Computer Graphics Metafile (CGM) Test Requirements Document (Update)

Prepared by
Lynne S. Rosenthal

U.S. DEPARTMENT OF COMMERCE
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NIST

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1 INTRODUCTION

1.1 Purpose

This report was prepared by the National Institute of Standards and Technology/Computer Systems Laboratory (NIST/CSL) in support of the Computer-aided Acquisition and Logistics Support (CALS) initiative. It represents a NIST/CSL FY93 contract deliverable task to implement CALS Conformance Testing Services for CGM. In particular, this report updates the CGM Test Requirements Document.

1.2 Background

Conformance testing is a way of determining if a CGM product correctly implements the CGM standard and its associated application profile (AP). To meet CALS conformance test requirements, NIST/CSL developed validation test services for testing metafiles and generators for conformance to both the FIPS 128 and the CALS CGM AP, MIL-D-28003. A test service for interpreters is under development.

One of the first tasks in developing the CGM conformance test suite was to produce a test requirements document. This document, produced in FY89, describes the features and functions defined in FIPS 128 and MIL-D-28003 to which an implementation shall be tested for conformance. Since 1990 and the publication of this original test requirements document, both the CGM standard, ANSI/ISO 8632 and the MIL-D-28003 have been revised. The revised CGM standard, ANSI/ISO 8632:1992 and MIL-D-28003A include new functionality and consequently, additional requirements. Due to these changes in the standard and CALS CGM AP, it is necessary to update the conformance test suite and tools.

1.3 Scope

The objective of a CALS CGM Test Requirements document is to gather together all the requirements that must be satisfied in order for an implementation of the FIPS 128 and CALS CGM AP (e.g., metafile, generator, or interpreter) to be said to be in conformance with the standard and AP.

The original Test Requirements document was published in 1989 as NISTIR 4329. This update supplements the original document and contains only those requirements that result from the new functionality as specified in MIL-D-28003A. It does not repeat the requirements specified in NISTIR 4329.

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1.4 Methodology

The CGM functional description, ANSI/ISO 8632-1:1992 was systematically read and all new[1] requirements relating to the conformance of instances of CGMs were extracted. A similar approach was taken for the CGM binary encoding, ANSI/ISO 8632-3:1992 and the CALS CGM AP, MIL-D-28003A. Additionally, requirements related to generator and interpreter conformance were extracted from MIL-D-28003A.

Each separate statement of requirements is numbered sequentially and start with a letter, (i.e., "F", "B", or "M") which indicates the source of the requirements. "F" requirements are derived from the CGM Functional Description, Part 1. "B" requirements are derived from the CGM Binary Encoding, Part 3. "M" requirements are derived from the CALS CGM AP, MIL-D-28003A. A citation is given for each statement, identifying the clause or table from which the requirement was extracted.

1.5 Overview of new/changed requirements

The CGM standard, ANSI/ISO 8632:1992 contains changes due to the following actions:

> specification of version 2 CGM, a result of Amendment 1 to ISO 8632:1987,
> specification of version 3 CGM, a result of Amendment 3 to ISO 8632:1987,
> approval and publication of defect reports, a result of fixing errors and ambiguities in ISO 8632:1987.
> normative inclusion of the formal grammar as specified in Annexes A, B, and C of ISO 8632:1992.

The CALS CGM AP contains additions which reflect the changes to the ANSI/ISO standard as well as some deletions and CALS-related changes.

The remainder of this document is organized as follows:

- Section 2 presents the requirements of the Functional Specification, Part 1 of the CGM standard.

- Section 3 presents the requirements of the Binary Encoding, Part 3 of the CGM standard.

- Section 4 presents the requirements of the revised CALS CGM AP, concentrating mainly on the changes between MIL-D-28003 and MIL-D-28003A.

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[1] New requirements refer to requirements which result from changes or additions between ANSI/ISO 8632:1987 and ANSI/ISO 8632:1992.

2 REQUIREMENTS EXTRACTED FROM ANSI/ISO 8632-1:1992

2.1 Version 1 CGM requirements

F1 Clause 4.3.4.5, 5.1
For type string-fixed (SF) parameters, the 7-bit environment is assumed and only 7-bit ISO 2022 controls are allowed.

F2 Clause 4.3.4.5, 5.1
ISO 646 is the default character set for string fixed (SF) parameters.

F3 Clause 4.3.4.5
In SF parameters, the two character sets G0 and G1 may be accessed by using SI to invoke G1 into positions 2/1 to 7/14 of the 7-bit code chart; and using SO to invoke G0 into positions 2/1 to 7/14 of the 7-bit code chart.

F4 Clause 4.3.4.5, 5.1
Character set selection for non-graphical text strings, shall be accomplished only through use of embedded ISO 2022 controls.

F5 Clause 4.3.4.5, 5.1
Non-graphical text strings shall not be subject to character attributes and controls.

F6 Clause 5.3.14, 5.3.15, 5.7.22
Private values shall not be allowed in any enumerated parameter; e.g., Character Coding Announcer, Interior Style, and Character Set List.

2.1.1 Delimiter elements

F7 Clause 4.3.4.5
BEGIN METAFILE causes ISO 646 to be designated as the G0 set and ISO 8859 to be designated as the G1 set.

F8 Clause 5.2.1, 5.2.3
The parameter string for BEGIN METAFILE and BEGIN PICTURE is type SF.

F9 Clause 4.2, 5.2.2
END METAFILE shall occur exactly once in every CGM.

F10 Clause 4.2, 5.2.4
BEGIN PICTURE BODY shall occur in all metafiles which contain a BEGIN PICTURE element. (NOTE, this implies that the BEGIN PICTURE BODY must be present in an empty picture).

2.1.2 Metafile Descriptor elements

F11   Clause 4.3
      METAFILE VERSION and METAFILE ELEMENT LIST shall occur only
      once in the Metafile Descriptior.

F12   Clause 5.3.2
      The parameter string for METAFILE DESCRIPTION, FONT LIST, and
      CHARACTER SET LIST sequence tail is type SF.

F13   Clause 4.7.6, 5.3.10
      The color indices or direct values implied by the local color
      precision setting shall lie within the range of color values
      specified by the COLOUR VALUE EXTENT.

F14   Clause 5.3.10
      The parameters of the COLOUR VALUE EXTENT element depends on
      the selected color model.

2.1.3 Picture descriptor elements

F15   Clause 4.4.2
      The color mode selected by the COLOUR SELECTION MODE element
      is for the whole picture.

2.2 Version 2 CGM requirements

F16 Clause 0.9
A valid version 1 metafile is also a valid version 2 metafile.

F17 The required sequential relationships between version 2
metafile elements are documented by means of the state diagram
in Appendix A.

2.2.1 Delimiter elements

F18 Clause 4.2, 4.6.11.1
Primitives grouped together to form a composite primitive
known as a closed figure, is delimited by BEGIN/END FIGURE
elements.

F19 Clause 4.2, 4.10.1, 4.10.3
Segments are delimited by BEGIN/END SEGMENT elements.

F20 Clause 5.2.6
BEGIN SEGMENT is the first element of a segment. All
subsequent elements until the next END SEGMENT belong to this
segment.

F21 Clause 4.2, 4.6.11.1
BEGIN FIGURE and END FIGURE are used to delimit primitives
grouped together to form a composite primitive.

F22 Clause 5.2.9
If the current region has not yet been closed by a preceding
NEW REGION ELEMENT and if the last point of the last line
element is not coincident with the current closure point, then
the current subregion is closed by a line segment connecting
the las point of the preceding line element to the current
closure point.

2.2.2 Metafile descriptor elements

F23 Clause 4.3, 5.3.1
Only one metafile version occurrence is allowed.

F24 Clause 4.3.2.3
The Version-2 set includes all elements from the drawing-plus-
control set plus a set of listed elements.

F25 Clause 4.3.2.4
The extended-primitives set shall be used to indicate those
primitives which are available in version 1, but not defined
in ISO 7942 (GKS).

F26   Clause 4.3.2.5
       The Version-2-GKSM is a set of Version 2 metafile elements for
       ISO 7942 GKS) picture capture.

F27   Clause 5.3.18
       The parameters of SEGMENT PRIORITY EXTENT are non-negative,
       and minimum display priority shall be less than maximum
       display priority.

F28   Clause 4.10.2.1
       Global segments are defined in the Metafile Descriptor and are
       not part of the picture.

2.2.3 Picture descriptor elements

F29   Clause 4.4
       The following Picture Descriptor elements may appear within
       the picture body (in v2/3): COLOUR SELECTION MODE, LINE WIDTH
       SPECIFICATION MODE, MARKER SIZE SPECIFICATION MODE, EDGE WIDTH
       SPECIFICATION MODE, and INTERIOR STYLE SPECIFICATION MODE.

F30   Clause 4.4.4
       MAXIMUM VDC EXTENT defines an extent which bounds the VDC
       extent values which may be found in the metafile.

F31   Clause 4.4.7
       The device viewport specifies the region of the device display
       surface into which the VDC extent is to be mapped.

F32   Clause 4.4.7
       VDC-to-Device mapping is determined by the VDC extent, device
       viewport, and device viewport mapping.

F33   Clause 4.4.7, 5.4.9
       The DEVICE VIEWPORT SPECIFICATION MODE element selects one of
       three coordinate systems: by fraction [0.0 to 1.0] of the
       available display surface; in millimeters times a scale
       factor; or in physical device coordinates.

F34   Clause 4.4.7, 5.4.8
       The device viewport is specified in terms of two points on the
       device display surface at diagonally opposite corners of the
       rectangle.

F35   Clause 4.4.7, 5.4.8, 5.4.10
       The VDC-to-Device mapping maps the first point specifying the
       VDC extent on to the corner of the effective viewport
       corresponding to the first point specifying the device
       viewport, and similarly for the second point. The mapping is
       linear in each dimension.

F36   Clause 4.4.7
       If both device viewport and scaling mode appear in the same
       metafile, then the last specified is used.   If neither
       appears, then the default values for device viewport take
       precedence.

F37   Clause 4.4.8
       LINE   REPRESENTATION,   MARKER   REPRESENTATION,   TEXT
       REPRESENTATION, FILL REPRESENTATION, and EDGE REPRESENTATION
       are used to set attribute values in a bundle table.

2.2.4 Control elements

F38   Clause 4.5.2
       There are three different clipping modes for lines, markers,
       and edges: LINE CLIPPING MODE, MARKER CLIPPING MODE, and EDGE
       CLIPPING MODE.

F39   Clause 4.5.2
       The required clipping mode is recorded in the metafile with
       the LINE CLIPPING MODE, MARKER CLIPPING MODE, and EDGE
       CLIPPING MODE elements.

F40   Clause 4.5.2
       When the CLIP INDICATOR associated with a graphical primitive
       is 'on', only those parts of a graphical primitive considered
       inside   the   effective   clip   region   are   rendered   on
       interpretation.

F41   Clause 4.5.2
       Clipping   may   be   either   'locus',   'shape',   or   'locus then
       shape'.

F42   Clause 4.5.2, 4.6.4.6
       Clipping   for   fill   primitives   is   consistent   with   'shape'
       clipping.

F43   Clause 4.5.2, 4.7.3.2
       Clipping   for   text   primitives   is   determined   by   the   text
       precision. For 'string' precision, clipping proceeds on a per
       string basis as 'locus' clipping.   For 'character' precision,
       clipping   proceeds   on   a   per   character   basis,   as   'locus'
       clipping. For stroke precision, clipping proceeds as 'shape'
       clipping.

F44   Clause 4.5.2
       Clip   rectangles   applied   to   graphical   primitives   within
       segments may be subject to transformations in VDC space.

F45   Clause 4.6.11.1.2, 5.5.10
       NEW REGION starts a new region.

F46 Clause 4.6.11.1.2, 5.5.10
NEW REGION may occur at any time during the closed figure
construction.

F47 Clause 5.5.10
The first point of the next line element following a NEW
REGION element becomes the new closure point, starting a new
subregion.

F48 Clause 4.5.3
The SAVE/RESTORE PRIMITIVE CONTEXT elements are used to save
and restore attributes and control elements as collections.

F49 Clause 4.5.3
The values for attributes controlled by specification or
selection modes are saved in the mode in which they were last
specified and when restored, the current specification and
modes are not changed.

2.2.5 Graphical elements

F50 Clause 4.6.1.5
For 'locus' clipping of line elements, the mathematical locus
of the line is clipped at the intersection with the clip
rectangle before shape rendering is applied.

F51 Clause 4.6.1.5
For 'shape' clipping of line elements, the shape of the
rendered line is clipped to the intersection with the clip
rectangle; i.e., nothing is drawn outside the clip rectangle.

F52 Clause 4.6.1.5
For 'locus then shape' clipping of line elements, the
mathematical locus of the line is clipped, and then
subsequently the rendered shape of the clipped locus is again
clipped.

F53 Clause 4.6.2.3
For 'locus' clipping the specifying points of each marker are
clipped at the intersection with the clip rectangle before
shape rendering is applied. The marker is only visible if its
specifying point is within the clip rectangle.

F54 Clause 4.6.1.5
For 'shape' clipping, the shape of the rendered marker symbols
are clipped to the intersection with the clip rectangle; i.e.,
nothing is drawn outside the clip rectangle.

F55 Clause 4.6.1.5
For 'locus then shape' clipping, clipping is first applied to
the specifying points of each marker, then subsequently the
rendered shape of the markers are again clipped.

F56   Clause 4.6.11
        Edge attribute values shall be associated with the edge
        portions of the complete graphic object.

F57   Clause 4.6.11
        The entire fill object is considered a single unit on
        interpretation.

F58   Clause 4.6.11
        The first point of the first line primitive in a new region is
        the closure point for that region.

F59   Clause 4.6.11
        A closed figure consists of one or more regions.

F60   Clause 4.6.11
        A region has a closed boundary, which is either concave,
        convex, or self intersecting.

F61   Clause 4.6.11
        A fill primitive between BEGIN and END FIGURE closes the last
        region and begins a new region.

F62   Clause 4.6.11
        A closed figure consisting of only line primitives consists of
        a single region.

F63   Clause 4.6.11.2.1
        For fill primitives (except POLYGON SET), the complete edge
        becomes an explicit boundary portion and edge portion in the
        closed figure.

F64   Clause 4.6.11.2.1
        For line primitives, only those portions become explicit
        boundary portions and edge portions which would normally be
        drawn if an interpreter were rendering the line primitive
        independently in a metafile.

F65   Clause 4.6.11.2.2
        Edge attributes are never associated with implicit boundary
        portions.

F66   Clause 4.6.11.2.3
        No boundary or edge portion is created connecting two regions.

F67   Clause 4.6.11.3.2
        Each fill primitive contributes a complete region to the
        figure.

F68   Clause 5.6.20
       The circular arc center reversed is displayed with current
       line element attributes.

F69   Clause 5.6.20
       Valid values of CIRCULAR ARC CENTER REVERSED element's vector
       components are those which produce vectors of non-zero length.

F70   Clause 5.6.20
       Valid values of CIRCULAR ARC CENTER REVERSED element's radius
       are non-negative VDCs.

F71   Clause 4.6.11.1.2, 5.6.21
       If CONNECTING EDGE is invoked after the last line primitive in
       an open region, an explicitly boundary portion and edge
       portion is added.

F72   Clause 5.6.21
       The appearance of the connection edge is determined by the
       edge attributes.

2.2.6 Attribute elements

F73   Clause 4.7.7
       The PICK IDENTIFIER provides a means of identification of
       primitives within segments. It has no graphical effect.

F74   Clause 5.7.36
       The pick identifier value is associated with all graphical
       primitive elements within a segment until the next PICK
       IDENTIFIER.

2.2.7 Segment elements

F75   Clause 4.10
       Graphical objects may be grouped in segments. Graphical
       primitive elements and attribute elements may be located
       within segments.

F76   Clause 4.2, 4.10.1, 4.10.3
       Each segment is uniquely identified by a segment identifier.

F77   Clause 4.10.1
       Once a segment is defined, it shall not be changed.

F78   Clause 4.10.2
       Defining a local segment in the picture body automatically
       includes that segment in the picture's image. Local segments
       defined in the Picture Descriptor are included in the
       picture's image when reference from within that picture.

F79   Clause 4.10.2
      Local segments have no existence beyond the bounds of the
      picture in which they are defined.

F80   Clause 4.10.2.1
      Global segments can be referred to by any of the pictures in
      the metafile in which they are defined.

F81   Clause 4.10.2.1
      COPY SEGMENT shall be used to incorporate the global segment
      into a picture.

F82   Clause 4.10.2.2
      Segments are not allowed to be defined in Picture Descriptor
      State.

F83   Clause 4.10.2.3
      Within pictures, no elements are allowed that would modify the
      contents or default appearance of global segments.

F84   Clause 4.10.2.3
      The only references to global segments within pictures shall
      be by using the COPY SEGMENT element.

F85   Clause 4.10.4.1
      Segment attributes shall be set only after the segment has
      been opened with the BEGIN SEGMENT element, and before any
      other type of element.

F86   Clause 4.10.4.1
      At the start of a segment, all segment attributes are set to
      their default values.

F87   Clause 4.10.4.2
      In all segment elements (e.g., SEGMENT TRANSFORMATION,
      HIGHLIGHTING, DISPLAY PRIORITY, PICK PRIORITY), the segment
      identifier must be identical to the identifier of the segment
      in which the element occurs.

F88   Clause 4.10.4.2
      Clipping rectangles are not transformed by the segment
      transformation.

F89   Clause 4.10.4.2
      Scaling, translation, and rotation of segments are allowed to
      be defined during segment definition.

F90   Clause 4.10.4.2
      A SEGMENT TRANSFORMATION stored in the metafile is applied
      before the application of the VDC-to-Device mapping.

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F91   Clause 4.10.4.3
      The only legal values for segment highlighting are: NORMAL or
      HIGHLIGHTED.

F92   Clause 4.10.4.4
      Segments with higher display priorities are displayed as if
      they are in front of segments with lower display priorities.

F93   Clause 4.10.4.4, 5.3.18
      In a metafile, the display priority is an integer in the range
      defined by the SEGMENT PRIORITY EXTENT.

F94   Clause 4.10.4.5, 5.3.18
      In a metafile, the pick priority attribute is an integer in
      the range defined by the SEGMENT PRIORITY EXTENT.

F95   Clause 4.10.4.5
      SEGMENT PICK PRIORITY shall cause no graphical effect.

F96   Clause 4.10.5, 5.10.1
      The COPY SEGMENT inserts the elements of the referenced
      segment into the picture at the point of occurrence of the
      element.

F97   Clause 4.10.5, 5.10.1
      The copy transformation is applied to graphical objects before
      they are copied.

F98   Clause 4.10.5, 5.10.2
      The inheritance filter controls whether individual attribute
      values are reapplied to the elements.

F99   Clause 4.10.5, 5.10.2
      The inheritance filter setting values are either 'segment' or
      'state list'.

F100 Clause 4.10.5
      The default inheritance filter setting value is 'segment' for
      all attributes and controls.

F101 Clause 4.10.5
      The INHERITANCE FILTER is used to select the attributes and
      controls.

F102 Clause 4.10.5, 5.10.3
      The legal values for CLIP INHERITANCE are either 'state list'
      or 'intersection'.

F103 Clause 4.10.5, 5.10.3
      If the CLIP INHERITANCE value is 'state list', then the clip
      rectangle associated with primitives in the copied segment is
      that of the last CLIP RECTANGLE encountered.

F104 Clause 4.10.5, 5.10.3
If the CLIP INHERITANCE value is 'inheritance' and both the modal state list clip indicator and the clip indicator associated with the primitives of the copied segment are 'on', then the resulting clipping boundary is the intersection of the modal state list clip rectangle with the clipping boundary resulting from the application of the copy transformation to the clip rectangle associated with the primitives.

F105 Clause 4.10.5
Segment Transformations are never applied to clipping boundaries.

F106 Clause 4.10.5
The default value for CLIP INHERITANCE is 'state list'.

F107 Clause 6
The default values for the following segment attributes are: SEGMENT TRANSFORMATION = 1.0,0.0, 0.0,1.0, 0.0,0.0; SEGMENT HIGHLIGHTING = normal; SEGMENT DISPLAY PRIORITY = 0; SEGMENT PICK PRIORITY = 0.

2.3 Version 3 CGM requirements

F108 Clause 0.9
A valid version 2 metafile is also a valid version 3 metafile.

F109 The required sequential relationships between metafile
elements are documented by means of the state diagram in
Appendix A.

2.3.1 Delimiter elements

F110 Clause 4.2
A compound path may be used to defined a compound line
primitive or for displaying text strings along an arbitrary
text path.

F111 Clause 4.2
A compound line is defined by line primitive elements
occurring between BEGIN COMPOUND LINE and END COMPOUND LINE.

F112 Clause 4.2
A compound text path is defined by line primitives occurring
between BEGIN/END COMPOUND TEXT PATH elements.

F113 Clause 4.2
A compound clipping or shielding region may be defined by line
and filled-area elements occurring between BEGIN/END
PROTECTION REGION elements.

F114 Clause 4.2
A sequence of TILE and/or BITONAL TILE elements between the
BEGIN/END TILE ARRAY delimiters defines a tile array.

2.3.2 Metafile descriptor elements

F115 Clause 4.3.2
The Version-3 set includes all elements from the Version-2 set
plus a set of listed elements.

F116 Clause 4.3.4.1
The architecture for font resources is defined in ISO 9541.

F117 Clause 5.3.11
For color models RGB and CMYK, the parameters of COLOUR VALUE
EXTENT represent an extent which bounds the direct colour
values. For color models CIELAB, CIELUV, and RGB-related, the
parameters represent the scale and offset that relate each
component of a direct color value to the color value of the
corresponding color space.

F118 Clause 4.3.4.1
The exact name of a font resource is listed in the FONT LIST.

F119 Clause 4.3.4.1
      If the font named in the FONT LIST is not available to the
      interpreter, the FONT PROPERTIES and GLYPH MAPPING elements
      contain font descriptive information about the desired fonts
      and font resources.

F120 Clause 4.3.4.2
      The font properties which may appear are those in the Minimum
      Font Description Subset of ISO 9541-2 and any registered
      properties.

F121 Clause 4.3.4.2
      FONT PROPERTIES prioritization indicates which properties take
      precedence.   The higher the priority the greater the
      importance.

F122 Clause 4.3.4.4
      The GLYPH MAPPING element associates the AFII identifiers with
      single-byte or multi-byte codes.   (AFII is the glyph
      registrar.)

F123 Clause 4.3.4.4
      The AFII registered glyphs are accessed through the CGM
      character set and switching mechanisms.

F124 Clause 5.3.21
      The font index in the FONT PROPERTIES element must have been
      previously defined in the FONT LIST.

F125 Clause 5.3.22
      The character set index used in the GLYPH MAPPING element
      cannot also be specified in a CHARACTER SET LIST element.

F126 Clause 4.7.6, 5.3.19
      The COLOUR MODEL element is used to select among the color
      models: RGB, CIELAB, CIELUV, CMYK, RGB-related.

F127 Clause 5.3.20, Table 12
      The calibration data and legal calibration selection values
      for each color model are specified in Table 12.

2.3.3 Picture descriptor elements

F128 Clause 5.4.16
      The INTERIOR STYLE SPECIFICATION MODE selects the method for
      specifying geometric aspects associated with filled-area
      primitives and the transformation behavior of those aspects.

F129 Clause 4.7.1.2, 5.4.17
      LINE AND EDGE TYPE DEFINITION specifies the precise definition
      of the solid/gap sequences which comprise a line or edge type.

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F130 Clause 5.4.17
LINE AND EDGE TYPE DEFINITION defines a line type or edge type
and associates it with an index. The index must be negative.

F131 Clause 5.4.17
The list of dash elements comprise the definition of the LINE
AND EDGE TYPE DEFINITION index. There is at least one element
in the list. If there is one element, a solid line is drawn.

F132 Clause 5.4.17
The dash cycle repeat length defines the length of one
complete cycle of the dash pattern. The list of dash elements
= the dash cycle repeat length.

F133 Clause 5.4.17
The LINE WIDTH SPECIFICATION MODE determines the units of the
dash cycle repeat length. LINE AND EDGE TYPE DEFINITION
elements may be interleaved with LINE WIDTH SPECIFICATION
MODEL elements.

F134 Clause 5.4.18
HATCH STYLE DEFINITION defines a hatch style and associates it
with an index. The index must be negative.

F135 Clause 5.4.18
The center of the first hatch line is aligned with the FILL
REFERENCE POINT. The color of each hatch line is the current
fill color. The line width of the hatch lines is = one gap
width unit. The direction of the hatch lines is specified by
the hatch direction vectors specifier parameter.

F136 Clause 5.4.18
The INTERIOR STYLE SPECIFICATION MODE determines the units of
the duty cycle length.

F137 Clause 5.4.19
The GEOMETRIC PATTERN DEFINITION defines a geometric pattern
and associates it with an index. The index must be positive
and is referenced with the PATTERN INDEX element.

F138 Clause 5.4.19
The two points of the pattern extent of the GEOMETRIC PATTERN
DEFINITION element must be distinct points.

2.3.4 Control elements

F139 Clause 4.5.4
Protection regions are identified by an index. If an index is
reused, the old definition is deleted and the new protection
region indicator takes the initial value 'off'.

F140 Clause 5.5.13
The region indicator parameter determines how the protection
region associated with the given index is used. If the value
is: 'off', region is not used; 'clip', region is used for
clipping; 'shield', region is used for shielding.

F141 Clause 4.5.4
Regions which are constructed by line elements are closed by
NEW REGION, END PROTECTION REGION, or any filled area
elements.

F142 Clause 5.2.10
A defined region is associated with a region index parameter,
by which it may be referenced by the PROTECTION REGION
INDICATOR element.

F143 Clause 4.5.4
If a protection region is used within a segment (i.e.,
PROTECTION REGION INDICATOR value is 'clip' or 'shield' for
region inside segment), it behaves as do clip rectangles with
respect to transformations.

F144 Clause 4.5.4
The effective protection region for clipping and/or shielding,
when protection regions are defined, or referenced, within
segments, is determined by CLIP INHERITANCE in the same way as
for the simpler rectangle clipping.

F145 Clause 4.5.4
When a protection region is set for clipping, only the
portions of the graphical elements inside or on the boundary
of the region are drawn.

F146 Clause 4.5.4
When a protection region is set for shielding, only the
portions of the graphical elements outside the region and its
boundary are drawn.

F147 Clause 4.5.4
If clip regions overlap, the effective clip region is the
intersection of the individual regions.

F148 Clause 4.5.4
If several clip and shield regions are in effect
simultaneously, only portions of the graphical elements inside
or on the boundary of the intersection of all individual clip
regions and outside the union of all individual shield regions
are drawn.

F149 Clause 4.5.5, 4.7.3.2
The GENERALIZED TEXT PATH MODE selects the method for placing
the text along the text path.

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F150 Clause 4.5.5, 4.7.3.2
When GENERALIZED TEXT PATH MODE is off, the text is displayed along the last text path defined by the BEGIN/END COMPOUND PATH elements.

F151 Clause 4.5.5, 4.7.3.2
When GENERALIZED TEXT PATH MODE is non-tangential, the characters are drawn along the text path but the character orientation vectors are not rotated relative to the text path.

F152 Clause 4.5.5, 4.7.3.2
When GENERALIZED TEXT PATH MODE is axis-tangential, the characters are positioned along the text path and the character orientation vectors for each character are rotated by an amount equal to the angle of the tangent to the text path at the character position.

F153 Clause 4.5.6
The MITRE LIMIT provides a means of specifying how long mitres are to be truncated to form a flat bevel.

F154 Clause 4.5.6
Mitre length is the distance from the point at which the inside edges of the adjoining line segments meet to the point at which the outside edges meet.

F155 Clause 4.5.6
When the mitre length divided by the line width exceeds the MITRE LIMIT, then the mitre join is truncated. If truncation results in a flat bevel within the triangular notch of the corresponding bevel join style, then the bevel join style is used.

F156 Clause 4.5.7
The TRANSPARENT CELL COLOUR allows a given value of a cell color specifier to be transparent. (This element can apply to the CELL ARRAY, TILE, or BITONAL TILE elements or filling patterns defined by PATTERN TABLE elements)

F157 Clause 4.5.7
To invoke transparency, the cell color specifier shall be defined as transparent prior to the occurrence of the affected element in the metafile.

F158 Clause 4.5.7
The rendering of any element affected by TRANSPARENT CELL COLOUR shall not involve more than one distinct value of cell color specifier simultaneously being designated as transparent.

2.3.5 Graphical primitive elements

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F159 Clause 4.6
     TEXT, RESTRICTED TEXT, and APPEND TEXT elements and related
     text attribute elements are defined in the current VDC space.
     They are affected by changes to the Virtual Device Coordinate
     format.

F160 Clause 4.6.1.1
     The curve (line) element, HYPERBOLIC ARC generates the conic
     arc as a hyperbolic arc.

F161 Clause 4.6.1.1
     The curve (line) element, PARABOLIC ARC generates the conic
     arc as a parabolic arc.

F162 Clause 4.6.1.1
     The spline curve (line) element, NON-UNIFORM B-SPLINE,
     generates a Non-Uniform B-Spline curve.

F163 Clause 4.6.1.1
     The spline curve (line) element, NON-UNIFORM RATIONAL B-
     SPLINE, generates a Non-Uniform Rational B-Spline (NURBS)
     curve.

F164 Clause 4.6.1.1
     The spline curve (line) element, POLYBEZIER, generates a
     sequence of one or more cubic Bezier curves.

F165 Clause 4.6.1.2
     When using compound line, a line consisting of a number of
     distinct elements, such as straight lines and arcs, is treated
     as a single element.

F166 Clause 4.6.1.2
     Line attributes may not change within a compound line.

F167 Clause 4.6.4.7
     If the INTERIOR STYLE SPECIFICATION MODE is absolute the
     geometric aspects of fill interiors are subject to all
     transformations.

F168 Clause 4.6.5.2
     Between the BEGIN/END TILE ARRAY elements are a series of
     equally sized individual tiles which form a contiguous
     rectangular block.

F169 Clause 4.6.5.2
     The first tile, with tile identifier 1, is placed at the
     position parameter of the BEGIN TILE ARRAY element.
     Subsequent tiles are placed in order first in the cell path
     direction, then in the line progression direction. Tiles are
     numbered sequentially (as they are placed).

F170 Clause 4.6.5.2
BITONAL TILE defines a two colored, rectangular raster image
of either uncompressed or compressed data.

F171 Clause 4.6.5.2
The colors of BITONAL TILE are the values associated with
indexes 0 and 1.

F172 Clause 4.6.5.2
TILE defines a bitonal or full color rectangular raster image
of either uncompressed or compressed data.

F173 Clause 4.6.5.2
The colors associated with the cells of TILE element are
either direct or indexed color and specified according to the
applicable color precisions and modes.

F174 Clause 4.6.5.2
TILE and BITONAL TILE contain no positioning or dimensioning
information. They contain only raster data and any applicable
control parameters.

F175 Clause 4.6.5.2
The parameters of BEGIN TILE ARRAY apply to the collection of
tiles and uniformly to each tile in the collection.

F176 Clause 5.2.16
The parameters of BEGIN TILE ARRAY define the tile. The point
specified by the position parameter is used to place the first
tile. The cell path direction is the direction of progression
of successive cells along a line relative to the VDC x-axis.
The line progression is the direction of progression of
successive cell lines and is relative to the cell path
direction. The values of cell size and number of cells/tile
in path direction define the tile size in the cell path
direction. The values of cell size and number of cells/tile in
line direction define the tile size in the line progression
direction.

F177 Clause 4.6.5.2
The cell color data of the tile elements is a compressed
stream of cell color specifiers.

F178 Clause 4.6.5.2, 5.2.16
The position of the actual image data may be offset such that
there is a border of undefined data surrounding the actual
image. This undefined data is included in the encoding of the
tiles which overlap the border and the defined image.

F179 Clause 4.6.8
The start and end of the hyperbolic arc are parmeterized by
vectors from the center.

F180 Clause 4.6.8
The canonical hyperbolic arc is defined by x*x - y*y = 1 and passes through the point u1 and at u1 the tangent to the hyperbola is parallel to u2. The hyperbola has center at the origin.

F181 Clause 4.6.9
The general parabolic arc is parameterized by the endpoints of the arc and the intersection of the tangents to the arc at the endpoints.

F182 Clause 4.6.10.1
The non-uniform B-spline is parameterized by a spline order, list of knots, a list of control points, and parameter range limits defining the curve section to be drawn.

F183 Clause 4.6.10.1
The non-uniform rational B-spline is parameterized by a spline order, list of knots, list of control points, list of weights associated with the control points, and parameter range limits defining the curve section to be drawn.

F184 Clause 4.6.10.2
The polybezier is parameterized by a list of points and an indicator specifying the degree of continuity between the individual Bezier curves. If there are n(n>=1) curves, then the data list will contain 4n points if continuity is discontinuous or 3n+1 points if continuity is continuous.

F185 Clause 4.6.12
A symbol created by POLYSYMBOL is sized and oriented according to the symbol attributes and placed with its reference point coinciding with the specified position points.

F186 Clause 4.6.12.2
The selection, sizing, and placement of symbols is specified by the symbol attribute elements.

2.3.6 Attribute elements

F187 Clause 4.7.1.2
For LINE CAP unspecified, any implementation dependent treatment is acceptable.

F188 Clause 4.7.1.2
For LINE CAP butt, the line is squared off at the endpoint; there is no projection beyond the endpoint.

F189 Clause 4.7.1.2
For LINE CAP round, a semicircular arc with diameter equal to the line width is drawn around the endpoint and filled in. The line projects beyond the endpoint.

F190 Clause 4.7.1.2
For LINE CAP projecting square, the line is squared off at a distance equal to half the line width beyond the endpoint.

F191 Clause 4.7.1.2
For LINE CAP triangle, a cap is added to the line which is an equilateral triangle whose side equals the line width.

F192 Clause 4.7.1.2
LINE CAP is applicable to open endpoints of line elements or to interior endpoints.

F193 Clause 4.7.1.2
The interior caps must either match the caps on the open endpoints or be implementation dependent.

F194 Clause 4.7.1.2
For LINE JOIN unspecified, any implementation dependent treatment is acceptable.

F195 Clause 4.7.1.2
For LINE JOIN mitre, the outer edges of the two adjoining line segments are extended until they meet at a point.

F196 Clause 4.7.1.2
For LINE JOIN round, a circular arc with diameter equal to the line width is drawn around the vertex between the adjoining segments and is filled in, producing a round corner.

F197 Clause 4.7.1.2
For LINE JOIN bevel, the adjoining line segments are terminated with a butt cap and the resulting triangular notch is filled in.

F198 Clause 4.7.1.2
Line caps and line joins behave as does line width with respect to transformation.

F199 Clause 4.7.1.2
For LINE TYPE CONTINUATION unspecified, no special treatment is required.

F200 Clause 4.7.1.2
For LINE TYPE CONTINUATION continue, the style is continued without interruption across vertices.

F201 Clause 4.7.1.2
For LINE TYPE CONTINUATION restart, the style is restarted at each vertex.

F202 Clause 4.7.1.2
For LINE TYPE CONTINUATION adaptive continue, the style is
continued, but each vertex must be inked including vertices at
the ends of the line primitive which might otherwise not be
drawn because of a non-solid line type.

F203 Clause 4.7.1.2
LINE TYPE INITIAL OFFSET controls how much of the first cycle
of a non-solid line type to omit before drawing commences for
a line primitive. It is specified as a fraction of one full
cycle.

F204 Clause 4.7.3.1
For RESTRICTED TEXT TYPE basic, the string specified is
constrained not to exceed the text restriction box.

F205 Clause 4.7.3.1
For RESTRICTED TEXT TYPE boxed, the baseline to capline
distance of the text string exactly fills the text restriction
box in the vertical direction and the width of the string
exactly fits the box in the horizontal direction.

F206 Clause 4.7.3.1
For RESTRICTED TEXT TYPE isotropic, the text string is
displayed as large as possible within the text restriction box
without altering the ratio of the height to the width of the
string.

F207 Clause 4.7.3.1
For RESTRICTED TEXT TYPE justified, the text string exactly
fits the text restriction box in the width direction without
changing the proportions of the characters.

F208 Clause 5.7.22
Legal values for INTERIOR STYLE are; hollow, solid, pattern,
hatch, empty, geometric pattern, and interpolated.

F209 Clause 4.7.4.3
The color and line type of the lines in the hatch may be
defined as part of the hatch style definition using the HATCH
STYLE DEFINITION element.

F210 Clause 4.7.4.3
Changing the definition of an already defined hatch index
shall have no retroactive or dynamic effects.

F211 Clause 4.7.4.3.2
Interpolated interior parallel is a multi-stage style. Each
stage is semi-infinite band bounded by two parallel lines. A
reference color is defined on each parallel line. Color is
constant within the band and equal to the linear interpolant
of the reference colors. Color for outermost bands is

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constant and equal to the corresponding outer-most reference colors.

F212 Clause 4.7.4.3.2
Interpolated interior elliptical is a multi-stage style. Each style is an elliptical annulus with a reference color defined on each of the inner and outer bounding ellipses. Colors are constant along ellipses which are concentric to the reference ellipse.

F213 Clause 4.7.4.3.2
For interpolated interior triangular, colors are associated with three points defining a triangle.

F214 Clause 5.7.43
For the INTERPOLATED INTERIOR element, the values of the scalars of the reference geometry must produce distinct (non-coincident) geometry reference points.

F215 Clause 4.7.4.4
EDGE CAP specifies the appearance of the endpoints of edges. The supported styles and definitions are the same as for the LINE CAP element.

F216 Clause 4.7.4.4
EDGE JOIN specifies the appearance of edges at the vertices of filled-area elements or at junctions between distinct elements in compound filled area elements. The supported styles and their definitions are as for the LINE JOIN element.

F217 Clause 4.7.4.4
EDGE TYPE CONTINUATION provides control of the behavior of non-solid edge types at interior vertices and junctions of the edges of filled-area elements. The supported styles and their definitions are as for the LINE TYPE CONTINUATION element.

F218 Clause 4.7.4.4
EDGE TYPE INITIAL OFFSET controls how much of the first cycle of a non-solid line type to omit before drawing commences for a line primitive. It is specified as a fraction of one full cycle.

F219 Clause 4.7.5
Geometric information related to line width, line type, edge width, edge type, marker size and fill interiors is specified with modes: absolute, scaled, fractional, and mm.

F220 Clause 4.7.5
In absolute mode, the associated aspects are conceptually rendered in VDC space before it applies any associated transformations.

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F221 Clause 4.7.5
Scaled mode is completely device and interpreter independent -
neither the final displayed sizes nor their relationship to
the rest of the displayed picture are precisely controllable.

F222 Clause 4.7.5
Fractional mode precisely specifies the sizes according to
their relationship to the rest of the picture but not in terms
of actual physical measurements.

F223 Clause 4.7.5
MM mode precisely specifies the sizes in terms of their actual
physical measurements which remain invariant as display size
varies.

F224 Clause 4.7.6
Color models define a color coordinate system and subspace
within which each color is represented by a point

F225 Clause 4.7.6
The meaning of each color space is defined by the
transformation necessary to convert a color specification
expressed in a reference color space to or from the
specification of the same color in the CGM color space (color
calibration).

F226 Clause 4.7.6
The reference color space is normalized such that the Y
tristimulus value is 1 for the reference white.

F227 Clause 4.7.6
The reference white value is the only calibration data
applicable to the CIELAB and CIELUV color spaces.

F228 Clause 4.7.6
Calibration data for the RGB color space consists of a 3x3
matrix specifying the position of the RGB primaries in CIEXYZ
space.

F229 Clause 4.7.6
The calibration data for the CMYK color space consists of CMYK
grid locations and corresponding CIEXYZ values.

F230 Clause 4.7.8
The path of a compound text path consists of a number of
distinct elements which serve as a reference path for laying
out subsequent text strings.

F231 Clause 4.7.8
If two adjacent line segments of a compound text path are not
contiguous, then the path includes the straight line segment
joining these two points.

F232 Clause 4.7.8
Each glyph in a text string is placed with its reference point on the compound text path according to the alignment.

F233 Clause 4.7.9, 5.7.48
The value of the symbol library index of the SYMBOL LIBRARY INDEX element must correspond to a value already specified in the SYMBOL LIBRARY LIST element.

F234 Clause 4.7.9, 5.7.51
For the SYMBOL ORIENTATION element, the symbol up vector and the symbol base vector must be non-collinear and have positive length.

3 REQUIREMENTS EXTRACTED FROM ANSI/ISO 8632-3:1992

3.1 Version 1 binary encoding requirements

B1: Clause 6, 7.6
Individual run-lengths in CELL ARRAY shall not be constrained to start on word boundaries.

B2: Clause 4.4
When partitioning elements, only the beginnings of elements, and not the start of each partition, is constrained to start on word boundaries.

B3: Table 8
The Character Expansion Factor can be 0 or any positive real number.

B4: Annex C
NOOP is legal in Metafile Element List.

B5: Clause 5.3
The character count of string type parameters counts octets, not complete character codes.

B6: Clause 7.3, 7.7
Private values shall not be allowed in any enumerated parameter; e.g., Character Coding Announcer, Interior Style, and Character Set List.

3.2 Version 2 binary encoding requirements

B7 Table 1
When DEVICE VIEWPORT SPECIFICATION MODE is 'fraction of display surface', the parameter type VC is real.

B8 Table 1
When DEVICE VIEWPORT SPECIFICATION MODE is 'millimetres with scale factor' or 'physical device coordinates', the parameter type VC is integer.

B9 Table 1
The abstract parameter type VC, a single VC value, is a either real or integer depending on the DEVICE VIEWPORT SPECIFICATION MODE element. If the mode is 'fraction of display surface', the value is real; otherwise, the value is integer.

B10 Table 3
BEGIN SEGMENT has 1 parameter, P1 which is a unique segment identifier.

B11   Table 4
      NAME PRECISION has 1 parameter with precision values of 8, 16,
      24, or 32.

B12   Table 4
      SCALING MODE parameter is always encoded as Floating Point,
      regardless of the values of the fixed/floating flag of REAL
      PRECISION.

B13   Table 5
      The valid values of DEVICE VIEWPORT SPECIFICATION MODE are
      fraction of drawing surface, millimetres with scale factor,
      and physical device coordinates.

B14   Table 5
      DEVICE VIEWPORT SPECIFICATION MODE parameter is always encoded
      as Floating Point, regardless of the values of the
      fixed/floating flag of REAL PRECISION.

B15   Table 5
      DEVICE VIEWPORT MAPPING has 3 enumerated parameters: P1 values
      are: 'not forced' or 'forced'; P2 values are: 'left',
      'center', or 'right'; and P3 values are: 'bottom', 'center',
      or 'top'.

B16   Table 5
      LINE REPRESENTATION has 4 parameters, P2 has standardized
      values 1-5. The parameters correspond to the bundle table
      entries.

B17   Table 5
      MARKER REPRESENTATION has 4 parameters, P2 has standardized
      values 1-5. The parameters correspond to the bundle table
      entries.

B18   Table 5
      TEXT REPRESENTATION has 6 parameters. The parameters
      correspond to the bundle table entries.

B19   Table 5
      FILL REPRESENTATION has 5 parameters, P2 is an enumerated
      style, P4 has standardized values 1-6. The parameters
      correspond to the bundle table entries.

B20   Table 5
      EDGE REPRESENTATION has 4 parameters, P2 has standardized
      values 1-5. The parameters correspond to the bundle table
      entries.

B21   Table 6
      LINE CLIPPING MODE has 1 enumerated parameter, valid values
      are: 'locus', 'shape', and 'locus then shape'.

B22   Table 6
MARKER CLIPPING MODE has 1 enumerated parameter, valid values are: 'locus', 'shape', and 'locus then shape'.

B23   Table 6
EDGE CLIPPING MODE has 1 enumerated parameter, valid values are: 'locus', 'shape', and 'locus then shape'.

B24   Table 6
NEW REGION has no parameters.

B25   Table 6
The P1 parameter of SAVE PRIMITIVE CONTEXT is the unique context name.

B26   Table 6
The P1 parameter of RESTORE PRIMITIVE CONTEXT is a context name that corresponds to name in SAVE PRIMITIVE CONTEXT.

B27   Table 7
CIRCULAR ARC CENTRE REVERSED has 6 parameters, a point and 5 vdc values.

B28   Table 7
CONNECTING EDGE has no parameters.

B29   Table 8
PICK IDENTIFIER has 1 parameter.

B30   Clause 7.7
For line types, marker types, and edge types, registered values greater than 5 are reserved for registration. For Hatch indices, values above 6 are reserved for registration.

B31   Table 11
COPY SEGMENT has 3 parameters; an identifier, 6 values of the transformation matrix, and an enumerated value: 'no' or 'yes'.

B32   Table 11
INHERITANCE FILTER has 2 parameters; P1 is a list of up to 70 attribute or group designators, P2 is an enumerated value: 'state list' or 'segment'.

B33   Table 11
CLIP INHERITANCE has 1 parameter with the enumerated value: 'state list' or 'intersection'.

B34   Table 11
SEGMENT TRANSFORMATION has 2 parameters; an identifier, and 6 values of the transformation matrix.

B35 Table 11
SEGMENT HIGHLIGHTING has 2 parameters; an identifier and the enumerated value: 'normal' or 'highlighted'.

B36 Table 11
SEGMENT DISPLAY PRIORITY has 2 parameters; an identifier and the display priority.

B37 Table 11
The default segment display priority is equal to the minimum segment priority value.

B38 Table 11
SEGMENT PICK PRIORITY has 2 parameters; an identifier and the pick priority.

B39 Table 11
The default segment pick priority is equal to the minimum segment pick value.

B40 Clause 8
The default NAME PRECISION is 16 bits.

3.3 Version 3 binary encoding requirements

B41 Table 1, note 15
The bitstream (BS) data type is encoded as a stream of binary digits (bits) packed in 16-bit unsigned integers.

B42 Table 1, note 16
The abstract parameter type CD is a 3-tuple or 4-tuple of color coordinates depending on the COLOUR MODEL.

B43 Table 3
BEGIN COMPOUND PATH has 1 enumerated parameter with value: 'text path' or 'compound line'.

B44 Table 3
BEGIN PROTECTION REGION has 1 parameter, a region index.

B45 Table 3
BEGIN TILE ARRAY has 13 parameters; a point position, enumerated cell path direction (0, 90, 180, 270 degrees), enumerated line progression direction (90, 270), number of tiles in path direction, number of tiles in line direction, number of cells/tile in path and line directions, cell size in path and line directions, image offset in path and line directions, image size in path and line directions.

B46 Table 4
Each character is stored in 1 or more consecutive octets, depending upon the coding of the character set.

B47 Table 4
The COLOUR VALUE EXTENT element provides the mapping between a direct color component and the corresponding real value.

B48 Table 4
For RGB or CMYK, the COLOUR VALUE EXTENT has 2 parameters, the minimum and maximum color values.

B49 Table 4
For CIELAB or CIELUV, the COLOUR VALUE EXTENT has 3 parameters; the scale and offset pair for the first, second and third components.

B50 Table 4
The standardized COLOUR MODEL values are RGB, CIELAB, CIELUV, and CMYK.

B51 Table 4
Color model values greater than 5 are reserved for registration.

B52 Table 4
COLOUR CALIBRATION has 4 parameters; reference white value for the X, Y, Z components; and the calibration data whose format depends on the color model.

B53 Table 4
FONT PROPERTIES has 4-tuple parameters containing the property indicator, property value type, property value, and priority.

B54 Table 4
Valid values for the property indicator are 1 - 6.

B55 Table 4
Property value values must be used in correct association with the property value type and property name.

B56 Table 4
GLYPH MAPPING has 5 parameter values: an index; enumerated basis set character set type; string of sequence tail; number of octets per code; and list of the glyph name pairs.

B57 Table 4
SYMBOL LIBRARY LIST has a variable parameter list depending on the number of library names. The number of parameters equals the number of names in the list.

B58 Table 5
The metric scale factor of the SCALING MODE and DEVICE VIEWPORT SPECIFICATION MODE elements must always be coded with floating point reals.

B59   Table 5
       The parameter range for the LINE WIDTH SPECIFICATION MODE is
       {0..3}, with values: 'absolute', 'scaled', 'fractional', and
       'mm'.

B60   Table 5
       The parameter range for the MARKER WIDTH SPECIFICATION MODE is
       {0..3}, with values: 'absolute', 'scaled', 'fractional', and
       'mm'.

B61   Table 5
       The parameter range for the EDGE WIDTH SPECIFICATION MODE is
       {0..3}, with values: 'absolute', 'scaled', 'fractional', and
       'mm'.

B62   Table 5
       INTERIOR STYLE SPECIFICATION MODE has 1 enumerated parameter
       with values: 'absolute', 'scaled', 'fractional', or 'mm'.
       Version 1/2 the style is limited to 'absolute'.

B63   Table 5
       The parameter list of LINE AND EDGE TYPE DEFINITION is
       variable. The index (line type) parameter is always negative.

B64   Table 5
       The parameter list of HATCH STYLE DEFINITION contains the
       hatch index; an enumerated style indicator with values:
       'parallel' or 'cross hatch'; the hatch direction for the x and
       y component in the first and second directions; a real duty
       cycle length; the number 'n' of hatch lines; list of 'n' gap
       widths; and list of 'n' line types.

B65   Table 5
       The HATCH STYLE DEFINITION has a variable parameter list. The
       index (hatch index) values are always negative and the style
       indicator is an enumerated value: 'parallel' or 'cross hatch'.

B66   Table 5
       The GEOMETRIC PATTERN DEFINITION has 4 parameters: an index;
       segment identifier; first corner point; and second corner
       point.

B67   Table 6
       AUXILIARY COLOUR values are either a 3-tuple or 4-tuple of
       direct color components, depending on the color model.

B68   Table 6
       PROTECTION REGION INDICATOR has 2 parameters: an index and a
       region indicator with values: 'off', 'clip', and 'shield'.

B69   Table 6
       GENERALIZED TEXT PATH MODE has 1 enumerated parameter with
       values: 'off', 'non-tangential', and 'axis tangential'.

B70   Table 6
       The MITRE LIMIT is parameter is a non-negative real.

B71   Table 7
       HYPERBOLIC ARC has 7 parameters to describe the arc: P1..P3
       are points; and P4..P7 are vdc values.

B72   Table 7
       PARABOLIC ARC has 3 parameters to describe the arc: tangent
       intersection; start; and end points.

B73   Table 7
       NON-UNIFORM B-SPLINE has a variable parameter list. The first
       2 parameters are always the spline order and number of control
       points.

B74   Table 7
       NON-UNIFORM RATIONAL B-SPLINE has a variable parameter list.
       The first 2 parameters are always the spline order and number
       of control points.

B75   Table 7
       POLYBEZIER has a variable parameter list: values for P1 are
       'discontinuous', 'continuous', and 'smooth'. The other
       parameters are a list of point sequences.

B76   Table 7
       SYMBOL has 2 parameters: a position point and the symbol
       index.

B77   Table 7
       TILE has 4 parameters: a tile identifier: an index (0..6)
       indicating the compression type; the cell color precision; and
       the compressed cell color specifiers.

B78   Table 7
       The compression type values 0-6 are registered; values greater
       than 6 are reserved for registration.

B79   Table 7
       The cell color precision values for TILE are the same as for
       the local color precision of CELL ARRAY.

B80   Table 8
       If the LINE WIDTH specification mode is absolute, the line
       width specifier is vdc; otherwise the specifier is real.

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B81 Table 8
If the MARKER SIZE specification mode is absolute, the line width specifier is vdc; otherwise the specifier is real.

B82 Table 8
If the EDGE WIDTH specification mode is absolute, the line width specifier is vdc; otherwise the specifier is real.

B83 Table 8
The parameter list for LINE AND EDGE TYPE DEFINITION is variable; containing the line type index, the dash cycle length, and 'n' parameters of dash elements.

B84 Table 8
LINE CAP has 2 parameters: the indicator with standardized values 1..5; and the enumerated dash cap indicator with values 'unspecified' or 'match'.

B85 Table 8
The LINE JOIN parameter is an indicator with standardized values 1..4.

B86 Table 8
The LINE TYPE CONTINUATION parameter has standardized values 1..4. Values greater than 4 are reserved for registration.

B87 Table 8
The LINE TYPE INITIAL OFFSET parameter is real.

B88 Table 8
The TEXT SCORE TYPE parameter has standardized values 1..4 for score type and 0 or 1 for score indicator.

B89 Table 8
The RESTRICTED TEXT TYPE parameter has standardized values 1..4.

B90 Table 8
The variable parameter list of INTERPOLATED INTERIOR DEFINITION contains the style with standardized values 1..3; the reference geometry; the number of 'm' stages; array of 'm' stage designators; and array of color specifiers.

B91 Table 8
EDGE CAP has 2 parameters: the indicator with standardized values 1..5; and the enumerated dash cap indicator with values: 'unspecified' or 'match'.

B92 Table 8
The EDGE JOIN parameter is an indicator with standardized values 1..4. Values greater than 4 are reserved for registration.

B93   Table 8
      The EDGE TYPE CONTINUATION parameter has standardized values
      1..4. Values greater than 4 are reserved for registration.

B94   Table 8
      The EDGE TYPE INITIAL OFFSET parameter is real.

B95   Table 8
      The SYMBOL LIBRARY INDEX parameter is an index which
      corresponds to an entry in the symbol table.

B96   Table 8
      The SYMBOL COLOUR parameter indicates the symbol color.

B97   Table 8
      SYMBOL SIZE has 3 parameters: the enumerated scale indicator
      with values: 'height', 'width', or 'both'; symbol height; and
      symbol width.

B98   Table 8
      SYMBOL ORIENTATION has 4 vdc parameters: the x and y up vector
      components; and the x and y base vector components.

4 REQUIREMENTS EXTRACTED FROM MIL-D-28003A

4.1 Delimiter Elements

M1 BEGIN SEGMENT
The number of simultaneously defined segments is limited to
256. This number of levels of nesting of segments is limited
to 4.

M2 BEGIN/END COMPOUND LINE
The number of contributing elements is limited to 32.

M3 END TILE ARRAY
Tile size is limited to 1048576 compressed color specifiers.

M4 END TILE ARRAY
The number of tiles is limited to 256.

4.2 Metafile Descriptor Elements

M5 METAFILE VERSION
Any of the version values, "1","2", or "3" shall be contained
in the metafile.

M6 METAFILE VERSION
The metafile version shall appear only once in a metafile.

M7 METAFILE DESCRIPTION
The element string must contain the phrase "MIL-D-
28003A/BASIC-1" followed by one of the strings "" (the null
string), ".0", ".1", or ".2".

M8 METAFILE DESCRIPTION
If Type 0 is encountered, the metafile is monochrome and shall
be capable of interpreting only monochrome.

M9 METAFILE DESCRIPTION
If Type 1 is encountered, the metafile is grayscale and shall
be capable of interpreting monochrome and grayscale.

M10 METAFILE DESCRIPTION
If Type 2 is encountered, the metafile is color and shall be
capable of interpreting monochrome, grayscale, and color.

M11 METAFILE DEFAULTS REPLACEMENT
This element shall not be partitioned, nor shall elements
within the METAFILE DEFAULTS REPLACEMENT.

M12 Order of Metafile Descriptor Elements
The first three Metafile Descriptor elements are: METAFILE
VERSION, METAFILE ELEMENT LIST, METAFILE DESCRIPTION.

M13 FONT LIST
     Up to 32 simultaneous fonts are supported with names selected
     from table IX and X in MIL-D-28003A.

M14 FONT LIST
     The font names "HERSHEY' is an acceptable substitution for
     "HERSHEY/".

M15 FONT LIST
     The font names are case insensitive (i.e., upper or lower case
     is not significant).

M16 FONT LIST
     Substitution of the named fonts with fonts which are
     metrically equivalent fonts is allowed.

M17 MAXIMUM COLOUR INDEX
     The MAXIMUM COLOUR INDEX must correspond to the color level
     (i.e., 0,1,or 2).

M18 MAXIMUM COLOUR INDEX
     The parameter is limited to 0-255 for color metafiles; 0-15
     for grayscale metafiles, and 0-1 for monochrome metafiles.

M19 NAME PRECISION
     The parameter value shall be limited to either 8 or 16 bits.

M20 Version 3 elements
     The following elements are not allowed: COLOUR MODEL, COLOUR
     CALIBRATION, FONT PROPERTIES, GLYPH MAPPING, SYMBOL LIBRARY
     LIST.

4.3 Picture Descriptor Elements

M21 COLOUR SELECTION MODE
     Only a single value of color selection mode, 0 or 1, may
     appear in each picture. The color mode may not be changed
     within a picture.

M22 Version 2 elements
     The following elements are not allowed: SET LINE
     REPRESENTATION, SET MARKER REPRESENTATION, SET TEXT
     REPRESENTATION, SET FILL REPRESENTATION, SET EDGE
     REPRESENTATION, DEVICE VIEWPORT, DEVICE VIEWPORT MAPPING,
     DEVICE VIEWPORT SPECIFICATION MODE.

M23 LINE and EDGE TYPE DEFINITION
     At most 16 user line types shall be specified simultaneously.
     The number of entries in the dash gap list parameter shall not
     exceed 8.

M24 HATCH STYLE DEFINITION
At most 16 user hatch styles shall be specified simultaneously. The number of entries in the gaps list parameter shall not exceed 8.

M25 Version 3 elements
The following elements are not allowed: GEOMETRIC PATTERN DEFINITION.

4.4 Control Elements

M26 Required Version 2 and 3 elements
The following elements must be present in version 2 or version 3 metafiles: LINE CLIP MODE, MARKER CLIP MODE, EDGE CLIP MODE.

M27 LINE CLIP MODE
The default value is 1 (shape). The basic values are 1..2.

M28 MARKER CLIP MODE
The default value is 1 (shape). The basic values are 1..2.

M29 EDGE CLIP MODE
The default value is 1 (shape). The basic values are 1..2.

M30 Version 2 elements
The following elements are not allowed: SAVE PRIMITIVE CONTEXT, RESTORE PRIMITIVE CONTEXT.

M31 Version 3 elements
The following elements are not allowed: PROTECTION REGION INDICATOR, GENERALIZED TEXT PATH MODE.

4.5 Graphical Primitive Elements

M32 TEXT, APPEND TEXT, RESTRICTED TEXT
Control characters (codes 1-31 and 128-159) are prohibited, but NUL (code 0) is allowed, in graphical text strings except as required to implement permissible character set switching mechanisms.

M33 closed figure
The number of contributing elements is limited to 32.

M34 POLYBEZIER
The number of bezier segments shall not exceed 256.

M35 TILE, BITONAL TILE
The basic values of the compression type parameter shall be limited to 0-6.

M36 NON UNIFORM B-SPLINE, NON UNIFORM RATIONAL B-SPLINE
The basic values for order are: 2..7. The number of control
points shall be <or= 1024.

4.6 Attribute Elements

M37 LINE TYPE
Basic values are the standardized values 1-5 and registered
values 6-15. Private values (i.e. those defined in MIL-D-
28003) are not allowed.

M38 LINE WIDTH
The width shall not exceed 10% of the drawing size, which is
defined as the shortest side of the VDC Extent. Wider lines
shall be rendered as filled areas.

M39 HATCH INDEX
Basic values are the standardized values 1-6. Private values
(i.e., those defined in MIL-D-28003) are not allowed.

M40 EDGE WIDTH
The width shall not exceed 10% of the drawing size, which is
defined as the shortest side of the VDC Extent. Wider lines
shall be rendered as filled areas.

M41 EDGE
Drawn edges of filled-area elements shall be centered on the
ideal mathematically-defined edge of the area.

M42 TEXT FONT INDEX
Every referenced font index shall correspond to a defined
entry in the font list.

M43 CHARACTER SET INDEX
Every referenced character set index shall correspond to a
defined entry in the character set list.

M44 ALTERNATE CHARACTER SET INDEX
Every referenced alternate character set index shall
correspond to a defined entry in the character set list.

M45 COLOUR TABLE
The starting color index shall correspond to the color level
(0,1,2) such that the index range is: 0-255 for color
metafiles, 0-15 for grayscale metafiles, and 0-1 for
monochrome metafiles.

M46 PICK IDENTIFIER
This element has no graphical effect. It may be ignored by
interpreters.

M47 LINE CAP
Basic values for line cap indicator are 1-5. Basic values for
dash cap indicator are 1-3.

M48 LINE JOIN
Basic values for the line join indicator are 1-4.

M49 LINE TYPE CONTINUATION
Basic values for continuation mode are 1-4.

M50 LINE TYPE INITIAL OFFSET
Basic values are 0.0 - 1.0 (inclusive).

M51 EDGE CAP
Basic values for edge cap indicator are 1-5. Basic values for
dash cap indicator are 1-3.

M52 EDGE JOIN
Basic values for the edge join indicator are 1-4.

M53 EDGE TYPE CONTINUATION
Basic values for continuation mode are 1-4.

M54 EDGE TYPE INITIAL OFFSET
Basic values are 0.0 - 1.0 (inclusive).

M55 RESTRICTED TEXT TYPE
Basic values are 2-6.

M56 RESTRICTED TEXT TYPE
The default value, 1, of this element is not allowed.

M57 RESTRICTED TEXT TYPE
This element shall appear in every version 3 metafile which
uses RESTRICTED TEXT (either in each picture or in a METAFILE
DEFAULTS REPLACEMENT element).

M58 Version 3 elements
The following elements are not allowed: TEXT SCORE TYPE,
INTERPOLATED INTERIOR, SYMBOL LIBRARY INDEX, SYMBOL COLOUR,
SYMBOL SIZE, SYMBOL ORIENTATION.

4.7 Segment Elements

M59 Global segments
When global segments are specified in the Metafile Descriptor,
all global segment definitions shall follow all other Metafile
Descriptor elements.

M60   Global segments
       When global segments are specified in the Picture Descriptor,
       all global segment definitions shall follow all other Picture
       Descriptor elements.

M61   COPY SEGMENT
       Segment copy references shall not be nested more than 4 deep.
       Depth 1 shall correspond to flat structure (i.e., no nesting
       or hierarchy).

M62   COPY SEGMENT
       Segment copy depth 1 shall correspond to flat structure (i.e.,
       no nesting or hierarchy).

M63   SEGMENT PICK PRIORITY
       This element has no graphical effect. It may be ignored by
       interpreters.

M64   Version 3 elements
       The following elements are not allowed: CLIP INHERITANCE,
       SEGMENT HIGHLIGHTING.

4.8 Escape Elements

M65   Escape
       No ESCAPE elements are allowed. (Those ESCAPE elements
       defined in MIL-D-28003 are no longer allowed.)

4.9 External Elements

M66   MESSAGE
       The action required flag shall not be used to alter the
       picture definition.

4.10 Generator Requirements

M67   Generators shall create metafiles which accurately and
       correctly define the intended picture.

M68   Generators shall produce only conforming basic metafiles.

4.11 Interpreter Requirements

M69   Interpreters shall be classified as: Type 0 – monochrome; Type
       1 – grayscale; or Type 2 – full color.

M70   Interpreters shall at a minimum, correctly interpret any
       conforming basic metafile of the same version and same type.

M71   The rendered picture shall accurately and correctly represent
       the metafile being interpreted.

M72   Color shall be rendered according to the category of the
      interpreter: monochrome, grayscale, or color.

M73   If mapping of color or grayscale is allowed, the principles
      set forth in MIL-D-28003A shall apply.

ELEMENT ORDERING REQUIREMENTS
State List Tables

The following tables are extracted from ISO 8632:1992. The tables show the required sequential relationships between metafile elements. The "states" in which each element is allowed for Version 1, Version 2, and Version 3 metafiles are described in the first table. This table also shows the lowest metafile version for which each element is defined.

Table 8 — CGM Elements by their allowed states

CGM Element	ver (1)	PCS	MDS	DR (3)	GSS, DSS	PDS	POS	LSS
		v1(2)	v1	v1	v2	v1	v1	v2
BEGIN METAFILE (4)	1							
END METAFILE	1	X	X					
BEGIN PICTURE	1	X	X					
BEGIN PICTURE BODY	1					X		
END PICTURE	1						X	
BEGIN SEGMENT(7), v2	2		X				X	
BEGIN SEGMENT, v3	2		X			X	X	
END SEGMENT	2				X			X
BEGIN FIGURE	2				X		X	X
END FIGURE	2							
BEGIN PROTECTION REGION	3				X		X	X
END PROTECTION REGION	3							
BEGIN COMPOUND LINE	3				X		X	X
END COMPOUND LINE	3							
BEGIN COMPOUND TEXT PATH	3				X		X	X
END COMPOUND TEXT PATH	3							
BEGIN TILE ARRAY	3						X	
END TILE ARRAY	3							
METAFILE VERSION	1		X					
METAFILE DESCRIPTION	1		X					
VDC TYPE	1		X					
INTEGER PRECISION	1		X					
REAL PRECISION	1		X					
INDEX PRECISION	1		X					
COLOUR PRECISION	1		X					
COLOUR INDEX PRECISION	1		X					
MAXIMUM COLOUR INDEX	1		X					
COLOUR VALUE EXTENT	1		X					
METAFILE ELEMENT LIST	1		X					
METAFILE DEFAULTS REPLACEMENT	1		X					
FONT LIST	1		X					
CHARACTER SET LIST	1		X					
CHARACTER CODING ANNOUNCER	1		X					
NAME PRECISION	2		X					
MAXIMUM VDC EXTENT	2		X					
SEGMENT PRIORITY EXTENT	2		X					
COLOUR MODEL	3		X					
COLOUR CALIBRATION	3		X					
FONT PROPERTIES	3		X					
GLYPH MAPPING	3		X					
SYMBOL LIBRARY LIST	3		X					

Table 8 — CGM Elements by their allowed states (continued)

CGM Element	ver (1)	CGM Major States						
		PCS	MDS	DR (3)	GSS, DSS	PDS	POS	LSS
		v1(2)	v1	v1	v2	v1	v1	v2
SCALING MODE	1			X		X		
COLOUR SELECTION MODE(7), v1	1			X		X		
COLOUR SELECTION MODE, v2/3	1			X	X	X	X	X
LINE WIDTH SPECIFICATION MODE(7), v1	1			X		X		
LINE WIDTH SPECIFICATION MODE, v2/3	1			X	X	X	X	X
MARKER SIZE SPECIFICATION MODE(7), v1	1			X		X		
MARKER SIZE SPECIFICATION MODE, v2/3	1			X	X	X	X	X
EDGE WIDTH SPECIFICATION MODE(7), v1	1			X		X		
EDGE WIDTH SPECIFICATION MODE, v2/3	1			X	X	X	X	X
VDC EXTENT	1			X		X		
BACKGROUND COLOUR	1			X		X		
DEVICE VIEWPORT	2			X		X		
DEVICE VIEWPORT MAPPING	2			X		X		
DEVICE VIEWPORT SPECIFICATION MODE	2			X		X		
LINE REPRESENTATION	2			X		X		
MARKER REPRESENTATION	2			X		X		
TEXT REPRESENTATION	2			X		X		
FILL REPRESENTATION	2			X		X		
EDGE REPRESENTATION	2			X		X		
INTERIOR STYLE SPECIFICATION MODE	3			X	X	X	X	X
LINE AND EDGE TYPE DEFINITION	3			X		X		
HATCH STYLE DEFINITION	3			X		X		
GEOMETRIC PATTERN DEFINITION	3			X		X		
VDC INTEGER PRECISION	1			X	X		X	X
VDC REAL PRECISION	1			X	X		X	X
AUXILIARY COLOUR	1			X	X		X	X
TRANSPARENCY	1			X	X		X	X
CLIP RECTANGLE	1			X	X		X	X
CLIP INDICATOR	1			X	X		X	X
LINE CLIPPING MODE	2			X	X		X	X
MARKER CLIPPING MODE	2			X	X		X	X
EDGE CLIPPING MODE	2			X	X		X	X
NEW REGION	2							
SAVE PRIMITIVE CONTEXT	2				X		X	X
RESTORE PRIMITIVE CONTEXT	2				X		X	X
PROTECTION REGION INDICATOR	3			X	X		X	X
GENERALIZED TEXT PATH MODE	3			X	X		X	X
MITRE LIMIT	3			X	X		X	X
TRANSPARENT CELL COLOUR	3			X	X	X	X	X

Table 8 — CGM Elements by their allowed states (continued)

CGM Element	ver (1)	PCS v1(2)	MDS v1	DR (3) v1	GSS, DSS v2	PDS v1	POS v1	LSS v2
POLYLINE	1				X		X	X
DISJOINT POLYLINE	1				X		X	X
POLYMARKER	1				X		X	X
TEXT	1				X		X	X
RESTRICTED TEXT	1				X		X	X
APPEND TEXT	1							
POLYGON	1				X		X	X
POLYGON SET	1				X		X	X
CELL ARRAY	1				X		X	X
GDP	1				X		X	X
RECTANGLE	1				X		X	X
CIRCLE	1				X		X	X
CIRCULAR ARC 3 POINT	1				X		X	X
CIRCULAR ARC 3 POINT CLOSE	1				X		X	X
CIRCULAR ARC CENTRE	1				X		X	X
CIRCULAR ARC CENTRE CLOSE	1				X		X	X
ELLIPSE	1				X		X	X
ELLIPTICAL ARC	1				X		X	X
ELLIPTICAL ARC CLOSE	1				X		X	X
CIRCULAR ARC CENTRE REVERSED	2				X		X	X
CONNECTING EDGE	2							
HYPERBOLIC ARC	3				X		X	X
PARABOLIC ARC	3				X		X	X
NON-UNIFORM B-SPLINE	3				X		X	X
NON-UNIFORM RATIONAL B-SPLINE	3				X		X	X
POLYBEZIER	3				X		X	X
POLYSYMBOL	3				X		X	X
BITONAL TILE	3							
TILE	3							
LINE BUNDLE INDEX	1			X	X		X	X
LINE TYPE	1			X	X		X	X
LINE WIDTH	1			X	X		X	X
LINE COLOUR	1			X	X		X	X
MARKER BUNDLE INDEX	1			X	X		X	X
MARKER TYPE	1			X	X		X	X
MARKER SIZE	1			X	X		X	X
MARKER COLOUR	1			X	X		X	X
TEXT BUNDLE INDEX	1			X	X		X	X
TEXT FONT INDEX	1			X	X		X	X
TEXT PRECISION	1			X	X		X	X
CHARACTER EXPANSION FACTOR	1			X	X		X	X
CHARACTER SPACING	1			X	X		X	X
TEXT COLOUR	1			X	X		X	X
CHARACTER HEIGHT	1			X	X		X	X
CHARACTER ORIENTATION	1			X	X		X	X

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Table 8 — CGM Elements by their allowed states (continued)

CGM Element	ver (1)	CGM Major States						
		PCS	MDS	DR (3)	GSS, DSS	PDS	POS	LSS
		v1(2)	v1	v1	v2	v1	v1	v2
TEXT PATH	1			X	X		X	X
TEXT ALIGNMENT	1			X	X		X	X
CHARACTER SET INDEX	1			X	X		X	X
ALTERNATE CHARACTER SET INDEX	1			X	X		X	X
FILL BUNDLE INDEX	1			X	X		X	X
INTERIOR STYLE	1			X	X		X	X
FILL COLOUR	1			X	X		X	X
HATCH INDEX	1			X	X		X	X
PATTERN INDEX	1			X	X		X	X
EDGE BUNDLE INDEX	1			X	X		X	X
EDGE TYPE	1			X	X		X	X
EDGE WIDTH	1			X	X		X	X
EDGE COLOUR	1			X	X		X	X
EDGE VISIBILITY	1			X	X		X	X
FILL REFERENCE POINT	1			X	X		X	X
PATTERN TABLE(7), v1	1			X			X	
PATTERN TABLE, v2/3	1			X		X	X	
COLOUR TABLE(7), v1	1			X			X	
COLOUR TABLE, v2/3	1			X		X	X	
ASPECT SOURCE FLAGS	1			X	X		X	X
PICK IDENTIFIER	2			X	X		X	X
LINE CAP	3			X	X		X	X
LINE JOIN	3			X	X		X	X
LINE TYPE CONTINUATION	3			X	X		X	X
LINE TYPE INITIAL OFFSET	3			X	X		X	X
TEXT SCORE TYPE	3			X	X		X	X
RESTRICTED TEXT TYPE	3			X	X		X	X
INTERPOLATED INTERIOR	3			X	X		X	X
EDGE CAP	3			X	X		X	X
EDGE JOIN	3			X	X		X	X
EDGE TYPE CONTINUATION	3			X	X		X	X
EDGE TYPE INITIAL OFFSET	3			X	X		X	X
SYMBOL LIBRARY INDEX	3			X	X		X	X
SYMBOL COLOUR	3			X	X		X	X
SYMBOL SIZE	3			X	X		X	X
SYMBOL ORIENTATION	3			X	X		X	X
ESCAPE	1	X	X	X	X	X	X	X
MESSAGE	1	X	X	X	X	X	X	X
APPLICATION DATA	1	X	X	X	X	X	X	X
COPY SEGMENT	2				X		X	X
INHERITANCE FILTER	2			X	X		X	X
CLIP INHERITANCE	2			X	X		X	X
SEGMENT TRANSFORMATION	2			X	X			X
SEGMENT HIGHLIGHTING	2			X	X			X
SEGMENT DISPLAY PRIORITY	2			X	X			X
SEGMENT PICK PRIORITY	2			X	X			X

Table 8 — CGM Elements by their allowed states (continued)

CGM Element	CGM Minor States				
	FOS v2	TOS v1	CPS v3	PRS v3	TAS v3
BEGIN METAFILE END METAFILE BEGIN PICTURE BEGIN PICTURE BODY END PICTURE					
BEGIN SEGMENT END SEGMENT BEGIN FIGURE END FIGURE BEGIN PROTECTION REGION	X			.	
END PROTECTION REGION BEGIN COMPOUND LINE END COMPOUND LINE BEGIN COMPOUND TEXT PATH END COMPOUND TEXT PATH			X(5) X(6)	X	
BEGIN TILE ARRAY END TILE ARRAY METAFILE VERSION METAFILE DESCRIPTION VDC TYPE .					X
INTEGER PRECISION REAL PRECISION INDEX PRECISION COLOUR PRECISION COLOUR INDEX PRECISION					
MAXIMUM COLOUR INDEX COLOUR VALUE EXTENT METAFILE ELEMENT LIST METAFILE DEFAULTS REPLACEMENT FONT LIST					
CHARACTER SET LIST CHARACTER CODING ANNOUNCER NAME PRECISION MAXIMUM VDC EXTENT SEGMENT PRIORITY EXTENT					
COLOUR MODEL COLOUR CALIBRATION FONT PROPERTIES GLYPH MAPPING SYMBOL LIBRARY LIST					

Table 8 — CGM Elements by their allowed states (continued)

CGM Element	CGM Minor States				
	FOS v2	TOS v1	CPS v3	PRS v3	TAS v3
SCALING MODE COLOUR SELECTION MODE LINE WIDTH SPECIFICATION MODE MARKER SIZE SPECIFICATION MODE EDGE WIDTH SPECIFICATION MODE					
VDC EXTENT BACKGROUND COLOUR DEVICE VIEWPORT DEVICE VIEWPORT MAPPING DEVICE VIEWPORT SPECIFICATION MODE					
LINE REPRESENTATION MARKER REPRESENTATION TEXT REPRESENTATION FILL REPRESENTATION EDGE REPRESENTATION					
INTERIOR STYLE SPECIFICATION MODE LINE AND EDGE TYPE DEFINITION HATCH STYLE DEFINITION GEOMETRIC PATTERN DEFINITION VDC INTEGER PRECISION	 X		 X	 X	
VDC REAL PRECISION AUXILIARY COLOUR TRANSPARENCY CLIP RECTANGLE CLIP INDICATOR	X X X	 X X	X	X	
LINE CLIPPING MODE MARKER CLIPPING MODE EDGE CLIPPING MODE NEW REGION SAVE PRIMITIVE CONTEXT	 X			 X	
RESTORE PRIMITIVE CONTEXT PROTECTION REGION INDICATOR GENERALIZED TEXT PATH MODE MITRE LIMIT TRANSPARENT CELL COLOUR					

Table 8 — CGM Elements by their allowed states (continued)

CGM Element	CGM Minor States				
	FOS v2	TOS v1	CPS v3	PRS v3	TAS v3
POLYLINE	X		X	X	
DISJOINT POLYLINE	X		X	X	
POLYMARKER					
TEXT					
RESTRICTED TEXT					
APPEND TEXT		X			
POLYGON	X			X	
POLYGON SET	X			X	
CELL ARRAY					
GDP	X		X	X	
RECTANGLE	X			X	
CIRCLE	X			X	
CIRCULAR ARC 3 POINT	X		X	X	
CIRCULAR ARC 3 POINT CLOSE	X			X	
CIRCULAR ARC CENTRE	X		X	X	
CIRCULAR ARC CENTRE CLOSE	X			X	
ELLIPSE	X			X	
ELLIPTICAL ARC	X		X	X	
ELLIPTICAL ARC CLOSE	X			X	
CIRCULAR ARC CENTRE REVERSED	X		X	X	
CONNECTING EDGE	X				
HYPERBOLIC ARC	X		X	X	
PARABOLIC ARC	X		X	X	
NON-UNIFORM B-SPLINE	X		X	X	
NON-UNIFORM RATIONAL B-SPLINE	X		X	X	
POLYBEZIER	X		X	X	
POLYSYMBOL					
BITONAL TILE					X
TILE					X
LINE BUNDLE INDEX					
LINE TYPE					
LINE WIDTH					
LINE COLOUR					
MARKER BUNDLE INDEX					
MARKER TYPE					
MARKER SIZE					
MARKER COLOUR					
TEXT BUNDLE INDEX		X			
TEXT FONT INDEX		X			
TEXT PRECISION		X			
CHARACTER EXPANSION FACTOR		X			
CHARACTER SPACING		X			
TEXT COLOUR		X			
CHARACTER HEIGHT		X			
CHARACTER ORIENTATION					

Table 8 — CGM Elements by their allowed states (concluded)

CGM Element	CGM Minor States				
	FOS v2	TOS v1	CPS v3	PRS v3	TAS v3
TEXT PATH					
TEXT ALIGNMENT					
CHARACTER SET INDEX		X			
ALTERNATE CHARACTER SET INDEX		X			
FILL BUNDLE INDEX					
INTERIOR STYLE					
FILL COLOUR					
HATCH INDEX					
PATTERN INDEX					
EDGE BUNDLE INDEX	X				
EDGE TYPE	X				
EDGE WIDTH	X				
EDGE COLOUR	X				
EDGE VISIBILITY	X				
FILL REFERENCE POINT					
PATTERN TABLE					
COLOUR TABLE					
ASPECT SOURCE FLAGS	X				
PICK IDENTIFIER					
LINE CAP					
LINE JOIN					
LINE TYPE CONTINUATION					
LINE TYPE INITIAL OFFSET					
TEXT SCORE TYPE		X			
RESTRICTED TEXT TYPE					
INTERPOLATED INTERIOR					
EDGE CAP					
EDGE JOIN					
EDGE TYPE CONTINUATION					
EDGE TYPE INITIAL OFFSET					
SYMBOL LIBRARY INDEX					
SYMBOL COLOUR					
SYMBOL SIZE					
SYMBOL ORIENTATION					
ESCAPE	X	X	X	X	X
MESSAGE	X		X	X	X
APPLICATION DATA	X		X	X	X
COPY SEGMENT					
INHERITANCE FILTER					
CLIP INHERITANCE					
SEGMENT TRANSFORMATION					
SEGMENT HIGHLIGHTING					
SEGMENT DISPLAY PRIORITY					
SEGMENT PICK PRIORITY					

Notes on the state tables:

1. The "ver" column in the tables indicates the lowest metafile version in which the element may appear.

2. These entries define the lowest metafile version for which this state is defined. Therefore "v1" indicates the state is defined for Version 1 metafiles (hence also for Version 2 and Version 3 metafiles); "v2" indicates that the state is defined for Version 2 metafiles (hence also for Version 3); and "v3" indicates that the state is defined only for Version 3 metafiles.

3. Defaults replacement mode is not really a metafile state, but for implementation purposes it behaves as one and so has been included in this table.

4. The Metafile Closed State is not included in this table — BEGIN METAFILE is the only element allowed in this state.

5. END COMPOUND LINE is only allowed in Compound Path State when that state was entered by the BEGIN COMPOUND LINE element.

6. END COMPOUND TEXT PATH is only allowed in Compound Path State when that state was entered by the BEGIN COMPOUND TEXT PATH element.

7. These elements have state rules which are different depending upon the metafile version. For example, COLOUR TABLE is not allowed in the picture body in Version 1 metafiles, but it is allowed in the picture body in Version 2 and Version 3 metafiles.

Major States :

PCS   Picture Closed State
MDS   Metafile Descriptor State
DR   Defaults Replacement Mode
GSS   Global Segment State
DSS   Picture Descriptor Segment State
PDS   Picture Descriptor State
POS   Picture Open State
LSS   Local Segment State

Minor States :

FOS   Figure Open State
TOS   Text Open State
CPS   Compound Path State
PRS   Protection Region State
TAS   Tile Array State

Table 9 — CGM state transitions into and out of minor states

Element	Original state	Final state
BEGIN FIGURE	GSS,LSS,POS	FOS
END FIGURE	FOS	previous state
TEXT (not-final)	GSS,LSS,POS	TOS
RESTRICTED TEXT (not-final)	GSS,LSS,POS	TOS
APPEND TEXT (final)	TOS	previous state
BEGIN COMPOUND LINE	GSS,LSS,POS	CPS
END COMPOUND LINE	CPS	previous state
BEGIN COMPOUND TEXT PATH	GSS,LSS,POS	CPS
END COMPOUND TEXT PATH	CPS	previous state
BEGIN PROTECTION REGION	GSS,LSS,POS	PRS
END PROTECTION REGION	PRS	previous state
BEGIN TILE ARRAY	POS	TAS
END TILE ARRAY	TAS	previous state