NIST SP 500-304 Annex D: Test Notes and Exceptions for the ANSI/NIST-ITL 1-2011 Update 2013 Conformance Testing Methodology Framework

[er|(Integrated Errata Edition)|er][1]

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November 2015

[1] [er|This edition integrates all errata discovered since NIST SP 500-304 Annex D was published. Any modifications from the originally published document are marked and contained within the [er||er] markers and highlighted for easy reference.|er]

Reports on Information Technology

The Information Technology Laboratory (ITL) at the National Institute of Standards and Technology (NIST) stimulates U.S. economic growth and industrial competitiveness through technical leadership and collaborative research in critical infrastructure technology, including tests, test methods, reference data, and forward-looking standards, to advance the development and productive use of information technology. To overcome barriers to usability, scalability, interoperability, and security in information systems and networks, ITL programs focus on a broad range of networking, security, and advanced information technologies, as well as the mathematical, statistical, and computational sciences. Special Publication 500-series reports on ITL's research in tests and test methods for information technology, and its collaborative activities with industry, government and academic organizations.

Foreword

The existence of biometric standards alone is not enough to demonstrate that products meet the technical requirements specified in the standards. Conformance testing captures the technical description of a specification and measures whether an implementation faithfully implements the specification. Conformance testing provides developers, users, and purchasers with increased levels of confidence in product quality and increases the probability of successful interoperability. Lack of conformance to the required standard(s) can, in many cases, jeopardize the expected biometric recognition performance or prevent access to the data (as well as impact the overall operational performance) since implementers may handle non-conformant records in different ways during processing.

Although no conformance test can be comprehensive enough to test all the different combinations of mandatory requirements of a standard and all possible combinations of conditional and optional characteristics that could be included in American National Standards Institute (ANSI)/NIST-ITL 2011 Update: 2013 (AN-2013) transactions, a well-designed conformance test tool that faithfully implements a standard conformance testing methodology could raise the level of confidence on the test results. Therefore, transactions tested with such a tool (and reported to be conformant to the standard), are more likely to conform to the standard.

The Computer Security Division (CSD) of NIST/ITL supports the development of biometric conformance testing methodology standards and other conformity assessment efforts through active technical participation in the development of biometric standards and associated conformance test architectures and test suites and develops these test tools to support users who require conformance to selected biometric standards and product developers interested in conforming to biometric standards by using the same testing tools available to users. Testing laboratories can also benefit from the use of these test tools. Under the conformance test software called "BioCTS", NIST/ITL CSD develops Conformance Test Architectures (CTAs) and Conformance Test Suites (CTSs) to test implementations of national and international biometric data interchange formats. These testing tools and related documentation can be found and downloaded at: http://www.nist.gov/itl/csd/biometrics/biocta_download.cfm.

Table of Contents

Tables

Annex D: Test Notes and Test Exceptions

[er|Errata
This edition integrates all errata discovered since NIST SP 500-304 Annex D was published. Any modifications from the originally published document are marked and contained within the [er||er] markers and highlighted for easy reference. |er]

D.1 Test Notes

The following test notes provide clarification of the assertion text provided in the Test Assertion column. The test notes describe:

- **Clarifications**: Additional information to help clarify complex assertions. Examples include image metadata and IDC comparisons, which depend upon the Record Type and are not easily defined using the Assertion Syntax.
- **Discrepancies**: Approach used when the base standard contains possible discrepancies or lacks clarity so that the requirement cannot be clearly understood from the provided information. For example, two separate sections of the standard list a Field as Optional and Mandatory respectively. In such a case, the approach used by the CTMF will provide justification for deciding which section is correct.
- **Exceptions**: Any AN-2013 requirements that are not addressed by the CTMF. These are considered exceptions because they are requirements in the base standard, but they are not yet addressed by the CTMF. See also: Test Exceptions.

t1. Exception-Character Sets. Requirements related to Character Sets other than 7-bit ASCII or binary are not addressed (for the Traditional encoding). See also: Test Exceptions.

t2. Clarification-IDC Comparisons. From 7.3.1: "Two or more records may share a single IDC solely to identify and link together records that pertain to different representations of the same biometric trait… two or more image records may share a single IDC only when they are enhancements of a single image; such transformations shall have identical dimensions, and shall not be distorted with respect to each other". For records with matching IDC's, refer to the tables below to determine the conformance status based upon the biometric sample types being compared. For matching IDC's that belong to record types not listed below, the result is a warning. Table D.1 is used to determine the biometric type of the record and the location of the Comparison ID used to compare two or more record types that are allowed to have matching IDC values. After determining the biometric type and comparison ID (if applicable) from Table D.1, Table D.3 is used to determine the conformance status (note: Table D.2 should be referenced instead of Table D.3 for special record types, indicated in Table D.1 with an asterisk *). For example, for two records with matching IDC values, if the first record is of type Finger and the second record is of type Finger, then according to Table D.3, the comparison ID's will need to be compared to determine the conformance result. In another example, if the two records are of a special type (indicated by an asterisk) such as Type 7, then the information in Table D.2 is used instead of Table D.3.

Table D.1 - IDC ID Location Comparison

IDC: ID Location Comparison		
Record Type	**Biometric**	**Field For Comparison ID**
4	FINGER	{Byte:1 in 4.004}
7*	USER-DEFINED*	NA
8	SIGNATURE	NA
9	MINUTIAE	NA
10	{10.003} <SCAR, MARK, TATTOO, or FACE>	IF {10.003} MO [ASCII(SCAR,MARK, TATTOO)] THEN {InfoItem:1 in 10.040}
11	VOICE	NA
12	DENTAL	NA
13	FRICTIONRIDGE	{InfoItem:1 in SubField:1 in 13.013}
14	FINGER	{InfoItem:1 in SubField:1 in 14.013}
15	PALM	{15.013}
16*	USER-DEFINED-OTHER*	NA
17	IRIS	{17.003}
18	DNA	NA
19	PLANTAR	{19.013}
20*	SOURCE*	NA
2, 21-99*	NOTBIOMETRIC*	NA

*For these types, see Table D.2

Table D.2 - IDC Comparison Results: Special Cases

IDC: Special Case Comparison Results				
First Record	**Second Record**	**Comparison IDs**	**Notes**	**Result**
ANY	NOTBIOMETRIC	NA	ANY represents any type-IDC values can only be the same for biometric traits	Error
ANY	SOURCE	NA	Validity depends on contents of the Type-20 Record	Warning
ANY	USER-DEFINED	NA	ANY represents any type. Validity depends on contents of Type-7 Record.	Warning
ANY (Except USER-DEFINED-OTHER)	USER-DEFINED-OTHER	NA	ANY represents any type. User-defined-other must be a type not already defined by the standard, so the traits are always from a different sample type.	Error
NOTBIOMETRIC	ANY	NA	ANY represents any type-IDC values can only be the same for biometric traits	Error
SOURCE	ANY	NA	Validity depends on contents of the Type-20 Record	Warning
USER-DEFINED	ANY	NA	ANY represents any type. Validity depends on contents of Type-7 Record.	Warning
USER-DEFINED-OTHER	USER-DEFINED-OTHER	NA	Validity depends on contents of the Type-16 Record.	Warning

USER-DEFINED-OTHER	ANY (Except USER-DEFINED-OTHER)	NA	ANY represents any type. User-defined-other must be a type not already defined by the standard, so the traits are always from a different sample type.	Error

Table D.3 - IDC Comparison Results

IDC: Comparison Results				
First Record	**Second Record**	**Comparison IDs**	**Notes**	**Result**
DENTAL	DENTAL	NA		Ok
DENTAL	NEQ DENTAL	NA		Error
DNA	DNA	NA		Ok
DNA	NEQ DNA	NA		Error
FINGER	FINGER	Same		Ok
FINGER	FINGER	Different		Error
FINGER	MINUTIAE	NA		Ok
FINGER	FRICTIONRIDGE	Same		Ok
FINGER	FRICTIONRIDGE	Different		Error
FINGER	PALM	All EQ 33 OR All EQ 36	33 and 36 are hypothenar codes (palm) but are part of the extended fingerprint set	Ok
FINGER	PALM	Any NEQ 33 OR Any NEQ 36	33 and 36 are hypothenar codes (palm) but are part	Error

			of the extended fingerprint set	
FINGER	NOT MO[FINGER, MINUTIAE, FRICTIONRIDGE, PALM]	NA		Error
FACE	FACE	NA		Ok
FACE	NEQ FACE	NA		Error
FRICTIONRIDGE	FRICTIONRIDGE, FINGER, PALM, or PLANTAR	Same		Ok
FRICTIONRIDGE	FRICTIONRIDGE, FINGER, PALM, or PLANTAR	Different		Error
FRICTIONRIDGE	MINUTIAE	NA		Ok
FRICTIONRIDGE	NOT MO[FRICTIONRIDGE, FINGER, PALM, PLANTAR, MINUTIAE]	NA		Error
IRIS	IRIS	Same		Ok
IRIS	IRIS	Different		Error
IRIS	NEQ IRIS	NA		Error
SCAR	SCAR	Same		Ok
SCAR	SCAR	Different		Warning
SCAR	MARK or TATTOO	Same or Different		Warning
SCAR	NOT MO[SCAR, MARK, TATTOO]	NA		Error
MARK	MARK	Same		Ok
MARK	MARK	Different		Warning
MARK	SCAR or TATTOO	Same or Different		Warning
MARK	NOT MO[SCAR, MARK, TATTOO]	NA		Error
MINUTIAE	MINUTIAE	NA		Ok
MINUTIAE	FINGER, PALM, PLANTAR, or FRICTIONRIDGE	NA		Ok

MINUTIAE	NOT MO[MINUTIAE, FINGER, FRICTIONRIDGE, PALM, PLANTAR]	NA		Error
SIGNATURE	SIGNATURE	NA		Ok
SIGNATURE	NEQ SIGNATURE	NA		Error
TATTOO	TATTOO	Same		Ok
TATTOO	TATTOO	Different		Warning
TATTOO	SCAR or MARK	Same or Different		Warning
TATTOO	NOT MO[SCAR, MARK, TATTOO]	NA		Error
PALM	PALM	Same		Ok
PALM	PALM	Different		Error
PALM	FRICTIONRIDGE	Same		Ok
PALM	FRICTIONRIDGE	Different		Error
PALM	MINUTIAE	NA		Ok
PALM	FINGER	Same AND Both EQ 33 OR 36	33 and 36 are hypothenar codes (palm) but are part of the extended fingerprint set	Ok
PALM	FINGER	Different OR Both NEQ 33 OR 36	33 and 36 are hypothenar codes (palm) but are part of the extended fingerprint set	Error
PALM	NOT MO[PALM, MINUTIAE, FRICTIONRIDGE, FINGER]	NA		Error
PLANTAR	PLANTAR	Same		Ok
PLANTAR	PLANTAR	Different		Error
PLANTAR	FRICTIONRIDGE	Same		Ok
PLANTAR	FRICTIONRIDGE	Different		Error
PLANTAR	MINUTIAE	NA		Ok

PLANTAR	NOT MO [PLANTAR, FRICTION RIDGE, MINUTIAE]	NA		Error
VOICE	VOICE	NA		Ok
VOICE	NEQ VOICE	NA		Error

t3. Discrepancy-Time and Date. This test note describes how the CTMF addresses the various date and time format requirements and indicates the approach taken for several discrepancies found throughout the standard. See table below. Year zero (0000) is invalid for all date and time types. Month/Day combinations must be valid based upon the valid calendar combinations (e.g. February 31) is invalid. Note that Section 7.7.2.1 provides general requirements for date and time values, including the following allowed values: month/MM (01 through 12); day/DD (01 through 31); hour/hh (00 through 23); minute/mm (0 through 59); and second/ss (0 through 59).

Table D.5 – Date and Time Formats

Date and Time Formats				
Date Format Title	**References**	**Standard Definition**	**Discrepancies**	**CTMF Implementation**
Local Date (Trad)	7.7.2.3, Annex B	YYYYMMDD YYYY designates the four-digit year; MM designates the month (01 through 12); DD represents the day of the month (01 through 31)	Some instances of Local Date in the standard indicate that zero values are allowed for the month and day when they are not known. This conflicts with the standard definition, which specifies that 01 is the minimum value.	Same as Standard Definition. Referred to in Assertion Syntax as: ValidLocalDate. Instances of local dates that allow zero values are treated as special cases and considered to be a "Local Date Estimate" (see definition in this table).
Local Date (XML)	7.7.2.3, Annex C	Common dates (other than GMT) shall be represented in the form YYYY-MM-DD (contained in<nc:Date>) , YYYY-MM (contained in <nc:YearMonth>), or YYYY (contained in <nc:Year>). YYYY designates the four-digit year; MM designates the month (01 through 12);	Some instances of Local Date in the standard indicate that zero values are allowed for the month and day when they are not known. This conflicts with the standard definition,	Same as Standard Definition. Referred to in Assertion Syntax as: NIEM-ValidLocalDate, NIEM-ValidLocalYearMonth, or NIEM-ValidLocalYear. Instances of local dates that allow zero values are treated as special cases and considered to be a "Local Date Estimate" (see definition in this table).

		DD represents the day of the month (01 through 31)	which specifies that 01 is the minimum value.	Note: The Schema also allows the <nc:DateTime> element, which is not valid. The CTMF allows only the <nc:Date>, <nc:YearMonth>, and< nc:Year elements>.
Local Date & Time (Trad)	7.7.2.4	None / Missing. Section 7.7.2.4 indicates that the format is different for each encoding, but Annex B does not provide a definition.	Undefined in standard.	YYYYMMDDhhmmss Referred to in standard as ValidLocalDateTime YYYY designates the four-digit year; MM designates the month (01 through 12); DD represents the day of the month (01 through 31); hh represents the hour (00 through 23); mm represents the minute (00 through 59); and ss represents the seconds (00 through 59). This is modeled after the UTC/GMT definition, but does not indicate the time zone (Z).
Local Date & Time (XML)	7.7.2.4	None / Missing. Section 7.7.2.4 indicates that the format is different for each encoding, but Annex C does not provide a definition.	Undefined in standard.	YYYY-MM-DDThh:mm:ss Referred to in standard as NIEM-ValidLocalDateTime YYYY designates the four-digit year; MM designates the month (01 through 12); DD represents the day of the month (01 through 31); hh represents the hour (00 through 23); mm represents the minute (00 through 59); and ss represents the seconds (00 through 59). T is a constant indicating time. This is modeled after the UTC/GMT definition, but does not indicate the time zone (Z). Must be contained in <nc:DateTime>
Local Date Estimate (Trad)	8.10.5, 8.20.5	This type is not formally defined in the standard, but is mentioned in the description text for certain fields (namely 10.005 and 20.005): "It may not be possible to know the exact date of imagery capture. In such a case, specify the date to the level known and fill the rest of the date with zeros."	This does not match the definition of Local Date in 7.7.2.3 because non-zero values are not allowed.	Same as ValidLocalDate, but allows zeros for unknown values. Referred to in CTMF as ValidLocalDateEstimate. These instances include, but may not be limited to: 10.005-PHD and 20.005-ACD

Local Date Estimate (XML)	8.10.5, 8.20.5	This type is not formally defined in the standard, but is mentioned in the description text for certain fields (namely 10.005 and 20.005): "It may not be possible to know the exact date of imagery capture. In such a case, specify the date to the level known and fill the rest of the date with zeros."	This does not match the definition of Local Date in 7.7.2.3 because non-zero values are not allowed.	Same as NIEM-ValidLocalDate, NIEM-ValidLocalYearMonth, or NIEM-ValidLocalYear, but allows zeros for unknown values. Referred to in CTMF as NIEM-ValidLocalDateEstimte, NIEM-ValidLocalYearMonthEstimate, NIEM-ValidLocalYearEstimate. These instances include, but may not be limited to: 10.005-PHD and 20.005-ACD
GMT/UTC (Trad)	7.7.2.2, Annex B	YYYYMMDDHHMMSSZ, a 15-character string that is the concatenation of the date with the time and concludes with the character "Z". The YYYY characters shall represent the year of the transaction. 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 of the month. The HH characters represent the hour; the MM the minute; and the SS represents the second.	None.	Same as Standard Definition. Referred to in CTMF as ValidUTC/GMT.
GMT/UTC (XML)	7.7.2.2, Annex C	YYYY-MM-DDThh:mm:ssZ T and Z are constants. Contained in <nc:DateTime>	None.	Same as Standard Definition. Referred to in CTMF as NIEM-ValidUTC/GMT.
Date Range Estimate (Trad)	8.10, 8.12, 8.20	This type is not formally defined in the standard, but is mentioned in the description text for certain fields. "time measure indicator followed by 1 or 2 digits. May be concatenated, with larger time units first. Units: Y year, M month, D day"	Discrepancy between the standard text and the character min and max restrictions in the record layout tables. The text states that single-digit year, month, and day values may be used, but the tables indicate a minimum length of 3, which indicates only two-digit values are allowed. This CTMF	Same as Standard Definition. Referred to in CTMF as DateRangeEstimate

			assumes a minimum character count of 2	
Date Range Estimate (XML)	8.10, 8.12, 8.20	This type is not formally defined in the standard, but is mentioned in the description text for certain fields. Defined by XML Schema type xsd:duration.	None.	Same as Standard Definition. Referred to in CTMF as NIEM-DateRangeEstimate Must validate against XML Schema type xsd:duration.
Date Time Offset (Trad)	8.10, 8.12, 8.20	This type is not formally defined in the standard, but is mentioned in the description text for certain fields. "time measure indicator followed by 1 or 2 digits. May be concatenated, with larger time units first. Units: Y year, M month, D day, h hour, m minute"	Discrepancy between the standard text and the character min and max restrictions in the record layout tables. The text states that single-digit year, month, and day values may be used, but the tables indicate a minimum length of 3, which indicates only two-digit values are allowed. This CTMF assumes a minimum character count of 2	Same as Standard Definition. Referred to in CTMF as DateTimeRangeEstimate
Date Time Offset (XML)	8.10, 8.12, 8.20	This type is not formally defined in the standard, but is mentioned in the description text for certain fields. Defined by XML Schema type xsd:duration.	None.	Same as Standard Definition. Referred to in CTMF as NIEM-DateTimeRangeEstimate Must validate against XML Schema type xsd:duration.
Time Index (Trad)	7.7.2.5	hh:mm:ss.sss where ss.sss refers to the seconds and milliseconds. Thus, the allowed special characters are the colon and the period	None.	Same as Standard Definition. Referred to in CTMF as TimeIndex
Time Index (XML)	7.7.2.5	hh:mm:ss.sss where ss.sss refers to the seconds and milliseconds. Thus, the allowed special characters are the colon and the period	None.	Same as Standard Definition. Referred to in CTMF as NIEM-TimeIndex

t4. Clarification-Image Tests. All assertions associated with compressed image types refer to the image metadata and not the image data itself. See the test assertion syntax in the CTMF for the defined Image Metadata Tags.

t5. Clarification-Rounding. Some image formats (such as PNG) use scale units other than pixels per inch (ppi) or pixels per centimeter (ppc), which are the measurements used in the requirements of the base standards. For those image formats, the use of a conversion factor is necessary to convert the pixel scale to the correct units (either ppi or ppc). This conversion may result in a decimal value that cannot be held in the THPS or TVPS fields, which hold Integer values only. In all such cases, section 7.7.8.4 of AN-2013 specifies that the result should be rounded up for values greater than or equal to X.5 and rounded down for values less than X.5.

t6. [er| This test note no longer applies. It previously addressed missing ASEG assertions, but they have been added.|er]

t7. Clarification-WSQ version. WSQ specification version 2.0 or higher is required, but there is no known method for determining the specification version of a WSQ image. Therefore, this is a level 3 requirement. The Ev field specifies the encoder version, but there is no requirement for WSQ specification versions to contain certain encoder versions (other than 3.1 containing an Ev of 2).

t8. Clarification-NCIC Codes. The NCIC codes (NCIC_Codes) are available at http://oregon.gov/OSP/CJIS/NCIC.shtml. Any values found in Annex E of NIST SP 500-271 are also valid.

t9. Clarification-Sequential. The term "sequentially assigned" has several interpretations. This testing methodology uses the following interpretation: order within the Transaction is not important; however, when rearranged and viewed in numeric order, the values must be sequential and incremented by 1.

t10. Clarification-XML Schema. The structural formatting of XML elements is best described using the XML Schema. Therefore, most structural NIEM requirements are tested using XML Schema Validation. This includes presence, cardinality, and ordering of elements and their child elements within the transaction. If discrepancies or errors are discovered in the XML Schema, a modified version will be developed and released to assist in conformance testing for XML structural requirements. Any exceptions to this approach will be documented as a separate assertion in the CTMF and associated CTM documents.

t11. Clarification-Image Requirements. This test note gathers the information found in various sections of AN-2013 regarding the valid constraints for resolution and compression algorithm values for the various image-type records, in an attempt to clarify the requirements. References are provided below the tables indicating the sections of the standard that were referenced to derive the information. Text shown in red indicates interpretations for values not specified in AN-2013. An explanation of these interpretations is provided below each table. For Type-10, the Character Type allowed should be Alphabetic, not Alphanumeric, because WSQ20 is not allowed. See Valid Image Resolution and Compression Values.

t12. Exception-Paths. For fields specifying paths (circles, ellipses, or open or closed paths) defined in Section 7.7.12 of AN-2013, there may be requirements regarding the structure of the vertices or points that are not addressed by the CTMF. See also: Test Exceptions.

t13. Discrepancy-Type-10 Oral Data. This test note addresses discrepancies in Sections 8.10.44 and B.2.6, and indicates the approach used by this version of the CTMF to address these issues. Field 10.048 has varying definitions among section B.2.6, Table 58, Section 8.10.44, and the XML Schema. The value of 10.048-PARC depends upon the text of *ANSI/ADA Standard No. 1077 – Dental Biometric Descriptors*, which was in the process of being published when the CTMF was published. Therefore, Character Type and Value Constraint assertions are not defined and Occurrence Max# is 1 for 10.048-PARC in the CTMF. Also, 10.048-PADT is treated as D↑ in this version of the CTMF based upon the description that it "shall appear in a subfield if PARC is not present in the subfield". The XML encoding is treated such that biom:PatternedInjuryDetail may repeat and contain optional PARC and PADT elements to match Traditional encoding.

t14. Discrepancy explanations. This test note indicates that there is a discrepancy among two or more sections of the standard text. In these cases, an assumption must be made regarding how the requirement should be implemented. These discrepancies and the assumptions made in this CTFM are listed below.

Table D.4 – Standard Discrepancies and CTFM Assumptions

Standard Discrepancies and CTFM Assumptions			
Standard Reference(s)	**Description**	**CTFM Assumption**	**Justification**
8.9.7.31	The TPD value description in 8.9.7.31 does not allow 85 or 86 even though WC indicates wrist or bracelet. Also, the statement is unclear as written because there is an overlap in the FPP values allowed: 21, 23, 26, and 28.	1.) The palm codes should include 85 and 86 2.) If ALL FGP values contain EXCLUSIVE palm codes (not the overlap) then TPD is limited to RLC, PTC, DTC, WC or PDC. And if ALL FGP values contain EXCLUSIVE finger codes (not the overlap) then TPD is limited to DIP, PIP or PDC. Otherwise, any Table46 value is valid.	WC indicates wrist or wrist bracelet, so values 85 and 86 should be allowed. There are multiple FGP instances allowed, so in order to restrict the TPD value, all of the FGP instances must indicate the same type of code (palm or finger). Otherwise, the TPD could be referring to any type and therefore any code should be allowed.
8.10.45, Table 58	There are several issues with the Char Count and Occurrence values indicated in Table 58 for information items in Field 10.049. These issues are related to information items which make use of "lists of values" using the '|' character to separate values.	I.) For 10.049-ULCL and 10.049-LLCL: Min/Max Characters are 1 to 2 (XML) and 1 to 19 (Traditional). Max# Occurrences is 5 (XML) and 1 (Traditional). II.) For 10.049-LPPL: Min/Max Characters are 1 to 2 (XML) and 1 to 38 (Traditional)	Because XML does not use the list of values format, the Character Min# and Max# and Occurrences are different for the two encodings.

		Max# Occurrences is 3 (XML) and 1 (Traditional) III.) For 10.049-LPPL: Min/Max Characters are 1 (XML) and 1 to 5 (Traditional) Max# Occurrences is 3 (XML) and 1 (Traditional)	
8.10.45	The description for 10.049-LPCT states that LPCT is "mandatory if LPCL contains the value O"; however, LPCL is not defined in the standard	LPCT is mandatory if either ULCL or LLCL contain O	LPCL seems to have been split into two fields (ULCL and LLCL) but the reference to LPCL was not removed.
8.10.45	Many of the information items in Field 10.049 should be dependent based upon their descriptions in Section 8.10.45, but they are listed as optional.	The following information items Cond Code are treated as Dependent rather than optional: 10.049-LPCT, 10.049-LPPT, 10.049-LPST, 10.049-LPMT	The description text in Section 8.10.45 indicates these values should be Dependent.
8.10.46	In Field 10.050, "visual image comparison descriptive text" is sometimes referred to as VICD and sometimes VICT.	"visual image comparison descriptive text" in 10.050 is 10.050-VICD.	VICD was chosen over VICT because it was used more frequently.
8.10.46, Table 58	The description for Field 10.050 states that "This field shall only be used if Field 10.003: Image type / IMT has a value of EXTRAORAL or INTRAORAL." This indicates Dependent, but the field is listed as Optional in Table 58.	10.050 is Dependent	The description text in Section 8.10.46 indicates that the field should be Dependent.
8.10.46, Table 58	Two information items in Field 10.050 should be optional based upon their descriptions in	10.050-VIDT and 10.050-VICD are Optional.	The description text in Section 8.10.46 does not indicate that there are any

	Section 8.10.46, but they are listed as dependent in Table 58.		dependencies for 10.050-VIDT or 10.050-VICD to be present.
8.10.47, Table 58	All information items in Field 10.051 should be optional based upon their descriptions in Section 8.10.47, but they are listed as dependent in Table 58.	10.051-RSU, 10.051-RSM, and 10.051-RSO are Optional.	The description text in Section 8.10.47 does not indicate that there are any dependencies for 10.051-VRSU, 10.051-RSM, and 10.051-RSO to be present.
Table 90	The lower bounds for Field 13.015-RHC and 13.015-BVC should be "greater than", not "greater than equal to". Type-13 is the only record type that contains the "greater than equal to" lower-bounds restriction for THC and BVC; all other records contain "greater than".	The constraint for 13.015-RHC is: LHC < RHC <= HLL. The constraint for 13.015-BVC is: TVC < BVC <= VLL	Type-13 is the only record type that contains the "greater than equal to" lower-bounds restriction for THC and BVC; all other records contain "greater than". This appears to be a typo.
Table 92	Field 14.021-LHC should use less than (<) for the upper bound, not less than equal to (=<).	0 <= LHC < HLL	This is based upon note #215 and is consistent with other record types.
[er] Table 92	Fields 14.023 and 14.024 Subfields should have an Occurrence Max# of 9 according to Section 7.7.7 (and not 5 as shown in the table).	9 Subfields is the correct upper limit, not 5.	Section 7.7.7, which is text-based, takes precedence over the conflicting table data in Table 92 regarding the number of Subfields allowed for Fields 14.023 an 14.024 |er]
Table 100	xx.992-T2C is a common Optional field. For 18.992 the text states the field is optional, but the record layout tables list them as mandatory.	18.992 is Optional	All other xx.992-T2C fields are optional in all other cases; therefore, it seems that the record layout table for Types 18 is incorrect.
8.22.5, Table 111, Annex G, XML Schema	Table 111 and Annex G both indicate that Field 22.006 is Mandatory. However, Section 8.22.5 reads "This optional field may be used … if this record contains an image of a human body."	Field 22.006 is Optional.	Field 22.006 is optional because Type-22 is not required to contain a body-type image.
Table 113	98.900-IID has a minimum character count of 15 in Table 113, but section 8.23.8 shows examples with shorter character counts. 98.900-IID has a maximum character count of 30 in Table 113, but some fields allow unlimited subfields, which could increase the value of 98.900-IID beyond	For 98.900-IID: Character Min#: 12 Character Max#: * (unlimited)	Some examples of valid values found in 8.23.8 are shorter than the specified minimum, for example: 3,9.373,4,NA (which has 12). Also, some fields allow unlimited subfields, so the max should be extended beyond 30. Since it is unknown

	30 characters (for example 9.373 allows unlimited subfields).		how many characters will be needed, the max is unlimited.

t15. Clarification-Field 20.016-NOP: 20.106-NOP is the only NOP instance in the standard that is optional. Because the number of HPO and VPO information items pairs is dependent upon NOP, it is unclear how many pairs are allowed when NOP is missing. This CTMF assumes that if NOP is missing (meaning that no data is present for NOP, but its information item separator is still present), then no instances of HPO or VPO, nor their information item separators shall be present.

t16. Clarification-Field 9.380: Several values in Field 9.380 are specified as having to be less than HLL or VLL. Values in 9.380 are expressed in 10 µm units, but HLL and VLL are specified in pixels, so the values are not comparable. The conversion is as follows, where X is the value specified in 10 µm units: X*500/2540 < HLL (or VLL). This conversion was created using the 500ppi requirement (see 8.9.7.0.1: "In all cases for the EFS…distances are stated in terms…of pixels at 500 pixels per inch") and the number of times 10 µm will divide into an inch (2540).

t17. Clarification-Field 11.033-COM: The standard lists the Character Min# for 11.033-COM as 0. However, by definition, if an information item is present, it must have data. The CTMF assumes the minimum Character Min# is therefore 1. Note, however, that this does not affect the ability of the user to omit 11.033-COM. This is a clarification that information items without data are considered to be not present.

t18. [er| **Clarification-Field xx.902-PRO:** Section 7.4.1 (note 20) states that the upper bound of 255 has been removed, even though not all of the record layout tables reflect this change (namely Type-12, Type-13, Type-14, Type-15, Type-16, Type-17, Type-18, Type-19, Type-20, and Type-21). |er]

D.1.1 Valid Image Resolution and Compression Algorithm Value Tables

In the tables below, "Valid" indicates the value is valid, "X" indicates the value is invalid, and "Legacy" indicates that the value is valid only for legacy systems.

Type-4 Images

Type-4 images may only be used at the 500ppi transmitting resolution class, and only WSQ20 may be used for compression. JPEGB and JPEGL are allowed as legacy values. Type-4 is subject to tolerance for resolution values.

Figure D.5: Type-4 Image Constraints

		Compression Algorithm						
		NONE (0)	WSQ20 (1)	JPEGB (2)	JPEGL (3)	JP2 (4)	JP2L (5)	PNG (6)
Transmitting Resolution	500 ppi	Valid	Valid	Legacy	Legacy	X	X	X
	Unspecified	Valid	Valid	Legacy	Legacy	X	X	X

Figure D.6: Type-4 Resolution Constraints

Resolution	Min	Max	Tolerance
Transmitting	500 ppi	500 ppi	2%
Scanning	500 ppi	Unbounded*	2%

***Must be transmitted at 500ppi.**

References:

- Only CGA values of NONE and WSQ20 (0 and 1) are valid for 500ppi as stated in 7.7.9.1.
- CGA values JPEGB and JPEGL are legacy for 500 ppi only as stated in 7.7.9.1.

- The same CGA constraints apply to unspecified resolutions because section 7.7.6 states that Record Type-4 shall not be used for anything but the 500 ppi class.
- Exemplar friction ridge images have a minimum scanning resolution of 500 ppi as stated in 7.7.6.2.1
- The transmitting resolution may only be 500 ppi as stated in 8.1.12.

Interpretations:

- The tolerance for fingerprint types is either 1% or 2% as specified in 7.7.6.1. This is dependent upon the FAP value, which is not available in Type-4 records. Therefore, 2% tolerance is assumed because it is the least restrictive.

Type-10 Images

Type-10 compression algorithm constraints are different for face and non-face types, and are independent of the resolution value. Specific resolution values constraints are not defined for Type-10 records.

Figure D.7: Type-10 Image Constraints

			Compression Algorithm						
			NONE	WSQ20	JPEGB	JPEGL	JP2	JP2L	PNG
Any Transmitting Resolution	SAP Value (Face Only)	< 30	Valid	X	Valid	Valid	Valid	Valid	Valid
		30 or 32	Valid	X	Valid	Valid	X	X	X
		>= 40	Valid	X	X	X	Valid	Valid	X
		Unspecified	Valid	X	Valid	Valid	Valid	Valid	Valid
	Non Face Type		Valid	X	Valid	Valid	Valid	Valid	Valid

Figure D.8: Type-10 Resolution Constraints

Resolution	Min	Max	Tolerance
Transmittin	Non-zero	Unbounded	None
Scanning	Non-zero	Unbounded	None

References:

- Only CGA of JPEGB or JPEGL are valid for FACE types with SAP of 30 or 32 as specified in E.6.1.
- Only CGA of JP2 or JP2L are valid for FACE types with SAP of 40 or greater as specified in E.6.1.
- The only invalid CGA value for non-FACE types is WSQ20 as specified in 7.7.9.4.

Interpretations:

- CGA value NONE is valid for all image types.
- Since no statement is made concerning SAP values < 30, it is assumed that any CGA values (except the fingerprint format WSQ20) are valid.
- Since no statement is made concerning unspecified SAP values, it is assumed that any CGA values (except the fingerprint format WSQ20) are valid.
- Since no resolution restrictions are made, it is assumed that a non-zero value must be present.

Type-13 Images

Type-13 compression algorithm constraints depend upon the transmitting resolution. The minimum scanning resolution is 1000ppi and the minimum transmitting resolution is 500ppi.

Figure D.9: Type-13 Image Constraints

		Compression Algorithm						
		NONE	WSQ20	JPEGB	JPEGL	JP2	JP2L	PNG
Transmitting Resolution	500 ppi	Valid	X	X	Legacy	X	Valid	Valid
	1000 ppi	Valid	X	X	X	X	Valid	X
	>= 2000 ppi	Valid	X	X	X	X	Valid	X
	Unspecified	Valid	X	X	Legacy*	X	Valid	Valid*
*Note that these cases apply only for 500 ppi resolution.								

Figure D.10: Type-13 Resolution Constraints

Resolution	Min	Max	Tolerance
Transmitting†	500 ppi	Scanning Resolution	None
Scanning	1000 ppi	Unbounded	None

†Increments by 100%

References:

- CGA of WSQ20, JPEGB, and JP2 are invalid for all resolutions, because they are excluded from Table 90 “Value Constraints” for 13.011-CGA.
- Only CGA values NONE, JP2L, and PNG are valid for 500 ppi as stated in 7.7.9.1.
- CGA value JPEGL is legacy for 500 ppi only as stated in 7.7.9.1.
- Only CGA of JP2L is valid for 1000 ppi (if compressed) as stated in 7.7.9.1.
- Latent images shall have a minimum scanning resolution of 1000 ppi as stated in 7.7.6.2.2.
- The transmitting resolution has a minimum of 500 ppi and must not be greater than the scanning resolution (see 7.7.6.3.2).
- According to section 7.7.6.2.3, the transmitting resolution value for all friction ridge types (Types 4, 13, 14, 15, 19, and sometimes 16 and 20) must be a member of the resolution migration path that starts at 500ppi and increments by 100%: (i.e.: 500ppi, 1000ppi, 2000ppi, 4000ppi…). The scanning resolution does not necessarily follow the resolution migration path, but it must be scaled down or interpolated to achieve the proper value for transmission.

Interpretations:

- CGA value NONE is valid for all resolutions.
- Since no statement is made regarding resolutions greater than 1000 ppi, it is assumed that the recommendations for 1000 ppi should apply for higher resolutions.
- Since no statement is made regarding unspecified resolutions (when THPS/TVPS are aspect ratio for example), it is assumed that the values indicated in Table 90 are valid. JPEGL is treated as legacy. PNG is treated as a 500 ppi class image.
- It is assumed that tolerance does not apply to Type-13. Section 7.7.6.1 indicates that fingerprint types are subject to a 1% or 2% tolerance, but Type-13 is not necessarily a fingerprint.

Type-14 Images

Type-14 compression algorithm constraints depend upon the transmitting resolution. The minimum scanning and transmitting resolution is 500ppi. Type-14 is subject to a tolerance for the resolution values that depends on the FAP value.

Figure D.11: Type-14 Image Constraints

		Compression Algorithm						
		NONE	WSQ20	JPEGB	JPEGL	JP2	JP2L	PNG
Transmitting Resolution	500 ppi	Valid	Valid	Legacy	Legacy	X	X	X
	1000 ppi	Valid	X	X	X	Valid	Valid	X
	>= 2000 ppi	Valid	X	X	X	Valid	Valid	X
	Unspecified	Valid	Valid	Legacy*	Legacy*	Valid	Valid	Valid
*Note that these cases apply only for 500 ppi resolution.								

Figure D.12: Type-14 Resolution Constraints

Resolution	Min	Max	Tolerance	
Transmitting†	500 ppi	Scanning Resolution	**FAP**	**Tolerance**
			10,20,30,40	2%
			45, 50, 60	1%
			Unspecified	2%
Scanning	500 ppi	Unbounded	**FAP**	**Tolerance**
			10,20,30,40	2%
			45, 50, 60	1%
			Unspecified	2%

†Increments by 100%

References:

- Only WSQ20 is valid for 500 ppi as stated in 7.7.9.1.
- CGA values JPEGB and JPEGL are legacy for 500 ppi only as stated in 7.7.9.1.
- Only CGA values of JP2 and JP2L are valid for 1000 ppi (if compressed) as stated in 7.7.9.1.
- Exemplar friction ridge images have a minimum scanning resolution of 500 ppi as stated in 7.7.6.2.1
- The transmitting resolution has a minimum of 500 ppi and must not be greater than the scanning resolution (see 7.7.6.3.2).
- According to section 7.7.6.2.3, the transmitting resolution value for all friction ridge types (Types 4, 13, 14, 15, 19, and sometimes 16 and 20) must be a member of the resolution migration path that starts at 500ppi and increments by 100%: (i.e.: 500ppi, 1000ppi, 2000ppi, 4000ppi…). The scanning resolution does not necessarily follow the resolution migration path, but it must be scaled down or interpolated to achieve the proper value for transmission.

Interpretations:

- CGA value NONE is valid for all resolutions.
- Since no statement is made regarding resolutions greater than 1000 ppi, it is assumed that the recommendations for 1000 ppi should apply for higher resolutions.
- Since no statement is made regarding unspecified resolutions (when THPS/TVPS are aspect ratio for example), it is assumed that any compression algorithm value is valid. JPEGB and JPEGL are treated as legacy.
- The tolerance for fingerprint types is either 1% or 2% as specified in 7.7.6.1. This is dependent upon the FAP value, which may not be defined (it is optional). Therefore, 2% tolerance is assumed when FAP is undefined because it is the least restrictive.

Type 15, 16, 19, and 20 Images

Note: Types 16 and 20 are only subject to the terms defined in this section if they contain friction ridge data. Friction ridge types 15 and 19 (and sometimes 16 and 20) have compression algorithm constraints that depend upon the transmitting resolution. The minimum scanning and transmitting resolution is 500ppi. These types are not subject to a tolerance for the resolution values.

Figure D.13: Types 15, 16, 19, and 20 Image Constraints

		Compression Algorithm						
		NONE	WSQ20	JPEGB	JPEGL	JP2	JP2L	PNG
Transmitting Resolution	500 ppi	Valid	Valid	Legacy	Legacy	X	X	X
	1000 ppi	Valid	X	X	X	Valid	Valid	X
	>= 2000 ppi	Valid	X	X	X	Valid	Valid	X
	Unspecified	Valid	Valid	Legacy*	Legacy*	Valid	Valid	Valid
*Note that these cases apply only for 500 ppi resolution.								

Figure D.14: Types 15, 16, 19, and 20 Resolution Constraints

Resolution	Min	Max	Tolerance
Transmitting†	500 ppi	Scanning Resolution	None
Scanning	500 ppi	Unbounded	None

†Increments by 100%

References:

- Only WSQ20 is valid for 500 ppi as stated in 7.7.9.1.
- CGA values JPEGB and JPEGL are legacy for 500 ppi only as stated in 7.7.9.1.
- Only CGA values of JP2 and JP2L are valid for 1000 ppi (if compressed) as stated in 7.7.9.1.
- Exemplar friction ridge images have a minimum scanning resolution of 500 ppi as stated in 7.7.6.2.1
- The transmitting resolution has a minimum of 500 ppi and must not be greater than the scanning resolution (see 7.7.6.3.2).
- According to section 7.7.6.2.3, the transmitting resolution value for all friction ridge types (Types 4, 13, 14, 15, 19, and sometimes 16 and 20) must be a member of the resolution migration path that starts at 500ppi and increments by 100%: (i.e.: 500ppi, 1000ppi, 2000ppi, 4000ppi…). The scanning resolution does not necessarily follow the resolution migration path, but it must be scaled down or interpolated to achieve the proper value for transmission.

Interpretations:

- CGA value NONE is valid for all resolutions.
- Since no statement is made regarding resolutions greater than 1000 ppi, it is assumed that the recommendations for 1000 ppi should apply for higher resolutions.
- Since no statement is made regarding unspecified resolutions (when THPS/TVPS are aspect ratio for example), it is assumed that any compression algorithm value is valid. JPEGB and JPEGL are treated as legacy.

Type-17 Images

Type-17 images have no restrictions on resolution values, and the compression algorithm values are not dependent on any other values in the record type.

Figure D.15: Type-17 Image Constraints

		Compression Algorithm						
		NONE	WSQ20	JPEGB	JPEGL	JP2	JP2L	PNG
Transmitting Resolution	Any Resolution	Valid	X	X	X	Valid	Valid	Valid

Figure D.16: Type-17 Resolution Constraints

Resolution	Min	Max	Tolerance
Transmitting	Non-zero	Unbounded	None
Scanning	Non-zero	Unbounded	None

References:

- Only CGA values of NONE, JP2, JP2L, and PNG for any resolution value as stated in 7.7.9.2.

Interpretations:

- Since no resolution restrictions are made, it is assumed that a non-zero value must be present.

D.2 Test Exceptions

An "exception" refers to any AN-2013 requirement that is not fully addressed by the CTMF. Table D.17 identifies and provides justification for all exceptions present in the tables.

Table D.17- Exceptions Table

Exception	Section	Requirement Summary	Justification
Domain Names / Application Profile Specifications	5.3.2	Data contained in this record shall conform in format and content to the specifications of the domain name(s) as listed in Field 1.013 Domain name / DOM found in the Type-1 record, if that field is in the transaction. The default domain is NORAM. Field 1.016 Application profile specifications / APS allows the user to indicate conformance to multiple specifications. If Field 1.016 is specified, the Type-2 record must conform to each of the application profiles. A DOM or APS reference uniquely identifies data contents and formats. Each domain and application profile 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 fields and definitions may be registered and reserved to have a specific meaning. When this occurs, the domain or application profile registrar is responsible for registering a single definition for each number used by different members of the domain or application profile.	The format and content of the record are defined by the DOM or APS. Each DOM and APS has related record-content definitions that may be updated. The evolving nature of the DOM and APS definitions and nature of using registrars means that the requirements are not defined in the base standard, and therefore not included in the CTMF.[2]
	6	An implementation domain, coded in Field 1.013 Domain name / DOM of a Type-1 record as an optional field, 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. The implementation domain is usually understood to be the primary application profile of the standard. New to this version of the standard, Field 1.016 Application profile specifications / APS allows multiple application profiles to be referenced. The organization responsible for the profile, the profile name and its version are all mandatory for each application profile specified. A transaction must conform to each profile that is included in this field. It is possible to use Field 1.016 and / or Field 1.013.	The "transaction must conform to each profile" included in the field, and those profiles are defined by the listed agency, which may be updated over time. The CTMF does not contain these requirements.[1]

[2] Requirements related to user, profile, or domain-specific information are not within the scope of the CTMF.

		A specified implementation domain and specified application profiles must all have the same definition for fields, subfields and information items that are contained in the transaction.	
Alternate Character Sets	5.6, Table 4	Field 1.015 Character encoding/DCS is an optional field that allows the user to specify an alternate character encoding… Field 1.015 Character encoding/DCS contains three information items: the character encoding set index/ CSI, the character encoding sent name/CSN, and the character encoding set version/CSV. The first two items are selected from the appropriate columns of Table 2.	Table 4 lists ASCII, UTF-16, UTF-8, and UTF-32 as possible encodings. However, the table also allows "User-defined" character encoding sets. Requirements related to the use of alternate character sets may not be specifically defined in the CTMF.[1]
Alternate Coordinate System	7.7.3, Table 6	The ninth information item is the geodetic datum code / GDC10. It is an alphanumeric value of 3 to 6 characters in length. This information item is used to indicate which coordinate system was used to represent the values in information items 2 through 7. If no entry is made in this information item, then the basis for the values entered in the first eight information items shall be WGS84, the code for the *World Geodetic Survey 1984 version - WGS 84 (G873)*. See Table 4 for values.	Table 6 lists 22 coordinate systems and the option to include "Other" types as well. It is not feasible for the CTMF to define conformance to coordinate systems listed by the user under "Other".[1] The CTM lists requirements for conformance to WGS84 because it is the default coordinate system used in the base standard.
	7.7.3	A fourteenth optional information item geographic coordinate other system identifier / OSI allows for other coordinate systems. This information items specifies the system identifier. It is up to 10 characters in length. Examples are: • MGRS (Military Grid Reference System) • USNG (United States National Grid) • GARS (Global Area Reference System) • GEOREF (World Geographic Reference) • LANDMARK (e.g. hydrant) and position relative to the landmark, for example: Landmark: hydrant 143 sector 5 Position: 5.2 meters directly E A fifteenth optional information item is the geographic coordinate other system value / OCV. It shall only be present if OSI is present in the record and OSI is set to LANDMARK. OCV is free text and may be up to 126 characters.	While some examples of other coordinate systems are listed in the standard (MGRS, USNG, GARS, GEOREF, LANDMARK), those values are not all-inclusive, and the user may indicate other coordinate systems that are not listed.[1]

Subject Acquisition Profiles SAP/FAP/IAP	7.7.5, Table 10, Table11, Table 12	A subject acquisition profile is used to describe a set of characteristics concerning the capture of the biometric sample. These profiles have mnemonics SAP for face, FAP for fingerprints and IAP for iris records.	The CTMF does not define requirements for testing if the image was captured under the conditions specified by the SAP, FAP, or IAP level as defined in Tables 10 through 13. However, requirements for valid profile level values are defined.
[er|		Removed exception regarding polygons and ASEG. |er]	