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Biometric Data Specification for Personal Identity Verification

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NOTE FOR REVIEWERS

1. NIST has created this Special Publication 800-76 (SP 800-76) in response to the comments received on the FIPS 201 public draft. The SP 800-76 provides the biometric data requirements to support interoperability among government agencies. Details regarding the acquisition and formatting of biometric data are moved from the FIPS 201 to this document.
2. Please submit your SP 800-76 comments using the comment template form provided on the <http://www.csrc.nist.gov/piv-project/fips201-support-docs.html> website. Please include the submitter's name and organization in the header section of the spreadsheet. This will greatly facilitate processing of comments by NIST.
3. Comments should be submitted to DraftFips201@nist.gov. It is requested that Federal organizations submit one consolidated/coordinated set of comments. Also, include "Comments on Public Draft SP 800-76" in the subject line.
4. The comment period closes at 5:00 EST (US and Canada) on February 7th, 2005. Comments received after the comment period closes will be handled on as-time-is-available basis.

REPORTS ON COMPUTER SYSTEMS TECHNOLOGY

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Executive Summary

The Homeland Security Presidential Directive HSPD-12 called for new standards to be adopted governing the interoperable use of identity credentials to allow physical and logical access to Federal government locations and systems. The Personal Identity Verification (PIV) for Federal Employees and Contractors, Federal Information Processing Standard (FIPS 201) was developed to establish standards for identity credentials. This document, Special Publication 800-76 (SP 800-76), specifies technical acquisition and formatting requirements for the biometric credentials of the PIV system and is a companion document to FIPS 201. It enumerates required procedures and formats for fingerprints and facial images by restricting values and practices included generically in published biometric standards. The primary design objective behind these particular specifications is universal interoperability. Specifically, SP 800-76 involves the preparation of biometric data suitable for transmission to the Federal Bureau of Investigation (FBI) for background checks. It also provides requirements for formatting of the biometric data on the PIV Card¹.

¹ A physical artifact (e.g., identity card, “smart” card) issued to an individual that contains stored identity credentials (e.g., photograph, cryptographic keys, biometric data) so that the claimed identity of the cardholder can be verified against the stored credentials by another person (human readable and verifiable) or an automated process (computer readable and verifiable).

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1. Introduction

1.1 Authority

This document has been developed by the National Institute of Standards and Technology (NIST) in furtherance of its statutory responsibilities under the Federal Information Security Management Act (FISMA) of 2002, Public Law 107-347.

NIST is responsible for developing standards and guidelines, including minimum requirements, for providing adequate information security for all agency operations and assets, but such standards and guidelines shall not apply to national security systems. This recommendation is consistent with the requirements of the Office of Management and Budget (OMB) Circular A-130, Section 8b(3), Securing Agency Information Systems, as analyzed in A-130, Appendix IV: Analysis of Key Sections. Supplemental information is provided A-130, Appendix III.

This recommendation has been prepared for use by federal agencies. It may be used by non-governmental organizations on a voluntary basis and is not subject to copyright. Nothing in this document should be taken to contradict standards and guidelines made mandatory and binding on Federal agencies by the Secretary of Commerce under statutory authority. Nor should this recommendation be interpreted as altering or superseding the existing authorities of the Secretary of Commerce, Director of the Office of Management and Budget (OMB), or any other Federal official.

1.2 Purpose and Scope

FIPS 201 [FIPS], Personal Identity Verification (PIV) for Federal Employees and Contractors, defines procedures for the PIV lifecycle activities including identity proofing, registration, PIV Card issuance, and PIV Card usage. FIPS also defines the structure of an identity credential which includes biometric data. This document contains technical specifications for biometric data mandated in FIPS. These specifications reflect the design goals of interoperability and performance. The goals are addressed by citing biometric standards normatively and by enumerating requirements where the standards include options and branches. In such cases, a biometric profile can be used to elucidate required versus optional content. This document goes further by constraining implementers' interpretation of the standards. Such restrictions are designed to ease implementation, facilitate interoperability, and ensure performance, in a manner tailored for PIV applications.

In the general case, it is implicit that a specification of a data format constitutes an injunction on an implementer to acquire and prepare the data in certain ways. Thus, this document supplements the *state* (data format) with some *process* (data acquisition) requirements.

1.3 Audience and Assumptions

This document is targeted at Federal agencies and implementers of PIV systems. Readers are assumed to have a working knowledge of biometric standards and applications.

1.4 Structure of Document

This document is organized as follows:

- Section 1 (this section) explains the authority, purpose and scope, audience and assumptions of the document, and outlines its structure.
- Section 2 defines terms and acronyms used in this document.
- Section 3 gives specifications for fingerprints used in PIV processes.
- Section 4 specifies facial image requirements for PIV.
- Section 5 defines the format of the common header used in all PIV biometric data representation.
- Section 6 specifies requirements on biometric devices.
- Section 7 is the bibliography.

2. Terms, Acronyms, and Notation

2.1 Terms

| Term | Definition |
|--------------|--|
| Platen | Imaging surface of a fingerprint reader. It is a touch pad upon which fingers are placed. |
| Segmentation | For fingerprints, segmentation is the separation of an N finger image into N single finger images. |

2.2 Acronyms

| Acronym | Definition |
|----------|--|
| ANSI | American National Standards Institute |
| BIOAPI | Biometric Application Programming Interface |
| CBEFF | Common Biometric Exchange Formats Framework |
| FIPS | Federal Information Processing Standard |
| EFTS / F | Electronic Fingerprint Transmission Specification (Appendix F) |
| INCITS | InterNational Committee for Information Technology Standards |
| ISO | International Organization for Standardization |
| IEC | International Electrotechnical Commission |
| NFIQ | NIST Fingerprint Image Quality |
| PIV | Personal Identity Verification |

3. Fingerprint Specifications

This section specifies acquisition and formatting requirements of fingerprint images. Section 3.1 provides requirements for a full set of fingerprint images. Section 3.2 provides format requirements for image transmission to FBI. Section 3.3 provides compression and cropping requirements for on-card storage.

3.1 Fingerprint Image Acquisition and Format

This section specifies requirements for electronic capture of full set of fingerprint images. It describes the mode of collection as well as the detailed format of the record header for storing the image data.

3.1.1 Acquisition

A subject's fingerprints shall be collected by taking three multi-finger plain impression images (also called a *slaps* or *flats*), as enumerated in Table 1. The multi-finger images shall be obtained by simultaneously placing multiple fingers on an imaging platen without any rolling movement. Ordinarily, all ten fingerprints shall be imaged in this process; however, if one or more fingers is not available (for instance, because of amputation) then as many fingers as are available shall be imaged.

Table 1: Fingers Imaged

| Mode of Collection | |
|--------------------|--|
| 1 | Combined impression of the four fingers on the right hand (except for the thumb) |
| 2 | Combined impression of the four fingers on the left hand (except for the thumb) |
| 3 | Combined impression of the left and right thumbs. |

Devices used for capture of these fingerprints shall have been certified as being compliant with the Appendix F requirements of the FBI's Electronic Fingerprint Transmission Specification (EFTS/F). This ensures conformance to the Image Acquisition Settings Level 31 of [FINGSTD]. The native scanning resolution of the device shall be 197 pixels per centimeter (500 pixels per inch). The imaging devices used to capture these images shall have the imaging dimensions specified in Table 2.

Table 2: Dimensions of Imaging Platen

| Size | Maximum Width (mm) | Maximum Height (mm) | Minimum Width (mm) | Minimum Height (mm) |
|------------------------------------|--------------------|---------------------|--------------------|---------------------|
| Dimensions for Four-Finger Platens | 83.3 | 76.2 | 76.2 | 50.8 |
| Dimensions for Two-Thumb Platens | 83.3 | 76.2 | 50.8 | 50.8 |

A set of rolled images may be collected, in addition to the plain impressions. Such a set shall include the three multi-finger plain impressions listed in Table 1, with the option that the two thumbs may be included separately.

3.1.2 Format

Fingerprint images retained shall be formatted according to the INCITS 381-2004 finger image based interchange format standard [FINGSTD]. Single-finger images shall be obtained by segmentation of the three multi-finger images. The single finger images shall be formatted in one [FINGSTD] record. The record may also include the associated multi-finger plain impressions. The record shall be wrapped in the CBEFF structure described in Section 5.

Table 3 gives clause-by-clause specialization of the [FINGSTD]. The primary purpose of the Table is to specify PIV requirements for those fields of [FINGSTD] that have optional content. Rows 2-11 give normative content. Row 12 mandates the CBEFF header. Rows 13-28 give PIV requirements for the fields of the General Record Header of Table 2 of [FINGSTD]. These are common to all images in the record. Similarly, Rows 29-39 provide requirements for the Finger Image Header Record in Table 4 of [FINGSTD]. Column 5 provides PIV specific requirements or parameter defaults of the standard.

Table 3: General Record Header

| 1. | Clause title and/or field name | INCITS 381-2004 | | PIV Values Allowed | Informative Remarks |
|-----|---|------------------|----------------|--------------------------------|--|
| | | Field or Content | Value Required | | |
| 2. | Byte and bit ordering (5.1) | NC | | A | Big Endian MSB then LSB |
| 3. | Scan sequence (5.2) | NC | | A | |
| 4. | Image acquisition reqs. (6) | NC | | Level 31 | Table 1 |
| 5. | Pixel Aspect Ratio (6.1) | NC | | A | 1:1 |
| 6. | Pixel Depth (6.2) | NC | | A | Level 31 → 8 |
| 7. | Grayscale data (6.3) | NC | | A | Level 31 → 1 byte per pixel |
| 8. | Dynamic Range (6.4) | NC | | A | Level 31 → 200 gray levels |
| 9. | Scan resolution (6.5) | NC | | A | Level 31 → 500 ppi |
| 10. | Image resolution (6.6) | NC | | 500 ppi - no interpolation | |
| 11. | Fingerprint image location (6.7) | NC | | A | Slap placement info, centering |
| 12. | CBEFF Header (7) | MF | MV | Patron Format A see Section 5. | Multi-field CBEFF Header |
| 13. | General Record Header (7.1) | NC | | A | |
| 14. | Format Identifier (7.1.1) | MF | MV | A | 0x46495200 ('F' 'I' 'R' 0x0) |
| 15. | Version Number (7.1.2) | MF | MV | 010 | 0x30313000 ('0' '1' '0' 0x0) Ver.1 Rev.0 |
| 16. | Record Length (7.1.3) | MF | MV | MIT | size excluding CBEFF structure |
| 17. | CBEFF Product Identifier (7.1.4) | MF | MV | A | CBEFF pid from IBIA |
| 18. | Capture Device ID (7.1.5) | MF | MV | A | vendor specified |
| 19. | Image Acquisition Level (7.1.6) | MF | MV | 31 | Settings Level 31 |
| 20. | Number of Images (7.1.7) | MF | MV | 10 or 13 | Denote by K, see line 29. See notes 1, 2, 3. |
| 21. | Scale units (7.1.8) | MF | MV | 0x01 0x02 | inches or centimeters |
| 22. | Scan resolution (horz) (7.1.9) | MF | MV | 500 197 | |
| 23. | Scan resolution (vert) (7.1.10) | MF | MV | 500 197 | |
| 24. | Image resolution (horz) (7.1.11) | MF | MV | 500 197 | |
| 25. | Image resolution (vert) (7.1.12) | MF | MV | 500 197 | |
| 26. | Pixel Depth (7.1.13) | MF | MV | 8 | Grayscale with 256 levels |
| 27. | Image compression alg. (7.1.14) | MF | MV | 2 | WSQ. See note 4 |
| 28. | Reserved (7.1.15) | MF | MV | A | four bytes |
| 29. | K fingerprints, or multi-finger prints, or palms | | | | |
| 30. | Finger data block length (7.2.1) | MF | MV | MIT | |
| 31. | Finger position (7.2.2) | MF | MV | MIT | |
| 32. | Count of views (7.2.3) | MF | MV | ≥ 1 | M views of this finger. See note 5. |
| 33. | M views of this finger, or multi-finger print, or palm | | | | |
| 34. | View number (7.2.4) | MF | MV | MIT | |
| 35. | Finger/palm image quality (7.2.5) | MF | MV | 1, 2, or 3 | NFIQ. See notes 6, 7, 8 and 9 |
| 36. | Impression type (7.2.6) | MF | MV | 0, 1, 2 or 3 | See ANSI NIST ITL 1-2000 |
| 37. | Horizontal line length (7.2.7) | MF | MV | ≥ 368 | See note 10 |
| 38. | Vertical line length (7.2.8) | MF | MV | ≥ 368 | |
| 39. | Finger image data (7.2.9) | MF | MV | MIT | Compressed WSQ Data |

| Acronym | | Meaning |
|---------|---------------------------------|---|
| MF | mandatory field | [FINGSTD] mandates a field shall be present in the record |
| MV | mandatory value | [FINGSTD] mandates a meaningful value for this field |
| NC | normative content | [FINGSTD] gives normative practice here. Such clauses do not define a field in the FIR. |
| A | as required by standard | For PIV, value or practice is as specified in [FINGSTD] |
| MIT | mandatory at instantiation-time | For PIV, mandatory value shall be determined at the time the record is instantiated |

NORMATIVE NOTES:

1. If certain fingers cannot be imaged, the value of this field shall be decremented accordingly.
2. The left and right four-finger images, and two-thumb, images may also be included. The value of this field shall be incremented accordingly.
3. This field will be 10 for just the fingers, and 13 if the slap impressions are included.
4. Compression of images whose image resolution is 500 ppi shall be implemented using a certified version of the Wavelet Scalar Quantization (WSQ) algorithm.
5. The term view refers to the number of images of that particular finger. This value will exceed one if imaging have been repeated. Inclusion of all images of a finger can afford some benefit in a matching process. Retention of all images with quality values 1-4 is recommended. The first such image should have quality 1-3 per the following notes.
6. Quality values shall be specified. The quality values shall be those produced by the NIST Fingerprint Image Quality (NFIQ) method discussed in [NFIQ]. Such values are intended to be predictive of the relative performance of a minutia based fingerprint matching system. A lower quality value indicates a superior fingerprint image.
7. The NFIQ values shall be computed at the time of acquisition, ideally before the images are compressed for storage. The sequence of steps involved in using NFIQ values for real-time quality assessment of the acquired image is provided in Table 4.

Table 4: Steps and Image Quality Assessment

| Step | Action |
|------|---|
| 1 | Attending official should inspect fingers and require absence of foreign material where possible. |
| 2 | Acquire fingerprints. |
| 3 | Perform any needed segmentation of multi-finger images into single-finger images |
| 4 | Compute NFIQ value for each single-finger image |
| 5 | If four or more images have NFIQ value less than or equal to 3 then go to step 8 |
| 6 | Otherwise repeat steps 2-5 up to three times |
| 7 | If after three acquisitions no four fingers have NFIQ values of 1-3 then go to step 8 anyway |
| 8 | Write the final record. |

8. Images of quality 4 and 5 shall only be present if reacquisition of the fingerprints from the live subject failed to improve quality.
9. The NFIQ value shall be set to 254 (the [FINGSTD] code for undefined) if this record is not a single finger print (i.e. it is a multi-finger image, or a palm print).
10. The values are minimum image sizes.

3.2 Fingerprint Image Specifications for Background Checks

PIV fingerprint images transmitted to the Federal Bureau of Investigation (FBI) as part of the background checking process shall be formatted according to the ANSI/NIST-ITL 1-2000 standard [FFSMT] and the CJIS-RS-0010 [EFTS] specification. The images shall each be contained in Type 4 or Type 14 records as described in Table 5. These records shall be prepared using the data obtained in Section 3.1. Thus, this section specifies only formatting requirements; it does not include sensor or acquisition related specifications beyond those in Section 3.1.

Table 5: Record Types for Background Checks

| | Data Format in [FFSMT] | Availability | Reference |
|---|--|-----------------|--|
| 1 | Fourteen Type 4 records | Now | Section 3.1.1.4 "Federal Applicant User Fee" of [EFTS] |
| 2 | Three Type 14 records. This is an extension to the FBI format allowing submission of unsegmented slap impressions. | From March 2005 | N-FACS Report [NFACS] |

In Option 2, fields 14.001 through 14.013 and 14.999 of the ANSI/NIST Type 14 record are required. In addition:

1. For single-finger Type 14 records, the 14.021 field shall be included. It shall contain NFIQ values [NFIQ]. This is a mandatory requirement for all slap (flat) fingerprint submissions to the FBI, starting in March 2005. The format, given in Table 6, supplements Table 16 in [FFSMT].
2. For multi-finger Type 14 records, the 14.022 field shall be included. It shall contain the coordinates of the left, right, top, and bottom corner pixels of the four constituent fingers, or the two constituent thumbs. The format, given in Table 6, supplements Table 16 in [FFSMT].

Table 6: Extended Fields of the Type-14 Record

| Identifier | Condition | Field Number | Field Name | Char. Type | Field Size Per Occurrence | | Occurrences | | Max. Size in Bytes | Example Data |
|------------|-----------|--------------|-----------------------------|------------|---------------------------|-----|-------------|-----|--------------------|--|
| | | | | | Min | Max | Min | Max | | |
| SEG | M | 14.021 | SEGMENT POSITION | N | 1 | 2 | 2 | 4 | 99 | 14.021:10<US>3<US>352<US>725<US>1265<RS> 9<US>375<US>750<US>175<US>765<RS> 8<US>800<US>1150<US>5<US>581<RS> 7<US>1200<US>1598<US>274<US>801<GS> |
| | M | | FINGER NUMBER | | | | | | | |
| | M | | LEFT | | | | | | | |
| | M | | RIGHT | | | | | | | |
| | M | | TOP | | | | | | | |
| M | BOTTOM | | | | | | | | | |
| IQM | M | 14.022 | IMAGE QUALITY | N | 1 | 2 | 2 | 4 | 58 | 14.022:10<US>5<RS>9<US>4<RS>8<US>3<RS>7<US>3<GS> |
| | M | | METRIC | | | | | | | |
| | M | | FINGER NUMBER QUALITY SCORE | | | | | | | |

NORMATIVE NOTES:

1. IQM stands for Image Quality Metric. This mandatory ASCII field shall contain the image quality scores for the individual fingers. Each finger score is defined by the FINGER NUMBER and the QUALITY SCORE separated by the <US> separator. Individual finger quality definitions are separated by the <RS> separator.
2. The field identifier SEG indicates Finger Segment Positions. This mandatory ASCII field shall contain offsets to the locations of image segments containing the individual fingers within the image. The offsets are relative to the origin, (0,0), which is in the upper left corner of the image. The horizontal offsets (X) are the pixel counts to the right, and the vertical offsets (Y) are the pixel counts down. A finger segment is defined by the FINGER NUMBER, the X coordinates (LEFT, RIGHT) and the Y coordinates (TOP, BOTTOM), of its bounding box. The five information items within a finger segment definition are separated by the <US> separator. Individual finger segment definitions are separated by the <RS> separator.

INFORMATIVE NOTES:

1. The codes <GS>, <RS>, and <US> are delimiters used here to represent non-printing ASCII characters.
2. The NFIQ values in 14.022, for example "9<US>4<RS>" means that finger 9 has quality 4.

3.3 Fingerprint Image Specifications for On-card Storage

Fingerprint images stored on the PIV Card shall be formatted according to the INCITS 381-2004 finger image standard [FINGSTD]. The images of the primary and secondary fingers shall be stored in two separate [FINGSTD] records. Each record data shall be wrapped in a CBEFF structure as defined in Section 5. These images may be two of those obtained from the full set of fingerprints specified in Section 3.1. Alternatively, the two images may be obtained exclusively for on-card storage in accordance with requirements outlined in Section 3.1. Due to the lack of storage on the PIV Card, two additional compression and cropping schemes are permitted for fingerprint images, as defined in Table 7.

Table 7: PIV Card Compression Options

| Default | | | | |
|---|-----------------------------------|------------------------------|----------------------|---------------------------------|
| The default is to be applied in cases where there no resource constraints | | | | |
| Pixels Both dimensions | Centimeters Both dimensions | Inches Both dimensions | Compression Ratio | Compressed Data Size (bytes) |
| 368 – 425 | 1.62 – 2.16 | 0.64 – 0.85 | 15:1 | 9029 – 12042 |
| Permitted Minimum Image Dimensions and Data Sizes Options 1 and 2 shall only be applied if space constraints require it. | | | | |
| Option 1 | | | | |
| Crop the image about the grayscale center of mass. Optionally invoke a minutiae detector to direct the cropping. Crop to no fewer than 368 pixels in both dimensions. Apply WSQ at whatever minimum compression ratio that will satisfy the storage requirements, but not to exceed 20:1. | | | | |
| Pixels Both dimensions | Centimeters Both dimensions | Inches Both dimensions | Compression Ratio | Compressed Data Size (bytes) |
| ≥ 368 | ≥ 1.85 | ≥ 0.73 | 15:1 to 20:1 | ≥ 6772 |
| Option 2 | | | | |
| Crop the image about the grayscale center of mass. Optionally invoke a minutiae detector to direct the cropping. Crop to no fewer than 320 pixels in both dimensions. Apply WSQ at | | | | |

| compression of 15:1. | | | | |
|------------------------------|-----------------------------------|------------------------------|----------------------|---------------------------------|
| Pixels Both dimensions | Centimeters Both dimensions | Inches Both dimensions | Compression Ratio | Compressed Data Size (bytes) |
| ≥ 320 | ≥ 1.62 | ≥ 0.64 | 15:1 | ≥ 6823 |

4. Facial Image Specifications

This section details normative requirements for PIV implementations where facial images are collected and retained electronically.

4.1 Acquisition and Format

This section specifies requirements for the collection and retention of facial images. Facial images shall be collected and formatted such that they conform to all normative clauses of INCITS 385-2004 [FACESTD]. The images shall be embedded within the CBEFF structure defined in Section 5. Because [FACESTD] is generic across applications it includes clauses that have either-or requirements. Column 6 of Table 8 gives normative practice or value specifications for PIV.

While the table is not fully conformant with the Implementation Conformance Statement [ICS] standard, the addition of a "values supported column" as specified in Section 9.1 of [ICS] should be used by implementers for checking conformance to the requirements.

Table 8: INCITS 385-2004 and PIV Requirements for Formatting of Facial Images

| 1. | | Clause title and/or field name | INCITS 385-2004 | | PIV | Informative Remarks | |
|-----|--|-----------------------------------|---|-------------|----------------------------|--|-----------------------------------|
| | | | Field or Content | Value Req'd | Values Allowed | | |
| 2. | | Byte Ordering (5.2.1) | NC | | A | Big Endian | |
| 3. | | Numeric Values (5.2.2) | NC | | A | Unsigned Ints | |
| 4. | CBEFF | CBEFF Header (5.3) | MF | MV | Patron format A of sec. 5. | Multi-field CBEFF Header | |
| 5. | Facial Header | Format Identifier (5.4.1) | MF | MV | A | hex values indicating INCITS 385-2004 records | |
| 6. | | Version Number (5.4.2) | MF | MV | A | | |
| 7. | | Record Length (5.4.3) | MF | MV | MIT | | |
| 8. | | Number of Facial Images (5.4.4) | MF | MV | ≥ 1 | one or more images (K ≥ 1). See line 21. | |
| 9. | Facial Info. Single instance of subject-specific info. | Face Image Block Length (5.5.1) | MF | MV | MIT | | |
| 10. | | Number of Feature Points (5.5.2) | MF | MV | ≥ 0 | positive, if features computed | |
| 11. | | Gender (5.5.3) | MF | OV | OIT | these fields populated with meaningful values at agency discretion, otherwise 0 for unspecified. | |
| 12. | | Eye color (5.5.4) | MF | OV | OIT | | |
| 13. | | Hair color (5.5.5) | MF | OV | OIT | | |
| 14. | | Feature Mask (5.5.6) | MF | OV | OIT | | |
| 15. | | | Expression (5.5.7) | MF | OV | 1 | Neutral |
| 16. | | | Pose Angles (5.5.8) | MF | OV | 0 | Unspecified = Frontal |
| 17. | | Pose Angle Uncertainty (5.5.9) | MF | OV | 0 | Attended operation so should be frontal. | |
| 18. | Features | MPEG4 Features (5.6.1) | NC | | OIT | | |
| 19. | | Center of Facial Features (5.6.2) | NC | | OIT | | |
| 20. | | The Facial Feature Block Encoding | OF | OV | OIT | | |
| 21. | K instances | | | | | | |
| 22. | Image Info. Each instance has image-specific info. | Facial Image Type (5.7.1) | MF | MV | 1 | See note 1. | |
| 23. | | Image Data Type (5.7.2) | MF | MV | 0 or 1 | See note 4. Compression alg. | |
| 24. | | Width (5.7.3) | MF | MV | MIT | See note 2. | |
| 25. | | Height (5.7.4) | MF | MV | MIT | | |
| 26. | | | Image Color Space (5.7.5) | MF | MV | 1 | sRGB. See Note 3. |
| 27. | | | Source Type (5.7.6) | MF | MV | 2 or 6 | digital still or digital video |
| 28. | | | Device Type (vendor supplied device ID) (5.7.7) | MF | MV | MIT | |
| 29. | | | Quality (5.7.8) | MF | MV | A | std requires 0 (i.e. unspecified) |
| 30. | Image Data | Data Structure (5.8.1) | MF | MV | MIT | Compressed Data | |
| 31. | Base Inherit | Inheritance (6.1) | NC | | A | | |

| 1. | | Clause title and/or field name | INCITS 385-2004 | | PIV | Informative Remarks | |
|-----|--|--|----------------------------------|------------------------|----------------------|------------------------------------|---|
| | | | Field or Content | Value Req'd | Values Allowed | | |
| 32. | Format | Image Data Encoding (6.2) | NC | | A + Note 4. | | |
| 33. | | Image Data Compression (6.3) | NC | | A + Note 4. | | |
| 34. | | Facial Header (6.4.1) | NC | | A | include 4 fields | |
| 35. | | Facial Information (6.4.2) | NC | | A | include 2 fields | |
| 36. | | Image Information (6.4.3) | NC | | A | include 8 fields | |
| 37. | | Inheritance (7.1) | NC | | A | Inherits Basic | |
| 38. | Scene | Purpose (7.2.1) | NC | | A | frontal Annex A | |
| 39. | | Pose (7.2.2) | NC | | Frontal | +/- 5 degrees | |
| 40. | | Expression (7.2.3) | NC | | Neutral | | |
| 41. | | Assistance in positioning face (7.2.4) | NC | | A | Only the subject appears | |
| 42. | | Shoulders (7.2.5) | NC | | A | Body + Face toward camera | |
| 43. | | Backgrounds (7.2.6) | NC | | Uniform Annex A.4.3 | Recommend 18% Gray per Annex A.4.4 | |
| 44. | | Subject and scene lighting (7.2.7) | NC | | A | Uniform | |
| 45. | | Shadows over the face (7.2.8) | NC | | A | None | |
| 46. | | Eye socket shadows (7.2.9) | NC | | A | None | |
| 47. | | Hot spots (7.2.10) | NC | | A | Should be absent. Diffuse light. | |
| 48. | | Eye glasses (7.2.11) | NC | | A | Subject's normal condition | |
| 49. | | Eye patches (7.2.12) | NC | | A | Medical only | |
| 50. | | Photographic | Exposure (7.3.2) | NC | | A | No saturation |
| 51. | | | Focus and Depth of Field (7.3.3) | NC | | A | In focus |
| 52. | Unnatural Color (7.3.4) | | NC | | A | White balance | |
| 53. | Color or grayscale enhancement (7.3.5) | | NC | | A + no recompress. | No post-processing | |
| 54. | Radial Distortion of the camera lens (7.3.6) | | NC | | A + Follow Annex A.8 | | |
| 55. | Digital | | Geometry | aspect ratio (7.4.2.1) | | A | 1:1 pixels |
| 56. | | origin (7.4.2.2) | | | A | top left is 0,0 | |
| 57. | | Color Profile | Density (7.4.3.1) | NC | A | 7 bits dynamic range in gray | |
| 58. | | | Color Sat (7.4.3.2) | NC | A | 7 bits dynamic range in grayscale | |
| 59. | | | Color space (7.4.3.3) | NC | | 24 bit RGB | Option a, reported in color space field above. See Note 3 |
| 60. | Video Interlacing (7.4.4) | NC | | A | | | |
| 61. | Full Frontal (clause 8) | Inheritance (8.1) | NC | | A | Inherits Frontal + Basic | |
| 62. | | Scene (8.2) | NC | | A | Inherits Frontal + Basic | |
| 63. | | Photographic | Centered Image (8.3.2) | NC | | A | Nose on vertical centerline |
| 64. | | | Position of Eyes (8.3.3) | NC | | A | Above horizontal centerline |
| 65. | | | Width of Head (8.3.4) | NC | | A | See note 2 |
| 66. | | | Length of Head (8.3.5) | NC | | A | |
| 67. | | Digital | Resolution (8.4.1) | NC | | CC ≥ 240 | |
| 68. | | Format | Inheritance (8.5.1) | NC | | A | |
| 69. | | | Image Information (8.5.2) | NC | | A | |

| Acronym | Meaning |
|---------|---------------------------------|
| FIR | Face Information Record |
| MF | mandatory field |
| OF | optional field |
| MV | mandatory value |
| OV | optional value |
| NC | normative content |
| A | as required |
| MIT | mandatory at instantiation-time |
| OIT | optional at instantiation-time |

NORMATIVE NOTES:

1. PIV facial images shall conform to the Full Frontal Image Type defined in Section 8 of [FACESTD].
2. Face recognition performance is a function of the spatial resolution of the image. [FACESTD] does not specify a minimum resolution for the Full Frontal Image Type. For PIV, faces shall be acquired such that a

20 centimeter target placed on, and normal to, a camera's optical axis at a range of 1.5 meters shall be imaged with at least 240 pixels across it. This ensures that the width of the head (i.e. dimension CC in Figure 8 of [FACESTD]) shall have sufficient resolution. This specification and clause 8.3.4 of [FACESTD] implies that the image width shall exceed 420 pixels. This resolution specification shall be attained optically without digital interpolation. The distance from the camera to the subject should be greater than or equal to 1.5 meters (for distortion reasons discussed in Annex A.8).

3. The image data shall be converted to the sRGB color space for storage. As stated in clause 7.4.3.3 of [FACESTD] this requires application of the color profile associated with the camera in use.
4. Image data shall be formatted in either of the compression formats enumerated in clause 6.2 of [FACESTD]. Maximum compression ratios are specified in Table 9. Both whole-image and single-region-of-interest (ROI) compression are permitted. If ROI compression is used, the inner region shall be rectangular with width greater than or equal to $4W/5$ and height greater than or equal to W , with W being the width of the image. The ROI shall be centered on the point located midway between the eyes and on the vertical axis through the nose. Compression should not be applied during intermediate stages of processing.

Table 9: Compression Ratios and Data Sizes for Facial Images

| Property | Whole-image compression | ROI compression |
|--|-------------------------|-----------------|
| Compression Ratio Inner Region | $\leq 24:1$ | $\leq 24:1$ |
| Compression Ratio Outer Region | | $\leq 120:1$ |
| Uncompressed Size for $W = 420, H = 560$ | 705600 | 705600 |
| Compressed size minimum (bytes) | 29400 | 19992 |

Table 9 sizes do not include the [FACESTD] header nor the CBEFF structure.

5. More than one image may be stored in the record. It may be appropriate to store several images if appearance changes over time (beard, no beard, beard) and images are gathered at re-issuance. The most recent image shall appear first and serve as the default provided to applications.

5. Common Header for PIV Biometric Data — CBEFF Structure

PIV biometric data records specified in [FINGSTD] and [FACESTD] shall be embedded in a data structure conforming to Common Biometric Exchange Formats Framework [CBEFF]. The data shall be signed: The CBEFF signature block shall include a signature (for integrity) as specified in Section 4.4.2 of [FIPS]. This overall arrangement is depicted in Table 10.

Table 10: Simple CBEFF Structure

| CBEFF STRUCTURE | | |
|-----------------|------------------------|-----------------------|
| CBEFF_HEADER | CBEFF_BIOMETRIC_RECORD | CBEFF_SIGNATURE_BLOCK |
| Section 5 | Sections 3,3.3 and 4 | FIPS 201 |

All PIV biometric data, except that detailed in Section 3.2, shall be stored in CBEFF Structures conforming to Patron Format A [CBEFF, Annex A]. That format specifies which CBEFF fields shall be present by means of a bit mask. The value for that mask for PIV shall be 0x3E70. The mask shall be included in the header. The required fields shall be in the order indicated in Table 11.

Table 11: PIV Compliant Patron Format A Fields

| Patron Format A Field | Length | Patron Format A Requirement | PIV Requirement | Options Mask | PIV Required Value |
|-----------------------------|----------|-----------------------------|-----------------|--------------|--------------------|
| BDB Format Owner | 2 bytes | M | M | | |
| BDB Format Type | 2 bytes | M | M | | |
| Security Options | 1 byte | M | M | | 0x0D |
| Options Fields Present Mask | 2 bytes | O | M | | 0x3E70 |
| Biometric Creation Date | 8 bytes | O | M | 0x0010 | |
| Validity Period | 16 bytes | O | M | 0x0020 | |
| Biometric Type | 3 bytes | O | M | 0x0040 | |
| Patron Header Version | 1 byte | O | M | 0x0200 | |
| Biometric Purpose | 1 byte | O | M | 0x0400 | |
| Biometric Data Type | 1 byte | O | M | 0x0800 | |
| Biometric Data Quality | 1 byte | O | M | 0x1000 | |
| Creator | 4+N | O | M | 0x2000 | |

INFORMATIVE NOTES:

- 0x3E70 is the sum of the elements in column 5.
- 0x0D is the bit pattern 00001101 meaning: options mask is present; data is signed but not encrypted; and integrity protection is present.
- PIV's CBEFF Patron Format based on NISTIR 6529-A Patron Format A is a superset of the fields in Patron Format C (BioAPI BIR).
- Column 4, PIV Requirement, is mandatory by definition.
- The values for the Format Owner and Format Type Code fields are given in the respective data format standards [FACESTD] and [FINGSTD].

6. Biometric Device Requirements

Devices used in the collection of biometric data for PIV shall be Biometric Service Providers (BSP) conformant to the [BIOAPI] and [CBEFF] standards. BioAPI provides modularity to the application developer. Devices shall produce data conformant to the CBEFF Patron Format C specified in [CBEFF, Annex C]. Given the requirement for PIV data to be formatted in the Patron Format A specification, all applications accessing a BSP shall be capable of transforming Patron Format C data into the Patron Format A specification. A transforming application is defined in Section 4.19 of [CBEFF].

7. Bibliography

| Citation Code | Document |
|---------------|---|
| BIOAPI | INCITS 358-2002, American National Standard for Information Technology - The BioAPI Specification. |
| FIPS | FIPS 201, Personal Identity Verification, National Institute of Standards and Technology, 2005. |
| FINGSTD | INCITS 381-2004, American National Standard for Information Technology - Finger Image-Based Data Interchange Format |
| FACESTD | INCITS 385-2004, American National Standard for Information Technology - Face Recognition Format for Data Interchange |
| CBEFF | NISTIR 6529-A - Common Biometric Exchange Formats Framework (CBEFF), NIST Interagency Report, April 2004. |
| | NIST 6529A is expected to be approved as INCITS 398-2005, American National Standard for Information Technology – Common Biometric Exchange Formats Framework (CBEFF) (same content as NISTIR 6529-A). Expected approval date: February 2005. |
| FFSMT | ANSI/NIST-ITL 1-2000 – Data Format for the Interchange of Fingerprint, Facial, & Scar Mark & Tattoo (SMT) Information, ANSI, 2000. |
| EFTS | CJIS-RS-0010 (V7) - Electronic Fingerprint Transmission Specification, Federal Bureau of Investigation, Department of Justice, January 1999. |
| NFACS | IAFIS-DOC-07054-1.0, CJIS, Federal Bureau of Investigation, Department of Justice, April 2004. |
| NFIQ | NISTIR 7151 - Fingerprint Image Quality, NIST Interagency Report, August 2004 |
| ICS | Methods for Testing and Specification (MTS); Implementation Conformance Statement (ICS) proforma style guide. EG 201 058 V1.2.3 (1998-04) |