous versions of the Standard

The first version of this standard, ANSI/NBS ICST 1 1986, was published by NIST (formerly the National Bureau of Standards) in 1986. It was a minutiae based standard. Revisions to the standard were made in 1993, 1997, 2000, and 2007. Updates to the standard are designed to be backward compatible, with new versions including additional information. All of these versions use "Traditional" encoding.

In 2008, 'NIEM[1] conformant encoding" using Extensible Markup Language (XML) was developed. The 2007 and 2008 versions of the standard are equivalent except for the encoding format.

In 2009 a minor supplement to the 2007 and 2008 versions was approved that extended encodings to handle multiple finger capture.

1.2 Summary of Changes for this Version of the Standard

With the additional content included in the standard over the years, its name has been changed to reflect that content. Thus, in order to reflect more properly the content of the standard, its name, beginning with this version, is changed to: *"Data Format for the Interchange of Biometric and Forensic Information."*

The 2011 version results from a workshop held in July 2010 at NIST. The following summarizes the principal changes reflected in this version:

1) Merging of Parts 1 and 2 of the Standard into a content based standard, with instructions for encoding contained in separate documents external to the standard.

2) Addition of a Record Type 18 for Deoxyribonucleic acid (DNA).

3) Modifications to the Facial records, including:

* Separation of Type-10 records - facial or scars, marks, tattoos (SMT) image records - into Type-11 (face) and Type-12 (SMT) record types, with retention of Type-10; and,

* Addition of forensic-oriented data fields, including anthropometric markup points; and,

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- [1] NIEM, the National Information Exchange Model, is a partnership of the U.S. Department of Justice and Department of Homeland Security. It is designed to provide a common semantic approach in XML applications.

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 * Inclusion of the NCIC codes[2] as tables in the Record Type description.

4)   Modifications to Type 9 (friction ridge minutiae) records, including:

    * Inclusion of the Extended Feature Set (EFS) for friction ridge data;

    * Addition of a field to contain Universal Latent Workstation annotations;

    * Extension of palmprint characterization to include 'grasp'; and,

    * Deprecation of the 'original' minutiae encoding format.

5)   Updates to the iris record including:

    * Additional rectilinear formats; and,

    * Forensic iris markup data.

6)   Deprecation of Record Type-3 (Low-resolution grayscale fingerprint image), Record Type-5 (Low-resolution binary fingerprint image), and Record Type 6 (High-resolution binary fingerprint image). Field 10.021 (POA) is deprecated in favor of Field 10.025.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note explanation of deprecation as a footnote

7)   Addition of encoding for plantars as Record Type 19.

8)   Addition of the Type-20 record to handle original images.

9)   Addition of new fields for most record types:

    * Geographic location reference for sample collection;

    * A hash of the image data; and,

    * A pointer to the original record image.

10)   Addition of Record Type 98 for Information Assurance Checking.

11)   Making the Domain Name in Record Type-1 mandatory for all new implementations of the standard.

2 Scope, purpose, and conformance

2.1   Scope

This standard defines the content, format, and units of measurement for the exchange of fingerprint, palmprint, plantar, facial/mugshot, scar mark & tattoo (SMT), iris, DNA, and other biometric sample and forensic information that may be used in the identification or verification process of a subject. The information

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Additional mention of forensics

•   [2] The Federal Bureau of Investigation (FBI) established the National Crime Information Center (NCIC). It has a computerized index of criminal justice information (i.e.- criminal record history information, fugitives, stolen properties, missing persons). NCIC codes are standardized to ensure consistency in data entry and retrieval.

•   [3] Deprecation means that the record type or field referenced is still allowed to be used but is discouraged from use.

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consists of a variety of mandatory and optional items. This information is primarily intended for interchange among criminal justice administrations or organizations that rely on automated identification systems or use other biometric and image data and/or forensic markups of image data for identification purposes.

Comment: Additional mention of forensics

2.2 Purpose

Information compiled and formatted in accordance with this standard may be recorded on machine-readable media or may be transmitted by data communication facilities. This information may have been gathered directly from a fingerprint scanner or from a variety of general or special-purpose devices such as iris cameras, DNA processing systems, general-purpose cameras, or flatbed scanners (such are used to capture paper fingerprint cards, latent fingerprint lifts or photographs, facial/mugshot, or other types of photographs). Law enforcement, criminal justice agencies, and other organizations that process biometric data use the standard to exchange DNA, fingerprint, palmprint, plantar, facial, iris, scar, marks and tattoo (SMT), and related biometric identification data, as well as forensic markups of images of faces, fingerprints and irises.

2.3 Conformance

Systems claiming conformance with this standard shall implement the transmitting and/or receiving of record types as defined by this standard according to the pre-established rules of an encoding format (see Section 3). Systems claiming conformance are not required to implement every record type specified herein. At a minimum, they must be capable of transmitting and receiving Type-1 records. However, in order for a transaction to be meaningful, there must be at least one additional type of record included (other than Record Type-2, which is optional). The implementer must document the record types supported in terms of transmitting and/or receiving. Those record types not implemented shall be ignored by the conforming system receiving a transaction.[4]

Comment: Clarification of wording

Comment: Clarification of wording

Comment: Conformance tools are referenced at the request of several persons. See the footnote.

3 Encodings of the Standard

All versions of the standard through 2007 use only the Traditional encoding. The 2008 version of the standard is equivalent to the 2007 version except that it describes the standard in NIEM-conformant XML encoding.

The encoding rules were incorporated directly into all previous versions of this standard. This version of the standard is solely content based. The rules and necessary files for the Traditional and NIEM-conformant encodings are posted at www.biometrics.nist.gov/standard but are not a part of this version of the standard itself. The standard does not now restrict encoding to any particular

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• [4] Some conformance assessment tools are available at www.biometrics.nist.gov/standard

format. However, in cases where an alternative encoding is used, the sending and receiving parties shall document encoding rules and assumptions. Rules for additional encodings may be posted at www.biometrics.nist.gov/standard with the consensus approval of the canvassees.

4 Transmitted data conventions

The following conventions apply to all encodings of the ANSI/NIST-ITL 1-2011 standard.

4.1 Friction Ridge Representation

Ridges in friction ridge images shall be represented as "dark ridges" on a light background, in either grayscale or binary image data.

4.2 Byte and bit ordering

Each information item, subfield, field, and record shall contain one or more bytes of data. Within a file, the order for transmission of both the ASCII and the binary representations of bytes shall be most significant byte first and least significant byte last otherwise referred to as Big-Endian format. Within a byte, the order of transmission shall be the most significant bit first and the least significant bit last. Figure 1 illustrates the order of transmission of the bytes and bits.
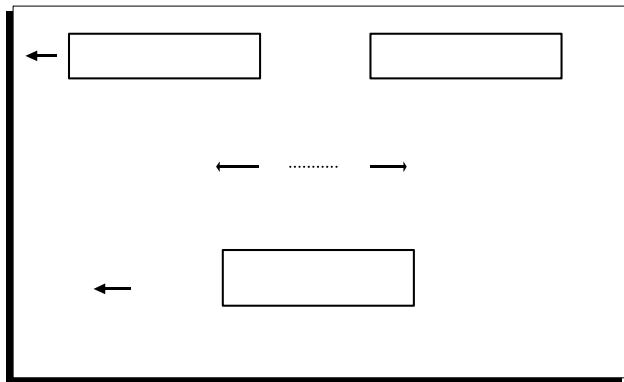
Figure 1 Byte and bit ordering

4.3 Grayscale data

Depending on the record type, grayscale image data may be transmitted in either compressed or uncompressed form. The transmission of uncompressed

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Brad Wing 6/25/10 11:52 AM
Comment: Explanation of encoding content. Note that this is now the extent of encoding references in the document itself. "Traditional" is used to refer to the encoding used in the original versions of the standard (up through 2007) and included here by reference. In the body of the standard, short names and long names have been eliminated, so as to further ensure that the standard is content based. Short-tag encoding is not specifically mentioned. The canvassees will vote on whether to post encoding rules for that format as an action separate from the content of the standard itself.

Brad Wing 6/19/10 5:07 PM
Comment: Note reordering within this section

Brad Wing 6/19/10 5:07 PM
Comment: Introductory sentence added.

grayscale images shall consist of pixels, each of which shall normally be quantized to eight bits (256 gray levels) and held in a single unsigned byte. Increased precision for pixel values greater than 255 shall use two unsigned bytes to hold sixteen-bit pixels with values in the range of 0-65535. For grayscale data, a true black pixel shall be represented by a zero. A true white pixel shall have all of its bits of precision set to "1". Therefore, true white pixels quantized to eight bits shall have a value of "255", while a value of "1023" shall be used for pixels quantized to ten bits. As explained in Section 4.2, grayscale values requiring less than 8 or 16 bits are expressed as one or two bytes, right justified and zero padded on the left.

The transmission of compressed grayscale images shall be the output of the appropriate grayscale compression algorithm specified. Upon reconstruction of a compressed image the grayscale value for each pixel shall be the same (for lossless algorithms) or nearly the same (for lossy algorithms) as pixels in an uncompressed image. Grayscale images are required for Record Type 4.

4.4 Binary data

Binary image data may be transmitted in either compressed or uncompressed form[5]. The transmission of uncompressed binary images shall consist of pixels, each of which shall be quantized to one of two levels (binary representation). A value of zero shall be used to represent a white pixel and a value of one shall be used to represent a black pixel. For transmission of uncompressed binary images, eight pixels shall be left justifies and packed into a single unsigned byte. The most significant bit of the byte shall be the first of the eight pixels scanned.

4.5 Color data

It is assumed that the scanned images consist of nominal 24 to 48-bit RGB pixels for color facial, SMT, iris, or user-defined testing images. Color image data may be transmitted in either compressed or uncompressed form. The transmission of uncompressed color images shall consist of RGB pixels, each component of which shall be quantized to at least 256 levels (8 bits). For each pixel, the three components shall be sequentially formatted for transmission on a pixel-by-pixel basis. Most identifying characteristics of the iris are revealed under infared illumination and are typically captured under grayscale images.

Table 1 lists the codes and their descriptions for each of the available color spaces used within this standard. All other color spaces are to be marked as undefined.

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[5] In NIEM-conformant encoding, binary image data is converted to ASCII for transmission using Base64 encoding. A description of Base64 encoding is available at www.biometrics.nist.gov/standard

Brad Wing 6/19/10 5:07 PM
Comment: Note removal of references to deprecated record types.

Brad Wing 6/19/10 5:07 PM
Comment: Note new footnote and the move of Annex C in 1-2008 to an external document.

Brad Wing 6/19/10 5:07 PM
Comment: Note reordering of the sections to group all color information together.

Table 1 Color spaces

Code	Description
UNK	Undefined
GRAY	Grayscale (monochrome)
RGB	Undetermined color space for an RGB image
SRGB	sRGB (IEC 61966-2-1)
YCC	YCbCr (legacy)
SYCC	YCbCr (JPEG 2000 compressed)

4.5.1 Backwards compatibility of color space

In versions of this standard prior to 2007, the term "color space" referred to device-dependent color information with a particular sequence and range for the three color channels. The choice was either RGB or an RGB-derivative space known as YCC. Neither space provides an objective definition of a particular color or relates to the way in which humans perceive color.

Although sRGB is the preferred color space for compressed images for this version, in the 2000 version of this standard, it was stated that "the preferred color space for compressed images using baseline JPEG and JFIF is YCbCr to be coded as 'YCC'," while the color space for uncompressed color images was to be labeled RGB. Therefore, for backwards compatibility purposes, new systems shall accommodate JPEG images that have been labeled as using the YCC color space. Specifically, systems conformant with this standard shall accept an entry of YCC and interpret it as meaning a (device-dependent) RGB color space.

4.5.2 Color space sRGB

To ensure that color images exchanged between differing systems can be correctly displayed or printed, images should be converted to the device-independent color space, sRGB[6], before compression or transmission to another system. As defined by IEC 61966-2-1, sRGB is a non-linear display profile that accommodates the voltage-to-color response characteristics of most high quality

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[6] For information on sRGB, see http://www.w3.org/Graphics/Color/sRGB or many of the white papers available at http://www.color.org.

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CRT monitors. The colors of the red, green, and blue phosphors (primaries) and the white point setting of an sRGB-conformant monitor are specified in the IEC document.

The relationship between sRGB and a linear RGB space having the IEC-defined primaries and white point is as follows:

$$value_{sRGB} = \begin{cases} 12.92 value_{lin}, & \text{for } value_{lin} \leq 0.0031308 \\ 1.055 value_{lin}^{(1/2.4)} - 0.055, & \text{for } value_{lin} > 0.0031308 \end{cases}$$

where $value_{lin}$ is an R, G, or B value in linear RGB space

(with a range of 0 to 1) and $value_{sRGB}$ is the corresponding

R, G, or B value in non-linear $sRGB$ space (also with a

range of 0 to 1). To convert from/to the range of 0 to 255,

divide/multiply by 255.

Typically, modern digital cameras, desktop scanners, LCD monitors, and printers, although they do not inherently operate in sRGB space, are designed with circuitry or software to produce sRGB output or to accommodate sRGB as an input space. If an image acquisition device's color space is unknown, sRGB is usually a reasonable choice. If an acquisition device and its software cannot provide sRGB output, various color management products are available commercially that use its color profile, often available from its manufacturer, to convert images in its native color space to sRGB.

4.6   Compression algorithms

Compressed image data shall adhere to the requirements of the algorithm used. Table 2 lists the binary (shown here in base 10 and used only in Record Type-4) and ASCII codes to be used for the available compression methods for encoding grayscale and color images described by this standard. The type of data being exchanged (fingerprint, face, etc.) limits the choice of compression algorithms. The description for each type of data exchange lists the legitimate compression algorithms that can be used for that type.

Brad Wing 6/19/10 5:07 PM
Comment: Note the removal of the section on binary compression algorithms since Record Types 3, 5, and 6 are deprecated.

Brad Wing 6/19/10 5:07 PM
Comment: Clarification that the first column is only applicable to Record Type-4.

Table 2 Grayscale & color image compression codes

Algorithm Name	Binary Code (In Base 10)	ASCII Code
Uncompressed	0	NONE

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WSQ Version 2.0	1	WSQ20
JPEG ISO/IEC 10918 (Lossy)	2	JPEGB
JPEG ISO/IEC 10918 (Lossless)	3	JPEGL
JPEG 2000 ISO/IEC 15444-1 (Lossy)	4	JP2
JPEG 2000 ISO/IEC 15444-1 (Lossless)	5	JP2L
Portable Network Graphics	6	PNG

The *"JPEGB"* algorithm indicates that the scanned or captured image was compressed using baseline JPEG. An entry of *"JPEGL"* indicates that the lossless mode of the JPEG algorithm was used to compress the image. If the image is captured in grayscale, then only the luminance component shall be compressed and transmitted. For JPEG, the data shall be formatted in accordance with the JPEG File Interchange Format, Version 1.02 (JFIF)[7].

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note the footnote. The JPEG descrption is no longer included as an Annex. It is available for reference at the website.

An entry of *"JP2"* indicates that the scanned or captured image was compressed using lossy JPEG 2000. (Conformance with ISO 15444-1 is provided through part 4 of the standard, ISO 15444-4 "Conformance Testing".) An entry of *"JP2L"* indicates that the lossless mode of the JPEG 2000 algorithm was used to compress the image.   For JPEG 2000, the data shall be formatted in conformance with JP2 format as described in ISO 15444-1.

Where JPEG 2000 is used for the compression of fingerprint images, specification/options contained in *Profile for 1000ppi Fingerprint Compression* shall apply. This reference addresses the 9 quality layers between 0.015 bpp and 0.55 bpp.

Where JPEG 2000 is used for compression of facial images, the following conditions shall apply:

Filters: The 9-7 irreversible filters described in ISO 15444-1 should be used for lossy mode; however for handheld devices (fixed point processors), the 5-3 reversible filters may be used instead. The 5-3 reversible filters shall be used for lossless mode. A conformant decoder shall be able to decode code streams created through both filters.

Number of resolution levels: The image shall be encoded using enough resolution levels to ensure that a thumbnail with max (width, height) <= 64 is

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[7] Developed by C-Cube Microsystems, 1778 McCarthy Blvd., Milpitas, CA 95035. A description of the File format is available at www.biometrics.nist.gov/standard

available in the image.   Example: a 640x480 image shall be encoded with 5 resolution levels, which enables sub-resolution decodes of 320x240, 160x120, 80x60, and 40x30.

Resolution as the dominant progression: JPEG 2000 allows five progression orders - LRCP, RLCP, RPCL, PCRL and CPRL. The RLCP progression order (resolution, layer, component, position) shall be used since it best facilitates decode and display of lower resolution derivative images by remote networked devices. Through the RLCP progression order, the code stream shall be formatted so that the resolution information of the image is the first data made available to a decoder in a streaming mode of operation.

Bits per channel: The number of bits per channel for encoders and decoders shall be 8-16 bits.

Single tile images: Facial images shall be encoded using only single tile to avoid tiling artifacts.

JPEG 2000 quality layers: The image shall be encoded using at least 10 quality layers to enable quality progressive decoding or sub-quality image extraction.

Region of Interest (ROI) Encoding is allowed: This encoding method is a useful way to compress a facial image to a small size, while retaining sufficient image quality within the specified ROI to perform either human or automated identification.
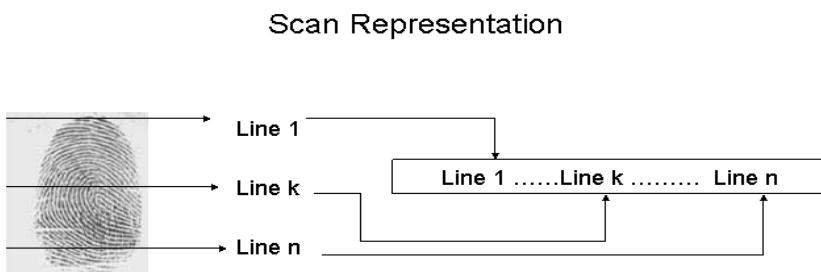
4.7   Scan sequence

Each image formatted in accordance with this standard shall appear to have been captured in an upright position and approximately centered horizontally in the field of view. The recorded image data shall appear to be the result of a scanning of a conventional inked impression of a friction ridge print or photo of a face or iris. This is also equivalent to a live-scan capture of the friction ridge print, or a camera capture of a face or iris. The scanning sequence (and recorded data) shall appear to have been from left-to-right, progressing from top-to-bottom of the fingerprint, plantar, palmprint, face, SMT, or iris. **Figure 2** illustrates the recording order for the scanned fingerprint image.

Brad Wing 6/19/10 5:07 PM
Comment: Wording change

For the purpose of describing the position of each pixel within an image to be exchanged, a pair of reference axes shall be used. The origin of the axes, pixel location (0,0), shall be located at the upper left-hand corner of each image. The x-coordinate (horizontal) position shall increase positively from the origin to the right side of the image.   The y-coordinate (vertical) position shall increase positively from the origin to the bottom of the image.

Figure 2 Order of the Scanned Image

Scan Representation

Note that the position or location of the scanning coordinates is not necessarily the same as the position or location of the minutiae coordinates for friction ridge data[8].

5 Image resolution requirements

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note new footnote

> **Comment:** This section has been substantially rewritten.

Image resolution requirements are applicable to fingerprint, palmprint, and plantar images. Facial, SMT, and iris images rely on the total number of pixels scanned and transmitted and are not dependent on the specific scanning resolution used.

5.1 Resolution accuracy requirement

All reported nominal resolutions either scanner or transmitting shall have a true resolution not varying more than 1% from the recorded value. For example a recorded scanning resolution of 500 has a lower true scanning resolution of 495, and a maximum of 505. The same holds true for transmitting resolution.

This requirement shall also apply to the scanner and transmitting resolution requirements throughout this document.

• [8] The deprecated standard format in Type 9 records of earlier versions of this standard used a coordinate system with (0,0) at the lower left corner of the image.

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5.2 Scanner resolution requirement

Friction ridge images to be exchanged shall be captured by an AFIS, live-scan reader, or other image capture devices operating at a nominal scanning resolution of at least 500 ppi.

Latent prints shall have a recorded scanning resolution of at least 1000 ppi.

The recommended migration path to higher scanning resolutions for image capturing devices with a native scanning resolution of 19.69 ppmm (500 ppi) shall be at a rate of 100% of the current native scanning resolution. The recommended migration path progresses from 19.69 ppmm to 39.37 ppmm (500 ppi to 1000 ppi), from 39.37 ppmm to 78.74 ppmm (1000 ppi to 2000 ppi), etc. Capture devices with native scanning resolutions not in step with this migration path are required to provide (through subsampling, scaling, or interpolating downward) an effective scanning resolution that matches the next lower interval in the migration path. For example a device with native scanning resolution of 47.24 ppmm (1200 ppi) is required to provide an effective resolution of 39.37 ppmm (1000 ppi).

5.3 Transmitting resolution requirement

Each image to be exchanged shall have a specific resolution associated with the transmitted data. This transmitting resolution does not have to be the same as the scanning resolution. However, the transmitting resolution shall be within the range of permissible resolution values for that record type. When an image is captured at a scanning resolution greater than the permissible upper limit of the transmitting resolution for that record type, the image shall be subsampled, scaled, or interpolated down. This processing to reduce the scanning resolution to a lower effective resolution must be performed before the transmission occurs. Processing to increase the resolution above scanning resolution is not permitted.

For Record Type-4, the transmitting resolution shall be the same as the minimum scanning resolution of 19.69 ppmm (500 ppi.) Any recorded transmitting resolution within the range of 19.69 ppmm (500 ppi) to 20.47 ppmm (520 ppi) is permitted for the processing of Type-4 records. If images are scanned at greater than 500 ppi and Record Type-4 is used, they must be transmitted at 500 ppi. Users are highly encouraged to use Record Type-14 for any images scanned at greater than 500 ppi.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note removal of references to deprecated records. Note that Type 4 is now REQUIRED to transmit at 500ppi as opposed to 'preferred'

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note the encouragement to use Record Type-14.

For variable-resolution images, the recorded transmitting resolution is not specified, but must be at least as great as 19.69 ppmm. There is no upper limit on the variable-resolution rate for transmission. However, the transmitting resolution shall not be greater than the scanning resolution.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note this new restriction.

The recommended migration path to higher transmitting resolutions is the same as for the scanning resolutions. That is, to progress from 19.69 ppmm to 39.37 ppmm (500 ppi to 1000 ppi), from 39.37 ppmm to 78.74 ppmm (1000 ppi to 2000 ppi), etc. For images captured at a native scanning resolution greater than the

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permissible upper limit of a transmitting resolution step in the migration path, it may be necessary to subsample, scale, or interpolate down. The result of this processing is to obtain an effective scanning resolution that conforms to a step in the transmission migration path.

The transmitting resolution shall be contained in fields specified by the format for the variable-resolution record. However, before transmitting variable-resolution records, the operational capabilities of the sending and receiving systems should be addressed, and prior agreement should be made with the recipient agency or organization before transmitting the image.

6   Transaction description

This standard defines the composition of a transaction that is transmitted to a remote site or agency. As specified in this standard, certain portions of the transaction shall be in accordance with definitions provided by the receiving agency. It shall contain one or more records each corresponding to one of the defined available types. The records are intended to convey specific types of related information pertinent to the transaction itself or to the subject of the transaction. All of the records belonging to a single transaction shall be .   **Table 3** Record Types 3, 5, and 6 are available in the 2007 and 2008 versions of this standard but are not explicitly described in this version of the standard.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note the exclusion of 3, 5 & 6 from the text of this version of the standard

Table 3   Record types

Record Identifier	record contents
1	Transaction information
2	User-defined descriptive text
3	Low-resolution grayscale fingerprint image (Deprecated)
4	High-resolution grayscale fingerprint image (for existing systems only) New applications are to use Record Type-14. Users are encouraged not to utilize.
5	Low-resolution binary fingerprint image (Deprecated)
6	High-resolution binary fingerprint image (Deprecated)

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note added wording for Record Types 4 and 7

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Record Identifier	record contents
7	User-defined image (for existing systems only) New applications are to use Record Type-13 for latent prints and Record Type-16 for test images. Users are encouraged not to utilize.
8	Signature image
9	Minutiae data
10	Facial or SMT image (for existing systems only) New applications are to use Record Type-11 for Facial Images and Record Type-12 for SMT images.
11	Facial image
12	SMT image
13	Variable-resolution latent friction ridge image
14	Variable-resolution fingerprint image
15	Variable-resolution palmprint Image
16	User-defined variable-resolution testing Image
17	Iris image
18	DNA data
19	Variable-resolution plantar image
20	Original Reference Image
21-97	Reserved for future use
98	Information assurance
99	CBEFF biometric data record

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** This wording is dependent upon approval of Record Types 11 & 12

The transaction shall contain one or more records pertaining to a single subject. The data in the Type-1 record shall always be recorded using the 7-bit American National Standard Code for Information Interchange (ASCII) as described in

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ANSI X3.4-1986. The text or character data in Type-2, Type-9, and records are normally recorded using the 7-bit ASCII code in variable-length fields with specified upper limits on the size of the fields. For data interchange between non-English speaking agencies, character sets other than 7-bit ASCII may be used in metadata. UTF-8 is the preferred method of storing textual data that cannot be represented as 7-bit ASCII. This method supports international character sets for all user-defined fields in all record types. By definition UTF-8 and other international character exchange methods are not applicable to Record Type-1 in all encodings.

7 Record type descriptions[9]

7.1 Type-1 Transaction information record

Transmissions to be exchanged are required to contain one and only one Type-1 record per transaction. A Type-1 record is mandatory and is required for each transaction. The Type-1 record shall always be the first record within the transaction. Depending on the usage and the number of fingerprint, palmprint, facial, SMT, DNA, plantar, iris, or other biometric information records available for processing, one or more additional records shall be present in the file. The Type-1 record shall provide information describing type and use or purpose for the transaction involved, a listing of each record included in the transaction, the originator or source of the physical record, and other useful and required information items. There is only one Type-1 record in each transaction.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Clarification

7.1.1 Implementation Domain (DOM)

An implementation domain[10], codified as Domain Name (DOM) in a Type-1 record, is a group of agencies or organizations that have agreed to use pre-assigned data fields with specific meanings (typically in Record Type-2) for exchanging information unique to their installations.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Revised wording

An example of an implementation domain is the one maintained by the Criminal Justice Information Services (CJIS) Division of the Federal Bureau of Investigation (FBI). It is the North American Domain subscribed to by the Royal Canadian Mounted Police (RCMP), the FBI, and several state and Federal agencies in North America.

- [9] Throughout this standard the terminology Record Type or record is used. It does not imply a separate file.

- [10] The "implementation domain" is not to be confused with the "Biometrics domain." The Biometrics domain is a namespace used in NIEM-conformant implementations of this standard.

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A change from earlier version of this standard is to make Domain Name (DOM) a mandatory field for all new implementations. Developers should be aware that historical implementations may not contain the DOM field[11].

7.1.2   Image designation character (IDC)

With the exception of the Type-1 record, each of the remaining records present in a transaction shall include a separate field containing the Image designation character (IDC). IDC references are established in Type-1 Field File Content (CNT). The IDC shall be used to relate information items in the CNT field of the Type-1 record to the other records in the transaction, and to properly identify and link together records that pertain to the same entity such as a particular finger or face. Thus, each instance of a record type, other than the Type-1 record, shall contain an IDC field. The value of the IDC shall be a sequentially assigned a positive integer starting from zero and incremented by one. If two or more records that are different representations of the same subject matter are present in a transaction, each of those records shall contain the same IDC. For example, a Type-14 image record of a specific fingerprint and the corresponding Type-9 minutiae record for the same finger would carry the same IDC number. Each record (including multiple occurrences of a Type) following Type-1 contains an IDC reference.

Note that the IDC serves a different purpose than the Original Image Record (OIV) value. (See Section 7.15.1) The OIV does not appear in Record Type-1.

Although there is no upper limit on the number of records that may be present in a file, generally a minimum of two will be present in a file. For example, a tenprint search inquiry transaction may consist of a Type-1 record, a Type-2 record, 14 Type-14 grayscale image records, two Type-8 signature records, six Type-15 palmprint records, and a Type-10 facial/mugshot image of the subject. Additional mugshot, SMT, iris, or other biometric records may expand the file even more. For this file configuration, the IDC shall range from "0" to "Max number of records minus one" which would include an IDC code for the Type-2 record. Within the same file, multiple record types may be present and represent the same image. For example, if core and delta location information for the rolled impressions is requested, the transmission may also need to accommodate ten minutiae records within the same file. For each image representing the ten finger positions, the same IDC would be used in both the image and minutiae records.

7.2   Type-2 User-defined descriptive text record

Type-2 records shall contain user-defined textual fields providing identification and descriptive information associated with the subject of the transaction. Each

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[11] Note that there is no formal central registry of implementation domains

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Comments:

Brad Wing 6/19/10 5:07 PM
Comment: Note reference to the website now in the footnote

Brad Wing 6/19/10 5:07 PM
Comment: Wording change

Brad Wing 6/19/10 5:07 PM
Comment: Revised wording to reflect Type-14 specifically.

Brad Wing 6/19/10 5:07 PM
Comment: New text

Brad Wing 6/19/10 5:07 PM
Comment: Wording change

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entry in a Type-2 record for a particular implementation domain shall have a definition and format that is listed with the Domain owner.

Data contained in this record shall conform in format and content to the specifications of the domain name as listed in Domain Name field found in the Type-1 record. A DOM reference therefore uniquely identifies data contents and formats. Each domain shall have a point of contact responsible for maintaining this list. The contact shall serve as a registrar and maintain a repository including documentation for all of its common and user specific Type 2 data fields. As additional fields are required by specific agencies for their own applications, new field tag numbers and definitions can be registered and reserved to have a specific meaning. When this occurs, the domain registrar is responsible for registering a single definition for each number used by different members of the domain. There be more than one Type-2 record per transaction.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Clarification

7.3 Type 4 fingerprint image records (Users are encouraged not to utilize)

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Note that descriptions of type 3,5 & 6 are removed.

Friction ridge images to be exchanged using Type-4 records shall be captured by an AFIS, live-scan reader, or other image capture devices operating at a nominal scanning resolution of 500 ppi.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Note that this changes the language from 'at least 500' to '500'

There may be multiple fingerprint images in a transaction; for example: ten rolled impressions of the individual fingers, two plain impressions of the thumbs, and two simultaneously obtained plain impressions of the four remaining fingers on each hand. Each image requires a separate Type-4 record.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Changes in wording in this paragraph to make intent clearer.

When the image data is obtained from a live-scan reader, it shall be the grayscale (or subsampled, scaled down, or interpolated output) of the live-scan fingerprint scanner and not a rescan of a hard copy fingerprint image.

Type-4 records shall contain and be used to exchange grayscale fingerprint image data For Record Type-4, the transmitting resolution shall be the same as the minimum scanning resolution of 19.69 ppmm (500 ppi.) Any recorded transmitting resolution within the range of 19.69 ppmm (500 ppi) to 20.47 ppmm (520 ppi) is permitted for the processing of Type-4 records.

New applications should use Type 14 records instead of Type 4 in order to transmit relevant metadata with the image.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Change to eliminate references to deprecated record types.

7.4 Type 7 User-defined image record (Users are encouraged not to utilize)

Type-7 records shall contain user-defined image data. This record type was designed for the exchange of binary image data that was not specified or

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Should this record type be DEPRECATED? (and thus removed)

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described elsewhere in this standard. It was intended as a temporary measure to enable the exchange of image data that would be defined by specific record types in later versions of the standard. Type-7 has often been used for the exchange of latent friction ridge data. However, users are encouraged to use Type-13 records for the exchange of latent friction ridge images. Type-16 is the version of this record for transfer of experimental, test or developmental data.

With the exception of the record length and IDC fields, the format, parameters, and types of images to be exchanged are undefined by this standard. These levels of required details shall be agreed upon between the sender and recipient. There may be multiple Type-7 records in a transaction. This record type shall not be used for new applications.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** New wording here.

7.5   Type 8 Signature image record

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Should this Record-Type be DEPRECATED?

Type-8 records shall contain and be used to exchange scanned binary or vectored signature image data. If scanned, the resolution of the image data shall be no less than the minimum scanning resolution of 500 ppi. If necessary, the scanned image data shall be subsampled, scaled down, or interpolated to fall within the limits of the transmitting resolution requirement. The resultant transmitting resolution shall be within 500ppi to 520 ppi. Vectored signature data shall be expressed as a series of binary numbers.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Specific wording used to clarify values. SHOULD this be expanded to allow 1000 ppi or greater?

There may be up to two of these Type-8 signature records in a file. Each Type-8 record shall contain image data representing the signature of the operator capturing biometric data.

7.6   Type-9 Minutiae data record

Type-9 records shall contain and be used to exchange minutiae or other friction ridge feature data derived from a fingerprint, palm, or plantar image. Uses may include, but are not limited to, fully automated searches of friction ridge matching systems, human-initiated searches of automated friction ridge matching systems, information exchange between human examiners, or definitions of information content of friction ridge images. The Extended Feature Set (EFS) is introduced to Type-9 in this version of the standard. It allows users to specify additional minutiae characteristics, as well as other features of a friction ridge print.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Revised wording to make clearer.

Each record shall represent the processed image data from which the location and orientation descriptors of extracted minutiae characteristics are listed. The primary use of this record type shall be for remote searching of latent prints. There may be multiple Type-9 records in a transaction.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Clarification

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7.7   Type-10 Facial or SMT; Type 11 Facial; and Type 12 SMT image

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Combining descriptions together.

Type-10 image records shall contain and be used to exchange facial and other image data from scars, marks, and tattoos (SMT) together with textual and forensic information pertinent to the digitized image. The source of the image data shall be the image captured from scanning a photograph, a live image captured with a digital camera, or a digitized "freeze-frame" from a video camera. There may be multiple Type-10, Type-11, and Type-12 records in a transaction. Although traditional implementations have used the Type 10 record for expressing both face and SMT images, newer applications must use the Type 11 for faces and the Type 12 for SMTs.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Added reference to forensics

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Revised wording in this sentence.

7.8   Type-13 Variable-resolution latent image record

Type-13 image records shall contain and be used to exchange variable-resolution latent friction ridge image data (fingerprint, palmprint and/or plantar) together with fixed and user-defined textual information fields pertinent to the digitized image. In all cases, the minimum scanning resolution (or effective scanning resolution) and transmission rate for latent images shall be 39.37 ppmm plus or minus 0.40 ppmm (1000 ppi plus or minus 10 ppi). The variable-resolution latent image data contained in the Type-13 record shall be uncompressed or may be the output from a lossless compression algorithm. There is no limit on the number of latent records that may be present in a transaction.

7.9   Type-14 Variable-resolution fingerprint image record

Type-14 image records shall contain and be used to exchange variable-resolution rolled fingerprint image or flat fingerprint data. Fixed and user-defined textual information fields pertinent to the digitized image may also be included.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Revised wording

The scanning resolution is not specified for this record type. While the Type-14 record may be used for the exchange of 19.69 ppmm (500 ppi) images, it is strongly recommended that the minimum scanning resolution (or effective scanning resolution) for fingerprint images be 39.37 ppmm plus or minus 0.40 ppmm (1000 ppi plus or minus 10 ppi). It should be noted that as the resolution is increased, more detailed ridge and structure information becomes available in the image. However, in all cases the scanning resolution used to capture a fingerprint image shall be at least as great as the minimum scanning resolution of 19.69 ppmm (500 ppi).

The variable-resolution fingerprint image data contained in the Type-14 record may be in a compressed form. In major case prints, there may be up to 78 images: each of the ten fingers may contain a rolled tip image and either one entire joint image or one full finger rolled image and left, center, and right full finger plain impressions.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Change of number to 78 with accompanying description.

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7.10 Type-15 Variable-resolution palmprint image record

Type-15 image records shall contain and be used to exchange variable-resolution palmprint image data together with fixed and user-defined textual information fields pertinent to the digitized image.

The scanning resolution is not specified for this record type. While the Type-15 record may be used for the exchange of 19.69 ppmm (500 ppi) images, it is strongly recommended that the minimum scanning resolution (or effective scanning resolution) for palmprint images be 39.37 ppmm plus or minus 0.40 ppmm (1000 ppi plus or minus 10 ppi). It should be noted that as the resolution is increased, more detailed ridge and structure information becomes available in the image. However, in all cases the scanning resolution used to capture a palmprint image shall be at least as great as the minimum scanning resolution of 19.69 ppmm (500 ppi).

The variable-resolution palmprint image data contained in the Type-15 record may be in a compressed form. Different combinations may include: two writer's palms to pair with two full palmprints; a writer's palm with an upper and lower palm from each hand; or a writer's palm with the thenar, hypothenar and interdigital areas, as well as grasp from each hand.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Inclusion of reference to grasp here.

7.11 Type-16 User-defined variable-resolution testing image record

The Type-16 image record is designed for developmental purposes and for the exchange of miscellaneous images. This record shall contain and be used to exchange image data together with textual information fields pertinent to the digitized image. Such an image is usually not elsewhere specified or described in this Standard.

The variable-resolution image data contained in the Type-16 record may be in a compressed form. With the exception of the tagged fields at the start of the record and the descriptors for the image data, the remaining details of the Type-16 record are undefined by this standard and shall be agreed upon between the sender and recipient.

7.12 Type-17 Iris image record

Type-17 image records shall contain and be used to exchange iris image data. This record type was developed to provide a basic level of interoperability and harmonization with the ANSI INCITS 379-2004 Iris Image Interchange Format and the ISO/IEC 19794-6 Iris Image Data Interchange Format. It also contains optional forensic descriptive data fields. Generic iris images may be exchanged using the mandatory fields of this record type. The Type-17 record encompasses the rectilinear image storage format that may be a raw uncompressed array of

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Inclusion of reference to iris forensics.

intensity values or a compressed format of the raw data.[12] The polar image format is still deprecated, as it was in the earlier versions of this standard.

7.13 Type-18 DNA data record

This record includes the capability to encode DNA data

The Type-18 record shall contain and be used to exchange DNA data. It was developed to provide a level of interoperability with the draft format of the ISO/IEC 19794-14 DNA data interchange format. Generic DNA data may be exchanged using the mandatory elements of this record type. Optional elements may also be used to exchange additional information.

7.14 Type-19 Plantar image record

Type-19 image records shall contain and be used to exchange variable-resolution plantar print image data together with fixed and user-defined textual information fields pertinent to the digitized image.

The scanning resolution is not specified for this record type. While the Type-19 record may be used for the exchange of 19.69 ppmm (500 ppi) images, it is strongly recommended that the minimum scanning resolution (or effective scanning resolution) for plantar images be 39.37 ppmm plus or minus 0.40 ppmm (1000 ppi plus or minus 10 ppi). It should be noted that as the resolution is increased, more detailed ridge and structure information becomes available in the image. However, in all cases the scanning resolution used to capture a plantar image shall be at least as great as the minimum scanning resolution of 19.69 ppmm (500 ppi).

The variable-resolution plantar image data contained in the Type-19 record may be in a compressed form.

7.15 Type 20 Original image record

Type 20 image records shall contain original images used to transmit an image that was prepared for submission in other Record Types. Several Record 20 instances may each contain an input used to generate the final image. This record type also includes logs of the type of data handling done in preparing the images transmitted in other record Types.

7.15.1 Type 20 Original image record value (OIV)

The OIR is specified for each original image (Type 20) record It contains two subfields. The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV. The second subfield is optional. It specifies the reference to the segmentation coordinates of the

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• [12]. As an update to the 2007 and 2008 version of the standard, this record also includes compact image formats shown to be efficient and reliable under the IREX study conducted by NIST.

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original image that is represented in this record type, which is a reference type value / RTV. Other Record Types with images include an optional field for OIV. This enables a cross reference of the image to be used biometrically and/or forensically with the original image and the log associated with how the image was processed to prepare it for the image Record Type.

7.16 Type- 98 Information assurance record

The Type-98 record shall contain security information that allows for the assurance of the authenticity and/or integrity of the transaction, including such information as binary data hashes, attributes for audit or identification purposes, and digital signatures.

7.17 Type-99 CBEFF biometric data record

Type-99 records shall contain and be used to exchange biometric data that is not supported by other ANSI/NIST-ITL lrecord types. This provides a basic level of interoperability and harmonization with the ANSI INCITS and other biometric interchange formats. This is accomplished by using a basic record structure that is conformant with ANSI INCITS 398-2005, the Common Biometric Exchange Formats Framework (CBEFF) and a biometric data block specification registered with the International Biometrics Industry Association (IBIA)[13]. This record type supports and is intended to be used for biometric data types or formats that are not already represented by an existing ANSI/NIST data type.

A CBEFF conformant Biometric Information Record (BIR) is made up of a Header, a Biometric Data Block (BDB), and an optional Signature Block. The Type-99 record does not include the Signature Block. Information required by the Header portion is encoded as tagged fields within the Type-99 record. The final tagged field of the Type-99 record will contain biometric data as specified by the BDB interchange format.

•   [13] For more information, go to <http://www.ibia.org>.

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8 Type-1 transaction information record

Record Type-1 is mandatory. Only one Type-1 record is present per transaction.
Shows the fields associated with this Record Type.

Table 4 Type-1 Transaction information record data

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	1.001		RECORD HEADER	1	1
VER	M	1.002	N	VERSION NUMBER	1	1
CNT	M	1.003		FILE CONTENT	2	Unlimited
FRC	M			FIRST RECORD CATEGORY	1	1
REC	M		N	RECORD CATEGORY CODE	1	1
CRC	M		N	CONTENT RECORD COUNT	1	1
ORC	C-CRC			OTHER RECORD CODES	CRC value	CRC value
REC	M		N	RECORD CATEGORY CODE	1	1
IDC	M		N	IMAGE DESIGNATION CHARACTER	1	1
TOT	M	1.004	A	TYPE OF TRANSACTION	1	1
DAT	M	1.005	N	DATE	1	1
PRY	O	1.006	N	PRIORITY	0	1
DAI	M	1.007	AN	DESTINATION AGENCY IDENTIFIER	1	1
ORI	M	1.008	AN	ORIGINATING AGENCY IDENTIFIER	1	1
TCN	M	1.009	N	TRANSACTION CONTROL NUMBER	1	1
TCR	O	1.010	N	TRANSACTION CONTROL REFERENCE NUMBER	0	1
NSR	M	1.011	N	NATIVE SCANNING RESOLUTION	1	1
NTR	M	1.012	N	NOMINAL TRANSMITTING RESOLUTION	1	1
DOM	M	1.013	AN	DOMAIN NAME	1	1
DNM	M		AN	ORGANIZATION NAME	1	1
DVN	O		AN	DOMAIN VERSION NUMBER	0	1
GMT	O	1.014	AN	GREENWICH MEAN TIME	0	1
DCS	O	1.015		DIRECTORY OF CHARACTER SETS		
CSD	M			CHARACTER SET DEFINITION	1	Unlimited
CSI	M		N	CHARACTER SET INDEX	1	1

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Brad Wing 6/19/10 5:07 PM
Comment: Table reinserted per requests from commentators.

Brad Wing 6/19/10 5:07 PM
Comment: Notice change from N to AN in DIA and ORI

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
CSN	M		AN	CHARACTER SET NAME	1	1
CSV	O		AN	CHARACTER SET VERSION	0	1

Condition codes: M = Mandatory; O= Optional;

C-field number = Conditional upon the value of the field referenced.

8.1 Field 1.001 Record Header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Revised wording for Record Headers in each Record Type.

8.2 Field 1.002: Version number / VER

This mandatory four-character ASCII value shall be used to specify the current version number of the standard implemented by the software or system creating the file. The format of this field shall consist of four numeric characters. The first two characters shall specify the major version number. The last two characters shall be used to specify the minor revision number. This version of the standard has the entry "0500"

8.3 Field 1.003: File content / CNT

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Reformatted and some clarification

This mandatory field shall list and identify each of the records in the transaction by record type and its IDC value. It also specifies the order in which the remaining records shall appear in the file.

It shall consist of two or more subfields. Each subfield shall contain two information items describing a single record found in the current file.

- The first subfield (**first record category / FRC)** shall relate to this Type-1 Transaction record.

  o The first information item within this subfield (**record category code / REC)** shall be "1". This indicates that the first record in the transaction is a Type-1 record consisting of header information.

  o The second information item of this subfield (**content record count / CRC)** shall be the sum of the Type-2 through Type-99 records contained in this transaction. This number is also equal to the count of the remaining subfields of Field 1.003.

- Each of the remaining subfields of Field 1.003 (**other record codes / ORC)** each correspond to a single Type-2 through Type-99 record

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contained in the file. Two information items shall comprise each of these subfields.

- o The first information item (**record category code / REC),** with numbers chosen from Table 3 identifies the record type.

- o The second information item (**image designation character / IDC)** shall be a positive integer equal to or greater than zero. See Section 7.1.2 for a description of the IDC.

8.4 Field 1.004: Type of transaction / TOT

This mandatory field shall contain an identifier, which designates the type of transaction and subsequent processing that this file should be given. (Note: Type of Transaction shall be in accordance with definitions provided by the receiving agency.)[14]

8.5 Field 1.005: Date / DAT

This mandatory field shall contain the local date that the transaction was initiated. It includes the year (YYYY), month (MM) and day (DD) in that order. The specific format is dependent upon the encoding. Field 1.014 is used to enter date and time information based on Greenwich Mean Time.

8.6 Field 1.006: Priority / PRY

This optional field shall contain a single information character to designate the urgency with which a response is desired. The values shall range from "1" to "9", with "1" denoting the highest priority. The default value shall be defined by the agency receiving the transaction.

8.7 Field 1.007: Destination agency identifier / DAI

This mandatory field shall contain the identifier of the administration or organization designated to receive the transmission. The size and data content of this field shall be user-defined and in accordance with the receiving agency.

8.8 Field 1.008: Originating agency identifier / ORI

This mandatory field shall contain the identifier of the administration or organization originating the transaction. The size and data content of this field shall be user-defined and in accordance with the receiving agency.

- [14] Earler versions of this standard using Traditional encoding specifically restricted the character length of TOT. This restriction has been eliminated as a requirement of the standard. Rules for particular application profiles, such as the FBI's EBTS may restrict or specify the character length of TOT.

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Brad Wing 6/19/10 5:07 PM
Comment: Note the handling of the TOT length change with the footnote.

Brad Wing 6/19/10 5:07 PM
Comment: Re-worded for clarification

8.9 Field 1.009: Transaction control number / TCN

This mandatory field shall contain the transaction control number as assigned by the originating agency. A unique alphanumeric control number shall be assigned to each transaction. For any transaction that requires a response, the respondent shall refer to this number in communicating with the originating agency.

8.10 Field 1.010: Transaction control reference / TCR

This optional field shall be used for responses that refer to the TCN of a previous transaction involving an inquiry or other action that required a response.

8.11 Field 1.011: Native scanning resolution / NSR

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Substantially re-worded

This mandatory field shall shall be set to "00.00" if there are no Type-4 records in the transaction. When there are Type-4 records present, this field is used to specify the native scanning resolution of the friction ridge image capture device. This field shall contain five bytes specifying the resolution in pixels per millimeter. The resolution shall be expressed as two numeric characters followed by a decimal point and two more numeric characters. Therefore, images with scanning resolution greater than or equal to 2500 may not be transmitted using Record Type 4. Since Record Type-4 only allows a nominal transmitting resolution of 500ppi, down-sampling if the scanning resolution is greater than 500 ppi. Users are strongly encouraged to use Record Type-14 if scanning an image at greater than 500 ppi.

8.12 Field 1.012: Nominal transmitting resolution / NTR

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Substantially re-worded

This mandatory field shall be set to "00.00" if there are no Type-4 records in the transaction. When there are Type-4 records present, this field specifies the nominal transmitting resolution for the friction ridge image(s) being exchanged. This field shall contain five bytes specifying the transmitting resolution in pixels per millimeter. The transmitting resolution shall be within the range specified by the transmitting resolution requirement: 500ppi (19.69) to 520 ppi.

8.13 Field 1.013: Domain name / DOM

> Brad Wing 6/19/10 5:07 PM
> **Comment:** reformatting

This mandatory[15] field identifies the domain name for the user-defined Type-2 record implementation. The domain name may only appear once within a transaction. It shall consist of one or two information items.

- [15] This has been optional in previous versions of ANSI/NIST ITL standards. To ensure backward compatibility, programmers should allow for the possibility that this field may not be present. All new implementations of the standard shall contain a value for this field.

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    * The mandatory first information item (**organization name / DNM)** will uniquely identify the agency, entity, or implementation used for formatting the fields in the Type-2 record. The default value for the field shall be the North American Domain implementation (NORAM).

    * An optional second information item (**domain version number / DVN)** shall contain the unique version of the particular implementation, such as 7.02.

8.14 Field 1.014: Greenwich Mean Time / GMT

This optional field provides a mechanism for expressing the date and time in terms of universal Greenwich Mean Time (GMT) units. If used, the GMT field contains the universal date that will be in addition to the local date contained in Field 1.005 (DAT). Use of the GMT field eliminates local time inconsistencies encountered when a transaction and its response are transmitted between two places separated by several time zones. The GMT provides a universal date and 24-hour clock time independent of time zones. For the exact format of this item, see the relevant encoding documents at www.biometrics.nist.gov/standard. All encodings contain the following data:

- "YYYY" characters represent the year of the transaction
- "MM" characters shall be the tens and units values of the month
- "DD" characters shall be the tens and units values of the day of the month
- "HH" characters represent the hour
- "MM" the minute, and
- "SS" represents the second

The complete date shall not exceed the current date.

8.15 Field 1.015: Directory of character sets / DCS

This optional field is a directory or list of character sets other than 7-bit ASCII that may appear within this transaction.

This field shall contain one or more subfields (**character set definition / CSD)**, each with at least two information items and an optional third information item.

- The first information item in each subfield (**character set index / CSI)** is the three-character identifier for the character set index number that references an associated character set throughout the transaction file.

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> Brad Wing 6/19/10 5:07 PM
> **Comment:** reformatting and reference to the encoding document

> Brad Wing 6/19/10 5:07 PM
> **Comment:** reofrmatting

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- The second information item in each subfield (**character set name / CSN)** shall be the common name for the character set associated with that index number.

- The optional third information item (**character set version / CSV)** is the specific version of the character set used. In the case of the use of UTF-8, the third optional information item can be used to hold the specific version of the character set used with UTF-8, so that the display terminal can be switched to the correct font family.

Table 5 lists the reserved named character sets and their associated 3-character index numbers.

Table 5 Directory of character sets

Character set index	Character set name	Description
000	ASCII	7-bit English (Default)
001	ASCII	8-bit Latin
002	UNICODE	16-bit
003	UTF-8	8-bit
004-127	-------------	Reserved for ANSI/NIST future use
128-999	-------------	User-defined character sets

9 Type-2 user-defined descriptive text record

Type-2 records are optional, but when present, shall contain textual information relating to the subject of the transaction and shall be represented in an ASCII format. This record may include such information as the state or FBI numbers, physical characteristics, demographic data, and the subject's criminal history. Every transaction usually contains one or more Type-2 records which is dependent upon the entry in the Type-of-Transaction Field 1.004 (TOT).

Additional Type-2 records may be included in the file.

Table 6 Type 2 record data

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
	M	2.001		RECORD HEADER	1	1
IDC	M	2.002	N	IMAGE DESIGNATION CHARACTER	1	1
----	O	2.003 →		USER DEFINED FIELDS	0	Unlimited

Condition codes: M = Mandatory; O= Optional;

C-field number = Conditional upon the value of the field referenced.

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9.1   Fields for Type-2 records

The first two data fields of the Type-2 record are mandatory and defined by this standard. The remaining fields of the record(s) shall conform to the format, content, and requirements of the subscribed Domain Name (DOM) used by the agency to which the transmission is being sent.

9.1.1   Field 2.001: Record header

The content of this field depends upon the encoding chosen.   See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

9.1.2   Field 2.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-2 record as found in the file content (CNT) field of the Type-1 record.

9.1.3   Field 2.003 and above: User-defined fields

Individual fields required for given transaction types, including field size and content, shall conform to the specifications set forth by the agency to which the transmission is being sent.

10 Type-4 fingerprint image records

The Type-4 record is based on the use of a captured fingerprint image obtained using a scanning resolution that is at least as great as the minimal scanning resolution of 19.69 ppmm (500 ppi) and transmitted between 500 ppi and 520 ppi. Users are encouraged not to utilize Type-4 records, and are encouraged to utilize Type-14 records.

Record Type-4 does not contain fields for image hash, original image reference value, or geographic collection reference since the Traditional encoding for this record type is fixed in length and order.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** See section on transmission resolution

Table 7 Type 4 record data

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	4.001		RECORD HEADER	1	1
IDC	M	4.002	N	IMAGE DESIGNATION CHARACTER	1	1
IMP	M	4.003	N	IMPRESSION TYPE	1	1

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
FGP	M	4.004	N	FINGER POSITION	1	1
ISR	M	4.005	N	IMAGE SCANNING RESOLUTION	1	1
HLL	M	4.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	4.007	N	VERTICAL LINE LENGTH	1	1
GCA/BCA	M	4.008	N	COMPRESSION ALGORITHM	1	1
DATA	M	4.009	Binary or Base64	IMAGE DATA	1	1

Condition codes: M = Mandatory; O= Optional;

C-field number = Conditional upon the value of the field referenced.

10.1 Field 4.001: Record Header

The content of this field depends upon the encoding chosen.   See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

10.2 Field 4.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-4 record as found in the file content (CNT) field of the Type-1 record.

10.3 Field 4.003: Impression type / IMP

This mandatory field shall be selected from Table 8, describing the manner by which the fingerprint image information was obtained. (This table is referenced by other Record Types with friction ridge data, which is why non-fingerprint codes are included in it)

Table 8 Friction ridge impression types

Description	Code
Live-scan plain fingerprint	0
Live-scan rolled fingerprint	1
Nonlive-scan plain fingerprint	2
Nonlive-scan rolled fingerprint	3
Latent fingerprint impression	4
Latent fingerprint tracing	5
Latent fingerprint photo	6

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Latent fingerprint lift	7
Live-scan fingerprint vertical swipe	8
Live-scan palm	10
Nonlive-scan palm	11
Latent palm impression	12
Latent palm tracing	13
Latent palm photo	14
Latent palm lift	15
Live-scan optical contact plain fingerprint	20
Live-scan optical contact rolled fingerprint	21
Live-scan non-optical contact plain fingerprint	22
Live-scan non-optical contact rolled fingerprint	23
Live-scan optical contactless plain fingerprint	24
Live-scan optical contactless rolled fingerprint	25
Live-scan non-optical contactless plain fingerprint	26
Live-scan non-optical contactless rolled fingerprint	27
Other	28
Unknown	29

10.4 Field 4.004: Fingerprint generalized position / FGP

This mandatory field shall contain the decimal code number corresponding to the known or most probable finger position and shall be taken from **Table 9** (only finger numbers 0-14 apply to Type 4). **Table 9** also lists the maximum image width and length dimensions for each of the finger positions. This table includes finger position codes referenced by other Record Types in this standard. The code "0", for "Unknown Finger", shall be used to reference every finger position from one through ten.

Up to five additional finger positions may be referenced by entering the alternate finger positions using the same format.
references are to be used, the unused information items shall be filled with the binary equivalent of "255". That is, five information items are required in each record.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Reworded for clarity.

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Table 9 Friction ridge position code & image dimensions

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Note inclusion of palm and plantar in this table. Several persons asked to see them all together.

Finger position	Finger code	Max Width (mm)	(in)	Max Length (mm)	(in)
Unknown	0	40.6	1.6	38.1	1.5
Right thumb	1	40.6	1.6	38.1	1.5
Right index finger	2	40.6	1.6	38.1	1.5
Right middle finger	3	40.6	1.6	38.1	1.5
Right ring finger	4	40.6	1.6	38.1	1.5
Right little finger	5	40.6	1.6	38.1	1.5
Left thumb	6	40.6	1.6	38.1	1.5
Left index finger	7	40.6	1.6	38.1	1.5
Left middle finger	8	40.6	1.6	38.1	1.5
Left ring finger	9	40.6	1.6	38.1	1.5
Left little finger	10	40.6	1.6	38.1	1.5
Plain right thumb	11	25.4	1.0	76.2	3.0
Plain left thumb	12	25.4	1.0	76.2	3.0
Plain right four fingers	13	81.3	3.2	76.2	3.0
Plain left four fingers	14	81.3	3.2	76.2	3.0
Left & right thumbs	15	81.3	3.2	76.2	3.0
EJI or tip	19	114.3	4.5	127.0	5.0
Palm Position	**Palm code**	**Max Width (mm)**	**(in)**	**Max Height (mm)**	**(in)**
Unknown palm	20	139.7	5.5	203.2	8.0
Right full palm	21	139.7	5.5	203.2	8.0
Right writer's palm	22	44.5	1.8	127.0	5.0
Left full palm	23	139.7	5.5	203.2	8.0
Left writer's palm	24	44.5	1.8	127.0	5.0

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Right lower palm	25	139.7	5.5	139.7	5.5
Right upper palm	26	139.7	5.5	139.7	5.5
Left lower palm	27	139.7	5.5	139.7	5.5
Left upper palm	28	139.7	5.5	139.7	5.5
Right other	29	139.7	5.5	203.2	8.0
Left other	30	139.7	5.5	203.2	8.0
Right interdigital	31	139.7	5.5	76.2	3.0
Right thenar	32	76.2	3.0	114.3	4.5
Right hypothenar	33	76.2	3.0	114.3	4.5
Left interdigital	34	139.7	5.5	76.2	3.0
Left thenar	35	76.2	3.0	114.3	4.5
Left hypothenar	36	76.2	3.0	114.3	4.5
Right grasp	37	139.7	5.5	203.2	8.0
Left grasp	38	139.7	5.5	203.2	8.0
Plantar Position	**Plantar code**	**Max Width (mm)**	**(in)**	**Max Height (mm)**	**(in)**
Unknown sole	60	139.7	5.5	203.2	8.0
Sole – right foot	61	139.7	5.5	203.2	8.0
Sole – left foot	62	139.7	5.5	203.2	8.0
Unknown toe	63	139.7	5.5	203.2	8.0
Right big toe	64	44.5	1.8	127.0	5.0
Right second toe	65	44.5	1.8	127.0	5.0
Right middle toe	66	44.5	1.8	127.0	5.0
Right fourth toe	67	44.5	1.8	127.0	5.0
Right little toe	68	44.5	1.8	127.0	5.0
Left big toe	69	44.5	1.8	127.0	5.0
Left second toe	70	44.5	1.8	127.0	5.0
Left middle toe	71	44.5	1.8	127.0	5.0
Left fourth toe	72	44.5	1.8	127.0	5.0

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Left little toe	73	44.5	1.8	127.0	5.0
Front / ball of right foot	74	139.7	5.5	76.2	3.0
Back / heel of right foot	75	139.7	5.5	76.2	3.0
Front / ball of left foot	76	139.7	5.5	76.2	3.0
Back / heel of left foot	77	139.7	5.5	76.2	3.0

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Table 9 is *extended* with ***minimum*** dimensions for common 2 finger and 3 finger combinations[16]. Note that mobile devices can use the codes defined in the above table, as well as those presented below.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Footnote revised for clarity

Finger position	Finger code	Min Width (mm)	(in)	Min Length (mm)	(in)
2-Finger Combinations					
Right index/middle	40	40.6	1.6	38.1	1.5
Right middle/ring	41	40.6	1.6	38.1	1.5
Right ring/little	42	40.6	1.6	38.1	1.5
Left index/middle	43	40.6	1.6	38.1	1.5
Left middle/ring	44	40.6	1.6	38.1	1.5
Left ring/little	45	40.6	1.6	38.1	1.5
Right index/ Left index	46	40.6	1.6	38.1	1.5
3-Finger Combinations					
Right index/middle/ring	47	63.5	2.5	38.1	1.5
Right middle/ring/little	48	63.5	2.5	38.1	1.5
Left index/middle/ring	49	63.5	2.5	38.1	1.5
Left middle/ring/little	50	63.5	2.5	38.1	1.5

10.5 Field 4.005: Image scanning resolution /

This field is mandatory. It shall contain a value of "0" if the minimum scanning resolution of 500 ppi is used and a "1" if the native scanning resolution is used. The preferred transmitting resolution (500 ppi to 520 ppi) shall be the same as the minimum scanning resolution.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Revised for clarity on resolutions.

10.6 Field 4.006: Horizontal line length / HLL

This mandatory field shall be used to specify the number of pixels contained on a single horizontal line of the transmitted image.

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[16] No maximum dimensions are included, but there are practical maximum upper limits to the image size. The minimum areas for codes 42, 45, 48 and 50 *may* not be sufficient for practical use. The actual size will depend upon the equipment used.

It should be noted that codes 13 15 and 40 50 are for *simultaneous* 2 and 3 and 4 finger combinations.   The titles of the finger combinations are given from the thumb outwards (that is, left to right for the right hand and right to left for the left hand). Code 46 Right index / Left index means that the right index placed on the right portion of the imaging area and the left index on the left portion of that same imaging area.

10.7 Field 4.007: Vertical line length / VLL

This mandatory field shall be used to specify the number of horizontal lines contained in the transmitted image.

10.8 Field 4.008: Compression algorithm / CGA / BCA

This mandatory field shall be used to specify the type of compression algorithm used (if any). A zero denotes no compression. Otherwise, the contents shall be a number allocated to the particular compression technique used by the interchange parties. The specific code for each algorithm can be found in **Table 2** or from the domain registrar who will maintain a registry relating these numbers to the compression algorithms. The Wavelet Scalar Quantization (WSQ), or the JPEG 10918 standard algorithms are recommended for compressing the grayscale data at 500 ppi.

10.9 Field 4.009: Image data / DATA

Each pixel of the uncompressed grayscale image shall be quantized to eight bits (256 gray levels) contained in a single byte. For the exchange of an uncompressed binary image, eight pixels shall be left justified and packed into a single unsigned byte. The most significant bit of the byte shall be the first of the eight pixels scanned. If compression is used, the pixel data shall be compressed in accordance with the compression technique specified in the GCA / BCA field.

11 Type-7 user-defined image record

Type-7 records shall contain user-defined binary image information relating to the transaction submitted for processing. This record type was originally defined to handle miscellaneous images such as those pertaining to mugshots, latent prints, palmprints, wrists, toes, soles, etc. that were not addressed elsewhere in the early versions of this standard. Users are discouraged from utilizing this Record Type. For latent prints users should utilize Record Type-13. New implementations based on this standard shall use the Record Type-13 records for latent records, and other record types, as appropriate, for transmitting biometric and forensic images.

Images transmitted using Record Type-7 shall consist of scanned pixels that may be either binary or grayscale output. Each grayscale pixel value shall be expressed as an unsigned byte. A value of "0" shall be used to define a black pixel and an unsigned value of "255" shall be used to define a white pixel. For binary pixels, a value of "0" shall represent a white pixel and a value of "1" shall represent a black pixel. If compression is used, the algorithm shall be the same as that specified for Type-4 logical records.

Record Type-7 does not contain fields for image hash, original image reference value, or geographic collection reference since the Traditional encoding for this record type is fixed in length and order.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** Clarification of encouragement to use record type 13.

Table 10 Type 7 record data

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
	M	7.001		RECORD HEADER	1	1
IDC	M	7.002	N	IMAGE DESIGNATION CHARACTER	1	1
---	O	7.003 →		USER DEFINED FIELDS	0	Unlimited

Condition codes: M = Mandatory; O= Optional;

C-field number = Conditional upon the value of the field referenced.

11.1 Field 7.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

11.2 Field 7.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-7 logical record as found in the file content (CNT) field of the Type-1 record.

11.3 User-defined fields for Type-7 logical record

The remaining fields of the Type-7 logical record shall be user-defined. Individual fields required for a given transaction, such as field description, size, binary or grayscale nature of the data, and content shall conform to the specifications set forth by the agency to which the transmission is being sent.

12 Type-8 signature image record

Type-8 records shall contain either scanned or vectored signature data. Each Type-8 record shall cover an area of up to 1000 mm^2.

If scanned, the resolution shall be the minimum scanning resolution or the native scanning resolution, and the scan sequence shall be left to right and top to bottom. The scanned data shall be a binary representation quantized to two levels.

If vectored signature data is present, it shall be expressed as a series of binary numbers.

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Record Type-8 does not contain fields for image hash, original image reference value, or geographic collection reference since the Traditional encoding for this record type is fixed in length and order.

Note that a maximum of two signature image records are allowed per transaction.

Table 11 Type 8 record data

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
	M	8.001		RECORD HEADER	1	1
IDC	M	8.002	N	IMAGE DESIGNATION CHARACTER	1	1
SIG	M	8.003	N	SIGNATURE TYPE	1	1
SRT	M	8.004	N	SIGNATURE REPRESENTATION TYPE	1	1
ISR	M	8.005	N	IMAGE SCANNING RESOLUTION	1	1
HLL	M	8.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	8.007	N	VERTICAL LINE LENGTH	1	1
DATA	M	8.008	Binary or Base64	IMAGE DATA	1	1
HCV	C-SRT		N	HORIZONTAL COORDINATE VALUE		
VCV	C-SRT		N	VERTICAL COORDINATE VALUE		
PPV	C-SRT		N	PEN PRESSURE VALUE		

Condition codes: M = Mandatory; O= Optional;

C-field number = Conditional upon the value of the field referenced.

12.1 Field 8.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

12.2 Field 8.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-8 logical record as found in the file content (CNT) field of the Type-1 record.

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12.3 Field 8.003: Signature type / SIG

This mandatory field shall contain a "0" for the signature image of the subject, or a "1" for the signature image of the official processing the transaction.

12.4 Field 8.004: Signature representation type / SRT

This mandatory field shall be "0" if the image is scanned and not compressed, a binary "1" if the image is scanned and compressed, and "2" if the image is vector data.

12.5 Field 8.005: Image scanning resolution / ISR

This mandatory field shall contain a "0" if the minimum scanning resolution of 500 ppi is used and a "1" if the native scanning resolution (above 500 ppi) is used[17]. A value of "0" shall also be used if the image is vector data.

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Clarified wording

12.6 Field 8.006: Horizontal line length / HLL

This mandatory field shall be used to specify the number of pixels contained on a single horizontal line of the transmitted signature image. For vectored signature data, the value shall be zero.

12.7 Field 8.007: Vertical line length / VLL

This mandatory field shall be used to specify the number of horizontal lines contained in the transmitted signature image. For vectored signature data, the value shall be zero.

12.8 Field 8.008: Signature image data / DATA

This mandatory field shall contain uncompressed scanned image signature data, compressed scanned image signature data, or vectored image signature data. The entry contained in the SRT field shall indicate which form of the signature data is present.

Uncompressed scanned image data

If the SRT field contains the value of zero, then this field shall contain the uncompressed scanned binary image data for the signature. In uncompressed mode, the data shall be packed at eight pixels per byte.

Compressed scanned image data

If the SRT field contains the binary value of one, then this field shall contain the scanned binary image data for the signature in compressed form using the ANSI/EIA-538-1988 facsimile compression algorithm.

Vectored image data

> Brad Wing 6/19/10 5:07 PM
> **Comment:** Revised for clarity

•   [17] Scanning resolutions below 500 ppi shal not be used.

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If the SRT field contains the equivalent of the value of two, then this field shall contain a list of vectors that describes the pen position. Each of the entries is a subfield.

- The first subfield is a **horizontal coordinate value / HCV.**
- The second subfield is a **vertical coordinate value / VCV.**
- The third subfield is the **pen pressure value / PPV** of line segments within the signature.

Both the X (VHC) and Y (VVC) coordinates shall be expressed in units of .0254 mm (.001 inches) referenced from the bottom leftmost corner of the signature[18]. Positive values of X shall increase from left-to-right and positive values of Y shall increase from bottom-to-top.

The pen pressure (VPP) shall be a constant value until the next vector becomes active. A value or pressure of "0" shall represent a "pen-up" (or no pressure) condition. The value of "1" shall represent the least recordable pressure for a particular device, while "254" shall represent the maximum recordable pressure for that device. To denote the end of the vector list, "255" shall be inserted in this entry.

13 Type-9 minutiae data record

Type-9 records shall contain ASCII text describing minutiae and related information encoded from a finger, palm, or plantar image. There is no limit on the number of Type-9 records for a latent search transaction. The Type-9 record shall also be used to exchange minutiae and related information from latent friction ridge images between similar or different systems.

Minutiae information may be extracted and encoded in any of several different manners depending on the system that is used to scan an image, extract minutiae, and encode the minutiae template.

Each minutia shall be identified by an index number that is assigned to it. The numbering shall begin at "1" and be incremented by "1" for as many times as there are minutiae encountered. This allows each miniutia to be uniquely identified. The numbering of the minutiae shall be unordered.

As required, ridge counts shall be determined from each minutia in a fingerprint or palmprint to certain other neighboring minutiae. When this occurs, ridge counts between designated minutiae shall be associated with the applicable index numbers so as to ensure maintenance of the proper relationships.

Brad Wing 6/19/10 5:07 PM
Comment: Reworded

- [18] This is not the same coordinate system as described in Section4.7

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Reserved blocks, each consisting of several fields, are registered and allocated for use by specific vendors. As these blocks may contain proprietary information, no detailed information is provided regarding the content of these vendor-defined fields aside from the range of field numbers in this standard. For detailed information on each of these tagged fields, the vendor must be contacted. These alternative blocks of reserved fields allow vendors to encode minutiae data and any additional required characteristic or feature data in accordance with their own system's specific hardware and software configuration. **Table 12** identifies the vendor implementations and their assigned blocks of field numbers.

Record fields 126-150 correspond to the conventions defined and described originally by the ANSI INCITS 378-2004 standard. ANSI/INCITS has deprecated this standard and adopted the ISO standard for fingerprint minutia (ISO/IEC 19794-2). There is a direct correspondence between the original INCITS standard and the later ISO standard.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** This is an important distinction.

Record Fields 300-398 are the Extended Feature Set.

Field 399 is used for "universal latent" annotation information.

Record Type-9 does not contain fields for image hash, since it is not an image Record Type.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** New text

All fields of the Type-9 records shall be recorded as ASCII text. Although this record type can also be used to accommodate a variety of methods used by different AFIS vendors for encoding minutiae data according to their particular requirements, each vendor implementation must contain the first four fields described below. Fields corresponding to the M1-378 / ISO 19794-2 features, the Extended Feature Set and the Universal Latent annotation may be used with or without the fields associated with registered implementations.

> **Brad Wing 6/19/10 5:07 PM**
> **Comment:** New explanation

Table 12 Type 9 record data

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
	M	9.001		RECORD HEADER	1	1
IDC	M	9.002	N	IMAGE DESIGNATION CHARACTER	1	1
SIG	M	9.003	N	IMPRESSION TYPE	1	1
---	M	9.004 – 9.012		DEPRECATED See previous versions of this standard for their definitions.		
---	O	9.013 – 9.030		IAFIS FEATURES	User defined	User defined
---	O	9.031 –		COGENT SYSTEMS FEATURES	User	User

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
		9.055			defined	defined
---	O	9.056 – 9.099		MORPHOTRAK FEATURES	User defined	User defined
---	O	9.100 – 9.125		NEC FEATURES	User defined	User defined
See Section13.6	O	9.126 – 9.150	See Section13.6	M1-378 / ISO 19794-2 FEATURES		
---	O	9.151— 9.175		L1 / IDENTIX FEATURES	User defined	User defined
RSV	---	9.176 – 9.299		RESERVED FOR FUTURE DEFINITION		
See Section 13.7		9.300 – 9.399	See Section 13.7	EXTENDED FEATURE SET		
RSV	---	9.400 – 9.900		RESERVED FOR FUTURE DEFINITION		
LAI	O	9.901	AN	UNIVERSAL LATENT ANNOTATION	0	1

Condition codes: M = Mandatory; O= Optional;

C-field number = Conditional upon the value of the field referenced.

13.1 Field 9.001: Record header

The content of this field depends upon the encoding chosen.   See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

13.2 Field 9.002: Image designation character / IDC

The IDC contained in this field shall be the IDC of the Type-9 record as found in the file content (CNT) field of the Type-1 record.

13.3 Field 9.003: Impression type / IMP

This ASCII field shall describe the manner by which the fingerprint, plantar or palmprint image information was obtained. The ASCII value for the proper code as selected from Table 8 for friction ridge impressions shall be entered in this field to signify the impression type.

13.4 Fields 9.013 – 9.030: IAFIS Features

This set of fields is defined by the FBI. A full description is available at www.fbibiospecs.org

> Brad Wing 6/19/10 5:07 PM
> **Comment:** New description

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13.5 Fields 9.031 – 9.125: Registered vendor minutiae fields

See **Table 12** for the vendor names. The vendors define these fields.

13.6 Fields 9.126 – 9.150: M1-378 / ISO 19794-2 Minutia data

The following method shall be used for determining placement (location and angular direction) of individual minutia when using this data block.
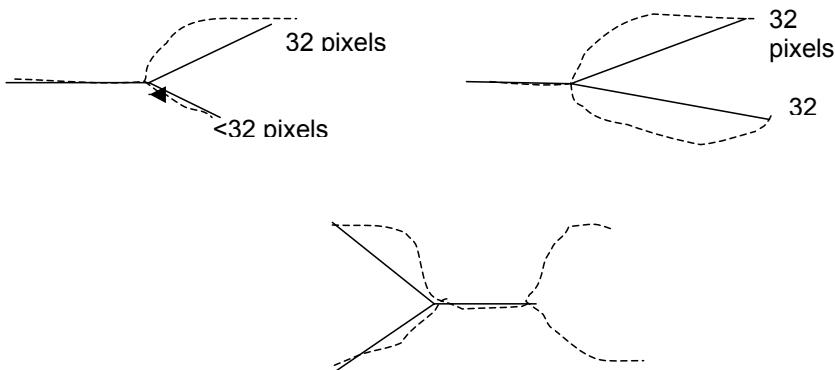
The position or location of a minutia representing a ridge ending shall be the point of forking of the medial skeleton of the valley area immediately in front of the ridge ending. If the three legs of the valley area were thinned down to a single-pixel-wide skeleton, the point of the intersection is the location of the minutia. Similarly, the location of the minutia for a bifurcation shall be the point of forking of the medial skeleton of the ridge. If the three legs of the ridge were each thinned down to a single-pixel-wide skeleton, the point where the three legs intersect is the location of the minutia.

After all ridge endings have been converted to bifurcations, all of the minutiae of the fingerprint image are represented as bifurcations.   The X and Y pixel coordinates of the intersection of the three legs of each minutia can be directly formatted. Determination of the minutia direction can be extracted from each skeleton bifurcation. The three legs of every skeleton bifurcation must be examined and the endpoint of each leg determined. **Figure 3** illustrates the three methods used for determining the end of a leg that is based on a scanning resolution of 500 ppi. The ending is established according to the event that occurs first. The pixel count is based on a scan resolution of 500 ppi. Different scan resolutions would imply different pixel counts.

- A distance of .064" (the 32nd pixel)
- The end of skeleton leg that occurs between a distance of .02" and .064" (the 10th through the 32nd pixels); shorter legs are not used
- A second bifurcation is encountered within a distance of .064" (before the 32nd pixel)

Figure 3 M1-378 / ISO 19794-2 Minutiae angle components

> Brad Wing 6/19/10 5:07 PM
> **Comment:** This information is moved up from the annex.

The angle of the minutiae is determined by constructing three virtual rays originating at the bifurcation point and extending to the end of each leg. The smallest of the three angles formed by the rays is bisected to indicate the minutiae direction.

The coordinate system used to express the minutiae of a fingerprint shall be a Cartesian coordinate system. Minutiae locations shall be represented by their x and y coordinates. The origin of the coordinate system shall be the upper left corner of the original image with x increasing to the right and y increasing downward. Both x and y coordinates of a minutiae shall be represented in pixel units from the origin

Angles are expressed in standard mathematical format, with zero degrees to the right and angles increasing in the counterclockwise direction. Recorded angles are in the direction pointing back along the ridge for a ridge ending and toward the center of the valley for a bifurcation

Note that when 'mandatory' is stated in sections 13.6.x it only applies when the block is encoded. It is not mandatory to include these fields if M1-378 / ISO 19794-2 format are not used.

Brad Wing 6/19/10 5:07 PM
Comment: Clarification added

Table 13 M1-378 / ISO 19794-2 Related Fields

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
CBI	M	9.126		CBEFF INFORMATION	1	1
CFO	M		N	CBEFF FORMAT TYPE	1	1
CFT	M		N	CBEFF PRODUCT IDENTIFIER	1	1

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count Min	Occur count Max
PID	M		N	CBEFF PRODUCT IDENTIFIER	1	1
CEI	M	9.127		CAPTURE EQUIPMENT ID	1	1
AFS	M		A	APPENDIX F STATUS	1	1
CEI	M			CAPTURE EQUIPMENT ID	1	1
HLL	M	9.128	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	9.129	N	VERTICAL LINE LENGTH	1	1
SLC	M	9.130	N	SCALE UNITS	1	1
HPS	M	9.131	N	HORIZONTAL PIXEL SCALE	1	1
VPS	M	9.132	N	VERTICAL PIXEL SCALE	1	1
FVW	M	9.133	N	FINGER VIEW	1	16
FPZ	M	9.134	N	FINGER POSITION	1	1
FQD	M	9.135		FINGER QUALITY DATA	1	1
FQV	M			FINGER QUALITY VALUE	1	Unlimited
PMP	M		N	PREDICTED MATCHING PERFORMANCE	1	1
QVI	M		N	VENDOR ID	1	1
NPC	M		N	NUMERIC PRODUCT CODE	1	1
NOM	M	9.136	N	NUMBER OF MINUTIAE	1	1
FMD	M	9.137		FINGER MINUTIAE DATA	1	1
FMV	M			FINGER MINUTIA VALUES	1	Unlimited
MAN	M		N	MINUTIA INDEX NUMBER	1	1
MXC	M		N	'X' COORDINATE	1	1
MYC	M		N	'Y' COORDINATE	1	1
MAV	M		N	MINUTIA ANGLE	1	1
MTY	M		AN	MINUTIA TYPE	1	1
QOM	M		N	QUALITY OF MINUTIA	1	1
RCI	O	9.138		RIDGE COUNT INFORMATION	0	1
RCM	M			RIDGE COUNT METHOD	1	1
REM	M		N	RIDGE COUNT EXTRACTION METHOD	1	1
FI1	M		N	FILLER 1	1	1
FI2	M		N	FILLER 2	1	1
RCD	M			RIDGE COUNT DATA	1	Unlimited

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
CMI	M		N	CENTER MINUTIA INDEX NUMBER	1	1
NMN	M		N	NEIGHBORING MINUTIA INDEX NUMBER	1	1
NRC	M		N	NUMBER OF RIDGES CROSSED	1	1
CIN	O			CORE INFORMATION	0	1
COD	M			CORE DATA	1	Unlimited
XCO	M		N	'X' COORDINATE	1	1
YCO	M		N	'Y' COORDINATE	1	1
AOC	M		N	ANGLE OF THE CORE	1	1
DIN	O			DELTA INFORMATION	0	1
DED	M			DELTA DATA	1	Unlimited
XCD	M		N	'X' COORDINATE	1	1
YCD	M		N	'Y' COORDINATE	1	1
AOD	M		N	ANGLE OF THE DELTA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

13.6.1 Field 9.126: 19794-2 CBEFF information / CBI

This mandatory field shall contain three information items.

• The first information item **(CBEFF Format Owner / CFO)** shall contain the value "27". This is the identification of the assigned by the International Biometric Industry Association (IBIA) to INCITS Technical Committee M1.

• The second information item **(CBEFF Format Type / CFT)** is assigned a value of "513" to indicate that this record contains only location and angular direction data without any Extended Data Block information. A value of "514" indicates the presence of extended data.

• The third information item **(CBEFF Product Identifier / PID)** identifies the "owner" of the encoding equipment. The vendor establishes this value. It can be obtained from the IBIA website (www.ibia.org) if it is posted.

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13.6.2 Field 9.127: 19794-2 Capture equipment identification / CEI.

This mandatory field shall contain two information items.

•   The first **(Appendix F status / AFS)** shall contain "APPF" if the equipment used originally to acquire the image was certified to conform with Appendix F (IAFIS Image Quality Specification, January 29, 1999) of CJIS-RS-0010, the Federal Bureau of Investigation's Electronic Fingerprint Transmission Specification. If the equipment did not conform it will contain the value of "NONE".

o   The second information item **(Capture Equipment ID / CEI)** shall contain the, which is a vendor-assigned product number of the capture equipment. A value of "0" indicates that the capture equipment ID is unreported.

13.6.3 Field 9.128: 19794-2 Horizontal line length /HLL

This mandatory ASCII field shall contain the number of pixels contained on a single horizontal line of the transmitted image. The maximum horizontal size is limited to 65,534 pixels.

13.6.4 Field 9.129: 19794-2 Vertical line length / VLL

This mandatory ASCII field shall contain the number of horizontal lines contained in the transmitted image. The maximum vertical size is limited to 65,534 pixels.

13.6.5 Field 9.130: 19794-2 Scale units / SLC

This mandatory ASCII field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

13.6.6 Field 9.131: 19794-2 Horizontal pixel scale / HPS

This mandatory ASCII field shall specify the integer pixel density used in the horizontal direction providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

13.6.7 Field 9.132: 19794-2 Vertical pixel scale / VPS

This mandatory ASCII field shall specify the integer pixel density used in the vertical direction providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

13.6.8 Field 9.133: 19794-2 Finger view / FVW

This mandatory field contains the view number of the finger associated with this record's data. The view number begins with "0" and increments by one to "15".

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13.6.9 Field 9.134: 19794-2 Finger position / FPZ

This mandatory field shall contain the code designating the finger position that produced the information in this Type-9 record. A code between 1 and 10 taken from **Table 9** shall be used to indicate the finger position.

13.6.10 Field 9.135: 19794-2 Finger Quality Data / FQD

This mandatory field shall contain the quality of the overall finger minutiae data. There may be multiple subfields (Finger Quality Value / FQV) for each algorithm and predictive performance measure. Each subfield shall contain three information items.

* The first information item **(predicted matching performance / PMP)** of the biometric sample contains the ASCII representation of the integer image quality score between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality. An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards.

* The second information item **(vendor ID / QVI)** is a 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

* The third information item **(numeric product code / NPC)** is assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but it is not required to be registered. It indicates which of the vendor's algorithms was used in the calculation of the quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65535.

13.6.11 Field 9.136: 19794-2 Number of Minutiae / NOM

The mandatory field shall contain a count of the number of minutiae recorded in this data block.

13.6.12 Field 9.137: 19794-2 Finger minutiae data / FMD

This mandatory field has six information items, each containing the details for a single minutia. The total number of minutiae subfields **(Finger minutia values / FMV)** must agree with the count found in field 136.

> • The first information item **(minutia index number / MAN)**, shall be initialized to "1" and incremented by "1" for each additional minutia in the fingerprint.

> • The second information item **('x' coordinate / MXC)** is expressed in pixel units.

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• The third information item **('y' coordinate / MYC)** is expressed in pixel units.

• The fourth information item **(minutia angle / MAV)** is recorded in units of two degrees. This value shall be nonnegative between 0 and 179.

• The fifth information **(minutia type / MTY)** has a value of "0" to represent a minutiae of type "OTHER", a value of "1" for a ridge ending and a value of "2" for a ridge bifurcation.

• The sixth information item **(quality of minutia / QOM)** shall range from 1 as a minimum to 100 as a maximum. A value of "0" indicates that no quality value is available.

13.6.13   Field 9.138: 19794-2 Ridge count information / RCI

This field shall consist of a series of subfields.

The first subfield **(ridge count method / RCM)** has three information items:

• The first information item **(ridge count extraction method / REM)** may have a value of 0,1 or 2. A "0" indicates that no assumption shall be made about the method used to extract ridge counts, nor their order in the record. A "1" indicates that for each center minutiae, ridge count data was extracted to the nearest neighboring minutiae in four quadrants, and ridge counts for each center minutia are listed together. A "2" indicates that for each center minutiae, ridge count data was extracted to the nearest neighboring minutiae in eight octants, and ridge counts for each center minutia are listed together.

• The remaining two information items **(Filler 1 / FI1 and Filler 2 / FI2)** of this first subfield shall each contain "0".

Subsequent subfields **(ridge count data / RCD)** have three information items each.

• The first information item **(center minutia index / CMI)** is a number

• The second information item **(neighboring minutia index / NMN)** is a number, and

• The third information **(number of ridges crossed / NRC)** is a number.

13.6.14 **Field 9**.139: 19794-2 Core information / CIN

This field will consist of one subfield **(core data / COD)** for each core present in the original image. Each subfield consists of three information items.

- The first item **('x' coordinate / XCO)** is in pixel units.

- The second item **('y' coordinate / YCO)** is in pixel units.

- The third information item **(angle of the core / AOC)** is recorded in units of 2 degrees. The value shall be a nonnegative value between 0 and 179.

13.6.15 **Field 9**.140: 19794-2 Delta information / DIN

This field will consist of one subfield **(delta data / DED)** for each delta present in the original image. Each subfield consists of three information items.

- The first item **('x' coordinate / XCD)** is in pixel units.

- The second item **('y' coordinate / YCD)** is in pixel units.

- The third information item **(angle of the delta / AOD)** is recorded in units of 2 degrees. The value shall be a nonnegative value between 0 and 179.

13.6.16 **Fields 9.**151 – 9.175 Registered vendor minutiae fields

See **Table 12** for the vendor names. The vendors define these fields.

13.7 Fields 9.300 – 9.398 Extended feature set fields

This data block defines the content, format, and units of measurement for the definition and/or exchange of friction ridge feature information that may be used in the identification of a subject based on fingerprint or palmprint image information. This information is intended for an individual examiner to define the content of a single impression or comparison of two impressions, as well as for interchange between criminal justice administrations or organizations that use fingerprints or palmprints for identification purposes.

The purpose of this specification is to define a quantifiable, repeatable, and clear method of characterizing the information content of a fingerprint or other friction ridge image.

13.7.1 Field 9 139: EFS Coordinate system

The relative position of all Extended Friction Ridge Features shall be expressed as positive integers in units of 10 micrometers (0.01 mm or 0.00039 in), with the

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origin in the top left of the Region Of Interest (see Section 0). In this coordinate system, values of X increase from left to right and values of Y increase from top to bottom. All positions must be in the range (0,0)-(ROI.width-1, ROI.height-1).

There are no specific maximum dimensions in the coordinate system, since dimensions are limited by the image dimensions. Note, however, that dimensions for a single impression will always fall well within an upper bound of 50 cm (19.7", or 50000 units).[19]

In all cases throughout this document in which specific distances are specified, the distances are stated in terms that correspond to an integer number of pixels at 500 pixels per inch, and the metric equivalents are rounded to two significant digits (0.01 mm).
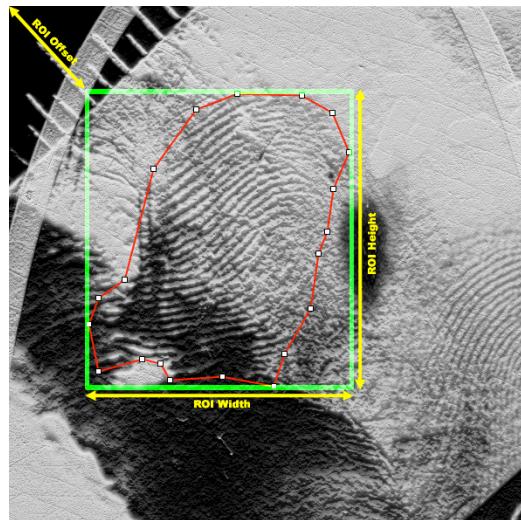
13.7.2 EFS Region of interest

Figure 4 is a single rectangle (including an optional polygon) that bounds the area of the original image containing a single friction ridge impression, and separates it from the background and any other friction ridge data present in the image. *All* other Extended Friction Ridge Features are in relation to the Region of Interest, *not* to the original image: all coordinates are relative to the top left corner of the ROI, and may not equal or exceed the width and height of the ROI.

When the ROI is a polygon, the ROI rectangle is simply a bounding box around that polygon: the ROI offset is defined as the minimum of the X and Y coordinates of all ROI vertices, and the ROI width and height are defined as the range (maximum – minimum) of the X and Y coordinates of all ROI vertices.

---
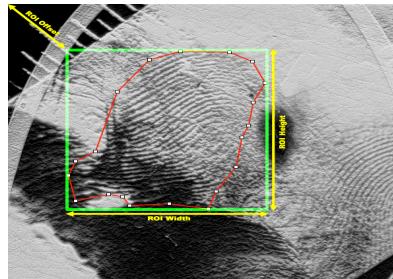
1.   [19] A 99th percentile adult male hand (wrist to fingertip) is 8.4" (213 mm) long; a 99th percentile adult male foot is 11.7" (298 mm) long. [A. R. Tilley, *The Measure of Man and Woman: Human Factors in Design, Revised Version*; Wiley; 2002] In extreme cases palms may be 32.4 cm long (12.75") and feet may be 47 cm long (18.5"). (e.g., Robert Pershing Wadlow [*Guinness Book of World Records Online*, www.guinnessworldrecords.com/])

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Figure 4:   EFS Region of interest

There can only be one region of interest for a given feature set. If there are multiple impressions within a single image, more than one feature set can be marked for the image, resulting in multiple Type-9 records associated with a single image, differentiated by the region of interest.

13.7.3 EFS Angles

All angles are measured in positive integer degrees counterclockwise from the right, from 0 to 359 degrees, as shown in **Figure 5**.

Figure 5:   EFS Measurement of angles

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13.7.4 EFS Paths and polygon

A path is an ordered set of 2 to 99 vertices. The order of the vertices must be in their consecutive order along the length of the path. No two vertices may occupy the same location. A path may not have any sides crossing. Each vertex is expressed as an (X, Y) pair of positive integers in units of 0.01 mm.

A closed path, or polygon, completes a circuit: the polygon side defined by the last vertex and the first vertex shall complete the polygon. A polygon must contain at least 3 vertices. Polygons are used in

> Field 9.300 Region of Interest / ROI

> Field 9.324 Distinctive Features / DIS

> Field 9.357 Local Quality Issues / LQI

An open path is a series of connected points in which there is not an implicit connection between the last and first vertices. Open paths are used in Field 9.357 Ridge Path Segments / RPS). Each path is stored as a single data entry, with a comma separating the X and Y coordinates for a given vertex, and a dash separating consecutive vertices. For example:

- `X1,Y1-X2,Y2-X3,Y3`

If multiple paths are present in the same field, they are separate subfields:

- `Subfield 1: X1,Y1-X2,Y2-X3,Y3`
- `Subfield 2: X4,Y4-X5,Y5-X6,Y6`

13.7.5 EFS Unknown, omitted or non-applicable values

Unknown, omitted, or non-applicable values are left empty in the Extended Friction Ridge Feature fields. If values are not known or are not applicable, a simple field without information items shall not be included in the file.

13.7.6 EFS No features present

The following fields are used in this specification to indicate whether the absence of a particular type of feature means that there are no instances of that type of field present, as opposed to simply not having been marked.

For example, if there are no cores included in **Field 9.320 Cores (COR)**, then **Field 9.325 No Cores Present (NCR)** would be set to "Y" if analysis determined that there were no cores discernable, but would have been omitted if analysis had not been conducted for cores.

Table 14:   EFS Correspondence of Features and Presence Fields

Feature fields	Presence Fields
EFS Field 9.320 Cores / COR	Field 9.325 No Cores Present (NCR)
EFS Field 9.321 Deltas / DEL	Field 9.326 No Deltas Present (NDL)
Field 9.324 Distinctive Features (DIS)	Field 9.327 No Distinctive Features Present (NDF)
Field 9.331 Minutiae (MIN)	Field 9.334 No Minutiae Present (NMP)
Field 9.340 Dots (DOT)	Field 9.346 No Dots Present (NDT)
Field 9.341 Incipient Ridges (INR)	Field 9.347 No Incipient Reidges Present (NIR)
Field 9.342 Creases and Linear Discontinuities (CLD)	Field 9.348 No Creaes Present (NCR)
Field 9.343 Ridge Edge Features (REF)	Field 9.349 No Ridge Edge Features Present (NRE) **13.9.30 EFS Field 9.349 No Ridge Edge Features Present / NRE**
Field 9.345 Pores (POR)	Field 9.344 No Pores Present (NPP)

If a "No <X> Present" field is included, it will be populated with a "Y" indicating the analysis of the image has positively determined that there are no instances of that feature present in the image. If the analysis has not been performed for that particular feature, or if the analysis has determined there are a number of those features present in the image, the "No <X> Present" field will be omitted from the transaction.

EFS Definitions of feature confidence and local quality

13.7.7 EFS Field 9.308 Ridge Quality/Confidence Map / RQM

This is an assessment of confidence in small local areas within an image. The local quality map is used to define the confidence in all other features, and therefore is key information. In addition, when the quality map indicates a high-quality region in which features are not marked, that information can be used as "negative features" or definitive absence of features, which can be used for exclusion.

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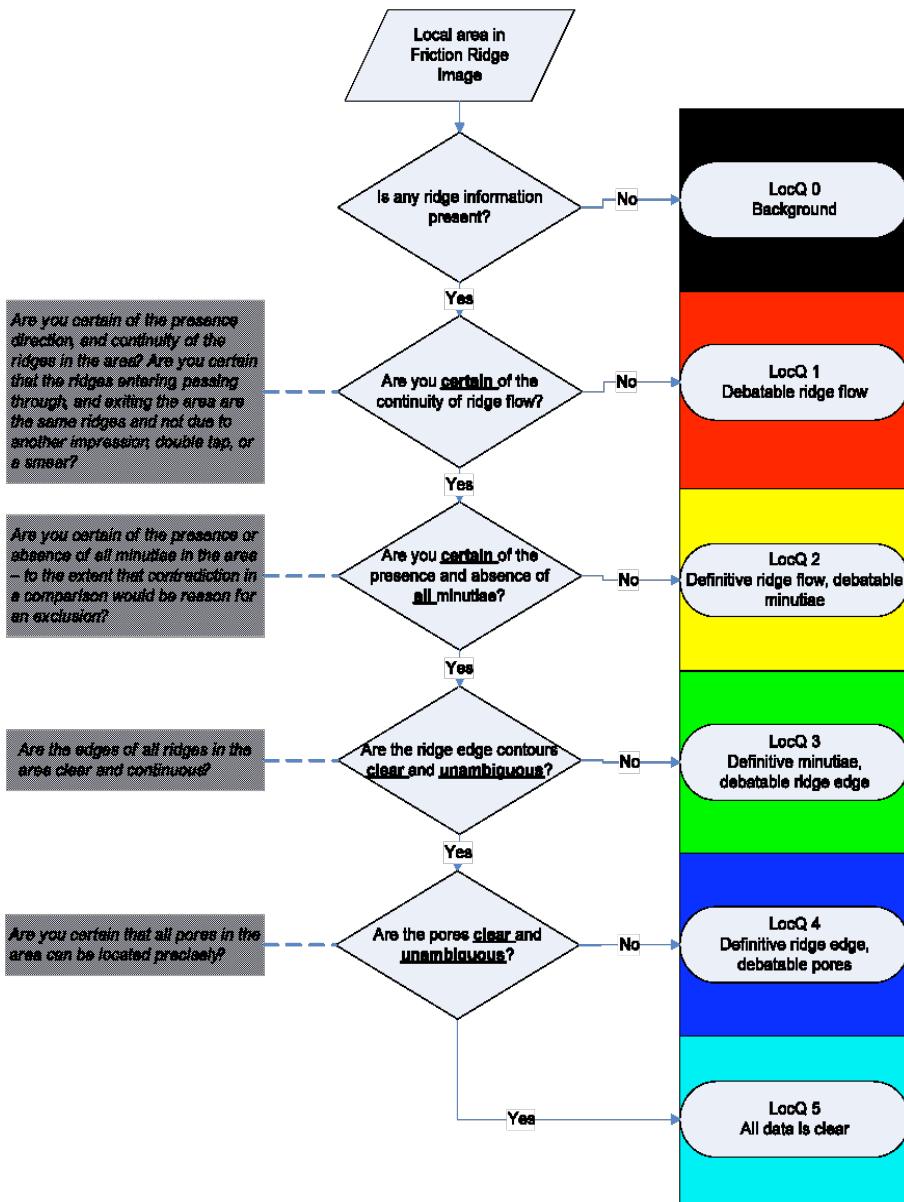
Figure 6: **EFS Decision process for local friction ridge quality**

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Table 15:   **EFS Definitions for ridge quality map values**

			Ridge flow	Minutiae	Dots	Incipients	Ridge edge features	Pores	
Black	0	Background			✖				Black (0,0,0)
Red	1	Debatable ridge flow	?		✖				Red (255,0,0)
Yellow	2	Definitive ridge flow, debatable minutiae	✔	?	✖				Yellow (255,255,0)
Green	3	Definitive minutiae, debatable ridge edges	✔		?		✖		Green (0,255,0)
Blue	4	Definitive ridge edges, debatable pores		✔			?		Blue (0,0,255)
Aqua	5	All features definitive		✔					Aqua (0,240,240)

Legend:

✔	Definitive and unambiguous.	Presence and absence of features are definitive. Location of features is definitive unless specifically noted otherwise (such as by radius of uncertainty). Contradictory presence or absence of features in a comparison is cause for exclusion.
?	Debatable or ambiguous.	Features may be marked, but presence, absence, and location are debatable. Corresponding/contradictory features in a comparison are supporting evidence for individualization/exclusion.
✖	Not discernable or unreliable	Features should not be marked and will be ignored if present. No evidence for individualization or exclusion in a comparison.

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13.7.8 EFS Date and Time

The date and time are stored in terms of universal Greenwich Mean Time / GMT units. Date and time together are saved in a single information item, represented as "YYYYMMDDHHMMSSZ," a 15-charater string that is the concatenation of the date with the GMT and concludes with "Z." The "YYYY" characters shall represent the year of the transaction, the "MM" characters shall be the tens and units values of the month, and the "DD" characters shall be the tens and units values of the day of the month, the "HH" characters represent the hour, the "MM" the minute, and the "SS" represents the second. The complete date and time shall not exceed the current date and time (Example: 08:48:28 AM, March 19, 2009 EST (US Eastern Standard Time) = 20090319134828Z. Note that EST = GMT -5). See the rules and procedures for the appropriate encoding for details on the representation of this field. Date and time are included as information items in these fields:

Field 9.350 Method of Feature Detection / MFD

Field 9.352 Examiner Analysis Assessment / EAA

Field 9.362 Examiner Comparison Determination / ECD

13.7.9 EFS Field Descriptions

Table 16 shows the names and acronyms for fields and information items within the fields. The Condition Code indicates whether the field is mandatory ("M"), optional ("O"), or conditional ("C"). For information items, the Condition Code indicates when the field is present whether the information item is mandatory ("– m"), can be left empty ("– o"), or is conditional ("– c"). Note that the Condition Code only defines those fields that are mandatory for all transactions that use this record: specific transactions that use Extended Friction Ridge Features may require a superset of the fields to be mandatory. Details of Conditional situations are explained in the field information item descriptions. "Character type" indicates N = Numeric; A = Alphabetic; AN = Alphanumeric;S = Special characters (e.g., commas, hyphens). All fields are ASCII text fields

Note that some fields do not have maximum field sizes or number of occurrences, to accommodate palmprint requirements.

Note that there are multiple blocks of fields that are reserved for future definition, so that similar fields can continue to be grouped together even as new fields are added to this standard.

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Table 16:   Record layout for extended friction ridge feature fields

Mnemonic	Cond code	Field #	Field name —Information Items	Char type	Number of occurrences (Min/Max)	
ROI	M	9.300	Region of Interest		1	1
	— m		— Width	N		
	— m		— Height	N		
	— c		— Horizontal offset	N		
	— c		— Vertical offset	N		
	— o		— Polygon (Closed Path)	NS		
ORT	O	9.301	Orientation		0	1
	— m		— Direction	N		
	— m		— Uncertainty	N		
FPP	M	9.302	Finger/Palm Position(s)		1	20
	— m		— Position Code	N		
	— o		— Finger Segment	A		
	— o		— Off-center Fingerprint Position	A		
	— o		— Polygon (Closed Path)	NS		
RSV		9.303 9.306	Reserved for future definition			
PAT	O	9.307	Pattern Classification		0	7
	— m		— General Classification	A		
	— c		— Subclassification	A		
	— c		— Delta Relationship	A		
RQM	O	9.308	Ridge Quality Map	N	0	n/a
RQF	C	9.309	Ridge Quality Map Format		0	1
	— c		— Grid size	N		

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Mnemonic	Cond code	Field #	Field name —*Information Items*	Char type	Number of occurrences (Min/Max)	
	— *c*		— *Data format*	*A*		
RFM	O	9.310	Ridge Flow Map	AN	0	Unlimited
RFF	C	9.311	Ridge Flow Map Format		0	1
	— *c*		— *Sampling frequency*	*N*		
	— *c*		— *Data format*	*A*		
RWM	O	9.312	Ridge Wavelength Map	N	0	Unlimited
RWF	C	9.313	Ridge Wavelength Map Format		0	1
	— *c*		— *Sampling frequency*	*N*		
	— *c*		— *Data format*	*A*		
TRV	O	9.314	Tonal Reversal	A	0	1
PLR	O	9.315	Possible Lateral Reversal	A	0	1
FQM	O	9.316	Friction Ridge Quality Metric		0	20
	— *m*		— *Quality metric value*	*N*		
	— *m*		— *Quality algorithm vendor code*	*AN*		
	— *m*		— *Quality algorithm product code*	*N*		
PGS	O	9.317	Possible Growth or Shrinkage		0	1
	— *m*		— *Type*	*A*		
	— *o*		— *Comment*	*ANS*		
RSV		9.318 9.319	Reserved for future definition			
COR	O	9.320	Cores		0	Unlimited
	— *m*		— *X*	*N*		
	— *m*		— *Y*	*N*		

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Mnemonic	Cond code	Field #	Field name —*Information Items*	Char type	Number of occurrences (Min/Max)	
	— *o*		— *Direction*	*N*		
	— *o*		— *Radius of position uncertainty*	*N*		
	— *o*		— *Direction uncertainty*	*N*		
DEL	O	9.321	Deltas		0	Unlimited
	— *m*		— *X*	*N*		
	— *m*		— *Y*	*N*		
	— *o*		— *Direction up*	*N*		
	— *o*		— *Direction left*	*N*		
	— *o*		— *Direction right*	*N*		
	— *o*		— *Type*	*A*		
	— *o*		— *Radius of position uncertainty*	*N*		
	— *o*		— *Direction uncertainty up*	*N*		
	— *o*		— *Direction uncertainty left*	*N*		
	— *o*		— *Direction uncertainty right*	*N*		
CDR	O	9.322	Core-Delta Ridge Counts		0	Unlimited
	— *m*		— *Core Index*	*AN*		
	— *m*		— *Delta Index*	*AN*		
	— *m*		— *Min ridge count*	*N*		
	— *o*		— *Max ridge count*	*N*		
CPR	O	9.323	Center Point of Reference		0	3
	— *m*		— *Method*	*A*		
	— *m*		— *X*	*N*		
	— *m*		— *Y*	*N*		

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Mnemonic	Cond code	Field #	Field name —*Information Items*	Char type	Number of occurrences (Min/Max)	
	— *o*		— *Radius of position uncertainty*	N		
DIS	O	9.324	Distinctive Features		0	Unlimited
	— *m*		— *Type*	A		
	— *m*		— *Polygon (Closed Path)*	NS		
	— *o*		— *Comment*	ANS		
NCR	O	9.325	No Cores Present	A	0	1
NDL	O	9.326	No Deltas Present	A	0	1
NDF	O	9.327	No Distinctive Features Present	A	0	1
RSV		9.328 9.330	Reserved for future definition			
MIN	O	9.331	Minutiae		0	Unlimited
	— *m*		— *X*	N		
	— *m*		— *Y*	N		
	— *m*		— *Theta*	N		
	— *m*		— *Type*	A		
	— *o*		— *Radius of position uncertainty*	N		
	— *o*		— *Direction uncertainty*	N		
MRA	O	9.332	Minutiae Ridge Count Algorithm	A	0	1
MRC	O	9.333	Minutiae Ridge Counts		0	Unlimited
	— *m*		— *Minutia Index A*	N		
	— *m*		— *Minutia Index B*	N		
	— *o*		— *Ridge Count*	N		
	— *o*		— *Reference number*	N		

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Mnemonic	Cond code	Field #	Field name —*Information Items*	Char type	Number of occurrences (Min/Max)	
	— *o*		— *Residual*	*N*		
NMP	O	9.334	No Minutiae Present	A	0	1
RCC	O	9.335	Ridge Count Confidence		0	Unlimited
	— *m*		— *X1*	*N*		
	— *m*		— *Y1*	*N*		
	— *m*		— *X2*	*N*		
	— *m*		— *Y2*	*N*		
	— *m*		— *Method of Ridge Counting*	*A*		
	— *m*		— *Confidence Value*	*N*		
RSV		9.336 9.339	Reserved for future definition			
DOT	O	9.340	Dots		0	Unlimited
	— *m*		— *X1*	*N*		
	— *m*		— *Y1*	*N*		
	— *o*		— *Length*	*N*		
INR	O	9.341	Incipient Ridges		0	Unlimited
	— *m*		— *X1*	*N*		
	— *m*		— *Y1*	*N*		
	— *m*		— *X2*	*N*		
	— *m*		— *Y2*	*N*		
CLD	O	9.342	Creases and Linear Discontinuities		0	Unlimited
	— *m*		— *X1*	*N*		
	— *m*		— *Y1*	*N*		
	— *m*		— *X2*	*N*		
	— *m*		— *Y2*	*N*		

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Mnemonic	Cond code	Field #	Field name —*Information Items*	Char type	Number of occurrences (Min/Max)	
	— *o*		— *Type*	*A*		
REF	O	9.343	Ridge Edge Features		0	Unlimited
	— *m*		— *X*	*N*		
	— *m*		— *Y*	*N*		
	— *m*		— *Type*	*A*		
NPP		9.344	No Pores Present	A	0	1
POR	O	9.345	Pores		0	Unlimited
	— *m*		— *X*	*N*		
	— *m*		— *Y*	*N*		
NDT	O	9.346	No Dots Present	A	0	1
NIR	O	9.347	No Incipient Ridges Present	A	0	1
NCR	O	9.348	No Creases Present	A	0	1
NRE	O	9.349	No Ridge Edge Features Present	A	0	1
MFD	O	9.350	Method of Feature Detection		0	Unlimited
	— *m*		— *Field(s)*	*AN*		
	— *m*		— *Method*	*A*		
	— *o*		— *Algorithm vendor*	*AN*		
	— *o*		— *Algorithm*	*AN*		
	— *o*		— *Examiner Last Name*	*AN*		
	— *o*		— *Examiner First Name*	*AN*		
	— *m*		— *Examiner Affiliation*	*AN*		
	— *m*		— *Date and time*	*AN*		
	— *o*		— *Notes*	*ANS*		
COM	O	9.351	Comments	ANS	0	Unlimited

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Data Format for the Interchange of Biometric and Forensic Information

Mnemonic	Cond code	Field #	Field name —Information Items	Char type	Number of occurrences (Min/Max)	
LPM	O	9.352	Latent Processing Method	A	0	9
EAA	O	9.353	Examiner Analysis Assessment		0	20
	— m		— Value	A		
	— m		— Examiner Last Name	AN		
	— m		— Examiner First Name	AN		
	— m		— Examiner Affiliation	AN		
	— m		— Date/Time	N		
	— o		— Comment	ANS		
EOF	O	9.354	Evidence of Fraud		0	Unlimited
	— m		— Fraud Type	A		
	— o		— Comment	ANS		
LSB	O	9.355	Latent Substrate		0	3
	— m		— Code	AN		
	— o		— Comment	ANS		
LMT	O	9.356	Latent Matrix		0	3
	— m		— Code	N		
	— o		— Comment	ANS		
LQI	O	9.357	Local quality issues		0	Unlimited
	— m		— Type	A		
	— m		— Polygon (Closed Path)	NS		
	— o		— Comment	ANS		
RSV		9.358 9.359	Reserved for future definition			
AOC	O	9.360	Area of Correspondence		0	Unlimited
	— m		— IDC Reference	N		

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Mnemonic	Cond code	Field #	Field name —Information Items	Char type	Number of occurrences (Min/Max)	
	— m		— Polygon (Closed Path)	NS		
	— o		— Comment	ANS		
CPF	O	9.361	Corresponding Points or Features		0	Unlimited
	— m		— Label	AN		
	— m		— Point or Feature	A		
	— c		— Field Number	AN		
	— c		— Field Occurrence	N		
	— c		— X	N		
	— c		— Y	N		
	— o		— Comment	ANS		
ECD	O	9.362	Examiner Comparison Determination		0	Unlimited
	— m		— IDC reference	N		
	— m		— Determination	A		
	— m		— Work in progress	A		
	— m		— Examiner Last Name	AN		
	— m		— Examiner First Name	AN		
	— m		— Examiner Affiliation	AN		
	— m		— Date and Time	AN		
	— o		— Comment	ANS		
RSV		9.363 9.371	Reserved for future definition			
SIM	O	9.372	Skeletonized Image	ANS	0	Unlimited
RPS	O	9.373	Ridge Path Segments	NS	0	Unlimited
RSV		9.374 9.399	Reserved for future definition			

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Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

13.7.10 EFS Field 9.300 Region of Interest / ROI

This mandatory field defines a rectangle (and an optional polygon) that bounds the region of the image that contains the fingerprint of interest and separates it from the background and any other fingerprints present in the image. *All* other Extended Friction Ridge Features are in relation to the Region of Interest rectangle, *not* to the original image. Note that if the region of interest is defined as a polygon, the region of interest rectangle is simply a bounding box around the polygon.

This field contains the following information items:

- The first information item (**Width / EWI)** is the width of the region of interest rectangle in units of 10 micrometers (0.01mm).

- The second information item **(Height / EHE)** is the height of the region of interest rectangle in units of 10 micrometers (0.01mm).

- The third information item **(Horizontal offset / EHO)** is the horizontal distance in units of 10 micrometers from the left edge of the original image to the left edge of the region of interest rectangle. This information item is mandatory if the original image is present in the ANSI/NIST file (in a Type-13, 14, or 15 record), and optional otherwise.

- The fourth information item **(Vertical offset / EVO)** is the vertical distance in units of 10 micrometers from the top edge of the original image to the top edge of the region of interest rectangle. This information item is mandatory if the original image is present in the ANSI/NIST file (in a Type-13, 14, or 15 record), and optional otherwise.

- The fifth information item **(Polygon / EPY)** is a closed path that further defines the friction ridge area under consideration within the Region of Interest. If the polygon is defined, the ROI rectangle shall be the bounding box for the polygon. The vertices of the polygon are relative to the ROI rectangle. See Section 13.7.4 for a description of how to enter this information item.

| Brad Wing 6/19/10 5:07 PM |
| **Comment:** Reordered and reworded. |

13.7.11 EFS Field 9.301 Orientation / ORT

This optional field allows the orientation (deviation from upright) and its uncertainty to be specified. While arbitrary rotation of the image is not recommended due to image degradation concerns, rotation of the image in multiples of 90° can be performed without image degradation and is acceptable.
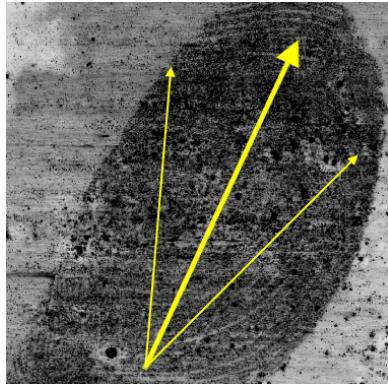
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If this field is omitted, the direction shall default to 0 (upright) and uncertainty shall default to 15, indicating that the image is rotated 0±15°.

If orientation cannot be determined, the uncertainty subfield shall be set to 180.

This field contains the following information items:

- The first information item **(Direction / EOD)** contains the deviation of the region of interest from upright (fingertip up) in integer degrees. Positive angles are counterclockwise, negative angles are clockwise. A value of "0" indicates an upright direction. Valid values range from "-179" through "180".

- The second information item **(Uncertainty / EUC)** contains the uncertainty of the orientation direction, in non-negative integer degrees, so that the resulting orientation is Direction± Uncertainty°. Valid values range from "0" to "180": a value of "0" indicates a certain direction, while a value of "180" indicates an unknown orientation. If this information item is omitted, the uncertainty shall default to "15" (±15°).

Figure 7: Example of orientation: -25 ± 20 degrees

13.7.12   EFS Field 9.302 Finger/Palm/Plantar Position / FPP

This mandatory field shall contain one or more of the possible physical positions that correspond to the region of interest. Multiple data entries may be used to note the presence of more than one position in the image: polygons are required in this case to delineate the locations of the positions. For example, a region of interest that includes a finger's medial and proximal segment can note those as

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multiple data entries, with polygons to indicate the locations. This field contains the following three information items:

- The first information item **(Position code / EPN)** contains the code number corresponding to the known or most probable position shall be taken and entered as a one- or two-character ASCII subfield

The second information item **(Finger segment / FSM)** is optional and only applies to fingerprints in which all or part of the medial or proximal segments (lower joints) are present in the image, in which case the 3-character code from **Table 17** is used to indicate the finger segment position. This information item defaults to DST: if the Position Code indicates a fingerprint and the Finger Segment is not specified, the impression shall be regarded as including solely the distal segment with no substantive portions of the medial or proximal segments. See **Figure 8** for more information, and

Figure 9 for examples. This information item shall be omitted if the Position Code indicates a palm or foot.

The third information item **(Off-center fingerprint / OCF)** is optional and only applies to fingerprints in which the impression does not contain the central area of the fingerprint (i.e. the core or a center point of reference), in which case the 1-character code from

Table 18 is used to indicate the off-center position of the fingerprint image.

Figure 11 shows examples of off-center fingerprint positions. This information item shall be omitted if the Position Code indicates a palm or foot.

The fourth information item **(Polygon / PYG)** is a closed path that delineates the portion of the region of interest corresponding to the Position Code/Finger Segment codes. See

- **Figure 9** and **Figure 10** for examples. If the bounding box is not defined, the Position Code/Finger Segment codes are assumed to apply to the entire region of interest.
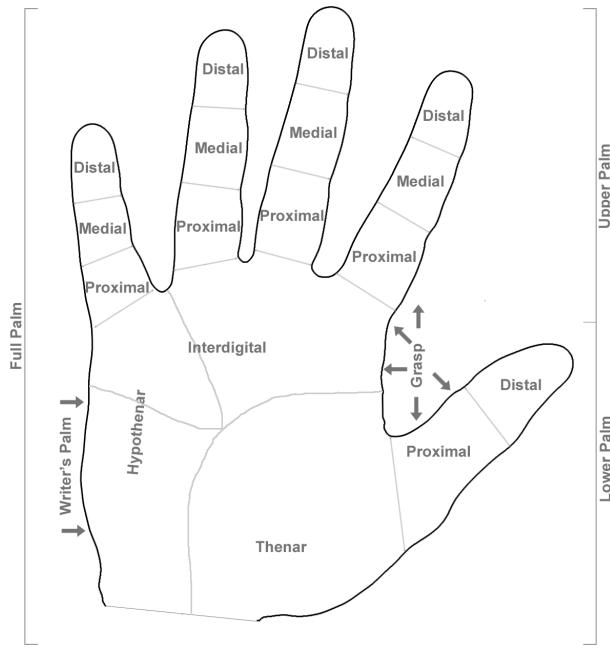
Table 17:   Finger segment codes

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Name	Code	Description
Distal Segment	DST	The segment of the finger or thumb farthest from the palm (default)
Medial Segment	MED	The middle segment of the finger (the thumb does not have a medial segment)
Proximal Segment	PRX	The segment of the finger or thumb closest to the palm
Unknown Segment	UNK	Image is an unknown segment of a finger or thumb.

Table 18:   Off-center fingerprint positions

Name	Code	Description
Tip	T	The plain or rolled tip of the image
Right Side	R	The right side of the finger or thumb
Left Side	L	The left side of the finger or thumb

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Figure 8:   Palm and finger segment positions.[20]

If the physical position for the image cannot be determined, the following fields shall be used (see **Table 9**):

If the image is from a finger (including the lower joints) but the finger position is unknown, the code "0" (Unknown fingerprint) shall be used.

If the image is from a palm but the location cannot be determined, the code "20" (Unknown palm) shall be used.

If the type of friction skin is unknown, each of the possible positions shall be included as separate data entries. Codes "0" (Unknown fingerprint) and "20" (Unknown palm) together address all friction ridge areas on the hands; codes "37" (Unknown sole of foot) and "40" (Unknown toe) together address all friction ridge areas on the feet.

If the image/region of interest contains multiple areas, this field allows the option to label and mark each of those areas within the region of interest. Each of the areas present shall be indicated using the appropriate Position Code/Finger

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[20] **Note that the interdigital and hypothenar areas overlap at the base of the little finger**

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Segment codes, with a polygon delineating each of the areas. Polygons may overlap if appropriate. See **Figure 10** and **Figure 11** for examples.
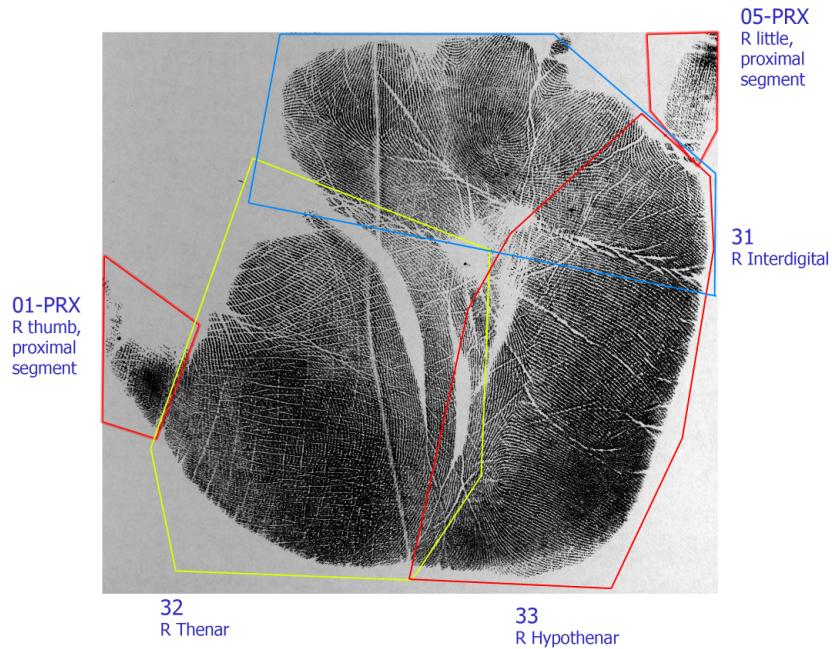
If the image is an exemplar entire joint image or full finger view (from a set of complete friction ridge exemplars), or a latent of equivalent area, it shall be marked with the finger number (0-10), and shall have the individual segments marked with polygons.

If the image is of a palm (or foot), each of the palm areas present shall be marked with the relevant position code and delineated with a polygon.

Figure 9: EFS Use of polygons to mark multiple finger segments

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Figure 10: EFS Use of polygons to mark multiple areas within a palm impression
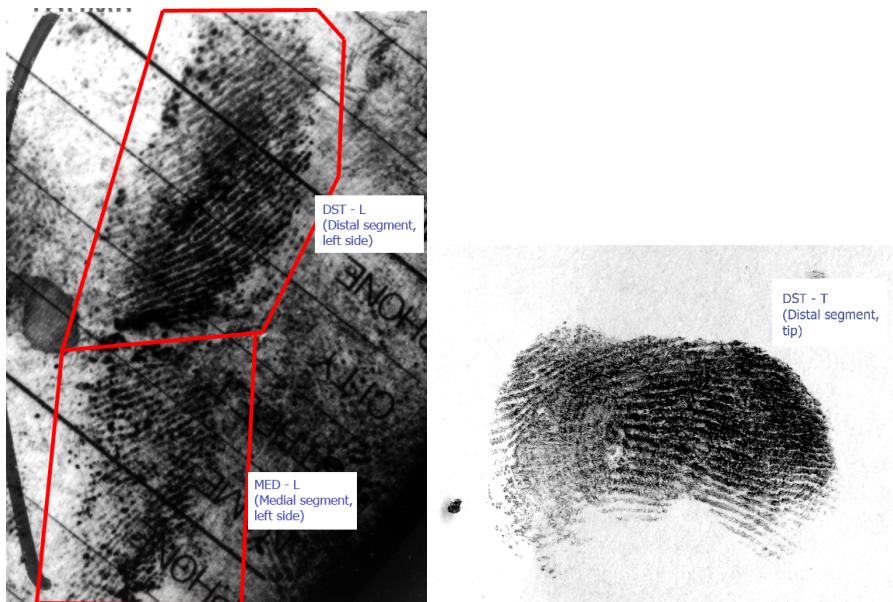
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Figure 11: EFS Examples of off-center fingerprint positions

13.7.13   EFS Field 9.307 Pattern Classification / PAT

This field contains fingerprint classification information for the image. This field shall only be used for fingerprints, and shall be omitted (left empty) for other friction ridge impressions. The field consists of three information items.

- The first information item **(General Classification / GCF)** is the general set of pattern classifications (arch, whorl, left & right loop) used by most current automated systems.

- The second information item **(Subclassification / SUB)** is the detailed subclassification of arches and whorls that may optionally be provided by a human examiner or automated system. This information item shall only be included for arches or whorls, and only if the subclassification can be determined precisely.

- The third information item **(Whorl Delta Relationship / WDR)** may optionally be used by a human examiner or automated system to provide the relationship between the deltas in a whorl. This information item shall only be included for whorls if the subclass is known, and only if the whorl delta relationship can be determined precisely. This information item shall

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be set to I (Inner), O (Outer), or M (Meeting), following the guidelines from *The Science of Fingerprints*[21] (p 60).

This field may repeat up to seven times, indicating all possible pattern classifications. Classification must be conservative: if the pattern is known precisely, only a single pattern shall be indicated; however, if there is any doubt as to the precise classification, all possible patterns shall be included. If the pattern cannot be classified, but a pattern type can be definitively excluded, then that shall be indicated by including all possible patterns. For example, a latent that contains a delta but no other pattern area information could possibly be a left loop, right loop, whorl (of any type), or tented arch.

Complete Scar (SR) and Dissociated Ridges/Dysplasia (DR) should only be noted if the fingerprint could not be classified. If the print can be classified and scar(s), dissociated ridges, and/or dysplasia are present, this field should note the classification(s) and the scar(s), dissociated ridges, and/or dysplasia should be noted in **Field 9.324 Distinctive Features / DIS.**

Note that the use of **Field 9.322 Core-Delta Ridge Counts (CDR)** can be used to further subcategorize pattern classification.

Table 19: Pattern classification codes

	Pattern Classification	General Class	Subclass	Whorl Delta Relationship
Arches	Arch, type not designated	AU		
	- Plain Arch		PA	
	- Tented Arch		TA	
Whorls	Whorl, type not designated	WU		
	- Plain Whorl		PW	I, O, or M
	- Central Pocket Loop		CP	I, O, or M

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[21] Federal Bureau of Investigation; *The Science of Fingerprints*; Rev 12-84; ISBN 0-16-076078-X: "*When the deltas have been located, the ridge emanating from the extreme left delta is traced until the point nearest or opposite the extreme right delta is reached. The number of ridges intervening between the tracing ridge and the right delta are then counted. If the ridge traced passes inside of (above) the right delta, and three or more ridges intervene between the tracing ridge and the delta, the tracing is designated as an "inner" […] If the ridge traced passes outside of (below) the right delta, and three or more ridges intervene between the tracing ridge and the delta, the tracing is designated as an "outer" […] All other tracings are designated as "meeting."*

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Brad Wing 6/19/10 5:07 PM
Comment: Move quote to the footnote.

	- Double Loop		DL	I, O, or M
	- Accidental Whorl		AW	I, O, or M
Loops	Right Slant Loop	RS		
	Left Slant Loop	LS		
Unable to print	Amputation	XX		
	Temporarily unable to print (e.g., bandaged)	UP		
Unable to classify	Unable to Classify	UC		
	- Complete Scar	SR		
	- Dissociated Ridges/Dysplasia	DR		

13.7.14 EFS Field 9.308 Ridge Quality/Confidence Map / RQM

Local friction ridge quality (as defined in the Ridge Quality Map) is an assessment of confidence in small local areas within an image. The local quality map is used to define the confidence in all other features, and therefore is key information. In addition, when the quality map indicates a high-quality region in which features are not marked, that information can be used as "negative features" or definitive absence of features, which can be used for exclusion.

Accurate and consistent markup of local quality is essential, and the guidelines in this section should be followed as closely as possible. The names and color-coding indicated here should be used whenever possible.

For every cell in a grid superimposed on the Region of Interest, this optional field notes the local ridge quality of the friction ridge detail within that cell. Local ridge quality defines clarity in terms of the ability to discern detail in a given location. The quality of each cell will be represented with a local quality (LocQ) value 0 through 5 representing the quality of ridge detail in that cell, as specified in **Table 20**, below.

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Table 20: Local ridge quality codes

Local Quality Code	Name	Shorthand description		Display color
5	Definitive pores	Pores and ridge edges are obvious and unambiguous		Aqua [RGB=(0,240,240)]
4	Definitive ridge edges, debatable pores	Ridge edges, minutiae, and ridge flow are obvious and unambiguous; pores are either debatable or not present		Blue [RGB=(0,0,255)]
3	Definitive minutiae, debatable ridge edges	Minutiae, and ridge flow are obvious and unambiguous; ridge edges are debatable		Green [RGB=(0,255,0)]
2	Definitive ridge flow, debatable minutiae	Continuity of ridge flow is certain; minutiae are debatable		Yellow [RGB=(255,255,0)]
1	Debatable ridge flow	Continuity of ridge flow is uncertain		Red [RGB=(255,0,0)]
0	Background	No ridge information		Black or no color [RGB=(0,0,0)]

13.7.15   EFS Field 9.309 Ridge Quality Map Format / RQF

This field defines the grid size or data representation format used in Field 9.308. Its use is conditional on the presence of that field. This field consists of two information items:

- The first information item **(Grid size / GSZ)** may be used to define grid sizes (both the horizontal and vertical dimensions of a single cell in the grid): valid settings range from "1" (0.01mm) through "41" (0.41mm). The recommended grid size is 0.20mm (0.008") – note this is 4 pixels at 500ppi, or 8 pixels at 1000ppi.

- The second information item **(Data format / RDF)** defines the format used in Field 9.308 using the codes defined in Table 21. For all formats:

  1. The first cell starts at the top left corner of the Region of Interest, with cells in order left to right.
  2. All of the quality values for each row are stored in one data entry, with rows separated by a RS character.
  3. If the width and/or height of the Region of Interest are not evenly divisible by the Grid Size, partial cells shall be included at the right and/or bottom of the ridge flow map.
  4. The number of data entries in the field is the same as the number of cells in one column: the Region of Interest's height divided by the Grid Size, rounded up.

Table 21: Ridge quality map data representation format options

Code	Type	Description
UNC	Uncompressed (concatenated decimal)	The values for each grid cell in the Ridge Quality Map field are single-character integer values as defined in Table 20, with one character per cell. All quality values for one row are concatenated left to right, with one data entry for each row. The number of characters in one data entry is the same as the number of cells in one row: the Region of Interest's width divided by the Grid Size, rounded up.
RLE	Run-Length Encoded	The unencoded values for each data entry are identical to those used in UNC format. The numeric values for each grid cell (0-5) are then replaced with alphabetic equivalents (A-F), and then any sequential runs of the same character are prefixed by the decimal count of repeated characters. Individual characters are not preceded by a count. For example: 00000000000000000000000000000000000000000000000000 (50 characters) Is saved as "50A" 00000000000011223345555555544444221000000000000000 (50 characters) Is saved as "12A2B3C2DE7F5E2CB16A" (20 characters)

13.7.16   EFS Field 9.310 Ridge Flow Map / RFM

This field contains the direction of friction ridges at various sampling points throughout the region of interest. This field is based on a uniform sampling frequency that defaults to 0.41 mm (0.016 in – note this is 8 pixels at 500 ppi, or 16 pixels at 1000 ppi). The sampling frequency may optionally be set to a higher resolution in Field 9.311. The first sampling point in the image is the top left-most point in the region of interest. The same sampling frequency is used both horizontally and vertically. Values shall be included for all sampling points in the

region of interest, even if the sampling points are at the edge of the region of interest.

For each sampling point, angles shall be reported in integer degrees, with 0 degrees to the right (horizontal), increasing counterclockwise to a maximum value of 179° (since 180°=0°). Undefined angles are recorded as noted in **Error! Reference source not found.**.

Note that the area used for determining direction (window size) may be larger or smaller than the sampling frequency. Different window sizes may be used within a single image, at the discretion of the implementer. For example, an implementer may choose to use a uniform window size except in areas of high curvature, in which a smaller window size may be used.

13.7.17   EFS Field 9.311 Ridge Flow Map Format / RFF

This field permits setting the sampling frequency or data representation format used in the Field 9.310 to values other than the defaults. Its use is conditional on the presence of Field 9.310. This field consists of two information items:

- The first information item **(Sampling Frequency / SFQ)** is set by default to 0.41mm (0.016"). This information item may be used to define higher resolution sampling frequencies than the default: valid settings range from "1" (0.01mm) through "41" (0.41mm).

- The second information item **(Data format / RDF)** defines the format used in the Ridge Flow Map field, as defined in Table 22. The default is the uncompressed ("UNC") format

Table 22: Ridge flow map data representation format options

Code	Type	Description
UNC	Uncompressed (concatenated hexadecimal)	Each ridge flow value is a 2-character hexadecimal value. The angles are stored in 2-character hexadecimal representation with leading zeros, so valid values range from "00" (0dec) to "B3" (179dec). Undefined angles: If the direction cannot be determined at a given location, the location at that point shall be marked as "XX". All of the ridge flow values for a given row shall be concatenated in order left to right. The number of characters in one data entry is twice the number of cells in one row.
B64	Base 64	Each ridge flow value is a 1-character base-64[22] value. The angles are divided by three to enable storing in a single base-64 character, which has the effect of quantizing to three degrees. Undefined angles: If the direction cannot be determined at a given location, the location at that point shall be marked as "*" (asterisk). All of the ridge flow values for a given row shall be concatenated in order left to right and saved as a separate data entry. The number of characters in one data entry is the number of cells in one row.

13.7.18   EFS Field 9.312 Ridge Wavelength Map / RWM

This optional field contains the peak-to-peak distance between ridges at various sampling points throughout the region of interest. This field is based on a uniform sampling frequency that defaults to 0.41mm (0.016 in – note this is 8 pixels at 500 ppi, or 16 pixels at 1000 ppi). The sampling frequency may optionally be set to a higher resolution in **Field 9.313 Ridge Wavelength Map Format / RWF.** The first sampling point in the image is the top left-most point. The same sampling frequency is used both horizontally and vertically. Values shall be

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2.   [22] Base-64 is a method of representing binary data as text, as specified in IETF RFC 2045 (http://tools.ietf.org/html/rfc2045).

included for all sampling points in the image, even if the sampling points are at the edge of the image.

For each sampling point in the Region of Interest, distances between ridge peaks, measured perpendicular to ridge flow, shall be reported in 2-character decimal format using units of 10 micrometers (0.01mm). The size of the area around the sampling point (window size) used to determine measurements is left to the discretion of the implementer, and may vary within an image. Unknown values shall be set to "XX". Valid values are therefore "01" (0.01mm) through "99" (0.99mm or greater). (In practice, the actual stored values are likely to be "30" to "70" in most cases (0.3 – 0.7mm).

The 2-character decimal wavelength values for each sampling point are concatenated left to right for all sampling points in a row, with one data entry for each row. The number of characters in one data entry is twice the number of sampling points in one row.

13.7.19   EFS Field 9.313 Ridge Wavelength Map Format / RWF

This field permits setting the sampling frequency or data representation format used in Field 9.312 to values other than the defaults. This field is conditional on the presence of Field 9.312. This field consists of two information items:

- The first information item **(Sampling frequency / FWS)** is set by default to 0.41mm (0.016"). This information item may be used to define higher resolution sampling frequencies than the default: valid settings range from "1" (0.01mm) through "41" (0.41mm).

- The second information item **(Data format / FDF)** is optional. It defines the format used in Field 9.312. The default (and currently the only setting) is the uncompressed ("UNC") format[23].

13.7.20   EFS Field 9.314 Tonal Reversal / TRV

Ridges in friction ridge images are generally represented as dark areas, with valleys as light areas. This field indicates whether the entire image is reversed tonally (black-for-white). If all or part of the image is reversed tonally, this 1-character optional field is set to the appropriate value from **Table 23**. Otherwise this field is omitted.

Partial tonal inversion can occur in different ways. If definable portions of the image are negative, Field 9.357 can be used to define the specific tonally reversed areas. Note that in some cases, the tonal reversal is so mixed that only

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- [23] *This information item is a placeholder. Because of the possibly very large size of RWM, this provides for future, more compressed formats*

portions of individual ridges are reversed, making it impractical or impossible to define the tonally reversed areas.[24]

Note that when this field is set, the image in the Type-13 record should be left as it was originally received (i.e., tonally reversed): setting this field and reversing the image when saving will result in inconsistent data. When this field is set, a software user interface may display the tonally corrected image, but save the image as originally received with this field set.

Table 23: Tonal reversal codes

Code	Description
N	Negative – ridges are light and valleys are dark throughout the image.
P	Partial – ridges are light and valleys are dark only in portions of the image.

13.7.21 EFS Field 9.315 Possible Lateral Reversal / PLR

This field indicates if the original image is or may be laterally reversed (i.e., flipped left-right). In many cases, an examiner cannot tell the correct lateral direction of the image, such as latents on tape that has been closed on itself, or latents that may have been transferred to the substrate/surface. If the image is or may be laterally reversed, this 1-character optional field is set to the appropriate value from **Table 24**; otherwise, this field is to be omitted.

When this field is set to L (Image is known to be laterally reversed), the image in the Type-13 record should be left as it was originally received (i.e., laterally reversed): setting this field and reversing the image when saving will result in inconsistent data.

When this field is set a software user interface may display the laterally corrected image, but save the image as received with this field set.

When this field is set to U (Image may be laterally reversed), it is *incumbent on the recipient* (software system or examiner) to search/compare the impression and features *both* as presented and flipped left-right.

Table 24: Lateral reversal codes

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3.   [24] One example of how this can occur is if light powder is applied from a single direction, leaving one edge of each ridge light and the remainder dark.

Code	Description
L	Image is known to be laterally reversed.
U	Image may be laterally reversed

13.7.22   EFS Field 9.316 Friction Ridge Quality Metric / FQM

This optional field is used to specify one or more different metrics of friction ridge quality for the friction ridge impression corresponding to this record, as delimited by the region of interest. The meaning attributed to this metric must be defined and interpreted by the producer of the scoring algorithm or by the person or system used to assign the metric to the image. The metric may be a predictor of AFIS matcher accuracy performance or a different metric to indicate a value associated with the quality of the image for a particular function.

If the corresponding image is present in the file with this Type-9 record, this field corresponds to fields 13.024, 14.024, and 15.024, but differs in that the quality metric is limited to the area in the image delimited by the region of interest.

This field identifies a quality score and the algorithm used to create the quality score. This information is useful to enable the recipient of the quality score to differentiate between quality scores generated by different algorithms and adjust for any differences in processing or analysis as necessary.

This field consists of three information items:

- The first information item **(Quality metric value / QMV)** shall be a quantitative expression of the quality of the biometric sample. This item contains the ASCII representation of the integer friction ridge quality score between 0 and 100 assigned to the data by a quality algorithm. Higher values indicate better quality. An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards.

- The second information item **(Quality algorithm vendor code / QAV)** shall specify the integer value that is the ID of the vendor of the quality algorithm used to calculate the quality score. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

- The third information item **(Quality algorithm product code / QPC)** shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not required. It indicates which of the vendor's algorithms was used in the

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calculation of the quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65535.

13.7.23 EFS Field 9.317 Possible growth or shrinkage / PGS

This optional field is only used in the unusual circumstance that the friction ridge impression is believed to have changed size or scale from potential comparisons. This provides for handling of images from deceased subjects with desiccated skin, or with swollen skin due to water exposure. This also provides for handling of overall growth of subjects between capture, such as in comparing an adult's fingerprints with those taken as a child. In these cases the size of ridges and distances between ridges change to a greater extent than would ordinarily be assumed in comparisons; this field acts as a flag to indicate that greater than ordinary dimensional variation should be expected in performing subsequent comparisons.

This field is to be omitted unless there is reason to believe that growth or shrinkage may have occurred. This field consists of two information items:

- The first information item **(Type / TGS)** is selected from **Table 25**.
- The second information item **(Comment / COM)** contains optional text describing the rationale for believing that growth or shrinkage may have occurred.

Table 25: Growth or shrinkage codes

Code	Description
G	Growth: impression is believed to be dimensionally larger than exemplars or other prints from the same subject.
S	Shrinkage: impression is believed to be dimensionally smaller than exemplars or other prints from the same subject.
B	Both: impression may be dimensionally larger or smaller than exemplars or other prints from the same subject.

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13.7.24   EFS Field 9.320 Cores / COR

A core is located at the focus of the innermost recurving ridgeline of a ridge pattern: if the ridge is viewed as a section of a circle, the core is the center of that circle; if the ridge is viewed as an ellipse or parabola, the core is the focal point of that curve. The direction of the core is away from the center of the curve. **Figure 12** shows an example of how the core is placed. Note that the core is not on the innermost recurving ridgeline itself.

Figure 12:   Placement of the core at the focus of the innermost recurving ridgeline

The core or cores of a fingerprint are defined for all pattern classifications other than plain arches, as shown in **Table 26**.

Cores may be marked on tented arches if an innermost recurving ridge is present above the delta, so that each side of the recurving ridge extends to either side of the delta.

Plain or central pocket loop whorls will only have one core if the innermost recurving ridge is circular, or two cores if elliptical. A circular whorl only has one core and does not have a defined direction.

Accidentals may have any number of cores.
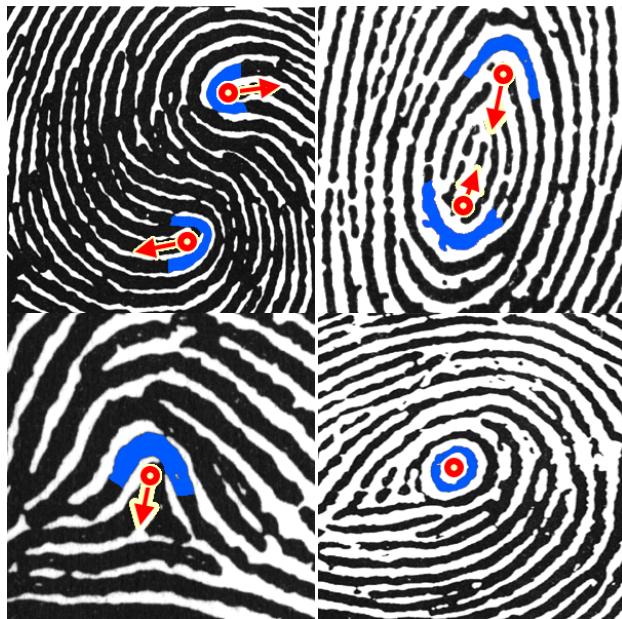
For palmprints or other non-fingerprint friction ridge images, any number of core-like patterns may be defined using this field if such structures are present.

Table 26: Number of cores and deltas by pattern class

Pattern Classification		Cores	Deltas
Arches	- Plain Arch	0	0
	- Tented Arch	0 or 1	0 or 1
Whorls	- Plain Whorl	1 or 2	2
	- Central Pocket Loop	1 or 2	2

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	- Double Loop	2	2
	- Accidental Whorl	N	N
Loops		1	1

Figure 13: Examples of core locations for a double loop whorl, plain whorl, tented arch, and central pocket loop whorl

This field consists of the following information items:

- The first information item **('x' coordinate / CXC)** is expressed in units of 10 micrometers (0.01mm)

- The second information item **('y' coordinate / CYC)** is expressed in units of 10 micrometers (0.01mm)

- The third information item **(Direction / CDI)** is optional. This is set to the average tangent direction of the two closest ridges as measured 1.63mm (0.064 inches) from the focal point. This is approximately the same as the direction of the directrix of the best fitting parabola. The direction must be omitted (left empty) for circular whorls, or if the direction is unknown.

- The fourth information item (**Radius of position uncertainty / RPU)** defines the radius of a circle centered at the location (X,Y) of the core; the circle is sized to include the area of other possible locations of the core, if the precise location cannot be determined (such as due to poor clarity). If the location is known precisely, the radius of position uncertainty may be omitted or set to 0. The radius of uncertainty is measured in integer units of 10 micrometers (0.01mm), and may overlap the edge of the image.

- The fifth information item **(Direction uncertainty / DUY)** is optional. It contains the uncertainty of the direction of the core, in non-negative integer degrees. Valid values range from "0" to "180": a value of "0" (default) indicates a certain direction, while a value of "180" indicates an unknown orientation.

Note that if one or more cores are present and the features set is from a fingerprint, Pattern Class (PAT) should be defined. Note that this does not mean that the classification has to be known definitively, but must at least be known to the extent of excluding plain arches.

13.7.25   EFS Field 9.321 Deltas / DEL

For fingerprints, one or more deltas are defined for all pattern classifications other than plain arches, as shown in **Table 26**. Note that tented arches should have deltas marked if such a structure is present. Accidentals may have any number of deltas. Most palmprints contain four interdigital deltas and one carpal delta. Other delta-like patterns may be defined using this field if such structures are present in friction ridge images. This field consists of the following information items:

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- The first information item **('x' coordinate / DXC)** is expressed in units of 10 micrometers (0.01mm)

- The second information item **('y' coordinate / DYC)** is expressed in units of 10 micrometers (0.01mm)

- The third information item **(Direction up / DUP)** is optional and is expressed in degrees counterclockwise from the right[25].

- The fourth information item **(Direction left / DLF)** is optional and is expressed in degrees counterclockwise from the right

- The fifth information item **(Direction right / DRT)** is optional and is expressed in degrees counterclockwise from the right

- The sixth information item **(Type / DTP)** is optional and contains the type of delta, as defined in **Table 27**.

- The seventh information item **(Radius of position uncertainty / RPU)** is optional. It defines the radius of a circle centered at the location (X,Y) of the delta; the circle is sized to include the area of other possible locations of the delta, if the precise location cannot be determined (such as due to poor clarity). If the location is known precisely, the radius of position uncertainty may be omitted or set to 0. The radius of uncertainty is measured in integer units of 10 micrometers (0.01mm), and may overlap the edge of the image.

- The eighth information item **(Direction uncertainty up / DUU)** is optional. It contains the uncertainty of the delta angle up. Valid values range from "0" to "180": a value of "0" (default) indicates a certain direction, while a value of "180" indicates an unknown orientation.

- The ninth information item **(Direction uncertainty left / DUL)** is optional. It contains the uncertainty of the delta angle up. Valid values range from "0" to "180": a value of "0" (default) indicates a certain direction, while a value of "180" indicates an unknown orientation.

- The tenth information item **(Direction uncertainty right / DUR)** is optional. It contains the uncertainty of the delta angle up. Valid values range from "0" to "180": a value of "0" (default) indicates a certain direction, while a value of "180" indicates an unknown orientation.

- [25] The three angles shall be reported in order by increasing angle, which for fingerprint deltas with known orientation will result in the order up, left, then right. These three information items may be omitted (left empty).

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Table 27: EFS delta codes

Code	Applies to	Name	Description
L	Fingerprint	Left fingerprint delta	The delta to the left of the image for whorls or right loops. For accidentals with more than two deltas, this indicates the leftmost delta.
R	Fingerprint	Right fingerprint delta	The delta to the right of the image for whorls or left loops. For accidentals with more than two deltas, this indicates the rightmost delta.
I00 I02..I05 I07..I10	Palm	Interdigital delta (with finger number)	The deltas at the base of the fingers in the interdigital areas. The finger number shall be noted if known, else set to "00". Note that thumbs do not have interdigital deltas.
C	Palm	Carpal delta	The delta at the base of the palm where the thenar and hypothenar meet.
<empty>	Fingerprint, Palm, or Foot	Other delta	Any other delta or delta-like structure in a friction ridge impression.

Note that if one or more deltas are present and the features set is from a fingerprint, Pattern Class (PAT) should be defined. Note that this does not mean that the classification has to be known definitively, but must at least be known to the extent of excluding plain arches.

Figure 14: Palm with carpal delta and inter-digital deltas 7-10 marked

13.7.26   EFS Field 9.322 Core Delta ridge counts / CDR

This field contains the count of intervening ridges between each core and delta. Each ridge count has a minimum and maximum value, so that a range can be noted. If the exact value is known, then that value should be put in the minimum and maximum fields. If only a minimum is known, such as when a delta is not visible, the maximum value shall be omitted. Ridge counts can be any non-negative integer.

When this field is used for fingerprints, ridge counts shall be provided between each core and each delta, unless there are more than two cores or two deltas in an accidental whorl, in which case only the leftmost and rightmost of the cores and deltas need be used for ridge counts.

This field consists of four information items:

- The first information item **(Core index / CIX)** is the index of the core corresponding to this count. Shall be set to "1" if only one core is defined. If the relevant core is not defined, this shall be set to "U" to indicate an upper core or "L" to indicate a lower core (whorls only), permitting minimum ridge counts when cores are not in the region of interest.

- The second information item **(Delta index / DIX)** is the index of the delta corresponding to this count. Shall be set to "1" if only one delta is defined.

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If the relevant delta is not defined, this shall be set to "L" to indicate a left delta or "R" to indicate a right delta, permitting minimum ridge counts when deltas are not in the region of interest.

- The third information item **(Minimum ridge count / MRC)** contains the precise ridge count, if it is known; otherwise, it contains the minimum of the range of ridge count values.

- The fourth information item **(Maximum ridge count / XRC)** contains the precise ridge count, if it is known; otherwise, it shall be omitted (left empty).

If this field is present and the image is a fingerprint, Pattern Class (PAT) is strongly recommended; transactions based on this specification may choose to make this a requirement.

13.7.27 EFS Field 9.323 Center point of reference / CPR

This field contains the location of a center point of reference of a fingerprint, which can be used to define how centered a fingerprint is, as a feature, for registration or orientation, and for quality measurements. While the core may serve some of the same purposes, a center point of reference is defined for arches and provides a single center location for complex whorls, unlike cores.

The location of a center point of reference can be determined using different algorithms, as stored in the Method information item. The center point of reference is defined for fingerprints or toeprints, not for other types of friction ridge images.

This field consists of the following information items:

- The first information item **(Method / CPM)** is the method of determining the X, Y location, selected from Table 28.

- The second information item (**'x' coordinate / PXC**) is in units of 10 micrometers (0.01mm)

- The third information item (**'y' coordinate / PYC**) is in units of 10 micrometers (0.01mm)

- The fourth information item **(Radius of position uncertainty / CRU)** is optional. The radius of position uncertainty is 0 (default) if the location is known precisely; if the precise location cannot be determined (such as due to poor clarity), the position is marked at the best estimate of position, with a radius including the area of other possible locations, in integer units of 10 micrometers (0.01mm). The radius of uncertainty can overlap the edge of the image.

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Table 28: EFS Methods of determining center point of reference locations

Code	Name	Description
L	Lateral center only	The center location is defined laterally (across the finger) but is not meaningful in the other dimension (longitudinally, or along the finger). Lateral center is most frequently used for defining the center line of arches, tips, and lower joints. Lateral center is only meaningful if the orientation (Field 9.301) is known; the point marked is the center with respect to the orientation angle.
0	Uppermost point of the ridge with greatest curvature	For a fingerprint with a known or estimated orientation, the center point is determined by finding the highest point of each ridge that is convex pointing upward, and measuring the curvature/peak angle by following the ridge 1.63mm (0.064in) in both directions from that point. The point with the minimum angle (greatest curvature) is the center point of reference.
1	Overall fingerprint focal point	The overall fingerprint focal point is the point where the lines perpendicular to ridge flow converge. The point of convergence is determined in terms of least squares (see, e.g., Novikov and Kot (1998)[26])

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4.   [26] Novikov S.O and Kot V.S.; "Singular Feature Detection and Classification of Fingerprints using Hough Transform"; *Proc. Of SPIE (Int. Workshop on Digital Image Processing and Computer Graphics (6th): Applications in Humanities and Natural Sciences)*; vol 3346, pp 259-269, 1998
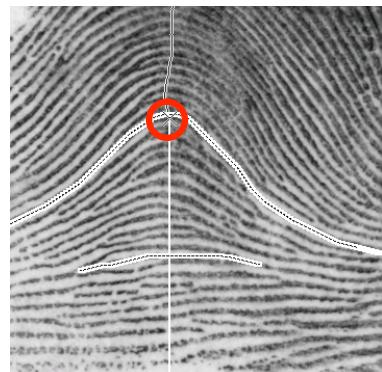
Figure 15:   EFS Lateral center example
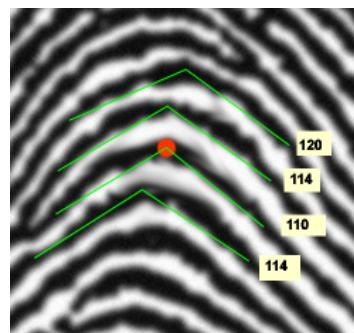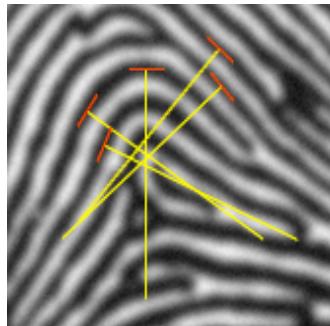
Figure 16:   EFS Uppermost point of the ridge with greatest curvature. [27]

- [27] **Measurements are angles (degrees)**

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Figure 17: EFS Overall fingerprint focal point

13.9.31 EFS Field 9.324 Distinctive Features / DIS

This field is used to define one or more areas containing unusually discriminating features that are not fully defined using other Extended Friction Ridge Features. The characteristics noted in this field are specific to the friction skin itself, as opposed to issues specific to the impression (such as smudging) which are noted in Field 9.357.

This field consists of three information items:

- The first information item **(Type / DIT)** is selected from **Table 29**

- The second information item **(Polygon / DIP)** is a closed path outlining the area of the distinctive feature.

- The third information item is **(Comment / COM)** contains optional text describing the feature.

Table 29: **EFS Types of distinctive features**

Code	Description
SCAR	Scar
WART	Wart or blister
MINGROUP	Unusual group or cluster of minutiae
CORE	Unusually distinctive core area
DELTA	Unusually distinctive delta area
MINUTIA	Unusually shaped minutia
CREASE	Unusually distinctive crease

CLEAR	Large clear field of ridges; large clear area with no minutiae
DYSPLASIA	Dissociated ridges / Dysplasia
OTHERFEAT	Other unusual features not characterized elsewhere; details should be noted in comments

13.9.32   EFS Field 9.325 No cores present / NCR

This optional field is used to indicate whether the analysis process has determined that no cores could be discerned in the image:

If the analysis process has determined that no cores could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.

13.9.33   EFS Field 9.325 No deltas present / NDL

This optional field is used to indicate whether the analysis process has determined that no cores could be discerned in the image:

If the analysis process has determined that no cores could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.

13.9.34   EFS Field 9.325 No distinctive features present / NDF

This optional field is used to indicate whether the analysis process has determined that no distinctive characteristics could be discerned in the image:

If the analysis process has determined that no distinctive characteristics could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.
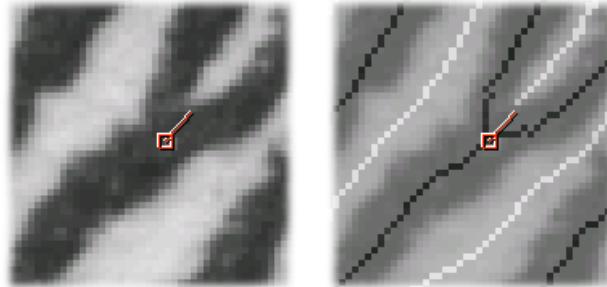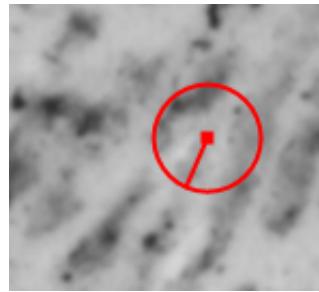
13.9.35   EFS Field 9.326 Minutiae / MIN

The type of minutiae shall be marked if clearly identifiable as a ridge ending or bifurcation; otherwise, it shall be marked as unknown type. The location for a bifurcation shall be at the "Y" of the ridge, with the direction running down the valley (see **Figure 18**). The location for a ridge ending or unknown type shall be at the "Y" of the valley, with the direction running up the ridge (see **Figure 19**). Note that the ridge ending location corresponds with that used for the FBI's EFTS and INCITS 378, and differs from some vendor-specific approaches. If the precise location for a ridge ending cannot be ascertained, a radius of uncertainty shall be marked to include the area of possible locations. If the type is unknown,
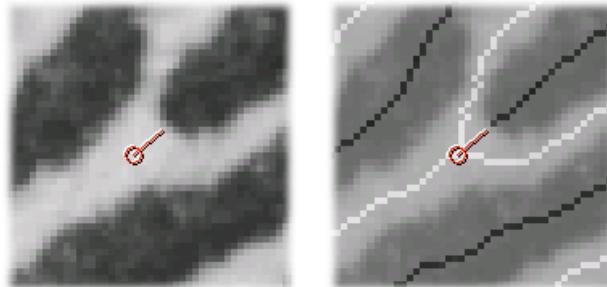
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the radius of uncertainty must be indicated (see **Figure 20**).[28]
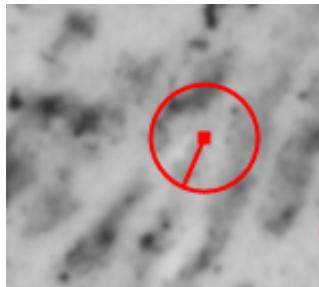
Figure 18:   EFS Minutia placement for a bifurcation. [29]

Figure 19:   EFS Minutia placement for a ridge ending.[30]

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[28] Note the relationship between **Field 9.308 Ridge Quality / Confidence Map (RQM)** and minutiae: in areas of Ridge Quality/Confidence that are green, blue, or aqua, the presence and absence of minutiae is definitive, and can be used for exclusion in future comparisons — otherwise the region should be marked yellow.

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•   [29] **The center of the bifurcation should be at the "Y" of the ridge. The theta angle should run down the valley.**

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Figure 20:   EFS Minutia placement when type is unknown. [31]

There are three confidence values used to define how precisely the minutia can be defined: confidence in existence, direction, and location. Each of these optional information items contains a positive integer value from "1" to "100" indicating the percentage confidence in the existence of the minutia. If the confidence value is determined by a human examiner, the only valid values shall be "100" (certain) or "50" (debatable); automated algorithms may use the full range.

This field consists of six information items:

- The first information item **('x' coordinate / MXC)** is expressed in units of 10 micrometers (0.01mm). [32]

- The second information item **('y' coordinate / MYC)** is expressed in units of 10 micrometers (0.01mm).

- The third information item **(Theta / MTD)** is expressed in degrees. [33]

- The fourth information item **(Type / MTY)** is selected from **Field 9.324 Distinctive Features / DIS**. [34]

> Brad Wing 6/23/10 1:09 PM
> **Comment:** Rewritten for consistency of presentation

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[30] **The center of the ridge ending should be at the "Y" of the valley. The theta angle should run up the ridge.**

• [31] **The minutia is placed as for a ridge ending, type is set to unknown, and the radius of uncertainty is defined to include possible points of intersection with neighboring ridges**.

• [32] Ridge endings are located at the fork of the midpoint of the valley (see **Figure 19**), and bifurcations are at the fork of the midpoint of the ridge (**Figure 18**). Unknown types are marked as for ridge endings, but with the radius of uncertainty also defined.

• [33] The angle of the minutia is determined by constructing three virtual rays originating at the minutia and extending 1.93mm (0.064" – about three ridge widths) along each ridge (for a bifurcation) or valley (for a ridge ending). The smallest of the three angles formed by the rays is bisected to indicate the minutiae direction.

• [34] The type of minutia shall be set if the examiner/encoding process is confident as to type: the "either" type shall be used for all minutiae that are not clearly identifiable as a ridge ending or a bifurcation. Because of the frequency with which minutiae appear to be ridge endings in one impression and bifurcation in another, even in clear images, it is recommended that the minutiae type be used as supporting evidence rather than as a basis for exclusion. All complex minutiae types (crossovers/trifurcations etc) should be marked as combinations of bifurcation/endings. Unusually distinctive types/combinations of minutiae should be marked as unusual minutiae/groups of minutiae in **Field 9.324**

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- The fifth information item **(Radius of position uncertainty / MRU)** defines the radius of a circle centered at the location (X,Y) of the minutia[35]

- The sixth information item **(Direction uncertainty / MDU)** contains an integer value from "0" (default) to "180" indicating the precision in the direction (theta) of the minutia, measured in degrees. The resulting direction is Theta±Uncertainty°.[36]

Distinctive Features (DIS).

- [35] The circle is sized to include the area of other possible locations of the minutia, if the precise location cannot be determined (such as due to poor consistencyof presentation). If the location is known precisely, the radius of position uncertainty may be omitted or set to 0. The radius of uncertainty is measured in integer units of 10 micrometers (0.01mm), and may overlap the edge of the Region of Interest.

[36] Examples of cases in which confidence in direction may be low include cases when the ridge stops or bends close to the minutia so that a good angle measurement cannot be taken, or cases with three equally spaced legs.

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Table 30: EFS Codes for minutia types

Code	Description
E	Ridge ending
B	Ridge bifurcation
X	Either ridge ending or bifurcation, not clearly distinguishable

13.9.36   EFS Field 9.332 Minutiae Ridge Count Algorithm / MRA

This optional field defines the algorithm used in determining how neighboring minutiae are selected for use in the ridge counts in the Minutiae Ridge Counts (MRC) field. The value for this field shall be selected from **Table 19**.

Table 31: EFS Codes for minutiae ridge count algorithms

Code	Description
OCTANT	The minutiae used for ridge counts are the nearest neighbors in eight octants, with the center of the 0th octant defined by the current minutia's theta, and the 1st through 7th octants proceeding counter clockwise. Ridge count values are set to number of intervening ridges. (Default)
EFTS7	Identical to OCTANT algorithm, except that ridge count values are one more than the number of intervening ridges. See [EFTS7][37] for further details.

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5.   [37] Federal Bureau of Investigation, "Electronic Fingerprint Transmission Standard", Version 7.1.

13.9.37   EFS Field 9.333 Minutiae Ridge Counts / MRC

This field contains the counts of intervening ridges between specified minutiae. **Field 9.332 Minutia Ridge Count Algorithm / MRA** governs how the minutiae are selected for ridge counts, and the details of how the ridges are counted. Note that if **Field 9.382: Skeletonized image / SIM** is used for ridge counts it can be derived from that field rather than included explicitly. This field consists of five information items:

- The first information item **(Minutia Index A / MIA)** contains the index of the first minutia.

- The second information item **(Minutia Index B / MIB)** contains the index of the second minutia.

- The third information item **(Ridge count / MIR)** contains the number of intervening ridges between minutiae A and B.[38]

- The fourth information item **(Reference number / MRN)** is optional and, if used, containsa reference number specific to the ridge count algorithm.[39]

- The fifth information item **(Residual / MRS)** is optional and is specific to the OCTANT and EFTS7 ridge count algorithms, specifying the half of the octant in which the neighboring minutia lies. The residual is 0 if the neighboring minutia lies in the clockwise half of the octant, or 1 if the minutia lies in the counterclockwise half of the octant.

13.9.38   EFS Field 9.334 No Minutiae Present / NMP

This optional field is used to indicate whether the analysis process has determined that no minutiae **(Field 9.331 Minutiae / MIN)** could be discerned in the image:

If the analysis process has determined that no minutiae could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.

- [38] Unknown ridge counts shall be omitted (left empty). Other details or special cases (if any) are governed by the Minutiae Ridge Count Algorithm (MRA) field.

- [39] For the OCTANT and EFTS7 ridge count algorithms, this information item specifies the octant

13.9.39   EFS Field 9.335 Minutiae Ridge Count Confidence / RCC

This optional field is used to indicate confidence in intervening ridge counts between any two points. While primarily used to indicate ridge count confidence between minutiae, this confidence measure can also apply to other features such as Core/Delta ridge counts. If this field not used, the default assumption is that the ridge counts were manually determined. This field provides a means to save state when only a portion of ridge counts have been manually checked.

This field consists of six information items:

- The first information item **(AX / AXC)** contains the x coordinates for Point A, in units of 10 micrometers (0.01mm).

- The second information item **(AY / AYC)** contains the y coordinates for Point A, in units of 10 micrometers (0.01mm).

- The third information item **(BX / BXC)** contains the x coordinates for Point B, in units of 10 micrometers (0.01mm).

- The fourth information item **(BY / BYC)** contains the y coordinates for Point B, in units of 10 micrometers (0.01mm).

- The fifth information item **(Method of Ridge Counting / MRC)** states the method by which ridge counts were determined and/or validated selected from **Table 32**.

- The sixth information item **(Confidence value / MCV)** contains the confidence value for a ridge count from 0 to 99, with 0 indicating no confidence.

Table 32   EFS Codes for methods of ridge counting

Value	Definition	Description
A	Auto	The ridge count was automatically performed without human review
T	Manual Tracing	The ridge count was automatically determined, based on a skeletonised image created by a human examiner.
M	Manual Ridge Count	The ridge count was determined or validated manually by a human examiner.

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13.9.40   EFS Field 9.340 Dots / DOT

A dot is a single or partial ridge unit that is shorter than local ridge width. Longer ridge units are considered standard ridges and should be marked as such, with two ridge endings. Potential dots that are substantially thinner than local ridge width should be marked as incipient ridges. A dot is marked by its center point. Elongated dots may optionally have their length marked along the longest dimension.

This field consists of three information items:

- The first information item **(Dot 'x' coordinate / DOX)** is the x coordinate of the center of the dot, expressed in units of 10 micrometers (0.01mm).

- The second information item **(Dot 'y' coordinate / DOY)** is the y coordinate of the center of the dot, expressed in units of 10 micrometers (0.01mm).

- The third information item **(Dot length / DOL)** is an optional information item containing the length of the dot along its longest dimension.

13.9.41   EFS Field 9.341 Incipient Ridges / INR

An incipient is a thin ridge, substantially thinner than local ridge width. An incipient is marked with the X,Y endpoints along its longest dimension. If the incipient is a series of clearly separate (thin) dots, they should be marked as separate incipients. If an unbroken incipient curves, it should be marked as a series of adjoining line segments.

This field consists of four information items:

- The first information item **(X1 / X1C)** contains the 'x' coordinate of one endpoint, in units of 10 micrometers (0.01mm).

- The second information item **(Y1 / Y1C)** contains the 'y' coordinate of one endpoint, in units of 10 micrometers (0.01mm).

- The third information item **(X2 / X2C)** contains the 'x' coordinate of the other endpoint, in units of 10 micrometers (0.01mm).

- The fourth information item **(Y2 / Y2C)** contains the 'y' coordinate of the other endpoint, in units of 10 micrometers (0.01mm).

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13.9.42 EFS Field 9.342 Creases and Linear Discontinuities / CLD

The permanent flexion creases are the named creases that separate the joints of the fingers and divide the palm. The crease name shall be noted for permanent flexion creases. Linear discontinuities are creases, cracks, cuts, and thin or non-permanent scars. They are often called "white lines". Linear discontinuities result in small gaps in two or more ridges. If a continuous discontinuity curves, it should be marked as a series of adjoining line segments. If a crease is feathered or composed of a series of crisscross creases, each of the short creases shall be marked separately.

This field consists of five information items:

- The first information item **(DX1 / XX1)** contains the 'x' coordinate of one endpoint, in units of 10 micrometers (0.01mm).

- The second information item **(DY1 / XY1)** contains the 'y' coordinate of one endpoint, in units of 10 micrometers (0.01mm).

- The third information item **(DX2 / DX2)** contains the 'x' coordinate of the other endpoint, in units of 10 micrometers (0.01mm).

- The fourth information item **(DY2 / DY2)** contains the 'y' coordinate of the other endpoint, in units of 10 micrometers (0.01mm).

- The fifth information item **(Type / TPD)** shall be noted using the codes from **Table 33** (illustrated in **Figure 21**)[40]

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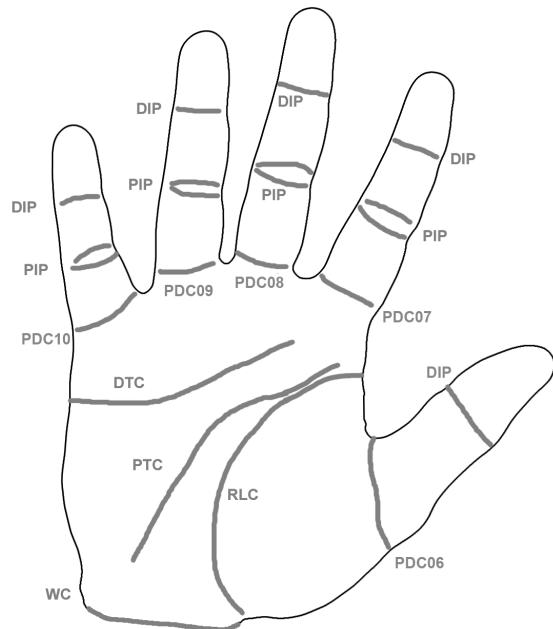
[40] For fingerprints, the only permanent flexion crease is the DIP (the distal interphalangeal crease separating the distal and medial segments of the finger, or between the proximal and distal segments of the thumb); all other permanent flexion creases relate to the palms or lower finger joints. For a feathered crease, multiple line segments may all share the same flexion crease label.

Table 33:   EFS Codes for permanent flexion creases

Code	Name	Location
DIP	Distal interphalangeal crease	Finger between medial and distal segments, or Thumb between proximal and distal segments
PIP	Proximal interphalangeal crease	Finger between proximal and medial segments
PDC##	Proximal digital crease	Finger/Thumb at Palm. The 2-digit fingerprint position code is appended (e.g. PDC01-PDC10)[41] The fingerprint position code is 00 if the finger position cannot be determined.
RLC	Radial longitudinal crease (also known as bottom crease)	Palm around base of thumb (thenar)
PTC	Proximal transverse crease (also known as middle crease)	Diagonal across palm
DTC	Distal transverse crease (also known as top crease)	Palm at base of interdigital area
WC	Wrist crease	Wrist

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6.   [41] Indicating which proximal digital crease is present is helpful in defining the location for partial interdigital latents.

Figure 21:   EFS Locations of major flexion creases

13.9.43   EFS Field 9.342 Creases and Linear Discontinuities / CLD

Ridge edge features include Protrusions (abrupt increases in ridge width), Indentations (abrupt decreases in ridge width), and Discontinuities (points where a ridge stops briefly):

A protrusion (or spur) is an abrupt increase in ridge width that is not long enough to be called a bifurcation. An event on a ridge longer than local ridge width shall be marked as a standard bifurcation with a ridge ending; a shorter event shall be marked as a protrusion. Protrusions are marked at the center of the protruding area.

An indentation is an abrupt decrease in ridge width. Indentations are marked at the center of the gap in the ridge.

A discontinuity is a point where the ridge stops briefly and restarts again without shifting. A wider gap in the ridge flow, or where the ridges do not line up across the divide, should be marked as two ridge endings, not a discontinuity. A series of discontinuities in a line (such as a cut or crack)

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should be marked as a linear discontinuity, using the Creases and Linear Discontinuities (CLD) field. A discontinuity is marked at the center of the gap in the ridge.

This field consists of three information items:

- The first information item **('x' coordinate / CLX)** contains the 'x' coordinate of one endpoint, in units of 10 micrometers (0.01mm).

- The second information item **('y' coordinate / CLY)** contains the 'y' coordinate of one endpoint, in units of 10 micrometers (0.01mm).

- The third information item **(Type / CLT)** states the type of feature: either P (Protrusion), I (Indentation), or D (Discontinuity).

13.9.44 EFS Field 9.344 No pores present / NPP

This optional field is used to indicate whether the analysis process has determined that no pores **(Field 9.345 Pores / POR)** could be discerned in the image:

If the analysis process has determined that no dots could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.

13.9.45 EFS Field 9.345 Pores / POR

Each pore is marked by its center point. This field consists of two information items:

- The first information item **('x' coordinate / POX)** contains the 'x' coordinate of the center of the pore, in units of 10 micrometers (0.01mm).

- The second information item **('y' coordinate / POY)** contains the 'y' coordinate of the center of the pore, in units of 10 micrometers (0.01mm).

13.9.46 EFS Field 9.346 No Dots Present / NDT

This optional field is used to indicate whether the analysis process has determined that no dots (

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13.9.47   EFS Field 9.340 Dots / DOT

If the analysis process has determined that no dots could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.

13.9.48   EFS Field 9.347 No Incipient Ridges Present / NIR

This optional field is used to indicate whether the analysis process has determined that no incipient ridges **(Field 9.341 Incipient Ridges / NIR)** could be discerned in the image:

If the analysis process has determined that no incipient ridges could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.

13.9.49   EFS Field 9.348 No Creases Present / NCR

This optional field is used to indicate whether the analysis process has determined that no creases **(Field 9.342 Creases and Linear Discontinuities / CLD)** could be discerned in the image:

If the analysis process has determined that no creases could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.

13.9.50   EFS Field 9.349 No Ridge Edge Features Present / NRE

This optional field is used to indicate whether the analysis process has determined that no ridge edge features **(Field 9.343 Ridge Edge Features / REF)** could be discerned in the image:

If the analysis process has determined that no ridge edge features could be discerned in the image, this field shall be set to Y.

Otherwise, this field will be omitted.

13.9.51   EFS Field 9.350 Method of Feature Detection / MFD

This field states the method(s) by which the Extended Friction Ridge features were detected and/or edited. Each time that fields are created or modified, the

date and name of the automated algorithm or human examiner is noted in a new data entry in this field.[42] This field consists of nine information items:

- The first information item **(Field / FIE)** indicates which fields correspond to the method noted: it contains a single field (e.g. "9.331"), a comma-separated list of fields without spaces (e.g. "9.340, 9.341, 9.343"), or "ALL".

- The second information item **(Method / FME)** states the method by which the fingerprint features were detected and encoded, from **Table 34**.

- The third information item **(Algorithm vendor / FAV)** identifies the vendor of the encoding algorithm.[43]

- The fourth information item **(Algorithm / FAL)** shall identify the algorithm by name and version.[44]

- The fifth information item **(Examiner last name / ELN)** shall contain the surname (last name) of the fingerprint examiner, for methods other than "AUTO"

- The sixth information item **(Examiner first name / EFN)** shall contain the first name (given name, or first and middle names) of the fingerprint examiner

- The seventh information item **(Examiner affiliation / EAF)** shall contain the employer or organizational affiliation of the examiner, for methods other than "AUTO"

- The eighth information item **(Date and Time / EMT)** shall contain the date and time that the determination was made, using Greenwich Mean Time (GMT).

- The ninth information item **(Notes / NTS)** is an optional item that may contain free text with additional information regarding the detection or modification of features.

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[42] When features are created or edited on multiple occasions, the new data entries should be added to this field without deleting the original data entries. For example, if minutiae are manually encoded by an examiner, then subsequently a second examiner modifies the minutiae, there would be two "MAN" entries for the Minutiae field (9.331)

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- [43] This applies for methods other than "MAN". If the algorithm is registed with the IBIA, this information item shall contain the prefix "IBIA" followed by the vendor's hexadecimal IBIA vendor ID. If an IBIA ID is not available, this shall just contain the name of the vendor or organization.

- [44] This applies for methods other than "MAN. If the algorithm is registered with the IBIA, this information item shall contain the prefix "IBIA" followed by the hexadecimal IBIA product type ID.

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Table 34:   EFS Codes for methods of feature detection

Code	Usage
AUTO	The fingerprint features were detected and encoded by an automated process without any possibility of human editing. The algorithm shall be noted in the appropriate information item.
REV	The fingerprint features were detected and encoded by an automated process, and manually reviewed without the need for manual editing. The algorithm and examiner's name shall be noted in the appropriate information items.
EDIT	The fingerprint features were detected and encoded by an automated process, but manually edited. The algorithm and examiner's name shall be noted in the appropriate information items.
MAN	The fingerprint features were manually detected and encoded. The examiner's name shall be noted in the appropriate information item.

13.9.52   EFS Field 9.351 Comments / COM

This text field contains additional information not noted in other fields. This may include unformatted text information such as location, background information, or descriptive information. If comments need to be made about specific portions of the impression, use Field 9.324 or Field 9.357.

13.9.53   EFS Field 9.352 Latent Processing Method / LPM

This text field contains a three-letter code from **Table 35** indicating the technique(s) used to process the latent fingerprint. This field is only used for latent images. Unprocessed impressions (patent images visible to the naked eye) are labeled VIS. Multiple methods can be marked if appropriate. Methods should only be marked if they contributed substantively to the visualization of the image, and are not a list of all methods attempted.

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Table 35: EFS Codes for methods of latent processing

Code	Processing method		Code	Processing method
ADX	Ardrox		MBD	7-p-methoxybenzylanimo-4-nitrobenz-2-oxa-1, 3-diazole
ALS	Alternate light source		MBP	Magnetic black powder
AMB	Amido black		MGP	Magnetic grey powder
BLE	Bleach (sodium hypochlorite)		MPD	Modified physical developer
BLP	Black powder		MRM	Maxillon flavine 10gff, Rhodamine 6g, and MBD
BPA	Black powder alternative (for tape)		NIN	Ninhydrin
CBB	Coomassie brilliant blue		OTH	Other
CDS	Crowle's double stain		PDV	Physical developer
COG	Colloidal gold		R6G	Rhodamine 6G
DAB	Diaminobenzidine		RAM	Cyanoacrylate fluorescent dye (Rhodamine 6G, Ardrox, MBD)
DFO	1,8-diazafluoren-9-one		SAO	Safranin O
FLP	Fluorescent powder		SDB	Sudan black
GRP	Gray powder		SGF	Superglue fuming (cyanoacrylate)
GTV	Gentian violet		SSP	Stickyside powder
IOD	Iodine fuming		SVN	Silver nitrate
ISR	Iodine spray reagent		TEC	Theonyl Europiom Chelate
LAS	Laser		VIS	Visual (patent image, not processed by other means)
LCV	Leucocrystal violet		WHP	White powder
LQD	Liquid-drox		ZIC	Zinc chloride

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13.9.54   EFS Field 9.353 Examiner Analysis Assessment / EAA

This text field indicates an examiner's assessment of the value of the single impression delineated by **Field 9.300 Region of Interest / ROI.** See also **Field 9.362 Examiner Comparison Determination / ECD** for comparison determinations. This field consists of six information items:

- The first information item **(Value / AAV)** indicates the value of the impression, from *Table 36*.

- The second information item **(Examiner last name / ALN)** shall contain the surname (last name) of the fingerprint examiner

- The third information item **(Examiner first name / AFN)** shall contain the first name (given name, or first and middle names) of the fingerprint examiner

- The fourth information item **(Examiner affiliation / AAF)** shall contain the employer or organizational affiliation of the examiner, for methods other than "AUTO"

- The fifth information item **(Date and Time / AMT)** shall contain the date and time that the determination was made, using Greenwich Mean Time (GMT).

- The sixth information item **(Comment / ACM)** contains additional clarifying information for the examiner analysis assessment.

Table 36:   EFS Codes for value assessments

Code	Usage
VALUE	The impression is of value and is appropriate for further analysis and potential comparison. Sufficient details exist to render an individualization and/or exclusion decision.
LIMITED	The impression is of limited, marginal, value. It is not of value for individualization, but may be appropriate for exclusion.
NOVALUE	The impression is of no value, is not appropriate for further analysis, and has no use for potential comparison.
NONPRINT	The image is not a friction ridge impression.

13.9.55   EFS Field 9.354 Evidence of Fraud / EOF

This text field indicates that there is basis for determination that the image may be fraudulent. This field consists of two information items:

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- The first information item **(Type of fraud / FRA)** indicates the potential type of fraud attempted as determined from the impression, from **Table 37**.

- The second information item (**Comment / CFD)** contains text that provides clarifying information regarding the assessment of potential evidence of fraud.

Table 37:   EFS Codes for fraud type assessments

Code	Name	Usage
EVA	Evidence of evasion	Evasion includes actions that prevent/lessen the likelihood of matching such as by degrading or obscuring physical characteristics or mutilating fingers.
SPO	Evidence of spoofing	Spoofing includes purposefully attempting to match a different person; techniques include modifying biological characteristics and using fabricated characteristics.
FOR	Evidence of forged evidence	Forged evidence is forensic evidence that was fraudulently placed on the surface from which it was collected.
FAB	Evidence of fabricated evidence	Fabricated evidence is forensic evidence that never existed on the surface from which it was supposedly collected.

13.9.56   EFS Field 9.355 Latent Substrate / LSB

This field is used to define the substrate, or surface on which the friction ridge impression was deposited. This field consists of the following information items:

- The first information item **(Code / CLS)** indicates the type of substrate, from the Code column of

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- **Table 38**.
  - The second information item **(Comment / CLC)** is optional and may contain text that provides clarifying information regarding the substrate.

Table 38: EFS codes for types of latent substrates

Category	Code	Description
Porous Substrate		
	1A	Paper
	1B	Cardboard
	1C	Unfinished/raw wood
	1D	Other/unknown porous substrate
Nonporous Substrate		
	2A	Plastic
	2B	Glass
	2C	Metal, painted
	2D	Metal, unpainted
	2E	Glossy painted surface
	2F	Tape, adhesive side
	2G	Tape, nonadhesive side
	2H	Aluminium foil
	2I	Other/unknown nonporous substrate
Semiporous Substrate		
	3A	Rubber or latex
	3B	Leather
	3C	Photograph, emulsion side
	3D	Photograph, paper side
	3E	Glossy or semi-glossy paper or cardboard
	3F	Satin or flat finish painted surface
	3G	Other/unknown semiporous substrate
Other / Unknown Substrate		
	4A	Other substrate (Specify)
	4B	Unknown substrate

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13.9.57   EFS Field 9.355 Latent Matrix / LMT

This field is used to define the matrix, or substance deposited by the finger that forms the impression. This field consists of three information items:

- The first information item indicates the type of matrix, from the Code column of **Table 39**.[45]

- The second information item **(Comment / CLA)** is optional and may contain text that provides clarifying information regarding the matrix.

Table 39:   EFS Codes for types of latent matrices

Code	Description
1	Natural perspiration and/or body oils (eccrine and/or sebaceous)
	Visible contaminants:
2	Blood
3	Paint
4	Ink
5	Oil or grease
6	Dirt or soil
7	Other visible contaminants
8	Impression in pliable material
9	Contaminant removal via touch
10	Other/unknown matrix

13.9.58   EFS Field 9.357 Local Quality Issues / LQI

This field is used to define one or more areas containing localized quality or transfer issues that are not fully defined using other Extended Friction Ridge Features. The problems noted in this field apply to the specific impression under consideration; issues that are specific to the friction skin itself (such as scars) are noted in (**Field 9.324 Distinctive Features / DIS).** This field consists of three information items:
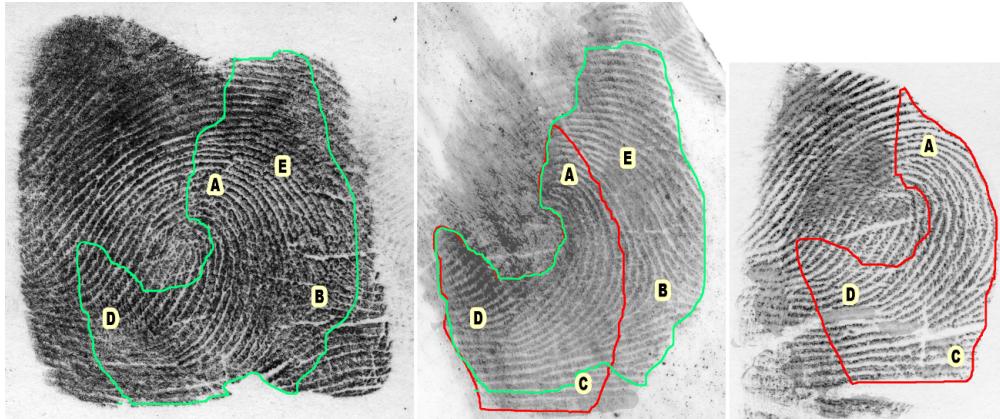
- [45] Note that all visible contaminants are apparent rather than necessarily known to certainty: for example, the substrate may be marked as blood if it appears to be blood; if known for certain that should be indicated as a comment.

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- The first information item **(Type / LQT)** is the type of characteristic, selected from *Table 40.*

- The second information item **(Polygon / LQP)** is a closed path outlining the area of the distinctive feature.

- The third information item **(Comment / LQC)** is optional and may contain text describing the quality issue.

Table 40:   EFS Codes of quality issue types

Code	Description
ARTIFACT	Digital artifacts, such as occasionally caused by compression or livescan devices.
BACKGROUND	Interference with background makes following ridges difficult (e.g. check patterns)
COMPRESSED	Distorted area in which ridges are compressed together
DISTORT	Miscellaneous distortion (See also Compressed and Stretched)
NEGATIVE	Used if only a portion of the friction ridge image is tonally reversed (has ridges and valleys inverted so that ridges appear white and valleys appear black). Note that Field 9.314 Tonal Reversal (TRV) is used if the entire image is tonally reversed.
OVERDEV	Overdeveloped area: excessive processing medium such as ink, powder, etc.
OVERLAP	Area in which another friction ridge impression is superimposed over the impression of interest
SMEAR	Smeared or smudged area
STRETCHED	Distorted area in which ridges are stretched apart from each other
TAPE	Lifting tape artifacts (crease, bubble, etc.)
OTHER	Other quality issues not characterized elsewhere; details should be noted in Comments

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Figure 22: EFS Examples of areas and points of correspondence in rolled exemplar, latent, and plain exemplar images

13.9.59 EFS Field 9.360 Area of Correspondence / AOC

This field is to be used only when two or more images contained in a single ANSI/NIST file are compared as candidates for individualization (potential mates). The area of correspondence[46] is a polygon enclosing the region of usable ridge detail present in both images being compared. If the corresponding areas are discontinuous, more than one area of correspondence may be defined for a pair of images.

One Type-9 record may have multiple AOCs defined that correspond to different images, as shown in **Figure 23**. For example, a latent could have areas of correspondence with both the rolled and plain exemplars from one subject, or a latent could have areas of correspondence with candidate exemplars from two different subjects.

This field consists of 3 information items:

- The first information item **(IDC Reference)** indicates the target image for a given AOC.[47]

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- [46] Comparison features are especially appropriate in transactions in which one latent image is bundled with one or more candidate/potential match images in order to show which areas and points in the latent image correspond to areas and points in the candidate images. Such transactions may be useful for exchanges between examiners, or for communicating results back from AFIS searches. See **Figure 22** for an example. Note that the latent has two different areas of correspondence, one for each of the exemplars.
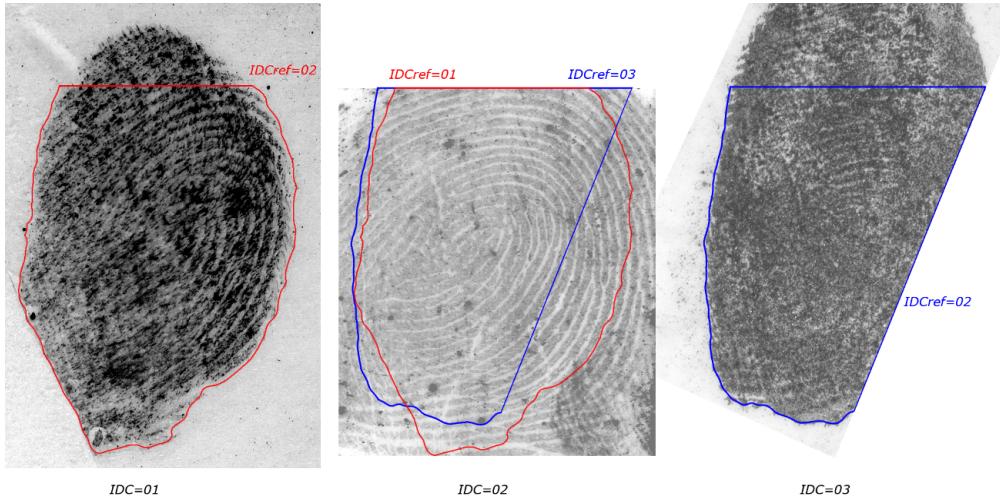
[47] Figure 23 shows examples of the use of IDC references in Corresponding Regions of Interest. The first image (IDC 01) has a single AOC, corresponding to the second image, so IDCref=02; the second image (IDC 02) has AOCs corresponding to each of the other images, with IDCref=01 and IDCref=03; the third image (IDC 03) has a single AOC, corresponding to the second image, so IDCref=02.

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- The second information item **(Polygon / AOP)** defines the outline of the corresponding area. It is a closed path.

- The third information item **(Comment / ACM)** is optional and allows a free text comment or description related to the AOC.

Figure 23:   EFS Examples of the use of IDC references in Areas of Correspondence for more than 2 images

13.9.60   EFS Field 9.361 Corresponding Points or Features / CPF

This field is used to label points or features for comparison of the current feature set with other Type-9 feature sets in this ANSI/NIST file, as was shown in **Figure 22**. This field is to be used only when two or more images contained in a single ANSI/NIST transaction are compared as candidates for individualization (potential mates). For each of the two images being compared, specific points or features that can be found in both images are marked in each of the two Type-9 records, with correspondence indicated by the use of the same label. Labels within a single Type-9 record shall be unique. For example, if an ANSI/NIST transaction contains one latent and multiple candidate exemplars, a feature labeled "A" in the latent's Type-9 feature set corresponds with the feature labeled "A" (if present) in all of the exemplar Type-9 feature sets. Corresponding Points or Features may refer to arbitrary points, or may refer to predefined features (as

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noted in **Table 43**). The features include point features (such as minutiae, dots, or pores), but also may refer to areas (such as distinctive characteristics), lines (incipients or creases), or paths (ridge path segments). Arbitrary points may be used to indicate characteristics that were not noted during analysis, or to indicate points in an exemplar that was not previously marked up.[48]

This field consists of seven information items:

- The first information item **(Label / LBC)** is a 1-3 character alphanumeric label is used to indicate correspondence between CPFs in different Type-9 records.[49]

- The second information item **(Point or Feature / POF)** is a 1-character information item used to indicate the type of correspondence or non-correspondence, set to the appropriate value from **Table 42**.

- The third information item **(Field Number / FNU)** is used only if POF = F. The Field Number information item indicates the type of field being compared, from **Table 43**.[50]

- The fourth information item **(Field Occurrence / FOC)** is used only if POF = F. The Field Occurrence information item indicates which data entry (occurrence) of the specified field the label is applied to.[51]

- The fifth information item **(Point 'x' coordinate / PXV)** is used only if POF = P. It is expressed in units of 10 micrometers (0.01mm).

- The sixth information item **(Point 'y' coordinate / PYV)** is used only if POF = P. It is expressed in units of 10 micrometers (0.01mm).

- The seventh information item **(Comment / PFC)** is optional and may contain free text comment or description related to the CPF.

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[48] For example, see **Table 41**: assume that a latent and exemplar are both present in an ANSI/NIST file, and that the latent and exemplar columns in these tables are examples from field 9.361 from different type-9 records in that file. The left table shows that the latent minutia (field 9.331) #5 corresponds to the exemplar minutia #63, with the label "M1". The right table shows that location (123,230) within the latent's ROI corresponds to location (1024,765) within the exemplar's ROI.

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• [49] Labels within a single Type-9 record shall be unique. Note that the use of a given label in one type-9 record means that that point or feature corresponds with any or all other features with the same label in other type-9 records in the ANSI/NIST transaction.

• [50] Note that these are simply the Type-9 field numbers of the fields that can be used for comparisons.

• [51] Note that this is a 1-based index, not a 0-based index: occurrences are numbered (1...count), not (0...count-1).

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Table 41: EFS Examples of corresponding points and features

	Latent	Exemplar			Latent	Exemplar
Label	M1	M1		Label	X1	X1
Type	F	F		Type	P	P
Field Number	331	331		X	123	1024
Field Occurrence	5	63		Y	230	765

Table 42: EFS Codes for types of corresponding points and features

Category	Code	Type	Description
Definite correspondence	F	Feature	The labelled feature definitely corresponds to the specific feature defined by the Field Number and Field Occurrence information items. (X and Y information items are unused)
	P	Point	The labelled feature definitely corresponds to the location with the coordinates defined in the X,Y information items. (Field Number and Field Occurrence information items are unused)
Possible or debatable correspondence	DF	Debatable Feature	The labelled feature may debatably correspond to the feature defined by the Field Number and Field Occurrence information items. (X and Y information items are unused)
	DP	Debatable Point	The labelled feature may debatably correspond to the location with the coordinates defined in the X,Y information items. (Field Number and Field Occurrence information items are unused)
Definite lack of correspondence	X	Does not exist	The labelled feature definitely does not exist in the impression, and the consistency of presentation of the potentially corresponding region is sufficient to make a definite determination. (X, Y, Field Number, and Field Occurrence information items are unused)
Inconclusive	R	Out of region	The labelled feature is not visible in the impression because it lies outside of the area of correspondence for this image: the feature may or may not be present, but the impression does not include the relevant area (X, Y, Field Number, and Field Occurrence information items are unused)
	U	Unclear area	The labelled feature is not visible in the impression because the potentially corresponding region is not sufficiently clear: the feature may or may not be present, but local quality issues prevent a definite determination. (X, Y, Field Number, and Field Occurrence information items are unused)

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Table 43:   EFS Codes for field numbers used for corresponding features

Field number	Type
320	Cores
321	Deltas
324	Distinctive Characteristics
331	Minutiae
340	Dots
341	Incipient Ridges
342	Creases and Linear Discontinuities
343	Ridge Edge Features
345	Pores
373	Ridge Path Segments

13.9.61   EFS Field 9.362 Examiner Comparison Determination / ECD

This text field indicates an examiner's determination based on analysis and comparison of two specified friction ridge images. Note that the determinations labeled "potential" are included to mark preliminary determinations for work in progress, and are not final determinations. This field consists of eight information items:

- The first information item **(IDC Reference / EDC)** indicates the target image for a given determination, and is used in the same way as the IDC subfield in Field 9.360.

- The second information item **(Determination / EDE)** indicates a comparison conclusion, from **Table 44**.

- The third information item **(Work in Progress / WIP)** is set to "PRELIMINARY" (default) or "FINAL". For a determination to be accepted for further processing, the status must be set to "FINAL". The purpose of this is to allow saving work in progress, and requiring a double-check to verify that determinations are in fact final.[52]

> Brad Wing 6/23/10 1:09 PM
> **Comment:** Reorganized for consistency of presentation

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7.   [52] The Work in progress flag is included so that e.g. someone going to lunch or home for the night, or screening out a long list of candidates, can flag cases requiring further evaluation. A classic human factors design error is not allowing people to save work in progress, resulting either in losing work or rushing determinations.

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- The fourth information item **(Examiner last name / ELN)** is the surname (last name) of the fingerprint examiner.

- The fifth information item **(Examiner first name / EFN)** is the given name (first name or first and middle names) of the fingerprint examiner.

- The sixth information item **(Examiner affiliation / EAF)** is the employer or organizational affiliation of the examiner.

- The seventh information item **(Date and Time / DTG)** is the date and time that the determination was made, in terms of Greenwich Mean Time (GMT) units.

- The eighth information item **(Comment / CZZ)** is optional and may contain text that provides clarifying or qualifying information regarding the comparison determination.

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Table 44:   EFS Codes for comparison determinations

Code	Name	Usage
INDIV	Individualization	The two impressions originated from the same source.
INC_C	Inconclusive, but with corresponding features noted	No conclusive determination can be made. Corresponding features are present, and no substantive contradictory features are present. The correspondence of features is supportive of the conclusion that the two impressions originated from the same source, but not to the extent sufficient for individualization. This determination should be made if the examiner determines that the impressions are almost certainly from the same source, but cannot make an individualization determination. This is sometimes described as a qualified conclusion.
INC_D	Inconclusive, but with dissimilar features noted	No conclusive determination can be made. Non-corresponding features are present. The dissimilarity of features is supportive of the conclusion that the two impressions originated from different sources, but not to the extent sufficient for exclusion. This determination should be made if the examiner determines that the impressions are almost certainly not from the same source, but cannot make an exclusion determination. This is sometimes described as a qualified exclusion.
INC_N	Inconclusive due to no overlapping area	Individualization and exclusion are not possible because no corresponding or potentially corresponding areas of friction ridge detail are present. This determination should be made if there is sufficient information in the impressions to determine that there are no areas in the impressions to compare, such as when one print is of the left half of a finger and the other is of the right half.
INC_I	Inconclusive due to insufficient information	Individualization and exclusion are not possible because of insufficient corresponding or contradictory data. This category should be used if the specific other types of inconclusive determinations do not apply.
EX_SRC	Exclusion of source	The two impressions originated from different sources of friction ridge skin, but the subject cannot be excluded.
EX_SUB	Exclusion of subject	The two impressions originated from different subjects.
NONE	No determination	No determination has been made. (default)

13.9.62   EFS Field 9.372 Skeletonized Image / SIM

The ridge path for the entire region of interest can be represented as a skeletonized image, also known as a ridge tracing, which reduces the friction ridge impression to an image with thinned representations of each ridge. The skeletonized image is a 2-tone image with a white background and a black single-pixel-wide thinned representation of each ridge.

The skeletonized image, also know as ridge tracing, is stored as a 1-bit grayscale PNG compressed image, bit-packed 6 bits per character using Base-64

representation. The entire PNG-formatted image is included as a single data entry. Interlacing, alpha transparency, and color palettes shall not be used. The resolution of the skeletonized image must be the same as the original image. Each black pixel can have 1,2, or 3 neighboring black pixels (1,2,3-connexity); other values (0, 4-8) are errors. The skeletonized image's dimensions shall be identical to the Region of Interest (ROI).

The values in **Field 9.308 Ridge Quality/Confidence Map / RQM** are used to distinguish between the areas in which the skeleton is debatable and those in which it is definitive.
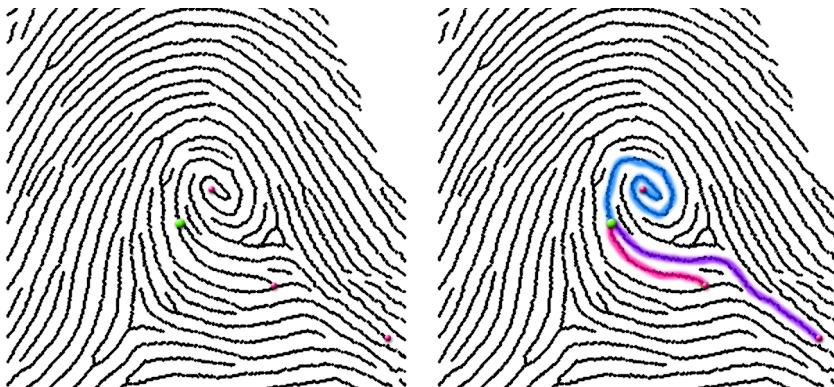
Table 45 shows the relationship between the local quality values and the tracing.

Table 45:   EFS codes for local ridge quality and tracing

Ridge path	Local Quality Code	Name
Ridge path is definitive	5	Definitive pores
	4	Definitive ridge edges, debatable pores
	3	Definitive minutiae, debatable ridge edges
Ridge path is debatable	2	Definitive ridge flow, debatable minutiae
No ridge path	1	Debatable ridge flow
	0	Background

13.9.63   EFS Field 9.373 Ridge Path Segments / RPS

Ridge path representation is a means of annotating the image (rather than replacing the image). It is a clear way of defining and communicating the specific path of each ridge, both for a human examiner and an automated extractor. The ridge path can be decomposed of a number of ridge path segments. Each ridge path segment (if completely visible) is the portion of a ridge that connects two minutiae, so each ridge path segment starts and stops either where the ridge intersects another ridge path segment (a bifurcation) or ends (a ridge ending). In the infrequent case in which a ridge segment forms a complete loop back on itself without intersecting another ridge segment (such as near the core of some plain whorls or central pocket loops), the ridge path starts and stops at a single arbitrary point on the ridge.

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Figure 24:   Example of interrelationships between minutiae, with connecting ridge path segments highlighted

Ridge path segments may not be visible over their entire length due to image consistency-of-presentation problems or due to being truncated by the edge of the impression, and therefore one or both ends of a ridge segment may not end at points defined as minutiae. Effective use of ridge path representations requires distinguishing between any areas in which the skeleton is debatable rather than definitive. **Field 9.308 Ridge Quality/Confidence Map / RQM** is used for this purpose:

Table 45 shows the relationship between the local quality values and the ridge path. **Figure 25** shows an example of a skeletonized image with a quality map: black and red areas (quality 0-1) have no skeleton; the yellow areas are poor (quality 2) and the skeleton information is not definitive; in other areas the skeleton is definitive.
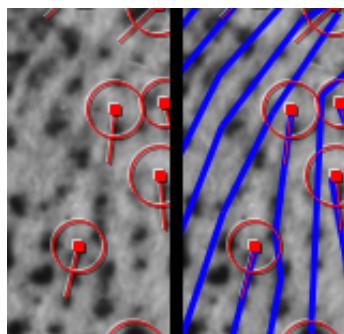
Figure 25:   Examples of fingerprint, skeletonized representation, and overlay of original / skeleton / quality map

A ridge skeleton can represent sophisticated interrelationships between features. For example, **Figure 24** shows that the bifurcation in red shares the same ridge with the three minutiae in green. The human latent fingerprint comparison process relies heavily on such feature interrelationships.

Note that the PATH format permits the treatment of each ridge segment as a distinct feature, indexed by its data entry (occurrence) number. Each ridge segment can be associated with the minutiae at its ends and features such as pores and ridge edge features along its length. Dots and incipients can be associated with the ridge segments on either side. Each ridge ending is associated with one ridge segment; each bifurcation is associated with three ridge segments.

In the case that the type of minutia cannot be determined or its precise location cannot be ascertained, a minutia can be tentatively associated with any ridge segments that cross the minutia's radius of uncertainty, as shown in **Figure 26**.

Figure 26:   Examples of minutiae of uncertain type and radii of uncertainty, without and with ridge segments

Each ridge path segment is saved as an open path (ordered set of vertices). Incipient ridges, dots, ridge discontinuities, and protrusions are not included in the ridge path representation. Each skeletized ridge segment is stored as a separate data entry (occurrence). Each endpoint of a ridge segment is either shared by 3 ridge segments (at a bifurcation) or is unique to a single ridge segment (at a ridge ending).

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Field 9.901: Universal latent annotation information / LAI

This optional field is used to store annotation or processing information associated with the Universal Latent Workstation or compatible software. It is a text field with up to 300 characters per occurrence and an unlimited number of occurrences.

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14 Type-10 facial or SMT image record

Type-10 records shall contain facial and/or SMT image data and related ASCII information pertaining to the specific image contained in this record. It shall be used to exchange both grayscale and color image data in a compressed or uncompressed form Note that this version of the standard separates facial into Type 11 and SMT images into Type 12. Updates to reflect the recommendations included in the "Mobile ID Devices Best Practices Recommendations, Version 1.0" and other revisions to facial biometric data encoding are included in this version of the standard.

Table 46 Type-10 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
	M	10.001		RECORD HEADER	1	1
IDC	M	10.002	N	IMAGE DESCIGNATION CHARACTER	1	1
IMT	M	10.003	A	IMAGE TYPE	1	1
SRC	M	10.004	AN	SOURCE AGENCY / ORI	1	1
PHD	M	10.005	N	PHOTO DATE	1	1
HLL	M	10.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	10.007	N	VERTICAL LINE LENGTH	1	1
SLC	M	10.008	N	SCALE UNITS	1	1
HPS	M	10.009	N	HORIZONTAL PIXEL SCALE	1	1
VPS	M	10.010	N	VERTICAL PIXEL SCALE	1	1
CGA	M	10.011	AN	COMPRESSION ALGORITHM	1	1
CSP	M	10.012	A	COLOR SPACE	1	1
SAP	M	10.013	N	SUBJECT ACQUISITION PROFILE	1	1
FIP	O	10.014		FACE IMAGE POSITION WITH FULL IMAGE	1	1
LHC	M⇑		N	LEFT HORIZONTAL COORDINATE VALUE	1	1
RHC	M⇑		N	RIGHT HORIZONTAL COORDINATE VALUE	1	1
TVC	M⇑		N	TOP VERTICAL COORDINATE VALUE	1	1
BVC	M⇑		N	BOTTOM VERTICAL COORDINATE VALUE	1	1
BBC	O⇑		A	BOUNDING BOX CODE	1	1
RSV		10.015		RESERVED FOR FUTURE DEFINITION		

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
SHPS	O	10.016	N	SCAN HORIZONTAL PIXEL SCALE	0	1
SVPS	O	10.017	N	SCAN VERTICAL PIXEL SCALE	0	1
DIS	O	10.018		DISTORTION	0	1
IDK	M⇑		A	DISTORTION CODE	1	1
IDM	M⇑		A	MEASUREMENT CODE	1	1
DSC	M⇑		A	DISTORTION SEVERITY CODE	1	1
LAF	O	10.019	A	LIFHTING ARTIFACTS	0	1
POS	O	10.020	A	SUBJECT POSE	0	1
POA	C-POS	10.021	N	POSE OFFSET ANGLE	0	1
PXS	O	10.022	A	PHOTO DESCRIPTION (Deprecated in this version)	0	9
PAS	C-SAP	10.023	A	PHOTO ACQUISITION SOURCE	0	1
SQS	O	10.024		SUBJECT QUALITY SCORE	0	9
QVS	M⇑			QUALITY VALUE SUBFIELD	1	Unlimited
QVU	M⇑		N	QUALITY VALUE	1	1
QAV	M⇑		N	ALGORITHM VENDOR IDENTIFICATION	1	1
QAP	M⇑		N	ALGORITHM PRODUCT IDENTIFICATION	1	1
SPA	C-POS	10.025	N	SUBJECT POSE ANGLE	0	1
YAW	M⇑		N	YAW ANGLE	1	1
PIT	M⇑		N	PITCH ANGLE	1	1
ROL	M⇑		N	ROLL ANGLE	1	1
YAWU	O⇑		N	YAW UNCERTAINTY	0	1
PITU	O⇑		N	PITCH UNCERTAINTY	0	1
ROLU	O⇑		N	ROLL UNCERTAINTY	0	1
SXS	C-SAP	10.026	A	SUBJECT FACIAL DESCRIPTION	0	50
SEC	C-SAP	10.027	A	SUBJECT EYE COLOR	0	1
SHC	C-SAP	10.028	A	SUBJECT HAIR COLOR	0	2
SFP		10.029	N	FACIAL FEATURE POINTS	0	88
FPC	M⇑		N	FEATURE POINT TYPE	1	1
FPI	M⇑		N	FEATURE POINT CODE	1	1

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Data Format for the Interchange of Biometric and Forensic Information

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
HVC	M⇑		N	X COORDINATE	1	1
VCV	M⇑		N	Y COORDINATE	1	1
DMM	O	10.030	A	DEVICE MONITORING CODE	0	1
TMC	O	10.031	N	TIERED MARKUP COLLECTION	0	88
AMC	O	10.032	A	ANTHROPOMETRIC 3D MARUP CODES	0	88
FEC	C-TMC	10.033		FEATURE CONTOURS	0	88
CTC	M⇑		N	CONTOUR CODE	1	1
PPQ	M⇑		N	NUMBER OF POINTS ON THE POLYLINE	1	1
PPV	M⇑			VERTICES OFFSET	3	99
PHV	M⇑		N	HORIZONTAL PIXEL OFFSET OF VERTEX	1	1
PVV	M⇑		N	VERTICAL PIXEL OFFSET OF VERTEX	1	1
RSV		10.034-10.039		RESERVED FOR FUTURE DEFINITION		
SMT	C-IMT	10.040	A	NCIC DESIGNATION CODE FOR LOCATION	1	3
SMS	C-IMT	10.041		SCAR / MARK / TATTOO SIZE	0	1
HGT	M⇑		N	SMT HEIGHT	1	1
WID	M⇑		N	SMT WIDTH	1	1
SMD	O	10.042		SMT DESCRIPTORS	0	1
SDT	M⇑			SMT DATA GROUPING	1	9
SMI	M⇑		A	SMT CODE INDICATOR	1	1
TAC	C-SMI		A	TATTOO CLASS	1	1
TSC	C-TAC		A	TATTOO SUBCLASS	1	1
TDS	O⇑		A	TATTOO DESCRIPTION	1	1
COL	C-SMD	10.043		SMT COLORS PRESENT	0	1
CSF	C-SDT		A	SMT COLOR GROUPING	1	9
CCX	M⇑		A	COLOR CODE	1	12
ITX	O	10.044	A	IMAGE TRANSFORM CODES	1	18
RSV		10.044-10.199		RESERVED FOR FUTURE DEFINITION		
UDF	O	10.200-		USER DEFINED FIELDS		

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Data Format for the Interchange of Biometric and Forensic Information

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
		10.990				
RSV		10.991-10.995		RESERVED FOR FUTURE DEFINITION		
HAS	O	10.996	N	IMAGE HASH	0	1
OIV	O	10.997		ORIGINAL IMAGE REFERENCE	0	1
OIR	M⇑		N	ORIGINAL IMAGE REFERENCE CODE	1	1
RTV	O⇑		N	SEGMENTATION REFERENCE VALUE	0	1
GEO	O	10.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE, MINUTE, SECOND VALUE	0	1
DATA	M	10.999	B	IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

14.1 Field 10.001 Record Header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

14.2 Field 10.002 Image designation character / IDC

This mandatory field shall be used to identify the text information contained in this record. The IDC contained in this field shall be the IDC of the Type-10 record as found in the file content (CNT) field of the Type-1 record.

14.3 Field 10.003: Image type / IMT

This mandatory ASCII field is used to indicate the type of image contained in this record. It shall contain *"FACE", "SCAR", "MARK"*, or *"TATTOO"* to indicate the appropriate image type. If Field 10.042, information item SMI contains "CHEMICAL" OR "BRANDED" OR "CUT" then field 10.003 should be marked "TATTOO", since it is a deliberately applied or drawn image.

Brad Wing 6/21/10 9:26 AM
Comment: Note new explanation and cross-reference to 10.042.

14.4 Field 10.004: Source agency / ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that originally captured the image contained in the record. Normally,

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the Originating Agency Identifier, ORI, of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

14.5 Field 10.005: Photo date / PHD

This mandatory ASCII field shall contain the date that the facial or SMT image contained in the record was captured.

The *YYYY* characters shall represent the year the image was captured; the *MM* characters shall be the tens and units values of the month; and the *DD* characters shall be the tens and units values of the day in the month. See the rules for encodings to get the format of this field.

14.6 Field 10.006: Horizontal line length / HLL

This mandatory ASCII field shall contain the number of pixels contained on a single horizontal line of the transmitted image.

14.7 Field 10.007: Vertical line length / VLL

This mandatory ASCII field shall contain the number of horizontal lines contained in the transmitted image.

14.8 Field 10.008: Scale units / SLC

This mandatory ASCII field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

14.9 Field 10.009: Horizontal pixel scale / HPS

This mandatory ASCII field shall specify the integer pixel density used in the horizontal direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

14.10 Field 10.010: Vertical pixel scale / VPS

This mandatory ASCII field shall specify the integer pixel density used in the vertical direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

14.11 Field 10.011: Compression algorithm / CGA

This mandatory ASCII field shall contain an entry from **Table 2** (other than WSQ) to specify the algorithm used for compressing the color or grayscale image. An entry of *"NONE"* in this field indicates that the data contained in this record is uncompressed. The image shall be represented as an array of n rows by m columns by at least 8-bit pixels. Each pixel in a monochrome image shall be represented by eight or more bits. Color images shall be represented as a series of sequential samples of a red, green, and blue intensity for each pixel. The image shall be organized in row-major order, with the lowest address

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> Brad Wing 6/20/10 2:18 PM
> **Comment:** Revised to be encoding neutral

corresponding to the upper left corner of the image. For those images that are to be compressed, the method for the compression of facial and SMT images is specified by the baseline mode of the JPEG, JPEG 2000, or PNG algorithms.

14.12 Field 10.012: Color space / CSP

This mandatory ASCII field shall contain an entry from **Table 1** to identify the color space used to exchange the image data. If the color space for an image cannot be determined, an entry of "RGB" shall be entered.

For JPEG-compressed color images (stored using the JFIF format), the preferred (external) color space is sRGB and an entry of "SRGB" shall be used. For all grayscale (monochrome) images, an entry of "GRAY" shall be used.

For JPEG 2000 images stored using the JP2 format, the available enumerated color spaces are sRGB, sYCC, and grayscale, to be entered, respectively, as "SRGB", "SYCC", and "GRAY". The preferred (external) color space for color images is sRGB. If a photo acquisition device uses another ICC[53] color profile, the acquisition system must convert the image data to one of these enumerated color spaces before the JP2 image may be embedded in a Type-10 record.

For uncompressed color images containing non-interleaved red, green, and blue pixels in that order, the preferred color space is sRGB and an entry of "SRGB" shall be used.

Note that the field codes do not determine if the image data is JPEG, JPEG 2000, or uncompressed color images. Field 10.011 will need to be examined to make that determination.

14.13 Field 10.013: Subject acquisition profile / SAP

The Subject Acquisition Profile (SAP) is a mandatory ASCII text field when field 10.003 contains "FACE". The intent of this field is to provide a general description of the criteria under which the facial image was captured. This field shall contain an ASCII character code selected from Table 47 to indicate the numeric value of the acquisition profile and conditions used to acquire the image. Typically, the higher the value, the stronger the acquisition requirements become. Therefore, in the text below, the SAP value will also be denoted as a "level".

Table 47 is a brief description of each of the levels. Note that levels 10 to 15 denote transactions associated with image acquisition under the guidance of other facial standards or application profiles. Levels 30 to 51 reference best practice recommendations consisting of increasingly more stringent requirements that must be satisfied. See the Best Practice Image Capture Requirements for SAP levels 30,40,50 and 51 at www.biometrics.nist.gov/standard

Brad Wing 6/20/10 2:50 PM
Comment: Moving the annexes to separate documents.

• [53] International Color Consortium (ICC), http://www.color.org/

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Table 47: Subject acquisition profiles

Subject Acquisition Profile	Attribute Level Code
Unknown profile	0
Surveillance facial image	1
Driver's license image (AAMVA)	10
ANSI Full Frontal facial image (ANSI 385)	11
ANSI Token facial image (ANSI 385)	12
ISO Full Frontal facial image (ISO/IEC 19794-5)	13
ISO Token facial image (ISO/IEC 19794-5)	14
PIV facial image (NIST SP 800-76)	15
Legacy Mugshot	20
Best Practice Application – Level 30	30
Mobile ID Best Practice Level 32	32
Best Practice Application – Level 40	40
Mobile ID Best Practice Level 42	42
Best Practice Application – Level 50	50
Best Practice Application – Level 51	51
Mobile ID Best Practice Level 52	52

The *Mobile ID Best Practice Recommendation* lists SAP levels specifically oriented to mobile devices. Those SAP levels for face (32, 42, and 52) may be entered in this field.

Comment [Brad Wing 6/20/10 2:47 PM]: Note the addition of the codes associated with mobile best practices

14.13.1   Level-0 (Unknown profile)

This level denotes any case when the Subject Acquisition Profile is unknown. This value can be used to alert systems that the profile of the face image needs to be determined manually or via advanced face image quality evaluation techniques.

14.13.2   Level-1 (Surveillance facial image)

This SAP denotes a surveillance facial image: a face image captured without specific regard to scene, photographic, or digital requirements. For example, an image of a face from commonly available surveillance video equipment is generally considered a surveillance facial image. Typically surveillance facial

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images are of relatively poor quality compared to mugshots, including significant pose angle used for the frontal view, poor image resolution, poor image contrast, etc.

14.13.3   Levels 10-15 (Other application profiles)

Levels 10-15 shall denote transaction associated with capture under the guidance of other facial standards or application profiles as defined below.

Level-10 denotes a driver license facial portrait described in the AAMVA International Specification – DL/ID Card Design

Level-11 denotes an ANSI facial image that meets requirements of the Full Frontal Image type defined in ANSI INCITS 385-2004

Level-12 denotes an ANSI facial image that meets requirements of the Token Face Image type defined in ANSI INCITS 385-2004

Level-13 denotes an ISO facial image that meets the requirements of the Full Frontal Image defined in International standard ISO/IEC 19794-5

Level-14 denotes an ISO facial image that meets the requirements of the Token Face Image type defined in International standard ISO/IEC 19794-5

Level-15 denotes a PIV facial image that meets requirements of Biometric Data Specification for Personal Identity Verification defined in NIST SP 800-76.

Note that the facial images of Level-13 and Level-14 may come from travel documents as described in "Deployment of Machine Readable Travel Documents'', ICAO Technical Report, version 2.0.

14.13.4   Level-20 (Legacy facial mugshot)

A facial image conforming to this application profile level shall be a mugshot formatted according to ANSI/NIST-ITL 2000, but not necessarily or known to be conforming to the best practice requirements given in level-30. The subject pose(s) can be Frontal, Profile, or Angled.

14.13.5   Best Practice Application Level-30

A facial image conforming to a level-30 application profile shall include at least one mugshot record conforming to all best practice requirements (BPR). These mugshots shall adhere to strict background, lighting, and resolution requirements. In particular, the background is 18% gray, the lighting is three-point, and the image size is at least 480x600 pixels with an aspect ratio of 1:1.25.

14.13.6   Best Practice Application Level-40

A facial image conforming to the level-40 application profile can be captured with an off-the-shelf 1megapixel camera. Requirements for conformance with level-40 facial image capture include the following:

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- Conformance to the minimum requirements for the capture of level-30 facial images
- At least one frontal face image shall be captured which conforms to the "face image capture requirements"
- The minimum number of pixels in the electronic digital image shall be 768 pixels in the horizontal direction by 1024 pixels in the vertical direction and
- Facial images shall conform to the "head and shoulders" composition detailed requirements.

It should be noted that the image quality of the captured facial images will be improved as the number of pixels in both directions are increased. However, as images are captured with an increased number of pixels, the 3:4 (Width:Height) aspect ratio shall be maintained.

14.13.7   Best Practice Application Level-50 and Level-51

A facial image conforming to the level 50 and level 51 application profiles shall include "face image capture requirements". These profile levels are intended to allow for examination of up to forensic-level (10 ppmm) detail on a subject's face. The only difference between level-50 and level-51 is that level-50 specifies the "head and shoulders" composition requirements while level-51 specifies the "head only" composition requirements.

Identification applications require approximately 1700 pixels wide by 2515 pixels high on the face for the 99th percentile male in the U.S. population.   Allocating 50% of the image width for the head requires approximately 3400 pixels for a "head and shoulders photo" image width. For a level-50 image capture profile, the minimum number of pixels in the electronic digital image shall be 3300 pixels in the horizontal direction by 4400 pixels in the vertical direction. Off-the-shelf 15 (or more) megapixel digital cameras satisfy this requirement.

As an alternative, allocating 70% of the image width for the head requires approximately 2400 pixels for the "head only" facial capture. For a level-51 image capture profile, the minimum number of pixels in the electronic digital image shall be 2400 pixels in the horizontal direction by 3200 pixels in the vertical direction. Off-the-shelf 8 megapixel digital cameras satisfy this requirement.

The level-50 and level-51 SAPs allow for the encoding of face images that are consistent with the discussion above and with the "face image capture requirements". It should be noted that the image quality of the captured facial images might be improved as the number of pixels in both directions are increased. Figure 27 illustrates the improvement in image quality from levels 30 to 50/51. However, as images are captured with an increased number of pixels, the 3:4 (Width:Height) aspect ratio shall be maintained.

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| a. Level 30 | b. Level 40 | c. Levels 50 and 51 |

Figure 27: Examples of resolution for levels 30, 40, & 50/51

14.14 Field 10.014: Face image position coordinates within full image / FIP

This is an optional field.

If the face image contains more than one face, or is not cropped to a "head only" or "head and shoulders" composition, this optional field contains offsets to the location(s) of the bounding box(es) of one or more full or partial face(s) within a larger image. This field is only appropriate for images that do *not* comply with SAP Levels 30, 40, 50, or 51, because those images are by definition cropped to a "head only" or "head and shoulders" composition.

If the image contains more than one face, the first occurrence of this field (first bounding box) indicates the face of interest; all associated Type 10 fields (e.g., SFP 10.029, POS 10.020) are limited to the face defined by the first bounding box in the larger image. This field consists of four (4) mandatory and one (1) optional information item. This field is comprised of five information items:

•   The first information item (left horizontal coordinate value / LHC) is the left horizontal offset of the bounding box is relative to the origin positioned in the upper left corner of the image. It is expressed in pixel counts across.

•   The second information item (right horizontal coordinate value / RHC) is the right horizontal offset of the bounding box is relative to the origin positioned in the upper left corner of the image. It is expressed in pixel counts across.

•   The third information item (top vertical coordinate value / TVC) is the top vertical offset of the bounding box relative to the origin positioned in the

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> **Comment:** Reorganized to be consistent with presentation format

upper left corner of the image. It is expressed in pixel counts down.

• The fourth information item **(bottom vertical coordinate value / BVC)** is the bottom vertical offset of the bounding box relative to the origin positioned in the upper left corner of the image. It is expressed in pixel counts down.

• The fifth information item **(bounding box code / BBC)** is the bounding box type, indicating the contents of the bounding box. If this field is omitted, the default value shall be H (Head only). Its potential clues are:

S: Head and Shoulders — the image within the bounding box is compliant with a head and shoulders composition

H: Head Only — the image within the bounding box is compliant with a head only composition

F: Face Only — the image within the bounding box contains a subject s two eyes, nose, and mouth

N: Non Frontal Head — Image within the bounding box contains the subject s entire head, but is not frontal facing or is otherwise not compliant with a head only composition

X: Partial face

14.15 Field 10.016: Scanned horizontal pixel scale / SHPS

This optional ASCII field shall specify the horizontal pixel density used for the scanning of the image providing the SLC field contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

14.16 Field 10.017: Scanned vertical pixel scale / SVPS

This optional ASCII field shall specify the vertical pixel density used for the scanning of the image providing the SLC field contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

14.17 Field 10.018: Distortion / DIS

This optional field contains the type of distortion, whether it is estimated or calculated, and its relative severity. This field consists of three information items.

The first information item is the **distortion code / IDK**. The allowed values for this field are: "Barrel" (Image appears to be spherized or "inflated"; also known as wideangle or fisheye distortion or "Pincushion" (Image appears to be pinched at the center or bowed inwards.

• The second information item is an alphabetic code**, which is a distortion measurement code / IDM,** that indicates if the distortion is estimated (E) or calculated (C).

• The third information item is the **distortion severity code / DSC**. The allowed values are: Mild, Moderate or Severe.

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14.18 Field 10.019: Lighting artifacts / LAF

This optional field contains the type of lighting artifacts found in the Type 10 image record. This field consists of one information item. Multiple lighting artifacts may be repeated as subfields. The codes are:

F: Face shadows

H: Hot spots

R: Reflections from eye glasses

14.19 Field 10.020: Subject pose / POS

This optional field is to be used for the exchange of facial image data. When included, this field shall contain one ASCII character code selected from Table 48 to describe the pose of the subject. For the determined 3D pose entry "D", Field 10.025 shall contain a set of determined 3D pose angles (i.e., Yaw, Pitch, and Roll angles) away from the full frontal face orientation. Note that the offset angle in Field 10.021 is opposite from the yaw angle in Field 10.025 as indicated by a minus sign.

Table 48 Subject pose

Pose description	Pose code
Full Face Frontal	F
Right Profile (90 degree)	R
Left Profile (90 degree)	L
Angled Pose	A
Determined 3D Pose	D

14.20 Field 10.023: Pose offset angle / POA

This shall only be used for the exchange of facial image data if Field 10.020 (POS) contains an "A" to indicate an angled pose of the subject. This field shall be omitted for a full face or a profile. This ASCII field specifies the pose direction of the subject at any possible orientation within a circle. Its value shall be to the nearest degree.

The offset angle shall be measured from the full-face pose position and have a range of values from -180 degrees to +180 degrees. A positive angle is used to express the angular offset as the subject rotates from a full-face pose to their left (approaching a right profile). If the entry in the POS field is an "F", "L" or "R", the contents of this field are to be ignored.

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14.21 Field 10.023: Photo acquisition source / PAS

This optional field shall specify the classification of the source of the image contained in this record. This field is mandatory if the SAP entry (Field 10.013) is "40" or greater for face image records. When included, this field shall contain an ASCII character code selected from Table 49 to describe the source of captured image data.

Table 49 Acquisition source type codes

Acquisition source type attribute	Attribute code
Unspecified or unknown	UNSPECIFIED
Static photograph from an unknown source	UNKNOWN PHOTO
Static photograph from a digital still-image camera	DIGITAL CAMERA
Static photograph from a scanner	SCANNER
Single video frame from an unknown source	UNKNOWN VIDEO
Single video frame from an analogue video camera	ANALOGUE VIDEO
Single video frame from a digital video camera	DIGITAL VIDEO
Vendor specific source	VENDOR

The *"VENDOR"* category is used to enter unlisted or miscellaneous source attributes of the facial image.

14.22 Field 10.024: Subject quality score / SQS

This optional ASCII field shall specify quality score data for facial images stored in this record. They identify a quality score and the algorithm used to create the quality score. This information is useful to enable the recipient of the quality score to differentiate between quality scores generated by different algorithms and adjust for any differences in processing or analysis as necessary.

The subfield **(Quality Value / QVS)** may be repeated. It is comprised of the following information items:

- The first information item **(quality value / QVU)** shall be a quantitative

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expression of the predicted matching performance of the biometric sample. This item contains the ASCII representation of the integer image quality score between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality. An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards.

- The second information item **(algorithm vendor identification / QAV)** shall specify the ID of the vendor of the quality algorithm used to calculate the quality score. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

- The third information item **(algorithm product identification / QAP)** shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but it is not required to be registered. This indicates which of the vendor's algorithms was used in the calculation of the quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65,535.

14.23 Field 10.025: Subject pose angles / SPA

This optional ASCII field shall be present when Field 10.020 (POS) contains a *"D"* to indicate a set of determined 3D pose angles of the same subject. Each angle value shall be to the nearest integer degree.

If the entry in the POS Field is an *"F", "L"*, or *"R",* the contents of this field are ignored. When present, this information shall be entered as three or six information items. If this field is used, the first three are mandatory. The last three are optional.

- The first information item is the **Yaw angle / YAW** (rotation about the vertical 'y' axis)

- The second information item is the **Pitch angle / PIT** (rotation about 'x' horizontal axis)

- The third information item is the **Roll angle / ROL** (rotation about the 'z' axis).

- The fourth information item is the **uncertainty in degrees for Yaw / YAWU**.

- The fifth information item is the **uncertainty in degrees for Pitch / PITU**

- The sixth information item is the **uncertainty in degrees for Roll / ROLU**

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14.24 Field 10.026: Subject facial description / SXS

This optional ASCII field shall be used for the exchange of facial image data. This field is mandatory if the SAP entry (Field 10.013) is "40" or greater. When present, it shall describe the facial expression of the subject and other attributes associated with the subject's captured facial image. This field may have one or more subfields each containing a single information item. Attributes associated with   the   facial   image   may   be   selected   from

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Table 50 and entered in this field. For "Physical Characteristic", enter a characteristic the NCIC Code Manual[54]. For the "Other Characteristic" enter unlisted or miscellaneous attributes as unformatted text used to describe the attribute. Multiple attributes may be listed.

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> **Comment:** This eliminates the need for Annex E

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[54] See the Ninth edition (December 2000) of the NCIC Code Manual. If the NCIC Code Manual is updated, the latest edition shall be the governing document regarding valid codes.

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Table 50 Subject facial description codes

Facial description attribute	Attribute code
Expression unspecified	UNKNOWN
Neutral (non-smiling) with both eyes open and mouth closed)	NEUTRAL
Smiling where the inside of the mouth and/or teeth is not exposed (closed jaw).	SMILE
Subject having mouth open	MOUTH OPEN
Having teeth visible	TEETH VISIBLE
Raising eyebrows	RAISED BROWS
Frowning	FROWNING
Looking away from the camera	EYES AWAY
Squinting	SQUINTING
Subject wearing left eye patch	LEFT EYE PATCH
Subject wearing right eye patch	RIGHT EYE PATCH
Subject wearing clear glasses	CLEAR GLASSES
Subject wearing dark or visible colored glasses (medical)	DARK GLASSES
Head covering/hat	HAT
Wearing scarf	SCARF
Having moustache	MOUSTACHE
Having beard	BEARD
Ear(s) obscured by hair	NO EAR
Blinking (either or both eyes closed)	BLINK
Having distorting medical condition impacting feature point detection	DISTORTING CONDITION
Physical characteristics	<From NCIC Code Manual>54
Other characteristics	<Unformatted Text>

14.25 Field 10.027: Subject eye color / SEC

This optional ASCII field shall be used for the exchange of facial image data. This field is mandatory if the SAP entry (Field 10.013) is "40" or greater. When present, it shall describe the eye color of the subject as seen in the photograph. If unusual or unnatural such as may be the case when colored contact lenses are present and the "real" eye color cannot be ascertained, then the color should be labeled as "XXX". Eye color attributes and attribute codes are given by

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Table 51 Eye color codes

Eye color attribute	Attribute code
Black	BLK
Blue	BLU
Brown	BRO
Gray	GRY
Green	GRN
Hazel	HAZ
Maroon	MAR
Multicolored	MUL
Pink	PNK
Unknown	XXX

14.26 Field 10.028: Subject hair color / SHC

This optional ASCII field shall be used for the exchange of facial image data. This field is mandatory if the SAP entry (Field 10.013) is "40" or greater. When present, it shall contain an entry from Table 52 that describes the hair color of the subject as seen in the photograph. For unusual or unnatural colors not listed in the table, or the "real" color cannot be ascertained, the hair color should be labeled as "XXX". If the subject is completely bald, or has a completely shaved head, then the hair color shall be labeled as "BAL". When the subject is predominantly bald, but hair color is discernable, then the appropriate hair color attribute code shall follow "BAL".

Table 52 Hair color codes

Hair color attribute	Attribute code
Unspecified or unknown	XXX
Bald	BAL
Black	BLK
Blonde or Strawberry	BLN
Brown	BRO
Gray or Partially Gray	GRY
Red or Auburn	RED

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Sandy	SDY
White	WHI
Blue	BLU
Green	GRN
Orange	ONG
Pink	PNK
Purple	PLE

14.27 Field 10.029: 2D Facial feature points / FFP

The optional field shall be used for the exchange of facial image data feature points or landmarks. When present, it shall describe special attributes of manually or automatically detected facial feature points of the captured facial image. This information shall be entered as a four information item feature point block as described in Table 53. Multiple facial points may be listed using these four information items.

Table 53 Subject feature point field

Item	Size	Value	Notes
Feature Point Type FPC	1 character	1 or 2 (other values reserved)	1) Denotes a 2D Feature Point. Z coordinate is ignored. 2) Anthropometric landmark as defined in **Table 55**
Feature Point Code FPI	3-5 characters	If Feature Point Type = 1 A.B in ASCII text as described in 14.27.1.1 If Feature Point Type = 2 Codes are described in 14.27.1.3	
X coordinate HCV	1 5 characters	Horizontal pixel count from upper left pixel.	Count starts at 0.
Y coordinate VCV	1 5 characters	Vertical pixel count from upper left pixel.	Count starts at 0.
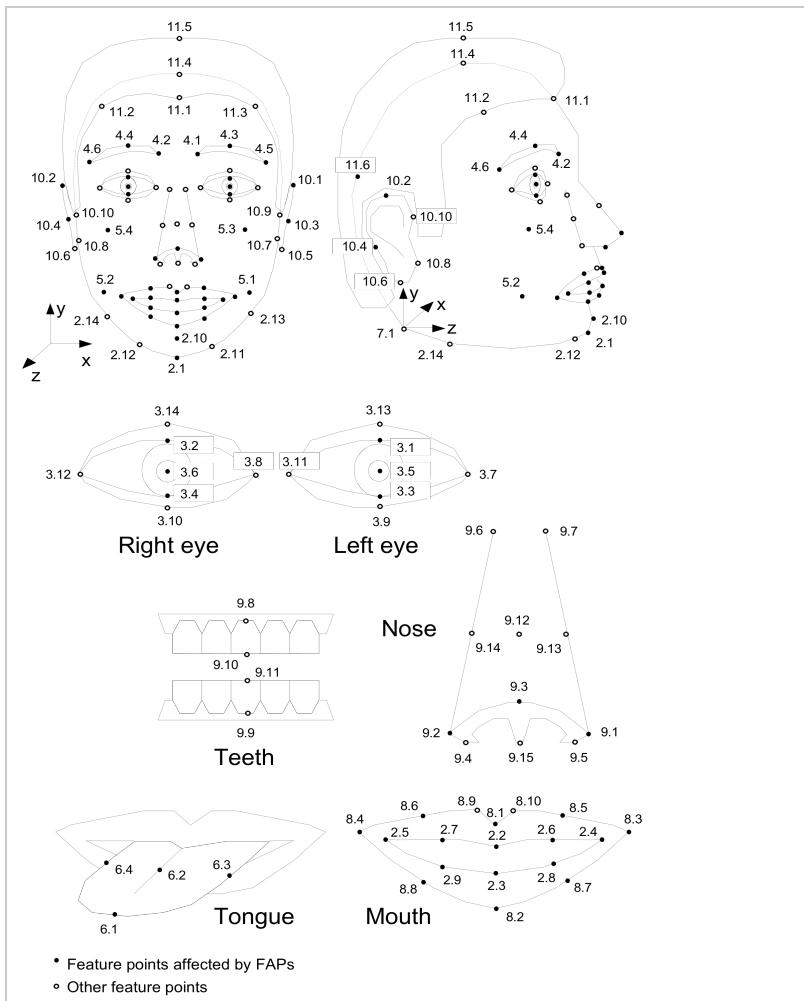
Feature points shall be included in the record format if they have been accurately determined, thereby providing the option that that these parameters do not have to be re-determined when the image is processed for face recognition tasks.

Typically a computer algorithm will either accurately determine the position of the feature point or completely fail and provide either clearly erroneous or no landmark information. Therefore, a method for accurate determination is the use of computer-automated feature point determination followed by human verification and potential override of the computer determined feature points.

14.27.1.1   MPEG4 Feature points

The feature point code item shall specify the feature point that is stored in the feature point block. The codes for the feature points are taken from the MPEG4 standard and defined as MPEG4 feature points. Each feature point code is represented by a notation A.B using a major (A) and a minor (B) value. The encoding of the feature point code is given by the numeric ASCII representation of the value of A.B. The period is required, and the maximum size of this entry shall be 5 characters.
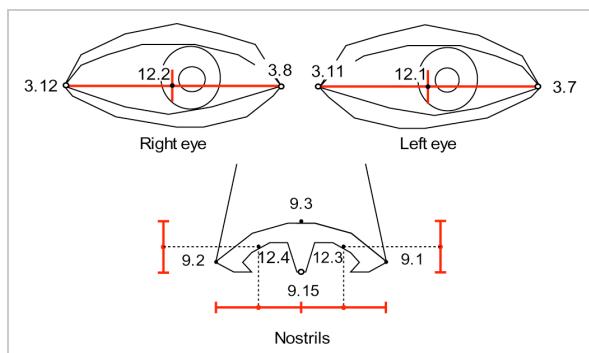
Figure 28 denotes the feature point codes associated with feature points as given by Annex C of ISO/IEC 14496-2. Each code is given by major value A and minor value B. For example, the code for the left corner of the left eye is given by major value 3 and minor value 7.

Figure 28 Feature point codes defined in ISO/IEC 14496-2

14.27.1.2   Eye and nostril center Feature Points

The eye center feature points 12.1 (left) and 12.2 (right) are defined to be the horizontal and vertical midpoints of the eye corners (3.7, 3.11) and (3.8, 3.12) respectively. The left nostril center feature point 12.3 is defined to be the midpoint of the nose feature points (9.1, 9.15) in the horizontal direction and (9.3, 9.15) in the vertical direction. Similarly, the right nostril center feature point 12.4 is defined to be the midpoint of the nose feature points (9.2, 9.15) in the

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horizontal direction and (9.3, 9.15) in the vertical direction. Both the eye center and nostril center Feature points are shown in Figure 29 and values given in

Table **54**.

Figure 29 Eye and nostril center feature points

Table 54 Eye and nostril center feature point codes

Center Feature Point	Midpoint of Feature Points		Feature Point code
Left Eye	3.7, 3.11		12.1
Right Eye	3.8, 3.12		12.2
Left Nostril	Horizontal	Vertical	12.3
	9.1, 9.15	9.3,9.15	
Right Nostril	Horizontal	Vertical	12.4
	9.2, 9.15	9.3,9.15	

14.27.1.3   Anthropometric landmarks with and without MPEG4 counterparts.

This section uses the definitions specified by ISO[55]. Tables and contents in this section are from the standard referenced in footnote 55.

• [55] See ISO/IEC 19794-5 Information technology – Biometric data interchange formats – Part 5: Face image data, Clause 5.5.6 Anthropometric Landmarks.
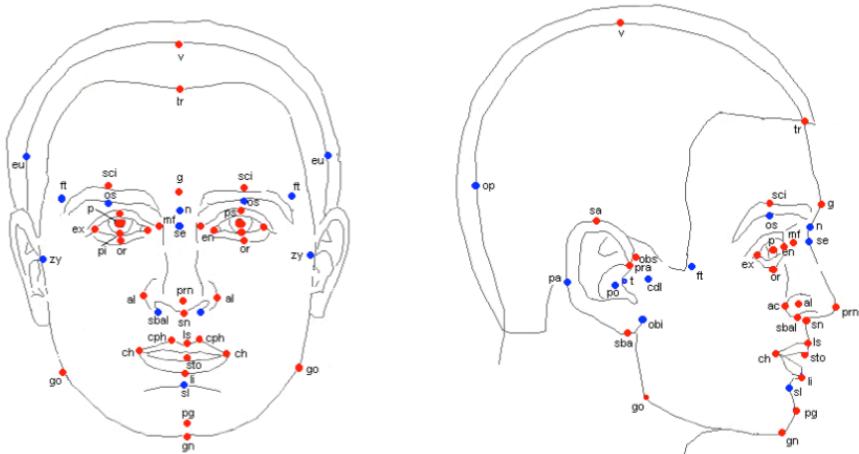
Anthropometric landmarks extend the MPEG4 feature model with points that are used in forensics and anthropology for person identification via two facial images or image and skull over a long time. They also allow specification of points that are in use by criminal experts and anthropologists.

Figure 30 and

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Table 55 show the definition of the anthropometric landmarks. The set of points represents the craniofacial landmark points of the head and face. The latter are used in forensics for "Face to face" and "Skull to face" identification. They are entered in Field 10.032. Some of these points have MPEG 4 counterparts, others not.

Figure 30 Anthropometric facial landmarks [56]

The figure above and the table below are extracted from a draft version of an ISO document (ISO/IEC 19794 5 Information technology Biometric data interchange formats Part 5: Face image data)[57]. Thus, there may be modifications in the final version of the ISO document.

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[56] red landmarks denote with MPEG4 counterparts and blue without MPEG4 counterparts.

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Table 55 ISO Definitions of the Anthropometric landmarks

Feature Point ID	MPEG4 Feature Point	Anthropometric Point Name	Description
V	11.4	vertex	The highest point of head when the head is oriented in Frankfurt Horizon.
G		glabella	The most prominent middle point between the eyebrows
op		opisthocranion	Situated in the occipital region of the head is most distant from the glabella
eu		eurion	The most prominent lateral point on each side of the skull in the area of the parietal and temporal bones
ft		frontotemporale	The point on each side of the forehead, laterally from the elevation of the linea temporalis
tr	11.1	trichion	The point on the hairline in the midline of the forehead
y		zygion	The most lateral point of each of the zygomatic
go	2.15 2.16	gonion	The most lateral point on the mandibural angle close to the bony gonion
sl		sublabiale	Determines the lower border of the lower lip or the upper border of the chin
pg	2.10	pogonion	The most anterior midpoint of the chin, located on the skin surface in the front of the identical bony landmark of the mandible
gn	2.1	menton (or gnathion)	The lowest median landmark on the lower border of the mandible
cdl		condylion laterale	The most lateral point on the surface of the condyle of the mandible
en	3.11 3.8	endocanthion	The point at the inner commissure of the eye fissure
ex	3.7 3.12	exocanthion (or ectocanthion)	The point at the outer commissure of the eye fissure
P	3.5 3.6	center point of pupil	Is determined when the head is in the rest position and the eye is looking straight forward

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Feature Point ID	MPEG4 Feature Point	Anthropometric Point Name	Description
or	3.9 3.10	orbitale	The lowest point on the lower margin of each orbit
ps	3.1 3.2	palpebrale superius	The highest point in the midportion of the free margin of each upper eyelid
pi	3.3 3.4	palpebrale inferius	The lowest point in the midportion of the free margin of each lower eyelid
os		orbitale superius	The highest point on the lower border of the eyebrow
sci	4.3 4.4	superciliare	The highest point on the upper border in the midportion of each eyebrow
N		nasion	The point in the middle of both the nasal root and nasofrontal suture
se[58]		sellion (or subnasion)	Is the deepest landmark located on the bottom of the nasofrontal angle
al	9.1 9.2	alare	The most lateral point on each alar contour
prn	9.3	pronasale	The most protruded point of the apex nasi
sn	9.15	subnasale	The midpoint of the angle at the columella base where the lower border of the nasal septum and the surface of the upper lip meet
sbal		subalare	The point at the lower limit of each alar base, where the alar base disappears into the skin of the upper lip
ac	9.1 9.2	alar curvature (or alar crest) point	The most lateral point in the curved base line of each ala
mf	9.6 9.7	maxillofrontale	The base of the nasal root medially from each endocanthion
cph	8.9 8.10	christa philtri landmark	The point on each elevated margin of the philtrum just above the vermilion line

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•   [58] This document assumes that sellion (or subnasion) is equivalent to the more commonly known term "bridge of nose".

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Feature Point ID	MPEG4 Feature Point	Anthropometric Point Name	Description
ls	8.1	labiale (or labrale) superius	The midpoint of the upper vermillion line
li	8.2	labiale (or labrale) inferius	The midpoint of the lower vermillion line
ch	8.3 8.4	cheilion	The point located at each labial commissure
sto		Stomion	The imaginary point at the crossing of the vertical facial midline and the horizontal labial fissure between gently closed lips, with teeth shut in the natural position
sa	10.1 10.2	superaurale	The highest point of the free margin of the auricle
sba	10.5 10.6	subaurale	The lowest point of the free margin of the ear lobe
pra	10.9 10.10	preaurale	The most anterior point on the ear, located just in front of the helix attachment to the head
pa		postaurale	The most postrerior point on the free margin of the ear
obs	10.3 10.4	otobasion superious	The point of attachment of the helix in the temporal region
obi		otobasion infrious	The point of attachment of the ear lobe to the cheek
po		porion (soft)	The highest point of the upper margin of the cutaneous auditory meatus
t		tragion	The notch on the upper margin of the tragus

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The anthropometric landmark code has the format A.B.   A specifies the global landmark of the face to which this landmark belongs, such as nose, mount, etc. B specifies the particular point.   In case a Landmark Point has two symmetrical entities (left and right) the right entity always has a greater and even minor code value.   All landmark points from the left part of the face have odd minor codes, and those from the right part have even minor codes. Both A and B are in the range from 1 to 15. Hence the code A*16 + B is written to the 1 byte landmark point code field, e.g. Feature Point Code ID P or Feature Point Code 3.6 is written as 54.

The error of an anthropometric 3D landmark point location should be no greater than 3mm. The point shall withstand from the nearest point on the surface no further than 3mm. The point on the surface is a vertex, or a point on an edge, or a point on a face of the surface.

The Z field is not used if the Landmark Point Type is equal to MPEG4 feature or anthropometric 2D landmark. In case the Landmark Point Type equals anthropometric 3D landmark this field along with the horizontal and vertical positions denotes the coordinates of the landmark point in the 3D Cartesian coordinate system. The metric coordinates of 3D landmarks shall be obtained by multiplying the X, Y, and Z coordinates by a fixed scale of 0.02mm. Note, that the Landmark Point Type field codes the type of the Landmark Point and determines the interpretation of the Z coordinate.

14.28 Field 10.030: Device monitoring mode / DMM

This optional field provides information describing the level of human monitoring for the face image capture device. This field will contain an entry from Table 56 to indicate the monitoring mode of the biometric sample capture device.

Table 56 Device monitoring modes

CONDITION	DESCRIPTION
CONTROLLED	Operator physically controls the subject to acquire biometric sample
ASSISTED	Person available to provide assistance to subject submitting the biometric
OBSERVED	Person present to observe operation of the device but provides no assistance
UNATTENDED	No one present to observe or provide assistance
UNKNOWN	No information is known

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14.29 Field 10.031: Tiered markup collection / TMC

This optional field describes the specific facial feature points contained in 10.029 and if level 5, contours shall be contained in 10.033.

Table 57   Tiered Markup Collections (frontal)

Value	Facial feature points/Contours	Description
1	Eye centers	2D Feature Points: Centers of eyes: 12.1 and 12.2
2	Eyes, mouth	2D Feature Points: Centers of eyes: 12.1 and 12.2 Center of mouth: sto
3	Eyes, nose, mouth	2D Feature Points for: Corners of eyes: 3.7, 3.11, 3.8, 3.12 Bridge and tip of nose: Se, 9.3 Corners of mouth: 8.3, 8.4
4	Eyes, nose, mouth, and head	2D Feature Points for: Corners of eyes: 3.7, 3.11, 3.8, 3.12 Pupils: 3.5, 3.6 Edges of nostrils: 9.4, 9.5 Corners of mouth: 8.3, 8.4 Tops and bottoms of ears: 10.1, 10.5, 10.2, 10.6 Chin: 2.1 Top of head and/or hair: 11.4, 11.5
5	Facial feature points and contours for eyes, brows, nose, mouth and face outline	Top of upper lip contour Bottom of lower lip contour Left and right eyebrow contours Left and right eye contours Chin contour 2D Feature Points for:

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Value	Facial feature points/Contours	Description
		Left and right eyes: 3.7, 3.11, 12.1, 3.8, 3.12, 12.2 Nose: 9.1, 9.2, 9.3, 9.15 Mouth corners: 8.3, 8.4 Ear tops and bottoms: 10.1, 10.5, 10.2, 10.6
6 99	Reserved	Reserved for future use
100 999	User defined	User defined

14.30 Field 10.032: Anthropometric 3D markup codes / AMC

The codes included in this optional field of five information items may be repeated. The maximum number of feature points shall be 88. The codes and explanations are defined in **Table 58**

Table 58. They are extensions of the MPEG4 feature model and are often used by forensic specialists.

Table 58 Feature Contour Code Descriptions

Contour Code	Contour Description
eyetop	Bottom of upper eye lid
eyebottom	Top of lower eye lid
upperliptop	Top of upper lip
upperlipbottom	Bottom of upper lip
lowerliptop	Top of lower lip
lowerlipbottom	Bottom of lower lip
rightnostril	Subject s right nostril
leftnostril	Subject s left nostril
lefteyebrow	Curvature of top of subject s left eye socket

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righteyebrow	Curvature of top of subject s right eye socket
chin	Chin
faceoutline	Face outline includes the entire head, all facial hair, and ears
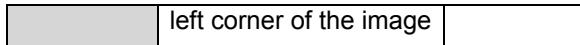
14.31 Field 10.033: Feature contours / FEC

This optional field contains four information items: contour code (see **Table 59**) and the number of points defining the contour and for each point on the contour the x position and y position. Contours are polylines (i.e., open line segments that do not close or overlap) or sequences of points that generally increase from left to right and top to bottom.

Each subfield consists of the following data. A minimum of three points is required to describe a feature contour.

Table 59 Feature Contours Field Description

Subfield / Information item	Description	Mnemonic
1	Contour code	CTC
2	Number of points on the polyline, between 3 and 99	PPQ
3	Subfield containing the pixel offset of the vertex	PPV
3 / 1	Horizontal pixel offset (X) relative to the origin positioned in the upper left corner of the image	PHV
3 / 2	Vertical pixel offset (Y) relative to the origin positioned in the upper	PVV

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	left corner of the image

14.32 Field 10.040: NCIC SMT code / SMT

This field is mandatory for a Type-10 record containing SMT image data. It is used to identify a general location of the captured scar, mark, tattoo, or other characteristic (including piercings) in an image. The contents of this field will be an entry chosen from the current version of the NCIC Code Manual. The captured image can encompass an area larger than that specified by a single NCIC body part code for the particular image type. This situation can be accommodated by listing multiple NCIC codes. In this case the primary code is listed first.

For the *"marks"* category, the NCIC manual lists the common locations for needle track marks. For other body part locations not listed under the *"marks"* category, use the body location codes listed for scars.

This field shall be used only when field 10.003 = "SCAR", "MARK", or "TATTOO".

14.33 Field 10.041: SMT size / SMS

This optional field shall contain the dimensions of portion of scar, mark or tattoo contained in this record (it may be the entire scar, mark or tattoo). It shall consist of two information items: height / **HGT** and width / **WID**. Each dimension shall be entered to the nearest centimeter.

This field shall be used only when field 10.003 = "SCAR", "MARK", or "TATTOO".

14.34 Field 10.042: SMT descriptors / SMD

This optional field is used to describe the content of the SMT image to an extent greater than documented in Field 10.040. It shall consist of one or more subfields **(Scar mark tattoo data / SDT)**. Each subfield shall contain three or four information items that provide progressively detailed information describing the total image or a portion of the image. This field shall be used only when field 10.003 = "SCAR", "MARK", or "TATTOO".

The first information item **(SMT Code Indicator / SMI)** of each subfield shall identify the source of the image as being a scar, a mark, or a tattoo. It shall contain *"SCAR"* to indicate healed scar tissue that was the result an accident or medical procedure. An entry of *"MARK"* shall be used for the pattern resulting from needle or track marks. For deliberately applied or drawn images, the first information item shall contain *"TATTOO"* to indicate a common tattoo or indelible image resulting from the pricking of the skin with a coloring matter; *"CHEMICAL"* if the image was created by the use of chemicals to burn the image into the skin; *"BRANDED"* if the image was burned into the skin using a branding iron or other form of heat; or *"CUT"* if the image was caused by incision of the skin.

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Brad Wing 6/20/10 3:39 PM
Comment: Change of reference directly to the code manual.

Brad Wing 6/20/10 4:51 PM
Comment: Reorganized for clarity

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The second information item **(Tattoo class / TAC)** shall be the general class code of tattoo chosen from Table 60. This does not apply to scars and marks

The third information item **(Tattoo subclass / TSC)** of the subfield shall be the appropriate subclass code selected from Table 61 a-h that lists the various subclasses of tattoos for each of the general classes. For each general class of tattoo, there are several defined subclasses.

Table 60 Tattoo classes

Class description	Class code
Human Forms and Features	HUMAN
Animals and Animal Features	ANIMAL
Plants	PLANT
Flags	FLAG
Objects	OBJECT
Abstractions	ABSTRACT
Insignias & Symbols	SYMBOL
Other Images	OTHER

Table 61 Tattoo subclasses

a) Human tattoo subclasses

Subclass	Subclass code
Male Face	MFACE
Female Face	FFACE
Abstract Face	ABFACE
Male Body	MBODY
Female Body	FBODY
Abstract Body	ABBODY
Roles (Knight, Witch, man, etc.)	ROLES
Sports Figures (Football Player, Skier, etc.)	SPORT
Male Body Parts	MBPART
Female Body Parts	FBPART

Abstract Body Parts	ABBPART
Miscellaneous Human Forms	MHUMAN
Skulls	SKULL

b) Animal tattoo subclasses

Subclass	Subclass code
Cats & Cat Heads	CAT
Dogs & Dog Heads	DOG
Other Domestic Animals	DOMESTIC
Vicious Animals (Lions, etc.)	VICIOUS

Horses (Donkeys, Mules, etc.)	HORSE
Other Wild Animals	WILD
Snakes	SNAKE
Dragons	DRAGON
Birds (Cardinal, Hawk, etc.)	BIRD
Spiders, Bugs, and Insects	INSECT
Abstract Animals	ABSTRACT
Animal Parts	PARTS
Miscellaneous Animal Forms	MANIMAL

c) Plant tattoo subclasses

Subclass	Subclass code
Narcotics	NARCOTICS
Red Flowers	REDFL
Blue Flowers	BLUEFL
Yellow Flowers	YELFL
Drawings of Flowers	DRAW
Rose	ROSE
Tulip	TULIP
Lily	LILY
Miscellaneous Plants, Flowers, Vegetables	MPLANT

d) Flags tattoo subclasses

Subclass	Subclass code
American Flag	USA
State Flag	STATE
Nazi Flag	NAZI
Confederate Flag	CONFED
British Flag	BRIT
Miscellaneous Flags	MFLAG

e) Objects tattoo subclasses

Subclass	Subclass code
Fire	FIRE
Weapons(Guns, Arrows, etc.)	WEAP
Airplanes	PLANE
Boats, Ships, & Other Vessels	VESSEL
Trains	TRAIN
Cars, Trucks, and Vehicles	VEHICLE
Mythical (Unicorns, etc.)	MYTH
Sporting Objects (Football, Ski, Hurdles, etc.)	SPORT
Water & Nature Scenes (Rivers, Sky, Trees, etc.)	NATURE
Miscellaneous Objects	MOBJECTS

f) Abstract tattoo subclasses

Subclass	Subclass code
Figure(s)	FIGURE
Sleeve	SLEEVE
Bracelet	BRACE
Anklet	ANKLET
Necklace	NECKLC
Shirt	SHIRT
Body Band	BODBND
Head Band	HEDBND
Miscellaneous Abstract	MABSTRACT

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g) Symbols tattoo subclasses

Subclass	Subclass code
National Symbols	NATION
Political Symbols	POLITIC
Military Symbols	MILITARY
Fraternal Symbols	FRATERNAL
Professional Symbols	PROFESS
Gang Symbols	GANG
Miscellaneous Symbols	MSYMBOLS

h) Other tattoo subclasses

Subclass	Subclass code
Wording (Mom, Dad, Mary, etc.)	WORDING
Freeform Drawings	FREEFRM
Miscellaneous Images	MISC

Table 62 Color codes

Color description	Color code
Black	BLACK
Brown	BROWN
Gray	GRAY
Blue	BLUE
Green	GREEN
Orange	ORANGE
Purple	PURPLE
Red	RED
Yellow	YELLOW
White	WHITE
Multi-colored	MULTI
Outlined	OUTLINE

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The fourth information item **(Tattoo description / TDS)** in this subfield shall be an ASCII text string that provides additional qualifiers to describe the image or portion of the image. For example, to fully describe a tattoo, there may be a class description of *"ANIMAL"*, with a subclass description of *"DOG"*, and qualified by *"golden retriever with an overbite"*.

An SMT image consisting of several parts or sub-images shall use multiple subfields to fully describe the various parts or features found in the total image. The first subfield shall describe the most predominant feature or sub-image contained in the SMT image. Subsequent subfields shall describe additional portions of the image that are not part of the main or central focal point of the image. For example, a tattoo consisting of a man with a snake on the arm being followed by a dog may contain three subfields - one describing the man, a second describing the snake, and a third describing the dog.

14.35 Field 10.043: Color / COL

This optional field shall contain one subfield corresponding to each subfield contained in Field 10.042. Each subfield shall contain one or more information items that list the color(s) of the tattoo or part of the tattoo. For each subfield, the first information item in the subfield shall be the predominant color chosen from Table 62. Additional colors for the sub-field shall be entered as information items in the subfield.

14.36 Field 10.044: Image transform / ITX

This optional field is used in the case when the image in this Type 10 record has been transformed from the original image. Note that the untransformed image(s) (optionally) may be included in a Type 20 record. This field may be repeated if multiple transforms were performed.

Table 63 Face/SMT image transform description

Value	Description
AGE	Age progressed
AXIS	Offaxis image rectification / Angle correction
COLORSHIFT	Color shifted
CONTRAST	Contrast stretched
CROP	Cropped
DIST	Distortion corrected (e.g. fisheye correction)
DOWNSAMPLE	Downsampled

Value	Description
GRAY	Grayscale from color
ILLUM	Illumination transform
IMGFUSE	Image level fusion of two or more images
INTERPOLATE	Upsampled
MULTCOMP	Multiply compressed
MULTIVIEW	Multiview image
POSE	Face specific pose correction
ROTATE	Rotated (in plane)
SNIR	Simulated Near IR
SUPERRES	Superresolution image, derived from multiple lower resolution images
WHITE	White balance adjusted

14.37 Field 10.045: Occlusion / OCC

This optional field defines the outline and contents of any occlusion that partially

This field shall consist of at the following subfields.

The first subfield (occlusion opacity / OCCO) is from **Table 64**

The second subfield (occlusion type / OCCT) is from **Table 65**.

The third subfield is the total number of points defined / OCPQ

The fourth subfield (Boundary of occlusion / BOO) is a set of N consecutive points (each being two information items). The boundary is defined as an n-vertex polygon, where "n" is between 3 and 99. The order of the vertices must be in their consecutive order around the perimeter of the polygon, either clockwise or counterclockwise. No two vertices may occupy the same location. The polygon side defined by the last subfield and the first subfield shall complete the polygon. The polygon must be a simple, plane figure with no sides crossing and no interior holes.

The first information item (Horizontal offset / PHX) is the horizontal pixel offset of the vertex relative to the origin positioned in the upper left corner of the image.

> **Brad Wing** 6/20/10 5:04 PM
> **Comment:** Reorganized for consistency

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The second information item (Vertical offset / PVY) is the vertical pixel offset of the vertex relative down from the origin positioned in the upper left corner of the image.

Table 64: Face occlusion opacity

Code	Type	Description
T	Total	There is no face detail in the area of the occlusion.
I	Interference	The occlusion contains interfering texture such as hair or reflection.
L	Partial light	There is face detail in the area of the occlusion that is lighter than the rest of the face.
S	Partial shadow	There is face detail in the area of the occlusion that is darker than the rest of the face.

Table 65: Face occlusion type

Code	Type	Description
H	Head covering	Hair, hat, veil, burka, or other head covering.
S	Specular	Specularity, reflection of light by the face.
H	shadow	Shadow cast on the face.
R	Reflection	Reflection of an object.
O	Other	Any other occlusion blocking the face image

14.38 Field 10.200 990 User-defined fields / UDF

These fields are user-definable fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present they shall contain ASCII textual information.

14.39 Field 10.996: Image hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, hash value shall be calculated using SHA 256.

14.40 Field 10.997: Original image reference / OIV

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

Brad Wing 6/20/10 5:09 PM
Comment: Reorganized for consistency

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 The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

14.41 Field 10.998: Geographic sample location / GEO

> Brad Wing 6/20/10 5:10 PM
> **Comment:** Reorganized for consistency

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

14.42 Field 10.999: Image data / DATA

This mandatory field shall contain all of the grayscale or color image data from a face, scar, mark, tattoo, or other image.

Each pixel of uncompressed grayscale data shall be quantized to eight bits (256 gray levels) and shall occupy a single byte. Uncompressed color image data shall be expressed as 24 or 48 bit sRGB pixels. For the 24-bit sRGB, the first byte shall contain the eight bits for the red component of the pixel, the second byte shall contain the eight bits for the green component of the pixel, and the third byte shall contain the last eight bits for the blue component of the pixel. For the 48-bit sRGB pixel, each color component will occupy two bytes. If compression is used, the pixel data shall be compressed in accordance with the compression technique specified in the CGA field. If the JPEG algorithm is to be used to compress the data, this field shall be encoded using the JFIF format specification.

15   Type 11 Facial image record

The Type 11   record is designed to contain ONLY facial images. If approved, it will be filled with a copy of the fields from Record Type 10 dealing with face.

16   Type 12 SMT image record

The Type 12   record is reserved for SMT data ONLY. If approved, it will be filled with a copy of the fields from Record Type 10 dealing with SMT.

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17   Type-13 variable-resolution latent image record

The Type-13 record shall contain image data acquired from latent captures of fingerprint, plantar or palmprint images. These images are intended to be transmitted to agencies that will automatically extract or provide human intervention and processing to extract the desired feature information from the images. Information regarding the scanning resolution used, the image size, and other parameters required to process the image, are recorded as tagged fields within the record.

Table 66 Type-13 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	13.001		RECORD HEADER	1	1
IDC	M	13.002	N	IMAGE DESIGNATION CHARACTER	1	1
IMP	M	13.003	N	IMPRESSION TYPE	1	1
SRC	M	13.004	AN	SOURCE AGENCY / ORI	1	1
LCD	M	13.005	N	PLATENT CAPTURE DATE	1	1
HLL	M	13.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	13.007	N	VERTICAL LINE LENGTH	1	1
SLC	M	13.008	N	SCALE UNITS	1	1
HPS	M	13.009	N	HORIZONTAL PIXEL SCALE	1	1
VPS	M	13.010	N	VERTICAL PIXEL SCALE	1	1
CGA	M	13.011	AN	COMPRESSION ALGORITHM	1	1
BPX	M	13.012	N	BITS PER PIXEL	1	1
FGP	M	13.013	N	FRICTION RIDGE POSITION	1	Unlimited
SPD	C-FGP	13.014		SEARCH POSITION DESCRIPTORS	1	9
FGP	M⇑		N	FINGER RIDGE POSITION CODE	1	1
SLC	M⇑		N	PORTION OF EJI OR TIP IMAGE TO SEARCH	1	1
PPC	C-FGP	13.015		PRINT POSITION COORDINATES	1	12
FVC	M⇑		N	FULL FINGER VIEW CODE	1	1
SLC	M⇑		N	LOCATION OF SEGMENT	1	1
LHC	M⇑		N	LEFT HORIZONTAL COORDINATE	1	1
RHC	M⇑		N	RIGHT HORIZONTAL COORDINATE	1	1
TVC	M⇑		N	TOP VERTICAL COORDINATE	1	1

Brad Wing 6/21/10 10:08 AM
Comment: Table now included in record description; with subfields and information items

Brad Wing 6/21/10 10:15 AM
Comment: Note change on upper limit

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
BVC	M⇑		N	BOTTOM VERTICAL COORDINATE	1	1
SHPS	O		N	SCANNED HORIZONTAL PIXEL SCALE	0	1
SVPS	O	13.017	N	SCANNED VERTICAL PIXEL SCALE	0	1
RSV		13.018-13.019		RESERVED FOR FUTURE DEFINITION		
COM	O	13.020	AN	COMMENT	0	1
RSV		13.021-13.023		RESERVED FOR FUTURE DEFINITION		
LQM	O	13.024		LATENT QUALITY METRIC	0	1
LQS	M⇑			LATENT QUALITY SUBFIELD BY ALGORITHM	1	Unlimited
FGP	M⇑		N	FRICTION RIDGE CODE	1	1
QVU	M⇑		N	QUALITY VALUE	1	1
QAV	M⇑		N	QUALITY ALGORITHM VENDOR	1	1
QAP	M⇑		N	QUALITY ALGORITHM PRODUCT ID	1	1
RSV		13.025-13.195		RESERVED FOR FUTURE DEFINITION		
HAS	O	13.996	N	IMAGE HASH	0	1
OIV	O	13.997		ORIGINAL IMAGE REFERENCE	0	1
OIR	M⇑		N	REFERENCE CODE	1	1
RTV	O⇑		N	SEGEMENTATION REFERENCE TYPE VALUE	0	1
GEO	O	13.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
DATA	M	13.999	B	IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

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17.1 Field 13.001 Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

17.2 Field 13.002 Image designation character / IDC

This mandatory field shall be the IDC of the Type-13 record as found in the file content (CNT) field of the Type-1 record.

17.3 Field 13.003 Impression type / IMP

This mandatory field shall be a latent code selected from **Table 8**, describing the manner by which the friction ridge image information was obtained. The long name is reflective of the fact that originally this field only applied to Fingerprint images.

17.4 Field 13.004: Source agency / ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that originally captured the latent image contained in the record. Normally, the Originating Agency Identifier, ORI, of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

17.4.1 Field 13.005: Latent capture date / LCD

This mandatory ASCII field shall contain the date that the latent image contained in the record was captured. See the relevant Annex in this standard for the exact encoding format for this data. The *YYYY* characters shall represent the year the image was captured; the *MM* characters shall be the tens and units values of the month; and the *DD* characters shall be the tens and units values of the day in the month.

17.4.2 Field 13.006: Horizontal line length / HLL

This mandatory ASCII field shall contain the number of pixels contained on a single horizontal line of the transmitted image.

17.4.3 Field 13.007: Vertical line length / VLL

This mandatory ASCII field shall contain the number of horizontal lines contained in the transmitted image.

17.4.4 Field 13.008: Scale units / SLC

This mandatory ASCII field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or

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a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

17.4.5 Field 13.009: Horizontal pixel scale / HPS

This mandatory ASCII field shall specify the integer pixel density used in the horizontal direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

17.4.6 Field 13.010: Vertical pixel scale / VPS

This mandatory ASCII field shall specify the integer pixel density used in the vertical direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

17.4.7 Field 13.011: Compression algorithm / CGA

This mandatory ASCII field shall specify the algorithm used to compress the transmitted grayscale images. An entry of *"NONE"* in this field indicates that the data contained in this record is uncompressed. For those images that are to be losslessly compressed, this field shall contain the code from **Table 2** to indicate the compression method used for the latent fingerprint images. See Section 5.6.1. for additional information on the usage of JPEG 2000 for the compression of fingerprint images. The domain registrar shall maintain a registry of acceptable compression techniques and corresponding codes that may be used as they become available. Note: The best practice for latent prints is no compression or lossless compression.

17.4.8 Field 13.012: Bits per pixel / BPX

This mandatory ASCII field shall contain the number of bits used to represent a pixel. This field shall contain an entry of "8" for normal grayscale values of "0" to "255". Any entry in this field greater than "8" shall represent a grayscale pixel with increased precision.

17.4.9 Field 13.013: Friction ridge generalized position / FGP

This mandatory field shall contain one or more possible finger, plantar or palm positions that may be the source of the latent image. The decimal code number corresponding to the known or most probable friction ridge position shall be taken from **Table 9** and entered as a one- or two-character ASCII subfield. Additional friction ridge positions may be entered. The code "0", for "Unknown Finger", shall be used to reference every finger position from one through ten. Code "19" shall be used to reference one or more parts of an EJI or tip. The code "20", for "Unknown Palm", shall be used to reference every listed palmprint position. The code "60" for "Unknown Sole," or code "63" for "Unknown Toe" shall be used to reference every listed plantar position.

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17.4.10   Field 13.014: Search position descriptors / SPD

This shall be present if and only if the finger position code "19" appears in Field 13.013. It is used to narrow the search of the latent image in this record against a database. This field shall consist of two mandatory information items.

The first information **(probable decimal finger position code / FGP)** (0-10) is taken from **Table 9**. A "0" indicates that all the fingers of a possible candidate should be searched.

 The second information item **(Entire joint image - EJI or tip** image / SLC) is the code taken from

Table **67** to indicate the portion of the in the database to search. Latent images of full-length fingers use codes FV1 through FV4 as defined in

Table **67**. Figure 31 is an illustration of the Entire Joint Image for a middle finger with each of the full finger views and constituent parts identified. The EJI code is used for the case where all four finger images are to be considered. For the case where the latent is to be compared to proximal, distal, or medial segments of a finger, this information item will contain the appropriate finger segment character. Multiple portions of the EJI can be listed.

Table 67 EJI and tip codes

TYPE OF IMAGE	IMAGE CODE
Entire Joint Image	EJI
Rolled Tip	TIP
Full Finger Rolled Image	FV1
Full Finger Plain Image – left side	FV2
Full Finger Plain Image – center	FV3
Full Finger Plain Image – right side	FV4
Proximal, Distal, or Medial Segments	PRX, DST, MED

NOTE: Fields 13.014 and 13.015 are included to make the standard flexible enough to accommodate many different scenarios and applications. These two fields facilitate searching of latents formatted within Type-13 records against Type-14 records contained in the various databases. The search of a database by a latent can be narrowed with the use of additional information such as finger position, finger segment, or full finger view. It is unlikely that an entire EJI will ever be left at the scene of a crime. But a latent can be searched against the

EJIs based on a specific finger segment or full finger view. This can be accomplished for a portion of the latent described by the X and Y coordinates.

17.4.11   Field 13.015: Print position coordinates / PPC

> Brad Wing 6/21/10 8:33 AM
> **Comment:** Reorganized for clarity

If finger position code "19" appears in field 13.013, this field contains offsets to the locations for the bounding box of the EJI, each of the full finger views, or segments within the EJI. When used, this field shall consist of six (6) mandatory information items to describe the type or portion of the latent image contained in this record and its location within an entire joint image.

This information will describe either the location of the entire joint image, one full finger view, or segment. Individual full finger or segment definitions may be repeated as subfields

The first information item is the number of the full finger view / FVC with values of "FV1" through "FV4". Values of "FV1" to "FV4" specify the bounding coordinates for each full finger view. For the case of a fingertip, the first information item shall be "TIP"
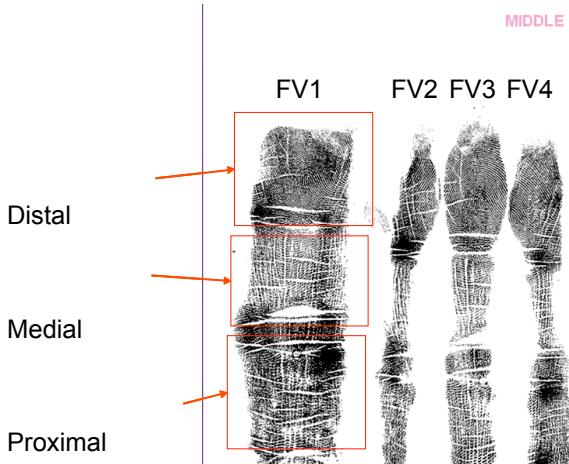
The second information item is used to identify the location of a segment / SLC within a full finger view. It will contain the not applicable code "NA" if the image portion refers to a full finger view, tip or to the entire joint image locations. It shall contain "PRX", "DST", "MED" for a proximal, distal, or medial segment

The third information item is the left horizontal coordinate value / LHC. It is the horizontal offset in pixels to the right relative to the origin positioned in the upper left corner of the image.

The fourth information item is the right horizontal coordinate value / RHC. It is the horizontal offset in pixels to the right relative to the origin positioned in the upper left corner of the image.

The fifth information item is the top vertical coordinate value / TVC is the vertical offset (pixel counts down) to the top of the bounding box.

The sixth information item is the bottom vertical coordinate value / BVC. It is the vertical offset from the upper left corner of the image down to the bottom of the bounding box. It is counted in pixels

.

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Figure 31Entire joint image

17.4.12   Field 13.016: Scanned horizontal pixel scale / SHPS

This optional ASCII field shall specify the horizontal pixel density used for the scanning of the original impression providing the SLC field contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

17.4.13   Field 13.017: Scanned vertical pixel scale / SVPS

This optional ASCII field shall specify the vertical pixel density used for the scanning of the original impression providing the SLC field contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

17.4.14   Field 13.020: Comment / COM

This optional field may be used to insert comments or other ASCII text information with the latent image data.

17.4.15   Field 13.024: Latent quality metric / LQM

This optional ASCII field is used to specify one or more different metrics of latent image quality score data for the image stored in this record. The meaning attributed to this metric must be defined and interpreted by the producer of the scoring algorithm or by the person or system used to assign the metric to the latent image. The metric may be a predictor of AFIS matcher accuracy performance or a different metric to indicate a value associated with the quality of the latent image for a particular function.

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This field may contain one or more **(latent quality metric subfields / LQS)**, each consisting of four information items. This subfield is repeated for each latent image and quality algorithm used.

The first information item is the code / FGP as chosen from **Table 9**.

The second information item shall be a quantitative expression of the predicted matching performance of the biometric sample, which is a quality value / QVU. This item contains the ASCII representation of the integer image quality score between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality.   An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards.

The third information item shall specify the ID of the vendor of the quality algorithm used to calculate the quality score, which is an algorithm vendor identification / QAV. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization

The fourth information item shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not required. This is an algorithm product identification / QAP that indicates which of the vendor's algorithms was used in the calculation of the quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65,535.

17.4.16 Fields 13.200-990: User-defined fields / UDF

These fields are user-definable fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present they shall contain ASCII textual information.

17.5 Field 13.996: Image hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, hash value shall be calculated using SHA 256.

17.6 Field 13.997: Original image reference / OIV

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

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The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

17.7 Field 13.998: Geographic sample location / GEO

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

17.8   Field 13.999: Image data / DATA

This mandatory field shall contain all of data from a captured latent image each pixel of uncompressed grayscale data shall normally be quantized to eight bits (256 gray levels) contained in a single byte. If the entry in BPX Field 13.012 is greater than "8", the number of bytes required to represent a pixel will be different.   If compression is used, the pixel data shall be compressed in accordance with the compression technique specified in the CGA field.

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18 Type-14 variable-resolution fingerprint image record

The Type-14   record shall contain and be used to exchange fingerprint image data from a rolled tenprint, an identification flat, or a major case print (also referred to as a complete friction ridge exemplar). All fingerprint impressions shall be acquired from a tenprint card, a major case print card, a single or multiple finger flat capture device contactless fingerprint sensor that outputs 2D fingerprint images, or a live-scan device. Captured images are intended to be transmitted to agencies that will automatically extract the desired feature information from the images for matching purposes. Textual information regarding the scanning resolution, the image size and other parameters or comments required to process the image are recorded as tagged fields within the record.

The Type-14 record is also used to exchange identification flats (simultaneous plain impressions captured on a platen). Several Type-14 image records are used to contain the flat fingerprint impressions. Two of the image records contain the left and right simultaneous four fingers, and a third contains the two thumbs. Their are also codes for two and three and four finger combinations. Offsets to the locations of image segments containing the individual fingers are included with the image records for individual flat prints resulting from segmentation of a four finger slap image. If a four finger slap image is generated by stitching individual images together, it must be noted as such using the Comment field (14.020).   Additional fields are defined to contain the NIST Fingerprint Image Quality (NFIQ) metric, alternate image quality metrics, and metrics for predicting the correctness of the segmentation.

Table 68 Type-14 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	14.001		RECORD HEADER	1	1
IDC	M	14.002	N	IMAGE DESIGNATION CHARACTER	1	1
IMP	M	14.003	N	IMPRESSION TYPE	1	1
SRC	M	14.004	AN	SOURCE AGENCY / ORI	1	1
FCD	M	14.005	N	FINGERPRINT CAPTURE DATE	1	1
HLL	M	14.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	14.007	N	VERTICAL LINE LENGTH	1	1
SLC	M	14.008	N	SCALE UNITS	1	1

Brad Wing 6/21/10 11:07 AM
Comment: Table now included in record description; with subfields and information items

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count Min	Occur count Max
HPS	M	14.009	N	HORIZONTAL PIXEL SCALE	1	1
VPS	M	14.010	N	VERTICAL PIXEL SCALE	1	1
CGA	M	14.011	AN	COMPRESSION ALGORITHM	1	1
BPX	M	14.012	N	BITS PER PIXEL	1	1
FGP	M	14.013	N	FRICTION RIDGE POSITION	1	Unlimited
PPD	C-FGP	14.014		PRINT POSITION DESCRIPTORS	1	9
FGP	M⇑		N	FINGER RIDGE POSITION CODE	1	1
SLC	M⇑		N	PORTION OF EJI OR TIP IMAGE TO SEARCH	1	1
PPC	C-FGP	14.015		PRINT POSITION COORDINATES	1	12
FVC	M⇑		N	FULL FINGER VIEW CODE	1	1
SLC	M⇑		N	LOCATION OF SEGMENT	1	1
LHC	M⇑		N	LEFT HORIZONTAL COORDINATE	1	1
RHC	M⇑		N	RIGHT HORIZONTAL COORDINATE	1	1
TVC	M⇑		N	TOP VERTICAL COORDINATE	1	1
BVC	M⇑		N	BOTTOM VERTICAL COORDINATE	1	1
SHPS	O	14.016	N	SCANNED HORIZONTAL PIXEL SCALE	0	1
SVPS	O	14.017	N	SCANNED VERTICAL PIXEL SCALE	0	1
AMP	O	14.018	A	AMPUTATED OR BANDAGED	0	4
RSV		14.019		RESERVED FOR FUTURE DEFINITION		
COM	O	14.020	AN	COMMENT	0	1
SEG	O	14.021	N	FINGER SEGMENT POSITIONS	0	1
FBA	M⇑			FINGER SEGMENT BY ALGORITHM	1	Unlimited
FGP	M⇑		N	FINGER POSITION NUMBER	1	1
LHC	M⇑		N	LEFT HORIZONTAL COORDINATE VALUE	1	1
RHC	M⇑		N	RIGHT HORIZONTAL COORDINATE VALUE	1	1
TVC	M⇑		N	TOP VERTICAL COORDINATE VALUE	1	1
BVC	M⇑		N	BOTTOM VERTICAL COORDINATE VALUE	1	1

Brad Wing 6/21/10 11:07 AM
Comment: Note change on upper limit

Brad Wing 6/21/10 12:34 PM
Comment:

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
NQM	O	14.022		NIST QUALITY METRIC	0	4
FGP	M⇑		N	FINGER POSITION CODE	1	1
QVU	M⇑		N	IMAGE QUALITY SCORE	1	1
SQM	O	14.023		SEGMENTATION QUALITY METRIC	0	1
LQS	M⇑			LATENT QUALITY SUBFIELD BY ALGORITHM	1	Unlimited
FGP	M⇑		N	FRICTION RIDGE CODE	1	1
QVU	M⇑		N	QUALITY VALUE	1	1
QAV	M⇑		N	QUALITY ALGORITHM VENDOR	1	1
QAP	M⇑		N	QUALITY ALGORITHM PRODUCT ID	1	1
FQM	O	14.024		FINGERPRINT QUALITY METRIC	0	1
QMS	M⇑			QUALITY METRIC SUBFIELD	1	Unlimited
FGP	M⇑		N	FRICTION RIDGE CODE	1	1
QVU	M⇑		N	QUALITY VALUE	1	1
QAV	M⇑		N	QUALITY ALGORITHM VENDOR	1	1
QAP	M⇑		N	QUALITY ALGORITHM PRODUCT ID	1	1
ASEG	O	14.025		ALTERNATE FINGER SEGMENT POSITION	0	Unlimited
FPC	M⇑		N	FINGER POSITION CODE	1	1
VNV	M⇑		N	POSITION POLYGON VERTEX QUANTITY	3	99
PPV	M⇑		N	POSITION POLYGON VERTEX	1	1
PHV	M⇑		N	POSITION HORIZONTAL COORDINATE VALUE	1	1
PVV	M⇑		N	POSITION VERTIC COOALRDINATE VALUE	1	1
DMM	O		A	DEVICE MONITORING MODE	1	1
SAP	O	14.031	N	SUBJECT ACQUISTION PROFILE	1	1
HAS	O	14.996	N	IMAGE HASH	0	1
OIV	O	14.997		ORIGINAL IMAGE REFERENCE	0	1

> **Brad Wing 6/21/10 12:46 PM**
> **Comment:** Is this the correct value? It doesn't allow for an extra finger (5 fingers on the slap instead of four)

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
OIR	M⇑		N	REFERENCE CODE	1	1
RTV	O⇑		N	SEGEMENTATION REFERENCE TYPE VALUE	0	1
GEO	O	14.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
DATA	M	14.999	B	IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

18.1 Field 14.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

18.2 Field 14.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-14 record as found in the file content (CNT) field of the Type-1 record.

18.3 Field 14.003: Impression type / IMP

This mandatory field shall be selected from **Table 8**, describing the manner by which the fingerprint image information was obtained.

18.4 Field 14.004: Source agency / ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that originally captured the image contained in the record. Normally, the Originating Agency Identifier, ORI, of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

18.5 Field 14.005: Fingerprint capture date / FCD

This mandatory ASCII field shall contain the date that the image contained in the record was captured. See the relevant encoding instructions at www.biometrics.nist.gov/standard for the exact encoding format for this data. The

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YYYY characters shall represent the year the image was captured; the *MM* characters shall be the tens and units values of the month; and the *DD* characters shall be the tens and units values of the day in the month.

18.6 Field 14.006: Horizontal line length / HLL

This mandatory ASCII field shall contain the number of pixels contained on a single horizontal line of the transmitted image.

18.7 Field 14.007: Vertical line length / VLL

This mandatory ASCII field shall contain the number of horizontal lines contained in the transmitted image.

18.8 Field 14.008: Scale units / SLC

This mandatory ASCII field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

18.9 Field 14.009: Horizontal pixel scale / HPS

This mandatory ASCII field shall specify the integer pixel density used in the horizontal direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

18.10 Field 14.010: Vertical pixel scale / VPS

This mandatory ASCII field shall specify the integer pixel density used in the vertical direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

18.11 Field 14.011: Compression algorithm / CGA

This mandatory ASCII field shall specify the algorithm used to compress the transmitted grayscale images. An entry of *"NONE"* in this field indicates that the data contained in this record is uncompressed. For those images that are to be losslessly compressed, this field shall contain the code from **Table 2** to indicate the compression method used for the fingerprint images. WSQ or JPEG 10918 are to be used for those images scanned or transmitted at 500 ppi and JPEG 2000 for those images scanned and transmitted at ppi greater than 500   See Section 5.6.1.for additional information on the usage of JPEG 2000 for the compression of fingerprint images. The domain registrar shall maintain a registry of acceptable compression techniques and corresponding codes that may be used as they become available.

18.12   Field 14.012: Bits per pixel / BPX

This mandatory ASCII field shall contain the number of bits used to represent a pixel. This field shall contain an entry of "8" for normal grayscale values of "0" to

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"255". Any entry in this field greater than "8" shall represent a grayscale pixel with increased precision.

18.13 Field 14.013: Finger generalized position / FGP

This mandatory field shall contain one or more possible finger positions that may match the image. The decimal code number corresponding to the known or most probable finger position shall be taken from **Table 9** and entered as a one- or two-character ASCII subfield. The code "0", for "Unknown Finger", shall be used to reference every finger position from one through ten. Code "19" shall be used to reference one or more parts of an EJI or tip.

18.14 Field 14.014: Print position descriptors / PPD

This ASCII field shall be present if and only if the finger position code "19" appears in Field 14.013.   This field shall consist of two mandatory information items.

The first information item (probable finger position code / FGP) (0-10) taken from **Table 9**.

The second information item (EJI or tip image / SLC) is the code taken from **Table 67** to indicate the portion that is stored as a single image in the database. There may be up to 17 such images for a single finger. Images of full-length fingers use codes FV1 through FV4 as defined in

Table **67**. Figure 31 is an illustration of the Entire Joint Image for a middle finger with each of the full finger views and constituent parts identified.

18.15 Field 14.015: Print position coordinates / PPC

If finger position code "19" appears in field 14.013, this field contains offsets to the locations for the bounding box of the EJI, each of the full finger views, or segments within the EJI. When used, this field shall consist of six (6) mandatory information items to describe the type or portion of the image and its location within an entire joint image.

The first information item (number of the full finger view / FVC) has values of "FV1" through "FV4", specifying the bounding coordinates for each full finger view.

The second information item is the (location of a segment within a full finger view / SLC) It will contain the not applicable code "NA" if the image portion refers to a full finger view or to the entire joint image locations. It shall contain "PRX", "DST", "MED" for a proximal, distal, or medial segment.

The third information item is the left horizontal coordinate value / LHC. It is the horizontal offset in pixels to the right relative to the origin positioned in the upper left corner of the image.

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The fourth information item is the right horizontal coordinate value / RHC. It is the horizontal offset in pixels to the right relative to the origin positioned in the upper left corner of the image.

The fifth information item is the top vertical coordinate value / TVC is the vertical offset (pixel counts down) to the top of the bounding box.

The sixth information item is the bottom vertical coordinate value / BVC. It is the vertical offset from the upper left corner of the image down to the bottom of the bounding box. It is counted in pixels

This information will describe either the location of the entire joint image, one full finger view, or segment. Individual full finger or segment definitions may be repeated.

18.16 Field 14.016: Scanned horizontal pixel scale / SHPS

This optional ASCII field shall specify the horizontal pixel density used for the scanning of the original impression providing the SLC field contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

18.17 Field 14.017: Scanned vertical pixel scale / SVPS

This optional ASCII field shall specify the vertical pixel density used for the scanning of the original impression providing the SLC field contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

18.18 Field 14.018: Amputated or bandaged / AMP

This optional ASCII field shall specify if one or more fingers are amputated or bandaged. This field shall consist of one subfield for each amputated or missing finger. Each subfield shall contain two information items. The first item is the finger number / FGP between one and ten as chosen from **Table 9**.

The second item is the amputated or bandaged code / FMC (AMPCD).

The following is a list of allowable indicators for the AMPCD:

Descriptor	___AMPCD
Amputation	XX
Unable to print (e.g., bandaged)	UP

Multiple amputated or unprintable finger positions can each be entered as a separate information item. This field is to be used anytime there are fewer than expected printable fingers in a submission (e.g., less than four in a left or right slap or less than two in a two-thumb slap). A partially scarred finger should be printed.

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18.19 Field 14.020: Comment / COM

This optional ASCII field may be used to insert comments or other ASCII text information with the image data.

18.20 Field 14.021: Finger segment position(s) / SEG

This mandatory ASCII field shall contain offsets to the locations of image segments containing the individual fingers within the flat images of simultaneous fingers from each hand or the two simultaneous thumbs. (FGP= 13,14,15 or 40 50). There is a subfield **(Finger segment by algorithm / FBA)** that occurs at least once, and may be repeated if more than one algorithm is used to segment the image. Each subfield contains five information items.

The first information item is the finger position number / FGP with values of "FV1" through "FV4". Values of "FV1" to "FV4" specify the bounding coordinates for each full finger view. For the case of a fingertip, the first information item shall be "TIP"

The second information item is the left horizontal coordinate value / LHC. It is the horizontal offset in pixels to the right relative to the origin positioned in the upper left corner of the image.

The third information item is the right horizontal coordinate value / RHC. It is the horizontal offset in pixels to the right relative to the origin positioned in the upper left corner of the image.

The fourth information item is the top vertical coordinate value / TVC is the vertical offset (pixel counts down) to the top of the bounding box.

The fifth information item is the bottom vertical coordinate value / BVC. It is the vertical offset from the upper left corner of the image down to the bottom of the bounding box. It is counted in pixels

18.21 Field 14.022: NIST quality metric / NQM

This optional ASCII field shall contain the NIST Fingerprint Image Quality (NFIQ) scores for the individual finger(s) derived from the slap impressions or individual rolled fingerprints. It consists of two information items.

The first item is the finger number / FGP between one and ten as chosen from **Table 9**.

The second item is the image quality score / QVU which is a quantitative expression of the predicted AFIS matcher accuracy performance of the fingerprint image. The scores range from "1" for the best quality image, to "5" for the worst quality image. A "254" indicates that no score was ever computed while an entry of "255" shall indicate a failed attempt to calculate the image quality metric.

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18.22 Field 14.023: Segmentation quality metric / SQM

This optional ASCII field provides a measure of estimated correctness regarding the accuracy of the location of the segmented finger within the right or left four finger or two thumbs slap image. For each segmented finger, this field shall contain four information items.

This field may contain one or more subfields, each consisting of four information items. This subfield **(Segmentation quality subfield / QMS)** is repeated for each segmented finger with coordinates that appear in field 14.021. For the case where more than one segmentation algorithm is applied to a multi-finger plain image, the set of segmentation information items for each finger shall be ordered corresponding to the entries in field 14.021.

The first information item is the code / FGP as chosen from **Table 9**.

The second information item shall be a quantitative expression of the predicted matching performance of the biometric sample, which is a **quality value / QVU**. This item contains the ASCII representation of the integer image quality score between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality.   An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards.

The third information item shall specify the ID of the vendor of the quality algorithm used to calculate the quality score, which is an **algorithm vendor identification / QAV**. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization

The fourth information item shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not required. This is an **algorithm product identification / QAP** that indicates which of the vendor's algorithms was used in the calculation of the quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65,535.

18.23 Field 14.024: Fingerprint quality metric / FQM

This optional ASCII field is used to specify one or more different metrics of fingerprint image quality score data for the image stored in this record.   The meaning attributed to this metric must be defined and interpreted by the producer of the scoring algorithm or by the person or system used to assign the metric to the fingerprint image. The metric may be a predictor of AFIS matcher accuracy performance or a different metric to indicate a value associated with the quality of the fingerprint image for a particular function.

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This field may contain one or more subfields, each consisting of four information items. This subfield **(Quality Metric Subfield / QMS)** is repeated for each finger image and quality algorithm used.

The first information item is the finger number / FGP chosen from **Table 9**

The second information item (image quality score / QVU) shall be a quantitative expression of the predicted matching performance of the biometric sample. This item contains the ASCII representation of the integer between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality. An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a fingerprint image quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards

The third information item (algorithm vendor identification / QAV) shall specify the ID of the vendor of the quality algorithm used to calculate the quality score. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

The fourth information item (algorithm product identification / QAP) shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not required. QAP indicates which of the vendor's algorithms was used in the calculation of the fingerprint image quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65535.

18.24 Field 14.025: Alternate finger segment position(s) / ASEG

This optional ASCII field is an alternate approach to describing the locations for each of the image segments of up to four individual fingers within a flat image containing the capture of four simultaneous fingers or two simultaneous thumbs. This field uses an n-vertex polygon to encompass each finger image segment, where "n" is between 3 and 99. The order of the vertices must be in their consecutive order around the perimeter of the polygon, either clockwise or counterclockwise. No two vertices may occupy the same location. The polygon side defined by the last subfield and the first subfield shall complete the polygon. The polygon must be a simple, plane figure with no sides crossing and no interior holes.

This field shall consist of up three subfields. The field is repeated for each separate segmentation.

The first subfield **(Finger position code / FPC)** is the finger number from **Table 9**.

Brad Wing 6/22/10 4:04 PM
Comment: Note revision of this field.

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The second subfield **(Position polygon vertex quantity / VNV)** is the number of vertices encompassing the segmented finger (between 3 and 99)

The third subfield is the vertex information **(Position polygon vertex / PPV).** It is comprised of two information items:

The first information item is the **(Position horizontal coordinate value / PHV).** It is the horizontal pixel offset (x-across) relative to the origin positioned in the upper left corner of the image.

The second information item is the **(Position vertical coordinate value / PVV).** It is the vertical pixel offset (y-down) relative to the origin positioned in the upper left corner of the image.

18.25 Field 14.030: Device monitoring mode / DMM

This optional field provides information describing the level of human monitoring for the image capture device. This field will contain an entry from Table 56 to indicate the monitoring mode of the biometric sample capture device.

18.26 Fields 14.031: Subject acquisition profile / SAP

This optional information item states the combination of characteristics that comprise a subject acquisition profile. This is designed for use in mobile biometric capture applications. The SAP level for fingerprint is to be specified as in the current version of the *Mobile ID Devices Best Practices Recommendation (BPR)*. Note that SAP 5 is inapplicable, since that SAP is minutiae and not image. SAP levels defined in the BPR of 10 through 40 are PIV certified, with an allowed error of ±10%. However, this standard calls for an allowed maximum error of 5%, corresponding to SAP levels above 40.

> **nist 6/20/10 2:18 PM**
> **Comment:** New language added in response toquestion whether PIV certified sensors are recognizedand whether SAPs below 45 are recognized. (Lepley)

18.27 Fields 14.200-990: User-defined fields / UDF

These fields are user-definable fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present they shall contain ASCII textual information.

18.28 Field 14.996: Image hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, hash value shall be calculated using SHA 256

18.29 Field 14.997: Original image reference / OIV

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

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The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

 The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

18.30 Field 14.998: Geographic sample location / GEO

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

18.31 Field 14.999: Image data / DATA

This mandatory field shall contain all of the data from a captured fingerprint image.

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19 Type-15 variable-resolution palmprint image record

The Type-15   record shall contain and be used to exchange palmprint image data together with fixed and user-defined textual information fields pertinent to the digitized image. Information regarding the scanning resolution used, the image size, and other parameters or comments required to process the image are recorded as tagged fields within the record. Palmprint images transmitted to other agencies will be processed by the recipient agencies to extract the desired feature information required for matching purposes.

The image data shall be acquired directly from a subject using a live-scan device, a palmprint card, a major case print card, or other media that contains the subject's palmprints.

Any method used to acquire the palmprint images shall be capable of capturing a set of images for each hand. This set shall include the writer's palm as a single scanned image, and the entire area of the full palm extending from the wrist bracelet to the tips of the fingers as one or two scanned images. If two images are used to represent the full palm, the lower image shall extend from the wrist bracelet to the top of the interdigital area (third finger joint) and shall include the thenar, and hypothenar areas of the palm. The upper image shall extend from the bottom of the interdigital area to the upper tips of the fingers. This provides an adequate amount of overlap between the two images. The standard also has provision for encoding the interdigital, thenar, and hypothenar areas separately for each palm.   By matching the ridge structure and details contained in this common area, an examiner can confidently state that both images came from the same palm.

As a palmprint transaction may be used for different purposes, it may contain one or more unique image areas recorded from the palm or hand. A complete palmprint record set for one individual will normally include the writer's palm and the full palm image(s) from each hand. Since anl image record may contain only one binary field, a single Type-15 record will be required for each writer's palm and one to three Type-15 records for each full palm. Therefore, four to eight Type-15 records will be required to represent the subject's palmprints in a normal palmprint transaction.

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Table 69 Type-15 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
	M	15.001		RECORD HEADER	1	1
IDC	M	15.002	N	IMAGE DESIGNATION CHARACTER	1	1
IMP	M	15.003	N	IMPRESSION TYPE	1	1
SRC	M	15.004	AN	SOURCE AGENCY / ORI	1	1
PCD	M	15.005	N	PALMPRINT CAPTURE DATE	1	1
HLL	M	15.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	15.007	N	VERTICAL LINE LENGTH	1	1
SLC	M	15.008	N	SCALE UNITS	1	1
HPS	M	15.009	N	HORIZONTAL PIXEL SCALE	1	1
VPS	M	15.010	N	VERTICAL PIXEL SCALE	1	1
CGA	M	15.011	AN	COMPRESSION ALGORITHM	1	1
BPX	M	15.012	N	BITS PER PIXEL	1	1
FGP	M	15.013	N	PALMPRINT POSITION	1	Unlimited
RSV		15.014-15.015		RESERVED FOR FUTURE DEFINITION		
SHPS	O	15.016	N	SCANNED HORIZONTAL PIXEL SCALE	0	1
SVPS	O	15.017	N	SCANNED VERTICAL PIXEL SCALE	0	1
RSV		15.018-15.019		RESERVED FOR FUTURE DEFINITION		
COM	O	15.020	AN	COMMENT	0	1
RSV		15.021-15.023		RESERVED FOR FUTURE DEFINITION		
FQM	O	15.024		PALMPRINT QUALITY METRIC	0	1
QMS	M⇑			QUALITY METRIC SUBFIELD	1	Unlimited
FGP	M⇑		N	FRICTION RIDGE CODE	1	1
QVU	M⇑		N	QUALITY VALUE	1	1
QAV	M⇑		N	QUALITY ALGORITHM VENDOR	1	1
QAP	M⇑		N	QUALITY ALGORITHM PRODUCT ID	1	1

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
RSV		15.025-15.029		RESERVED FOR FUTURE DEFINITION		
DMM	O	15.030	A	DEVICE MONITORING MODE	1	1
RSV		15.031-15.199		RESERVED FOR FUTURE DEFINITION		
UDF		15.200-15.990		USER-DEFINED FIELDS		
RSV		15.991-15.995		RESERVED FOR FUTURE DEFINITION		
HAS	O	15.996	N	IMAGE HASH	0	1
OIV	O	15.997		ORIGINAL IMAGE REFERENCE	0	1
OIR	M⇑		N	REFERENCE CODE	1	1
RTV	O⇑		N	SEGEMENTATION REFERENCE TYPE VALUE	0	1
GEO	O	15.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
DATA	M	15.999	B	IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

19.1 Field 15.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

19.2 Field 15.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-15 record as found in the file content (CNT) field of the Type-1 record.

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19.3 **Field 15.003: Impression type / IMP**

This mandatory field shall be selected from **Table 8**, describing the manner by which the fingerprint image information was obtained.

19.4 Field 15.004: Source agency / ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that originally captured the palmprint image contained in the record. Normally, the Originating Agency Identifier, ORI, of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

19.5 Field 15.005: Palmprint capture date / PCD

This mandatory ASCII field shall contain the date that the palmprint image contained in the record was captured. See the relevant Annex in this standard for the exact encoding format for this data. The *YYYY* characters shall represent the year the image was captured; the *MM* characters shall be the tens and units values of the month; and the *DD* characters shall be the tens and units values of the day in the month.

19.6 Field 15.006: Horizontal line length / HLL

This mandatory ASCII field shall contain the number of pixels contained on a single horizontal line of the transmitted image.

19.7 Field 15.007: Vertical line length / VLL

This mandatory ASCII field shall contain the number of horizontal lines contained in the transmitted image.

19.8 Field 15.008: Scale units / SLC

This mandatory ASCII field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

19.9 Field 15.009: Horizontal pixel scale / HPS

This mandatory ASCII field shall specify the integer pixel density used in the horizontal direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

19.10 Field 15.010: Vertical pixel scale / VPS

This mandatory ASCII field shall specify the integer pixel density used in the vertical direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

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19.11 Field 15.011: Compression algorithm / CGA

This mandatory ASCII field shall specify the algorithm used to compress the transmitted grayscale images. An entry of *"NONE"* in this field indicates that the data contained in this record is uncompressed. For those images that are to be losslessly compressed, this field shall contain the code from **Table 2** to indicate the compression method used for the palmprint images. WSQ or JPEG 10918 are to be used for those images scanned or transmitted at 500 ppi and JPEG 2000 for those images scanned and transmitted at ppi greater than 500. See Section 5.6.1. for additional information on the usage of JPEG 2000 for the compression of friction ridge images. The domain registrar shall maintain a registry of acceptable compression techniques and corresponding codes that may be used as they become available.

19.12   Field 15.012: Bits per pixel / BPX

This mandatory ASCII field shall contain the number of bits used to represent a pixel. This field shall contain an entry of "8" for normal grayscale values of "0" to "255". Any entry in this field greater than "8" shall represent a grayscale pixel with increased precision.

19.13 Field 15.013: Palmprint position / PLP

This mandatory tagged field shall contain the palmprint position that matches the palmprint image. The decimal code number corresponding to the known or most probable palmprint position shall be taken from Table 9 and entered as a two-character ASCII subfield.

19.14 Field 15.016: Scanned horizontal pixel scale / SHPS

This optional ASCII field shall specify the horizontal pixel density used for the scanning of the original impression providing the SLC field contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

19.15 Field 15.017: Scanned vertical pixel scale / SVPS

This optional ASCII field shall specify the vertical pixel density used for the scanning of the original impression providing the SLC field contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

19.16 Field 15.020: Comment / COM

This optional ASCII field may be used to insert comments or other ASCII text information with the image data.

19.17   Field 15.024: Palmprint quality metric / PQM

This optional ASCII field is used to specify one or more different metrics of palmprint image quality score data for the image stored in this record.   The meaning attributed to this metric must be defined and interpreted by the producer of the scoring algorithm or by the person or system used to assign the metric to the palmprint image. The metric may be a predictor of AFIS matcher accuracy

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performance or a different metric to indicate a value associated with the quality of the palmprint image for a particular function.

This field may contain one or more subfields, each consisting of four information items. This subfield **(Quality Metric Subfield / QMS)** is repeated for each palm image and quality algorithm used.

The first information item is the palm reference number / FGP chosen from **Table 9**

The second information item (image quality score / QVU) shall be a quantitative expression of the predicted matching performance of the biometric sample. This item contains the ASCII representation of the integer between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality.   An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a fingerprint image quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards

The third information item (algorithm vendor identification / QAV) shall specify the ID of the vendor of the quality algorithm used to calculate the quality score. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

The fourth information item (algorithm product identification / QAP) shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not required. QAP indicates which of the vendor's algorithms was used in the calculation of the fingerprint image quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65535.

19.18 Field 15.030: Device monitoring mode / DMM

This optional field provides information describing the level of human monitoring for the image capture device. This field will contain an entry from Table 56 to indicate the monitoring mode of the biometric sample capture device.

19.19 Fields 15.200-990: User-defined fields / UDF

These fields are user-defined fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present they shall contain ASCII information.

19.20 Field 15.996: Image hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, hash value shall be calculated using SHA 256.

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19.21 Field 15.997: Original image reference / OIV

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

19.22 Field 15.998: Geographic sample location / GEO

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

19.23 Field 15.999: Image data / DATA

This mandatory field shall contain all of the data from a captured palmprint image. Each pixel of uncompressed grayscale data shall normally be quantized to eight bits (256 gray levels) contained in a single byte. If the entry in BPX Field 15.012 is greater than 8, the number of bytes required to contain a pixel will be different.   If compression is used, the pixel data shall be compressed in accordance with the compression technique specified in the CGA field.

20 Type-16 user-defined testing image record

The Type-16 record shall contain and be used to exchange image data together with textual information fields pertinent to the digitized image. This record type allows the standard to provide the ability to exchange images not addressed by other record types in the standard. It is intended as the user-defined record to be used for developmental or test purposes.

The image data contained in the Type-16 record may be in a compressed form. With the exception of the tagged fields described below, the format, parameters, and types of images to be exchanged are undefined by this standard and shall be agreed upon between the sender and recipient.

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Table 70 Type-16 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
	M	16.001		RECORD HEADER	1	1
IDC	M	16.002	N	IMAGE DESIGNATION CHARACTER	1	1
IMP	M	16.003	N	IMPRESSION TYPE	1	1
SRC	M	16.004	AN	SOURCE AGENCY / ORI	1	1
UTD	M	16.005	N	USER DEFINED TESTING DATE	1	1
HLL	M	16.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	16.007	N	VERTICAL LINE LENGTH	1	1
SLC	M	16.008	N	SCALE UNITS	1	1
HPS	M	16.009	N	HORIZONTAL PIXEL SCALE	1	1
VPS	M	16.010	N	VERTICAL PIXEL SCALE	1	1
CGA	M	16.011	AN	COMPRESSION ALGORITHM	1	1
BPX	M	16.012	N	BITS PER PIXEL	1	1
FGP	M	16.013	N	PALMPRINT POSITION	1	Unlimited
RSV		16.014-16.015		RESERVED FOR FUTURE DEFINITION		
SHPS	O	16.016	N	SCANNED HORIZONTAL PIXEL SCALE	0	1
SVPS	O	16.017	N	SCANNED VERTICAL PIXEL SCALE	0	1
RSV		16.018-16.019		RESERVED FOR FUTURE DEFINITION		
COM	O	16.020	AN	COMMENT	0	1
RSV		16.021-16.023		RESERVED FOR FUTURE DEFINITION		
FQM	O	16.024		USER DEFINED QUALITY METRIC	0	1
QMS	M⇑			QUALITY METRIC SUBFIELD	1	Unlimited
QVU	M⇑		N	QUALITY VALUE	1	1
QAV	M⇑		N	QUALITY ALGORITHM VENDOR	1	1
QAP	M⇑		N	QUALITY ALGORITHM PRODUCT ID	1	1
RSV		16.025-16.029		RESERVED FOR FUTURE DEFINITION		

Brad Wing 6/21/10 1:09 PM
Comment: Table now included in record description; with subfields and information items

Brad Wing 6/21/10 1:09 PM
Comment: Note change on upper limit

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
DMM	O	16.030	A	DEVICE MONITORING MODE	1	1
RSV		16.031-16.199		RESERVED FOR FUTURE DEFINITION		
UDF		16.200-16.990		USER-DEFINED FIELDS		
RSV		16.991-16.995		RESERVED FOR FUTURE DEFINITION		
HAS	O	16.996	N	IMAGE HASH	0	1
OIV	O	16.997		ORIGINAL IMAGE REFERENCE	0	1
OIR	M⇑		N	REFERENCE CODE	1	1
RTV	O⇑		N	SEGEMENTATION REFERENCE TYPE VALUE	0	1
GEO	O	16.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
DATA	M	16.999	B	IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

20.1 Field 16.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

20.2 Field 16.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-16 record as found in the file content (CNT) field of the Type-1 record.

20.3 Field 16.003: User-defined image / UDI

This mandatory field shall contain the type of user-defined image contained in this record. Its content shall be defined by the user and be in accordance with the receiving agency.

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20.4 Field 16.004: Source agency / ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that originally captured the image contained in the record. Normally, the Originating Agency Identifier, ORI, of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

20.5 Field 16.005: User-defined testing date / UTD

This mandatory ASCII field shall contain the date that the image contained in the record was captured. The *YYYY* characters shall represent the year the image was captured; the *MM* characters shall be the tens and units values of the month; and the *DD* characters shall be the tens and units values of the day in the month. For example, 20040229 represents February 29, 2004.

20.6 Field 16.006: Horizontal line length / HLL

This mandatory field shall contain the number of pixels contained on a single horizontal line of the transmitted image.

20.7 Field 16.007: Vertical line length / VLL

This mandatory field shall contain the number of horizontal lines contained in the transmitted image.

20.8 Field 16.008: Scale units / SLC

This mandatory field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

20.9 Field 16.009: Horizontal pixel scale / HPS

This mandatory field shall specify the integer pixel density used in the horizontal direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

20.10 Field 16.010: Vertical pixel scale / VPS

This mandatory field shall specify the integer pixel density used in the vertical direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

20.11 Field 16.011: Compression algorithm / CGA

This mandatory field shall contain an entry from **Table 2** to specify the algorithm used for compressing the image. An entry of *"NONE"* in this field indicates that the data contained in this record is uncompressed.

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20.12   Field 16.012: Bits per pixel / BPX

This mandatory field shall contain the number of bits used to represent a pixel. This field shall contain an entry of "8" for normal grayscale values of "0" to "255". Any entry in this field greater than "8" shall represent a grayscale pixel with increased precision.

20.13   Field 16.013: Color space / CSP

This optional field shall contain an entry from **Table 1** to identify the color space used to exchange the image data. If the color space for an RGB image cannot be determined, an entry of "RGB" shall be entered.   The description for field 10.012 contains additional information on the color space field.

20.14   Field 16.016: Scanned horizontal pixel scale / SHPS

This optional ASCII field shall specify the horizontal pixel density used for the scanning of the original image providing the SLC field contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

20.15   Field 16.017: Scanned vertical pixel scale / SVPS

This optional ASCII field shall specify the vertical pixel density used for the scanning of the original image providing the SLC field contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

20.16   Field 16.020: Comment / COM

This optional ASCII field may be used to insert comments or other ASCII text information with the image data.

21.17   Field 16.024: User-defined testing image quality score/ UQS

This optional ASCII field is used to specify one or more different metrics of image quality score data for the image stored in this record.   The meaning attributed to this metric must be defined and interpreted by the producer of the scoring algorithm or by the person or system used to assign the metric to the image. The metric may be a predictor of AFIS matcher accuracy performance or a different metric to indicate a value associated with the quality of the image for a particular function.

This field may contain one or more subfields, each consisting of three information items. This subfield **(Quality Metric Subfield / QMS)** is repeated for each image and quality algorithm used.

The first information item (image quality score / QVU) shall be a quantitative expression of the predicted matching performance of the biometric sample. This item contains the ASCII representation of the integer between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality.   An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a fingerprint image quality score was made. The use of additional values to

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convey other information should be harmonized with ISO/IEC 19794 standards

The second information item (algorithm vendor identification / QAV) shall specify the ID of the vendor of the quality algorithm used to calculate the quality score. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

The third information item (algorithm product identification / QAP) shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not required. QAP indicates which of the vendor's algorithms was used in the calculation of the fingerprint image quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65535.

21.18   Field 16.030: Device monitoring mode / DMM

This optional field provides information describing the human monitoring operation of the image capture device. This field will contain an entry from Table 56 to indicate the monitoring mode of the biometric sample capture device.

21.19   Fields 16.200-990: User-defined fields / UDF

These fields are user-definable fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present they shall contain ASCII textual information.

21.20   Field 16.996: Image hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, hash value shall be calculated using SHA 256.

21.21   Field 16.997: Original image reference / OIV

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

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21.22   Field 16.998: Geographic sample location / GEO

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

21.3   Field 16.999: Image data / DATA

This mandatory field shall contain all of the pixel data from a captured image.

21 Type-17 Iris image record

The Type-17 record shall contain and be used to exchange generic iris image data using mandatory fields of this record type. Optional fields may be used to exchange additional information available in the INCITS 379-2004 – Iris Image Interchange Format standard and the ISO/IEC 19794-6 iris image data interchange format standard. Images may be monochrome or color with 256 or more intensity levels (gray or per-color component), and vary in size depending on field of view and compression.

The iris standard specifies interchange formats for biometric authentication systems that utilize iris recognition. The first, which is represented in this record type, is based on a rectilinear image storage format that specifies a raw, uncompressed or compressed array of intensity values. Additional compact representations of the rectilinear image storage format are defined as an option in this record.

Note that a polar image specification is not represented in this record type. If such a polar representation is required for a specific application, a Type-99 CBEFF biometric data record may be used.

Table 71 Type-17 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	17.001		RECORD HEADER	1	1

> **Brad Wing 6/21/10 1:19 PM**
> **Comment:** Table now included in record description; with subfields and information items

Data Format for the Interchange of Biometric and Forensic Information

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
IDC	M	17.002	N	IMAGE DESIGNATION CHARACTER	1	1
FID	M	17.003	N	IMPRESSION TYPE	1	1
SRC	M	17.004	AN	SOURCE AGENCY / ORI	1	1
ICD	M	17.005	N	IRIS CAPTURE DATE	1	1
HLL	M	17.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	17.007	N	VERTICAL LINE LENGTH	1	1
SLC	M	17.008	N	SCALE UNITS	1	1
HPS	M	17.009	N	HORIZONTAL PIXEL SCALE	1	1
VPS	M	17.010	N	VERTICAL PIXEL SCALE	1	1
CGA	M	17.011	AN	COMPRESSION ALGORITHM	1	1
BPX	M	17.012	N	BITS PER PIXEL	1	1
CSP	M	17.013	A	COLOR SPACE	1	1
RAE	O	17.014	AN	ROTATION ANGLE OF EYE	0	1
RAU	O	17.015	AN	ROTATION UNCERTAINTY	0	1
IPC	O	17.016		IMAGE PROPERTY CODE	0	1
IHO	M⇑		N	HORIZONTAL ORIENTATION CODE	1	1
IVO	M⇑		N	VERTICAL ORIENTATION CODE	1	1
IST	M⇑		N	SPECIFIC SCAN TYPE	1	1
DUI	O	17.017	ANS	DEVICE UNIQUE IDENTIFIER	0	1
GUI	O	17.018	AN	GLOBAL UNIQUE IDENTIFIER	0	1
MMS	O	17.019	ANS	MAKE/MODEL/SERIAL NUMBER	0	1
MAK	M⇑		ANS	MAKE	1	1
MOD	M⇑		ANS	MODEL	1	1
SER	M⇑		ANS	SERIAL NUMBER	1	1
ECL	O	17.020	A	EYE COLOR	0	1
COM	O	17.021	AN	COMMENT	0	1
SHPS	O	17.022	N	SCANNED HORIZONTAL PIXEL SCALE	0	1
SVPS	O	17.023	N	SCANNED VERTICAL PIXEL SCALE	0	1

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count Min	Occur count Max
IQS	O	17.024		IMAGE QUALITY SCORE	0	1
QMS	M⇑			QUALITY METRIC SUBFIELD	1	Unlimited
QVU	M⇑		N	QUALITY VALUE	1	1
QAV	M⇑		N	QUALITY ALGORITHM VENDOR	1	1
QAP	M⇑		N	QUALITY ALGORITHM PRODUCT ID	1	1
ALS	O	17.025		ACQUISITION LIGHTING SPECTRUM	0	1
SPV	M⇑		AN	SPECTRUM VALUE	1	1
LOW	C-SPV		N	SPECTRUM LOWER BOUND	0	1
HIG	C-SPV		N	SPECTRUM UPPER BOUND	0	1
IRD	O	17.026	N	IRIS DIAMETER	0	1
RSV		17.027-17.029		RESERVED FOR FUTURE DEFINITION		
DMM	O	17.030	A	DEVICE MONITORING MODE	1	1
SAP	O	17.031	N	SUBJECT ACQUISITION PROFILE	1	1
ISF	O	17.032	N	COMPACT STORAGE FORMAT	1	1
IPB	O	17.033		IRIS PUPIL BOUNDARY	1	1
IPC	M⇑		A	IRIS PUPIL CODE	1	1
IPPQ	M⇑		N	TOTAL NUMBER OF POINTS	1	1
ICP	M⇑		N	CONSECUTIVE POINTS	1	IPPQ value
PHX	M⇑		N	HORIZONTAL POINT OFFSET	1	1
PVY	M⇑		N	VERTICAL POINT OFFSET	1	1
ISB	O	17.034		IRIS SCLERA BOUNDARY	1	1
ISC	M⇑		A	IRIS SCLERA CODE	1	1
ISPQ	M⇑		N	TOTAL NUMBER OF POINTS	1	1
SCP	M⇑		N	CONSECUTIVE POINTS	1	ISPQ value
SHX	M⇑		N	HORIZONTAL POINT OFFSET	1	1

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
SVY	M⇑		N	VERTICAL POINT OFFSET	1	1
UEB	O	17.035		UPPER EYELID BOUNDARY	1	1
UEC	M⇑		A	UPPER EYELID CODE	1	1
UEPQ	M⇑		N	TOTAL NUMBER OF POINTS	1	1
UCP	M⇑		N	CONSECUTIVE POINTS	1	UEPQ value
UHX	M⇑		N	HORIZONTAL POINT OFFSET	1	1
UVY	M⇑		N	VERTICAL POINT OFFSET	1	1
LEB	O	17.036		LOWER EYELID BOUNDARY	1	1
LSC	M⇑		A	LOWER EYELID CODE	1	1
LEPQ	M⇑		N	TOTAL NUMBER OF POINTS	1	1
LCP	M⇑		N	CONSECUTIVE POINTS	1	LEPQ value
LHX	M⇑		N	HORIZONTAL POINT OFFSET	1	1
LVY	M⇑		N	VERTICAL POINT OFFSET	1	1
OCC	O	17.037		OCCLUSION	1	1
OCC	M⇑		A	OCCLUSION CODE	1	1
OCT	M⇑		A	OCCLUSION TYPE	1	1
OCPQ	M⇑		N	TOTAL NUMBER OF POINTS	1	1
OCP	M⇑		N	CONSECUTIVE POINTS	1	OCPQ value
OHX	M⇑		N	HORIZONTAL POINT OFFSET	1	1
OVY	M⇑		N	VERTICAL POINT OFFSET	1	1
RSV		17.038-17.039		RESERVED FOR FUTURE DEFINITION		
RAN	O	17.040	N	RANGE	1	1
LAV	O	17.041	N	LENS ANGLE OF VIEW	1	1
ITX	O	17.044		IMAGE TRANSFORMATION	0	1
ITV	M⇑		A	IMAGE TRANSFORMATION VALUES	1	Unlimited

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Data Format for the Interchange of Biometric and Forensic Information

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
RSV		17.045-17.099		RESERVED FOR FUTURE DEFINITION		
UDF		17.100-17.990		USER-DEFINED FIELDS		
RSV		17.991-17.995		RESERVED FOR FUTURE DEFINITION		
HAS	O	17.996	N	IMAGE HASH	0	1
OIV	O	17.997		ORIGINAL IMAGE REFERENCE	0	1
OIR	M⇑		N	REFERENCE CODE	1	1
RTV	O⇑		N	SEGEMENTATION REFERENCE TYPE VALUE	0	1
GEO	O	17.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
DATA	M	17.999	B	IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

21.1 Field 17.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

21.2 Field 17.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-17 record as found in the file content (CNT) field of the Type-1 record.

21.3 Field 17.003: Feature identifier / FID

This mandatory field shall contain an identifier for the eye represented by the image in the record. An entry of "0" in this field indicates that the image in this record is undefined. An entry of "1" in this field indicates that the image in this

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record is the subject's right eye. An entry of "2" in this field indicates that the image in this record is the subject's left eye.

21.4 Field 17.004: Source agency / ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that originally captured the iris image contained in the record. Normally, the Originating Agency Identifier, ORI, of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

21.5 Field 17.005: Iris capture date / ICD

This mandatory ASCII field shall contain the date that the iris image contained in the record was captured. See the relevant Annex in this standard for the exact encoding format for this data. The *YYYY* characters shall represent the year the image was captured; the *MM* characters shall be the tens and units values of the month; and the *DD* characters shall be the tens and units values of the day in the month.

21.6 Field 17.006: Horizontal line length / HLL

This mandatory ASCII field shall contain the number of pixels contained on a single horizontal line of the transmitted image.

21.7 Field 17.007: Vertical line length / VLL

This mandatory ASCII field shall contain the number of horizontal lines contained in the transmitted image.

21.8 Field 17.008: Scale units / SLC

This mandatory ASCII field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

21.9 Field 17.009: Horizontal pixel scale / HPS

This mandatory ASCII field shall specify the integer pixel density used in the horizontal direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

21.10 Field 17.010: Vertical pixel scale / VPS

This mandatory ASCII field shall specify the integer pixel density used in the vertical direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

21.11 Field 17.011: Compression algorithm / CGA

This mandatory ASCII field shall specify the algorithm used to compress the transmitted color or grayscale images. **Table 2** contains the codes for the

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compression methods. An entry of "NONE" in this field indicates that the data contained in this record is uncompressed. The image shall be represented as an array of n rows by m columns by at least 8-bit pixels. Each pixel in a monochrome image shall be represented by eight or more bits. Color images shall be represented as a sequential sample of a red, green, and blue intensity for each pixel. The image shall be organized in row-major order, with the lowest address corresponding to the upper left corner of the image.

For those images that are to be compressed, the method of compression of iris images is specified by the baseline mode of the JPEG algorithm or JPEG 2000.

21.12 Field 17.012: Bits per pixel / BPX

This mandatory ASCII field shall contain the number of bits used to represent a pixel. This field shall contain an entry of "8" for normal grayscale values of "0" to "255". Any entry in this field greater than "8" shall represent a grayscale pixel with increased quantization.

21.13 Field 17.013: Color space / CSP

This mandatory ASCII field shall contain an entry from **Table 1** to identify the color space used to exchange the image data. If the color space for an RGB image cannot be determined, an entry of "RGB" shall be entered in field 17.013. The description for field 10.012 contains additional information on the color space field.

21.14 Field 17.014: Rotation angle of eye / RAE

This optional field shall indicate the rotation angle of the eye. For rectilinear images, rotation angle = round (65536 * angle / 360) modulo 65536. The angle is measured in degrees from horizontal to the inter-pupillary line. The value "FFFF" indicates rotation angle of eye is undefined.

21.15 Field 17.015: Rotation uncertainty / RAU

This optional field shall indicate the rotation uncertainty. The rotation uncertainty is equal to [round (65536 * uncertainty / 180)]. The uncertainty is measured in degrees and is the absolute value of maximum error. The value "FFFF" indicates uncertainty is undefined.

21.16 Field 17.016: Image property code / IPC

This optional field shall contain the image property code. It shall contain three information items.

The first information item is the **horizontal orientation code / IHO**. Values for Horizontal Orientation shall be one of: "0" for Undefined, "1" for Base, or "2" for Flipped. "Base" orientation refers to images corresponding to the view facing the subject, where the nasal side of subject's left eye or outer edge of the subject's right eye is on the left side the of image. "Flipped" orientation

> **Brad Wing 6/21/10 1:35 PM**
> **Comment:** Reorganized for clarity

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refers to images where the orientation is opposite from that described for "Base".

The second information item is the **vertical orientation code / IVO**. Values for Vertical Orientation shall be one of: "0" for Undefined, "1" for Base, or "2" for Flipped. "Base" orientation refers to images where the superior (top) edge of the eye is at the top of the image. "Flipped" orientation refers to images where the orientation is opposite from that described for "Base".

The third information item is the **specific scan type / IST**. Values for Scan Type shall be one of: "0" for Undefined, "1" for Progressive, "2" for Interlace Frame, or "3" for Interlace Field. "Progressive" indicates that the image was captured using progressive scanning, in which case all image lines are generated sequentially. "Interlace Frame" indicates that the image was captured using interlaced scanning, in which two fields are generated in sequence, the first composed of odd-numbered lines and the second of even-numbered lines. "Interlace Field" indicates that the image was captured using interlaced scanning, in which only one field is generated, and then each line is duplicated to produce a full size image.

21.17 Field 17.017: Device unique identifier / DUI

This optional field shall contain a sixteen-byte string uniquely identifying the device or source of the data. This data can be one of: (1) Device Serial number, identified by the first character "D", (2) Host PC Mac address, identified by the first character "M", (3) Host PC processor ID, identified by the first character "P", and (4) No serial number, identified by all zero's.

21.18 Field 17.018: Global unique identifier / GUI

This optional field shall contain a 16-byte string to indicate a GUID – a globally unique identifier.

21.19 Field 17.019: Make/Model/Serial Number / MAK / MOD / SER

This optional field contains the make, model and serial number for the iris capture device. It shall consist of three information items. Each information item shall be 1 to 50 characters. Any or all information items may indicate that information is unknown with the value "0".

21.20 Field 17.020: Eye color / ECL

This optional field shall specify the subject's eye color. When used, this field shall contain an entry chosen from

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Table 51.

21.21 Field 17.021: Comment / COM

This optional field may be used to insert comments or other ASCII text information with the iris image data.

21.22 Field 17.022: Scanned horizontal pixel scale / SHPS

This optional ASCII field shall specify the horizontal pixel density used for scanning providing the SLC field contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

21.23   Field 17.023: Scanned vertical pixel scale / SVPS

This optional ASCII field shall specify the vertical pixel density used for scanning providing the SLC field contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

21.24 Field 17.024: Image Quality Score / IQS

This optional ASCII field is used to specify one or more different metrics of image quality score data for the image stored in this record.   The meaning attributed to this metric must be defined and interpreted by the producer of the scoring algorithm or by the person or system used to assign the metric to the image. The metric may be a predictor of AFIS matcher accuracy performance or a different metric to indicate a value associated with the quality of the image for a particular function.

This field may contain one or more subfields, each consisting of three information items. This subfield **(Quality Metric Subfield / QMS)** is repeated for each image and quality algorithm used.

The first information item (image quality score / QVU) shall be a quantitative expression of the predicted matching performance of the biometric sample. This item contains the ASCII representation of the integer between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality.   An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a fingerprint image quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards

The second information item (algorithm vendor identification / QAV) shall specify the ID of the vendor of the quality algorithm used to calculate the quality score. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

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The third information item (algorithm product identification / QAP) shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not required. QAP indicates which of the vendor's algorithms was used in the calculation of the fingerprint image quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65535.

21.25 Field 17.025: Acquisition and lighting spectrum / ALS

This optional field indicates the acquisition spectrum used in capturing the iris image. The acquisition spectrum is the effective acquisition spectrum, which is limited by both the lighting spectrum and the spectrum limitations of the acquisition device: it is defined by the overlap of the two spectra.

Values shall be one of the following[59]:

Value	Description	Spectrum
NIR	Near-infrared acquisition	Approx. 700–850 nm
VIS	Visible full-spectrum acquisition	Approx. 380–750 nm
RED	Red portion of visible full-spectrum illumination	620–750 nm
DEFINED	Defined acquisition spectrum, in range of nanometers rounded to the nearest 10nm, e.g. "0740-0760" or "0800-0830". This option provides the means to specify the acquisition spectrum when known with precision. When this value is used, it shall be accompanied by two information items. The format of these two information items shall be a 4-digit integer specifying the minimum of the spectrum range in nanometers, followed by a hyphen, followed by a 4-digit integer specifying the maximum of the spectrum range in nanometers. The minimum value must be less than or equal to the maximum value.	
OTHER	Unspecified acquisition spectrum	

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[59] When "DEFINED" is chosen, it must be specified if it's a low bound spectrum value / LOW or a high bound spectrum value / HIG

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21.26 Field 17.026: Iris Diameter / IRD

This optional field shall specify the expected iris diameter in pixels.

21.27 Field 17.030: Device monitoring mode / DMM

This optional field provides information describing the human monitoring operation of the image capture device. This field will contain an entry from Table 56 to indicate the monitoring mode of the biometric sample capture device.

21.28 Field 17.031: Subject acquisition profile / SAP

This optional field lists the SAP levels associated with mobile acquisition devices. The SAP level for iris is to be entered in accordance with the latest version of the *Mobile ID Best Practice Recommendations*.

21.29 Field 17.032: Compact storage format[60] / ISF

This optional field is used when an iris image is stored using one of the following compact storage formats. The codes are shown in **Table 72**.

> **Brad Wing 6/21/10 4:36 PM**
> **Comment:** Reworked for clarity

Table 72 Iris rectilinear compact formats

Type code	Description
1	Raw: 640x480
3	Cropped
7	Cropped and Masked

21.30 Field 17.033: Iris pupil boundary / IPB

This optional field defines the pupillary boundary, between the iris and pupil. This field shall consist of the following. The last subfield consists of two information items.

The first subfield (Iris pupil code / IPC) is one ASCII character containing the code from Table 73

The second subfield (number of points defined / IPPQ) is a numeric value of the total number of points describing the boundary

The third subfield (consecutive points / ICP) contains two information items.

The first information item (horizontal offset / PHX) is the pixel count across from the origin at the upper left corner of the image.

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[60] See "Performance of Iris Recognition Algorithms on Standard Images", NIST Interagency Report 7629

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The second information item (horizontal offset / PVY) is the pixel count down

Table 73 Iris boundary definition codes

Code	Type	Number of points	Description
C	Circle	2	The boundary is defined by two points: the center is defined in the first subfield, and any point on the circle is defined in the second subfield.
E	Ellipse	3	The boundary is defined by three points: both endpoints of one of the ellipse's axes are defined in the first and second subfields, and one endpoint from the other axis is defined in the third subfield.
P	Polygon	n	The boundary is defined as an n-vertex polygon, where "n" is between 3 and 99. The order of the vertices must be in their consecutive order around the perimeter of the polygon, either clockwise or counterclockwise. No two vertices may occupy the same location. The polygon side defined by the last subfield and the first subfield shall complete the polygon. The polygon must be a simple, plane figure with no sides crossing and no interior holes.

21.31 Field 17.034 Iris Sclera Boundary / ISB

This optional field defines the limbic boundary, between the iris and sclera. This field shall consist of the following:

The first subfield (Iris sclera code / ISC) is one ASCII character containing the code from Table 73

The second subfield (number of points defined / ISPQ) is a numeric value of the total number of points describing the boundary

The third subfield (consecutive points / SCP) contains two information items.

The first information item (horizontal offset / SHX) is the pixel count across from the origin at the upper left corner of the image.

The second information item (horizontal offset / SVY) is the pixel count down from the origin at the upper left corner of the image.

21.32 Field 17.035: Upper eyelid boundary / UEB

This optional field defines the boundary between the upper eyelid and the eye. This field shall consist of the following:

The first subfield (Upper eyelid code / UEC) is one ASCII character containing the code from Table 73

The second subfield (number of points defined / UEPQ) is a numeric value of the total number of points describing the boundary

The third subfield (consecutive points / UCP) contains two information items.

The first information item (horizontal offset / UHX) is the pixel count across from the origin at the upper left corner of the image.

The second information item (horizontal offset / UVY) is the pixel count down from the origin at the upper left corner of the image.

21.33 Field 17.036: Lower eyelid boundary / LEB

This optional field defines the boundary between the lower eyelid and the eye. This field shall consist of the following:

The first subfield (Lower eyelid code / LSC) is one ASCII character containing the code from Table 73

The second subfield (number of points defined / LEPQ) is a numeric value of the total number of points describing the boundary

The third subfield (consecutive points / LCP) contains two information items.

The first information item (horizontal offset / LHX) is the pixel count across from the origin at the upper left corner of the image.

The second information item (horizontal offset / LVY) is the pixel count down from the origin at the upper left corner of the image.

21.34 Field 17.037: Occlusion / OCC

This optional field defines the outline and contents of any occlusion that partially or totally blocks the image of the iris.

This field shall consist of the following:

The first subfield (Occlusion code / ONC) is one ASCII character containing the code from **Table 74**

The second subfield (Occlusion type / OCT) is one ASCII character containing the code from Table

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The third subfield (number of points defined / OCPQ) is a numeric value of the total number of points describing the boundary

The fourth subfield (consecutive points / OCP) contains two information items.

The first information item (horizontal offset / OHX) is the pixel count across from the origin at the upper left corner of the image.

The second information item (horizontal offset / OVY) is the pixel count down from the origin at the upper left corner of the image.

Table 74: Iris occlusion opacity

Code	Type	Description
T	Total	There is no iris detail in the area of the occlusion.
I	Interference	The occlusion contains interfering texture such as eyelashes or reflection.
L	Partial Light	There is iris detail in the area of the occlusion that is lighter than the rest of the iris.
S	Partial shadow	There is iris detail in the area of the occlusion that is darker than the rest of the iris.

Table 75: Iris occlusion type

Code	Type	Description
L	Lashes	Eyelashes or reflections of eyelashes
S	Specular	Specularity, reflection of light by the iris
H	Shadow	Shadow cast on the iris
R	Reflection	Reflection of an object
O	Other	Any other occlusion, such as eyeglass frames blocking the image

21.35 Field 17.040: Range / RAN

This optional field contains the estimated distance from the lens of the camera to the iris, measured in millimeters.

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21.36 Field 17.041: Lens angle of view / LAV

This optional field describes angular extent of a given scene (off frontal angle) imaged by a camera, measured in degrees.

21.37 Field 17.044: Image transform / ITX

This optional field is used in the case when the image in this Type-17 record has been transformed from the original image. Note that the untransformed image(s) (optionally) may be included in a Type-20 record.

The information item **Image transform value / ITV** may be repeated as needed.

Table 76 Iris image transform descriptions

Value	Description
AGE	Age progressed
AXIS	Off--axis image rectification / Angle correction
COLORSHIFT	Color shifted
CONTRAST	Contrast stretched
CROP	Cropped
DIST	Distortion corrected (e.g. fisheye correction)
DOWNSAMPLE	Down-sampled
GRAY	Grayscale from color
ILLUM	Illumination transform
IMGFUSE	Image-level fusion of two or more images
INTERPOLATE	Up-sampled
MULTCOMP	Multiply compressed
MULTIVIEW	Multi-view image
POSE	Face-specific pose correction
ROTATE	Rotated (in-plane)
SNIR	Simulated Near IR
SUPERRES	Super-resolution image, derived from multiple lower resolution images

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Value	Description
WHITE	White balance adjusted

21.38 Field 17.200-990 User-defined fields / UDF

These fields are user-defined fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. Ig present they shall contain ASCII information.

21.39 Field 17.996: Image hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, hash value shall be calculated using SHA 256.

21.40 Field 17.997: Original image reference / OIV

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield **(geographic reference text / GRT)** is free form text describing a street address or other physical location.

The second sufield **(degree value / DEG)** has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield **(degree minute second value / DMS)** has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

21.41 Field 17.999: Image data / DATA

This mandatory field shall contain the iris image.

22   Type-18 DNA record

The Type-18 record shall contain and be used to exchange DNA data.[61]   This shall be used to exchange Autosomal Short Tandem Repeat (STR), X-Short Tandem Repeat (X-STR) Y-Short Tandem Repeat (Y-STR), Mitrochondrial (mtDNA), and electropherogram images of DNA data. The electropherogram image shall not be compressed. This record type is based on DNA profile data from genetic profiling techniques that are standardized and commonly used for the purpose of discriminating between individuals.

Standard profiling systems exploit the non-coding regions of DNA that are referred to as "junk DNA." The coding regions are deliberately avoided in order to maintain the privacy and civil rights of the donor. However, national data protection and privacy legislation may impose special security safeguards, such as – but not limited to – encryption of data transfers and / or storage.

The record contains:

- A DNA Record Header (Field 18.005) containing information about the sending and receiving parties for DNA processing. This may not be identical to the ORI/SRC and transaction receiving parties.

A DNA Sample field (18.006) describing biological materials used to generate the DNA profile form crime scene and paternity investigation.

- A DNA Data profile field (18.007) describing genotype separation and detection of the full genotype at one or more DNA markers.

- There are additional optional fields that are used depending upon the type of DNA processing that has been performed:

    o DNA STR, X-STR and Y-STR field (18.008)

    o Mitochondrial field (18.009)

    o Electropherogram image field (18.999)

<div style="color:#888">Comment [Brad Wing 6/22/10 11:41 AM]: I have tried to reflect the input that I received in the format of the standard. I hope that I interpreted it correctly.</div>

<div style="color:#888">Comment [Brad Wing 6/22/10 11:53 AM]: Please check my wording.</div>

Table 77 Type-18 Record

<div style="color:#888">Comment [Brad Wing 6/22/10 9:56 AM]: Table now included in record description; with subfields and information items</div>

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	18.001		RECORD HEADER	1	1
IDC	M	18.002	N	IMAGE DESIGNATION CHARACTER	1	1

- [61] This record type is designed to be in harmony with the ISO/IEC 197994-14 DNA data interchange format, which was in draft form at the time of the passage of this version of the ANSI/NIST-ITL standard.

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
DNT	M	18.003		DNA TECHNOLOGY TYPE	1	1
SRC	M	18.004	AN	SOURCE AGENCY / ORI	1	1
DRI	M	18.005		DNA HEADER INFORMATION	1	1
FID	M		A	FORMAT IDENTIFIER	1	1
HDT	M		N	HEADER TYPE	1	1
DIR	M		N	HEADER DIRECTION	1	1
DVR	M		N	VERSION	1	1
SPY	M			SENDING PARTY	1	1
CSC	M		AN	CODE OF SENDING COUNTRY / SUB COUNTRY	1	1
NSA	M		AN	NAME OF AGENCY	1	1
SRS	M		A	SURNAME	1	1
GVS	M		A	GIVEN NAME	1	1
RPY	M			RECEIVING PARTY	1	1
CRC	M		AN	CODE OF RECEIVING COUNTRY / SUB COUNTRY	1	1
NRA	M		AN	NAME OF AGENCY	1	1
SRR	M		A	SURNAME	1	1
GVR	M		A	GIVEN NAME	1	1
LTY	M		A	LAB TYPE	1	1
BID	M		AN	BATCH ID	1	1
KID	M			KIT ID	1	1
KNM	M		AN	KIT NAME	1	1
KMF	M		AN	KIT MANUFACTURER	1	1
KDS	M		AN	KIT DESCRIPTION	1	1
NRD	M		N	NUMBER OF DNA RECORD DATA	1	1
CFG	M		N	CERTIFICATION FLAG	1	1
DSI	M	18.006		DNA SAMPLE INFORMATION	1	1
SCY	M		N	SAMPLE CATEGORY	1	1
SCT	M		N	SAMPLE CELLULAR TYPE	1	1
STT	M		N	SAMPLE TYPING TECHNOLOGY	1	1
SSI	M		N	SAMPLE SOURCE INDICATOR	1	1
SCM	M		AN	SAMPLE COLLECTION METHOD TEXT	1	1

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
SCD	M			SAMPLE COLLECTION DATE	1	1
GMT	M		AN	GREENWICH MEAN TIME SAMPLE COLLECTED	1	1
DAT	M		AN	LOCAL DATE TIME SAMPLE COLLECTED	1	1
DPD	M	18.007		DNA PROFILE DATA	1	1
DTS	M		AN	LOCAL DATE TIME PROFILE STORED	1	1
PTP	M		N	PROFILE TYPE	1	1
RES	M		AN	RESULT	1	1
PRF	M		AN	PROFILE ID	1	1
REQ	M		A	REQUEST TYPE	1	1
ERM	O		A	ERROR MESSAGE	1	1
SUP	O		A	SUPPLEMENTAL MESSAGE	1	1
DPF	C STT	18.008		DNA STR AND Y STR PROFILE	0	Unlimited
STR	M⇑		N	DNS STR TYPE	1	1
DLC	M⇑			DNA LOCUS	1	29
iNP	M⇑		N	INFORMATION PART	1	1
ALN	M⇑		N	REFERENCE NUMBER OF ALLELE CALL	1	1
ALC	M⇑		AN	ALLELE CALL	1	1
DMP	C STT	18.009		DNA MITOCHONDRIAL PROFILE	0	1
MT1	M⇑		AN	MITO CONTROL REGION 1	1	1
MT2	M⇑		AN	MITO CONTROL REGION 2	1	1
MQ1	M⇑		AN	MITO DNA QUALITY 1	1	1
MQ2	M⇑		AN	MITO DNA QUALITY 2	1	1
UDP	C STT	18.010		USER DEFINED PROFILE	0	1
HAS	O	18.996	N	IMAGE HASH	0	1
OIV	O	18.997		ORIGINAL IMAGE REFERENCE	0	1
OIR	M⇑		N	REFERENCE CODE	1	1
RTV	O⇑		N	SEGEMENTATION REFERENCE TYPE VALUE	0	1
GEO	O	18.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1

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Data Format for the Interchange of Biometric and Forensic Information

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
DATA	C STT	18.999	B	ELECTROPHEROGRAM IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

22.1 Field 18.001 Record Header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

22.2 Field 18.002 Image designation character / IDC

This mandatory field shall be the IDC of the Type-18 record as found in the file content (CNT) field of the Type-1 record.

22.3 Field 18.003 DNA Technology Type / DNT

This field is mandatory and the numeric value is selected from the following table:

Brad Wing 6/22/10 10:10 AM
Comment: Note the ability to specify Mobile DNA units, which is not part of the ISO standard

Table 78 DNA Technology types

Value	Description
1	Laboratory DNA processing unit
2	Rapid DNA / mobile processing unit
3	Other

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22.4 Field 18.004: Source agency / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that is sending the DNA data contained in the record. Normally, the Originating Agency Identifier, ORI, will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

Brad Wing 6/22/10 11:28 AM
Comment: This may be different from the laboratory. It may be the associated law enforcement organization.

22.5 Field 18.005: DNA Record Header Information (DRI)

This mandatory field shall be used to provide detailed information relating to the DNA record. It consists of eleven mandatory subfields, as described below.

- The first subfield **(Format Identifier / FID)** is always entered as "DNA"

- The second subfield **(Header Type / HTY)** indicates whether the DNA record contains multiple or single data analyses. Possible entries are:
  - o   0 = "Multiple" or
  - o   1 = "Single"

- The third subfield **(Header Direction / HDI)** indicates the type of message, with possible entries of
  - o   0 = "Request" or
  - o   1 = "Answer".

- The fourth subfield **(Version / HVR)** corresponds to the version of the FBI Combined DNA Index System (CODIS)[62] standard upon which this record type is based. The value used in this version of the standard is 3.0

- The fifth subfield **(Sending Party / HSP)** contains four information items:
  - o   The ISO 3166 2 **code of the sending country or sub country / CSC.** This is the code of where the DNA was processed -- not necessarily the nation of the ORI / SRC.
  - o   The **name of the agency / NSA** that originally processed the DNA data (This may not be the same as the entry in field 18.004)
  - o   The name of the person at the laboratory that composed the DNA record metadata. Comprise the third and fourth information items:
    - ▪ **Surname / SRA** which is the family name or last name
    - ▪ **Given name / GVS** which is the personal / first or first and

Brad Wing 6/22/10 11:39 AM
Comment: Explanation added for clarification

Brad Wing 6/22/10 11:39 AM
Comment: Borken out to be consistent with other record types.

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[62]For information, see www.fbi.gov/hq/lab/html/codis1.htm

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- The sixth subfield **(Receiving Party / RPY)** contains four information items:

  - The ISO-3166-2 **code of the receiving country** or sub-country **/ CRC.** This is the code of the country / sub-country that receives/received the data or request from the NOA described above. This may be different from the ORI/ SRC.

  - The name of the **agency receiving the message / NRA.** This is the name of the agency that receives/received the data or request from the NOA described above. This may be different from the ORI/ SRC.

  -

  - The name of the person at the laboratory that receives the DNA data comprise the third and fourth information items:

    - **Surname / SRR** which is the family name or last name

    - **Given name / GVR** which is the personal / first or first and middle name

- The seventh subfield **(Lab Type / LTY)** contains a single character describing the laboratory that processed the DNA. Allowable values are:

  - G = Government

  - I = Industry

  - O = Other laboratory

- The eighth subfield **(Batch ID / BID)** shall contain an identifier for the batch to which a locus belongs. This may be referred to as the gel or plate identifier. A specimen may have loci from multiple batches. The Batch ID shall be a string up to 32 characters.

- The ninth subfield **(Kit ID / KID)** shall contain three information items:

  - **Kit Name / KNM**

  - **Manufacturer / KMF**

  - **Description of the Kit** (with part or catalog number)[63] **/ KDS**

- The tenth subfield **(Number of DNA Record Data / NRD)** shall contain the total number of DNA data contained in this record.

- The eleventh subfield **(Certification Flag / CFG)** shall contain one of the following numeric values relating to the processing laboratory:

> Brad Wing 6/22/10 11:39 AM
> **Comment:** Explanations added (hopefully correctly) about the different types of agencies involved in DNA processing and transmission.

> Brad Wing 6/22/10 11:27 AM
> **Comment:** Note that the list in not to be contained directly in the standard, because it will be dated and this standard will exist as a stand-alone document for years.

> Brad Wing 6/22/10 11:27 AM
> **Comment:** Note that the certification is in this block in the input I received but in the Profile data block in the ISO version

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- [63]A current list of kits, manufacturers and descriptions is available at www.biometrics.nist.gov/standard

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- o   0   No validation
- o   1   ISO validation
- o   2   GLP validation
- o   3   Other
- o   255   Unknown

22.6 Field 18.006: DNA Sample Information / DSI

This mandatory field contains subfields. Some of the subfields contain multiple information items, as described below.

- The first subfield **(Sample Category / SCY)** shall represent the category to which the DNA sample belongs.   It contains a numeric value from the following table.

Table 79 DNA Sample Donor Types

0 Arrestee	1 Biological Child	2 Biological Father	3 Biological Mother	4 Biological Sibling	5 Convicted Offender
6 Forensic Unknown	7 Insurgent	8 KST (Known Or Suspected Terrorist)	9 Maternal Relative	10 Missing Person	11 Paternal Relative
12 Suspect Unknown	13 Unidentified Living	14 Unidentified Dead	15 Victim Known	16 Other	

- The second subfield **(Sample Cellular Type / SCT)** represents the origination cell type from where the sample was collected.   It shall contain a numeric value from the following table:

Table 80 DNA Sample Cellular Types

0 Blood	1 Bone	2 Comingled Biological Material	3 Hair	4 Saliva	5 Semen
6 Skin	7 Sweat or Fingerprint	8 Tissue	9 Other	10 Unknown	

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- The third subfield **(Sample Typing Technology / STT)** represents the technology utilized to type the DNA sample. It shall contain a number from the following list:

    o 0   STR (including X STR and Y STR) (indicates presence of Field 18.008)

    o 1   mtDNA (indicates presence of Field 18.009)

    o 2   elecropherogram image (indicates presence of Field 18.999)

    o 3   Other (indicates presence of field 18.010   User Defined field)

- The fourth subfield **(Sample Source Indicator / SSI)** contains an indicator as to whether the identity of the specimen contributor is known. It is a one byte Boolean value character: 0 (unknown) or 1 (known).

- The fifth subfield **(Sample Collection Method   / SCM)** contains a description of the method used to collect the DNA sample. It is a character string up to 255 characters.

- The sixth subfield **(Sample Collection Date / SCD)** contains the date that the sample was collected. It is comprised of two information items:

    o Transaction Time **Coordinated Universal Time / GMT**[64]

    o Local **Date Time / DAT**

22.7 Field 18.007: DNA Profile Data / DPD

This mandatory field is mandatory. It contains information and structure associated with the DNA profile data. It is comprised of the following subfields

- The first subfield **(Date and Time / DTS)**[64] is the date that the profile was stored.

- The second subfield **(Profile Type / PTP)** is a character string. Allowable values are 0 = Person or 1   Stain.

- The third subfield **(Result / RES)** is entered with a value from **Table 81**

- The fourth subfield **(Profile ID / PRF)** is a character string with a unique party identification.

- The fifth subfield **(Request Type / REQ)** is entered with a value from **Table 82**

- The optional sixth subfield **(Error Message / ERM)** is a character string.

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[64] See rules for the encoding being used to specify the format of time fields

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- The optional seventh subfield **(Supplement Message / SUP)** is a character string.

Table 81: DNA result codes

Code	Description
0	Unable to process
1	No hit
2	Hit
3	Hit, high/exact
4	Hit, moderate
5	Hit, low
6	User defined 1
7	User defined 2
8	User defined 3
9	User defined 4
10	User defined 5

Table 82: DNA request codes

Code	Description
0	Data submission
1	Data submission and search
2	Search only
3	User defined 1

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4	User defined 2
5	User defined 3
6	User defined 4
7	User defined 5
8	User defined 6
9	User defined 7
10	User defined 8

22.8 Field 18.008: DNA STR, X STR, and Y STR Profile / DPF

This optional field is comprised of subfields as described below. It may be repeated for each combination of data type and locus type data.
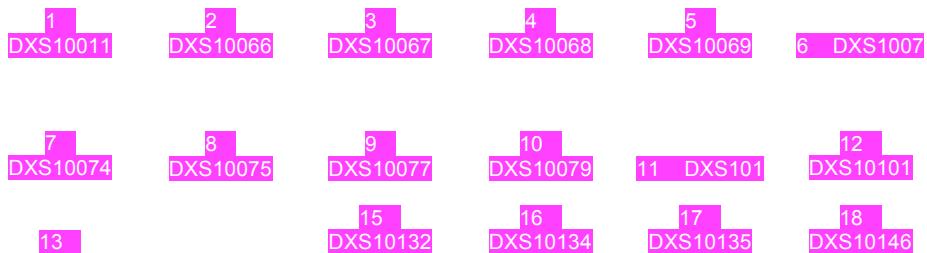
- The first subfield **(DNA STR Type / STR)** contains one of the following numeric values:
  - o 0   STR Profile
  - o   1= X STR Profile
  - o   2= Y STR Profile

The second subfield **(DNA Locus / DLC)** is comprised of three information items. This subfield is repeated 52 times for STR, in the order shown in

Table 83, 17 times for X STR, in the order shown in

- **Table 84**, and 61 times for Y STR, in the order shown in

1 DXS10011	2 DXS10066	3 DXS10067	4 DXS10068	5 DXS10069	6 DXS1007
7 DXS10074	8 DXS10075	9 DXS10077	10 DXS10079	11 DXS101	12 DXS10101
13		15 DXS10132	16 DXS10134	17 DXS10135	18 DXS10146

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DXS10103
14 DXS10131

19 DXS10147	20 DXS10148	21 DXS6789	22 DXS6795	23 DXS6800	24 DXS6801
25 DXS6803	26 DXS6807	27 DXS6809	28 DXS7130	29 DXS7132	30 DXS7133
31 DXS7423	32 DXS7424	33 DXS8377	34 DXS8378	35 DXS981	36 DXS9898
37 DXS9902	38 GATA165B12	39 GATA172D05	40 GATA31E08	41 HPRTB	

- **Table 85**.
  - o The first information item is the **Information Part / INP**. It is 1 byte consisting of 8 bits.

8	7	6	5	4	3	2	1

    The eighth bit contains a 1 if no allele is found, even if analysis is carried out. Otherwise, fill with zero.

    The seventh bit contains a 1 if the precise call cannot be determined, due to a failure. Otherwise, fill with zero.

    The sixth bit contains a 1 if the locus is not analyzed. Otherwise, fill with zero.

    Bits 5 to 1 are reserved and are filled with zero in this version.

  - o The second information item is the **Reference Number of the Allele Call / ALN**. The number ranges from 0 to 255. When the locus is not analyzed, this number shall be zero.

> Brad Wing 6/22/10 3:34 PM
> **Comment:** This needs clarification on how it relates to the third information item.

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> o The third information item is the **Allele Call / ALC**. The allele call contains 4 bytes.

Table 83 STR Loci

1 Amelogenin	2 CD4	3 CSF1PO	4 D10S1248	5 D10S143	6 D10S1435	7 D10S2325
8 D11S446	9 D11S4463	10 D12ATA6	11 D12ATA63	12 D123S91	13 D13S317	14 D14S143
15 D14S1434	16 D16S539	17 D17S130	18 D17S1301	19 D17S974	20 D18S51	21 D18S853
22 D18S854	23 D19S433	24 D1GATA1	25 D1GATA113	26 D1S1627	27 D1S1656	28 D1S1677
29 D20S108	30 D20S1082	31 D20S482	32 D21S11	33 D21S2055	34 D22S1045	35 D2S1338
36 D2S1776	37 D2S441	84 D3S1358	39 D3S1744	40 D3S3053	41 D3S4529	42 D4S2364
43 D4S2366	44 D4S2408	45 D5S2500	46 D5S818	47 D6S1017	48 D6S1043	49 D6S474
50 D7S1517	51 D7S820	52 D8S1115	53 D8S1132	54 D8S1179	55 D9S1122	56 D9S2157
57 F13A128	58 F13B	59 Fes	60 FGA	61 GABA 32	62 Penta D	63 Penta E

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64 SE33	65 TH01	66 TPOX	67 vWA

Table 84 X STR Loci

1 DXS10011	2 DXS10066	3 DXS10067	4 DXS10068	5 DXS10069	6 DXS1007
7 DXS10074	8 DXS10075	9 DXS10077	10 DXS10079	11 DXS101	12 DXS10101
13 DXS10103	14 DXS10131	15 DXS10132	16 DXS10134	17 DXS10135	18 DXS10146
19 DXS10147	20 DXS10148	21 DXS6789	22 DXS6795	23 DXS6800	24 DXS6801
25 DXS6803	26 DXS6807	27 DXS6809	28 DXS7130	29 DXS7132	30 DXS7133
31 DXS7423	32 DXS7424	33 DXS8377	34 DXS8378	35 DXS981	36 DXS9898
37 DXS9902	38 GATA165B12	39 GATA172D05	40 GATA31E08	41 HPRTB	

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Table 85 Y STR Loci

1 CDY_a	2 CDY_b	3 DYS19	4 DYS385a	5 DYS385b
6 DYS388	7 DYS389I	8 DYS38911	9 DYS38912	10 DYS390
11 DYS391	12 DYS392	13 DYS393	14 DYS395S1a	15 DYS395S1b
16 DYS406S1	17 DYS413a	18 DYS413b	19 DYS425	20 DYS426
21 DYS436	22 DYS437	23 DYS438	24 DYS439	25 DYS441
26 DYS442	27 DYS444	28 DYS446	29 DYS447	30 DYS448
31 DYS449	32 DYS450	33 DYS452	34 DYS454	35 DYS455
36 DYS456	37 DYS458	38 DYS459a	39 DYS459b	40 DYS460
41 DYS461	42 DYS462	43 DYS463	44 DYS464a	45 DYS464b
46 DYS464c	47 DYS464d	48 DYS472	49 DYS481	50 DYS487

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51 DYS490	52 DYS492	53 DYS511	54 DYS520	55 DYS522
56 DYS527	57 DYS531	58 DYS532	59 DYS534	60 DYS537
61 DYS557	62 DYS568	63 DYS570	64 DYS572	65 DYS576
66 DYS578	67 DYS590	68 DYS594	69 DYS607	70 DYS617
71 DYS635	72 DYS641	73 DYS650	74 DYS652	75 DYS709
76 DYS710	77 DYS712	78 DYS715	79 DYS717	80 GATA H4
81 GGAAT1B07	82 YCA II a	83 YCA II b	84 YGATAA10	85 YGATAC4

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Table 86 IUPAC DNA codes

IUPAC Value	Definition
R	G, A
Y	T, C
M	A, C
K	G, T
S	G, C
W	A, T
H	A, C, T
B	G, T, C
V	G, C, A
D	G, A, T
N	G, A, T, C
I	Deletion

Sequence Alphabet
A
T
C
G

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22.9 Field 18.009: DNA Mitochondrial Data / DMD

To accommodate the differences in how mtDNA types are derived (differences from reference), the interpretation issue is avoided in this standard by dividing the control region into 2 regions (even though HV3) exists) to ensure any insertions / deletions/ C stretches are included.   This method enables any receiver of the data to use it in a way that that are accustomed (either using the full sequence or interpreting the full sequence according to their own methodology).   The resultant data use would then be fully consistent with the receiver's database and enable processing.   This field is comprised of four subfields:

- **Mitro Control Region 1 / MT1** is defined as a inclusive of HV1, starting at 16024 and ending at 16569. The string shall be 576 characters.
- **Mito Control Region 2 / MT2** is defined as inclusive of HV2 and HV3, starting at 1 and ending at 576. The string shall be 546 characters.
- **Mito DNA Quality 1 / MQ1** is a string value.
- **Mito DNA Quality 2 / MQ2** is a string value.

22.10 Field 18.010: DNA User Defined Profile / UDP

This optional field is user defined, when other than STR, X STR, Y STR mtDNA, or an Electropherogram iis included as part of the transaction. The sender must provide the receiver with a description of the field contents.

22.11 Field 18.996 Image Hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, hash value shall be calculated using SHA 256.

22.12 Field 18.997: Original image reference / OIV

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

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22.13 Field 18.998: Geographic sample location / GEO

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

22.14 Field 18.999 Electropherogram Image Data

This optional field contains the electropherogram data .

23 Type-19 Plantar biometric data record

The Type-19 record shall contain and be used to exchange plantar print image data together with fixed and user-defined textual information fields pertinent to the digitized image. Information regarding the scanning resolution used, the image size, and other parameters or comments required to process the image are recorded as tagged fields within the record. Plantar print images transmitted to other agencies will be processed by the recipient agencies to extract the desired feature information required for matching purposes. Plantars are defined in this standard to be friction ridge prints from the foot. The areas are the five individual toes, ball/inter-digital area, arch and heel for each foot. A record card for printing the plantar images is called the Plantar Print Record (PPR), with four cards per record: one flat and one rolled impression for each foot.   It is recommended to capture foot friction ridge data at 1000 ppi.

Table 87 Type-19 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	19.001		RECORD HEADER	1	1
IDC	M	19.002	N	IMAGE DESIGNATION CHARACTER	1	1
IMP	M	19.003	N	IMPRESSION TYPE	1	1
SRC	M	19.004	AN	SOURCE AGENCY / ORI	1	1

> **Brad Wing 6/22/10 3:55 PM**
> **Comment:** Table now included in record description; with subfields and information items

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
XCD	M	19.005	N	PLANTAR PRINT CAPTURE DATE	1	1
HLL	M	19.006	N	HORIZONTAL LINE LENGTH	1	1
VLL	M	19.007	N	VERTICAL LINE LENGTH	1	1
SLC	M	19.008	N	SCALE UNITS	1	1
HPS	M	19.009	N	HORIZONTAL PIXEL SCALE	1	1
VPS	M	19.010	N	VERTICAL PIXEL SCALE	1	1
CGA	M	19.011	AN	COMPRESSION ALGORITHM	1	1
BPX	M	19.012	N	BITS PER PIXEL	1	1
XLP	M	19.013	N	PLANTAR PRINT POSITION	1	Unlimited
RSV		19.014-15.015		RESERVED FOR FUTURE DEFINITION		
SHPS	O	19.016	N	SCANNED HORIZONTAL PIXEL SCALE	0	1
SVPS	O	19.017	N	SCANNED VERTICAL PIXEL SCALE	0	1
ASEG	O	19.018		ALTERNATE PLANTAR SEGMENT POSITION	0	Unlimited
FPC	M⇑		N	PLANTAR POSITION CODE	1	1
VNV	M⇑		N	POSITION POLYGON VERTEX QUANTITY	3	99
PPV	M⇑		N	POSITION POLYGON VERTEX	1	1
PHV	M⇑		N	POSITION HORIZONTAL COORDINATE VALUE	1	1
PVV	M⇑		N	POSITION VERTIC COOALRDINATE VALUE	1	1
RSV		19.019		RESERVED FOR FUTURE DEFINITION		
COM	O	19.020	AN	COMMENT	0	1
RSV		19.021-19.023		RESERVED FOR FUTURE DEFINITION		
XQM	O	19.024		PLANTAR TPRINT QUALITY METRIC	0	Unlimited
QMS	M⇑			QUALITY METRIC SUBFIELD	1	1
FGP	M⇑		N	FRICTION RIDGE CODE	1	1
QVU	M⇑		N	QUALITY VALUE	1	1
QAV	M⇑		N	QUALITY ALGORITHM VENDOR	1	1

Brad Wing 6/22/10 3:55 PM
Comment: Note change on upper limit

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
QAP	M⇑		N	QUALITY ALGORITHM PRODUCT ID	1	1
RSV		19.025-19.029		RESERVED FOR FUTURE DEFINITION		
DMM	O	19.030	A	DEVICE MONITORING MODE	1	1
RSV		19.031-19.199		RESERVED FOR FUTURE DEFINITION		
UDF		19.200-19.990		USER-DEFINED FIELDS		
RSV		19.991-19.995		RESERVED FOR FUTURE DEFINITION		
HAS	O	19.996	N	IMAGE HASH	0	1
OIV	O	19.997		ORIGINAL IMAGE REFERENCE	0	1
OIR	M⇑		N	REFERENCE CODE	1	1
RTV	O⇑		N	SEGEMENTATION REFERENCE TYPE VALUE	0	1
GEO	O	19.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
DATA	M	19.999	B	IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

23.1 Field 19.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

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23.2 Field 19.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-19 record as found in the file content (CNT) field of the Type-1 record.

23.3 Field 19.003: Impression type / IMP

This mandatory field shall be selected from Table 7, describing the manner by which the plantar image information was obtained.

23.4 Field 19.004: Source agency / ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that originally captured the plantar image contained in the record. Normally, the Originating Agency Identifier, ORI, of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

23.5 Field 19.005: Plantar print capture date / XCD

This mandatory ASCII field shall contain the date that the plantar print image contained in the record was captured. See the relevant Annex in this standard for the exact encoding format for this data. The *YYYY* characters shall represent the year the image was captured; the *MM* characters shall be the tens and units values of the month; and the *DD* characters shall be the tens and units values of the day in the month.

23.6 Field 19.006: Horizontal line length / HLL

This mandatory ASCII field shall contain the number of pixels contained on a single horizontal line of the transmitted image.

23.7 Field 19.007: Vertical line length / VLL

This mandatory ASCII field shall contain the number of horizontal lines contained in the transmitted image.

23.8 Field 19.008: Scale units / SLC

This mandatory ASCII field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

23.9 Field 19.009: Horizontal pixel scale / HPS

This mandatory ASCII field shall specify the integer pixel density used in the horizontal direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

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23.10 Field 19.010: Vertical pixel scale / VPS

This mandatory ASCII field shall specify the integer pixel density used in the vertical direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

23.11 Field 19.011: Compression algorithm / CGA

This mandatory ASCII field shall specify the algorithm used to compress the transmitted grayscale images. An entry of *"NONE"* in this field indicates that the data contained in this record is uncompressed. For those images that are to be losslessly compressed, this field shall contain the code from **Table 2** to indicate the compression method used for the plantar print images. WSQ or JPEG 10918 are to be used for those images scanned or transmitted at 500 ppi and JPEG 2000 for those images scanned and transmitted at ppi greater than 500 that are on the migration path. See Section 5.6.1. for additional information on the usage of JPEG 2000 for the compression of friction ridge images. The domain registrar shall maintain a registry of acceptable compression techniques and corresponding codes that may be used as they become available.

23.12   Field 19.012: Bits per pixel / BPX

This mandatory ASCII field shall contain the number of bits used to represent a pixel. This field shall contain an entry of "8" for normal grayscale values of "0" to "255". Any entry in this field greater than "8" shall represent a grayscale pixel with increased precision.

23.13 Field 19.013: Plantar print position / XLP

This mandatory tagged field shall contain the plantar print position that matches the plantar print image. The decimal code number corresponding to the known or most probable position shall be taken from Table 9 and entered as a two-character subfield.

23.14 Field 19.016: Scanned horizontal pixel scale / SHPS

This optional ASCII field shall specify the horizontal pixel density used for the scanning of the original impression providing the SLC field contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio. 9

23.15 Field 19.017: Scanned vertical pixel scale / SVPS

This optional ASCII field shall specify the vertical pixel density used for the scanning of the original impression providing the SLC field contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

23.16 Field 19.018: Plantar segment position(s) / ASEG

This optional ASCII field is an alternate approach to describing the locations for each of the image segments of up to four individual fingers within a flat image containing the capture of four simultaneous fingers or two simultaneous thumbs. This field uses an n-vertex polygon to encompass each finger image segment,

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consecutive order around the perimeter of the polygon, either clockwise or counterclockwise. No two vertices may occupy the same location. The polygon side defined by the last subfield and the first subfield shall complete the polygon. The polygon must be a simple, plane figure with no sides crossing and no interior

This field shall consist of up three subfields.   The field is repeated for each segmentation.

The first subfield **(Finger position code / FPC)** is the finger number from **Table 9**.

The second subfield **(Position polygon vertex quantity / VNV)** is the number of vertices encompassing the segmented finger (between 3 and 99)

The third subfield is the vertex information **(Position polygon vertex / PPV).** It is comprised of two information items:

The first information item is the **(Position horizontal coordinate value / PHV).**   It is the horizontal pixel offset (x- across) relative to the origin positioned in the upper left corner of the image.

The second information item is the **(Position vertical coordinate value / PVV).**   It is the vertical pixel offset (y - down) relative to the origin positioned in the upper left corner of the image.

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Comment: REVISED TO BE CONSISTENT WITH RECORD TYPE 14

23.17 Field 19.020: Comment / COM

This optional ASCII field may be used to insert comments or other ASCII text information with the image data.

23.18   Field 19.024: Plantar print quality metric / XQM

This optional ASCII field is used to specify one or more different metrics of plantar print image quality score data for the image stored in this record.   The meaning attributed to this metric must be defined and interpreted by the producer of the scoring algorithm or by the person or system used to assign the metric to the plantar print image. The metric may be a predictor of AFIS matcher accuracy performance or a different metric to indicate a value associated with the quality of the plantar print image for a particular function.

This field may contain one or more subfields, each consisting of four information items. This subfield **(Quality Metric Subfield / QMS)** is repeated for each plantar image and quality algorithm used.

The first information item is the **plantar reference number / FGP** chosen from **Table 9**

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The second information item **(image quality score / QVU)** shall be a quantitative expression of the predicted matching performance of the biometric sample. This item contains the ASCII representation of the integer between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality. An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a fingerprint image quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards

The third information item **(algorithm vendor identification / QAV)** shall specify the ID of the vendor of the quality algorithm used to calculate the quality score. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

The fourth information item **(algorithm product identification / QAP)** shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not required. QAP indicates which of the vendor's algorithms was used in the calculation of the fingerprint image quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65535.

23.19 Field 19.030: Device monitoring mode / DMM

This optional field provides information describing the level of human monitoring for the image capture device. This field will contain an entry from Table 56 to indicate the monitoring mode of the biometric sample capture device.

23.20 Fields 19.200-990: User-defined fields / UDF

These fields are user-defined fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present, they shall contain ASCII textual information.

23.21 Field 19.996: Image hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, hash value shall be calculated using SHA 256.

23.22 Field 19.997: Original image reference / OIV

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

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The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

 The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

23.23 Field 19.998: Geographic sample location / GEO

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

23.24 Field 19.999: Image data / DATA

This mandatory field shall contain all of the data from a captured plantar print image.

Each pixel of uncompressed grayscale data shall normally be quantized to eight bits (256 gray levels) contained in a single byte. If the entry in BPX Field 19.012 is greater than 8, the number of bytes required to contain a pixel will be different. If compression is used, the pixel data shall be compressed in accordance with the compression technique specified in the CGA field.

24 Type 20 Original image record

The Type 20 record contains the original image that has been processed to populate the   image Record Types. This record type also allows an organization to record how original data was processed to provide the image or biometric sample cross referenced by the OIR (Original Image Reference).

Table 88 Type-20 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**

> **Brad Wing 6/22/10 5:18 PM**
> **Comment:** Table now included in record description; with subfields and information items

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
	M	20.001		RECORD HEADER	1	1
IDC	M	20.002	N	IMAGE DESIGNATION CHARACTER	1	1
OID	M	20.003	N	OIR DESCRIPTION	1	1
SRC	M	20.004	AN	SOURCE AGENCY / ORI	1	1
IMD	O	20.005	N	IMAGE DATE	0	1
HLL	O	20.006	N	HORIZONTAL LINE LENGTH	0	1
VLL	O	20.007	N	VERTICAL LINE LENGTH	0	1
SLC	O	20.008	N	SCALE UNITS	0	1
HPS	O	20.009	N	HORIZONTAL PIXEL SCALE	0	1
VPS	O	20.010	N	VERTICAL PIXEL SCALE	0	1
IFT	M	20.011	AN	IMAGE FORMAT	1	1
BPX	O	20.012	N	BITS PER PIXEL	0	1
CSP	O	29.013	N	COLOR SPACE	0	1
LOG	M	20.014		SAMPLE LOG	1	Unlimited
DAT	M⇑		AN	DATE	1	1
DSC	M⇑		AN	DESCRIPTION	1	1
SEG	O	20.015		ORIGINAL IMAGE SEGMENT POSITION	0	Unlimited
RTV	M⇑		N	REFERENCE TYPE VALUE	1	1
IPT	M⇑		N	INTERNAL FILE REFERENCE POINTER	1	1
VNV	O⇑		N	POSITION POLYGON VERTEX QUANTITY	0	1
PHV	O⇑		N	POSITION POLYGON VERTEX	0	99
PHV	O⇑		N	POSITION HORIZONTAL COORDINATE VALUE	0	1
PVV	O⇑		N	POSITION VERTICAL COORDINATE VALUE	0	1
SHPS	O	20.017	N	SCANNED HORIZONTAL PIXEL SCALE	0	1
SVPS	O	20.018	N	SCANNED VERTICAL PIXEL SCALE	0	1
COM	O	20.020	AN	COMMENT	0	1
RSV		20.021 – 20.099		RESERVED FOR FUTURE DEFINITION		

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
UDF		20.100-20.990		USER DEFINED FIELDS		
RSV		20.991 - 20.995		RESERVED FOR FUTURE DEFINITION		
HAS	O	20.996	N	IMAGE HASH	0	1
OIR	O	20.997		ORIGINAL IMAGE REFERENCE	0	1
GEO	O	20.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
DATA	M	20.999	B	IMAGE DATA	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

24.1 Field 20.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

24.2 Field 20.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type 20 record as found in the file content (CNT) field of the Type 1 record. It is recommended to start numbering of the IDCs for original images at 100.

24.3 Field 20.003: OIR description / OID

This mandatory field indicates how this record is being used. This field has a value of 1 when there are no other Record Type-20 instances that were used to generate the image contained in this instance of Record Type-20. When there exist a series of images used to create an image that forms the basis of entries in other Record Types, then this field is set to 2 for all of the component images. A final image created from a series of images is indicated by this field being set to

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3. Note that when this field is set to 2 or 3, all of the Record Type-20 instances in that group shall have the same IDC in Field 20.002.

24.4 Field 20.004: Source agency / ORI / SRC

This optional ASCII field shall contain the identification of the administration or organization that originally captured the image contained in the record. Normally, the Originating Agency Identifier, ORI, of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

24.5 Field 20.005: Image date / IMD

This optional ASCII field shall contain the date that the image contained in the record was captured. The *YYYY* characters shall represent the year the image was captured; the *MM* characters shall be the tens and units values of the month; and the *DD* characters shall be the tens and units values of the day in the month.

24.6 Field 20.006: Horizontal line length / HLL

This optional ASCII field shall contain the number of pixels contained on a single horizontal line of the transmitted image.

24.7 Field 20.007: Vertical line length / VLL

This optional ASCII field shall contain the number of horizontal lines contained in the transmitted image.

24.8 Field 20.008: Scale units / SLC

This optional ASCII field shall specify the units used to describe the image sampling frequency (pixel density). A "1" in this field indicates pixels per inch, or a "2" indicates pixels per centimeter. A "0" in this field indicates no scale is given. For this case, the quotient of HPS/VPS gives the pixel aspect ratio.

24.9 Field 20.009: Horizontal pixel scale / HPS

This optional ASCII field shall specify the integer pixel density used in the horizontal direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

24.10 Field 20.010: Vertical pixel scale / VPS

This optional ASCII field shall specify the integer pixel density used in the vertical direction of the transmitted image providing the SLC contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

24.11 Field 20.011: Image format / IFT

This mandatory ASCII field shall contain an entry from **Table 2** to specify the algorithm used for compressing the color or grayscale single frame image. An entry of *"NONE"* in this field indicates that the data contained in this record is uncompressed.

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For video inputs, the format of the video is entered using codes from **Table 89**. If the video type is not in the table below, enter the video type specified in the user manual of the device that was used to capture the image

Table 89 Video Codes

Video Type	ASCII Code
MPEG-1	MPEG1
MPEG-2	MPEG2
MPEG-4	MPEG4
VC-1	VC1
VHS	VHS
VHS-C	VHSC
DVD	DVD
Blu-ray	BLU
Ogg-Theora	OGG
Unknown	UNK

For other types of inputs (such as presentation formats), enter the standard suffix to the file type name that indicates the file type (e.g. PDF).

24.12 Field 20.012: Bits per pixel / BPX

This optional ASCII field shall contain the number of bits used to represent a pixel for a non video image. This field shall contain an entry of "8" for normal grayscale values of "0" to "255". Any entry in this field greater than "8" shall represent a grayscale pixel with increased precision.

24.13 Field 20.013: Color space / CSP

This optional ASCII field shall contain an entry from **Table 1** to identify the color space used to exchange the image data. If the color space for an RGB image cannot be determined, an entry of "RGB" shall be entered.

For JPEG-compressed color images (stored using the JFIF format), the preferred (external) color space is sRGB and an entry of "SRGB" shall be used. For all grayscale (monochrome) images, an entry of "GRAY" shall be used.

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For JPEG 2000 images stored using the JP2 format, the available enumerated color spaces are sRGB, sYCC, and grayscale, to be entered, respectively, as "SRGB", "SYCC", and "GRAY". The preferred (external) color space for color images is sRGB. If a photo acquisition device uses another ICC[65] color profile, the acquisition system must convert the image data to one of these enumerated color spaces before the JP2 file may be embedded in a Type 10 record.

For uncompressed color images containing non-interleaved red, green, and blue pixels in that order, the preferred color space is sRGB and an entry of "SRGB" shall be used.

Note that the field codes do not determine if the image data is JPEG, JPEG 2000, or uncompressed color images.

24.14 Field 20.014: Sample log /

This field has a subfield **(Sample log operation grouping/ SHG)** that contains four information items. The subfield is repeated for each operation. The Log in this field only applies to the data contained in field 20.999 of this instance of this record type.

- The first information item is **date / DAT**, indicating the date of the particular operation See the rules for the encoding being used for the exact format of this information item.

- The second information item is **Description / DSC**. This information item shall contain a description of the operation.[66]

24.15 Field 20.016: Original image segment position(s) /

This optional ASCII field is an alternate approach to describing the locations for of images within the original image. This field uses an n vertex polygon to encompass each finger image segment, where "n" is between 3 and 99. The order of the vertices must be in their consecutive order around the perimeter of the polygon, either clockwise or counterclockwise. No two vertices may occupy the same location. The polygon side defined by the last subfield and the first subfield shall complete the polygon. The polygon must be a simple, plane figure with no sides crossing and no interior holes.

This field shall consist of up three subfields. The field is repeated for each separate segmentation.

* The first subfield is the **reference type value / RTV.** This provides a unique index to a segmentation image. When using the OIV field in other record

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Comment: This field has been revised from the first draft.

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Comment: This field has been reworked.

</div>

- [65] International Color Consortium (ICC), http://www.color.org/

- [66] Examples include (but are not limited to) cropping, morphing, re-sampling, lighting enhancement, age progression, color adjustment, super-resolution, (re)compression and scanning and transmission log.

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types, this information item value may comprise the second (optional) subfield of the OIV field.

*   The second subfield is **(internal file reference pointer text / IPT)** it is set to 0 if the original image is a single image file. If the original file in Field 20.999 is a PDF, video, or presentation file, or has multiple locations where an image may be located, this information item is the reference to the particular instance, such as page, video frame, or slide number, (contained in the original such as image data) used to derive the image transmitted in other record types. If a particular frame is chosen and there is no segmentation needed, the following information items are not used.

The optional third subfield **(Position polygon vertex quantity / VNV)** is the number of vertices encompassing the segmented finger (between 3 and 99)

The optional fourth subfield is the vertex information **(Position polygon vertex / PPV).** It is comprised of two information items:

The first information item is the **(Position horizontal coordinate value / PHV).** It is the horizontal pixel offset (x across) relative to the origin positioned in the upper left corner of the image.

The second information item is the **(Position vertical coordinate value / PVV).** It is the vertical pixel offset (y   down) relative to the origin positioned in the upper left corner of the image.

24.16 Field 20.017: Scanned horizontal pixel scale / SHPS

This optional ASCII field shall specify the horizontal pixel density used for the scanning of the original image providing the SLC field contains a "1" or a "2". Otherwise, it indicates the horizontal component of the pixel aspect ratio.

24.17   Field 20.018: Scanned vertical pixel scale / SVPS

This optional ASCII field shall specify the vertical pixel density used for the scanning of the original image providing the SLC field contains a "1" or a "2". Otherwise, it indicates the vertical component of the pixel aspect ratio.

24.18 Field 20.020: Comment / COM

This optional ASCII field may be used to insert comments or other ASCII text information with the image data.

24.19 Fields 21.200-990: User-defined fields / UDF

These fields are user-defined fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present they shall contain ASCII information.

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24.20 Field 20.996: Image hash / HAS

This optional field has the hash value of the image contained in the 999 field of this record, calculated using SHA 256.

24.21 Field 20.997: Original image reference code/

This mandatory field contains a reference number for the image. It refers to the original image stored in this record. Note that the segment references are contained in Field 20.016, if they exist. This number corresponds to the OIR that may be referenced as the first information item in the OIV field of other Record Types.

24.22 Field 20.998: Geographic sample location / GEO

This optional field is composed of three optional subfields; one of which must be chosen.

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

24.23 Field 20.999: Image data / DATA

Note that this data may be a still image or a video sequence. This mandatory field shall contain all of the data from a original source image.

Each pixel of uncompressed grayscale data shall normally be quantized to eight bits (256 gray levels) contained in a single byte. If the entry in BPX Field 20.012 is greater than 8, the number of bytes required to contain a pixel will be different. If compression is used, the pixel data shall be compressed in accordance with the compression technique specified in the CGA field.

25 Type-98 Information Assurance record

The Type-98 record shall contain security information that allows for the assurance of the authenticity and/or integrity of the transaction, including such information as binary data hashes, attributes for audit or identification purposes, and digital signatures. The Information Assurance (IA) record includes a common Header and an IA Data Block (IADB). Two mandatory fields in the IA Header are

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IADB Format Owner and IADB Format Type. The IADB Format Owner field denotes the vendor, standards body, working group, or industry consortium that has defined the format of the IA data (the data contained in the IADB). The values in the IADB Format Type field are assigned by the format owner and represent a specific IADB format as specified by the format owner. This may be a non-standard, unpublished data format or a data format that has been standardized by an industry group, consortium, or standards body. It is the combined IADB Format Owner/IADB Format Type value that uniquely identifies the IADB format.

There may be multiples of Record Type 98 to satisfy mulitiple IA requirements for different owners.

The records that are hashed or signed or otherwise protected are those other than this Record and Record 1, since Record 1 is created with this record as input.

Table 90 Type-98 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	98.001		RECORD HEADER	1	1
IDC	M	98.002	N	IMAGE DESIGNATION CHARACTER	1	1
RSV		98.003		RESERVED FOR FUTURE DEFINITION		
SRC	M	98.004	AN	SOURCE AGENCY / ORI	1	1
DCD	M	98.005	N	IA DATA CREATION DATE	1	1
DFO	M	98.006	AN	IADB FORMAT OWNER	1	1
DFT	M	98.007	AN	IADB FORMAT TYPE	1	1
RSV		98.008-98.199		RESERVED FOR FUTURE DEFINITION		
UDF		98.200-98.900		USER-DEFINED FIELDS		
DATA	M	98.999	B	INFORMATION ASSURANCE DATA BLOCK	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

> **Brad Wing 6/23/10 11:03 AM**
> **Comment:** Table now included in record description; with subfields and information items

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25.1 Field 98.001: Record header

The content of this field depends upon the encoding chosen. See www.biometrics.nist.gov/standard for the content of this field for the encoding used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

25.2 Field 98.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-98 record as found in the file content (CNT) field of the Type-1 record. The IDC is set to 500 for this record. This IDC is needed to complete the CNT field of record 1. It does not point to any other record in the transaction.

25.3 Field 98.004: Source agency/ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that has written this Record.

25.4 Field 98.005: IA data creation date / DCD

This mandatory ASCII field shall contain the date and time that IA data was created. The YYYY characters shall represent the year the image was captured; the MM characters shall be the tens and units values of the month; the DD characters shall be the tens and units values of the day in the month; the hh characters shall be the tens and units values of the hour of the day in 24-hour format; the mm characters shall be the tens and units values of the minute within the hour; the ss characters shall be the tens and units values of the second of the minute.

25.5 Field 98.006: IADB format owner / DFO

This mandatory ASCII field shall be used to denote the vendor, standards body, working group, or industry consortium that has defined the format of the information assurance data (in the IADB). In an IA record the IADB Format Owner and Format Type, when used in combination, should uniquely identify the specific format of the IADB content. This IADB format definition may be published (public) or unpublished (non-public).

25.6 Field 98.007: IADB format type / DFT

This mandatory field shall be used to identify the value assigned by the format owner to represent the specific IADB Format as specified by the format owner. This may be a nonstandard, unpublished data format or a data format that has been standardized by an industry group, consortium or standards body.

25.7 Field 98.200-900: User-defined fields / UDF

These fields are user-definable fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present, they shall contain ASCII textual information.

25.8 Field 98.999: Information assurance data block / IAD

This mandatory field shall contain the Information Assurance Data Block (IADB).

26 Type-99 CBEFF biometric data record

The Type-99 record shall contain and be used to exchange biometric data that is not supported by other ANSI/NIST-ITL records. This data is exchanged in a format that conforms to INCITS 398-2005, the Common Biometric Exchange Formats Framework.

The CBEFF conformant Biometric Information Record (BIR) used by the Type-99 record includes a common Header and a Biometric Data Block (BDB). Two mandatory fields in the CBEFF Header are Format Owner and Format Type. The Format Owner field denotes the vendor, standards body, working group, or industry consortium that has defined the format of the biometric data (the data contained in the BDB). A CBEFF requirement is that format owners register with the IBIA for an assigned identifier of the format owner. The values used in the Format Type field are assigned by the format owner and represent a specific

The BDB format is specified by the format owner. This may be a non-standard, unpublished data format or a data format that has been standardized by an industry group, consortium, or standards body. It is the combined CBEFF Format Owner/Format Type value that uniquely identifies the BDB format.

The Type-99 record provides the CBEFF fields necessary for users to send, receive, and interpret biometric data in any registered BDB format (with the exception of biometric data which is exchanged using the other records in this standard). The data carried in the Biometric Data Block field (99.999) is the BDB. The format of that data is identified by the field's BDB Format Owner and BDB Format Type as described by the CBEFF standard.

Table 91 Type-99 Record

Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	**Max**
	M	99.001		RECORD HEADER	1	1
IDC	M	99.002	N	IMAGE DESIGNATION CHARACTER	1	1
RSV		98.003		RESERVED FOR FUTURE DEFINITION		
SRC	M	99.004	AN	SOURCE AGENCY / ORI	1	1
DCD	M	98.005	N	BIOMETRIC CREATION DATE	1	1
RSV	M	99.006-		RESERVED FOR FUTURE DEFINITION		

Comment [Brad Wing 6/23/10 11:20 AM]: Table now included in record description; with subfields and information items

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Mnemonic	Cond code*	Field number	Character Type	Field name	Occur count	
					Min	Max
		99.099				
HDV	M	99.100	N	CBEFF HEADER VERSION	1	1
BTY	M	99.101	N	BIOMETRIC TYPE	1	1
BDQ	O	99.102		BIOMETRIC DATA QUALITY	0	1
QMS	M⇑			QUALITY METRIC SUBFIELD	1	1
QVU	M⇑		N	IMAGE QUALITY SCORE	1	1
QAV	M⇑		N	ALGORITHM VENDOR IDENTIFICATION	1	1
QAP	M⇑		N	ALGORITHM PRODUCT IDENTIFICATION	1	1
BFO	M	99.103	AN	BDB FORMAT OWNER	1	1
BFT	M	99.104	AN	BDB FORMAT TYPE	1	1
RSV		99.105 – 99.199		RESERVED FOR FUTURE DEFINITION		
UDF		98.200-98.990		USER-DEFINED FIELDS		
RSV		99.991 – 99.995		RESERVED FOR FUTURE DEFINITION		
HAS	O	99.996	N	BDB HASH	0	1
OIR	O	99.997		ORIGINAL IMAGE REFERENCE	0	1
GEO	O	99.998		GEOGRAPHIC SAMPLE LOCATION	0	1
GRT	O⇑		AN	GEOGRAPHIC REFERENCE TEXT	0	1
DEG	O⇑		AN	DEGREE VALUE	0	1
DMS	O⇑		AN	DEGREE MINUTE SECOND VALUE	0	1
BDB	M	99.999		BIOMETRIC DATA BLOCK	1	1

Key for Character type: N=Numeric; A=Alphabetic; AN=Alphanumeric; B=Binary or Base64

Key for Cond. code: M=Mandatory; O=Optional; C-x=Conditional on Field x value; M⇑=Mandatory if the field/subfield is used; O⇑=Optional if the field/subfield is used.

26.1 Field 99.001: Record header

The content of this field depends upon the encoding chosen.   See www.biometrics.nist.gov/standard for the content of this field for the encoding

used. In Traditional encoding, the content is the length of the record. In NIEM-conformant encoding it is the record type-number.

26.2 Field 99.002: Image designation character / IDC

This mandatory field shall be the IDC of the Type-99 record as found in the file content (CNT) field of the Type-1 record.

26.3 Field 99.004: Source agency / ORI / SRC

This mandatory ASCII field shall contain the identification of the administration or organization that originally captured the biometric sample contained in the record. Normally, the ORI of the agency that captured the image will be contained in this field. The SRC shall be defined by the user and be in accordance with the receiving agency.

26.3.1 Field 99.005: Biometric creation date / BCD

This mandatory ASCII field shall contain the date and time that the biometric sample was captured. The YYYY characters shall represent the year the image was captured; the MM characters shall be the tens and units values of the month; the DD characters shall be the tens and units values of the day in the month; the hh characters shall be the tens and units values of the hour of the day in 24-hour format; the mm characters shall be the tens and units values of the minute within the hour; the ss characters shall be the tens and units values of the second of the minute.

26.3.2 Field 99.100: CBEFF header version / HDV

This mandatory ASCII field shall be used to identify the version of CBEFF specification that this record conforms to. The format is two characters for major version number followed by two characters for minor version. The current version of CBEFF is INCITS 398-2005 represented by the string '0101' (major version '01' and minor version '01').

26.3.3 Field 99.101: Biometric type / BTY

This mandatory ASCII field shall be used to identify the type of biometric technology. This specification adopts the values presented in CBEFF with the addition of two leading zeros for future expansion. Table 92 lists the current biometric type codes.

Table 92: CBEFF Biometric type

Biometric Type Name	Biometric Type Code
No Information Given	'00000000'
Multiple Biometrics Used	'00000001'
Facial Features	'00000002'

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Voice	'00000004'
Fingerprint	'00000008'
Iris	'00000010'
Retina	'00000020'
Hand Geometry	'00000040'
Signature Dynamics	'00000080'
Keystroke Dynamics	'00000100'
Lip Movement	'00000200'
Thermal Face Image	'00000400'
Thermal Hand Image	'00000800'
Gait	'00001000'
Body Odor	'00002000'
DNA	'00004000'
Ear Shape	'00008000'
Finger Geometry	'00010000'
Palmprint	'00020000'
Vein Pattern	'00040000'
Foot Print	'00080000'

26.3.4 Field 99.102: Biometric data quality / BDQ

This optional ASCII field is used to specify a quality score for the biometric data stored in the BDB in this record. This field may contain one or more subfields, each consisting of four information items. This subfield **(Quality Metric Subfield / QMS)** is repeated for each plantar image and quality algorithm used.

The first information item **(image quality score / QVU)** shall be a quantitative expression of the predicted matching performance of the biometric sample. This item contains the ASCII representation of the integer between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality.   An entry of "255" shall indicate a failed attempt to calculate a quality score. An entry of "254" shall indicate that no attempt to calculate a fingerprint image quality score was made. The use of additional values to convey other information should be harmonized with ISO/IEC 19794 standards

The second information item **(algorithm vendor identification / QAV)** shall specify the ID of the vendor of the quality algorithm used to calculate the quality score. This 4-digit hex value is assigned by IBIA and expressed as four ASCII characters. The IBIA shall maintain the Vendor Registry of CBEFF Biometric Organizations that will map the value in this field to a registered organization.

The third information item **(algorithm product identification / QAP)** shall specify a numeric product code assigned by the vendor of the quality algorithm, which may be registered with the IBIA, but registration is not

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required. QAP indicates which of the vendor's algorithms was used in the calculation of the fingerprint image quality score. This field contains the ASCII representation of the integer product code and should be within the range 1 to 65535.

26.3.5 Field 99.103: BDB format owner / BFO

This mandatory ASCII field shall be used to denote the vendor, standards body, working group, or industry consortium that has defined the format of the biometric data (in the BDB). In a CBEFF structure the BDB Format Owner and Format Type, when used in combination, uniquely identify the specific format of the BDB content. The format and content of the BDB is "owned" by the CBEFF Client (see Clause 6.1 of the CBEFF standard). This BDB format definition may be published (public) or unpublished (non-public).

A CBEFF requirement is that format owners register with IBIA for an assigned identifier of the format owner. The number is guaranteed to be unique. Refer to the CBEFF standard, Clause 6, "CBEFF Patrons and Clients," for registration information.

The four hex digits assigned by IBIA shall be represented by a string of four ASCII characters.

26.3.6 Field 99.104: BDB format type / BFT

This mandatory ASCII field shall be used to identify the value assigned by the format owner to represent the specific BDB Format as specified by the format owner. This may be a non-standard, unpublished data format or a data format that has been standardized by an industry group, consortium, or standards body. The registration of the Format Type value is recommended but not required. Refer to the CBEFF standard, Clause 6, "CBEFF Patrons and Clients," for registration information.

The four hex digits assigned by the format owner shall be represented by a string of four ASCII characters.

26.3.7 Field 99.200-990: User-defined fields / UDF

These fields are user-definable fields. Their size and content shall be defined by the user and be in accordance with the receiving agency. If present, they shall contain ASCII textual information.

26.4 Field 99.996: BDB hash / HAS

The BDB hash value shall be calculated using SHA 256.

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26.5 Field 99.997: Original image reference / OIR

This optional field refers to an image in Record Type 20 with the same OIR. This is an optional field and is used when the image transmitted in this record is derived from an original image. This field consists of two subfields.

The first subfield contains the reference code / OIR for a particular Record Type 20. This is mandatory for each OIV.

The second subfield is optional. It specifies the reference to the segmentation coordinates of the original image that is represented in this record type, which is a reference type value / RTV.

26.6 Field 99.998: Geographic sample location / GEO

This optional field is composed of three optional subfields; one of which must be chosen.

The first subfield (geographic reference text / GRT) is free form text describing a street address or other physical location.

The second sufield (degree value / DEG) has the format ±xxx.xxxx±yyy.yyyy, where x refers to latitude and y refers to longitude. For example, +039.1455-077.2057.

The third subfield (degree minute second value / DMS) has the format ±xxxDxxMxxS±yyyDyyMyyS, where x refers to latitude and y refers to longitude. For example, +039D08M44S-077D12M20S.

26.6.1 Field 99.999: Biometric data block / BDB

This mandatory field shall contain the CBEFF Biometric Data Block (BDB).

27 Handling Records for Another individual

If biometric or forensic data for another individual is to be recorded or transmitted, a new file shall be generated for that individual using the same format as described previously.

28 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this American National Standard.   At the time of publication, the versions indicated were valid.   All standards are subject to revision, and parties that utilize this American National Standard are encouraged to investigate the possibility of applying the most recent versions of the standards indicated below.

Brad Wing 6/23/10 11:38 AM
Comment: Changed to reflect inclusion of forensic data in the standard

Brad Wing 6/23/10 11:39 AM
Comment: Moved from the beginning of the document to the end (per suggestions from reviewers)

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ANSI X3.4-1986 (R1992), Information Systems --- Coded Character Sets ---7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).[67]

ANSI X3.172-1990, Information Systems --- Dictionary for Information Systems.

ANSI/EIA - 538-1988 Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Equipment.

ANSI/IAI 2-1988, Forensic Identification --- Automated Fingerprint Identification Systems --- Glossary of Terms and Acronyms.[68]

ANSI INCITS 378-2004, Finger Minutiae Format for Data Interchange.[69]

ANSI INCITS 398-2005, the Common Biometric Exchange Formats Framework (CBEFF)

ANSI/NIST-ITL 1-2000, Information systems – Data Format for the Interchange of Fingerprint, Facial, and Scar Mark & Tattoo (SMT) Information.[70]

ANSI/NIST-ITL 1-2007

ANSI/NIST-ITL 2-2008

ANSI/NIST-ITL 1a-2009

IAFIS-DOC-0178-7.1 Electronic Fingerprint Transmission Specification, Version 7.1, May 2, 2005[71].

IAFIS-IC-0110 (V3) WSQ Gray-scale Fingerprint Image Compression Specification, December 19, 1997. http://www.fbibiospecs.org/docs/WSQ_Gray-scale_Specification_Version_3.pdf

ISO 646-1983 7-Bit Coded Character Set for Information Interchange.[72]

ISO 8601-1988, Data Elements and Interchange Formats - Information Interchange Representation of Dates and Times.

ISO/IEC International Standard 10918-1, Information Technology - Digital Compression and Coding of Continuous-Tone Still Images Part 1: Requirements and Guidelines. This is commonly referred to as the JPEG (Joint Photographic Experts Group) algorithm.

• [67] ANSI X3 Documents available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

• [68] Available from the International Association for Identification.

• [69] All INCITS documents available from http://www.incits.org

• [70] http://fingerprint.nist.gov/standard

• [71] All CJIS, IAFIS, and NCIC documents available from Criminal Justice Information Services Division, Federal Bureau of Investigation 935 Pennsylvania Avenue, NW, Washington, DC 20535.

• [72] All ISO documents available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

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ISO/IEC 14496-2, MPEG4 Feature Points, Annex C.

ISO/IEC International Standard 15444-1, JPEG 2000, Information Technology - Digital Compression and Coding of Continuous-Tone Still Images Part 1: Requirements and Guidelines.

ISO/IEC FCD 19794-5, Information Technology – Biometric data interchange formats – Part 5:Face image data

MTR 04B0000022 (Mitre Technical Report), Margaret Lepley, *Profile for 1000ppi Fingerprint Compression*, Version 1.1, April 2004.[73] Available at: http://www.mitre.org/work/tech_papers/tech_papers_04/lepley_fingerprint/lepley_fingerprint.pdf

National Crime Information Center (NCIC) Code Manual, Ninth Version, December, 2000.

NIST Special Publication 500 280, Mobile ID Device Best Practice Recommendation Version 1.0, April 2009 http://fingerprint.nist.gov/mobileid/MobileID-BPRS-20090825-V100.pdf

Introduction to the National Information Exchange Model (NIEM), Document Version 0.3, NIEM Program Management Office, February 12, 2008 http://www.niem.gov/files/NIEM_Introduction.pdf

National Information Exchange Model Concept of Operations, NIEM Program Management Office, January 9, 2007 http://www.niem.gov/files/NIEM_Concept_of_Operations.pdf

National Information Exchange Model Naming and Design Rules, NIEM Technical Architecture Committee (NTAC), October 31, 2008 http://www.niem.gov/pdf/NIEM-NDF-1-3.pdf

Techniques for Building and Extending NIEM XML Components, Version 2.0.1, August 7, 2007, Georgia Tech Research Institute http://www.niem.gov/Techniques_for_Building_and_Extending_NIEM.pdf

NIST Interagency Report 7629, IREX I, Performance of Iris Recognition Algorithms on Standard Images, September 22, 2009

   Executive Summary: http://nist.gov/irex/irex_summary.pdf

   Report: http://iris.nist.gov/irex/irex_report.pdf

Federal Bureau of Investigation; The Science of Fingerprints;

Rev 12 84; ISBN 0 16 076078 X

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[73] http://www.mitre.org/work/tech_papers/tech_papers_04/lepley_fingerprint/lepley_fingerprint.pdf

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NIST Fingerprint Image Quality (NFIQ), NISTIR 7151 ed., National Institute of Standards and Technology, 2004.[74] Available at: http://fingerprint.nist.gov/NFIS/ir_7151.pdf

29 Definitions

The following definitions and those given in the American National Standard Automated Fingerprint Identification Systems --- Glossary of Terms and Acronyms, ANSI/IAI 2-1988, apply to this standard.

AAMVA

Abbreviation for the American Association of Motor Vehicle Administrators.

ANSI

Abbreviation for the American National Standards Institute, Inc.

Aspect ratio

The width-to-height ratio of the captured image.

BDB

Abbreviation for Biometric Data Block used in CBEFF.

CBEFF

Abbreviation for Common Biometric Exchange Formats Framework. It provides a set of definitions used to exchange biometric data in a standardized manner. It forms the basis for Type-99 records.

complete friction ridge exemplars

A set of exemplar images of all finger and palm friction skin for an individual. Complete friction ridge exemplars include full palmprint images, as well as rolled fingerprints, plain fingerprints, entire joint images, and rolled tips for all fingers. See major case prints.

distal segment

The segment of a finger or thumb farthest from the palm.

DNA

Acronym for Deoxyribonucleic Acid. This is a chemical that forms a double helix that is unique to all but identical siblings.

• [74] Also see: E. Tabassi, "A novel approach to fingerprint image quality" in IEEE International Conference on Image Processing ICIP-05, Genoa, Italy, September 2005.

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effective scanning resolution

The number of pixels per unit distance that remain after a captured image has been subsampled, scaled, or interpolated down to produce an image having a lower value of scanning resolution (fewer pixels per mm) than was used originally to capture the image.

EFS

Acronym for the Extended Feature Set for markup of friction ridge data.

entire joint image

An exemplar image containing all four full finger views (cf.) for a single finger. A set of major case prints (cf.) includes entire joint images for all fingers.

exemplar image

An impression or image of friction ridge skin purposely collected with the knowledge of the subject; a non latent friction ridge image.

FAP

Abbreviation for Facial Animation Parameter.

fingerprint

In general, a latent or an exemplar image or impression of the friction ridges of all or any part of a finger or thumb. In this document, unless otherwise specified, fingerprint denotes an impression of the distal (outermost) segment of a finger or thumb.

flat fingerprint

A fingerprint image resulting from the touching of a single finger to a livescan platen or paper fingerprint card without any rolling motion. Also known as a single finger plain impression.

friction ridge image

An image of an impression from the palmar surfaces of the hands or fingers, or from the plantar (sole) surfaces of the feet or toes.

friction ridge skin

The papillary skin surface of the palmar surfaces of the hands and fingers, and the plantar surfaces of the feet and toes.

full finger view

A full finger view is a rolled or plain image of a full length finger showing all segments. An entire joint image (cf.) includes four full finger view images: one rolled; left, center, and right plain.

GPS

Acronym for the Global Positioning System.

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IBIA

Abbreviation for International Biometric Industry Association.

ICC

Abbreviation for International Color Consortium.

impression

A mark containing friction ridge detail produced on a surface by pressure.

incipient ridge

A friction ridge not fully developed that may appear shorter and thinner in appearance than fully developed friction ridges.

interdigital area

The portion of the palm along the base of the fingers.

IREX

Acronym for the Iris Exchange Program. This is a program at NIST in support of iris-based applications based on standardized interoperable iris imagery.

latent image

A friction ridge image of unknown origin.

latent print

An impression or image of friction ridge skin left inadvertently on a surface, especially if not readily visible to the eye; a non exemplar friction ridge image.

Level 1 features

Friction ridge flow and general morphological information. Level 1 features include (but are not limited to) pattern classifications.

Level 2 features

Individual friction ridge paths and friction ridge events, e.g., bifurcations, ending ridges, dots. Level 2 features include (but are not limited to) minutiae and the interrelationships between minutiae.

Level 3 features

Friction ridge dimensional attributes, e.g., width, edge shapes, and pores.

record

A record independent of its physical environment; portions of one record may be located in different physical records, or several records or parts of records may be located in one physical record.

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major case prints

A set of exemplar images of all finger and palm friction skin for an individual. Major case prints include full palmprint images, as well as rolled fingerprints, plain fingerprints, entire joint images, and rolled tips for all fingers. A set of major case prints may optionally include plantar images. They are also known as complete friction ridge exemplars. (Note that the term Major Case Prints may be deprecated for some uses because in legal contexts it can be incorrectly read as making an implication regarding the severity of the case.)

In order to ensure that segmentation of a multi-finger plain image has been performed correctly (if single finger flat images are transmitted), the original multi-finger plain images shall accompany the segmented single-finger images.

Also, 2 plain impressions of the thumbs are specifically required in major case prints.

Major case prints may be transmitted using either Type-4 or Type-14 records, with Type-14 preferred.

> **Brad Wing 7/7/10 9:41 AM**
> **Comment:** Note the inclusion of a requirement to forward the original multi-finger plain image along with the segmented images. (NEW)

matrix

The substance deposited by the finger that forms the impression.

medial segment

The middle segment of the finger. The thumb does not have a medial segment.

minutia

The point where a friction ridge begins, terminates, or splits into two or more ridges. Minutiae are friction ridge characteristics that are used to individualize a friction ridge image (fingerprint, palmprint, plantar).

mugshot

Term used interchangeably with facial image.

native scanning resolution

The scanning resolution used by a specific AFIS, live-scan reader, or other image capture device and supported by the originator of the transmission.

NIEM

Abbreviation for the National Information Exchange Model. It is a partnership of US Government agencies designed to develop and support information exchange standards using XML.

NIST

Acronym for the National Institute of Standards and Technology.

nominal transmitting resolution

The number of pixels per unit distance (ppmm or ppi) of the transmitted image. The transmitting resolution may be the same as the scanning resolution for a particular image. On the other hand, the transmitting resolution may be less than the scanning resolution if the scanned image was subsampled, scaled, or interpolated down before transmission.

NFIQ

Abbreviation for NIST Fingerprint Image Quality.

palmprint

An exemplar or latent friction ridge image from the palm (side and underside) of the hand. A full palmprint includes the area from the wrist to the tips of the fingers. A lower palmprint includes the area from the wrist to the base of the fingers, including the entire interdigital area. An upper palmprint includes the area from the tips of the fingers to the interdigital area, and must include enough of the interdigital area to be able to determine that upper and lower palm images are from the same hand.

palmar

Having to do with the friction ridge skin on the hands (fingers

plain fingerprint

A fingerprint image resulting from the touching of one or more fingers to a livescan platen or paper fingerprint card without any rolling motion.

plantar

Having to do with the friction ridge skin on the feet (soles and toes).

ppi

Abbreviation for pixels per inch.

ppmm

Abbreviation for pixels per millimeter.

proximal segment

The segment of the finger or thumb closest to the palm.

recurving ridge

A ridge whose path begins in one direction, curves and continues in a path parallel or nearly parallel to its start.

An innermost recurving ridge is a recurving ridge that encloses no other recurving ridges.

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RGB

Abbreviation for Red, Green, Blue used to represent color pixels comprised of a specified number of bits to represent each of these primary color components.

ridge

A raised portion of the epidermis on the palmar or plantar skin, consisting of one or more connected ridge units of friction ridge skin.

ridge segment

A section of a ridge that connects two minutiae; a single non intersecting portion of a skeletonized image.

ridge tracing

See skeletonized image.

ridge unit

A portion of a ridge that contains one pore.

ROI

Abbreviation for region of interest.

rolled fingerprint

A fingerprint image collected by rolling the finger across a livescan platen or paper fingerprint card from nail to nail. Rolls may be from livescan devices or scanned from paper fingerprint cards.

SAP

Abbreviation for Subject Acquisition Profile. It is a series of sets of progressively more stringent parameters and requirements relevant to a device and modality.

skeletonized image

A representation of a friction skin image in which all pixels are white except for a 1 pixel wide thinned black skeleton following the midpoint of each ridge. Also known as a ridge tracing.

slap fingerprint

Slap fingerprints (slaps) are taken by simultaneously pressing the four fingers of one hand onto a scanner or fingerprint card. Slaps are also known as four finger simultaneous plain impressions.

SMT

Abbreviation used for scar, mark, and tattoo information.

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scanning resolution

Informally, the number of pixels per unit distance at which an image is captured (ppmm or ppi). More formally, "resolution" (resolving power) is distinct from "sampling frequency" (number of pixels per unit distance). Resolution can be characterized by a measurement of the Spatial Frequency Response (SFR) function. The capture of high quality friction ridge images generally requires an image quality specification, such as the FBI's IAFIS Image Quality Specification (EFTS Appendix F) or Image Quality Specifications for Single Finger Capture Devices (PIV), which defines both resolution and sampling frequency. Without such a specification, the term "resolution" is only informational.

substrate

Surface upon which a friction ridge impression is deposited.

record

A record containing unique ASCII field identifiers for variable-length data fields that is capable of being parsed based on the field identifier and the data contents of each field.

transaction

A command, message, or an input record that explicitly or implicitly calls for a processing action. Information contained in a transaction shall be applicable to a single subject.

valley

A lowered portion of the epidermis on the palmar or plantar skin, consisting of those areas between ridges.

W3C

Abbreviation for the World Wide Web Consortium. It is an international community that develops standards for web development.

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