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Industrial automation systems and integration — Product data representation and exchange —

Part 519: Application interpreted construct: Geometric tolerances

Systèmes d'automatisation industrielle et intégration — Représentation et échange de données de produits —

Partie 519: Construction interprétée d'application: Tolérances géométriques

Reference number
ISO 10303-519:2000(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

International Standard ISO 10303–519 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration,* Subcommittee SC4, *Industrial data.*

This International Standard is organized as a series of parts, each published separately. The parts of ISO 10303 fall into one of the following series: description methods, integrated resources, application protocols, abstract test suites, implementation methods, and conformance testing. The series are described in ISO 10303–1.

A complete list of parts of ISO 10303 is available from the internet:

http://www.nist.gov/sc4/editing/step/titles/

Annexes A and B form an integral part of this part of ISO 10303. Annexes C and D are for information only.

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a neutral mechanism capable of describing product data throughout the life cycle of a product independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving.

This International Standard is organized as a series of parts, each published separately. The parts of ISO 10303 fall into one of the following series: description methods, integrated resources, application interpreted constructs, application protocols, abstract test suites, implementation methods, and conformance testing. The series are described in ISO 10303–1. This part of ISO 10303 is a member of the application interpreted constructs series.

An application interpreted construct (AIC) provides a logical grouping of interpreted constructs that supports a specific functionality for the usage of product data across multiple application contexts. An interpreted construct is a common interpretation of the integrated resources that supports shared information requirements among application protocols.

This document specifies the application interpreted construct for the description of allowable deviation of physical characteristics of a product's shape according to ISO 1101:1999.

INTERNATIONAL STANDARD ISO 10303-519:2000(E)

Industrial automation systems and integration — Product data representation and exchange — Part 519: Application interpreted construct: Geometric tolerances

1 Scope

This part of ISO 10303 specifies the interpretation of the integrated resources to satisfy requirements for the representation of the allowable deviation of physical characteristics of a product's shape according to ISO 1101.

The following are within the scope of this part of ISO 10303:

— tolerances as constraints on shape aspects of a product;

— the specification of tolerances of the shape of a product;

— the representation of geometrical tolerances;

— the representation of tolerance values;

— the specification of datums and datum references;

— the identification of derived shape elements such as centre lines and intersections.

The following are outside the scope of this part of ISO 10303:

— the representation of plus-minus tolerances and limits and fits;

— the definition of the fundamental principles, concepts, and terminology of tolerancing and dimensioning;

— the mathematical definition of tolerances and datums;

— the description of dimensioning or tolerancing practices;

— the specification of dimensional inspection methods;

— the synthesis and analysis of tolerances;

— the tolerancing of product characteristics other than shape;

— the presentation of tolerances on engineering drawings;

— the representation of the product's shape;

— the representation of dimensions.

NOTE - This part of ISO 10303 provides the interpretation of the integrated resources in the area of product data indicated above, whereas the application of industrial requirements is a task to be fulfilled by application protocols (APs). Parts of ISO 10303 that make use of the elements defined in this part are strongly advised to check the ISO standards that deal with the application of tolerances available at the time of the development.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 10303. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10303 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1101[1)], *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out (Revision of ISO 1101:1983).*

ISO 5459:1981, *Technical drawings - Geometrical tolerancing - Datums and datum-systems for geometrical tolerances.*

ISO 8824-1:1995, *Information Technology - Open Systems Interconnection - Abstract Syntax Notation one (ASN.1) - Part 1: Specification of Basic Notation.*

ISO 10303-1:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 1: Overview and fundamental principles.*

ISO 10303-11:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 11: Description methods: The* EXPRESS *language reference manual.*

ISO 10303-41:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 41: Integrated generic resources: Fundamentals of product description and support.*

ISO 10303-47:1997, *Industrial automation systems and integration - Product data representation and exchange - Part 47: Integrated generic resources: Shape variation tolerances.*

[1)] To be published.

ISO 10303–202:1996, *Industrial automation systems and integration – Product data representation and exchange – Part 202: Application protocol: Associative draughting.*

ISO/TS 17450[1)], *Geometrical product specification (GPS) – Model for geometric specification and verification.*

3 Terms, definitions, and abbreviations

3.1 Terms defined in ISO 10303–1

For the purpose of this part of ISO 10303, the following terms defined in ISO 10303–1 apply:

— abstract test suite (ATS);

— application;

— application context;

— application protocol (AP);

— implementation method;

— information;

— integrated resource;

— interpretation;

— model;

— product;

— product data.

3.2 Terms defined in ISO 10303–202

For the purpose of this part of ISO 10303, the following terms defined in ISO 10303–202 apply:

3.2.1
application interpreted construct
a logical grouping of interpreted constructs that supports a specific function for the usage of product data across multiple application contexts

[ISO 10303–202:1996, definition 3.7.1]

3.3 Terms defined in ISO 5459

For the purpose of this part of ISO 10303, the following terms defined in ISO 5459 apply:

— datum system

3.4 Terms defined in ISO/TS 17450

For the purpose of this part of ISO 10303, the following terms defined in ISO/TS 17450 apply:

3.4.1
ideal feature
perfect shape feature defined by a type and characterisitcs

[ISO/TS 17450, definition 3.11]

3.4.2
invariance class
a group of ideal features defined by the same invariance degree

[ISO/TS 17450, definition 3.13]

3.4.3
invariance degree of an ideal feature
displacement(s) of the ideal feature for which the feature is kept identical in the space

[ISO/TS 17450, definition 3.14]

3.4.4
skin model
model of the physical interface of the workpiece with its environment

[ISO/TS 17450, definition 3.24]

3.5 Other definitions

For the purpose of this part of ISO 10303, the following definitions apply:

3.5.1
revolute surface feature
surface of invariance class revolute, helical, cylindrical, or spherical

3.6 Abbreviations

For the purpose of this part of ISO 10303, the following abbreviations apply:

AIC	application interpreted construct
AP	application protocol
ATS	abstract test suite

4 EXPRESS short listing

This clause specifies the EXPRESS schema that uses elements from the integrated resources and contains the types, entity specializations, and functions that are specific to this part of ISO 10303.

NOTE 1 - There may be subtypes and items of select lists that appear in the integrated resources that are not imported into the AIC. Constructs are eliminated from the subtype tree or select list through the use of the implicit interface rules of ISO 10303-11. References to eliminated constructs are outside the scope of the AIC. In some cases, all items of the select list are eliminated. Because AICs are intended to be implemented in the context of an application protocol, the items of the select list will be defined by the scope of the application protocol.

EXPRESS specification:

```
*)
SCHEMA aic_geometric_tolerances;

 USE FROM measure_schema                          --ISO 10303-41
  (derived_unit,
  named_unit);


 USE FROM shape_aspect_definition_schema          -- ISO 10303-47
  (apex,
  centre_of_symmetry,
  composite_shape_aspect,
  datum,
  datum_feature,
  datum_reference,
  datum_target,
  derived_shape_aspect,
  extension,
  geometric_alignment,
  geometric_intersection,
  parallel_offset,
  perpendicular_to,
```

```
  referenced_modified_datum,
  shape_aspect_deriving_relationship,
  symmetric_shape_aspect,
  tangent);


USE FROM shape_tolerance_schema                    -- ISO 10303-47
  (dimension_related_tolerance_zone_element,
  geometric_tolerance,
  geometric_tolerance_relationship,
  geometric_tolerance_with_datum_reference,
  geometric_tolerance_with_defined_unit,
  modified_geometric_tolerance,
  projected_zone_definition,
  runout_zone_definition,
  runout_zone_orientation_reference_direction,
  tolerance_zone,
  tolerance_zone_definition);

(*
```

NOTE 2 - The schemas referenced above can be found in the following parts of ISO 10303:

measure_schema	ISO 10303-41
shape_aspect_definition_schema	ISO 10303-47
shape_tolerance_schema	ISO 10303-47

4.1 Fundamental concepts and assumptions

The following entities are intended to be independently instantiated in the application protocol schemas that use this AIC:

— angularity_tolerance;

— circular_runout_tolerance;

— coaxiality_tolerance;

— common_datum;

— concentricity_tolerance;

— cylindricity_tolerance;

— flatness_tolerance;

— line_profile_tolerance;

— parallelism_tolerance;

— perpendicularity_tolerance;

— position_tolerance;

— roundness_tolerance;

— straightness_tolerance;

— surface_profile_tolerance;

— symmetry_tolerance;

— total_runout_tolerance.

The restrictions on the kind of geometric ideal features specified in the referenced standards apply when using the constructs defined in this part of ISO 10303. When designing a given part, several shapes may be successively considered: CAD systems are, usually, used to specify the nominal characteristics of a shape. However, the shape resulting from manufacturing, never fits exactly the nominal definition. Therefore, for a same part, two other shapes may be considered:

— an intermediate shape, where the manufacturing defects are considered and constrained with respect to the nominal characteristics by tolerances;

— the actual shape obtained after manufacturing.

NOTE 1 - See ISO/TS 17450 for further information about these three shapes.

NOTE 2 - The intermediate shape is named "skin model" in ISO/TS 17450.

EXAMPLE When a designer specifies that a face is planar, the manufactured face will not be actually a plane but a surface. The purpose of geometric tolerances is to specify the zone in which this surface shall lie on, e.g., between two parallel planes.

NOTE 3 - The actual manufactured shape is controlled by metrologists. Their control consists of evaluating, whether the size characteristics, they measure on the actual shape, are conforming to the nominal characteristics and to the tolerances on these characteristics.

This part of ISO 10303 specifies subtypes of the entity **geometric_tolerance** that is defined in ISO 10303-47. Consequently, these subtypes inherit the attribute **toleranced_shape_aspect**. In this part of ISO 10303 and in any annotated schema that uses the entity data types defined hereafter, the following statements apply:

— A **shape_aspect** referred to by the attribute **geometric_tolerance.toleranced_shape_aspect** shall identify an element of the nominal shape;

— A **shape_aspect**, playing the role of a **datum**, a **datum_feature** or a **datum_target**, shall identify an element of the nominal shape.

4.2 aic_geometric_tolerances entity definitions

4.2.1 angularity_tolerance

An **angularity_tolerance** is a type of **geometric_tolerance_with_datum_reference**. The tolerance zone is limited either by:

— two parallel planes, separated by the distance specified by the tolerance value. In this case, the planes form a specified angle with the datums that are referenced;

— a cylinder with a diameter that is specified by the tolerance value. In this case, the cylinder axis forms a specified angle with the datums that are referenced.

The specified angle shall not be a multiple of 90 degrees. In the case of 0 or 180 degrees, a **parallelism_tolerance** shall be used. In the case of 90 or 270 degrees, a **perpendicularity_tolerance** shall be used. The specified angle shall be defined using an instance of **angular_location**. The **toleranced_shape_aspect** is either a plane or a straight line.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY angularity_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system) < 3;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **angularity_tolerance** shall contain at least one element and at most two elements in its **datum_system**.

Informal propositions:

IP1: The datums referenced shall be sufficient to identify a plane or a straight line.

IP2: The datums referred to in **datum_system** shall be sufficient to enable orientation of the tolerance zone.

4.2.2 circular_runout_tolerance

A **circular_runout_tolerance** is a type of **geometric_tolerance_with_datum_reference**. The set of referenced datums shall contain an axis. There are four kinds of **circular_runout_tolerances:**

— radial;

— axial;

— in any direction;

— in a specified direction.

Refer to the definition of circular run-out tolerance in ISO 1101:1999 for a complete description of the different tolerance zones.

EXPRESS specification:

```
*)
ENTITY circular_runout_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system) <= 2;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **circular_runout_tolerance** shall contain one or two elements in its **datum_system**.

4.2.3 coaxiality_tolerance

A **coaxiality_tolerance** is a type of **geometric_tolerance_with_datum_reference**. This tolerance zone is limited by a cylinder, the diameter of which is the tolerance value. The cylinder axis is defined by the datums that are referenced.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY coaxiality_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system) <= 2;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **coaxiality_tolerance** shall contain one or two elements in its **datum_system**.

Informal propositions:

IP1: The **shape_aspect**, the **coaxiality_tolerance** is applied to, is a revolute surface feature.

4.2.4 common_datum

A **common_datum** is a type of **datum** and of **composite_shape_aspect** that is established by two other **shape_aspects** of type **datum**.

EXPRESS specification:

```
*)
ENTITY common_datum
  SUBTYPE OF (composite_shape_aspect, datum);
WHERE
  WR1:  SIZEOF ( SELF.component_relationships ) = 2;
  WR2:  SIZEOF ( QUERY ( sar <*
         SELF.component_relationships | NOT (
         ('AIC_GEOMETRIC_TOLERANCES.DATUM' IN
         TYPEOF (sar.related_shape_aspect)) AND NOT (
         'AIC_GEOMETRIC_TOLERANCES.COMMON_DATUM'
         IN TYPEOF (sar.related_shape_aspect)))))=0;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **common_datum** shall have exactly two **component_relationships**.

WR2: The datums, a **common_datum** is established by, shall be of type **datum** but not of type **common_datum**.

4.2.5 concentricity_tolerance

A **concentricity_tolerance** is a type of **geometric_tolerance_with_datum_reference** that describes the allowable tolerance a cylindrical or conical feature of a part may deviate from being concentric with respect to a datum. The **toleranced_shape_aspect** and the referenced datum correspond to points.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY concentricity_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system)=1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **concentricity_tolerance** shall contain exactly one element in its **datum_system**.

Informal propositions:

IP1: The **shape_aspect**, the **concentricity_tolerance** is applied to, is symmetrical with respect to rotation.

4.2.6 cylindricity_tolerance

A **cylindricity_tolerance** is a type of **geometric_tolerance** that describes the allowable tolerance a surface may deviate from being nominally cylindrical. The tolerance zone is limited by two coaxial cylinders, with a difference in radii of the tolerance value.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY cylindricity_tolerance
  SUBTYPE OF (geometric_tolerance);
WHERE
  WR1:  NOT ('AIC_GEOMETRIC_TOLERANCES.' +
             'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE' IN TYPEOF (SELF));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **cylindricity_tolerance** shall not be of type **geometric_tolerance_with_datum_reference**.

Informal propositions:

IP1: The **shape_aspect**, the **cylindricity_tolerance** is applied to, is a cylindrical face.

4.2.7 flatness_tolerance

A **flatness_tolerance** is a type of **geometric_tolerance** that describes the allowable tolerance a surface may deviate from being flat. The tolerance zone is limited by two parallel planes separated by the distance specified by the tolerance value.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY flatness_tolerance
  SUBTYPE OF (geometric_tolerance);
WHERE
  WR1:  NOT ('AIC_GEOMETRIC_TOLERANCES.' +
             'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE' IN TYPEOF (SELF));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **flatness_tolerance** shall not be of type **geometric_tolerance_with_datum_reference**.

Informal propositions:

IP1: The **shape_aspect**, the **flatness_tolerance** is applied to, shall be a nominally planar surface.

4.2.8 line_profile_tolerance

A **line_profile_tolerance** is a type of **geometric_tolerance** that applies to the intersection curves between the surface and the planes parallel to the reference plane.

NOTE 1 - The tolerance zone may be located by datums.

The ideal features corresponding to the intersection curves shall not be linear or circular. In the case where the intersection curves are linear or circular, **straightness_tolerance** or **roundness_tolerance** shall be used, respectively. There shall be another **shape_aspect**, which is related to the **toleranced_shape_aspect** by a **shape_aspect_relationship**. The **name** of the **shape_aspect_relationship** shall be either 'affected plane association', when the **related_shape_aspect** corresponds to the reference plane, or 'resulting intersection curve association', when the **related_shape_aspect** corresponds to one of the intersection curves.

NOTE 2 - The reference plane can be derived from the intersection curve and vice versa.

The tolerance zone is contained in a plane.

NOTE 3 - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY line_profile_tolerance
  SUBTYPE OF (geometric_tolerance);
WHERE
  WR1:  (NOT (('AIC_GEOMETRIC_TOLERANCES.' +
              'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)))
        OR
        (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
                    datum_system) <= 3);
  WR2:  SIZEOF ( QUERY (
        sar <* USEDIN ( SELF\geometric_tolerance.toleranced_shape_aspect,
                    'AIC_GEOMETRIC_TOLERANCES.' +
                    'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT' ) |
             (sar.name IN ['affected plane association',
                           'resulting intersection curve association'])
              ) ) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **line_profile_tolerance** shall contain at most three elements in its **datum_system**.

WR2: The **toleranced_shape_aspect** shall be the **relating_shape_aspect** of a **shape_aspect_relationship** that has a **name** of 'affected plane association' or 'resulting intersection curve association'.

4.2.9 parallelism_tolerance

A **parallelism_tolerance** is a type of **geometric_tolerance_with_datum_reference**. The tolerance zone is limited either by:

— two parallel planes, separated by the distance specified by the tolerance value. In this case, the planes are parallel to the datums that are referenced;

— a cylinder with a diameter that is specified by the tolerance value. In this case, the cylinder axis is parallel to the datums that are referenced.

The **toleranced_shape_aspect** is either a plane or a straight line.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY parallelism_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system) < 3;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **parallelism_tolerance** shall contain at least one element and at most two elements in its **datum_system**.

Informal propositions:

IP1: The **shape_aspect**, the **parallelism_tolerance** is applied to, is an axis or a planar surface.

IP2: The datums referenced shall be sufficient to define a plane or a straight line.

4.2.10 perpendicularity_tolerance

A **perpendicularity_tolerance** is a type of **geometric_tolerance_with_datum_reference**. The tolerance zone is limited either by:

— two parallel planes, separated by the distance specified by the tolerance value. In this case, the planes are perpendicular to the datums that are referenced;

— a cylinder with a diameter that is specified by the tolerance value. In this case, the cylinder axis is perpendicular to the datums that are referenced.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY perpendicularity_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system) <= 3;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **perpendicularity_tolerance** shall contain at least one element and at most three elements in its **datum_system**.

Informal propositions:

IP1: The **toleranced_shape_aspect** shall be either a plane or a straight line.

IP2: The datums referenced shall be sufficient to define a plane or a straight line.

4.2.11 position_tolerance

A **position_tolerance** is a type of **geometric_tolerance**. When the **toleranced_shape_aspect** is a single **shape_aspect**, the tolerance zone is limited either by:

— two parallel planes, separated by the distance specified by the tolerance value. In this case, the planes are located and oriented by the datums that are referenced;

— a cylinder with a diameter that is specified by the tolerance value. In this case, the cylinder axis is defined by the datums that are referenced.

NOTE 1 - When the **toleranced_shape_aspect** is a **composite_shape_aspect** ,e.g. eight holes, the tolerance zone may but need not be defined by referenced datums (see ISO 1101).

The location of the tolerance zone shall be specified with instances of **dimensional_location**.

NOTE 2 - The type **dimensional_location** is defined in ISO 10303-47.

NOTE 3 - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY position_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system)<=3;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **position_tolerance** shall contain at most three elements in its **datum_system**.

4.2.12 roundness_tolerance

A **roundness_tolerance** is a type of **geometric_tolerance** that describes the allowable tolerance a surface may deviate from being truly round in any planar cross-section perpendicular to the axis to the surface revolute feature. The **toleranced_shape_aspect** shall be of invariance class surface revolute feature but not a helical shape.

NOTE 1 - In the case of a sphere, any axis through the center point of the sphere may be considered.

The actual surface shall lie in a tolerance zone limited by two co-planar and concentric circles with a difference in radii of the tolerance value.

NOTE 2 - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY roundness_tolerance
  SUBTYPE OF (geometric_tolerance);
```

```
WHERE
  WR1:  NOT ('AIC_GEOMETRIC_TOLERANCES.' +
             'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE' IN TYPEOF (SELF));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **roundness_tolerance** shall not be of type **geometric_tolerance_with_datum_reference**.

4.2.13 straightness_tolerance

A **straigthness_tolerance** is a type of **geometric_tolerance** that applies either to the intersection curves between the surface and the planes parallel to the reference plane, or to an axis. The **toleranced_shape_aspect** is a surface or a straight line. Refer to the definition of straightness tolerance in ISO 1101 for a description of the different tolerance zones. In the case of intersection curves, the ideal features corresponding to the intersection curves shall be linear and there shall be another **shape_aspect**, which is related to the **toleranced_shape_aspect** by a **shape_aspect_relationship**. The **name** of the **shape_aspect_relationship** shall be 'affected plane association'.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY straightness_tolerance
  SUBTYPE OF (geometric_tolerance);
WHERE
  WR1:  NOT ('AIC_GEOMETRIC_TOLERANCES.' +
             'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE' IN TYPEOF (SELF));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **straightness_tolerance** shall not be of type **geometric_tolerance_with_datum_reference**.

4.2.14 surface_profile_tolerance

A **surface_profile_tolerance** is a type of **geometric_tolerance** that applies to a surface. The ideal feature corresponding to the surface shall not be planar or cylindrical. In the case where the ideal feature of the surface is planar or cylindrical, any of the other relevant types of **geometric_tolerance** shall be used.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY surface_profile_tolerance
  SUBTYPE OF (geometric_tolerance);
WHERE
  WR1:  (NOT (('AIC_GEOMETRIC_TOLERANCES.' +
              'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)))
        OR
        (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
                datum_system) <= 3);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **surface_profile_tolerance** shall contain at most three elements in its **datum_system**.

4.2.15 symmetry_tolerance

A **symmetry_tolerance** is a type of **geometric_tolerance_with_datum_reference**. The tolerance zone is limited by two parallel planes, separated by the distance specified by the tolerance value. The planes are located and oriented by the datums that are referenced.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY symmetry_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system) <= 3;
END_ENTITY;
```

```
(*
```

Formal propositions:

WR1: The **symmetry_tolerance** shall contain at most three elements in its **datum_system**.

4.2.16 total_runout_tolerance

A **total_runout_tolerance** is a type of **geometric_tolerance_with_datum_reference**. The set of referenced datums shall contain one revolute surface feature. The tolerance zone is limited either by:

— two coaxial cylinders, with a difference in radii equal to the tolerance value. In this case, the axis of the cylinders shall be the axis of the revolute surface feature, and the ideal feature corresponding to the toleranced surface is a cylinder;

— two parallel planes, separated by the distance specified by the tolerance value. In this case, the planes are perpendicular to the axis of the revolute surface feature, and the ideal feature corresponding to the toleranced surface is a plane.

NOTE - See ISO 1101:1999 for definition and areas of application of this type of tolerance.

EXPRESS specification:

```
*)
ENTITY total_runout_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
WHERE
  WR1:  SIZEOF(SELF\geometric_tolerance_with_datum_reference.datum_system) <= 2;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **total_runout** tolerance shall contain one or two elements in its **datum_system**.

EXPRESS specification:

```
*)
END_SCHEMA;
(*
```

Annex A
(normative)

Short names of entities

Table A.1 provides the short names of entities specified in this part of ISO 10303. Requirements on the use of the short names are found in the implementation methods included in ISO 10303.

Table A.1 – Short names of entities

Entity names	Short names
ANGULARITY_TOLERANCE	ANGTLR
CIRCULAR_RUNOUT_TOLERANCE	CRRNTL
COAXIALITY_TOLERANCE	CXLTLR
COMMON_DATUM	CMMDTM
CONCENTRICITY_TOLERANCE	CNCTLR
CYLINDRICITY_TOLERANCE	CYLTLR
FLATNESS_TOLERANCE	FLTTLR
LINE_PROFILE_TOLERANCE	LNP0
PARALLELISM_TOLERANCE	PRLTLR
PERPENDICULARITY_TOLERANCE	PRPTLR
POSITION_TOLERANCE	PSTTLR
ROUNDNESS_TOLERANCE	RNDTLR
STRAIGHTNESS_TOLERANCE	STRTLR
SURFACE_PROFILE_TOLERANCE	SRPRTL
SYMMETRY_TOLERANCE	SYMTLR
TOTAL_RUNOUT_TOLERANCE	TTRNTL

Annex B
(normative)

Information object registration

B.1 Document identification

To provide for unambiguous identification of an information object in an open system, the object identifier

{ iso standard 10303 part(519) version(0) }

is assigned to this part of ISO 10303. The meaning of this value is defined in ISO/IEC 8824-1, and is described in ISO 10303-1.

B.2 Schema identification

To provide for unambiguous identification of the aic_geometric_tolerances_schema in an open information system, the object identifier

{ iso standard 10303 part(519) version(1) object(1) aic-geometric-tolerances-schema(1) }

is assigned to the aic_geometric_tolerances_schema schema (see clause 4). The meaning of this value is defined in ISO/IEC 8824-1, and is described in ISO 10303-1.

Annex C
(informative)

EXPRESS-G diagrams

Figures C.1 through C.4 correspond to the EXPRESS generated from the short listing given in clause 4 using the interface specifications of ISO 10303-11. The diagrams use the EXPRESS-G graphical notation for the EXPRESS language. EXPRESS-G is defined in annex D of ISO 10303-11.

NOTE - The following select types: shape_tolerance_select, and dimensional_characteristic are interfaced into the AIC expanded listing according to the implicit interface rules of ISO 10303-11. These select types are not referenced by other entities in this part of ISO 10303.

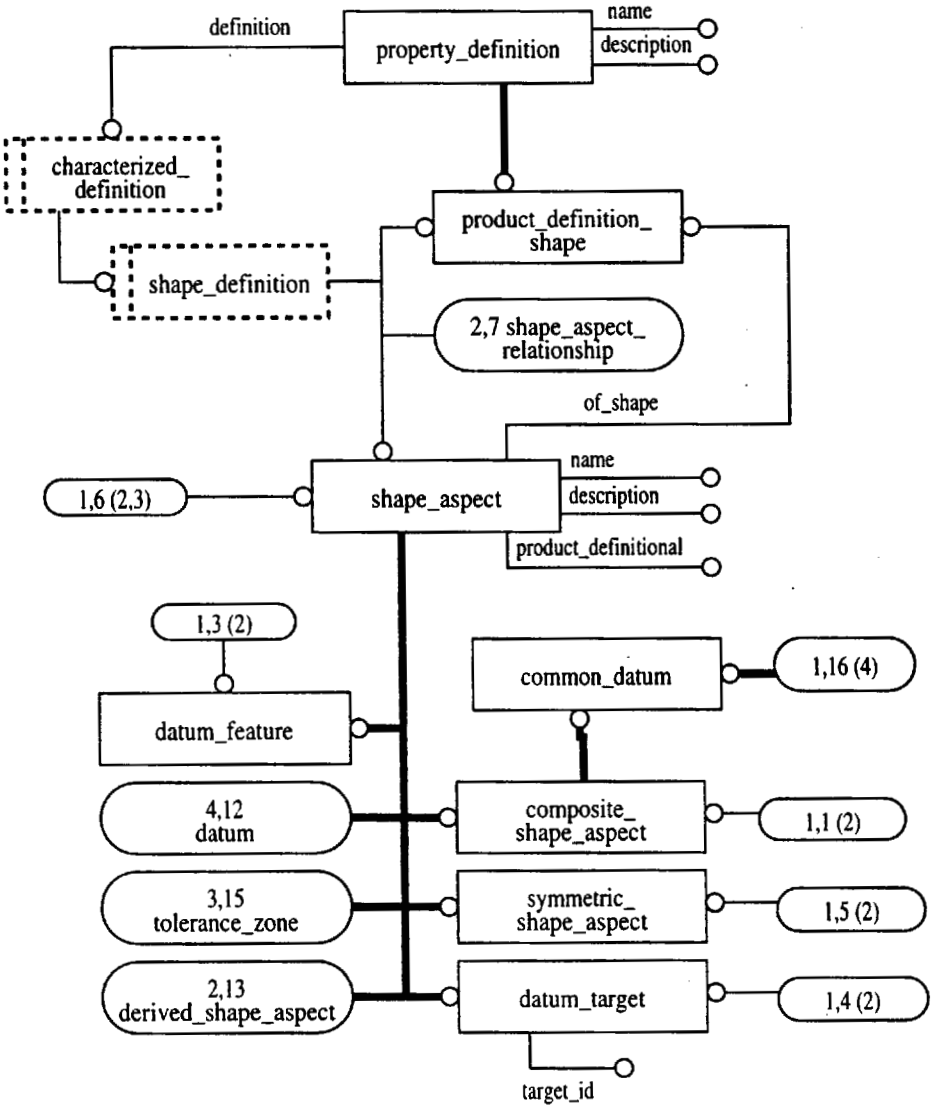

Figure C.1 – AIC expanded listing diagram in EXPRESS–G: 1 of 5

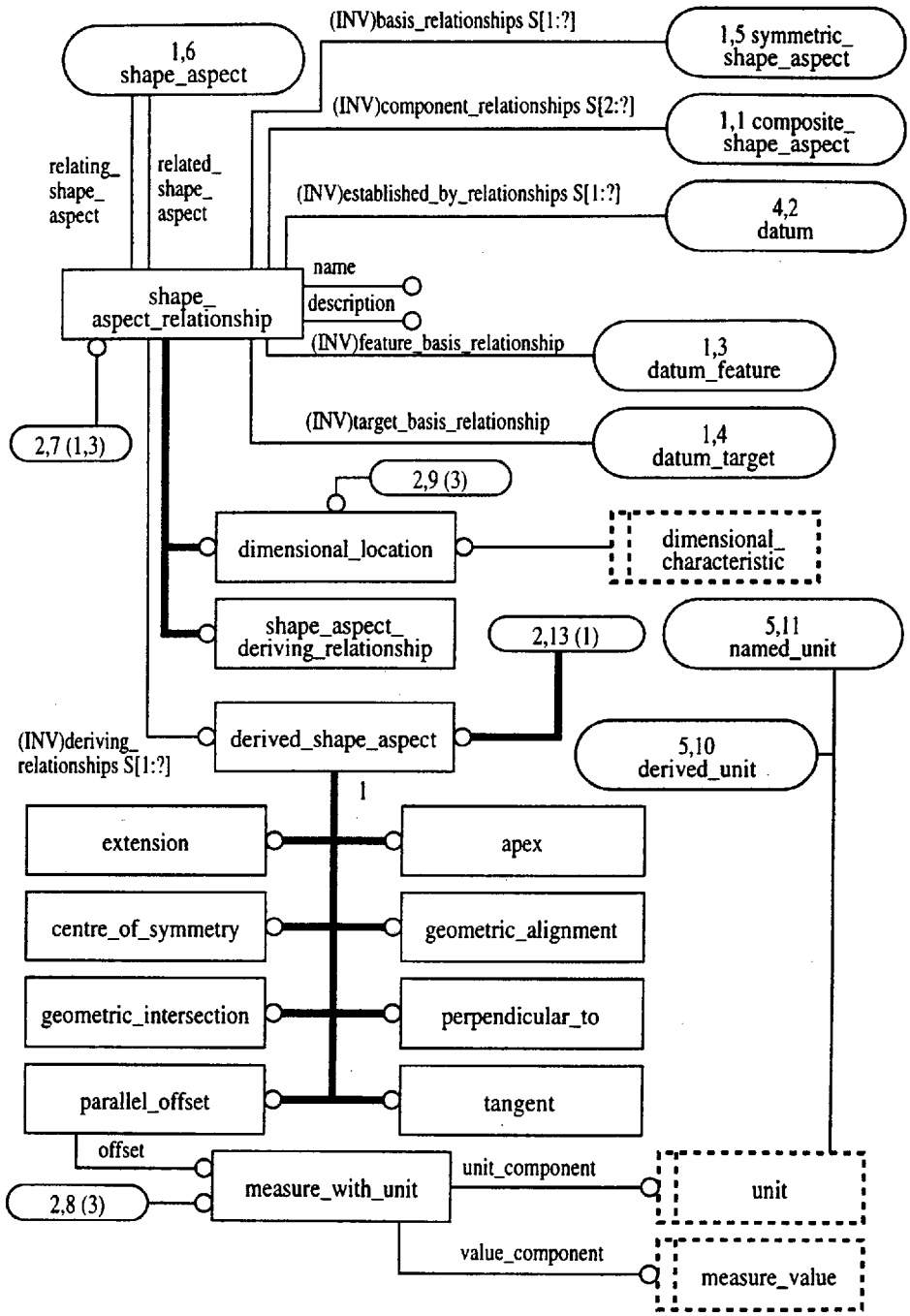

Figure C.2 – AIC expanded listing diagram in EXPRESS–G: 2 of 5

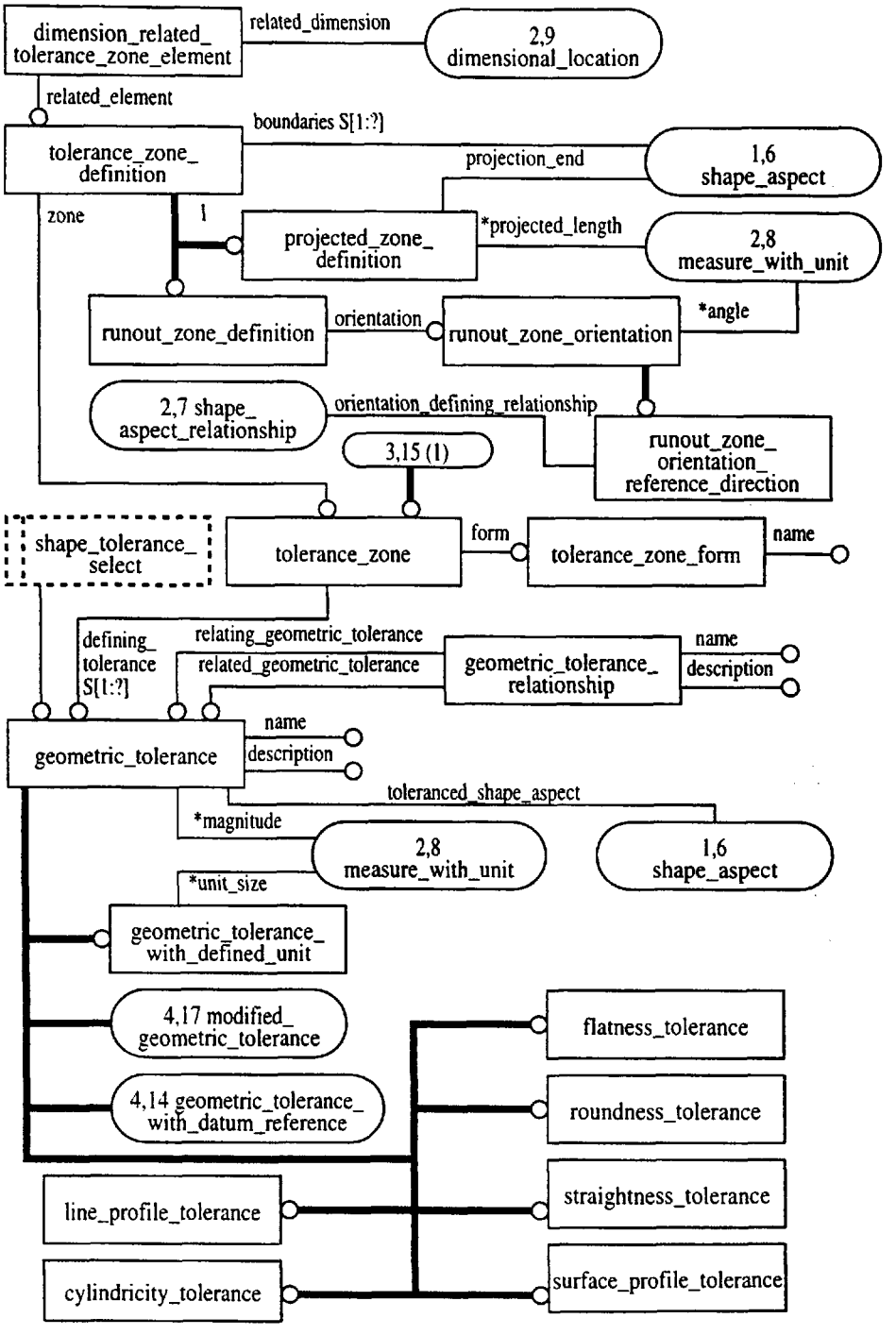

Figure C.3 – AIC expanded listing diagram in EXPRESS–G: 3 of 5

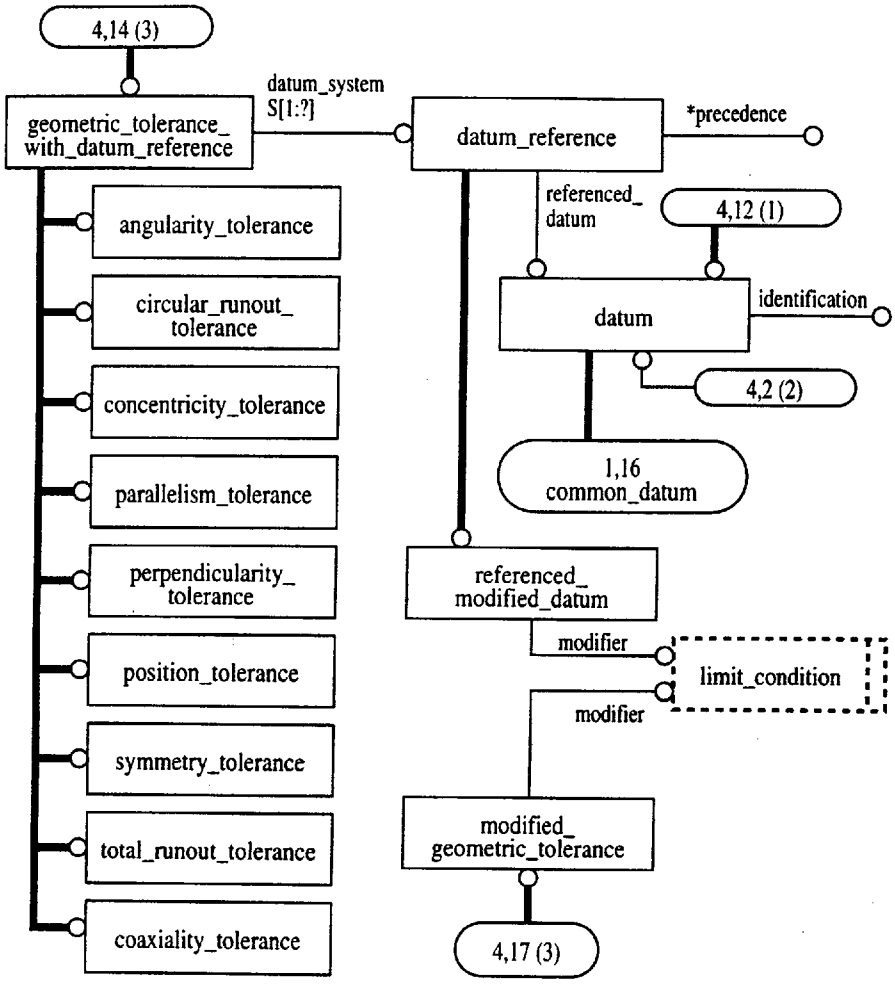

Figure C.4 – AIC expanded listing diagram in EXPRESS–G: 4 of 5

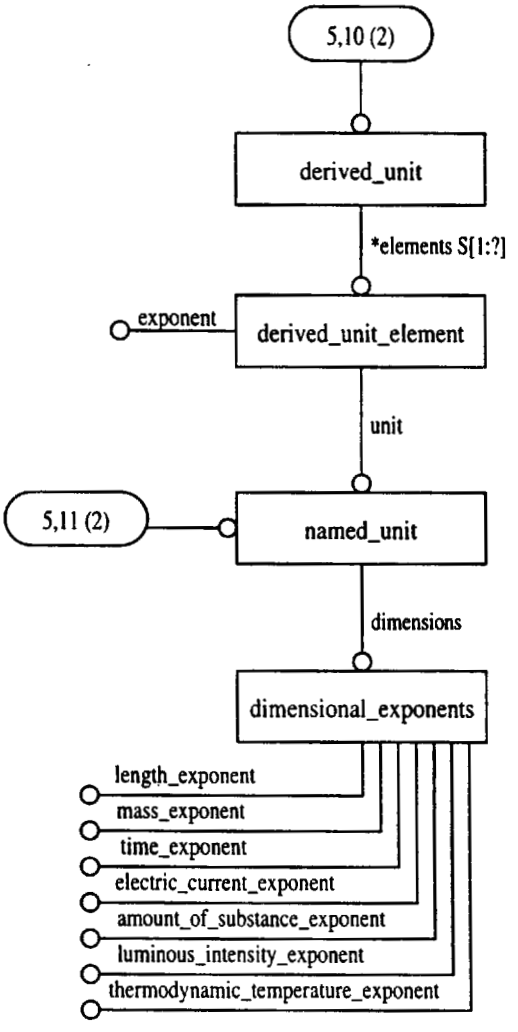

Figure C.5 – AIC expanded listing diagram in EXPRESS–G: 5 of 5

Annex D
(informative)

Computer interpretable listings

This annex references a listing of the EXPRESS entity names and corresponding short names as specified in this part of ISO 10303. It also provides a listing of each EXPRESS schema specified in this part of ISO 10303 without comments or other explanatory text. These listings are available in computer-interpretable form and can be found at the following URLs:

Short names: http://www.mel.nist.gov/div826/subject/apde/snr/

EXPRESS: http://www.mel.nist.gov/step/parts/part519/fdis/

If there is difficulty accessing these sites contact ISO Central Secretariat or contact the ISO TC 184/SC4 Secretariat directly at: sc4sec@cme.nist.gov.

NOTE - The information provided in computer-interpretable form at the above URLs is informative. The information that is contained in the body of this part of ISO 10303 is normative.

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