NOTE: This document identifier and heading has been changed on this page to reflect that this is a performance specification. There are no other changes to this document. The document identifier on subsequent pages has not been changed, but will be changed the next time this document is revised.

NON-MEASUREMENT SENSITIVE

MIL-PRF-28003A
15 November 1991

SUPERSEDING
MIL-D-28003
20 December 1988

PERFORMANCE SPECIFICATION

DIGITAL REPRESENTATION FOR COMMUNICATION OF ILLUSTRATION DATA: CGM APPLICATION PROFILE

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This military specification establishes the requirements to be met when 2-dimensional picture description or illustration data that is vector or mixed vector and raster is delivered in the digital format of the Computer Graphics Metafile (CGM) as specified by the Federal Information Processing Standard, FIPS PUB 128.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ATTN: CALS Digital Standards Office, DISA, Center for Standards, Code JIEO/JEBEB, 10701 Parkridge Blvd, Reston, VA 22091-4398, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A AREA IPSC

1.2 Classification. This specification establishes the requirements for the communication or interchange of illustration data in digital format for use in technical illustrations and publications. The CGM Application Profile (AP) specified herein consists of three parts: the metafile, the generator (which writes the metafile), and the interpreter (which reads the metafile). A metafile or an interpreter shall be classified as one of the following types:

Type 0--monochrome;

Type 1--grayscale;

Type 2--full color.

Metafiles conforming to any of these types are called "conforming basic metafiles." Interpreters conforming to any of these types are called "conforming basic interpreters." Generators that produce conforming basic metafiles are called "conforming basic generators."

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Standards. The following standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplements thereto, cited in the solicitation.

FEDERAL INFORMATION PROCESSING STANDARD

FIPS PUB 128 - Computer Graphics Metafile (CGM)

Note: FIPS PUB 128 adopts ANSI/ISO 8632:1992 as a Federal Information Processing Standard Publication (FIPS PUB).

(Copies of the referenced Federal Information Processing Standards are available to Department of Defense activities from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094. Others must request copies of FIPS from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.)

MILITARY STANDARD

MIL-STD-1840A - Automated Interchange of Technical Information

(Copies of the referenced military standard are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents. The following other Government document forms a part of this document to the extent specified herein. Unless otherwise specified, the issue is that cited in the solicitation.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

NBS SP 424 - A Contribution to Computer Typesetting Techniques: Tables of Coordinates for Hershey's Repertory of Oxidental Type Fonts and Graphic Symbols, NBS Special Publication 424, April 1976.

(Application for copies shall be addressed to the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

INTERNATIONAL STANDARDS ORGANIZATION

ISO 8632-1:1992 Computer Graphics Metafile (CGM), Part 1, Functional Specification

ISO 8632-3:1992 Computer Graphics Metafile (CGM), Part 3, Binary Encoding

NOTE: This is the revision of ISO 8632:1987 defining version 1, version 2, and version 3 metafiles.

(Application for copies shall be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

ISO Register of Graphical Items

(Application for copies shall be addressed to the ISO Registration Authority, National Institute of Standards and Technology, Building 225, Room A266, Gaithersburg, MD 20899.)

NATIONAL STANDARDS

ANSI X3.4 - 7-bit American National Standard Code for Information Interchange (7-bit ASCII)

ANSI X3.134/2 - 8-bit American National Standards Code for Information Interchange (8-bit ASCII)

(Application for copies shall be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018).

(Nongovernment standards and other publications are normally available from the organizations which prepare

or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General requirements. The conformance requirements specified herein pertain to the conformance of CGM metafiles, generators, and interpreters. CGM elements and parameters allowed in a conforming metafile are specified herein. The CGM metafile may include all elements and parameters specified in FIPS PUB 128 that are not disallowed by this specification, but to meet the requirements of a conforming basic metafile the values of CGM elements and parameters shall be restricted to the values in the "Basic Set" as specified herein. Illustration data which meets the requirements of this specification shall be in the form of one or more conforming basic metafiles.

3.1.1 Conforming basic metafile. A conforming basic metafile shall:

a. Conform to one of the versions 1, 2, or 3 as defined in Clause 7 of ANSI/ISO 8632:1992;
b. Conform to one of the three types (Type 0, 1, or 2) classified herein;
c. Contain no scalar values of parameter data outside the ranges specified herein;
d. Be encoded only with the CGM Binary Encoding, as defined in FIPS PUB 128 (ANSI/ISO 8632:1992, part 3); and
e. Conform to any additional metafile requirements specified herein.

3.1.2 Conforming basic generator. A conforming basic generator shall:

a. Be a "conforming MIL-D-28003A generator" according to the rules of Clause 7 of ANSI/ISO 8632:1992;
b. Produce only conforming basic metafiles (or can be reliably commanded to function in that mode);
c. Accurately implement all of the functional elements and parameters of FIPS PUB 128 [including the guidelines of FIPS PUB 128 (ANSI/ISO 8632:1992, annex D)];
d. Generate metafiles which accurately and correctly define the intended picture; and
e. Conform to any additional generator requirements specified herein.

3.1.3 Conforming basic interpreter. A conforming basic interpreter shall:

a. Be a "conforming MIL-D-28003A interpreter" according to the rules of Clause 7 of ANSI/ISO 8632:1992;

b. At a minimum, correctly interpret any conforming basic metafile of the same type (Type 0, 1, or 2); [Note: A Type 1 interpreter shall correctly interpret Type 0 and 1 basic conforming metafiles, and a Type 2 interpreter shall correctly interpret Type 0, 1, and 2 basic conforming metafiles.]
c. Accurately implement all of the functional elements and parameters of FIPS PUB 128 [including the guidelines of FIPS PUB 128 (ANSI/ISO 8632:1992, annex D.2 and D.5), and the recommendations for the treatment of circular and elliptical graphical primitive elements of FIPS PUB 128 (in ANSI/ISO 8632:1992, annex D.4.5] except as modified herein;
d. Conform to the additional interpreter requirements as specified herein;
e. Generate pictures which accurately and correctly represent the metafile being interpreted;
f. Parse and skip the elements and parameter values specified herein as ignorable (when interpreting a non-conforming metafile);
g. Render all text at "stroke" precision, regardless of the value of the metafile TEXT PRECISION element; and
h. Render color exactly, according to the category of the interpreter: monochrome, grayscale, or color.

Note: In cases where a contract allows mapping of metafile color or grayscale (e.g., many metafile colors to fewer or different interpreter colors, or color to monochrome) the following principles shall be applied:

(1) If the metafile color selection mode is "direct":
    (a) the value of the metafile BACKGROUND COLOUR shall map to one of the device background colors;
    (b) any color value of any other metafile element that is exactly equal to the value of the metafile BACKGROUND COLOUR shall also map to the device background color; and
    (c) all other color values in the metafile shall map to another device color that must be distinct from the device background color, and that must be closest to the specified metafile color according to some reasonable metric applied to color space.

(2) If the metafile color selection mode is "indexed":
   (a) only the BACKGROUND COLOUR and COLOUR TABLE elements contain RGB values to be mapped; thus, the metafile "effective background color" shall be specified to be the value of the BACKGROUND COLOUR element, or the value of the COLOUR TABLE setting of index 0 if the BACKGROUND COLOUR has been thus superseded;
   (b) the effective background color shall map to one of the device background colors;
   (c) any COLOUR TABLE values that exactly match the effective background color shall also map to this value; and
   (d) all other RGB values shall map to another device color that must be distinct from the device background color, and that must be closest to the specified metafile color according to some reasonable metric applied to color space.

3.1.4 Physical file structure. If the delivery medium is magnetic tape, then the metafile data shall be blocked into records of 800 bytes. For other media, the format shall be as specified in MIL-STD-1840A or by procurement specification.

3.1.5 Defects in FIPS PUB 128. A number of editorial defects (or errors) have been found in ANSI/ISO 8632, the standard adopted by FIPS PUB 128.

3.2 Specific requirements. Specific requirements for conforming basic metafiles, generators, and interpreters are specified in the following subsections. Conforming basic metafiles shall meet the constraints on the elements of FIPS PUB 128 as specified herein.

3.2.1 Metafile constraints. The Basic Set of values shall be limited by the constraints on Basic values and additional values as specified below. Where an element or parameter of FIPS PUB 128 is not mentioned herein, the Basic Set shall include all values of that element or parameter as specified in FIPS PUB 128.

3.2.1.1 **Delimiter elements.** Delimiter elements shall meet the constraints specified in table I. There are no other parameter range constraints imposed upon the delimiter elements, other than the length limits and Name Precision limits specified in 3.2.1.2.

TABLE I. Delimiter element constraints

Element	Basic Values
Version 1 Elements	
No additional constraints	
Version 2 Elements	
BEGIN SEGMENT	(Note 1)
END SEGMENT	
Version 3 Elements	
BEGIN COMPOUND LINE	(Note 2)
END COMPOUND LINE	
BEGIN PROTECTION REGION	
END PROTECTION REGION	
BEGIN TILE ARRAY	
END TILE ARRAY	(Note 3)

Note 1: Constraints on segments include constraints on the number of simultaneously defined segments and the nesting of segments specified herein.

Note 2: Constraints on the number and size of contributing elements shall be as for CLOSED FIGURE (see TABLE V).

Note 3: Constraints on tiled raster arrays include constraints on tile size and number of tiles as specified herein.

3.2.1.2 **Metafile descriptor elements.** Metafile descriptor elements shall meet the constraints specified in table II.

TABLE II. Metafile descriptor element constraints

Element	Basic Values
Version 1 Elements	
METAFILE VERSION	1,2,3 (Note 1)
METAFILE DESCRIPTION	(Note 2)
INTEGER PRECISION	16
REAL PRECISION	(1,16,16) (fixed point) (0,9,23) (floating point)
INDEX PRECISION	16
COLOUR PRECISION	8, 16
COLOUR INDEX PRECISION	8, 16
FONT LIST	(Note 3)
CHARACTER SET LIST	(0,4/2) (Note 4,7) (1,4/1) (Note 5,7)
CHARACTER CODING ANNOUNCER	0 (Basic 7-bit) 1 (Basic 8-bit)
MAXIMUM COLOUR INDEX	(Note 6)
Version 2 Elements	
NAME PRECISION	8,16
MAXIMUM VDC EXTENT	no constraints
SEGMENT PRIORITY EXTENT	no constraints
Version 3 Elements	
COLOUR MODEL	element not allowed
COLOUR CALIBRATION	element not allowed
FONT PROPERTIES	element not allowed
GLYPH MAPPING	element not allowed
SYMBOL LIBRARY LIST	element not allowed

Note 1: Any of the version values: "1", "2", and "3" are Basic values.

Note 2: There shall be exactly one METAFILE DESCRIPTION element in each metafile. The METAFILE DESCRIPTION element's string:

a) shall include a substring briefly identifying the generator of this metafile, including company, product, and product version;

b) shall contain the substring "MIL-D-28003A/BASIC-1"; and

c) shall have appended to this latter string either:
".0" if the metafile is monochrome;
".1" if the metafile is grayscale; or
".2" or "" (nothing, a null string) if the metafile is color.

Note 3: Thirty-two simultaneous fonts are supported. The font names are selected from the basic font names in 3.2.4.4.

Note 4: The character set is ANSI X3.4, 7-bit American National Standard Code for Information Interchange (7-bit ASCII).

Note 5: The character set is ANSI X3.134/2, 8-bit American National Standards Code for Information Interchange (8-bit ASCII). [Note: This is equivalent to ISO 8859/1, Right-Hand Part of Latin Alphabet Number 1.]

Note 6: For color metafiles, Basic values shall be limited to 0-255; for grayscale metafiles, Basic values shall be limited to 0-15; for monochrome metafiles, Basic values shall be limited to 0-1. MAXIMUM COLOUR INDEX shall apply to all color indexes defined or otherwise referenced, whether they are referenced implicitly or explicitly. An example of an implicit reference is a COLOUR TABLE element which defines 100 entries starting at index 250. Only index 250 is explicitly referenced by this element, but index 307, for example, is defined and therefore implicitly referenced.

Note 7: 4/2 and 4/1 are "column/row" notation for positions in code tables. These designate the character codes with decimal numeric values "66" and "65" respectively. The parameters are the 1-character strings "B" and "A" respectively.

3.2.1.3 Picture descriptor elements. Picture descriptor elements shall meet the constraints specified in table III.

TABLE III. Picture descriptor element constraints

Element	Basic Values
Version 1 Elements	
COLOUR SELECTION MODE	(Note 1)
SCALING MODE	(Note 2)
LINE WIDTH SPECIFICATION MODE	(Note 3)
MARKER SIZE SPECIFICATION MODE	(Note 3)
EDGE WIDTH SPECIFICATION MODE	(Note 3)
Version 2 Elements	
SET LINE REPRESENTATION	element not allowed
SET MARKER REPRESENTATION	element not allowed
SET TEXT REPRESENTATION	element not allowed
SET FILL REPRESENTATION	element not allowed
SET EDGE REPRESENTATION	element not allowed
DEVICE VIEWPORT	element not allowed
DEVICE VIEWPORT MAPPING	element not allowed
DEVICE VIEWPORT SPECIFICATION MODE	element not allowed
Version 3 Elements	
INTERIOR STYLE SPECIFICATION MODE	(Note 3)
LINE & EDGE TYPE DEFINITION	(Note 4)
HATCH STYLE DEFINITION	(Note 5)
GEOMETRIC PATTERN DEFINITION	element not allowed

Note 1: Only a single value of COLOUR SELECTION MODE shall be allowed in each picture.

Note 2: It is a rule of ANSI/ISO 8632:1992 that the scale-factor parameter of SCALING MODE shall always be a floating point number, even when REAL PRECISION has selected fixed point for other real numbers. It is not apparent in FIPS PUB 128 what the precision of this floating point parameter is when fixed point real numbers have been selected: its precision shall be (0,9,23).

Note 3: All of the values "scaled," "absolute," "fractional," and "mm" of ANSI/ISO 8632:1992 shall be Basic values.

Note 4: The number of entries in the dash gap list parameter shall not exceed 8. At most 16 user line types shall be specified simultaneously.

Note 5: The number of entries in the gaps array list parameter shall not exceed 8. At most 16 user hatch styles shall be specified simultaneously.

3.2.1.4 **Control elements.** Control elements shall meet the constraints specified in table IV.

TABLE IV. Control element constraints

Element	Basic Values
Version 1 Elements	
VDC INTEGER PRECISION	16, 32
VDC REAL PRECISION	(1,16,16) (fixed) (0,9,23) (floating point)
TRANSPARENCY	1 (on)
Version 2 Elements	
LINE CLIP MODE	1 (shape) (Note 1)
MARKER CLIP NODE	1 (shape) (Note 1)
EDGE CLIP MODE	1 (shape) (Note 1)
NEW REGION	no constraints
SAVE PRIMITIVE CONTEXT	element not allowed
RESTORE PRIMITIVE CONTEXT	element not allowed
Version 3 Elements	
MITRE LIMIT	no constraints
PROTECTION REGION INDICATOR	element not allowed
GENERALIZED TEXT PATH MODE	element not allowed
TRANSPARENT CELL COLOUR	no constraints

Note 1: Because the single allowed value is not the default value, this element shall appear in every conforming metafile, either in the picture body or in a Metafile Defaults Replacement, if the corresponding primitive is present in the metafile.

3.2.1.5 Graphical primitives. To ensure portability and predictability of results, conforming basic metafiles shall not contain any Generalized Drawing Primitive (GDP) elements. The parameter lists of graphical primitive elements shall meet the constraints specified in Table V. [Note: In the table "npts" refers to the number of points in a point list.]

TABLE V. Graphical primitive constraints

Element	Basic Values
Version 1 Elements	
POLYLINE	npts=2,3,4..1024
POLYMARKER	npts=1,2,3..1024
DISJOINT POLYLINE	npts=2,4,6..1024
POLYGON	npts=3,4,5..1024
POLYGON SET	npts=3,4,5..1024 (Note 1)
TEXT	(Note 2)
APPEND TEXT	(Note 2)
RESTRICTED TEXT	(Note 2)
Version 2 Elements	
Closed Figure	(Note 3)
CONNECTING EDGE	no constraints
CIRCULAR ARC CENTER REVERSED	no constraints
Version 3 Elements	
HYPERBOLIC ARC	no constraints
PARABOLIC ARC	no constraints
POLYBEZIER	1..256 Bezier segments
BITONAL TILE	(Note 4)
NON UNIFORM B-SPLINE	order, 2..7; number of control points, < or = 1024
NON UNIFORM RATIONAL B-SPLINE	order, 2..7; number of control points, < or = 1024

Note 1: In addition, any sub-polygon shall be well defined and have a minimum of 3 points.

Note 2: The string parameters of graphical text shall not contain any control characters (7 or 8 bit codes in the ranges 1..31 and 128..159) except as allowed by and necessary to implement the character set switching modes which can be selected by Basic values of CHARACTER CODING ANNOUNCER. The C0 character NUL (code value 0) shall be permitted, and shall have no effect. A string with one or more NUL characters present is exactly equivalent to the same string with those characters removed.

Note 3: Constraints on this element include those specified elsewhere herein on the individual components of this element (e.g., polyline vertex constraints). The number of individual graphical primitive elements comprising the Closed Figure shall not exceed 32.

Note 4: The Basic values for the bitonal tile compression type parameter shall be limited to 0-6. Constraints on the size and number of tiles which are specified elsewhere herein shall also apply.

3.2.1.6 Attribute elements. Attribute elements shall meet the constraints specified in table VI.

TABLE VI. Attribute element constraints

Element	Basic Values
Version 1 Elements	
LINE BUNDLE INDEX	1-5
LINE TYPE	1-5, 6-15 (Note 1)
LINE WIDTH	positive (Note 2)
MARKER BUNDLE INDEX	1-5
MARKER TYPE	1-5
MARKER SIZE	positive
TEXT BUNDLE INDEX	1-2
TEXT FONT INDEX	1-32 (Note 3,4)
CHARACTER HEIGHT	positive
CHARACTER SET INDEX	1-2 (Note 3,5)
ALTERNATE CHARACTER SET INDEX	1-2 (Note 3,5)
FILL BUNDLE INDEX	1-5
HATCH INDEX	1-6
EDGE BUNDLE INDEX	1-5
EDGE TYPE	1-5
EDGE WIDTH	positive (Note 2)
PATTERN TABLE	Index, 1-8 nx, 1-16 ny, 1-16
COLOUR TABLE	(Note 6)
Version 2 Elements	
PICK IDENTIFIER	(Note 7)
Version 3 Elements	
LINE CAP	1-5 and unspecified/match
LINE JOIN	1-4
LINE TYPE CONTINUATION	1-4
LINE TYPE INITIAL OFFSET	[0.0,1.0] (Note 8)
TEXT SCORE TYPE	element not allowed
RESTRICTED TEXT TYPE	2-6 (Note 9)

TABLE VI. Attribute element constraints - Continued.

Element	Basic Values
Version 3 Elements - Continued	
INTERPOLATED INTERIOR	element not allowed
EDGE CAP	1-5 and 1-3
EDGE JOIN	1-4
EDGE TYPE CONTINUATION	1-4
EDGE TYPE INITIAL OFFSET	[0.0,1.0] (Note 8)
SYMBOL LIBRARY INDEX	element not allowed
SYMBOL COLOUR	element not allowed
SYMBOL SIZE	element not allowed
SYMBOL ORIENTATION	element not allowed

Note 1: The line types specified in 3.2.2.1 shall be included in the Basic Set, and comprise the registered index values 6-15. These values have been registered with the ISO Registration Authority for Graphical Items and are in accordance with the ISO Register of Graphical Items.

Note 2: The width shall not exceed 10% of the drawing size, which for this purpose is defined as the shortest side of the UDC Extent. Wider lines shall be rendered as filled areas.

Note 3: The character set selected shall be representable in the font selected.

Note 4: Every referenced font index shall correspond to a defined entry in the FONT LIST.

Note 5: Every referenced character set index shall correspond to a defined entry in the CHARACTER SET LIST.

Note 6: For color metafiles, the start index shall be 0-255; for grayscale metafiles, the start index shall be 0-15; for monochrome metafiles the start index shall be 0-1.

Note 7: This element has no graphical effect and may be useful for preserving non-graphical application information. Therefore it is harmless when occurring in a metafile and may safely be ignored by interpreters.

Note 8: The notation means 0.0 to 1.0 inclusive.

Note 9: The default value of this element is 1, which is not included in the Basic Set. This element shall appear in every conforming basic metafile which uses RESTRICTED TEXT.

3.2.1.7 Segment elements. Segment elements shall meet the constraints specified in table VII.

TABLE VII. Segment element constraints

Element	Basic Values
Version 2 Elements	
COPY SEGMENT	(Note 1)
INHERITANCE FILTER	no constraints
CLIP INHERITANCE	element not allowed
SEGMENT TRANSFORMATION	no constraints
SEGMENT HIGHLIGHTING	element not allowed
SEGMENT DISPLAY PRIORITY	no constraints
SEGMENT PICK PRIORITY	no constraints (Note 2)

Note 1: Segment copy references shall not be nested more than 4 deep. That is, the depth of the hierarchy implied by allowing the COPY SEGMENT function to appear within the definition of another segment shall not exceed 4. Depth 1 shall correspond to flat structure, i.e., no nesting or hierarchy.

Note 2: This element has no graphical effect and may be useful for preserving application information. Therefore it is harmless when occurring in a metafile and may safely be ignored by interpreters.

Both global segments and local segments are allowed in conforming basic metafiles. When global segments are specified in the Metafile Descriptor, all global segment definitions shall follow all other Metafile Descriptor elements. When global segments are specified in the Picture Descriptor (Version 3 metafiles only), all global segment definitions shall follow all other Picture Descriptor elements.

3.2.1.7 **ESCAPE element.** To ensure portability and predictability of results, conforming metafiles shall contain only those ESCAPE elements that are specified in 3.2.4.5 herein.

3.2.1.8 External elements. No constraints. However, the "action required" flag of the MESSAGE element shall not be used in such a way that the picture definition is altered.

3.2.2 Additional attribute values.

3.2.2.1 Line types. Additional line types permitted under this specification are specified in table VIII.

TABLE VIII. Additional line types

LINE TYPE	ISO Register parameter value
single arrow	6
single dot	7
double arrow	8
stitch line	9
chain line	10
center line	11
hidden line	12
phantom line	13
break line, style 1	14
break line, style 2	15

The parameter values are those values which have been assigned by the ISO Registration Authority for Graphical Items, and are in accordance with the ISO Register of Graphical Items.

3.2.3 Element defaults. The defaults of all elements shall be as specified in FIPS PUB 128 (ANSI/ISO 8632, clause 6 of Part 1). Conforming basic metafiles shall be permitted to contain one or more METAFILE DEFAULTS REPLACEMENT elements to redefine any of these values with values from the Basic Set.

3.2.4 Semantic ambiguities. FIPS PUB 128 leaves the semantics of a number of graphical details unspecified or "implementation dependent." Requirements in the following sections shall apply for conforming basic generators and interpreters.

3.2.4.1 View surface clearing. The view surface shall be cleared upon interpretation of the BEGIN PICTURE BODY element.

3.2.4.2 Clipping. When the CLIP INDICATOR is "off", clipping shall be done to the intersection of the device viewport and the device view surface limits. When the CLIP INDICATOR is "on", clipping shall be done to the intersection of the clip rectangle,

the VDC EXTENT, the device viewport and the device view surface limits.

3.2.4.3 Edge centering. Drawn edges of filled-area elements shall be centered on the ideal mathematically-defined edge of the area.

3.2.4.4 Font specifications. The fonts in Table IX are public domain fonts, available as part of NBS SP 424. All of these fonts shall be basic capabilities of a conforming basic metafile. Any of these fonts may appear in the FONT LIST element in a conforming basic metafile. Font name shall be the concatenation of the string "HERSHEY/", to designate one of the Hershey fonts, and a "name string" to designate the particular typeface. Font name shall be designated as in Table IX. The string "HERSHEY:" shall be an acceptable substitute for "HERSHEY/".

TABLE IX. Basic font names

1.	HERSHEY/CARTOGRAPHIC_ROMAN
2.	HERSHEY/CARTOGRAPHIC_GREEK
3.	HERSHEY/SIMPLEX_ROMAN
4.	HERSHEY/SIMPLEX_GREEK
5.	HERSHEY/SIMPLEX_SCRIPT
6.	HERSHEY/COMPLEX_ROMAN
7.	HERSHEY/COMPLEX_GREEK
8.	HERSHEY/COMPLEX_SCRIPT
9.	HERSHEY/COMPLEX_ITALIC
10.	HERSHEY/COMPLEX_CYRILLIC
11.	HERSHEY/DUPLEX_ROMAN
12.	HERSHEY/TRIPLEX_ROMAN
13.	HERSHEY/TRIPLEX_ITALIC
14.	HERSHEY/GOTHIC_GERMAN
15.	HERSHEY/GOTHIC_ENGLISH
16.	HERSHEY/GOTHIC_ITALIAN
xx.	HERSHEY/SYMBOL_SET_1 (Note 2)
xx.	HERSHEY/SYMBOL_SET_2 (Note 2)
xx.	HERSHEY/SYMBOL_MATH (Note 2)

Note 1: Code tables defining the association of numeric character code value with character (glyph) will be included in a future revision of this specification.

Note 2: The set of required glyphs and the codes to invoke them will be included in a future revision of this specification.

TABLE X contains additional font names included in the Basic Set of fonts. The fonts in TABLE IX and TABLE X together shall comprise the Basic Set of the FONT LIST element. Any of these font names may appear in the FONT LIST element in a basic conforming metafile, and basic conforming metafiles shall not reference any font not listed in TABLE IX or TABLE X. A basic conforming interpreter may substitute fonts metrically identical to these named fonts when rendering a basic conforming metafile.

Some of the font names in TABLE X are trademarked. Some of the named fonts are proprietary and copyrighted, and therefore require permission of the owners to use them. However, this specification in no way requires the license of named fonts from their trademark or copyright owners. Metric equivalents of the named fonts are widely available. Substitution by interpreters of fonts which are "metrically equivalent", as specified in 4.3.1, constitutes compliance.

TABLE X. More basic font names

1.	TIMES_ROMAN (Note 1)
2.	TIMES_ITALIC
3.	TIMES_BOLD
4.	TIMES_BOLD_ITALIC
5.	HELVETICA (Note 1)
6.	HELVETICA_OBLIQUE
7.	HELVETICA_BOLD
8.	HELVETICA_BOLD_OBLIQUE
9.	COURIER
10.	COURIER_BOLD
11.	COURIER_ITALIC
12.	COURIER_BOLD_ITALIC
xx.	SYMBOL (Note 2)

Note 1: Times and Helvetica are registered trademarks of Allied Corporation, the owner of the copyright on the fonts of those names.

Note 2: The "SYMBOL" font in TABLE X contains greek characters in the familiar alphabetic positions, and various mathematical and publishing symbols in the upper code positions (159-255). The set of required glyphs and the codes to invoke them will be included in a future revision of this specification.

The case (upper/lower) of the font names of the above font tables in FONT LIST elements shall not be significant to conforming basic generators and conforming basic interpreters.

3.2.4.5 Escape elements. Conforming basic interpreters shall support the following ESCAPE elements:

None.

3.2.5 Implementation requirements for conforming basic generators and interpreters. The requirements in this section augment those of FIPS PUB 128 (ANSI/ISO 8632, Part 1, annex D.5, and Part 3, clause 8). These requirements specify additional element constraints and Basic values for certain maxima and minima that shall apply to conforming basic metafiles.

Name: METAFILE DEFAULTS REPLACEMENT

Description: The METAFILE DEFAULTS REPLACEMENT element shall not be partitioned. Elements within METAFILE DEFAULTS REPLACEMENT shall not be partitioned. Note that FIPS PUB 128 permits multiple occurrences of this element, so that partitioning is not required. Partitioning shall be permitted for all other elements.

Name: COLOUR TABLE

Description: The COLOUR TABLE element has an unspecified effect when it appears in a picture subsequent to any graphical primitives. If a COLOUR TABLE element defining the representation of a given color index appears in a picture, it shall appear before reference to that index by an attribute element or use of that index by a graphical primitive element (included in the latter shall be implicit use of default color index attribute values by the first occurrence of an associated primitive). Once a given color representation is specified and used, it shall not be respecified. [Note: These restrictions insure that interpreting systems without dynamic color update capabilities shall be able to render the intended picture accurately.]

Note 1: For indexed color selection, either background color and all color indexes in the metafile shall have their representations specified or none shall. Color indexes shall be specified by the COLOUR TABLE element. Background color shall be specified either by the BACKGROUND COLOUR element or by the color index 0 (BACKGROUND COLOUR is synonymous with color index 0--this is part of FIPS PUB 128 but is not apparent in the original text). A color index is "used" if it occurs in an element selecting a color value to be applied to a primitive (LINE COLOR, CELL ARRAY, etc). A

color index is also "used" if it is the default for a primitive attribute and the default applies to a displayed primitive. The background color is automatically "used" upon the occurrence of BEGIN PICTURE BODY.

Note 2: For direct color selection, either the background color and the color of each displayed primitive shall be explicitly specified, or none shall. In other words, either all colors shall be defaulted or none shall.

Name: PATTERN TABLE

Description: The PATTERN TABLE element has an unspecified effect when it appears in a picture subsequent to any graphical primitives filled with the affected pattern index. A PATTERN TABLE element defining the representation of a given pattern index shall be present if that pattern index is used within the picture. It shall appear before explicit reference to that index by any PATTERN INDEX element; or in the case of the default PATTERN INDEX, it shall appear before any implicit reference caused by the first occurrence of an associated filled primitive with interior style "pattern." Once a given pattern representation is specified and used, it shall not be respecified. [Note: These restrictions insure that interpreting systems without dynamic pattern update capabilities shall be able to render the intended picture accurately.]

Name: Maximum Color Array Dimension

Description: The Basic value for the number of color values that can appear in a color array or color list parameter shall be: 1048576 for CELL ARRAY element (one 1024x1024 image); 256 for each PATTERN TABLE element (one 16x16 pattern); and 2048 for the complete pattern table itself (eight 16x16 patterns); for Type 2 (color) metafiles, 256 for each COLOUR TABLE element (entries 0-255), and 256 for the complete color table itself; for Type 1 (grayscale) metafiles, 16 for each COLOUR TABLE element (entries 0-15) and 16 for the complete color table itself; for Type 0 (monochrome) metafiles, 2 for each COLOUR TABLE element (entries 0-1) and 2 for the complete color table itself; CELL ARRAY and PATTERN TABLE have color array parameters and COLOUR TABLE has a color list parameter.

Name: Tile Array

Description: Tile Array consists of tiles of compressed color specifiers. Each tile shall be no larger than 1048576 compressed color specifiers (one 1024x1024 image); there shall be no more than 256 tiles.

Name: Maximum Point Array Length

Description: The Basic value for the maximum number of points and VDC that can appear in parameters for metafile elements shall be 1024.

Name: Maximum String Length

Description: The Basic value for the maximum length of an individual string of characters shall be: 254 for all string parameters of graphical text strings; 1024 for all others (e.g., FONT LIST) except data records; 32767 for data records.

Name: Begin Segment

Description: A maximum of 256 segments, both global segments and local segments included in the count, may be defined at any time.

Name: Bundle Table

Description: Bundle representations are not settable herein. To insure predictable results, conforming interpreters and generators shall use the default values from Table XI.

TABLE XI. Default bundle tables

	Bundle Index				
Bundle Type	1	2	3	4	5
Line Bundle					
LINE TYPE	solid	dash	dot	dash-dot	dash-dot-dot
LINE WIDTH	1	1	1	1	1
LINE COLOUR	1	1	1	1	1
Marker Bundle					
MARKER TYPE	dot	plus	asterisk	circle	cross
MARKER SIZE	1	1	1	1	1
MARKER COLOUR	1	1	1	1	1
Text Bundle					
FONT INDEX	1	1			
TEXT PRECISION	stroke	stroke			
CHARACTER EXPANSION FACTOR	1	0.7			
CHARACTER SPACING	0	0			
TEXT COLOUR	1	1			
Fill Bundle					
INTERIOR STYLE	hatch	hatch	hatch	hatch	hatch
FILL COLOUR	1	1	1	1	1
HATCH INDEX	1	2	3	4	5
PATTERN INDEX	1	1	1	1	1
Edge Bundle					
EDGE TYPE	solid	dash	dot	dash-dot	dash-dot-dot
EDGE WIDTH	1	1	1	1	1
EDGE COLOUR	1	1	1	1	1

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor shall be responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure that supplies and services conform to prescribed requirements.

4.2 Responsibility for compliance. Deliverables under this specification shall meet all requirements of section 3. The inspection set forth herein shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements specified herein shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.3 Inspection procedures. Conforming basic metafiles shall be analyzed for conformance to the Basic Set of values for CGM elements and parameters of FIPS PUB 128 and as specified in section 3 herein. To confirm that the specifications of FIPS 128 and section 3, herein have been met, CGM Validation Test Software has been developed and a CGM Validation Test Service has been established by the Computer Systems Laboratory at the National Institute of Standards and Technology (NIST). The contractor shall be responsible for obtaining validation of the CGM deliverable from this NIST Validation Test Service. Conforming basic generators shall be examined as necessary to ascertain that they generate only conforming basic metafiles, and those metafiles correctly represent the picture within the constraints imposed herein. Conforming basic interpreters shall be examined as necessary to ascertain that they meet all of the minimum requirements specified herein, and that they produce the correct picture.

4.3.1 Font rendering. Any rendering of a font as specified herein is conforming if the rendering is "metrically identical" to the font metrics of the requested font. That is, the placement and alignment of the string and the placement, size, and shape of individual characters (i.e., the drawn portions of the character cells) shall be measurably identical. Such rendering does allow a good quality filled font to be substituted for a stroked Hershey font, for example. Finally, the Hershey "fonts" are really a mixture of fonts and character sets (e.g., Greek is a character set). The requirements specified herein shall be met by providing that the necessary character sets be supported in part, and the necessary typefaces be supported in part, so that the combinations required to render the listed 16 Hershey "fonts" shall be supported in full.

4.3.2 Error processing. A conforming basic interpreter shall recover from any exception condition. If there is something which is not understood by the interpreter, then the interpreter shall not "crash," and if possible that element shall be skipped, appropriate error warnings generated or logged, and interpretation continue with the next element following the problem element.

5. PACKAGING

Packaging of illustration data files for delivery shall be in accordance with the requirements of MIL-STD-1840A.

6. NOTES

6.1 Intended use. This specification is designed to be incorporated into a contract to define the technical requirements to be met when it is desired to purchase illustration or picture description data (in contrast to product definition data) in digital form for use in technical illustrations and technical publications. A metafile as specified herein represents illustration data in the form of a conforming basic metafile, i.e., it contains, in device-independent, system-independent, and implementation-independent form, the picture description data represented by the functions invoked through an application program interface. This specification defines the allowable elements and parameters which may be used to compose the picture. In addition, certain constraints on CGM generators and interpreters are specified herein to remove implementation dependencies, thereby serving to ensure predictable interchange of conforming basic metafiles between clients. Thus, this specification may also be used in a contract to define the

technical requirements to be met when it is desired to purchase conforming basic generators and/or interpreters.

6.1.1 CGM Application Profile (AP). Most standards tend to be very completely specified, and ideally all implementations of standards would implement all possible elements, options and permissible values. Then there would be no problems in exchanging either implementations or files. However, not all standards are completely specified, nor are all possible elements, options and permissible values implemented by all implementors. FIPS PUB 128, the CGM standard, is not completely specified. This was intentional on the part of the CGM standards committee to allow implementation on a wider range of existing systems and make the CGM standard more adaptable to the various needs and philosophies of a diverse clientele. This introduces difficulties in trying to unambiguously describe an intended picture using the CGM standard. Nor have all implementors of the CGM standard chosen to include all possible elements, options and permissible values available and allowed in the standard. For their own reasons they have chosen particular subsets of the CGM standard to implement. This means that a picture written to a metafile using a particular generator may not be able to be fully rendered using a particular interpreter. Unpredictable results can and do occur. In addition, since the behavior of generators and interpreters themselves are not part of the CGM standard, a further unpredictability of results can occur.

This is the reason that certain groups of users have gotten together to rigorously define and adhere to the same subset of the CGM standard. This ensures predictable results and interworking between machines, sites, and applications. Such subsets are known as application profiles.

This specification is a CGM Application Profile for a particular group of users, namely DoD and contractors dealing with DoD. It is based on FIPS PUB 128, and defines the allowable elements, parameters and options which may be used to compose a picture in a metafile. In addition to more completely specifying semantic gaps in the CGM standard, specifying the operations and required capabilities of generators and interpreters, specifying the particular subset of CGM elements and parameters and their Basic Set of values, this specification also:

- specifies implementation requirements;
- specifies maxima and minima values of certain CGM elements and parameters; and
- specifies some additional element values which have completed the process of Graphical Registration.

6.1.2 Structure of the CGM standard and this specification. Metafiles in the CGM standard are defined as a series of layers of detail. The highest level of structure is the metafile itself. Each metafile may contain one or more pictures, which are completely independent of each other. Each of the items stored in a metafile is stored as an element. Each element may have associated with it a list of data called parameters. Elements may be grouped into Segments, which may be referenced and reused multiple times. There are nine classes of elements, and each is defined in turn in the CGM standard: Delimiter elements, Metafile Descriptor elements, Control elements, Graphical Primitive elements, Attribute elements, Escape elements, External elements, and Segment elements. Specific requirements in section 3 herein are organized similarly. Additionally, a new class of elements is specified in section 3 herein, namely Segment elements, and are inserted after Attribute elements.

6.1.3 Basic and permissible values. "Permissible values" are the range of values for CGM elements and parameters as specified in FIPS PUB 128. "Basic values" are the range of permissible values that are mandatory for conformance to this specification, and are specified herein. In some cases Basic values are augmented herein by additional values. Thus, both the Basic values and additional values specified herein constitute the "Basic Set."

6.1.4 FIPS PUB 128. FIPS PUB 128 adopts the international Computer Graphics Metafile (CGM) standard, ANSI/ISO 8632, as the Federal Information Processing Standard (FIPS) for use by Federal agencies. The FIPS only provides for the use of ANSI/ISO 8632 within the Federal government, explaining what it is and how it is to be applied and implemented. ANSI/ISO 8632, part 1, provides the functional specification for CGM elements and parameters, and their permissible values, while parts 2, 3 and 4 specify encodings. In particular, ANSI/ISO 8632, part 3, specifies the Binary encoding. All references to FIPS PUB 128 herein apply to ANSI/ISO 8632, and where necessary will also cite in parentheses the particular reference location in ANSI/ISO 8632.

6.1.5 Metafile Descriptor Elements. It is unclear in FIPS PUB 128 whether there should be a mandatory ordering of Metafile Descriptor elements (the grammar implies some). ANSI/ISO 8632 recommends such an ordering; METAFILE VERSION, METAFILE ELEMENT LIST, and METAFILE DESCRIPTION should be the first three elements, in that order.

6.1.6 Additional attribute values.

6.1.6.1 Line types. The line types specified in table VIII of 3.2.2.1 have been registered by ISO, the International Standards Organization, for graphics registration, and are contained in the ISO Register of Graphical Items. In table VIII, the name of the line type is given, followed by the numeric value (the line type parameter) by which it is to be referenced. These values are the ISO-registered values.

6.1.6.2 Fonts and Character Sets. This Application Profile contains two character sets in the Basic Set, ASCII and ANSI X3.134/2 ("Right Hand Part of Latin Alphabet Number 1"). The Basic Set also specifies the Hershey fonts as one of the basic font families. There is finally, the requirement that the requested character set be representable in the requested font. X3.134/2 is not fully representable in the digitized databases of the original public domain versions of the Hershey fonts. Those characters of X3.134/2 which are not contained in the original Hershey set should be rendered in a way that is consistent in style and metrics of the requested Hershey font. For example, the style and metrics of a Hershey version of the character "LOWER CASE A ACCENT GRAVE" should have an obvious relationship to those of "LOWER CASE A."

This problem does not arise in the other font families specified herein.

It is recognized that the Hershey fonts may not be of adequate quality for modern publication requirements.

6.2 Ordering data. The contract or purchase order should specify the following:

a. Title, number, and date of this specification.

b. Whether the metafile is Type 0 (monochrome), Type 1 (grayscale), or Type 2 (full color). (See 1.2 and 3.2.1.2)

c. Physical file structure (see 3.1.4)

6.3 Definitions.

6.3.1 Acronyms and abbreviations used herein. Acronyms and abbreviations used herein are defined as follows:

a. ANSI - The American National Standards Institute.

b. AP - Application Profile.

c. CGM - Computer Graphics Metafile. Synonymous with FIPS PUB 128.

d. FIPS - Federal Information Processing Standard.

e. GDP - Generalized Drawing Primitive.

f. GKS - Graphical Kernel System.

g. ISO - International Organization for Standardization.

h. PUB - Publication.

i. RGB - The color model Red-Green-Blue.

j. SP - Special Publication.

k. VDC - Virtual Device Coordinates, the coordinate system of FIPS PUB 128.

6.3.2 Application Profile. A set of specifications (beyond that in the published standard) appropriate to a particular environment. The goal of an AP is to eliminate implementation dependencies and provide for the effective and unambiguous use of a standard.

6.3.3 Basic set. The set of Basic values and additional values for CGM elements and parameters as specified herein.

6.3.4 Basic values. Basic values are the subset of permissible values that are mandatory for conformance to this specification, and are specified herein.

6.3.5 Computer Graphics Metafile. The functional specification for a mechanism for storing and transferring illustration data. Refer to FIPS PUB 128.

6.3.6 Conforming basic generator. A metafile generator that produces only conforming basic metafiles (or can be reliably commanded to function in that mode), and additionally conforms to any additional generator requirements as specified herein.

6.3.7 Conforming basic interpreter. A metafile interpreter that correctly interprets and renders any conforming basic metafile of the same conformance classification (Type 0, 1, or 2) as specified herein, and additionally conforms to any additional requirements as specified herein.

6.3.8 Conforming basic metafile. A metafile that complies with this specification and that conforms to one of the three categories classified herein. Type 0 metafiles shall be specified as monochrome metafiles; Type 1 metafiles shall be specified as grayscale metafiles; and Type 2 metafiles shall be specified as color metafiles.

6.3.9 Metafile. Synonymous with CGM. A representation for the storage and transfer of graphical data and control information. This representation contains a device-independent description of one or more pictures.

6.3.10 Metafile generator. The software or hardware that creates a picture or conveys information in the CGM representation.

6.3.11 Metafile interpreter. The software or hardware that reads a CGM metafile and interprets the contents.

6.3.12 Permissible values. The range of values for CGM elements and parameters as specified in FIPS PUB 128.

6.3.13 Vector Graphics. The presentation or storage of images as sequences of line segments.

Note: Refer to FIPS PUB 128 (i.e., ANSI/ISO 8632, clause 3) for further definitions of computer graphics terms.

6.4 Subject term (keyword) listing.

Application profile
CGM
CGM metafile
Digital
FIPS PUB 128
Technical illustrations
Technical publications

APPENDIX A

DIFFERENCES BETWEEN MIL-D-28003 AND MIL-D-28003A

10. *SCOPE.*

10.1 *Scope.* This appendix is provided for informative purposes, to assist in evaluating revision MIL-D-28003A. It provides a compendium of the differences between the original specification and Revision A of the specification. This appendix is not a mandatory part of this specification. The material contained herein is intended for guidance only.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. *BACKGROUND.* MIL-D-28003 was completed and published as a part of the CALS Phase I program for digital delivery of technical materials in 1988. As explained in section 6, MIL-D-28003 is an "Application Profile" of the CGM standard, *ANSI/ISO 8632:1987.* It is the way in which the CGM standard is harnessed and applied for use by the CALS application community.

At the time that the 28000-series specifications were being devised, there was a similar initiative underway in the manufacturing sector--MAP/TOP. Work was well underway for a CGM application profile for this sector. There was close collaborative effort between this community and the CALS community to improve the quality of the specifications and to devise a single profile to serve the needs of both communities. The CGM profile of MAP/TOP V3.0 and MIL-D-28003 were very close in content and structure. The goal for the CALS community for this initial profile was a basic usable profile which did not deviate significantly from the profile of the MAP/TOP community.

During this period and subsequently the CALS program conducted requirements studies to more carefully define the needed facilities in a graphics format intended for technical illustrations. The results of these studies indicated a number of extensions and modifications specifically needed by the CALS constituency. Work commenced to produce a revision of MIL-D-28003 that more closely reflected the needs of the CALS community.

Concurrently work progressed within the ANSI and ISO graphics standards communities on two amendments to CGM, the so-called Amendment 1 and Amendment 3, which respectively defined Version 1 and Version 3 metafiles. There was also work within the

standards communities to give public standing to certain extensions to the CGM standard (and other graphics standards as well) by the process of "graphical registration". Finally, there was work in the ISO CGM committee, SC24/WG3 to resolve outstanding "defect reports" on CGM.

These revisions to the base CGM standard comprise additions that in many cases have been driven by the needs of constituencies such as technical publishing, engineering drawing, and graphic arts. Amendment 1 completed processing in late 1990, and Amendment 3 completed processing in fall of 1991. The two amendments plus the defects resolutions were folded into ISO 8632:1987 to produce ISO 8632:1992 (and the identical ANSI/ISO designations).

40. OVERVIEW OF CHANGES IN MIL-D-28003A. MIL-D-28003A contains additions which include standardized functionality from CGM Amendment 1 (Version 2 metafiles) and the nearly complete CGM Amendment 3 (Version 3 metafiles).

Besides additions MIL-D-28003A also contains some deletions and some changes. The experience of the CALS community and CGM standard users in general has provided information necessary to fine tune some of the original specifications of MIL-D-28003.

50. CRITERIA FOR CHANGES TO THE PROFILE. A number of criteria were considered in evaluating potential changes to MIL-D-28003. In many cases these criteria conflict and tradeoffs had to be made.

50.1 Universal Printability. It should be possible to build implementations based on commonly available technology that can print conforming metafiles as specified herein. Esoteric or unusual resources should not be required or allowed (e.g., unusual private font collections should be proscribed, as they tend to isolate islands of automation that have access to them).

50.2 Uniformity of Results. The specification should be sufficiently unambiguous that uniform results can be obtained based on this published specification in combination with the CGM standard itself. Each feature should be evaluated, and implementation leeway in rendering the feature should only be allowed if it is a specifically desirable feature.

50.3 High Expressive Power. This specification should enable conforming metafiles to efficiently represent the graphical

features commonly used in technical publishing. There should be good support for graphical text, advanced curves and conics, reusable symbols, etc.

50.4 Implementability. The additions to MIL-D-28003 should accomplish the most important currently-unsatisfied requirements of technical publishing without unduly increasing the implementation burden. Some increase is inevitable, but lower priority additions requiring extra work disproportionate to their utility should be deferred until a future revision (see Appendix B).

50.5 Close to Base Standard. As much as possible the specification should consist of limitations of the base CGM standard and specifications of implementation dependencies. Redefinitions of the base standard must absolutely be avoided, and unusual extensions should only be included where strongly justified. It is necessary that any conforming basic metafile be a legal CGM, and desirable that it be largely understood by high quality complete interpreters, even if they are not specifically written to comply with this specification.

50.6 Avoid Excessive Subsetting and Levels. Experience with standards and military specifications has shown that each conformance subset or level tends to become a separate dialect and attract a separate clique. Not only does universal printability suffer, but there is potential for widespread misunderstanding among consumers of conforming products as to what the product actually is.

60. SPECIFIC CHANGES IN MIL-D-28003A. The following summarizes the most important modifications, additions, and deletions in deriving MIL-D-28003A from MIL-D-28003. As an aid to evaluating these changes, the rationale for each change is discussed briefly.

60.1 Draft and Publication Conformance Levels. Some experts view the distinction between Draft and Publication qualities of interpreters as not useful. Digital deliverables will require publication-quality interpreters for either softcopy or hardcopy operational use. A draft quality interpreter will certainly be a useful tool in many circumstances, but is not identified as a key operational requirement for the digital delivery of documents. Therefore the concept of these two distinct conformance levels has been removed from MIL-D-28003A.

60.2 METAFILE VERSION. The Basic values of this element have changed from "1" (the only value in ANSI/ISO 8632:1987) in MIL-D-28003 to "1," " 2," or "3" in MIL-D-28003A (all of the values allowed in ANSI/ISO 8632:1992). In addition to reflecting the set of elements that may be present, the Version also may reflect changes in grammar. For example Version 2 metafiles allow the COLOUR TABLE to be present in the picture descriptor as well as the picture body, and in fact this is a preferable location.

60.3 Color.

60.3.1 Conformance Levels. A very high proportion of technical illustrations will be monochrome, or at best grayscale. MIL-D-28003 could be read as requiring that any conforming interpreter be able to print wide-spectrum full color. Features have been added to MIL-D-28003A to allow a conforming basic metafile to be classified and self-identified as Type 0 (monochrome), Type 1 (grayscale), or Type 2 (full color), and conforming basic interpreters can conform to one of those three categories.

60.3.2 MAXIMUM COLOR INDEX. The requirements have been aligned with the three conformance categories, and an ambiguity in the ANSI/ISO 8632 standard regarding the applicability to "implicitly defined" color indexes has been clarified.

60.3.3 Default Color Table. The default color table to be assumed by conforming basic interpreters in the absence of explicit color information has been deleted. There is no longer a specified default. The specification was contrary to the spirit of the specification that "all color table entries shall be defined or none shall." The "none" subclause was specifically intended to allow interpreter leeway in selection of colors where the precise colors either did not matter to the generator, or where the appropriate set have depended upon such factors as hardcopy vs. softcopy presentation of documents. In general the latter freedom will be useful for monochrome applications which make up the majority of technical illustrations.

60.3.4 All-or-none for Direct Color. MIL-D-28003 only applied the all-or-none definition requirement to the indexed color selection method. MIL-D-28003A extends the same principle to direct color selection.

60.3.5 Include BACKGROUND COLOUR in All-or-none. The indexed color "all-or-none" definition requirement of MIL-D-28003

overlooked that the BACKGROUND COLOUR element behaves the same as the definition of an index by COLOUR TABLE. It has now been included appropriately.

60.3.6 **Color Table Size.** The various requirements regarding starting index, table size, etc, have been modified to reflect the three conformance types of Type 0 (monochrome), Type 1 (grayscale), and Type 2 (full color).

60.4 **METAFILE DESCRIPTION.** The string will now reflect that the file conforms to MIL-D-28003A. The requirements for inclusion of identifying information for the source of the metafile are increased. A new suffix to the string identifies to which of the three conformance categories the file belongs.

60.5 **Additional Attribute and Primitive Restrictions.** A number of situations that are indeterminate in the ANSI/ISO 8632 base standard are specified:

1. The value 0 is prohibited for LINE WIDTH, EDGE WIDTH, and MARKER SIZE.

2. POLYLINEs with less than 2 points encoded, POLYGONs (and sub-polygons of POLYGON SET) with less than 3 points encoded, and DISJOINT POLYLINEs with odd numbers of points encoded, are prohibited.

3. Edges of filled areas are specified to be centered on the ideal boundary of the area.

4. Control characters (codes 1-31 and 96-127) are prohibited (NUL, 0, is allowed) in graphical text strings except as required to implement permissible character set switching mechanisms.

5. The line type continuation element of MIL-D-28003 has been removed, since there is now an included Amendment 3 element which allows control of this aspect.

60.6 **Text and Fonts.** Additional fonts may be used. These fonts are similar to the basic set of 13 specified by the PostScript product of Adobe Corporation (PostScript is a registered trademark of Adobe Corporation). Equivalents of these fonts are widely available in modern publishing systems.

APPENDIX A

All font indexes and character set indexes used in the metafile must be specified by the appropriate Metafile Descriptor elements.

The case (upper/lower) of the strings in the FONT LIST element is not significant. This was not addressed in MIL-D-28003.

In forming the names of the Hershey fonts, a "/" may be used in place of the ":" for separating the components of the font name. The former is consistent with name structuring conventions in the ISO font standards.

An appendix will be prepared and added to a future revision of MIL-D-28003A to show an unambiguous mapping of character codes to glyphs for the Hershey fonts of TABLE IX.

A subset of the publicly-defined symbols of TABLE IX (useful for Technical Illustration) will be added to a future revision of MIL-D-28003A. An appendix will also be prepared and added to a future revision of MIL-D-28003A which specifies such a symbol set and unambiguously associates character codes with symbols.

The "SYMBOL" font in TABLE X contains greek characters in the familiar alphabetic positions, and various mathematical and publishing symbols in the upper code positions (159-255). In a future revision of MIL-D-28003A, the greek symbols will be given unambiguous code assignments and will be illustrated in the published text. A subset of other symbols useful for Technical Illustration (and which is widely available in publishing and engineering systems) will be added to a future revision of MIL-D-28003A. An appendix will be prepared and added to a future revision of MIL-D-28003A, which specifies such a set of symbols and unambiguously associates character codes with symbols.

The maximum allowable length of non-graphical strings (e.g., FONT LIST names, METAFILE DESCRIPTION string, etc) has been increased from 254 to 1024.

60.7 **Hatch Styles and Line Types.** The extended hatch styles (concrete, steel, etc) of MIL-D-28003 have been removed. The conformance requirements for them were too ill-specified, and the usefulness of them in technical illustrations for weapons systems has been challenged (they appear more appropriate to architectural and civil engineering applications) as not worth the cost. Most of these may be reproducible by the user definable hatch, available in Version 3 metafiles, which has been included.

The extended line types, by contrast, seem more widely applicable to the application area and more readily implemented. The designators for these have been changed from the private negative numbers to the newly registered positive values.

60.8 Escapes. All of the specified ESCAPEs of MIL-D-28003 have been removed.

1. The clear disable has side effects that have not been dealt with, and it is contrary to the intention of the ANSI/ISO 8632 standard. As a presentation directive it could accompany the metafile in some way, but should not be embedded as functionality in the metafile.

2. The use of viewport would be difficult to reconcile with other content types on a typical MIL-STD-1840A application tape. It should also be considered as a presentation directive that could accompany the metafile but not be embedded in it.

3. The implicit colour table contains reasonable requirements. However, what is achievable using it can be accomplished explicitly by other standard means. The slight, potential saving of file size does not justify defining and adding the extended element.

60.9 Delivery Format. MIL-D-28003 attempted to specify the delivery format on physical media of conforming basic metafiles as 80-octet records with a blocking factor specified for tape. The delivery format does need to be specified somewhere within the CALS family of standards, but MIL-D-28003 is not the right place. Such requirements are the concern of the packaging and delivery standards (e.g., MIL-STD-1840A). MIL-D-28003A has replaced the requirement with an explicit statement that MIL-D-28003A does not specify the delivery format.

60.10 Additions--Picture Descriptor. Following are additions of Picture Descriptor elements from Version 2 and Version 3 metafiles.

60.10.1 SPECIFICATION MODES. Version 3 metafiles allow two new SPECIFICATION MODES, fractional and mm, for such items as LINE WIDTH SPECIFICATION MODE. For technical illustrations (and engineering drawing as well) these are considered more precise and behave more as required by these applications than the two existing modes. In addition an INTERIOR STYLE SPECIFICATION MODE

has been added to give similar control over the interiors of filled areas. These features are included in MIL-D-28003A.

60.10.2 Grammar of Version 2 Metafiles. The rules defining where elements can appear in the metafile are liberalized somewhat in Version 2 metafiles. For example, COLOUR TABLE can now (and should preferably) appear in the Picture Descriptor. The SPECIFICATION MODES above can also appear in the picture body. Most of these are allowed in MIL-D-28003A. MIL-D-28003A does restrict the COLOUR SELECTION MODE (also liberalized in Version 2 metafiles) to one value per picture.

60.10.3 Prohibited Elements. The DEVICE VIEWPORT Picture Descriptor element of Version2 metafiles is prohibited in conforming basic metafiles. In addition the bundle table setting elements are prohibited. Although the elements are not especially complicated, the utility of bundles is considered very low to this application community, and the overhead of implementing the elements does not justify the cost.

60.11 Additions--Control. Following are additions of Control elements from Version 2 and Version 3 metafiles.

60.11.1 Clipping Modes. Version 2 metafiles resolve an ambiguity in Version 1 metafiles concerning how lines and markers are clipped or cropped. Elements are added to MIL-D-28003 to set the clipping modes of lines, edges, and markers, with the Basic values constrained to a single value that makes sense in technical illustrations.

60.11.2 Mitre Limit. Line join is a feature of Version 3 metafiles which is included in MIL-D-28003A. The associated MITRE LIMIT element is included as well.

60.11.3 Prohibited Elements. Version 2 metafiles have elements to save and restore certain aspects of primitive context. These are prohibited in MIL-D-28003A.

Version 3 metafiles allow arbitrary clipping and shielding boundaries in addition to the existing rectangular clipping capability. These consist of general paths that can be used to clip and shield. While these are considered useful to technical illustration, their priority is lower than some other items. Thus they are assigned to the next revision of this specification.

Version 3 metafiles also include the ability to specify text along an arbitrary path. This is also assigned to the next revision of this specification.

60.12 Additions--Graphical Primitives. Following are additions of Graphical Primitive elements from Version 2 and Version 3 metafiles.

60.12.1 Version 2 Primitives. Version 2 added two primitives: Closed Figure, allowing the definition of a single filled area from a composite of other primitives, namely lines, arcs, polygons, etc.; and another flavor of Circular Arc, allowing seamless inclusion of arcs in Closed Figures in certain circumstances. Both primitives are adopted into MIL-D-28003A. The Closed Figure is adopted with size restrictions as the other variable size primitives have been into MIL-D-28003.

60.12.2 Version 3 Primitives. Parabolic arcs and hyperbolic arcs are defined in Version 3 metafiles and are included in MIL-D-28003A (thus completing the set required to translate, for example, the conic arc elements of IGES).

Cubic bezier curves are also defined, and are adopted into MIL-D-28003A (with appropriate size restrictions).

Tiled compressed raster elements are defined in a manner that allows integration of vector and raster within a picture, and in a way compatible with MIL-R-28002 and the ODA Part 7 Tiling Addendum. These are adopted into MIL-D-28003A (with appropriate size and compression option restrictions).

A "Compound Line" primitive (similar to the Version 2 Closed Figure, except not filled) is defined in Version 3 metafiles and this is adopted into MIL-D-28003A.

NURBS (non-uniform rational B-splines) are defined in Version 2 metafiles. These are included in MIL-D-28003A with appropriate restrictions on degree and size.

60.12.3 Prohibited Elements. The facility of externally defined symbol libraries is also defined in Version 3 metafiles. Inclusion of this facility herein is deferred until specific requirements are better defined, and such practical operational matters as naming conventions for and registration of symbol libraries have been completed.

60.13 Additions--Primitive Attributes. Following are additions of Primitive Attribute elements from Version 2 and Version 3 metafiles.

60.13.1 Version Attributes. A single new attribute, PICK IDENTIFIER, is defined in Version 2 metafiles. It is graphically meaningless, but may help to preserve certain application hooks into the graphics and so is adopted herein (it may safely be ignored by conforming basic interpreters).

60.13.2 Definable Line Types and Hatch. Version 3 metafiles allow user definable line (and edge) types and hatch styles. These are adopted with appropriate restrictions into MIL-D-28003A, and are considered high priority items for improving drawing quality, fidelity and translatability from other formats. Along with the user line/edge type definition elements, there are a couple of utility elements such as for specifying the continuation behavior and the initial offset in line patterns. These are adopted into MIL-D-28003A as well.

60.13.3 Cap and Join. Version 3 metafiles define elements to specify line cap and line join styles (and for edges as well). These are adopted into MIL-D-28003A, and are considered a fairly high priority item for improving drawing quality, fidelity and translatability from other formats.

60.13.4 Restricted Text Controls. Version 3 metafiles allow precise control of how text should fit the restriction box of the RESTRICTED TEXT element. This is one of the most important additions to MIL-D-28003A for controlling how text behaves, as well as for translating from other formats (e.g., IGES) having a "boxed text" model.

60.13.5 Prohibited Elements. Version 3 metafiles allow new, filled-interior filling methods: definable "geometric patterns" and interpolated or gradient interiors. While these are considered useful to technical illustration, they have lower priority than some other items. Therefore, they have been assigned to the next revision of this specification.

Version 3 metafiles also define attribute elements associated with external symbol libraries and arbitrary text path. As mentioned previously these features are deferred until the next revision of this specification.

60.14 Additions--Segments. Version 2 metafiles define the concept of "segments" to the metafile definition. A segment is

specified by indicating a grouping of primitives. Once specified the group can then be instanced repeatedly into pictures, with variations on position, scaling, rotation, and inheritance of such attributes as color. This segment mechanism is adopted into MIL-D-28003A with appropriate restrictions and with the elimination of a couple of less useful elements.

60.15 About Delimiter Elements. The new primitives, Closed Figure, Compound Line and Tile Array, are specified by initiating and terminating a definition sequence with the Delimiter Elements BEGIN <whatever> and END <whatever>. The clipping and shielding regions of Version 3 metafiles, which are not included in MIL-D-28003A, are also specified in this way.

60.16 About Metafile Descriptor Elements. Version 2 metafiles define the Metafile Descriptor elements NAME PRECISION, MAXIMUM VDC EXTENT, and SEGMENT PRIORITY EXTENT. These are basic "utility" elements and are adopted into MIL-D-28003A, with restrictions where appropriate.

Version 3 metafiles define several functionally significant Metafile Descriptor elements. SYMBOL LIBRARY LIST allows the reference of external symbol libraries for inclusion of their individual symbols into the metafile. As mentioned previously, inclusion of this feature in MIL-D-28003 is deferred pending requirements study and better definition of the mechanics of the feature.

COLOUR MODEL and COLOUR CALIBRATION allow selection of color models other than RGB (Red-Green-Blue), including the CMYK color printing model. These elements also include precise calibration information relating to the source of the color. Since color is a relatively minor part of interchange of technical illustrations at this point, inclusion of these features is deferred.

FONT PROPERTIES and GLYPH MAPPING have potential to solve some of the problems in graphical interchange. Their inclusion herein is premature at this point for a number of reasons: (1) the base standards from which the elements derive, ISO 9541 and ISO 10036 have not yet completed; (2) significant collections of glyphs have not yet been registered; (3) the requirements of CALS for symbols and glyphs in vector graphics have not yet been defined; and (4) the font substitution capabilities of FONT PROPERTIES can not be used effectively until further liberalization of font usage herein is defined and certain companion changes are implemented in MIL-STD-1840A.

APPENDIX A

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APPENDIX B

LOOKING BEYOND REVISION A OF MIL-D-28003

10. SCOPE.

10.1 Scope. This appendix is provided for informative purposes, to assist in evaluating Revision A of MIL-D-28003. This appendix is not a mandatory part of this specification. It provides a rationale for why certain features have been deferred from Revision A processing, and offers suggestions for how these features can be processed in future as either minor amendments or part of the next full revision cycle. The material contained herein is intended for guidance only.

20. APPLICABLE DOCUMENTS. This section is not applicable to this appendix.

30. OVERVIEW. Appendix A focusses on the differences between MIL-D-28003 and MIL-D-28003A, discussing all of the new features of Version 2 and Version 3 metafiles. Some features of these versions are of no interest to the technical publishing and engineering communities of CALS. Other features are useful but are deferred for one of two reasons: adequate groundwork and requirements definition does not yet exist; or the feature, although useful, is not a high-enough priority when both the added implementation burden and the number of other features already being added are considered.

The content of future revisions to this specification, as well as the best means of making and timing the additions, are now being considered.

The bulk of the changes will probably constitute a significant revision, which for the remainder of this discussion will be designated MIL-D-28003B. There are some items that ideally should have been included herein. However, these items have been adequately prepared and should not delay the start of the review process of this specification. In addition the review and reconciliation process for MIL-D-28003A represents a valuable opportunity for soliciting comments on requirements.

MIL-D-28003B probably should start its review process about 2 years after MIL-D-28003A is published. It is possible that some items not presently included in MIL-D-28003A, and upon which requirements comments are solicited, can be processed in the interim by minor amendment. For the purposes of this discussion these are referred to as "Interim Items."

40. INTERIM ITEMS. Need has repeatedly been expressed for a "symbol font," containing various common publishing, mathematical, and engineering symbols which may need to occur as an integral part of a graphical text string. The exact requirement has not yet been defined. There are a number of candidate symbol sets that can provide source material once the requirements are determined:

1. public domain Hershey symbol sets;

2. symbols specified for use with IGES;

3. proprietary but common sets such as the Adobe PostScript "Symbol" font (PostScript is a registered trademark of Adobe Corporation);

4. the registries of technical societies.

Continued examination of the symbol problem will result in a solution or recommendation that will be added to MIL-D-28003A without a major revision process.

50. SUBSTANTIAL ADDITIONS--28003B.

50.1 More Functionality from Version 2 and 3. There are features of Version 2 metafiles which have not been adopted into MIL-D-28003A. These are not targeted for adoption at any time. These features include:

1. settable bundles;

2. device viewport controls;

3. save/restore context;

4. a couple of implementation dependent segment attributes.

Some features of Version 3 metafiles have not been adopted into MIL-D-28003A. These features are targeted for adoption into the next major revision (MIL-D-28003B) of this specification. The need for certain other features is uncertain at this point. They include the following:

APPENDIX B

1. NURBS. These curves are becoming more common in engineering systems; adoption into MIL-D-28003B is probable.

2. SYMBOLS. Access to external libraries of standardized symbols is potentially very useful to engineering drawing and technical illustration; adoption into MIL-D-28003B is probable after mechanics of the elements are worked out.

3. FONT PROPERTIES. The ability to specify acceptable substitutes for a larger class of allowed but non-basic fonts is one goal of additional font improvements in MIL-D-28003B; adoption into MIL-D-28003B is probable.

4. GLYPH MAPPING. Access to large families of registered typographic and technical glyphs is desirable; adoption into MIL-D-28003B is probable after the glyph registry develops somewhat.

5. GEOMETRIC PATTERN and INTERPOLATE INTERIOR. While these features are essential to the highest quality results in graphic arts and presentation graphics, the precise requirements in Technical Illustrations are uncertain (and in engineering drawing are low); adoption or limited adoption into MIL-D-28003B is probable, pending further study of requirements.

6. GENERALIZED TEXT PATH. While this feature is essential to the highest quality results in graphic arts and presentation graphics, and is anticipated to be widely used in cartography, the precise requirements in Technical Illustrations are uncertain; adoption into MIL-D-28003B is possible pending further study of requirements.

7. ARBITRARY CLIP/SHIELD. The same as for GEOMETRIC PATTERN (they are functionally equivalent if the question of nesting is discounted).

8. COLOR. Because the great majority of Technical Illustration currently is monochrome, a strong requirement has not been generated for advanced color models and color calibration capabilities within the CALS community; adoption into MIL-D-28003B is unlikely unless additional requirements are generated. However, the increasing use of "softcopy" (CRTs) for document

presentation implies that some additional requirements work is needed on this question.

50.2 More Fonts. MIL-D-28003A has increased the selection of fonts which can be used by allowing a set which is widely available but not public domain. The additional fonts are of higher quality than the public domain Hershey fonts. MIL-D-28003B will likely expand the set of allowable fonts further. This will likely be in conjunction with some of the font substitution mechanisms just described, and ideally also in conjunction with a font resource content type (see next section).

50.3 Font Resource Content Type for MIL-STD-1840A. A major issue is achieving modern, high-quality typography in an open interchange environment such as CALS while still preserving universal printability. One way to solve font interoperability problems is for the font resource, or minimally parts of the font resource, to be delivered with the graphics and text of an electronic document. If the font metrics are available for the fonts utilized both in the graphics and in the text layout and formatting, then the approximation of unavailable fonts can be improved by an order of magnitude. If the shape descriptions themselves are also delivered, then substitution and approximation is no longer an issue.

There are ISO projects in reasonably-advanced stages that standardize the basic technology for interchange of font resources. These are based on widespread commercial practice.

Within the next two years the MIL-STD-1840A standard should be modified to allow "Font Resource" to be one of the allowable content types delivered on tape or whatever medium is being used. This is a necessary adjunct to solutions for presentation of the revisable content types of MIL-STD-1840A, for both graphical font presentation and text presentation and formatting.

Results of adding a Font Resource content type would be integrated into MIL-D-28003B.

50.4 Character Set Problems. Further study is needed on the issues of coordination of character, symbol, and glyph sets between the revisable content types of MIL-STD-1840A. MIL-D-28003B will have better basic capabilities in the areas of character sets and typographical symbols, and ideally these will be better coordinated with the other content types.

Custodians:
Army - CR
Navy - SH
Air Force - 24
DLA - DH

Review activities:
Army - AM
Air Force - 01,02
NSA - NS
DCA - DC
NASA - NA
Others - NBS, DOE, GPO, NCS

User activities:
OSD - IR
Army - AL, AT, AV, EA, ER, GL, ME, MI, MR, SM, TE, TM
Navy - AS, EC, OS, SA, YD
Air Force - 11, 13, 14, 17, 18, 19, 68, 79, 99

Preparing Activity
OSD-CL
(Project ILSS - 0044)

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	MIL-D-28003A	920814

3. DOCUMENT TITLE
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4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

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a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
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8. PREPARING ACTIVITY

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