Designation: D 6673 – 01~~4~~

Standard Practice for Sewn Products Pattern Data Interchange—Data Format[1]

This standard is issued under the fixed designation D 6673; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard is designed to facilitate communication between CAD/CAM systems that represent two-dimensional flat pattern pieces. This standard also provides conventions for representing related information such as grade rule tables. This standard is not intended to represent the relationships between pattern pieces or the correspondence between 2D or 3D sewn product pattern piece geometries.

1.2 The file format for the pattern data exchange file defined by this standard (Practice D 6673) complies with the Drawing Interchange File (DXF) format. Autodesk, Inc. developed the DXF format for transferring data between their AutoCAD(r) product and other software applications. This standard documents the manner in which pattern data should be represented within the DXF format. Users of this standard should have Autodesk, Inc.'s documentation on Drawing Interchange Files, found in the AutoCAD Reference Manual, in order to assure compatibility to all DXF format specifications. The AutoCAD Version 13 DXF specification is to be used. The file format for the grade rule table exchange file is an ASCII text file.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ANSI/AAMA Standard:*
ANSI/AAMA-292A

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *alternate grade reference line, n*— an optional internal line whose orientation is used for the x axis of a grade rule.

3.1.1.1 *Discussion*—The application of a grade rule will be oriented to the grade reference line unless an alternate grade reference line is specified. (See grade reference line.)

3.1.2 *annotation text, n*—optional user defined text that can be displayed when the pattern piece is plotted.

3.1.3 *base size, n*—the digitized or created size of a style.

3.1.3.1 *Discussion*—Base size is a synonym of sample size. (See sample size.)

3.1.4 *block, n*—a DXF keyword that is used to identify a section of the file that has information about one object.

3.1.4.1 *Discussion*—a block keyword should be used to identify the start of information for a pattern piece and the section should be ended with an endblk keyword.

3.1.5 *curve interpolation point, n*—points generated between curve points by a curve interpolation algorithm in a CAD vendor's system to create a curve which represents a contour.

3.1.6 *curve point, n*—a user defined point on a contour.

3.1.6.1 *Discussion*—When a curve interpolation algorithm is used to generate a curve, the resulting curve must pass through all user defined curve points. (See curve interpolation points, validation curve)

3.1.7 *curve tolerance, n*—the maximum perpendicular distance that the resulting curve can deviate from the original curve after transferring the data for the first time.

3.1.7.1 *Discussion*—Sufficient points should be added by the originating system to keep the shape of the curve within the user defined curve tolerance.

3.1.8 *cut lines, n*—the outside edges of a pattern piece used as a guide for cutting out the pattern piece. (See piece boundary.)

3.1.9 *drill hole, n*—a point that is part of a pattern piece that is not part of any line.

3.1.9.1 *Discussion*—Drill holes may be used to denote pocket or buttonhole placement.

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[1] This practice is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.63 on Sewn Product Automation .
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3.1.10 *entities, n*—a DXF keyword that is used to identify the section of the DXF file describing file identification information.

3.1.10.1 *Discussion*—Style system text must be placed in the entities section of the DXF file.

3.1.11 *graded nest, n*—a collection of pieces that represent every size in the size line for a particular pattern piece.

3.1.11.1 *Discussion*—The CAD vendor's system will apply the grade rules from the grade rule table to the base size of a piece to create the graded nest.

3.1.12 *grade reference line, n*—the horizontal line that defines the x axis for the pattern piece.

3.1.12.1 *Discussion*—The position of all other graded lines and points on the piece are determined in reference to grade reference line(s). a piece must have a grade reference line and may have one or more alternate grade reference lines. (See alternate grade reference line.)

3.1.13 *grade rule, n*—a named set of grade rule values consisting of one grade rule value for each size in the size ~~line.~~ list. (See grade rule values.)

3.1.13.1 *Discussion*—a grade rule is named by the grade rule identifier.

3.1.14 *grade rule identifier, n*—a user defined numeric name given to a grade rule.

3.1.15 *grade rules values, n*—values that define how an associated data point on a pattern piece moves from one size to another expressed in delta XY units.

3.1.16 *grade rule table, n*—a collection of grade rules.

3.1.17 *grade rule table name, n*—a user defined name given to a grade rule table.

3.1.18 *grade rule table data exchange file, n*—a text file to communicate grade rule values between different CAD/CAM systems.

3.1.19 *grainline, n*—line used to define the horizontal orientation, normally the X-axis, of a piece in a marker.

3.1.19.1 *Discussion*—The grainline is always parallel to the selvage (edge) of the material.

3.1.20 *internal cut outs, n*—lines, part of a pattern piece, not part of the piece boundary, which are cut during the cutting process.

3.1.21 *internal lines, n*—lines, part of a pattern piece, not a part of the piece boundary, which are not cut.

3.1.21.1 *Discussion*—Internal lines are not cut but may be drawn during the cutting process.

3.1.22 *line, n*—a collection of points that define part of a pattern piece.

3.1.23 *mirror line, n*—a line, part of a pattern piece, that divides two symmetrical parts.

3.1.23.1 *Discussion*—Since the pattern piece is symmetrical, only half of the piece needs to be digitized or created in the system. The other half is reflected across the mirror line.

3.1.24 *notch, n*—a shape used to mark a location.

3.1.24.1 *Discussion*—Notches are often used to line up two pieces of material to be sewn together.

3.1.25 *piece boundary, n*—a collection of lines that define the shape of a piece.

3.1.26 *piece information, n*—information that is piece specific.

3.1.27 *piece system text, n*—information provided in the transfer file that is piece specific.

3.1.28 *plaid reference line(s), n*—used for alignment of pattern pieces on plaid material during marker making.

3.1.29 *sample size, n*—the base size from which grade rule values are established.

3.1.30 *sew lines, n*—internal lines that indicate where stitching of pattern pieces is to be done.

3.1.31 *size list, n*—a list of all size names, in order from smallest to largest, for a particular style.

3.1.32 *size name, n*—a user defined name for a graded size.

3.1.32.1 *Discussion*—The size names can be alphabetical, numerical, or alphanumerical.

3.1.33 *smoothing, n*—a process in a CAD vendor's system that adds curve interpolation points to a curve. (See curve interpolation point.)

3.1.34 *stripe reference line, n*—line used for alignment of pattern pieces on stripe material during marker making.

3.1.34.1 *Discussion*—The stripe reference line can be either inside or outside the piece.

3.1.35 *style, n*—a collection of pattern pieces and related information that defines a sewn product.

3.1.36 *system text, n*—information related to either the style and/or pattern pieces in the DXF file.

3.1.37 *system text identifier, n*—keywords used in DXF file to construct syntax and associate values with specific system text.

3.1.38 *turn point, n*—point where a contour makes a sudden change in direction.

3.1.38.1 *Discussion*—If either line coming into the turn point is being smoothed, the turn point marks the end of smoothing.

3.1.39 *validation curve, n*—a set of points that represent the original curve in the exporting CAD system within curve tolerance of the original curve.

3.1.40 *validation vertex, n*—vertex that is inserted into a polyline in order to guarantee that the resulting polyline represents the original curve in the exporting CAD systems within a given curve tolerance

4. Summary of Practice

4.1 *Pattern Piece Transfer File Format*— The file format defined by this standard complies with the DXF format. A DXF file is a specially formatted ASCII text file. It consists of an optional header as well as tables, blocks and entities sections. The tables section allows for user-defined functional layering of a CAD drawing. Using this provision, this standard organizes the CAD data representing a pattern piece into a number of layers.

This standard currently can incorporate the following pattern piece information:

annotation (plotted) text;
alternate grade reference line(s);
cut line;
drill holes;
graded nests;
grade reference line;
grade rule identifiers;
grade rule table name;
grainline;
internal cutouts;
internal lines;
mirror line;
notches;
piece boundary, including turn points and curve points;
plaid reference lines;
sew lines;
stripe reference lines;
style information: style name; creation date and time, author, sample size, grade rule table name, units, standard version.
piece information: piece name, quantity, category, rotation, flip, tilt, fold.

4.2 *Header*—An optional header may precede the information in the file defined by this standard. However, because many CAD programs on the market today are unable to generate or accept a header, it is recommended that the use of the optional header be minimized.

4.3 *Layers*—The ASTM D13 proposed standard utilizes a layered file format. Information contained in the file defined by this standard is separated into distinct layers, each layer providing a specific type of information. Layer numbers are used to identify each layer and indicate which information is found in the layer.

Numbers are used, rather that text, since many programs that support the DXF format are unable to generate or accept non-numeric layer designations. Layer 1 is required. Information about each layer is described in 4.3.1 through 4.3.15.

The following four restrictions are placed on layer information:

(*1*) On Layer 1 the piece boundary line will be represented as one or more polylines that form a closed polygon.

(*2*) Layer 2 will contain all the turn points in the piece ~~whether they are part of the boundary or internals.~~ as found on layers 1, 8, 11, and 14.

(*3*) Layer 3 will contain all the curve points in the piece ~~whether they are part of the boundary or internal lines.~~ as found on layers 1, 8, 11, and 14.

(*4*) Layers 5, 6, 7, 9, 10 and 13 cannot contain polylines.

The following list for layer numbers are provided:

~~Layer 1~~	~~boundary line~~
Layer 1	piece boundary
Layer 2	turn points
Layer 3	curve points
~~Layer 84~~	~~quality validation curves~~
Layer 4	V-notch and slit notch
~~Layer 80~~	~~T-notch~~
~~Layer 81~~	~~castle notch~~
~~Layer 82~~	~~check notch~~
~~Layer 83~~	~~U-notch~~
Layer 5	grade reference and alternate grade reference line(s)
Layer 6	mirror line
Layer 7	grainline
Layer 8	internal line(s)
Layer 9	stripe reference line(s)
Layer 10	plaid reference line(s)
Layer 11	internal cutout(s)
Layer 12	intentionally left blank
Layer 13	drill holes
Layer 14	sew line(s)
Layer 15	annotation text
Layer 80	T-notch
Layer 81	castle notch
Layer 82	check notch
Layer 83	U-notch
Layer 84	piece boundary quality validation curves
Layer 85	internal lines quality validation curves
Layer 86	internal cutouts quality validation curves
Layer 87	sew lines quality validation curves

4.3.1 *Layer ~~1–Boundary Line~~ 1–Piece Boundary Layer*— The piece boundary ~~line~~ layer contains the boundary lines for each piece in the file. A separate BLOCK is used for each piece. Within each BLOCK are one or more polylines that constitute the piece boundary. Each polyline within the BLOCK corresponds to an individual pattern element.

The Piece Boundary ~~Line~~ BLOCK includes Turn Points, Curve Points, Notch Base Points, Grade Points and Mirror Line Points.

The piece boundary is a continuous, closed line, with points ordered in either the clockwise or counter clockwise direction. This layer is required.

DXF example of a piece boundary polyline containing vectorized curves:

```
0
POLYLINE
8
1                                   layer 1–boundary line
66
1                                   closed-polyline flag
0
VERTEX
8
1                                   layer 1–boundary line
10
450.369                             X coordinate
20
338.697                             Y coordinate
0
VERTEX
8
1                                   layer 1–boundary line
10
459.322                             X coordinate
20
338.316                             Y coordinate
0
VERTEX
8
1                                   layer 1–boundary line
10
457.195                             X coordinate
20
327.486                             Y coordinate
0
SEQEND
```

DXF example of a piece boundary polyline containing circular-interpolated curves:

```
0
POLYLINE
–8
1                                   layer 1–boundary line
66
1
70
1
0
VERTEX
8
1                                   layer 1–boundary line
10
0.0                                 X coordinate
20
0.0                                 Y coordinate
42
–0.014743                           bulge value
0
VERTEX
8
1                                   layer 1–boundary line
10
–45.900000                          X coordinate
20
–53.800000                          Y coordinate
42
–0.005465                           bulge value
0
VERTEX
8
1
10
–34.200000                          X coordinate
20
–38.600000                          Y coordinate
42
–0.018913                           bulge value
0
```

```
VERTEX
8
1                                   layer 1–boundary line
10
–19.100000                          X coordinate
20
–20.200000                          Y coordinate
0
SEQEND
```

4.3.1.1 *Style System Text*—In addition to the piece boundary, this layer contains information referred to as required style system text. It only occurs once on this layer in ENTITIES and is assumed to be valid for all pieces in the DXF file.

Style information is known as system text. This text ~~is~~ stands in contrast to annotation text, which is plotted out and is defined ~~at~~ as Layer 15 in the DXF file. System text is information about the style and/or pieces in the DXF file.

The correct syntax for system text is the system text identifier followed directly by a colon (:) character followed directly by a string of text representing the actual value of the identifier. Identifiers can be formed from upper or lower case characters but must ~~be~~ appear as specified in this standard. The value of the identifier is case sensitive and can include characters from the following ASCII 7-bit character subset, including the space character (' ') as well:

! ″ # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 :; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [\ ] ^ _ ′a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~

In some cases, the values of identifiers must have a specific format or value.

To avoid a loss of information, all values of identifiers must appear in the DXF file as they appeared in the exporting CAD system. Importing CAD systems should warn the user if the value of an identifier is being truncated on importing, resulting in a loss of information.

Style System Text	Correct Syntax (Identifier:<Value>)
style name	Style Name:<string>
creation date	Creation Date:<string>
creation time	Creation Time:<string>
author	Author:<vendor name>;<application>;<release #>
sample size	Sample Size:<string>
grade rule table	Grade Rule Table:<string>
units	Units:<METRIC | ENGLISH>
Standard Version	ASTM/D13Proposal 1 Version: XX
curve tolerance	Curve Tolerance:<float>

If the style being transferred has no sample size or grade rule table (as is the case in non-apparel sewn products), then the values of these system text identifiers can be left blank but the system text identifier is still required.

METRIC means that all values are in decimal millimeters to two places (e.g. 12.27) and ENGLISH means that all values are in decimal inches to four places (e.g. 4.8751).

The appropriate format for Creation Date is <dd-mm-yyyy> and for Creation Time it is <hh-mm>.

The curve tolerance system text must exist and only exists when ~~layer 84 is~~ Quality Validation Curves are used in the file. The tolerance value is represented using the units that have been defined. The curve tolerance is defined mathematically as the maximum projected distance of a ~~point on~~ vertex from a polyline on ~~layer 84~~ a Quality Validation Layer to the associated original curve (as calculated by the exporting system). It should be used by a receiving/importing system to determine accuracy of the generated curve (based on the turn points on layer 2 and the curve points on layer 3) to the original curve. Alternatively, the quality validation curve can be used directly to regenerate the original curve in polyline representation.

DXF example of system text:

```
TEXT
8
1
72
3
10
0.000
20
0.000
11
0.004
21
0.000
40
0.394
50
0.000
1
Style Name: SHIRT
0
```

4.3.1.2 *Piece System Text*—This is system text that appears within each piece BLOCK:

Piece System Text	Correct Syntax (Identifier:<Value>)
Piece Name	Piece Name:<string>
Quantity	Quantity:<R,L>
Rotation	Rotation:<0..360>
Flip	Flip:<X|Y>
Tilt	Tilt:<+/-0..90>
Fold	Fold:<Y|N>

Only Piece Name is required.

Quantity will be given as R, L where R indicates the number of right pieces required and L indicates the number of left pieces required. (Example 3,2)

Rotation is given in step increment degrees. It is assumed that the piece may rotate in this step increment up to 360 degrees.

Flip is defined as X (assuming flipping the piece about the horizontal axis) or Y (assuming flipping the piece about the vertical axis.

Tilt is an integer value that defines the maximum tilt in degrees that a piece may move. It is further assumed that the piece may be tilted positively or negatively up to the maximum defined tilt.

Fold indicates that the piece may be placed on the fold of tubular fabric.

4.3.1.3 *Piece Arrangement*—When multiple pieces are contained within a single file defined by this standard each piece shall be defined within a separate BLOCK. The BLOCK description must not contain any INSERT operations of other blocks.

Although multiple pieces are allowed within the file only a single style may be represented.

4.3.1.4 *Grade Rule Identifier Text*—Grading information is identified by text within the sample size block on layers containing graded points or notches. Grade information contained in the text entity is associated ~~to the points~~ with a point or vertex entity at the same XY location. The format for this information is as follows:

<string1>, <string2>

where # is required and followed by <string1> which is the grade rule identifier, <string2> is optional and can be used as the alternate grade reference identifier.

Any point or notch that will not be moved through grading must have a grade rule identifier associated with a zero growth grade rule.

The following layers can not include grade rules:

- 2 (turn point)
- 3 (curve point)
- 6 (mirror line)
- 84 (boundary quality validation curves)
- 85 (internal lines quality validation curves)
- 86 (internal cutouts quality validation curves)
- 87 (sew lines quality validation curves)

The grade rules associated with grade rule identifier may optionally be defined in a separate file called a Grade Rule Table File.

4.3.1.5 *Graded Nests*—A graded nest can be used to transfer grading growth information for pieces. Multiple blocks within a DXF file with the same piece name will indicate a graded nest.

Each graded size of a piece must be defined in a separate block with the size name of the piece included in the piece system text. The order of the BLOCKS represents the sequence of the sizes. Each block must contain a grade reference line. The growth information can be determined by stacking the pieces so the grade reference lines are coincident.

Only the sample size must have all of the piece system text ~~of~~ for the piece. All points and ATTDEF entities must be repeated in each block (i.e. each size) of the nest. Points and ATTDEF entities for each graded size are given in the same order, quantity and layer as the sample size.

Blocks in the DXF file can be placed on top of each other (i.e. to show stacks of graded patterns) or placed separately in their own coordinate space. The receiving system should be able to interpret the base pattern and appropriate delta grading regardless of which representation is used.

Sample sizes are exported the same as nongraded pieces. Because the points are the same on all sizes, only the sample size needs all the applicable layers. The following layers should not appear ~~on~~ within graded sizes:

Layer 2 Turn points
Layer 3 Curve points
~~Layer 4 Notches~~
Layer 4 Slit/V-notches
Layer 5 Alternate grade reference lines
Layer 80 T-notches
Layer 81 Castle notches
Layer 82 Check notches
Layer 83 U-notch

DXF example of a graded boundary point:

0
TEXT

8	
1	layer 1–boundary line
10	
387.900000	X coordinate
20	
–38.100000	Y coordinate
40	
0.100000	text height
1	
# 10	grade rule identifier

4.3.1.5.1 *Graded Nest Piece System Text*—The system text for each graded piece within a graded nest must contain the piece name and size. ~~Optionally, quantity~~ Quantity may also be ~~defined.~~ included.

Piece System Text	Correct Syntax
Piece Name	Piece Name:<string>
Size Name	Size Name:<string>
Quantity	Quantity:<R,L>

For the sample size, the size name system text specifies the actual Sample Size Name. The piece name for each graded size of a piece must be the same as the piece name for the sample size.

4.3.1.6 *Curve Quality Validation for Graded Piece Boundaries* —Quality validation curves ~~can be~~ are defined by validation verices of a polyline on a Quality Validation Layer to its associated layer ~~84 for all piece boundaries that are defined in the file. However, when~~ 8. When grade rules are applied to pieces with a given sample size, the curve quality of the resulting graded piece boundaries in the importing system cannot be validated to those of the exporting system. This is because this standard does not define a common curve interpolation algorithm. Under such circumstances, the quality of the graded piece ~~boundaries~~ polylines can only be validated using a graded nest. A graded nest will ensure that the piece ~~boundaries~~ polylines of all sizes are defined in the corresponding Quality Validation Layers. The following Quality Validation Layers are associated with the corresponding polyline layers:

~~Layer 84~~	~~contains the Quality Validation Curve(s) for layer 84. 1 polyline(s) (boundary)~~
Layer 84	contains the Quality Validation Curve(s) for layer 1 polyline(s) (boundary)
Layer 85	contains the Quality Validation Curve(s) for layer 8 polyline(s) (internal lines)
Layer 86	contains the Quality Validation Curve(s) for layer 11 polyline(s) (internal counts)
Layer 87	contains the Quality Validation Curve(s) for layer 14 polyline(s) (sew lines)

4.3.2 *Layer 2–Turn Points*—This layer contains points describing the ~~same~~ x/y location of turn points for layers 1, 8, 11, and ~~is used to distinguish those points at this XY location as turn points.~~ 14. A curve interpolation algorithm is applied between two consecutive turn points. Smoothness is not guaranteed at these points.

When a turn point is associated with a grade rule, the grade rule identifier text must be included. If there is no grade rule identifier ~~text~~ associated with ~~the~~ a turn point~~,~~ and it has two graded neighbors, then it is assumed to follow a linear proportional evolution between its two nearest graded neighbors. If it does not have two graded neightbors, then a zero growth grade rule is assumed.

DXF example of a turn point:

0	
point	
8	
2	layer 2–turn point
10	
0.0	X coordinate
20	
100.0	Y coordinate

4.3.3 *Layer 3–Curve Points*—This layer contains points decribing the x/y location of curve points for layers 1, 8, 11, and 14. Curve points define a curve between consecutive points for a given curve interpolation algorithm. A curve interpolation algorithm uses them to regenerate the original curve. At these points, smoothness of the curve should be guaranteed.

When a curve point is associated with a grade rule, the grade rule identifier text must be included. If there is no grade rule identifier text associated with the curve point, it is assumed to follow a linear proportional evolution between its two nearest graded neighbors.

DXF example of a curve point:

0	
POINT	
8	
3	layer 3–curve point
10	
35.300000	X coordinate
20	

31.000000	Y coordinate

4.3.3.1 *Layer 84–Boundary Quality Validation Curves* —This layer is mandatory. Layer 84 is used to define the quality validation curves that are associated with existing polylines in layer 1 (Piece Boundary). Layer 84 must contain the same quantity of polylines as the corresponding layer 1, in the same order. Each polyline in layer 84 should contain all the vertices of its corresponding polyline in layer 1, in the same order, and it should also contain intermediate additional validation vertices so that, for each curve segment, the distance of each point of a curve segment from the corresponding polyline segment of the original curve is less than the curve tolerance defined using style system text.

The POLYLINE entity is used to define the quality validation contour boundary in layer 84. Two consecutive points of a polyline represent a curve segment. Additional curve validation points are provided so that for each curve segment, the distance of each point of a curve segment from the corresponding polyline segment of the original curve is less than the curve tolerance given as style text on layer 1. The POLYLINE on layer 84 must include all points (turn points and curve points) existing on layer 1. All other points on layer 84 are considered to be curve validation points. The additional curve validation points are not on layer 3.

Example:

Assume a piece contour that starts as follows:

turn point	(x=0.00, y=0.00)
curve point	(x=50.50, y=50.50)
turn point	(x=100.00, y=100.00)
....	

Example of Curve Tolerance system text on layer 1:

```
0
TEXT
8
15
10
1.00
20
1.00
40
1.00
1
Curve Tolerance: 0.05
....
```

Example of a quality validation piece boundary on layer 84 (additional curve validation points added to match the given curve tolerance):

```
...
POLYLINE
8
84
1
66
70
1
0
VERTEX                          the turn point of the contour
8
84
10
0.00
20
0.00
0
VERTEX                          added curve validation point
8
84
10
25.25
20
25.25
0
VERTEX                          the curve point of the contour
8
84
10
50.50
20
50.50
0
VERTEX                          added curve validation point
8
```

84	
10	
75.25	
20	
75.25	
0	
VERTEX	the turn point of the contour
8	
84	
10	
100.00	
20	
100.00	
.....	continue for complete contour (all turn points and curve points of original contour on layer 1 have to be included)
0	
SEQEND	

4.3.3.2 Layer 85 - Internal Lines Quality Validation Curves - This layer is mandatory in every size that contains polyline(s) in layer 8.

Layer 85 is used to define the quality validation curves that are associated with existing polylines in layer 8 (Internal lines). Layer 85 must contain the same quantity of polylines as the corresponding layer 8, in the same order. Each polyline in layer 85 should contain all the vertices of its corresponding polyline in layer 8, in the same order, and it should also contain intermediate additional validation vertices so that, for each curve segment, the distance of each point of a curve segment from the corresponding polyline segment of the original curve is less than the curve tolerance defined using style system text.

4.3.3.3 Layer 86 - Internal cutouts Quality Validation Curves - This layer is mandatory in every size that contains polyline(s) in layer 11

Layer 86 is used to define the quality validation curves that are associated with existing polylines in layer 11 (Internal cutouts). Layer 86 must contain the same quantity of polylines as the corresponding layer 11, in the same order. Each polyline in layer 86 should contain all the vertices of its corresponding polyline in layer 11, in the same order, and it should also contain intermediate additional validation vertices so that, for each curve segment, the distance of each point of a curve segment from the corresponding polyline segment of the original curve is less than the curve tolerance defined using style system text.

4.3.3.4 - Layer 87 – Sew Lines Quality Validation Curves - This layer is mandatory in every size that contains polyline(s) in layer 14.

Layer 87 is used to define the quality validation curves that are associated with existing polylines in layer 14 (Sew lines). Layer 87 must contain the same quantity of polylines as the corresponding layer 14, in the same order. Each polyline in layer 87 should contain all the vertices of its corresponding polyline in layer 14, in the same order, and it should also contain intermediate additional validation vertices so that, for each curve segment, the distance of each point of a curve segment from the corresponding polyline segment of the original curve is less than the curve tolerance defined using style system text.

4.3.4 *Notches*—These layers contain additional points called notches. Notches are represented in a variety of ways and are described in the following subsections. Notches at the endpoints of a mirror line are not mirrored.

Notches are defined using the following information:

(*1*) A base point. A simple DXF point entity .

(*2*) An angle defined using the DXF group 50 . The angle of the notch is relative to the X-axis, measured counter-clockwise in degrees.

(*3*) A width at the boundary is defined using DXF group 39 (DXF Thickness command).

(*4*) A depth defined using DXF group 30 (DXF Z-coordinate entry). Depth is measured from the base point along the direction specified by the angle.

(*5*) A shape that is defined by the DXF layer on which it occurs.

Notches may be graded as any other graded entities. In cases where the notch is associated with a grade rule, the grade rule identifier must be included in this layer.

Notches can have coincident points or be dependent on the following layers:

(*1*) Layer 1—Piece ~~b~~ Boundary

(*2*) Layer 11—Internal cutouts

(*3*) Layer 14—Sew lines

An optional notch data type dependency is defined to exist between the notch and the object immediately preceding it in the DXF file. Notch dependency is valid for all notch types. Notch dependency is identified by the ATTDEF entity which must be included on the layer of the object where the dependent notch should be created. The position of the notch with the notch dependency on the object referenced by the ATTDEF entity is given as a perpendicular projection of the notch position to its object.

The group codes in ATTDEF entity for notch dependency are defined as follows:

8	layer of referenced entity

10	x-coordinate of first point of referenced entity
20	y coordinate of first point of referenced entity
11	x coordinate of first point of notch base point
21	y coordinate of notch base point
40	for text height
1	string (not case sensitive): “Link:<layer_nr>, where layer is the current notch layer (4,80,81,82,83)
2	string (not case sensitive): “Dependency”
3	empty string
70	flag set to value 2
72	flag set to value 3

DXF example for notch dependency on an internal cutout:

```
[...]
0
LINE
8
11
10
100.0000
20
150.0000
11
200.0000
21
150.0000
~~11~~
~~200.0000~~
~~21~~
~~150.0000~~
[...]
0
POINT
8
81                                  Castle notch
10
120.0000
20
120.0000
30
[...]
0
ATTDEF
8
11                                  Reference is a layer 11 (internal cutout) entity
10
100.0000                            Reference’s first point X
20
150.0000                            Reference’s first point Y
11
120.0000                            Notch base point first point X
21
120.0000                            Notch base point Y
40
10.0000                             “Text” height
1
Link:81                             “Text” identifies layer of the notch (castle notch in this case)
2
Dependency                          This “tag” field must be initialized
3
                                    Empty “Value” string
```

70	Flag 70
2	
72	Flag 72
3	
[...]	

In this example castle notch will be created on the internal cutout, as there is dependency defined between the castle notch on layer 81 and internal cutout on layer 11. This dependency also forces this castle notch to be projected perpendicularly to the internal cutout, at coordinates X=120.0000, Y=150.0000.

4.3.4.1 *Layer 4–Slit Notch*—A slit notch is defined by a base point with angle and depth information. It has no width. Its shape is a line.

DXF example of a slit notch:

0	
POINT	
8	
4	layer 4–notch
10	
266.600000	X coordinate
20	
176.800000	Y coordinate
30	
0.200000	depth
50	
267.610000	angle

4.3.4.2 *Layer 4–V-Notch*—A V-notch is defined by the base point along with depth, angle and width information. The width is defined to be at the boundary, with the notch base point in the middle. The shape is of a "V".

DXF example of a V-notch:

0	
POINT	
8	
4	layer 4–notch
10	
71.700000	X coordinate
20	
-5.700000	Y coordinate
30	
0.200000	depth
39	
0.400000	width
50	
87.470000	angle

4.3.4.3 *Layer ~~6~~ 80–T-Notch*—A T-notch is defined by a base point along with depth, angle and width information. The width is defined to be at end of the notch and not at the boundary. The shape is of a "T".

4.3.4.4 *Layer 81–Castle Notch*—A castle notch is defined by the base point along with depth, angle and width. The width applies evenly along the notch from the boundary to the end of the notch. The shape is rectangular.

4.3.4.5 *Layer 82–Check Notch*—A check notch is defined by the base point along with depth and width information. The width applies at the boundary. A positive opening width is used to describe a clockwise opening and a negative opening width is counter clockwise. The shape is like a V where one side is perpendicular to the boundary starting at the notch base point. The shape is like a check mark or tick mark.

4.3.4.6 *Layer 83–U-Notch*—A U-notch is defined by the base point along with depth, angle and width information. The width applies evenly along from the boundary to the end of the notch. The shape is rectangular with a semi-circle applied to the end of the notch.

4.3.5 *Layer 5–Grade/Alternate Grade Reference Line(s)*—A two-point line given on this layer identifies the grade reference line. This layer is optional and if omitted, the grade reference line is assumed to be the X-axis. Additional two-point lines, if present on this layer, identify alternate grade reference lines. A text number identifier must be included when alternate grade reference line(s) are given.

DXF example of a grade reference line:

0	
LINE	
8	
5	layer 5–grade reference line
10	
125.300000	X start point
20	
234.900000	Y start point
11	
342.700000	X end point

```
21
234.900000                                  Y end point
```

4.3.6 *Layer 6–Mirror Line*—This layer contains a two-point line that identifies the mirror line of the piece. These points are also found on the boundary layer.

Either the first two or the last two points of a piece boundary must match the mirror line's points. This layer is only valid and required if a piece is being mirrored.

DXF example of a mirror line:

```
0
LINE
8
6                                           layer 6–mirror line
10
125.300000                                  X start point
20
234.900000                                  Y start point
11
342.700000                                  X end point
21
234.900000                                  Y end point
```

4.3.7 *Layer 7–Grain ~~L~~line*—A two-point line given on this layer defines the grainline.

DXF example of a grainline:

```
0
LINE
8
7                                           layer 7–grainline
10
125.300000                                  X start point
20
234.900000                                  Y start point
11
342.700000                                  X end point
21
234.900000                                  Y end point
```

4.3.8 *Layer 8–Internal Lines*—These are lines consisting of two or more points. Text labels may be provided at the starting point of any internal line. Internal lines on Layer 8 are not cut. See also Layer 11. To indicate a non-mirrored line, the text string ″NM″ must be included.

DXF example of a graded internal line point:

```
0
TEXT
8
8                                           layer 8–internal line
10
409.000000                                  X coordinate
20
8.600000                                    Y coordinate
40
0.100000                                    text height
1
#8                                          grade rule identifier
```

4.3.9 *Stripe Reference Line(s)*—Two-point lines on this layer define stripe reference line(s). If multiple reference lines exist, an optional text number may be used to identify the lines. If a system uses match points, individual points on this layer are given.

DXF example of a stripe reference line:

```
0
LINE
8
9                                           layer 9–stripe reference line
10
125.300000                                  X start point
20
234.900000                                  Y start point
11
342.700000                                  X end point
21
234.900000                                  Y end point
```

DXF example of a stripe match point:

```
0
POINT
9
```

```
9                                   layer 9–stripe reference line
10
82.100000                           X coordinate (non-significant for matching)
20
-0.800000                           Y coordinate
```

4.3.10 *Layer 10–Plaid Reference Line(s)*—Two-point lines on this layer define plaid reference line(s). If multiple reference lines exist, an optional text number may be used to identify the lines. If a system uses match points, individual points on this layer are given.

DXF example of a plaid reference line:

```
0
LINE
8
10                                  layer 10–plaid reference line
10
125.300000                          X start point
20
234.900000                          Y start point
11
342.700000                          X end point
21
234.900000                          Y end point
```

DXF example of a plaid match point:

```
0
POINT
8
10                                  layer 10–plaid reference line
10
41.200000                           X coordinate
20
0.0                                 Y coordinate (non-significant for matching)
```

DXF example of a stripe/plaid match point:

```
0
POINT
8
9                                   layer 9–stripe reference line
10
221.800000                          X coordinate (non-significant for matching)
20
-8.200000                           Y coordinate
0
POINT
8
10                                  layer 10–plaid reference line
10
232.900000                          X coordinate
20
-9.300000                           Y coordinate (non-significant for matching)
```

4.3.11 *Layer 11–Internal Cutouts*— Lines consisting of two or more points on this layer define internal cutouts. To indicate a non-mirrored line, the text string “NM” must be included.

4.3.12 *Layer 12*—Intentionally left blank.

4.3.13 *Layer 13–Drill Holes*—Points on this layer define drill holes. Grade rule identifiers may be associated with points on this layer. To indicate non-mirrored drill holes, the text string “NM” must be included. The optional Z coordinate will represent the diameter of drill hole in units.

DXF example of a drill hole:

```
0
POINT
8
13                                  layer 13–drill hole
10
-9.400000                           X coordinate
20
234.700000                          Y coordinate
30
90.00000                            Z coordinate
```

4.3.14 *Layer 14–Sew Lines*—These are lines consisting of two or more points. Text labels may be provided at the starting point of any sew line. To indicate a non-mirrored line, the text string “NM” must be included.

4.3.15 *Layer 15–Annotation Text*— The annotation text will be displayed when the piece is plotted. The TEXT entity on layer 15 will be used for annotation text definition. Multiple lines of text on one annotation line are allowed. The annotation text may

contain the special character '\' to allow CAD systems to recognize line breaks.

DXF example of annotation text:

0	
TEXT	TEXT entity for annotation text
8	
15	on layer 15
10	
20.00	X–location of the annotation text
20	
20.0	Y–location of the annotation text
40	
5.0	text height (5 mm if units are metric)
50	
0	text direction (0 degrees relative to the X axis)
1	
pocket	annotation text

4.4 *Grade Rule Table Data Exchange File Format*—The file format defined by this standard for grade rule table information is an ASCII text file consisting of specific information in a free-format style. The file consists of a header and grade rule section. The header information will precede all grade rules in the file. The header contains information about the transfer file and information about the grade rule table. The grade rule section contains the grade rules in the table. The order in the file of this information is not important, but the format for the size list and grade rule items require specific ordering within the item. This file is optional.

The syntax used to describe the file format uses the following notations:

Uppercase text for readability, the required text is shown in upper-case.
Lowercase text, required parameters are shown as lowercase.
[|] Required parameter consisting of one of the uppercase text strings.
... Any number of parameters in same format.

4.4.1 *Header*—The specified text in the header is restricted to one occurrence. It is assumed that the information in the section is valid for all the grade rules in the file. The header section will contain the following exact text as the first word of a new line, followed by a colon (:), followed by the parameter(s) and will provide the following information:

ASTM/D13 Proposal 1 VERSION:xxx	where xxx is the version number of this document.
AUTHOR:author_name	where author_name is a string of characters which can consist of alphanumeric, dashes, and underscores.
CREATION DATE:dd-mm-yyyy	where dd is the day. mm is the month. yyyy is the year.
CREATION TIME:hh:mm	where hh is the hour. mm are the minutes.
UNITS:[ENGLISH | METRIC]	where METRIC means that all values are in decimal millimeters to two places (e.g. 12.27) and ENGLISH means that all values are in decimal inches to four places (e.g. 4.8751). Both the units identifier and the metric/English strings are not case sensitive.
UNIT FORMAT: <string>	(Optional. For English units only.) where string is the fractional denominator of the source rule table. This field is for information only and does not affect the data content of the file.
GRADE RULE TABLE: rule table_name	where rule table name is a character string that can consist of any ASCII that is not being defined as a separator.
SAMPLE SIZE:size_name	where size name is a character string that can consist of any ASCII that is not being defined as a separator.
NUMBER OF SIZES:n	where n is a decimal. There must be at least 2 sizes.
SIZE LIST:size_name1 size_name2... size_name_n	where size_name is the same format as the sample size. <spe> is any of the following separators: comma, space, tab, newline, or CR/LF. The order of the sizes in the size list specifies the order of the grade rule growths in each rule.

Other optional text information may also be supplied. Both upper/lower case is allowed and is insignificant.

4.4.2 *Grade Rules*—The grade rule section will contain all the grade rules in a table. Each grade rule will be of the following format:

RULE:
<sep>type<sep>grade_rule_identifier<sep>size_1_growths<sep>size_2_growths ... 0,0 ... size_n_growths

where:

RULE is an keyword required at the start of every rule and is always followed by a colon (:).

<sep> one or more of the following are used to separate the fields: comma, space, tab, newline, or CR/LF.

type is a keyword specifying the rule type. [DELTA] is the only choice currently. This specifies that the growths are the X and Y differences between the sample size and the size specified.

grade_rule_identifier is a positive or negative integer.

size_n_growth are the values used to specify how a point should change to create the size specified. The delta X and Y are to be in decimal inches if the units for the file is ENGLISH or in decimal millimeters if the units is METRIC (no rounding is necessary). The order of the size growths must match the order of the sizes in the size list. The sample size will always be in the size list at the location specified in the size line. The deltas for the sample size will always be 0,0.

5. Significance and Use

5.1 This standard practice is designed to facilitate two-dimensional, sewn pattern piece data exchange between CAD systems at the level of pattern design. It also facilitates grade rule table data exchange for sewn products in the apparel industry. It uses the DXF file format for pattern piece data exchange and a specially formatted ASCII file format for grade rule tables. It is limited to the transfer of pattern pieces within a style and the associated pattern piece and style information. It does not support the transfer of numerical cutter instructions; plotter instructions, complete marker-laying or spreading information, or product data specification information.

6. Keywords

6.1 apparel; CAD system; DXF file format; grading; pattern design; pattern piece; sewn product; style; upholstery