Recommended Practices for Geometric Dimensions & Tolerances (GD&T)

"Polyline Presentation"

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1 Introduction

1.1 CAx Implementor Forum

The CAx Implementor Forum (CAx-IF) is a joint effort between the ProSTEP iViP Association in Germany and PDES, Inc. in the USA. Its participants are the developers of 3D geometry STEP processors for AP203 and AP214, including both CAD system and third party translator software vendors. The main goal of this forum is to jointly develop, test and prove their STEP interfaces with focus on expanding scope and increased data exchange quality.

1.2 LOTAR

The AIA-ASD Stan LOTAR team is a working group at the ProSTEP iViP Association, and is aiming to develop an international standard for long-term archiving of CAD data (EN 9300 series). This standard focuses on various aspects of data storage and retrieval, especially quality issues in both the processes involved and the STEP files used themselves. In order to ensure consistency of the guidelines created in the course of this project, a close cooperation with the CAx-IF has been agreed. The scope of this Recommended Practices refers to LOTAR Part 120 Version 1.

1.3 Levels of GD&T information

The exchange of GD&T information is currently the main focus is both working groups. However, there are different levels of information that can be exchanged in that context, which are listed below:

- **Representation** – Describes the exchange of reusable, associative GD&T information in a STEP file. This information is by itself not visible in the 3D model, but a CAD system importing this file can use the Representation data to re-create the visible GD&T information. The representation approach also aims to pass GD&T data on to downstream applications, such as CAM.
- **Presentation** – Describes the exchange of GD&T information in a way that is visible for the user in the 3D model. There are three levels of presentation:
    - **Polyline Presentation** – This captures the information displayed for GD&T "as is", by breaking down the annotations and symbols into individual lines and arcs. This approach is the only one independent from the Representation, and is not machine-interpretable.
    - **Minimal Semantics Presentation** – Adds a minimum set of display information to the Representation data (such as position in 3D space and a reference point on the model).
    - **Full Semantics Presentation** – Adds all the positioning, styling and other information to the Representation, so that an importing system supporting this capability can fully re-create the GD&T information in the 3D model, by combining the information content from the Representation with the display settings given by the Presentation.

While the CAx-IF started working on the Representation capability, the LOTAR work group started with the Polyline Presentation approach described in the document, based on the users immediate need to capture this information in a STEP file.
As the long-term goal, both working groups intend to implement the Representation plus Full Semantics Presentation approach, which will render the most benefit for both documentation and reusability of data.

1.4 Scope of this document

This document defines a Recommended Practice for GD&T Polyline Presentation. The objective is to preserve the presentation (visualization) of 3D annotations and tolerances and also cross-links between these GD&T elements and the corresponding 3D geometry.

The following are within scope of this document :

- How to preserve following tolerances :
  - Angularity
  - Circular runout
  - Circularity
  - Coaxiality
  - Concentricity
  - Cylindricity
  - Flatness
  - Parallelism
  - Perpendicularity
  - Position
  - Profile of line
  - Profile of surface
  - Roundness
  - Straightness
  - Symmetry
  - Total runout
  - Surface roughness
- How to preserve following dimensions:
  - Auto computed by CAD System
  - Manually input by user
- How to preserve other GD&T information:
  - Datums
  - Views
  - Notes
  - Axis Systems
  - User Defined Properties
  - NOA (without picture transformation)
- How to define views
  - How to gather a set of geometrical entities representing an annotation, related to a view
  - How to style the annotation
  - How to relate an annotation with the geometrical STEP entities supporting it

The following are outside of the scope of this document:

- GD&T Representation
- GD&T Semantic Presentation (both minimal and full)
- How to preserve additional information:
  - Property rights
  - Form features

The current Recommended Practices for GD&T data were issued on 6 December, 2006. The Recommended Practices for GD&T Representation and Semantic Presentation are currently under development, and available on the WikiSTEP page http://www.wikistep.org/.

The transfer of property rights, and the relation of GD&T data presented as Polylines to Form Features, may be within the scope of future extensions of this document.

1.5 Definition of terms

Some terms used in this document, especially the term “view”, have different meanings in different contexts. Therefore, a definition of how these terms are used in this document is given.

1.5.1 View

A “view” in the context of GD&T Polyline Presentation complies with the following definition taken from ISO 16792, section 5.6:

Saved views

Saved views of a design model may be defined to facilitate presentation of the model and its annotation. A saved view shall have an identifier, be retrievable on demand, contain a model coordinate system that denotes the direction of the view relative to the model and may contain one or more of the annotation plane(s), a selected set of annotation, or a selected set of geometry.

Hence, the term “saved view” will be used in this document. The following list of equal terms might help in technical discussions:

- ISO 16792 - saved view
- CATIA V5 - capture
- UG NX - work view
- Pro/E - combine state

2 Presentation as Polylines

A polyline is a line created by a series of short straight line segments. The entity `polyline` is defined in Part 42, and already known in AP214 / AP203 Ed2 standard.
Using this type of entity, each GD&T feature and 3D annotation can be exported as a `geometric_curve_set` of `polylines`, `circles` and `trimmed_curves` where the basis curve is a `circle` (circular arcs). `Polylines` are defined by a list of `cartesian_points`.

Note that these shall be located in a plane parallel to the definition plane of the `annotation_plane` the GD&T element is assigned to, as described in section 2.4 below.

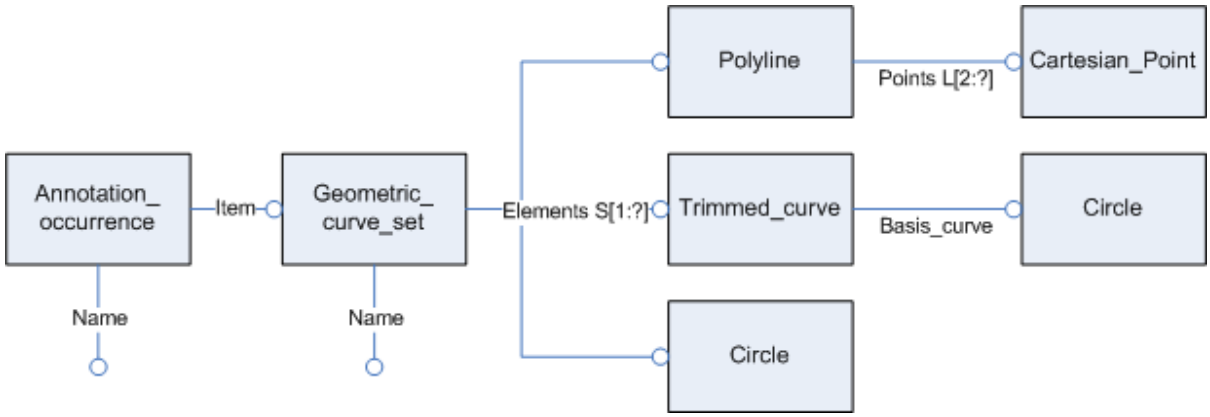

Figure 1 – Geometric_curve_set defining a Polyline Presentation

The name of the `geometric_curve_set` should provide the type of the GD&T. The intention is to be able in the importing system to filter for certain types of dimensions and tolerances, and, where possible, to allow the type to be displayed in the model feature tree or as a property after importing the STEP file. The pre-defined values for this are listed in section 2.1 below.
In addition, the name of the `annotation_occurrence` can be used to store the actual name of the annotation as defined by the user.

```
#581=ANNOTATION_OCCURRENCE('Simple Datum.1',(#580),#577);
#577=GEOMETRIC_CURVE_SET('datum',(#582,#592,#597,#600,#606));
#582=POLYLINE('Simple Datum.1',(#583,#584,#585,#586,#587,#588,#589,#590,
#591));
#592=POLYLINE('Simple Datum.1',(#593,#594,#595,#596));
#597=POLYLINE('Simple Datum.1',(#598,#599));
#600=POLYLINE('Simple Datum.1',(#601,#602,#603,#604,#605));
#606=POLYLINE('Simple Datum.1',(#607,#608,#609,#610));
```

Figure 2 – Excerpt from the Part21 file example defining a Polyline Presentation

2.1 Names for the geometric_curve_set

It is recommended that the name of the `geometric_curve_set` to be included in the STEP file is taken from the list given below. These are based on the ANSI/ISO standards NF EN ISO 1101. The corresponding tables are shown in Annex A. The intention is to provide the user with a harmonized list of names for display in the feature tree or as a property.

Note that the name of the `geometric_curve_set` is not intended to transport any intelligent GD&T information.

Tolerance Types	Dimension Types	Datum Types	Other
angularity circular runout circularity coaxiality concentricity cylindricity flatness parallelism perpendicularity position profile of line profile of surface roundness straightness symmetry total runout general tolerance	linear dimension radial dimension diameter dimension angular dimension ordinate dimension curve dimension general dimension	datum datum target	note label surface roughness weld symbol

Figure 3 – Suggested list of allowed names for the Geometric_curve_set

2.2 Styling of the Annotation

Each annotation transformed into polyline must preserve its graphic characteristics (colour, line type and width) and optional attributes (type of annotation, layer). The graphical attribute can be global for the annotation.

The style for the presentation will be defined at the `annotation_occurrence`, which is a sub-type of `styled_item`. The styles defined at this level shall be applied to all entities in the `geo-metric_curve_set`.

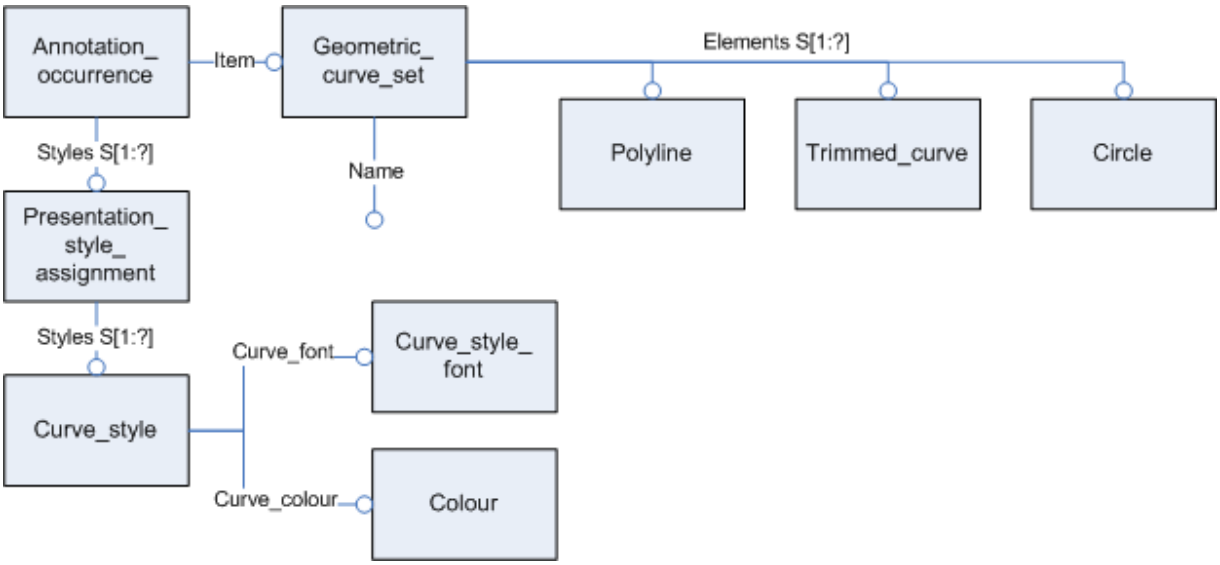

Figure 4 – Styling the Polyline Presentation

```
#581=ANNOTATION_OCCURRENCE('Simple Datum.1',(#580),#577);
#577=GEOMETRIC_CURVE_SET('datum',(#582,#592,#597,#600,#606));
#580=PRESENTATION_STYLE_ASSIGNMENT((#579));
#579=CURVE_STYLE(' ',#574,POSITIVE_LENGTH_MEASURE(0.13),#578);
```

Figure 5 – Excerpt from the Part21 file example illustrating a Polyline style

If certain elements within the presented GD&T information shall have a different style (e.g. the text shall have a different colour than the frame), this will be applied through a complex entity composed of `over_riding_styled_item` and `annotation_occurrence`. Since the portion of the presentation to be re-styled will consist of many polylines, an `additional geometric_curve_set` is needed to collect these. This `geometric_curve_set` shall have the name "over riding style set" and reference the subset of the polylines etc. that are contained within the full set of presentation data for this GD&T element.

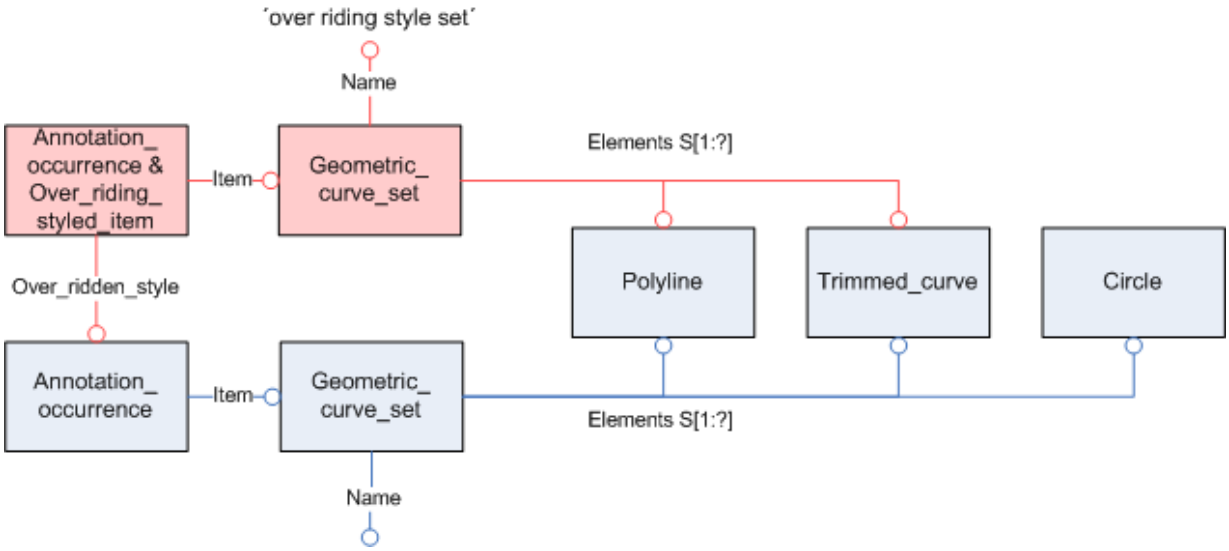

Figure 6 – Definition of the overriding style

2.3 Definition of the Annotation Plane

In order to position GD&T information and 3D annotations on the screen, users usually work with annotation planes. Each annotation is assigned to a reference plane and positioned parallel to that, at a specific position related to the geometry. In some systems, the assignment of an annotation to an annotation plane also has an organizational aspect in addition to positioning the annotation in 3D space.

This position must be preserved after conversion of GD&T and 3D annotations into polylines. The three-dimensional `cartesian_points` defining the `polylines` shall be located in a plane that is parallel to the definition plane of the `annotation_plane`.

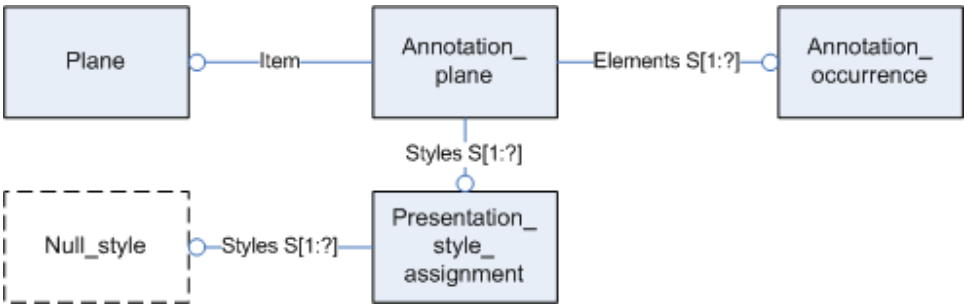

Figure 7 – Definition of the view plane

```
#571=PLANE('Front View.1',#570);
#572=ANNOTATION_PLANE('Front View.1',(#573),#571,(#581,#614,#821));
#573=PRESENTATION_STYLE_ASSIGNMENT((.NULL.));
#581=ANNOTATION_OCCURRENCE('Simple Datum.1',(#580),#577);
#614=ANNOTATION_OCCURRENCE('Perpendicularity.1',(#613),#611);
#821=ANNOTATION_OCCURRENCE('Simple Datum.2',(#820),#818);
```

Figure 8 – Excerpt from the Part21 file example defining a view plane

Note that at the moment the standard does not allow to define a `null_style` for an `annotation_plane`. This is a known issue that will be addressed in the standardization groups. If the creation of the `null_style` is not possible due to toolkit restrictions, the recommended workaround is creating a default `fill_area_style` with an empty colour.

```
#571=PLANE('Front View.1',#570);
#572=ANNOTATION_PLANE('Front View.1',(#573),#571,(#581,#614,#821));
#573=PRESENTATION_STYLE_ASSIGNMENT((#574));
#574=FILL_AREA_STYLE('NULL',(#575));
#575=FILL_AREA_STYLE_COLOUR('NULL',#576);
#576=COLOUR();
#581=ANNOTATION_OCCURRENCE('Simple Datum.1',(#580),#577);
#614=ANNOTATION_OCCURRENCE('Perpendicularity.1',(#613),#611);
#821=ANNOTATION_OCCURRENCE('Simple Datum.2',(#820),#818);
```

Figure 9 – Part21 file fragment using the workaround for null_style

Note that due to the way annotations are created and handled in many CAD systems, the elements describing an annotation have to be in a plane parallel to the plane defining the `annotation_plane`, and not necessarily exactly on that plane.

2.4 Linking the Annotations together

In order to correctly include all the annotations in the STEP file structure so that they can be easily found and organized later on, they will be collected in a `draughting_model`. Since this `draughting_model` relates to all annotations in the file, it is called the "global" `draughting_model`.

It references all `annotation_planes` in the file, which, in turn, include all `annotation_occurrences` in their sets of elements.

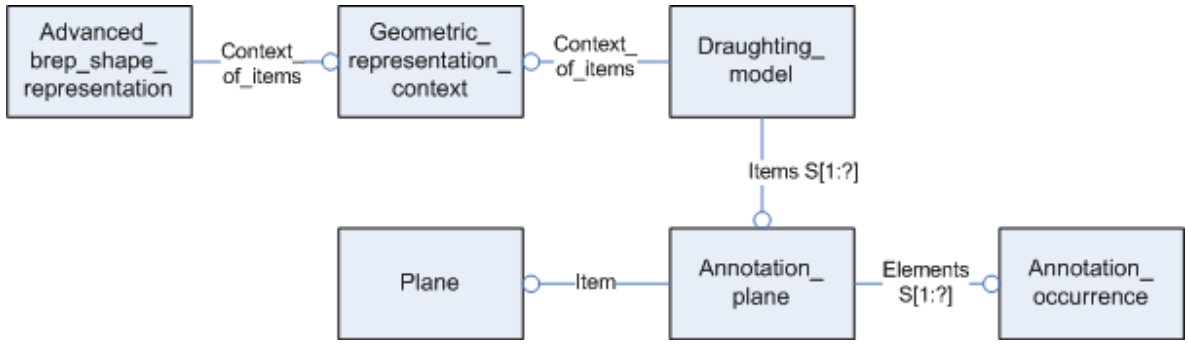

Figure 10 – Linking the annotations together

```
#21=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT((#
20))GLOBAL_UNIT_ASSIGNED_CONTEXT((#16,#17,#19))REPRESENTATION_CONTEXT('    ','
'));
#564=ADVANCED_BREP_SHAPE_REPRESENTATION('NONE',(#26),#21);
#566=DRAUGHTING_MODEL('',(#572,#887),#21);
#572=ANNOTATION_PLANE('Front View.1',(#573),#571,(#581,#614,#821));
#887=ANNOTATION_PLANE('Front View.2',(#888),#886,(#892,#1129));
```

Figure 11 – Excerpt from the Part21 file example illustrating the link

2.5 Linking the Annotations to the Geometry

3D annotations in general and GD&T elements in particular are linked with geometry, i.e. a specific portion of the geometric shape. For the user it shall be possible by selecting a GD&T or geometrical element, to highlight the linked element. This cross-link information has to be preserved in the STEP file.

In order to define the portion of the geometry the GD&T information relates to, at first the corresponding geometric element has to be identified. In Figure 12 shown below, this is assumed to be an `advanced_face` linked through some chain of elements to the `advanced_brep_shape_representation` defining the geometric shape. Next, a `shape_aspect` will be defined so that the face can be related to. The link between the `shape_aspect` and the `advanced_face` is created by an entity of type `geometric_item_specific_usage`, which is highlighted.

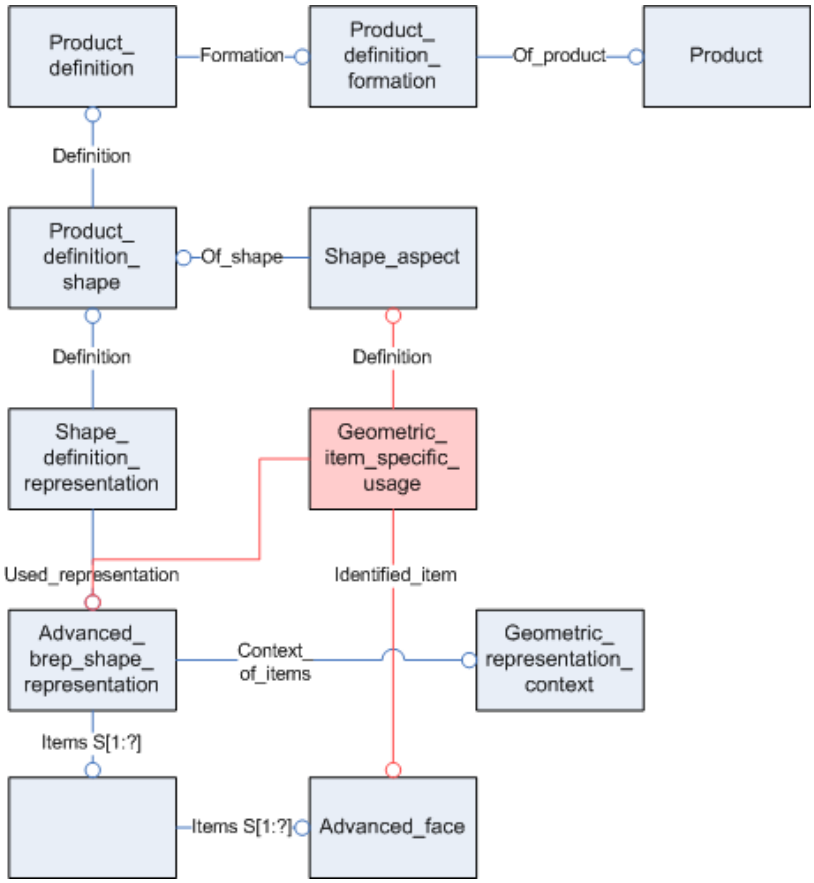

Figure 12 – Identification of the relevant portion of the geometry

```
#15=PRODUCT_DEFINITION_SHAPE(' ',' ',#14);
#21=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT((#
20))GLOBAL_UNIT_ASSIGNED_CONTEXT((#16,#17,#19))REPRESENTATION_CONTEXT('    ','
'));
#24=SHAPE_REPRESENTATION(' ',(#23),#21);
#25=SHAPE_DEFINITION_REPRESENTATION(#15,#24);
#26=MANIFOLD_SOLID_BREP('PartBody',#35);
#35=CLOSED_SHELL('Closed  Shell',(#75,#124,#136,#180,#211,#266,#290,#350,#410,
#432,#439,#461,#468,#492,#509,#526,#543));
#350=ADVANCED_FACE('PartBody',(#313,#331,#349),#295,.T.);
#564=ADVANCED_BREP_SHAPE_REPRESENTATION('NONE',(#26),#21);
#565=SHAPE_REPRESENTATION_RELATIONSHIP(' ',' ',#24,#564);
#1180=SHAPE_ASPECT('','GDT',#15,.F.);
#1181=GEOMETRIC_ITEM_SPECIFIC_USAGE('','GDT',#1180,#24,#350);
```

Figure 13 – Excerpt from the Part21 file example identifying the relevant portion of geometry

The next step is linking the `annotation_occurrences` to the geometry. This is done using a `draughting_model_item_association`, which references the global `draughting_model`, the `annotation_occurrence` in question and the `shape_aspect` that identifies the portion of the geometry that the annotation relates to, as defined above.

Note that if a geometric element in the source system is split during the conversion (e.g. a face split into two faces), the associativity is made with all the entities resulting from the split.

Figure 14 below illustrates the complete structure to identify the relevant portion of geometry and linking the annotation to it.

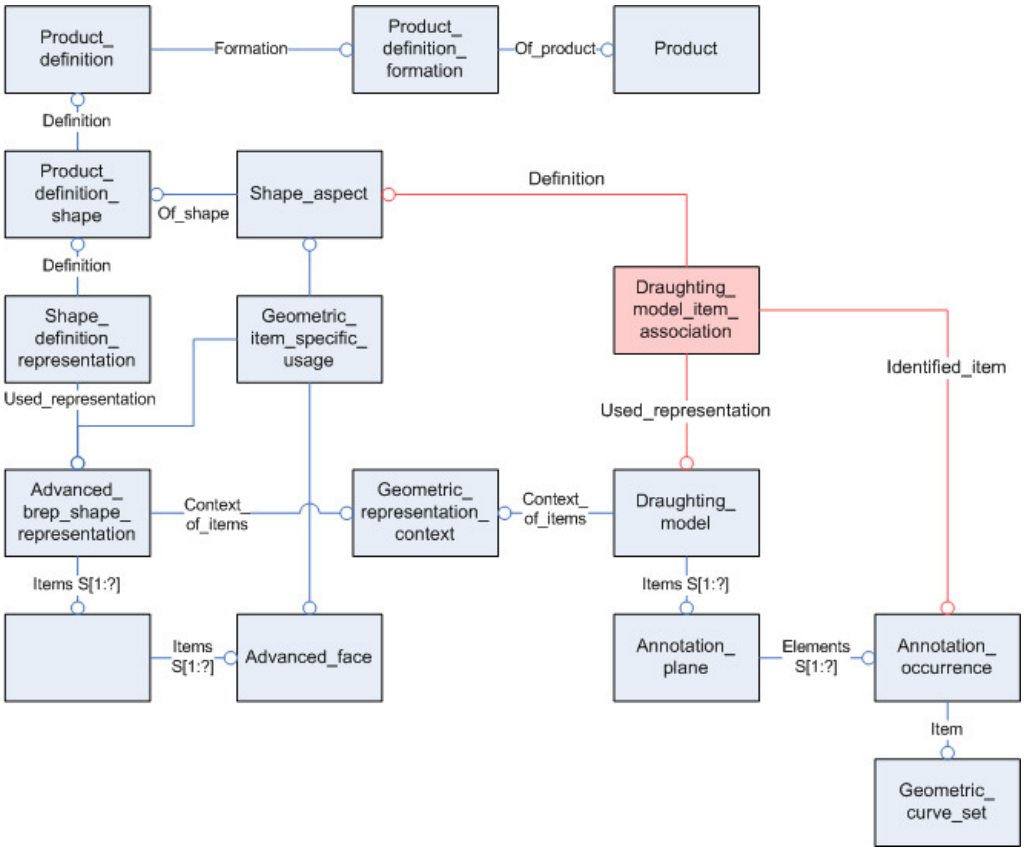

Figure 14 – Associating the annotation with the geometry

```
#566=DRAUGHTING_MODEL('',(#572,#887),#21);
#572=ANNOTATION_PLANE('Front View.1',(#573),#571,(#581,#614,#821));
#581=ANNOTATION_OCCURRENCE('Simple Datum.1',(#580),#577);
#1180=SHAPE_ASPECT('','GDT',#15,.F.);
#1182=DRAUGHTING_MODEL_ITEM_ASSOCIATION('','',#1180,#566,#581);
```

Figure 15 – Part21 file excerpt illustrating the association

2.6 Definition of Saved Views

In complex models or assemblies, the vast amount of data displayed can make the information unreadable for the user. Therefore, 3D annotations and GD&T elements are usually grouped into saved views, and for each view, only a specified subset of the annotations will be visible. See section 1.5.1 on how the term “saved view” is defined in the context of this document.

2.6.1 draughting_models for saved views

For each saved view defined by the user in the CAD system, there will be a specific `draughting_model` in the STEP file, which provides a set viewing orientation via a `camera_model_d3`. This links to the view reference system defining the position of the camera, and to a definition of the perspective.

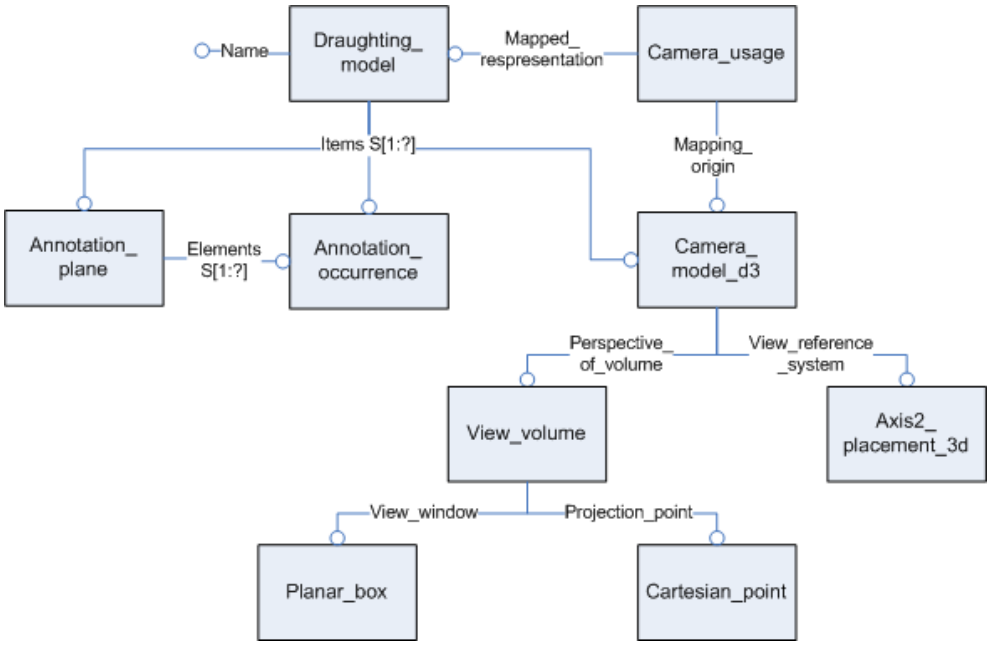

Figure 16 – Camera definition for a view

A detailed definition of `camera_model_d3` and `view_volume` can be found in the CAx-IF "Recommended Practices for Model Viewing" (see http://www.cax-if.de/documents/recprac-model_viewing-A4.pdf or http://www.cax-if.org/documents/recprac-model_viewing-letter.pdf).

The `draughting_model` defining the saved view can reference a subset of the annotations defined in the file. If such a `draughting_model` references an `annotation_plane`, all the `annotation_occurrences` in its set of elements are added to the view. Where reference is required for a subset of those annotations linked to an annotation plane, the `draughting_model` references those specific `annotation_occurrences` directly. See right side of Figure 17 for details.
The definition of saved views, however, is not mandatory in most CAD systems. There also may be annotations that are not included in a saved view, but they still are correctly included in the STEP file structure through the global `draughting_model`.
The global `draughting_model` and those defining saved views are also put in relation to each other; see Figure 17 and section 2.6.2 below for details.

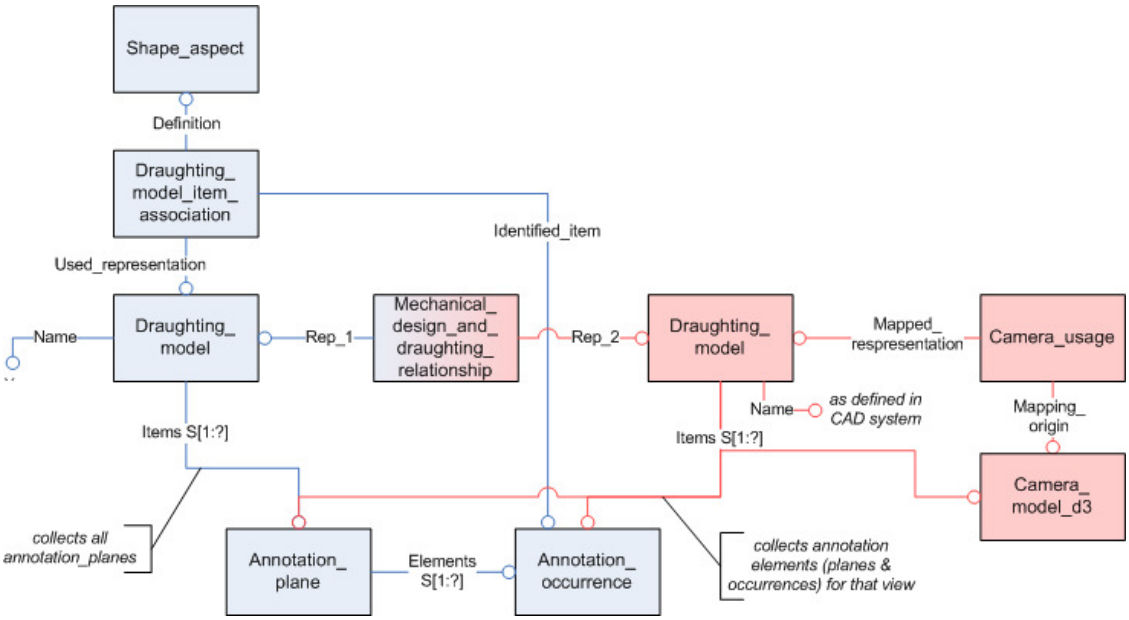

Figure 17 – Defining the global and saved views

2.6.2 Relating the draughting_models

Each `draughting_model` for a saved view is related to the global `draughting_model` through a `mechanical_design_and_draughting_relationship` (a subtype of `representation_relationship`), where the global view is always referenced in the `rep_1` attribute, and the saved view in `rep_2` (see Figure 17).
The following table illustrates the differences between the global `draughting_model` and that for a saved view:

Property	Global	Saved View
draughting_model.name	'' (empty string)	As defined by the user in the CAD system (non-empty string)
camera_model_d3	none related	one in the set of items, and related through a camera_usage
related annotations	all annotation_planes	Some annotation_planes and additional annotation_occurrences as per the saved view definition
mechanical_design_and_-draughting_relationship attribute	rep_1	rep_2
draughting_model_item_-association	one for each annotation_occurrence	none

Figure 18 – Global and saved view draughting_model properties

Note that the entity type `mechanical_design_and_draughting_relationship` will not be included in AP214 Edition 3. Since this type does not add any new attributes, and only carries a higher level of semantic in its name, the use of the supertype `representation_relationship` is recommended for Polyline Presentation in AP214 files. Note, too, that Edition 3 is the earliest version of AP214 supporting GD&T presentation according to approach described in this document.

3 Validation of Polyline Presentation Transfer

After conversion from CAD System to STEP and STEP to CAD System, users should be able to know precisely how many GD&T have been converted in the model, and for each view. In addition, the Polyline annotations themselves should be checked for completeness.
The following "validation properties" for GD&T as Polylines information are suggested:

1. Number of GD&T annotations in the file
2. Number of views in the file
3. Number of annotations per view
4. Total curve length per annotation

The basic STEP structure used for model-wide properties is the same as in other validation properties, compare with “geometric validation properties” and “assembly validation properties”. The name chosen in the context of this document is “annotation validation properties”, since the mechanism also applies to annotations that are not based on GD&T information.
The underlying logic is also identical with that from the other classes of validation properties: the exporting system includes the number of items in question as numeric values in the STEP file, while the importing system reads that value and compares it to the respective items created from importing the file. Any differences shall be flagged to the user.
Note that this applies only to model-wide validation properties (1. and 2. in the above list). There are issues with the structure in the STEP file that currently prevent the implementation of validation properties per view or per annotation, see section 4 Open Issues.

3.1 Number of annotations

The total number of annotations is linked to the definition of the top-level `product` in the file. The value contains the total number of annotations in the file, regardless of their semantic origin (GD&T or other) and which views they are assigned to. The suggested strings to use in the name attributes are shown in Figure 12 below:

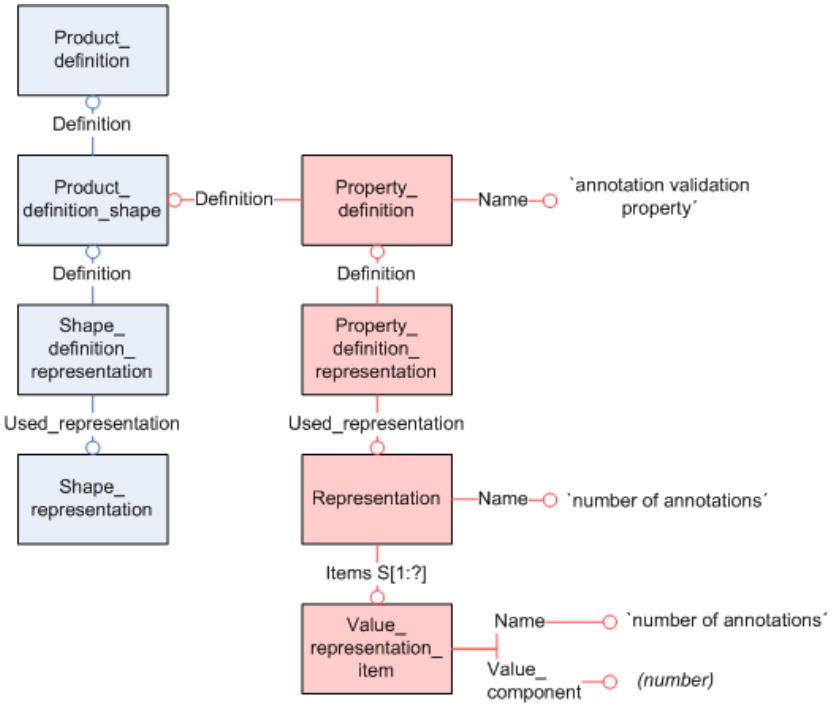

Figure 19 – Annotation validation property for total number of annotations per file

3.2 Number of views

The total number of views in the file is also linked to the top-level product in the file. The STEP file structure is the same as for the total number of annotations, see Figure 19. The only difference is the suggested strings for the name attributes, which are:

Attribute	Recommended value
property_definition.name	'annotation validation property'
representation.name	'number of views'
value_representation_item.name	'number of views'
value_representation_item.value_component	*(number of views)*

Figure 20 – Name attribute population for number of views per file

4 Open Issues

There are a number of suggested validation properties for GD&T polyline presentation, for which there is no known way of implementation at the moment, due to limitations in the STEP data model. The main issue is to find where to attach the `property_definition` to.
Taking a look into the mapping tables, the corresponding AIM object is `General_Property`, and depending on the intended use, the `property_definition` may be linked to:

- catalogue thread (feature_definition => externally_defined_thread)
- complex product, design contraint, ddid, document representation, item instance (product_definition)
- document file (document_file)
- feature definition (feature_definition)
- general feature (feature_definition => general_feature)
- item_definition(_instance)_relationship, prouct_structure_relationship (product_definition_relationship)
- item shape (product_definition_shape)
- product class (product_class)
- product specification (product_specification)
- shape element (shape_aspect)
- shape element relationship (shape_aspect_relationship)
- thread feature (shape_aspect => thread_occurrence)
- transition feature (shape_aspect => transition_feature)

Unfortunately, this does not include what is needed to implement the validation properties listed below. Especially, a definition of a property for representation would be needed, to be able to attach it to a `draughting_model`, i.e. a saved view.

4.1 Number of annotations per view

This annotation validation property is defined once for each saved view in the file, and states the number of annotations assigned to that saved view. The number is calculated by summing up the number of all `annotation_occurences` either in the set of elements of the `annotation_planes` referenced by the `draughting_model` defining the saved view, or referenced by that `draughting_model` directly.

Note that the sum of all 'annotation per view' properties is likely to be larger than the value given by the 'total number of annotations' property, since annotations may be assigned to more than view.

Figure 21 below sketches the STEP file structure as suggested so far. The link to the `draughting_model` defining the saved view, see section 2.6.1, is still to be defined, see above.

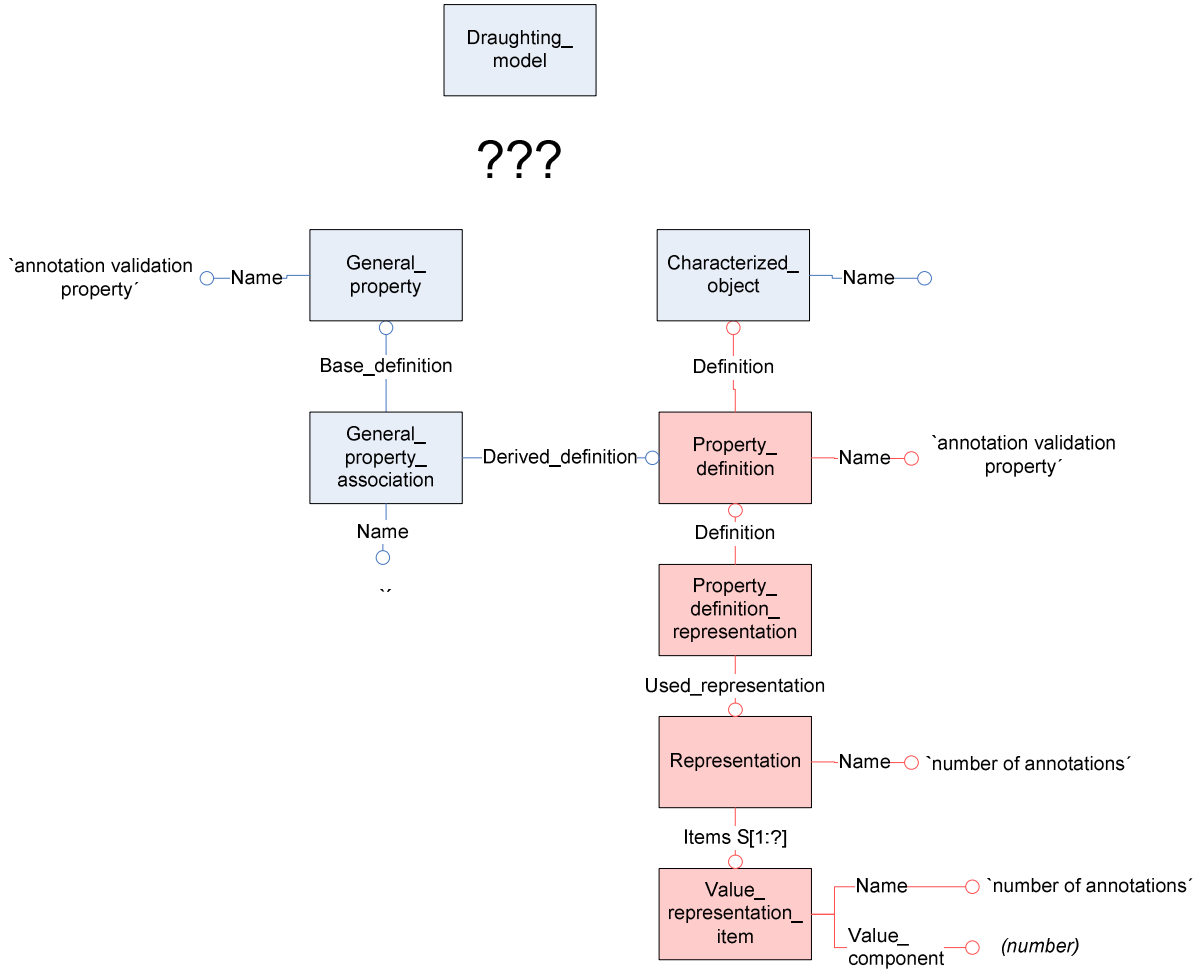

Figure 21 – Annotation validation property for number of annotations per view

In addition to the values shown in Figure 21 above, the `property_definition.description` is recommended as place to store the information about which view the number of annotations corresponds to, e.g. 'number of annotation in view <*saved view name*>'. The view may be identified by its name, number or STEP entity number in the file.

4.2 Total curve length per Polyline annotation

A polyline annotation, represented in the STEP file by the `geometric_curve_set` and the entities references by it, is basically a piece of wireframe geometry. Recent tests in the CAx-IF showed that "total curve length" is a meaningful validation property for the exchange of wireframe geometry. Hence, validation the total curve length of all polylines for an individual GD&T element allows to verify that no elements of the annotation – e.g. a decimal point – have been lost during the conversion.

The logical anchor entity to attach `property_defininition` to would be either the `annotation_occurrence` (`representation_item => styled_item`), or the `geometric_curve_set` (`representation_item => geometric_representation_item`), neither of which are in the list of mapping targets for General_Property, see above.
Detailed definition of this validation property is deferred until the structural issues have been resolved.

4.3 AP interoperability

The entity type `mechanical_design_and_draughting_relationship` should be added to AP214 at a later point in time to ensure full interoperability with AP203 Edition 2.

4.4 Transfer of Construction Geometry

Many CAD systems support the creation of construction geometry – i.e. geometric elements such as lines or planes, that are not part of the actual (manufactured) part shape. By default, these elements are not transferred during STEP data exchange. This is a long-known issue, but until now had only minor effects.
However, in some cases it is meaningful to attach datums, dimensions or tolerances to construction geometry elements. These GD&T elements become meaningless in the target system if the construction geometry is not transferred, too.

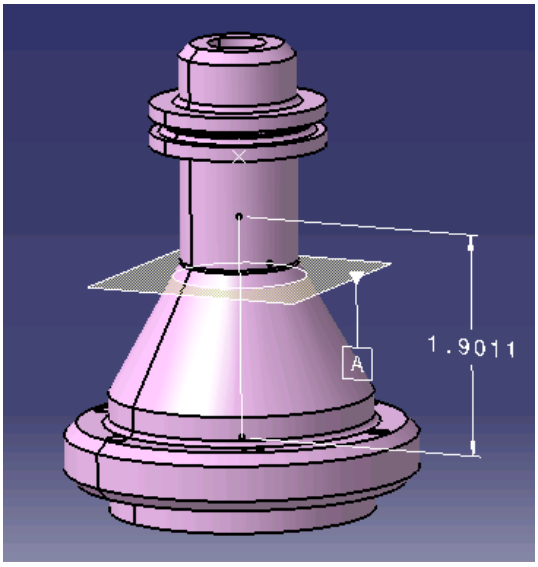

Figure 22 – Datum “A” referencing a construction geometry element

Currently, there is no agreed way to transfer geometric elements and classify them as construction geometry. This needs to be resolved in a later version of this document.

5 Part 21 File Example

The following Part21 File Example illustrates the presentation of GD&T Datums and Tolerances as Polylines. It is based on a LOTAR Part 210 Test File.

The EXPRESS Schema used is the AP203 Edition 2 schema from September 2007, which can be found on the CAx-IF homepages (www.cax-if.de or www.cax-if.org) under “Joint Testing Information”.

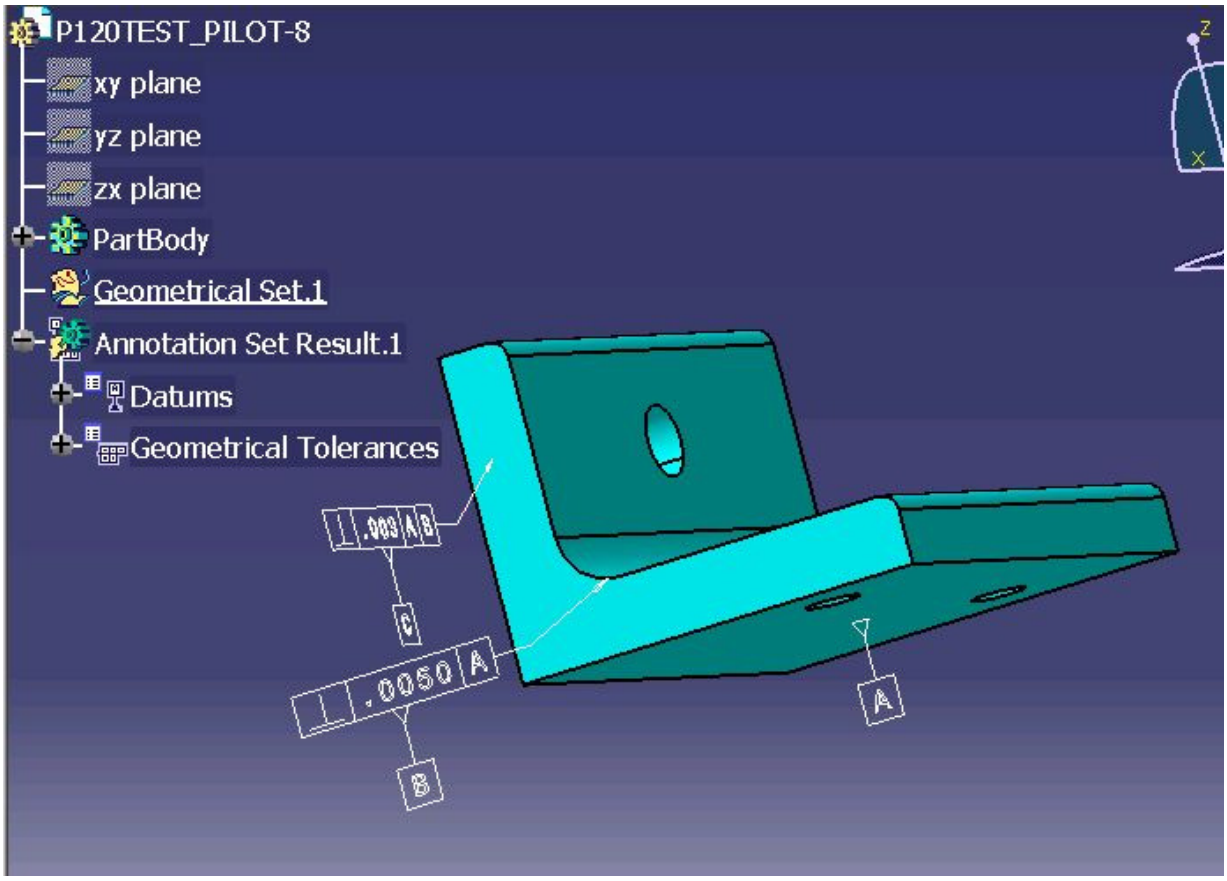

Figure 23 – Shape of the Part 21 file example including GD&T Polyline Presentation

```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION(('CATIA V5 STEP Exchange'),'2;1');
FILE_NAME('E:\\Etudes\\LOTAR\\Pilot-TestData\\Pilot-SNECMA-
Part\\week24\\P120TEST_PILOT-8.stp','2008-06-
11T07:51:21+00:00',('none'),('none'),'CATIA Version 5 Release 19 GA (IN-
10)','CATIA V5 STEP AP203 Edition 2','none');
FILE_SCHEMA(('AP203_CONFIGURATION_CONTROLLED_3D_DESIGN_OF_MECHANICAL_PARTS_AND
_ASSEMBLIES_MIM_LF  { 1 0 10303 403 2 1 2}'));
ENDSEC;
/* file written by CATIA V5R19 */
DATA;
#5=PRODUCT('P120TEST_PILOT-8','','Created by RSZ 2007 to support LOTAR Part
120v1 test pilot',(#2));
#2=PRODUCT_CONTEXT(' ',#1,'mechanical');
#1=APPLICATION_CONTEXT('configuration controlled 3D design of mechanical parts
and assemblies');
#14=PRODUCT_DEFINITION('',' ',#6,#3);
#3=PRODUCT_DEFINITION_CONTEXT('part definition',#1,' ');
#544=SHAPE_ASPECT('','Solid',#15,.F.);
#1180=SHAPE_ASPECT('','GDT',#15,.F.);
#1183=SHAPE_ASPECT('','GDT',#15,.F.);
#1186=SHAPE_ASPECT('','GDT',#15,.F.);
#1189=SHAPE_ASPECT('','GDT',#15,.F.);
#1192=SHAPE_ASPECT('','GDT',#15,.F.);
```

```
#15=PRODUCT_DEFINITION_SHAPE(' ',' ',#14);
#545=PROPERTY_DEFINITION('','shape for solid data with which properties are
associated',#544);
#550=PROPERTY_DEFINITION('geometric validation property','centroid of
#26',#544);
#556=PROPERTY_DEFINITION('geometric validation property','volume of
#26',#544);
#562=PROPERTY_DEFINITION('geometric validation property','surface area of
#26',#544);
#1197=PROPERTY_DEFINITION('annotation validation property','number of annota-
tions',#15);
#1201=PROPERTY_DEFINITION('annotation validation property','number of annota-
tions',#15);
#1206=PROPERTY_DEFINITION('geometric validation property','centroid of
Part',#15);
#1210=PROPERTY_DEFINITION('geometric validation property','volume of
Part',#15);
#1214=PROPERTY_DEFINITION('geometric validation property','surface area of
Part',#15);
#549=REPRESENTATION('centroid',(#548),#21);
#555=REPRESENTATION('volume',(#554),#21);
#561=REPRESENTATION('surface area',(#560),#21);
#1196=REPRESENTATION('number of annotations',(#1195),#21);
#1200=REPRESENTATION('number of annotations',(#1199),#21);
#1205=REPRESENTATION('centroid',(#1204),#21);
#1209=REPRESENTATION('volume',(#1208),#21);
#1213=REPRESENTATION('surface area',(#1212),#21);
#551=PROPERTY_DEFINITION_REPRESENTATION(#550,#549);
#557=PROPERTY_DEFINITION_REPRESENTATION(#556,#555);
#563=PROPERTY_DEFINITION_REPRESENTATION(#562,#561);
#1198=PROPERTY_DEFINITION_REPRESENTATION(#1197,#1196);
#1202=PROPERTY_DEFINITION_REPRESENTATION(#1201,#1200);
#1207=PROPERTY_DEFINITION_REPRESENTATION(#1206,#1205);
#1211=PROPERTY_DEFINITION_REPRESENTATION(#1210,#1209);
#1215=PROPERTY_DEFINITION_REPRESENTATION(#1214,#1213);
#565=SHAPE_REPRESENTATION_RELATIONSHIP(' ',' ',#24,#564);
#34=STYLED_ITEM(' ',(#33),#26);
#33=PRESENTATION_STYLE_ASSIGNMENT((#32));
#573=PRESENTATION_STYLE_ASSIGNMENT((.NULL.));
#580=PRESENTATION_STYLE_ASSIGNMENT((#579));
#613=PRESENTATION_STYLE_ASSIGNMENT((#612));
#820=PRESENTATION_STYLE_ASSIGNMENT((#819));
#888=PRESENTATION_STYLE_ASSIGNMENT((.NULL.));
#891=PRESENTATION_STYLE_ASSIGNMENT((#890));
#1128=PRESENTATION_STYLE_ASSIGNMENT((#1127));
#553=DERIVED_UNIT((#552));
#559=DERIVED_UNIT((#558));
#552=DERIVED_UNIT_ELEMENT(#16,3.);
#558=DERIVED_UNIT_ELEMENT(#16,2.);
#579=CURVE_STYLE(' ',#574,POSITIVE_LENGTH_MEASURE(0.13),#578);
#612=CURVE_STYLE(' ',#574,POSITIVE_LENGTH_MEASURE(0.13),#578);
#819=CURVE_STYLE(' ',#574,POSITIVE_LENGTH_MEASURE(0.13),#578);
#890=CURVE_STYLE(' ',#574,POSITIVE_LENGTH_MEASURE(0.13),#578);
#1127=CURVE_STYLE(' ',#574,POSITIVE_LENGTH_MEASURE(0.13),#578);
#32=SURFACE_STYLE_USAGE(.BOTH.,#31);
#31=SURFACE_SIDE_STYLE(' ',(#30));
#30=SURFACE_STYLE_FILL_AREA(#29);
#29=FILL_AREA_STYLE(' ',(#28));
```

```
#28=FILL_AREA_STYLE_COLOUR(' ',#27);
#43=VECTOR('Line Direction',#42,1.);
#59=VECTOR('Line Direction',#58,1.);
#83=VECTOR('Line Direction',#82,1.);
#92=VECTOR('Line Direction',#91,1.);
#99=VECTOR('Line Direction',#98,1.);
#106=VECTOR('Line Direction',#105,1.);
#144=VECTOR('Line Direction',#143,1.);
#153=VECTOR('Line Direction',#152,1.);
#160=VECTOR('Line Direction',#159,1.);
#167=VECTOR('Line Direction',#166,1.);
#195=VECTOR('Line Direction',#194,1.);
#226=VECTOR('Line Direction',#225,1.);
#240=VECTOR('Line Direction',#239,1.);
#247=VECTOR('Line Direction',#246,1.);
#252=VECTOR('Line Direction',#251,1.);
#281=VECTOR('Line Direction',#280,1.);
#298=VECTOR('Line Direction',#297,1.);
#305=VECTOR('Line Direction',#304,1.);
#358=VECTOR('Line Direction',#357,1.);
#365=VECTOR('Line Direction',#364,1.);
#418=VECTOR('Line Direction',#417,1.);
#423=VECTOR('Line Direction',#422,1.);
#447=VECTOR('Line Direction',#446,1.);
#452=VECTOR('Line Direction',#451,1.);
#483=VECTOR('Line Direction',#482,1.);
#500=VECTOR('Line Direction',#499,1.);
#517=VECTOR('Line Direction',#516,1.);
#37=DIRECTION('Axis2P3D Direction',(0.,-1.,0.));
#38=DIRECTION('Axis2P3D XDirection',(0.87758256189,0.,0.479425538604));
#42=DIRECTION('Vector Direction',(0.,-1.,0.));
#51=DIRECTION('Axis2P3D Direction',(0.,-1.,0.));
#58=DIRECTION('Vector Direction',(0.,-1.,0.));
#65=DIRECTION('Axis2P3D Direction',(0.,-1.,0.));
#77=DIRECTION('Axis2P3D Direction',(0.,1.,0.));
#78=DIRECTION('Axis2P3D XDirection',(0.,0.,1.));
#82=DIRECTION('Vector Direction',(0.,0.,1.));
#91=DIRECTION('Vector Direction',(1.,0.,0.));
#98=DIRECTION('Vector Direction',(0.,0.,1.));
#105=DIRECTION('Vector Direction',(1.,0.,0.));
#116=DIRECTION('Axis2P3D Direction',(0.,1.,0.));
#126=DIRECTION('Axis2P3D Direction',(0.,-1.,0.));
#138=DIRECTION('Axis2P3D Direction',(0.,-1.,0.));
#139=DIRECTION('Axis2P3D XDirection',(0.,0.,-1.));
#143=DIRECTION('Vector Direction',(1.,0.,0.));
#152=DIRECTION('Vector Direction',(0.,0.,-1.));
#159=DIRECTION('Vector Direction',(1.,0.,0.));
#166=DIRECTION('Vector Direction',(0.,0.,-1.));
#182=DIRECTION('Axis2P3D Direction',(1.,0.,0.));
#183=DIRECTION('Axis2P3D XDirection',(0.,-1.,0.));
#187=DIRECTION('Axis2P3D Direction',(1.,0.,0.));
#194=DIRECTION('Vector Direction',(1.,0.,0.));
#201=DIRECTION('Axis2P3D Direction',(1.,0.,0.));
#213=DIRECTION('Axis2P3D Direction',(1.,0.,0.));
#214=DIRECTION('Axis2P3D XDirection',(0.,1.,0.));
#218=DIRECTION('Axis2P3D Direction',(1.,0.,0.));
#225=DIRECTION('Vector Direction',(0.,-1.,0.));
#232=DIRECTION('Axis2P3D Direction',(1.,0.,0.));
```

```
#239=DIRECTION('Vector Direction',(0.,0.,1.));
#246=DIRECTION('Vector Direction',(0.,1.,0.));
#251=DIRECTION('Vector Direction',(0.,-1.,0.));
#268=DIRECTION('Axis2P3D Direction',(1.,0.,-0.));
#269=DIRECTION('Axis2P3D XDirection',(-0.,1.,-1.83697019872E-016));
#273=DIRECTION('Axis2P3D Direction',(1.,0.,-0.));
#280=DIRECTION('Vector Direction',(1.,0.,0.));
#292=DIRECTION('Axis2P3D Direction',(0.,0.,-1.));
#293=DIRECTION('Axis2P3D XDirection',(0.,1.,0.));
#297=DIRECTION('Vector Direction',(1.,0.,0.));
#304=DIRECTION('Vector Direction',(0.,1.,0.));
#315=DIRECTION('Axis2P3D Direction',(0.,0.,-1.));
#324=DIRECTION('Axis2P3D Direction',(0.,0.,-1.));
#333=DIRECTION('Axis2P3D Direction',(0.,0.,-1.));
#342=DIRECTION('Axis2P3D Direction',(0.,0.,-1.));
#352=DIRECTION('Axis2P3D Direction',(-0.,0.,1.));
#353=DIRECTION('Axis2P3D XDirection',(0.,-1.,0.));
#357=DIRECTION('Vector Direction',(0.,-1.,0.));
#364=DIRECTION('Vector Direction',(1.,0.,0.));
#375=DIRECTION('Axis2P3D Direction',(-0.,0.,1.));
#384=DIRECTION('Axis2P3D Direction',(-0.,0.,1.));
#393=DIRECTION('Axis2P3D Direction',(-0.,0.,1.));
#402=DIRECTION('Axis2P3D Direction',(-0.,0.,1.));
#412=DIRECTION('Axis2P3D Direction',(0.,0.,-1.));
#413=DIRECTION('Axis2P3D XDirection',(0.87758256189,-0.479425538604,0.));
#417=DIRECTION('Vector Direction',(0.,0.,-1.));
#422=DIRECTION('Vector Direction',(0.,0.,-1.));
#441=DIRECTION('Axis2P3D Direction',(0.,0.,-1.));
#442=DIRECTION('Axis2P3D XDirection',(0.87758256189,-0.479425538604,0.));
#446=DIRECTION('Vector Direction',(0.,0.,-1.));
#451=DIRECTION('Vector Direction',(0.,0.,-1.));
#470=DIRECTION('Axis2P3D Direction',(1.,0.,-0.));
#471=DIRECTION('Axis2P3D XDirection',(-0.,1.,-1.83697019872E-016));
#475=DIRECTION('Axis2P3D Direction',(1.,0.,-0.));
#482=DIRECTION('Vector Direction',(1.,0.,0.));
#494=DIRECTION('Axis2P3D Direction',(0.,1.,0.));
#495=DIRECTION('Axis2P3D XDirection',(0.,0.,1.));
#499=DIRECTION('Vector Direction',(0.,0.,1.));
#511=DIRECTION('Axis2P3D Direction',(-0.,0.,1.));
#512=DIRECTION('Axis2P3D XDirection',(0.,-1.,0.));
#516=DIRECTION('Vector Direction',(0.,-1.,0.));
#528=DIRECTION('Axis2P3D Direction',(1.,0.,0.));
#529=DIRECTION('Axis2P3D XDirection',(0.,1.,0.));
#568=DIRECTION('Axis2P3D Direction',(1.,0.,0.));
#569=DIRECTION('Axis2P3D XDirection',(0.,1.,0.));
#883=DIRECTION('Axis2P3D Direction',(0.,1.,-0.));
#884=DIRECTION('Axis2P3D XDirection',(-1.,0.,0.));
#581=ANNOTATION_OCCURRENCE('Simple Datum.1',(#580),#577);
#614=ANNOTATION_OCCURRENCE('Perpendicularity.1',(#613),#611);
#821=ANNOTATION_OCCURRENCE('Simple Datum.2',(#820),#818);
#892=ANNOTATION_OCCURRENCE('Perpendicularity.2',(#891),#889);
#1129=ANNOTATION_OCCURRENCE('Simple Datum.3',(#1128),#1126);
#22=CARTESIAN_POINT(' ',(0.,0.,0.));
#36=CARTESIAN_POINT('Axis2P3D Loca-
tion',(50.8000000002,12.6000000001,38.1000000002));
#41=CARTESIAN_POINT('Line Origine',(45.2273507322,38.1000000002,35.05564783));
#45=CARTESIAN_POINT('Vertex',(45.2273507322,3.5527136788E-015,35.05564783));
#47=CARTESIAN_POINT('Vertex',(45.2273507322,12.7000000001,35.05564783));
```

```
#50=CARTESIAN_POINT('Axis2P3D Location',(50.8000000002,0.,38.1000000002));
#54=CARTESIAN_POINT('Vertex',(56.3726492682,3.5527136788E-015,41.1443521703));
#57=CARTESIAN_POINT('Line
Origine',(56.3726492682,38.1000000002,41.1443521703));
#61=CARTESIAN_POINT('Vertex',(56.3726492682,12.7000000001,41.1443521703));
#64=CARTESIAN_POINT('Axis2P3D Loca-
tion',(50.8000000002,12.7000000001,38.1000000002));
#76=CARTESIAN_POINT('Axis2P3D Location',(0.,12.7000000001,12.7000000001));
#81=CARTESIAN_POINT('Line Origine',(101.6,12.7000000001,38.1000000002));
#85=CARTESIAN_POINT('Vertex',(101.6,12.7000000001,22.2250000001));
#87=CARTESIAN_POINT('Vertex',(101.6,12.7000000001,53.9750000002));
#90=CARTESIAN_POINT('Line
Origine',(50.8000000002,12.7000000001,22.2250000001));
#94=CARTESIAN_POINT('Vertex',(0.,12.7000000001,22.2250000001));
#97=CARTESIAN_POINT('Line Origine',(0.,12.7000000001,38.1000000002));
#101=CARTESIAN_POINT('Vertex',(0.,12.7000000001,53.9750000002));
#104=CARTESIAN_POINT('Line
Origine',(50.8000000002,12.7000000001,53.9750000002));
#115=CARTESIAN_POINT('Axis2P3D Loca-
tion',(50.8000000002,12.7000000001,38.1000000002));
#125=CARTESIAN_POINT('Axis2P3D Location',(50.8000000002,0.,38.1000000002));
#137=CARTESIAN_POINT('Axis2P3D Location',(0.,0.,57.1500000002));
#142=CARTESIAN_POINT('Line Origine',(50.8000000002,0.,57.1500000002));
#146=CARTESIAN_POINT('Vertex',(0.,0.,57.1500000002));
#148=CARTESIAN_POINT('Vertex',(101.6,0.,57.1500000002));
#151=CARTESIAN_POINT('Line Origine',(0.,0.,28.5750000001));
#155=CARTESIAN_POINT('Vertex',(0.,0.,3.5527136788E-015));
#158=CARTESIAN_POINT('Line Origine',(50.8000000002,0.,0.));
#162=CARTESIAN_POINT('Vertex',(101.6,0.,3.5527136788E-015));
#165=CARTESIAN_POINT('Line Origine',(101.6,0.,28.5750000001));
#181=CARTESIAN_POINT('Axis2P3D Loca-
tion',(50.8000000002,22.2250000001,22.2250000001));
#186=CARTESIAN_POINT('Axis2P3D Location',(101.6,22.2250000001,22.2250000001));
#190=CARTESIAN_POINT('Vertex',(101.6,22.2250000001,12.7000000001));
#193=CARTESIAN_POINT('Line
Origine',(50.8000000002,22.2250000001,12.7000000001));
#197=CARTESIAN_POINT('Vertex',(0.,22.2250000001,12.7000000001));
#200=CARTESIAN_POINT('Axis2P3D Location',(4.02238242714E-
011,22.2250000001,22.2250000001));
#212=CARTESIAN_POINT('Axis2P3D Location',(0.,0.,0.));
#217=CARTESIAN_POINT('Axis2P3D Location',(0.,9.52500000004,53.9750000002));
#221=CARTESIAN_POINT('Vertex',(0.,9.52500000004,57.1500000002));
#224=CARTESIAN_POINT('Line Origine',(0.,47.6250000002,12.7000000001));
#228=CARTESIAN_POINT('Vertex',(0.,73.0250000003,12.7000000001));
#231=CARTESIAN_POINT('Axis2P3D Location',(0.,73.0250000003,9.52500000004));
#235=CARTESIAN_POINT('Vertex',(0.,76.2000000003,9.52500000004));
#238=CARTESIAN_POINT('Line Origine',(0.,76.2000000003,4.76250000002));
#242=CARTESIAN_POINT('Vertex',(0.,76.2000000003,0.));
#245=CARTESIAN_POINT('Line Origine',(0.,38.1000000002,0.));
#250=CARTESIAN_POINT('Line Origine',(0.,4.76250000002,57.1500000002));
#267=CARTESIAN_POINT('Axis2P3D Loca-
tion',(50.8000000002,9.52500000004,53.9750000002));
#272=CARTESIAN_POINT('Axis2P3D Location',(101.6,9.52500000004,53.9750000002));
#276=CARTESIAN_POINT('Vertex',(101.6,9.52500000004,57.1500000002));
#279=CARTESIAN_POINT('Line
Origine',(50.8000000002,9.52500000004,57.1500000002));
#291=CARTESIAN_POINT('Axis2P3D Location',(0.,0.,0.));
#296=CARTESIAN_POINT('Line Origine',(50.8000000002,76.2000000003,0.));
```

```
#300=CARTESIAN_POINT('Vertex',(101.6,76.2000000003,0.));
#303=CARTESIAN_POINT('Line Origine',(101.6,38.1000000002,0.));
#314=CARTESIAN_POINT('Axis2P3D Location',(19.0500000001,50.8000000002,0.));
#318=CARTESIAN_POINT('Vertex',(23.2294869511,48.5167358726,0.));
#320=CARTESIAN_POINT('Vertex',(14.8705130491,53.0832641278,0.));
#323=CARTESIAN_POINT('Axis2P3D Location',(19.0500000001,50.8000000002,0.));
#332=CARTESIAN_POINT('Axis2P3D Location',(82.5500000003,50.8000000002,0.));
#336=CARTESIAN_POINT('Vertex',(86.7294869513,48.5167358726,0.));
#338=CARTESIAN_POINT('Vertex',(78.3705130493,53.0832641278,0.));
#341=CARTESIAN_POINT('Axis2P3D Location',(82.5500000003,50.8000000002,0.));
#351=CARTESIAN_POINT('Axis2P3D Location',(0.,76.2000000003,12.7000000001));
#356=CARTESIAN_POINT('Line Origine',(101.6,47.6250000002,12.7000000001));
#360=CARTESIAN_POINT('Vertex',(101.6,73.0250000003,12.7000000001));
#363=CARTESIAN_POINT('Line Origi-
ne',(50.8000000002,73.0250000003,12.7000000001));
#374=CARTESIAN_POINT('Axis2P3D Locatio-
n',(19.0500000001,50.8000000002,12.7000000001));
#378=CARTESIAN_POINT('Vertex',(14.8705130491,53.0832641278,12.7000000001));
#380=CARTESIAN_POINT('Vertex',(23.2294869511,48.5167358726,12.7000000001));
#383=CARTESIAN_POINT('Axis2P3D Locatio-
n',(19.0500000001,50.8000000002,12.7000000001));
#392=CARTESIAN_POINT('Axis2P3D Locatio-
n',(82.5500000003,50.8000000002,12.7000000001));
#396=CARTESIAN_POINT('Vertex',(78.3705130493,53.0832641278,12.7000000001));
#398=CARTESIAN_POINT('Vertex',(86.7294869513,48.5167358726,12.7000000001));
#401=CARTESIAN_POINT('Axis2P3D Locatio-
n',(82.5500000003,50.8000000002,12.7000000001));
#411=CARTESIAN_POINT('Axis2P3D Locatio-
n',(82.5500000003,50.8000000002,12.6000000001));
#416=CARTESIAN_POINT('Line Origi-
ne',(78.3705130493,53.0832641278,28.5750000001));
#421=CARTESIAN_POINT('Line Origi-
ne',(86.7294869513,48.5167358726,28.5750000001));
#440=CARTESIAN_POINT('Axis2P3D Locatio-
n',(19.0500000001,50.8000000002,12.6000000001));
#445=CARTESIAN_POINT('Line Origi-
ne',(14.8705130491,53.0832641278,28.5750000001));
#450=CARTESIAN_POINT('Line Origi-
ne',(23.2294869511,48.5167358726,28.5750000001));
#469=CARTESIAN_POINT('Axis2P3D Locatio-
n',(50.8000000002,73.0250000003,9.52500000004));
#474=CARTESIAN_POINT('Axis2P3D Location',(101.6,73.0250000003,9.52500000004));
#478=CARTESIAN_POINT('Vertex',(101.6,76.2000000003,9.52500000004));
#481=CARTESIAN_POINT('Line Origi-
ne',(50.8000000002,76.2000000003,9.52500000004));
#493=CARTESIAN_POINT('Axis2P3D Location',(0.,76.2000000003,0.));
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#1063=CARTESIAN_POINT('GDT',(137.645477295,4.91194963455,25.4375171661));
#1064=CARTESIAN_POINT('GDT',(138.926452637,4.91194963455,28.9425601959));
#1065=CARTESIAN_POINT('GDT',(139.440872192,4.91194963455,28.9425601959));
#1066=CARTESIAN_POINT('GDT',(140.716812134,4.91194963455,25.4375171661));
#1068=CARTESIAN_POINT('GDT',(139.72328186,4.91194963455,26.8950099945));
#1069=CARTESIAN_POINT('GDT',(139.183670044,4.91194963455,28.4382381439));
#1070=CARTESIAN_POINT('GDT',(138.644042969,4.91194963455,26.8950099945));
#1071=CARTESIAN_POINT('GDT',(139.72328186,4.91194963455,26.8950099945));
#1073=CARTESIAN_POINT('GDT',(132.017227173,4.91194963455,27.3287277222));
#1074=CARTESIAN_POINT('GDT',(131.664215088,4.91194963455,27.6212348938));
#1075=CARTESIAN_POINT('GDT',(131.573425293,4.91194963455,27.8179206848));
#1076=CARTESIAN_POINT('GDT',(131.543167114,4.91194963455,28.0599956512));
#1077=CARTESIAN_POINT('GDT',(131.608734131,4.91194963455,28.4382381439));
#1078=CARTESIAN_POINT('GDT',(131.805419922,4.91194963455,28.7105712891));
#1079=CARTESIAN_POINT('GDT',(132.123138428,4.91194963455,28.8769989014));
#1080=CARTESIAN_POINT('GDT',(132.566940308,4.91194963455,28.9375171661));
#1081=CARTESIAN_POINT('GDT',(133.81262207,4.91194963455,28.9375171661));
#1082=CARTESIAN_POINT('GDT',(133.81262207,4.91194963455,25.4375171661));
#1083=CARTESIAN_POINT('GDT',(132.496337891,4.91194963455,25.4375171661));
#1084=CARTESIAN_POINT('GDT',(132.027313232,4.91194963455,25.5081214905));
#1085=CARTESIAN_POINT('GDT',(131.679336548,4.91194963455,25.7148952484));
#1086=CARTESIAN_POINT('GDT',(131.462478638,4.91194963455,26.0427036285));
#1087=CARTESIAN_POINT('GDT',(131.386825562,4.91194963455,26.4865093231));
#1088=CARTESIAN_POINT('GDT',(131.432220459,4.91194963455,26.7840595245));
#1089=CARTESIAN_POINT('GDT',(131.553253174,4.91194963455,27.0311775208));
#1090=CARTESIAN_POINT('GDT',(131.749938965,4.91194963455,27.2127342224));
#1091=CARTESIAN_POINT('GDT',(132.017227173,4.91194963455,27.3287277222));
#1093=CARTESIAN_POINT('GDT',(132.662765503,4.91194963455,27.4850673676));
#1094=CARTESIAN_POINT('GDT',(133.348648071,4.91194963455,27.4850673676));
#1095=CARTESIAN_POINT('GDT',(133.348648071,4.91194963455,28.5189285278));
#1096=CARTESIAN_POINT('GDT',(132.622421265,4.91194963455,28.5189285278));
#1097=CARTESIAN_POINT('GDT',(132.350082397,4.91194963455,28.4886703491));
#1098=CARTESIAN_POINT('GDT',(132.158447266,4.91194963455,28.3978919983));
#1099=CARTESIAN_POINT('GDT',(132.042449951,4.91194963455,28.2415523529));
#1100=CARTESIAN_POINT('GDT',(132.002105713,4.91194963455,28.009563446));
#1101=CARTESIAN_POINT('GDT',(132.04750061,4.91194963455,27.7775745392));
#1102=CARTESIAN_POINT('GDT',(132.168533325,4.91194963455,27.616191864));
#1103=CARTESIAN_POINT('GDT',(132.375305176,4.91194963455,27.5153274536));
#1104=CARTESIAN_POINT('GDT',(132.662765503,4.91194963455,27.4850673676));
#1106=CARTESIAN_POINT('GDT',(132.551818848,4.91194963455,25.8561058044));
#1107=CARTESIAN_POINT('GDT',(133.348648071,4.91194963455,25.8561058044));
#1108=CARTESIAN_POINT('GDT',(133.348648071,4.91194963455,27.0614356995));
#1109=CARTESIAN_POINT('GDT',(132.597198486,4.91194963455,27.0614356995));
#1110=CARTESIAN_POINT('GDT',(132.27947998,4.91194963455,27.026134491));
#1111=CARTESIAN_POINT('GDT',(132.052536011,4.91194963455,26.9202270508));
#1112=CARTESIAN_POINT('GDT',(131.916366577,4.91194963455,26.7386703491));
#1113=CARTESIAN_POINT('GDT',(131.870986938,4.91194963455,26.4764213562));
#1114=CARTESIAN_POINT('GDT',(131.916366577,4.91194963455,26.1990451813));
#1115=CARTESIAN_POINT('GDT',(132.042449951,4.91194963455,26.00740242));
#1116=CARTESIAN_POINT('GDT',(132.254272461,4.91194963455,25.8914070129));
#1117=CARTESIAN_POINT('GDT',(132.551818848,4.91194963455,25.8561058044));
#1119=CARTESIAN_POINT('GDT',(101.599998474,4.91194963455,38.0261611938));
#1120=CARTESIAN_POINT('GDT',(121.081665039,4.91194963455,27.1875171661));
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#1121=CARTESIAN_POINT('GDT',(129.379638672,4.91194963455,27.1875171661));
#1123=CARTESIAN_POINT('GDT',(104.13004303,4.91194963455,36.0431060791));
#1124=CARTESIAN_POINT('GDT',(101.599998474,4.91194963455,38.0261611938));
#1125=CARTESIAN_POINT('GDT',(104.619018555,4.91194963455,36.9219894409));
#1131=CARTESIAN_POINT('GDT',(149.220687866,4.91194963455,9.73867034912));
#1132=CARTESIAN_POINT('GDT',(149.321563721,4.91194963455,9.31503868103));
#1133=CARTESIAN_POINT('GDT',(149.487991333,4.91194963455,9.01244544983));
#1134=CARTESIAN_POINT('GDT',(149.719970703,4.91194963455,8.82584571838));
#1135=CARTESIAN_POINT('GDT',(149.99230957,4.91194963455,8.76532649994));
#1136=CARTESIAN_POINT('GDT',(150.320114136,4.91194963455,8.85610485077));
#1137=CARTESIAN_POINT('GDT',(150.577316284,4.91194963455,9.12843894958));
#1138=CARTESIAN_POINT('GDT',(150.748794556,4.91194963455,9.57224369049));
#1139=CARTESIAN_POINT('GDT',(150.804275513,4.91194963455,10.1875171661));
#1140=CARTESIAN_POINT('GDT',(150.748794556,4.91194963455,10.797747612));
#1141=CARTESIAN_POINT('GDT',(150.582366943,4.91194963455,11.2465953827));
#1142=CARTESIAN_POINT('GDT',(150.325164795,4.91194963455,11.5189294815));
#1143=CARTESIAN_POINT('GDT',(149.99230957,4.91194963455,11.6147508621));
#1144=CARTESIAN_POINT('GDT',(149.750228882,4.91194963455,11.5643186569));
#1145=CARTESIAN_POINT('GDT',(149.543457031,4.91194963455,11.4231081009));
#1146=CARTESIAN_POINT('GDT',(149.382080078,4.91194963455,11.1961631775));
#1147=CARTESIAN_POINT('GDT',(149.271133423,4.91194963455,10.883482933));
#1148=CARTESIAN_POINT('GDT',(148.792022705,4.91194963455,10.883482933));
#1149=CARTESIAN_POINT('GDT',(148.943313599,4.91194963455,11.3625888824));
#1150=CARTESIAN_POINT('GDT',(149.205566406,4.91194963455,11.7257013321));
#1151=CARTESIAN_POINT('GDT',(149.56362915,4.91194963455,11.9526472092));
#1152=CARTESIAN_POINT('GDT',(149.99230957,4.91194963455,12.0333385468));
#1153=CARTESIAN_POINT('GDT',(150.526885986,4.91194963455,11.9072580338));
#1154=CARTESIAN_POINT('GDT',(150.935394287,4.91194963455,11.5542316437));
#1155=CARTESIAN_POINT('GDT',(151.197647095,4.91194963455,10.9742603302));
#1156=CARTESIAN_POINT('GDT',(151.288421631,4.91194963455,10.1875171661));
#1157=CARTESIAN_POINT('GDT',(151.197647095,4.91194963455,9.40077400208));
#1158=CARTESIAN_POINT('GDT',(150.935394287,4.91194963455,8.8208026886));
#1159=CARTESIAN_POINT('GDT',(150.526885986,4.91194963455,8.46273326874));
#1160=CARTESIAN_POINT('GDT',(149.99230957,4.91194963455,8.34169578552));
#1161=CARTESIAN_POINT('GDT',(149.523284912,4.91194963455,8.43751716614));
#1162=CARTESIAN_POINT('GDT',(149.145050049,4.91194963455,8.70480823517));
#1163=CARTESIAN_POINT('GDT',(148.877761841,4.91194963455,9.14356899261));
#1164=CARTESIAN_POINT('GDT',(148.736541748,4.91194963455,9.73867034912));
#1165=CARTESIAN_POINT('GDT',(149.220687866,4.91194963455,9.73867034912));
#1167=CARTESIAN_POINT('GDT',(150.037704468,4.91194963455,20.903591156));
#1168=CARTESIAN_POINT('GDT',(150.037704468,4.91194963455,13.6875171661));
#1170=CARTESIAN_POINT('GDT',(153.537704468,4.91194963455,13.6875171661));
#1171=CARTESIAN_POINT('GDT',(153.537704468,4.91194963455,6.68751716614));
#1172=CARTESIAN_POINT('GDT',(146.537704468,4.91194963455,6.68751716614));
#1173=CARTESIAN_POINT('GDT',(146.537704468,4.91194963455,13.6875171661));
#1174=CARTESIAN_POINT('GDT',(153.537704468,4.91194963455,13.6875171661));
#1176=CARTESIAN_POINT('GDT',(151.645004272,4.91194963455,23.6875171661));
#1177=CARTESIAN_POINT('GDT',(150.037704468,4.91194963455,20.903591156));
#1178=CARTESIAN_POINT('GDT',(148.430404663,4.91194963455,23.6875171661));
#1179=CARTESIAN_POINT('GDT',(151.645004272,4.91194963455,23.6875171661));
#1204=CARTESIAN_POINT('centre
point',(50.8000000002,26.1268471747,16.7036003642));
#566=DRAUGHTING_MODEL('',(#572,#887),#21);
#1203=MECHANICAL_DESIGN_GEOMETRIC_PRESENTATION_REPRESENTATION(' ',(#34),#21);
#24=SHAPE_REPRESENTATION(' ',(#23),#21);
#546=SHAPE_REPRESENTATION('',(#26),#21);
#23=AXIS2_PLACEMENT_3D(' ',#22,$,$);
#39=AXIS2_PLACEMENT_3D('Cylinder Axis2P3D',#36,#37,#38);
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#52=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#50,#51,$);
#66=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#64,#65,$);
#79=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#76,#77,#78);
#117=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#115,#116,$);
#127=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#125,#126,$);
#140=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#137,#138,#139);
#184=AXIS2_PLACEMENT_3D('Cylinder Axis2P3D',#181,#182,#183);
#188=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#186,#187,$);
#202=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#200,#201,$);
#215=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#212,#213,#214);
#219=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#217,#218,$);
#233=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#231,#232,$);
#270=AXIS2_PLACEMENT_3D('Cylinder Axis2P3D',#267,#268,#269);
#274=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#272,#273,$);
#294=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#291,#292,#293);
#316=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#314,#315,$);
#325=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#323,#324,$);
#334=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#332,#333,$);
#343=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#341,#342,$);
#354=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#351,#352,#353);
#376=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#374,#375,$);
#385=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#383,#384,$);
#394=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#392,#393,$);
#403=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#401,#402,$);
#414=AXIS2_PLACEMENT_3D('Cylinder Axis2P3D',#411,#412,#413);
#443=AXIS2_PLACEMENT_3D('Cylinder Axis2P3D',#440,#441,#442);
#472=AXIS2_PLACEMENT_3D('Cylinder Axis2P3D',#469,#470,#471);
#476=AXIS2_PLACEMENT_3D('Circle Axis2P3D',#474,#475,$);
#496=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#493,#494,#495);
#513=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#510,#511,#512);
#530=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#527,#528,#529);
#570=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#567,#568,#569);
#885=AXIS2_PLACEMENT_3D('Plane Axis2P3D',#882,#883,#884);
#13=DATE_AND_TIME(#11,#12);
#12=LOCAL_TIME(9,51,19.,#10);
#10=COORDINATED_UNIVERSAL_TIME_OFFSET(0,0,.AHEAD.);
#7=PRODUCT_CATEGORY('part','specification');
#554=MEASURE_REPRESENTATION_ITEM('volume meas-
ure',VOLUME_MEASURE(153796.969617),#553);
#560=MEASURE_REPRESENTATION_ITEM('surface area meas-
ure',AREA_MEASURE(30227.6458859),#559);
#1208=MEASURE_REPRESENTATION_ITEM('volume meas-
ure',VOLUME_MEASURE(153796.969617),#553);
#1212=MEASURE_REPRESENTATION_ITEM('surface area meas-
ure',AREA_MEASURE(30227.6458859),#559);
#11=CALENDAR_DATE(2008,11,6);
#8=PRODUCT_RELATED_PRODUCT_CATEGORY('part',$,(#5));
#20=UNCERTAINTY_MEASURE_WITH_UNIT(LENGTH_MEASURE(0.005),#16,'distance_accuracy
_value','CONFUSED CURVE UNCERTAINTY');
#123=FACE_BOUND('',#120,.T.);
#179=FACE_BOUND('',#176,.T.);
#331=FACE_BOUND('',#328,.T.);
#349=FACE_BOUND('',#346,.T.);
#391=FACE_BOUND('',#388,.T.);
#409=FACE_BOUND('',#406,.T.);
#49=EDGE_CURVE('',#46,#48,#44,.F.);
#56=EDGE_CURVE('',#46,#55,#53,.T.);
#63=EDGE_CURVE('',#55,#62,#60,.F.);
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#68=EDGE_CURVE('',#62,#48,#67,.F.);
#89=EDGE_CURVE('',#86,#88,#84,.T.);
#96=EDGE_CURVE('',#86,#95,#93,.F.);
#103=EDGE_CURVE('',#95,#102,#100,.T.);
#108=EDGE_CURVE('',#102,#88,#107,.T.);
#119=EDGE_CURVE('',#48,#62,#118,.T.);
#129=EDGE_CURVE('',#55,#46,#128,.T.);
#150=EDGE_CURVE('',#147,#149,#145,.T.);
#157=EDGE_CURVE('',#147,#156,#154,.T.);
#164=EDGE_CURVE('',#156,#163,#161,.T.);
#169=EDGE_CURVE('',#149,#163,#168,.T.);
#192=EDGE_CURVE('',#191,#86,#189,.F.);
#199=EDGE_CURVE('',#191,#198,#196,.F.);
#204=EDGE_CURVE('',#95,#198,#203,.T.);
#223=EDGE_CURVE('',#102,#222,#220,.T.);
#230=EDGE_CURVE('',#229,#198,#227,.T.);
#237=EDGE_CURVE('',#236,#229,#234,.T.);
#244=EDGE_CURVE('',#243,#236,#241,.T.);
#249=EDGE_CURVE('',#156,#243,#248,.T.);
#254=EDGE_CURVE('',#222,#147,#253,.T.);
#278=EDGE_CURVE('',#277,#88,#275,.F.);
#283=EDGE_CURVE('',#222,#277,#282,.T.);
#302=EDGE_CURVE('',#243,#301,#299,.T.);
#307=EDGE_CURVE('',#163,#301,#306,.T.);
#322=EDGE_CURVE('',#319,#321,#317,.T.);
#327=EDGE_CURVE('',#321,#319,#326,.T.);
#340=EDGE_CURVE('',#337,#339,#335,.T.);
#345=EDGE_CURVE('',#339,#337,#344,.T.);
#362=EDGE_CURVE('',#361,#191,#359,.T.);
#367=EDGE_CURVE('',#229,#361,#366,.T.);
#382=EDGE_CURVE('',#379,#381,#377,.T.);
#387=EDGE_CURVE('',#381,#379,#386,.T.);
#400=EDGE_CURVE('',#397,#399,#395,.T.);
#405=EDGE_CURVE('',#399,#397,#404,.T.);
#420=EDGE_CURVE('',#339,#397,#419,.F.);
#425=EDGE_CURVE('',#337,#399,#424,.F.);
#449=EDGE_CURVE('',#321,#379,#448,.F.);
#454=EDGE_CURVE('',#319,#381,#453,.F.);
#480=EDGE_CURVE('',#361,#479,#477,.F.);
#485=EDGE_CURVE('',#236,#479,#484,.T.);
#502=EDGE_CURVE('',#301,#479,#501,.T.);
#519=EDGE_CURVE('',#277,#149,#518,.T.);
#80=PLANE('Plane',#79);
#141=PLANE('Plane',#140);
#216=PLANE('Plane',#215);
#295=PLANE('Plane',#294);
#355=PLANE('Plane',#354);
#497=PLANE('Plane',#496);
#514=PLANE('Plane',#513);
#531=PLANE('Plane',#530);
#571=PLANE('Front View.1',#570);
#886=PLANE('Front View.2',#885);
#70=ORIENTED_EDGE('',*,*,#49,.F.);
#71=ORIENTED_EDGE('',*,*,#56,.T.);
#72=ORIENTED_EDGE('',*,*,#63,.T.);
#73=ORIENTED_EDGE('',*,*,#68,.T.);
#110=ORIENTED_EDGE('',*,*,#89,.F.);
#111=ORIENTED_EDGE('',*,*,#96,.T.);
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#112=ORIENTED_EDGE('',*,*,#103,.T.);
#113=ORIENTED_EDGE('',*,*,#108,.T.);
#121=ORIENTED_EDGE('',*,*,#119,.F.);
#122=ORIENTED_EDGE('',*,*,#68,.F.);
#131=ORIENTED_EDGE('',*,*,#63,.F.);
#132=ORIENTED_EDGE('',*,*,#129,.T.);
#133=ORIENTED_EDGE('',*,*,#49,.T.);
#134=ORIENTED_EDGE('',*,*,#119,.T.);
#171=ORIENTED_EDGE('',*,*,#150,.F.);
#172=ORIENTED_EDGE('',*,*,#157,.T.);
#173=ORIENTED_EDGE('',*,*,#164,.T.);
#174=ORIENTED_EDGE('',*,*,#169,.F.);
#177=ORIENTED_EDGE('',*,*,#129,.F.);
#178=ORIENTED_EDGE('',*,*,#56,.F.);
#206=ORIENTED_EDGE('',*,*,#96,.F.);
#207=ORIENTED_EDGE('',*,*,#192,.F.);
#208=ORIENTED_EDGE('',*,*,#199,.T.);
#209=ORIENTED_EDGE('',*,*,#204,.F.);
#256=ORIENTED_EDGE('',*,*,#223,.F.);
#257=ORIENTED_EDGE('',*,*,#103,.F.);
#258=ORIENTED_EDGE('',*,*,#204,.T.);
#259=ORIENTED_EDGE('',*,*,#230,.F.);
#260=ORIENTED_EDGE('',*,*,#237,.F.);
#261=ORIENTED_EDGE('',*,*,#244,.F.);
#262=ORIENTED_EDGE('',*,*,#249,.F.);
#263=ORIENTED_EDGE('',*,*,#157,.F.);
#264=ORIENTED_EDGE('',*,*,#254,.F.);
#285=ORIENTED_EDGE('',*,*,#278,.T.);
#286=ORIENTED_EDGE('',*,*,#108,.F.);
#287=ORIENTED_EDGE('',*,*,#223,.T.);
#288=ORIENTED_EDGE('',*,*,#283,.T.);
#309=ORIENTED_EDGE('',*,*,#164,.F.);
#310=ORIENTED_EDGE('',*,*,#249,.T.);
#311=ORIENTED_EDGE('',*,*,#302,.T.);
#312=ORIENTED_EDGE('',*,*,#307,.F.);
#329=ORIENTED_EDGE('',*,*,#322,.F.);
#330=ORIENTED_EDGE('',*,*,#327,.F.);
#347=ORIENTED_EDGE('',*,*,#340,.F.);
#348=ORIENTED_EDGE('',*,*,#345,.F.);
#369=ORIENTED_EDGE('',*,*,#230,.T.);
#370=ORIENTED_EDGE('',*,*,#199,.F.);
#371=ORIENTED_EDGE('',*,*,#362,.F.);
#372=ORIENTED_EDGE('',*,*,#367,.F.);
#389=ORIENTED_EDGE('',*,*,#382,.F.);
#390=ORIENTED_EDGE('',*,*,#387,.F.);
#407=ORIENTED_EDGE('',*,*,#400,.F.);
#408=ORIENTED_EDGE('',*,*,#405,.F.);
#427=ORIENTED_EDGE('',*,*,#420,.F.);
#428=ORIENTED_EDGE('',*,*,#345,.T.);
#429=ORIENTED_EDGE('',*,*,#425,.T.);
#430=ORIENTED_EDGE('',*,*,#405,.T.);
#434=ORIENTED_EDGE('',*,*,#425,.F.);
#435=ORIENTED_EDGE('',*,*,#340,.T.);
#436=ORIENTED_EDGE('',*,*,#420,.T.);
#437=ORIENTED_EDGE('',*,*,#400,.T.);
#456=ORIENTED_EDGE('',*,*,#449,.F.);
#457=ORIENTED_EDGE('',*,*,#327,.T.);
#458=ORIENTED_EDGE('',*,*,#454,.T.);
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#459=ORIENTED_EDGE('',*,*,#387,.T.);
#463=ORIENTED_EDGE('',*,*,#454,.F.);
#464=ORIENTED_EDGE('',*,*,#322,.T.);
#465=ORIENTED_EDGE('',*,*,#449,.T.);
#466=ORIENTED_EDGE('',*,*,#382,.T.);
#487=ORIENTED_EDGE('',*,*,#480,.T.);
#488=ORIENTED_EDGE('',*,*,#485,.F.);
#489=ORIENTED_EDGE('',*,*,#237,.T.);
#490=ORIENTED_EDGE('',*,*,#367,.T.);
#504=ORIENTED_EDGE('',*,*,#502,.F.);
#505=ORIENTED_EDGE('',*,*,#302,.F.);
#506=ORIENTED_EDGE('',*,*,#244,.T.);
#507=ORIENTED_EDGE('',*,*,#485,.T.);
#521=ORIENTED_EDGE('',*,*,#254,.T.);
#522=ORIENTED_EDGE('',*,*,#150,.T.);
#523=ORIENTED_EDGE('',*,*,#519,.F.);
#524=ORIENTED_EDGE('',*,*,#283,.F.);
#533=ORIENTED_EDGE('',*,*,#519,.T.);
#534=ORIENTED_EDGE('',*,*,#169,.T.);
#535=ORIENTED_EDGE('',*,*,#307,.T.);
#536=ORIENTED_EDGE('',*,*,#502,.T.);
#537=ORIENTED_EDGE('',*,*,#480,.F.);
#538=ORIENTED_EDGE('',*,*,#362,.T.);
#539=ORIENTED_EDGE('',*,*,#192,.T.);
#540=ORIENTED_EDGE('',*,*,#89,.T.);
#541=ORIENTED_EDGE('',*,*,#278,.F.);
#35=CLOSED_SHELL('Closed
Shell',(#75,#124,#136,#180,#211,#266,#290,#350,#410,#432,#439,#461,#468,#492,#
509,#526,#543));
#564=ADVANCED_BREP_SHAPE_REPRESENTATION('NONE',(#26),#21);
#6=PRODUCT_DEFINITION_FORMATION_WITH_SPECIFIED_SOURCE('',' ',#5,.NOT_KNOWN.);
#1181=GEOMETRIC_ITEM_SPECIFIC_USAGE('','GDT',#1180,#24,#350);
#1184=GEOMETRIC_ITEM_SPECIFIC_USAGE('','GDT',#1183,#24,#180);
#1187=GEOMETRIC_ITEM_SPECIFIC_USAGE('','GDT',#1186,#24,#180);
#1190=GEOMETRIC_ITEM_SPECIFIC_USAGE('','GDT',#1189,#24,#543);
#1193=GEOMETRIC_ITEM_SPECIFIC_USAGE('','GDT',#1192,#24,#543);
#44=LINE('Line',#41,#43);
#60=LINE('Line',#57,#59);
#84=LINE('Line',#81,#83);
#93=LINE('Line',#90,#92);
#100=LINE('Line',#97,#99);
#107=LINE('Line',#104,#106);
#145=LINE('Line',#142,#144);
#154=LINE('Line',#151,#153);
#161=LINE('Line',#158,#160);
#168=LINE('Line',#165,#167);
#196=LINE('Line',#193,#195);
#227=LINE('Line',#224,#226);
#241=LINE('Line',#238,#240);
#248=LINE('Line',#245,#247);
#253=LINE('Line',#250,#252);
#282=LINE('Line',#279,#281);
#299=LINE('Line',#296,#298);
#306=LINE('Line',#303,#305);
#359=LINE('Line',#356,#358);
#366=LINE('Line',#363,#365);
#419=LINE('Line',#416,#418);
#424=LINE('Line',#421,#423);
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#448=LINE('Line',#445,#447);
#453=LINE('Line',#450,#452);
#484=LINE('Line',#481,#483);
#501=LINE('Line',#498,#500);
#518=LINE('Line',#515,#517);
#75=ADVANCED_FACE('PartBody',(#74),#40,.F.);
#124=ADVANCED_FACE('PartBody',(#114,#123),#80,.T.);
#136=ADVANCED_FACE('PartBody',(#135),#40,.F.);
#180=ADVANCED_FACE('PartBody',(#175,#179),#141,.T.);
#211=ADVANCED_FACE('PartBody',(#210),#185,.F.);
#266=ADVANCED_FACE('PartBody',(#265),#216,.F.);
#290=ADVANCED_FACE('PartBody',(#289),#271,.T.);
#350=ADVANCED_FACE('PartBody',(#313,#331,#349),#295,.T.);
#410=ADVANCED_FACE('PartBody',(#373,#391,#409),#355,.T.);
#432=ADVANCED_FACE('PartBody',(#431),#415,.F.);
#439=ADVANCED_FACE('PartBody',(#438),#415,.F.);
#461=ADVANCED_FACE('PartBody',(#460),#444,.F.);
#468=ADVANCED_FACE('PartBody',(#467),#444,.F.);
#492=ADVANCED_FACE('PartBody',(#491),#473,.T.);
#509=ADVANCED_FACE('PartBody',(#508),#497,.T.);
#526=ADVANCED_FACE('PartBody',(#525),#514,.T.);
#543=ADVANCED_FACE('PartBody',(#542),#531,.T.);
#53=CIRCLE('generated circle',#52,6.35000000003);
#67=CIRCLE('generated circle',#66,6.35000000003);
#118=CIRCLE('generated circle',#117,6.35000000003);
#128=CIRCLE('generated circle',#127,6.35000000003);
#189=CIRCLE('generated circle',#188,9.52500000004);
#203=CIRCLE('generated circle',#202,9.52500000004);
#220=CIRCLE('generated circle',#219,3.17500000001);
#234=CIRCLE('generated circle',#233,3.17500000001);
#275=CIRCLE('generated circle',#274,3.17500000001);
#317=CIRCLE('generated circle',#316,4.76250000002);
#326=CIRCLE('generated circle',#325,4.76250000002);
#335=CIRCLE('generated circle',#334,4.76250000002);
#344=CIRCLE('generated circle',#343,4.76250000002);
#377=CIRCLE('generated circle',#376,4.76250000002);
#386=CIRCLE('generated circle',#385,4.76250000002);
#395=CIRCLE('generated circle',#394,4.76250000002);
#404=CIRCLE('generated circle',#403,4.76250000002);
#477=CIRCLE('generated circle',#476,3.17500000001);
#40=CYLINDRICAL_SURFACE('generated cylinder',#39,6.35000000003);
#185=CYLINDRICAL_SURFACE('generated cylinder',#184,9.52500000004);
#271=CYLINDRICAL_SURFACE('generated cylinder',#270,3.17500000001);
#415=CYLINDRICAL_SURFACE('generated cylinder',#414,4.76250000002);
#444=CYLINDRICAL_SURFACE('generated cylinder',#443,4.76250000002);
#473=CYLINDRICAL_SURFACE('generated cylinder',#472,3.17500000001);
#582=POLYLINE('Simple Da-
tum.1',(#583,#584,#585,#586,#587,#588,#589,#590,#591));
#592=POLYLINE('Simple Datum.1',(#593,#594,#595,#596));
#597=POLYLINE('Simple Datum.1',(#598,#599));
#600=POLYLINE('Simple Datum.1',(#601,#602,#603,#604,#605));
#606=POLYLINE('Simple Datum.1',(#607,#608,#609,#610));
#615=POLYLINE('Perpendicularity.1',(#616,#617));
#618=POLYLINE('Perpendicularity.1',(#619,#620));
#621=POLYLINE('Perpendicularity.1',(#622,#623));
#624=POLYLINE('Perpendicularity.1',(#625,#626));
#627=POLYLINE('Perpendicularity.1',(#628,#629));
#630=POLYLINE('Perpendicularity.1',(#631,#632));
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#633=POLYLINE('Perpendicularity.1',(#634,#635,#636,#637));
#638=POLYLINE('Perpendicularity.1',(#639,#640));
#641=POLYLINE('Perpendicularity.1',(#642,#643,#644,#645,#646));
#647=POLYLINE('Perpendicularity.1',(#648,#649,#650,#651,#652,#653,#654,#655,#6
56,#657,#658,#659,#660,#661,#662,#663,#664,#665));
#666=POLYLINE('Perpendicularity.1',(#667,#668,#669,#670,#671,#672,#673,#674,#6
75,#676,#677,#678,#679,#680,#681,#682,#683));
#684=POLYLINE('Perpendicularity.1',(#685,#686,#687,#688,#689,#690,#691,#692,#6
93,#694,#695,#696,#697,#698,#699,#700,#701,#702));
#703=POLYLINE('Perpendicularity.1',(#704,#705,#706,#707,#708,#709,#710,#711,#7
12,#713,#714,#715,#716,#717,#718,#719,#720));
#721=POLYLINE('Perpendicularity.1',(#722,#723,#724,#725,#726,#727,#728,#729,#7
30,#731,#732,#733,#734,#735,#736,#737,#738,#739,#740,#741,#742,#743,#744,#745,
#746,#747,#748,#749,#750,#751,#752,#753,#754,#755,#756,#757));
#758=POLYLINE('Perpendicularity.1',(#759,#760,#761,#762,#763,#764,#765,#766,#7
67,#768,#769,#770,#771,#772,#773,#774,#775,#776));
#777=POLYLINE('Perpendicularity.1',(#778,#779,#780,#781,#782,#783,#784,#785,#7
86,#787,#788,#789,#790,#791,#792,#793,#794));
#795=POLYLINE('Perpendicularity.1',(#796,#797,#798,#799,#800,#801,#802,#803,#8
04));
#805=POLYLINE('Perpendicularity.1',(#806,#807,#808,#809));
#810=POLYLINE('Perpendicularity.1',(#811,#812,#813));
#814=POLYLINE('Perpendicularity.1',(#815,#816,#817,#815));
#822=POLYLINE('Simple Da-
tum.2',(#823,#824,#825,#826,#827,#828,#829,#830,#831,#832,#833,#834,#835,#836,
#837,#838,#839,#840,#841));
#842=POLYLINE('Simple Da-
tum.2',(#843,#844,#845,#846,#847,#848,#849,#850,#851,#852,#853,#854));
#855=POLYLINE('Simple Da-
tum.2',(#856,#857,#858,#859,#860,#861,#862,#863,#864,#865,#866,#867));
#868=POLYLINE('Simple Datum.2',(#869,#870));
#871=POLYLINE('Simple Datum.2',(#872,#873,#874,#875,#876));
#877=POLYLINE('Simple Datum.2',(#878,#879,#880,#881));
#893=POLYLINE('Perpendicularity.2',(#894,#895));
#896=POLYLINE('Perpendicularity.2',(#897,#898));
#899=POLYLINE('Perpendicularity.2',(#900,#901));
#902=POLYLINE('Perpendicularity.2',(#903,#904));
#905=POLYLINE('Perpendicularity.2',(#906,#907));
#908=POLYLINE('Perpendicularity.2',(#909,#910));
#911=POLYLINE('Perpendicularity.2',(#912,#913));
#914=POLYLINE('Perpendicularity.2',(#915,#916,#917,#918));
#919=POLYLINE('Perpendicularity.2',(#920,#921));
#922=POLYLINE('Perpendicularity.2',(#923,#924,#925,#926,#927));
#928=POLYLINE('Perpendicularity.2',(#929,#930,#931,#932,#933,#934,#935,#936,#9
37,#938,#939,#940,#941,#942,#943,#944,#945,#946));
#947=POLYLINE('Perpendicularity.2',(#948,#949,#950,#951,#952,#953,#954,#955,#9
56,#957,#958,#959,#960,#961,#962,#963,#964));
#965=POLYLINE('Perpendicularity.2',(#966,#967,#968,#969,#970,#971,#972,#973,#9
74,#975,#976,#977,#978,#979,#980,#981,#982,#983));
#984=POLYLINE('Perpendicularity.2',(#985,#986,#987,#988,#989,#990,#991,#992,#9
93,#994,#995,#996,#997,#998,#999,#1000,#1001));
#1002=POLYLINE('Perpendicularity.2',(#1003,#1004,#1005,#1006,#1007,#1008,#1009
,#1010,#1011,#1012,#1013,#1014,#1015,#1016,#1017,#1018,#1019,#1020,#1021,#1022
,#1023,#1024,#1025,#1026,#1027,#1028,#1029,#1030,#1031,#1032,#1033,#1034,#1035
,#1036,#1037,#1038,#1039,#1040,#1041,#1042,#1043,#1044,#1045,#1046,#1047,#1048
,#1049,#1050,#1051,#1052,#1053,#1054,#1055,#1056));
#1057=POLYLINE('Perpendicularity.2',(#1058,#1059,#1060,#1061,#1062,#1063,#1064
,#1065,#1066));
```

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#1067=POLYLINE('Perpendicularity.2',(#1068,#1069,#1070,#1071));
#1072=POLYLINE('Perpendicularity.2',(#1073,#1074,#1075,#1076,#1077,#1078,#1079
,#1080,#1081,#1082,#1083,#1084,#1085,#1086,#1087,#1088,#1089,#1090,#1091));
#1092=POLYLINE('Perpendicularity.2',(#1093,#1094,#1095,#1096,#1097,#1098,#1099
,#1100,#1101,#1102,#1103,#1104));
#1105=POLYLINE('Perpendicularity.2',(#1106,#1107,#1108,#1109,#1110,#1111,#1112
,#1113,#1114,#1115,#1116,#1117));
#1118=POLYLINE('Perpendicularity.2',(#1119,#1120,#1121));
#1122=POLYLINE('Perpendicularity.2',(#1123,#1124,#1125,#1123));
#1130=POLYLINE('Simple Da-
tum.3',(#1131,#1132,#1133,#1134,#1135,#1136,#1137,#1138,#1139,#1140,#1141,#114
2,#1143,#1144,#1145,#1146,#1147,#1148,#1149,#1150,#1151,#1152,#1153,#1154,#115
5,#1156,#1157,#1158,#1159,#1160,#1161,#1162,#1163,#1164,#1165));
#1166=POLYLINE('Simple Datum.3',(#1167,#1168));
#1169=POLYLINE('Simple Datum.3',(#1170,#1171,#1172,#1173,#1174));
#1175=POLYLINE('Simple Datum.3',(#1176,#1177,#1178,#1179));
#46=VERTEX_POINT('',#45);
#48=VERTEX_POINT('',#47);
#55=VERTEX_POINT('',#54);
#62=VERTEX_POINT('',#61);
#86=VERTEX_POINT('',#85);
#88=VERTEX_POINT('',#87);
#95=VERTEX_POINT('',#94);
#102=VERTEX_POINT('',#101);
#147=VERTEX_POINT('',#146);
#149=VERTEX_POINT('',#148);
#156=VERTEX_POINT('',#155);
#163=VERTEX_POINT('',#162);
#191=VERTEX_POINT('',#190);
#198=VERTEX_POINT('',#197);
#222=VERTEX_POINT('',#221);
#229=VERTEX_POINT('',#228);
#236=VERTEX_POINT('',#235);
#243=VERTEX_POINT('',#242);
#277=VERTEX_POINT('',#276);
#301=VERTEX_POINT('',#300);
#319=VERTEX_POINT('',#318);
#321=VERTEX_POINT('',#320);
#337=VERTEX_POINT('',#336);
#339=VERTEX_POINT('',#338);
#361=VERTEX_POINT('',#360);
#379=VERTEX_POINT('',#378);
#381=VERTEX_POINT('',#380);
#397=VERTEX_POINT('',#396);
#399=VERTEX_POINT('',#398);
#479=VERTEX_POINT('',#478);
#1195=VALUE_REPRESENTATION_ITEM('number of annotations',COUNT_MEASURE(5));
#1199=VALUE_REPRESENTATION_ITEM('total number of views',COUNT_MEASURE(0));
#1182=DRAUGHTING_MODEL_ITEM_ASSOCIATION('','',#1180,#566,#581);
#1185=DRAUGHTING_MODEL_ITEM_ASSOCIATION('','',#1183,#566,#614);
#1188=DRAUGHTING_MODEL_ITEM_ASSOCIATION('','',#1186,#566,#821);
#1191=DRAUGHTING_MODEL_ITEM_ASSOCIATION('','',#1189,#566,#892);
#1194=DRAUGHTING_MODEL_ITEM_ASSOCIATION('','',#1192,#566,#1129);
#26=MANIFOLD_SOLID_BREP('PartBody',#35);
#25=SHAPE_DEFINITION_REPRESENTATION(#15,#24);
#547=SHAPE_DEFINITION_REPRESENTATION(#545,#546);
#9=PRODUCT_CATEGORY_RELATIONSHIP(' ',' ',#7,#8);
#18=PLANE_ANGLE_MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(0.0174532925199),#17);
```

```
#4=APPLICATION_PROTOCOL_DEFINITION('draft international stan-
dard','configuration_control_3d_design_ed2_mim',2004,#1);
#69=EDGE_LOOP('',(#70,#71,#72,#73));
#109=EDGE_LOOP('',(#110,#111,#112,#113));
#120=EDGE_LOOP('',(#121,#122));
#130=EDGE_LOOP('',(#131,#132,#133,#134));
#170=EDGE_LOOP('',(#171,#172,#173,#174));
#176=EDGE_LOOP('',(#177,#178));
#205=EDGE_LOOP('',(#206,#207,#208,#209));
#255=EDGE_LOOP('',(#256,#257,#258,#259,#260,#261,#262,#263,#264));
#284=EDGE_LOOP('',(#285,#286,#287,#288));
#308=EDGE_LOOP('',(#309,#310,#311,#312));
#328=EDGE_LOOP('',(#329,#330));
#346=EDGE_LOOP('',(#347,#348));
#368=EDGE_LOOP('',(#369,#370,#371,#372));
#388=EDGE_LOOP('',(#389,#390));
#406=EDGE_LOOP('',(#407,#408));
#426=EDGE_LOOP('',(#427,#428,#429,#430));
#433=EDGE_LOOP('',(#434,#435,#436,#437));
#455=EDGE_LOOP('',(#456,#457,#458,#459));
#462=EDGE_LOOP('',(#463,#464,#465,#466));
#486=EDGE_LOOP('',(#487,#488,#489,#490));
#503=EDGE_LOOP('',(#504,#505,#506,#507));
#520=EDGE_LOOP('',(#521,#522,#523,#524));
#532=EDGE_LOOP('',(#533,#534,#535,#536,#537,#538,#539,#540,#541));
#74=FACE_OUTER_BOUND('',#69,.T.);
#114=FACE_OUTER_BOUND('',#109,.T.);
#135=FACE_OUTER_BOUND('',#130,.T.);
#175=FACE_OUTER_BOUND('',#170,.T.);
#210=FACE_OUTER_BOUND('',#205,.T.);
#265=FACE_OUTER_BOUND('',#255,.T.);
#289=FACE_OUTER_BOUND('',#284,.T.);
#313=FACE_OUTER_BOUND('',#308,.T.);
#373=FACE_OUTER_BOUND('',#368,.T.);
#431=FACE_OUTER_BOUND('',#426,.T.);
#438=FACE_OUTER_BOUND('',#433,.T.);
#460=FACE_OUTER_BOUND('',#455,.T.);
#467=FACE_OUTER_BOUND('',#462,.T.);
#491=FACE_OUTER_BOUND('',#486,.T.);
#508=FACE_OUTER_BOUND('',#503,.T.);
#525=FACE_OUTER_BOUND('',#520,.T.);
#542=FACE_OUTER_BOUND('',#532,.T.);
#574=DRAUGHTING_PRE_DEFINED_CURVE_FONT('continuous');
#572=ANNOTATION_PLANE('Front View.1',(#573),#571,(#581,#614,#821));
#887=ANNOTATION_PLANE('Front View.2',(#888),#886,(#892,#1129));
#27=DRAUGHTING_PRE_DEFINED_COLOUR('cyan');
#575=DRAUGHTING_PRE_DEFINED_COLOUR('black');
#578=DRAUGHTING_PRE_DEFINED_COLOUR('white');
#577=GEOMETRIC_CURVE_SET('datum',(#582,#592,#597,#600,#606));
#611=GEOMETRIC_CURVE_SET('perpendicularity',(#615,#618,#621,#624,#627,#630,#63
3,#638,#641,#647,#666,#684,#703,#721,#758,#777,#795,#805,#810,#814));
#818=GEOMETRIC_CURVE_SET('datum',(#822,#842,#855,#868,#871,#877));
#889=GEOMETRIC_CURVE_SET('perpendicularity',(#893,#896,#899,#902,#905,#908,#91
1,#914,#919,#922,#928,#947,#965,#984,#1002,#1057,#1067,#1072,#1092,#1105,#1118
,#1122));
#1126=GEOMETRIC_CURVE_SET('datum',(#1130,#1166,#1169,#1175));
#16=(LENGTH_UNIT()NAMED_UNIT(*)SI_UNIT(.MILLI.,.METRE.));
#17=(NAMED_UNIT(*)PLANE_ANGLE_UNIT()SI_UNIT($,.RADIAN.));
```

```
#19=(NAMED_UNIT(*)SI_UNIT($,.STERADIAN.)SOLID_ANGLE_UNIT());
#21=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT((#
20))GLOBAL_UNIT_ASSIGNED_CONTEXT((#16,#17,#19))REPRESENTATION_CONTEXT(' ','
'));
ENDSEC;
END-ISO-10303-21;
```

Annex A Symbols and Names for Tolerances

Table 1 — Symbols for geometrical characteristics

Tolerances	Characteristics	Symbol	Datum needed	Subclause
Form	Straightness	—	no	18.1
	Flatness	▱	no	18.2
	Roundness	○	no	18.3
	Cylindricity	⌭	no	18.4
	Profile any line	⌒	no	18.5
	Profile any surface	⌓	no	18.7
Orientation	Parallelism	//	yes	18.9
	Perpendicularity	⊥	yes	18.10
	Angularity	∠	yes	18.11
	Profile any line	⌒	yes	18.6
	Profile any surface	⌓	yes	18.8
Location	Position	⌖	yes or no	18.12
	Concentricity (for centre points)	◎	yes	18.13
	Coaxiality (for axes)	◎	yes	18.13
	Symmetry	⌯	yes	18.14
	Profile any line	⌒	yes	18.6
	Profile any surface	⌓	yes	18.8
Run-out	Circular run-out	↗	yes	18.15
	Total run-out	⌰	yes	18.16

Figure 24 – Symbols for geometrical characteristics

Table 2 — Additional symbols

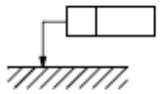
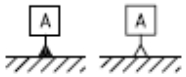
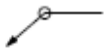
Description	Symbol	Reference
Toleranced feature indication		Clause 7
Datum feature indication		Clause 9 and ISO 5459
Datum target indication		ISO 5459
Theoretically exact dimension		Clause 11
Projected tolerance zone	Ⓟ	Clause 13 and ISO 10578
Maximum material requirement	Ⓜ	Clause 14 and ISO 2692
Least material requirement	Ⓛ	Clause 15 and ISO 2692
Free state condition (non-rigid parts)	Ⓕ	Clause 16 and ISO 10579
All around (profile)		Subclause 10.1
Envelope requirement	Ⓔ	ISO 8015
Common zone	CZ	Subclause 8.5
Minor diameter	LD	Subclause 10.2
Major diameter	MD	Subclause 10.2
Pitch diameter	PD	Subclause 10.2
Line element	LE	Subclause 18.9.4
Not convex	NC	Subclause 6.3
Any cross-section	ACS	Subclause 18.13.1

Figure 25 – Additional symbols