

# INTERNATIONAL STANDARD

# ISO 10303-522

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

### Part 522: Application interpreted construct: Machining features

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

*Partie 522: Construction interprétée d'application: Caractéristiques  
d'usinage*



Reference number  
ISO 10303-522:2006(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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10303-522 was prepared by Technical Committee ISO TC184/SC4, *Industrial automation systems and integration*, Subcommittee SC4 *Industrial data*.

This second edition of ISO 10303-522 cancels and replaces the first edition (ISO 10303-522:2003), of which it constitutes a technical revision.

ISO 10303 is organized as a series of parts, each published separately. The structure of ISO 10303 is described in ISO 10303-1.

Each part of ISO 10303 is a member of one of the following series: description methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, application protocols, abstract test suites, application interpreted constructs, and application modules. This part of ISO 10303 is a member of the 500 series.

A complete list of parts of ISO 10303 is available from the Internet:  
<<http://www.tc184-sc4.org/titles/>>

## Introduction

ISO 10303 is an International Standard for the computer-interpretable representation of product information and for the exchange of product data. The objective is to provide a neutral mechanism capable of describing products throughout their life cycle. This mechanism is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases, and as a basis for archiving.

This part of ISO 10303 is a member of the application interpreted construct 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 that identifies specific characteristics of part shape used in manufacturing. These characteristics are used to define manufacturing features. These shapes can be represented either by machining features defined in this application interpreted constructs, or by a boundary representation solid model, shared by other application protocols and used as application interpreted constructs in application protocols. The purpose of manufacturing features is to facilitate the identification of manufacturing shapes that are human and computer interpretable.

This edition of this part of ISO 10303 incorporates modifications that are upwardly compatible with the previous edition, and modifications that are not upwardly compatible with the previous edition. Modifications to EXPRESS specifications are upwardly compatible if:

- the modifications do not result in changes to instances that are encoded according to ISO 10303-21; such instances conform to both the unmodified and modified EXPRESS specifications;
- the modifications do not result in changes to software that conforms to ISO 10303-22 with respect to access to the data content of data structures;
- the modifications do not invalidate mappings to the previous edition of this part of ISO 10303 that are specified in the mapping table of an ISO 10303 application protocol.

The second edition of this part of ISO 10303 (ISO 10303-522:2006) includes the modifications to ISO 10303-522:2003 listed below. These modifications are categorized as follows: changes to the EXPRESS declarations, new EXPRESS declarations, and changes to definitions of EXPRESS entity data types.

The following EXPRESS declarations have been modified:

- chamfer;
- edge\_round;
- externally\_defined\_feature\_definition;
- feature\_definition;
- flat\_face;

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- outer\_round;
- outside\_profile;
- pocket;
- protrusion;
- revolved\_profile;
- rib\_top;
- rounded\_end;
- rounded\_u\_profile;
- square\_u\_profile;
- step;
- slot\_end;
- thread;
- vee\_profile;
- vee\_profile.

The following EXPRESS declarations have been added:

- gear;
- thread\_runout.

The expanded listing contains the EXPRESS for the entities defined in ISO 10303-522 and the integrated resource entities used by these entities is given in Annex D. A graphical representation of the expanded EXPRESS is given in Annex C. The short names of entities specified in ISO 10303-522 is given in Annex A. Requirements on the use of the short names are found in the implementation methods included in ISO 10303. A technical discussion on the usage of entities is given in the technical discussion found in Annex E. Annex B defines the information object identifier for the part as specified by ISO/IEC 8824-1.

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

## Part 522:

## Application interpreted construct: Machining features

### 1 Scope

This part of ISO 10303 specifies the interpretation of the integrated resources to satisfy requirements for machining feature use across a range of application protocols. The product data is based on existing part designs that have their shapes represented by machining features. This part of ISO 10303 supports digital representation for computer integrated manufacturing.

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

- features that are to be manufactured by either milling or turning processes;
- machining features for defining shapes necessary for manufacturing;

NOTE The machining feature set is defined in ISO 10303-224.

- machining feature definition elements necessary for creating machining features;
- shape representations necessary for creating machining features;
- features that can be replicated in patterns;
- implicit representation of machining features through selection of standard parameters.

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

- feature order or sequence;
- design features of a part.

### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 8824-1, *Information Technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation*

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

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

ISO 10303-42, *Industrial automation systems and integration — Product data representation and exchange — Part 42: Integrated generic resource: Geometric and topological representation*

ISO 10303-45, *Industrial automation systems and integration — Product data representation and exchange — Part 45: Integrated generic resource: Materials*

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

ISO 10303-224:2006, *Industrial automation systems and integration — Product data representation and exchange — Part 224: Application protocol: Mechanical product definition for process planning using machining features*

### 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.

- application;
- application activity model ( AAM);
- application interpreted model (AIM);
- application object;
- application protocol ( AP);
- application reference model ( ARM);
- implementation method;
- integrated resource;
- model;
- product;

- product data;
- protocol implementation conformance statement (PICS);
- unit of functionality (UoF).

## 3.2 Other definitions

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

### 3.2.1

#### **application interpreted construct (AIC)**

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

## 3.3 Abbreviations

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

|      |                                               |
|------|-----------------------------------------------|
| AIC  | application interpreted construct             |
| AP   | application protocol                          |
| PICS | protocol implementation conformance statement |
| UoF  | unit of functionality                         |

## 4 EXPRESS short listing

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

NOTE 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_machining_feature;

    USE FROM external_reference_schema          -- ISO 10303-41
        (externally_defined_item);

    USE FROM geometry_schema                    -- ISO 10303-42
        (bounded_curve,
         direction,
```

```

        plane,
        placement,
        point);

USE FROM measure_schema -- ISO 10303-41
    (count_measure,
     length_measure_with_unit,
     measure_with_unit,
     named_unit,
     plane_angle_measure_with_unit,
     ratio_measure_with_unit);

USE FROM product_definition_schema -- ISO 10303-41
    (product_definition);

USE FROM product_property_definition_schema -- ISO 10303-41
    (characterized_object,
     product_definition_shape,
     property_definition,
     shape_aspect,
     shape_aspect_relationship);

USE FROM product_property_representation_schema -- ISO 10303-41
    (property_definition_representation,
     shape_representation);

REFERENCE FROM product_property_representation_schema -- ISO 10303-41
    (get_property_definition_representations);

USE FROM qualified_measure_schema -- ISO 10303-45
    (descriptive_representation_item,
     measure_representation_item);

USE FROM shape_aspect_definition_schema -- ISO 10303-47
    (composite_shape_aspect);

USE FROM topology_schema -- ISO 10303-42
    (edge_curve,
     face_surface,
     oriented_face,
     path);

```

(\*

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

|                                        |              |
|----------------------------------------|--------------|
| document_schema                        | ISO 10303-41 |
| external_reference_schema              | ISO 10303-41 |
| geometry_schema                        | ISO 10303-42 |
| management_resources_schema            | ISO 10303-41 |
| measure_schema                         | ISO 10303-41 |
| product_definition_schema              | ISO 10303-41 |
| product_property_definition_schema     | ISO 10303-41 |
| product_property_representation_schema | ISO 10303-41 |
| qualified_measure_schema               | ISO 10303-45 |
| shape_aspect_definition_schema         | ISO 10303-47 |
| topology_schema                        | ISO 10303-42 |

## 4.1 Fundamental concepts and assumptions

The following entity data types are intended to be independently instantiable in each application protocol schema that use this AIC:

- applied\_area;
- boss;
- boss\_top;
- chamfer;
- chamfer\_offset;
- circular\_closed\_profile;
- circular\_pattern;
- closed\_path\_profile;
- composite\_hole;
- compound\_feature;
- direction\_shape\_representation;
- edge\_round;
- externally\_defined\_feature\_definition;
- face\_shape\_representation;
- feature\_component\_definition ;
- feature\_component\_relationship;
- feature\_definition;
- feature\_pattern;
- fillet;
- flat\_face;
- hole\_bottom;
- instanced\_feature;
- linear\_profile;

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- location\_shape\_representation;
- marking;
- modified\_pattern;
- ngon\_closed\_profile;
- open\_path\_profile;
- outer\_round;
- outside\_profile;
- partial\_circular\_profile;
- path\_feature\_component;
- path\_shape\_representation;
- pattern\_offset\_membership;
- pattern\_omit\_membership;
- planar\_shape\_representation;
- pocket;
- pocket\_bottom;
- profile\_floor;
- protrusion;
- rectangular\_closed\_profile;
- rectangular\_pattern;
- replicate\_feature;
- removal\_volume;
- revolved\_profile;
- rib\_top;
- rib\_top\_floor;
- round\_hole;

- rounded\_end;
- rounded\_u\_profile;
- shape\_defining\_relationship;
- shape\_representation\_with\_parameters;
- spherical\_cap;
- square\_u\_profile;
- step;
- slot;
- slot\_end;
- taper;
- tee\_profile;
- thread;
- transition\_feature;
- turned\_knurl;
- vee\_profile.

## 4.2 AIC\_machining\_feature entity definitions

See Annex E.2 for a discussion on machining feature usage. See ISO 10303-224 for definition and areas of application for these types of feature definitions.

### 4.2.1 applied\_area

An **applied\_area** is a type of **shape\_aspect** that is the representation of the bounded enclosed area used in the definition of the **thread** and **turned\_knurl** **feature\_definitions**.

NOTE A **Partial\_area\_definition** is defined in ISO 10303-224:2006, 4.2.159 and defines the requirement for **applied\_area**.

EXPRESS specification:

```
*)
ENTITY applied_area
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ( 'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
          IN TYPEOF(SELF.of_shape));
```

```

WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);

WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
'AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
used_representation)) ) |
(NOT({2 <= SIZEOF(impl_rep.used_representation.items) <= 3} )
) )) = 0)) )) = 0);

WR4: SIZEOF( QUERY( pd <* USEDIN( SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(SIZEOF( QUERY( pdr <* USEDIN( pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) AND
(SIZEOF( QUERY( srwp_i <* pdr.used_representation.items |
NOT (srwp_i.name IN ['orientation','effective length',
'maximum length']) )) > 0 ) )) = 0 ) )) = 0;

WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'effective length')) )) = 1)) ))
= 0)) )) <= 1);

WR6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'maximum length')) )) <= 1)) ))
= 0)) )) = 0);

```

```

WR7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
    'AIC_MACHINING_FEATURE.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    (('AIC_MACHINING_FEATURE.' +
    'SHAPE_REPRESENTATION_WITH_PARAMETERS')
    IN TYPEOF(pdr.used_representation)) ) |
    (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
    (('AIC_MACHINING_FEATURE.PLACEMENT'
    IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
    = 0)) )) = 0);
END_ENTITY; -- applied_area
(*

```

#### Formal propositions:

**WR1:** The **applied\_area** shall be an aspect of the shape of a **product\_definition\_shape**.

**WR2:** The **applied\_area** shall have its implicit representation specified by exactly one **shape\_representation\_with\_parameters**.

**WR3:** The **applied\_area** shall have an implicit representation that contains at least two and at most three **representation\_items** in its set of **items**.

**WR4:** The implicit representation of an **applied\_area** shall contain only **representation\_items** in its set **name** of either 'orientation', 'effective length', or 'maximum length'.

**WR5:** Exactly one **representation\_item** used for the implicit representation of the **applied\_area** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'effective length'.

**WR6:** At most one **representation\_item** used for the implicit representation of the **applied\_area** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'maximum length'.

**WR7:** Exactly one **representation\_item** used for the implicit representation of the **applied\_area** shall be of type **placement** with a **name** of 'orientation'.

#### Informal Proposition

**IP1:** When applied to a **knurl**, the **length\_measure\_with\_unit** with **name** of 'effective length' defines the overall length of the **knurl**.

## 4.2.2 boss

A **boss** is a type of **feature\_definition** that is an enclosed shape protrusion with a reference location and position. A **boss** shall be circular, rectangular, or complex.

NOTE A Boss is defined in ISO 10303-224:2006, 4.2.11 and defines the requirement for **boss**.

EXPRESS specification:

```

*)
ENTITY boss
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: SELF\characterized_object.description IN
      ['circular', 'complex', 'rectangular'];
    WR2: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pd)) |
      NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
      (sa_occ.description = 'boss height occurrence') AND
      (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (sar.description = 'path feature component usage') AND
      ('AIC_MACHINING_FEATURE.' +
      'SHAPE_DEFINING_RELATIONSHIP' IN TYPEOF (sar))) |
      ('AIC_MACHINING_FEATURE.PATH_FEATURE_COMPONENT' IN
      TYPEOF (sdr.relateing_shape_aspect)) AND
      (sdr.relateing_shape_aspect.description = 'linear') AND
      (sdr.name = 'boss height')))) = 1))) = 1))) = 0;
    WR3: SIZEOF( QUERY( pd <* USEDIN( SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      SIZEOF( QUERY( pdr <* USEDIN( pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      ('AIC_MACHINING_FEATURE.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS'
      IN TYPEOF(pdr.used_representation)) AND
      ({1 <= SIZEOF(pdr.used_representation.items) <= 2} ) ) ) = 1 ) ) = 1;
    WR4: SIZEOF( QUERY( pd <* USEDIN( SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      SIZEOF( QUERY( pdr <* USEDIN( pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      ('AIC_MACHINING_FEATURE.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS' IN
      TYPEOF(pdr.used_representation)) AND
      (SIZEOF( QUERY( srwp_i <* pdr.used_representation.items |
      (srwp_i.name = 'orientation') OR
      (srwp_i.name = 'fillet radius'))))
      = SIZEOF(pdr.used_representation.items)) ) ) = 1 ) ) = 1;
    WR5: SIZEOF (QUERY (pd <* USEDIN (SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'AIC_MACHINING_FEATURE.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS'
      IN TYPEOF (pdr.used_representation)) |
      NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
      (SIZEOF (

```

```

[ 'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
  'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
  TYPEOF (it)) = 2) AND (it.name = 'fillet radius')))) <= 1)))
  = 0))) = 0;
WR6: (NOT (SELF\characterized_object.description = 'circular')) OR
  (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
  IN TYPEOF (pd)) |
  NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
    'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
    (sa_occ.description = 'circular profile occurrence') AND
    (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
    'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
    'RELATED_SHAPE_ASPECT') |
    (sar.description = 'profile usage') AND
    ('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP'
  IN TYPEOF (sar))) |
    'AIC_MACHINING_FEATURE.CIRCULAR_CLOSED_PROFILE'
  IN TYPEOF (sdr.relate_shape_aspect))) = 1))) = 1))) = 0);
WR7: SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
  'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
  ('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
  IN TYPEOF(pd)) ) |
  (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
    'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
    ((sa_occ.description = 'top condition occurrence') AND
    (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
    'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
    'RELATED_SHAPE_ASPECT') |
    ((sar.description = 'boss top usage') AND
    ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
  IN TYPEOF(sar))) ) | (('AIC_MACHINING_FEATURE.BOSS_TOP'
  IN TYPEOF(fcr.relate_shape_aspect)) ) ) = 1)) ) = 1)) ) = 0;
WR8: (NOT (SELF\characterized_object.description = 'circular')) OR
  (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE' IN
  TYPEOF (pd)) |
  NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
    'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
    (sa_occ.description = 'change in diameter occurrence') AND
    (SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (sa_occ,
    'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
    'RELATED_SHAPE_ASPECT') |
    (sar.description = 'taper usage') AND
    ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
  IN TYPEOF (sar))) |
    (('AIC_MACHINING_FEATURE.TAPER'
  IN TYPEOF (fcr.related_shape_aspect))
  AND
  ('AIC_MACHINING_FEATURE.BOSS' IN TYPEOF
  (fcr.relate_shape_aspect)))
  ) )= 1))) <= 1))) = 0);
WR9: (NOT (SELF\characterized_object.description = 'complex')) OR
  (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |

```

```

'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE' IN
  TYPEOF (pd)) |
  NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
    'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
    (sa_occ.description = 'enclosed boundary occurrence') AND
    (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (sar.description = 'profile usage') AND
      ('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP'
        IN TYPEOF (sar))) |
      SIZEOF ([ 'AIC_MACHINING_FEATURE.NGON_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.CLOSED_PATH_PROFILE'] *
        TYPEOF (sdr.relate_shape_aspect)) = 1)) = 1))) = 1))) = 0);
WR10: (NOT (SELF\characterized_object.description
  IN ['complex', 'rectangular'])) OR
  (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
    IN TYPEOF (pd)) |
    NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
      (sa_occ.description = 'change in boundary occurrence') AND
      (SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (sa_occ,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATING_SHAPE_ASPECT') |
        (sar.description = 'taper usage') AND
        ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
          IN TYPEOF (sar))) |
        (('AIC_MACHINING_FEATURE.TAPER'
            IN TYPEOF (fcr.relate_shape_aspect))
          AND
          ('AIC_MACHINING_FEATURE.BOSS'
            IN TYPEOF (fcr.relate_shape_aspect))
          AND
          (fcr.relate_shape_aspect.description IN
            ['angle taper', 'directed taper']))
        )) = 1))) <= 1))) = 0);
WR11: (NOT (SELF\characterized_object.description = 'rectangular')) OR
  (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
    IN TYPEOF (pd)) |
    NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
      (sa_occ.description = 'rectangular profile occurrence') AND
      (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        (sar.description = 'profile usage') AND
        ('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP'
          IN TYPEOF (sar))) |
        'AIC_MACHINING_FEATURE.RECTANGULAR_CLOSED_PROFILE'
        IN TYPEOF (sdr.relate_shape_aspect))) = 1))) = 1))) = 0);

```

```

WR12: SIZEOF (QUERY(pdr <* get_property_definition_representations (SELF) |
    ( 'AIC_MACHINING_FEATURE.PLANAR_SHAPE_REPRESENTATION'
    IN TYPEOF ( pdr.used_representation ) ) AND
    ( pdr.used_representation.name ='maximum feature limit')) ) >=0;
END_ENTITY;  -- Boss

```

( \*

#### Formal propositions:

**WR1:** The **description** for the **boss** shall be either 'circular', 'complex', or 'rectangular'.

**WR2:** The **boss** shall be the basis shape for exactly one **shape\_aspect** with a **description** of 'boss height occurrence' that is the **related\_shape\_aspect** in exactly one **shape\_defining\_relationship** with a **name** of 'boss height' and a **description** of 'path feature component usage' in which the **relating\_shape\_aspect** is a **path\_feature\_component** with a **description** of 'linear'.

**WR3:** The implicit representation of the **boss** shall contain between one and two **representation\_items**.

**WR4:** The implicit representation of the **boss** shall contain only **representation\_items** that have a name of either 'orientation', or 'fillet radius'.

**WR5:** The implicit representation of the **boss** shall have at most one **representation\_item** of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'fillet radius'.

**WR6:** If the **boss** has a **description** of 'circular' the **boss** shall be the basis shape for exactly one **shape\_aspect** with a **description** of 'circular profile occurrence' that is the **related\_shape\_aspect** in exactly one **shape\_defining\_relationship** with a **description** of 'profile usage' in which the **relating\_shape\_aspect** is a **circular\_closed\_profile**.

**WR7:** The **boss** shall be the basis shape for exactly one **shape\_aspect** with a **description** of 'top condition occurrence' that is the **related\_shape\_aspect** in exactly one **feature\_component\_relationship** with a **description** of 'boss top usage' in which the **relating\_shape\_aspect** is a **boss\_top**.

**WR8:** The **boss** shall be the basis shape for at most one **shape\_aspect** with a **description** of 'change in diameter occurrence' that is the **related\_shape\_aspect** in exactly one **feature\_component\_relationship** in with a **description** of 'taper usage' in which the **relating\_shape\_aspect** is a **taper**.

**WR9:** If the **boss** has a **description** of 'complex', the **boss** shall be the basis shape for exactly one **shape\_aspect** with a **description** of 'enclosed boundary occurrence' that is the **related\_shape\_aspect** in exactly one **shape\_defining\_relationship** with a **description** of 'profile usage' in which the **relating\_shape\_aspect** is either a **ngon\_closed\_profile**, or **oclosed\_path\_profile**.

**WR10:** If the **boss** has a **description** of 'complex' or 'rectangular', the **boss** shall be the basis shape for at most one **shape\_aspect** with a **description** of 'change in boundary occurrence' that is the **related\_shape\_aspect** in exactly one **feature\_component\_relationship** with a **description** of 'taper usage' in which the **relating\_shape\_aspect** is a **taper** with a **description** of 'angle taper' or 'directed taper'.

**WR11:** If the **boss** has a **description** of 'rectangular', the **boss** shall be the basis shape for exactly one **shape\_aspect** with a **description** of 'rectangular profile occurrence' that is the **related\_shape\_aspect** in exactly one **shape\_defining\_relationship** with a **description** of 'profile usage' in which the **relating\_shape\_aspect** is a **rectangular\_closed\_profile**.

**WR12:** The **boss** shall have at most one **planar\_shape\_representation** with a **name** of 'maximum feature limit'.

Informal propositions:

**IP1:** The location shall be defined at the top of the **boss** at the approximate center of the feature.

**IP2:** The **boss** may be positioned on the face of a part with the Z-axis in the direction away from the part, or at the top of the Boss with the Z-axis in the direction of the part face.

**IP3:** The location, X direction, and Y direction of the **path\_feature\_component** with a **description** of 'boss height' shall be the same as the **boss**.

**IP4:** The placement of the **circular\_closed\_profile** that defines the diameter of a **boss** with a **description** of 'circular' shall be with the origin, X direction, and Y direction equal to that of the **boss**.

**IP5:** The placement of the **rectangular\_closed\_profile**, **ngon\_closed\_profile**, or **closed\_path\_profile** that defines the shape of a **boss** with a **description** of 'complex' shall be with the origin, X direction, and Y direction equal to that of the **boss**.

## 4.2.3 boss\_top

A **boss\_top** is a type of **shape\_aspect** that is the end condition for a **boss feature\_definition**.

NOTE A Boss\_top\_condition is defined in ISO 10303-224:2006, 4.2.12 and defines the requirement for **boss\_top**.

EXPRESS specification:

```
*)
ENTITY boss_top
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
      IN TYPEOF(SELF.of_shape.definition));
    WR2: (SELF.description IN ['planar', 'complex']);
    WR3: ((NOT (SELF.description = 'planar')) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('AIC_MACHINING_FEATURE.DIRECTION_SHAPE_REPRESENTATION'
        IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0)));
    WR4: ((NOT (SELF.description = 'planar')) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'AIC_MACHINING_FEATURE.' +
```

```

'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
((('AIC_MACHINING_FEATURE.LOCATION_SHAPE_REPRESENTATION')
IN TYPEOF(pdr.used_representation)) = 1)) = 0));
WR5: (NOT (SELF.description = 'complex')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
('AIC_MACHINING_FEATURE.FACE_SHAPE_REPRESENTATION')
IN TYPEOF(pdr.used_representation)) = 1)) = 0));
WR6: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
'RELATING_SHAPE_ASPECT') |
((sar.description = 'boss top usage') AND
(sar.name IN ['boss height start','boss height end']))AND
('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
IN TYPEOF(sar))) |
((fcr.related_shape_aspect.description = 'top condition occurrence')
AND
('AIC_MACHINING_FEATURE.BOSS'
IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)) AND
('AIC_MACHINING_FEATURE.BOSS_TOP'
IN TYPEOF(fcr.relating_shape_aspect)) )
)) >= 1);
WR7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) <= 1)) = 0));
WR8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) |
(NOT (SIZEOF(impl_rep.used_representation.items) = 1)) = 0)) = 0));
WR9: SIZEOF ( QUERY (pd <* USEDIN (SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
NOT (SIZEOF ( QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF (pdr.used_representation)) |
NOT (SIZEOF ( QUERY (it <* impl_rep.used_representation.items |
(SIZEOF (
['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *

```

```

        TYPEOF (it)) = 2) AND (it.name = 'top radius')))) <= 1)))
        = 0))) = 0;
END_ENTITY; -- boss_top
(*

```

#### Formal propositions:

**WR1:** The **boss\_top** shall be an aspect of the shape of a **feature\_component\_definition**.

**WR2:** The **description** of the **boss\_top** shall be either 'planar' or 'complex'.

**WR3:** If the **description** of the **boss\_top** is 'planar', the **boss\_top** shall have exactly one **direction\_shape\_representation**.

**WR4:** If the **description** of the **boss\_top** is 'planar', the **boss\_top** shall have exactly one **location\_shape\_representation**.

**WR5:** If the **description** of the **boss\_top** is 'complex', the **boss\_top** shall have exactly one **face\_shape\_representation**.

**WR6:** The **boss\_top** shall be the **relating\_shape\_aspect** in at least one **feature\_component\_relationship** with a **description** of 'boss top usage' and a **name** of either 'boss height start' or 'boss height end' in which the **related\_shape\_aspect** is a **shape\_aspect** of a **boss** with a **name** of 'top condition occurrence'.

**WR7:** The **boss\_top** shall have at most one **shape\_representation\_with\_parameters** to specify its implicit representation.

**WR8:** The **boss\_top** shall be represented implicitly by exactly one **representation\_item**.

**WR9:** The implicit representation of the **boss\_top** shall have at most one **representation\_item** of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'top radius'.

#### Informal propositions:

**IP1:** The location of the **boss\_top** shall be at the center of the face that is the mating face to a **boss** feature.

**IP2:** The **boss\_top** shall be defined on the mating face in the X-Y plane with the Z direction coincident to that of the mating **boss** feature.

## 4.2.4 chamfer

A **chamfer** is a type of **transition\_feature** that is the representation of a linear transition between two **shape\_aspects**. A **chamfer** defines the outside profile of a part.

NOTE A Chamfer is defined in ISO 10303-224:2006, 4.2.22 and defines the requirement for **chamfer**.

EXPRESS specification:

```

*)
ENTITY chamfer
  SUBTYPE OF (transition_feature);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('AIC_MACHINING_FEATURE.FACE_SHAPE_REPRESENTATION'
        IN TYPEOF(pdr.used_representation)) AND
        (pdr.used_representation.name = 'chamfer face')) )) <= 1)) )) = 0);
    WR2: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATING_SHAPE_ASPECT') |
      ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF(sar)) ) |
      (('AIC_MACHINING_FEATURE.CHAMFER_OFFSET'
      IN TYPEOF(fcr.related_shape_aspect))AND
      ('AIC_MACHINING_FEATURE.CHAMFER'
      IN TYPEOF(fcr.relateing_shape_aspect)) AND
      (fcr.related_shape_aspect.description = 'first offset') )
      )) = 1);
    WR3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATING_SHAPE_ASPECT') |
      ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF(sar)) ) |
      (('AIC_MACHINING_FEATURE.CHAMFER_OFFSET'
      IN TYPEOF(fcr.related_shape_aspect)) AND
      ('AIC_MACHINING_FEATURE.CHAMFER'
      IN TYPEOF(fcr.relateing_shape_aspect))AND
      (fcr.related_shape_aspect.description = 'second offset'))
      )) = 1);
  END_ENTITY; -- chamfer
  (*

```

Formal propositions:

**WR1:** The **chamfer** shall have at most one one **face\_shape\_representations** in the role of the chamfer face.

**WR2:** The **chamfer** shall be related to exactly one **chamfer\_offset** that specifies the first offset for the chamfer.

**WR3:** The **chamfer** shall be related to exactly one **chamfer\_offset** that specifies the second offset for the chamfer.

## 4.2.5 chamfer\_offset

A **chamfer\_offset** is a type of **shape\_aspect** that is the representation of the linear setbacks from the edge of two surfaces to create a **chamfer feature\_definition**.

NOTE A **First\_offset** is defined in ISO 10303-224:2006, 4.2.82 and a **Second\_offset** is defined in ISO 10303-224:2006, 4.2.216 and defines the requirement for **chamfer\_offset**.

### EXPRESS specification:

```

*)
ENTITY chamfer_offset
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: (SELF.description IN ['first offset','second offset']);
    WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('AIC_MACHINING_FEATURE.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
    WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('AIC_MACHINING_FEATURE.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) )) |
      (NOT (SIZEOF(impl_rep.used_representation.items) = 1)) ))
      = 0)) )) = 0);
    WR4: ((NOT (SELF.description = 'first offset')) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'AIC_MACHINING_FEATURE.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
          (('AIC_MACHINING_FEATURE.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS')
          IN TYPEOF(pdr.used_representation)) )) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
          ((SIZEOF([
            'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
            'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2) AND (it.name = 'offset amount')) )) = 1)) ))
          = 0)) )) = 0));
    WR5: ((NOT (SELF.description = 'first offset')) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'AIC_MACHINING_FEATURE.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
          (('AIC_MACHINING_FEATURE.FACE_SHAPE_REPRESENTATION'
```

```

IN TYPEOF(pdr.used_representation)) AND
(pdr.used_representation.name = 'first face shape')) )) <= 1)) ))
= 0));
WR6: ((NOT (SELF.description = 'second offset')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'offset amount')) OR
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.PLANE_ANGLE_MEASURE_WITH_UNIT']
* TYPEOF(it)) = 2) AND (it.name = 'offset angle')))) )) = 1)) ))
= 0)) )) = 0));
WR7: ((NOT (SELF.description = 'second offset')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.FACE_SHAPE_REPRESENTATION'
IN TYPEOF(pdr.used_representation)) AND
(pdr.used_representation.name = 'second face shape')) )) <= 1)) ))
= 0));
WR8: (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
'RELATED_SHAPE_ASPECT') |
(('AIC_MACHINING_FEATURE.' +
'FEATURE_COMPONENT_RELATIONSHIP')
IN TYPEOF(sar)) ) |
(('AIC_MACHINING_FEATURE.CHAMFER'
IN TYPEOF(sdr.relate_shape_aspect))AND
('AIC_MACHINING_FEATURE.CHAMFER_OFFSET'
IN TYPEOF(sdr.related_shape_aspect)))
)) = 1);
END_ENTITY; -- chamfer_offset
(*

```

#### Formal propositions:

**WR1:** The **description** for the **chamfer\_offset** shall be either 'first offset' or 'second offset'.

**WR2:** The **chamfer\_offset** shall have its implicit representation specified by exactly one **shape\_-representation\_with\_parameters**.

**WR3:** The **chamfer\_offset** shall have an implicit representation that contains exactly one **representation\_item** in its set of **items**.

**WR4:** If the **description** of the **chamfer\_offset** is 'first offset', exactly one **representation\_item** used for the implicit representation of the **chamfer\_offset** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'offset amount'.

**WR5:** If the **description** of the **chamfer\_offset** is 'first offset', the **chamfer\_offset** shall have at most one **face\_shape\_representation** with a **name** of 'first face shape'.

**WR6:** If the **description** of the **chamfer\_offset** is 'second offset', exactly one **representation\_item** used for the implicit representation of the **chamfer\_offset** shall be either of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'offset amount', or of type **measure\_representation\_item** and **plane\_angle\_measure\_with\_unit** with a **name** of 'offset angle'.

**WR7:** If the **description** of the **chamfer\_offset** is 'second offset', the **chamfer\_offset** shall have at most one **face\_shape\_representation** with a **name** of 'second face shape'.

**WR8:** The **chamfer\_offset** shall be the **related\_shape\_aspect** in at exactly one **feature\_component\_relationship** in which the **relating\_shape\_aspect** is a **chamfer**.

## 4.2.6 circular\_pattern

A **circular\_pattern** is a type of **replicate\_feature** that relates a base feature and one or more **shape\_aspects** which are the placement of the base feature at a specified circular location on the base part. A diameter is defined with a placement on the part and a number of base features are equally spaced around this diameter.

NOTE A Circular\_pattern is defined in ISO 10303-224:2006, 4.2.31 and defines the requirement for **circular\_pattern**.

### EXPRESS specification:

```
*)
ENTITY circular_pattern
  SUBTYPE OF (replicate_feature);
  WHERE
    WR1: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      ('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
      IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN
      (pds, 'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
      ((SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
      + 'RELATING_SHAPE_ASPECT') |
      ((( 'AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF(sar))) ) |
      ('AIC_MACHINING_FEATURE.SHAPE_ASPECT'
      IN TYPEOF(sdr.related_shape_aspect)) )) = 1)) )) <= 3)) )) = 0);
    WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('AIC_MACHINING_FEATURE.' +
```

```

'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) ) |
(NOT ((SIZEOF(impl_rep.used_representation.items) >= 3)
AND (SIZEOF(impl_rep.used_representation.items) <= 5))) ))
= 0)) )) = 0);
WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF(
['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'diameter')) )) <= 1)) ))
= 0)) )) = 0);
WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF(
['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'base feature rotation')) ))
<= 1)) )) = 0)) )) = 0);
WR6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND
('AIC_MACHINING_FEATURE.COUNT_MEASURE'
IN TYPEOF(it\measure_with_unit.value_component)) AND
(it.name = 'number of features')) )) = 1)) )) = 0)) )) = 0);
WR7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |

```

```

        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') ) |
        ('AIC_MACHINING_FEATURE.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        ((SIZEOF(
        ['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'angular spacing'))))= 1)) ))
        = 0)) )) = 0);
    WR8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
    'AIC_MACHINING_FEATURE.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') ) |
    ('AIC_MACHINING_FEATURE.' +
    'SHAPE_REPRESENTATION_WITH_PARAMETERS'
    IN TYPEOF(pdr.used_representation)) ) |
    (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
    (('AIC_MACHINING_FEATURE.PLACEMENT'
    IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
    = 0)) )) = 0);
END_ENTITY; -- circular_pattern
(*

```

#### Formal propositions:

**WR1:** The **circular\_pattern** shall be the **relating\_shape\_aspect** in no more than three **shape\_aspect\_-relationships**.

**WR2:** The **circular\_pattern** shall have exactly one implicit representation.

**WR3:** The implicit representation of the **circular\_pattern** shall contain between two and five **representation\_items** in its set of **items**.

**WR4:** The implicit representation of the **circular\_pattern** shall contain at most one **representation\_-item** of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'diameter'.

**WR5:** The implicit representation of the **circular\_pattern** shall contain at most one **representation\_-item** of type **measure\_representation\_item** and **plane\_angle\_measure\_with\_unit** with a **name** of 'base feature rotation'.

**WR6:** The implicit representation of the **circular\_pattern** shall contain exactly one **representation\_-item** of type **measure\_representation\_item** with a **value\_component** of type **count\_measure** and a **name** of 'number of features'.

**WR7:** The implicit representation of the **circular\_pattern** shall contain exactly one **representation\_-item** of type **measure\_representation\_item** and **plane\_angle\_measure\_with\_unit** with a **name** of 'angular spacing'.

**WR8:** The implicit representation of the **circular\_pattern** shall contain exactly one **representation\_-item** of type **placement** with a **name** of 'orientation'.

Informal propositions:

**IP1:** The location of the **circular\_pattern** shall be defined at the center of the circle.

**IP2:** The **circular\_pattern** shall be defined in the X-Y plane, with the X direction intersecting the placement position of the first base feature.

## 4.2.7 circular\_closed\_profile

A **circular\_closed\_profile** is a type of **shape\_aspect** that is an enclosed 2D area defined by a radius, with orientation and location. The location is defined to be at the center of the circular arc, and the orientation of the **circular\_closed\_profile** is the X-Y plane.

NOTE A **Circular\_closed\_profile** is defined in ISO 10303-224:2006, 4.2.25 and defines the requirement for **circular\_closed\_profile**.

EXPRESS specification:

```

*)
ENTITY circular_closed_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
          IN TYPEOF(SELF.of_shape.definition));
    WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
          (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'AIC_MACHINING_FEATURE.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
          (('AIC_MACHINING_FEATURE.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS')
          IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
    WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
          (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'AIC_MACHINING_FEATURE.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'AIC_MACHINING_FEATURE.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS')
          IN TYPEOF(pdr.used_representation)) ) |
          (NOT (SIZEOF(impl_rep.used_representation.items) = 2)) ))
          = 0)) )) = 0);
    WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
          (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'AIC_MACHINING_FEATURE.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
          (('AIC_MACHINING_FEATURE.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS')
          IN TYPEOF(pdr.used_representation)) ) |
          NOT(SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
          (('AIC_MACHINING_FEATURE.PLACEMENT'
          IN TYPEOF(it))

```

```

        AND (it.name = 'orientation')) )) = 1) )) = 0)) )) = 0);
WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
    'AIC_MACHINING_FEATURE.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    (('AIC_MACHINING_FEATURE.' +
    'SHAPE_REPRESENTATION_WITH_PARAMETERS')
    IN TYPEOF(pdr.used_representation)) ) |
    (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
    ((SIZEOF([
    'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
    'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it)) = 2) AND (it.name = 'diameter')) )) = 1)) ))
    = 0)) )) = 0);
END_ENTITY; -- circular_closed_profile
(*

```

#### Formal propositions:

**WR1:** The **circular\_closed\_profile** shall be an aspect of the shape of a **feature\_component\_definition**.

**WR2:** The **circular\_closed\_profile** shall have exactly one implicit representation defined by a relationship to a **shape\_representation\_with\_parameters**.

**WR3:** The **shape\_representation\_with\_parameters** that represents the **circular\_closed\_profile** shall contain two **representation\_items** in its set of **items**.

**WR4:** Exactly one **representation\_item** used for the implicit representation of a **circular\_closed\_profile** shall be of type **placement** with a **name** of 'orientation'.

**WR5:** Exactly one **representation\_item** used the implicit representation of a **circular\_closed\_profile** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'diameter'.

#### Informal propositions:

**IP1:** The location of the **circular\_closed\_profile** shall be defined at the center of the circle.

**IP2:** The **circular\_closed\_profile** shall be defined in the X-Y plane.

### 4.2.8 closed\_path\_profile

A **closed\_path\_profile** is a type of **shape\_aspect** that is a closed two dimensional area defined by a connected set of curves with a location and orientation. The start vertex and end vertex for the set of curves are the same point creating an enclosed area. The **closed\_path\_profile** is located at the approximate center of the enclosed area, and the orientation is in the X-Y plane.

NOTE A General\_closed\_profile is defined in ISO 10303-224:2006, 4.2.90 and defines the requirement for **closed\_path\_profile**.

EXPRESS specification:

```

*)
ENTITY closed_path_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
      IN TYPEOF(SELF.of_shape.definition));
    WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.' +
      'DEFINITION') |
      (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('AIC_MACHINING_FEATURE.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
    WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('AIC_MACHINING_FEATURE.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) )) |
      (NOT (SIZEOF(impl_rep.used_representation.items) = 1)) ))
      = 0)) )) = 0);
    WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('AIC_MACHINING_FEATURE.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) )) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      (('AIC_MACHINING_FEATURE.PLACEMENT'
      IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
      = 0)) )) = 0);
    WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.' +
      'DEFINITION') |
      (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('AIC_MACHINING_FEATURE.PATH_SHAPE_REPRESENTATION')
      IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
  END_ENTITY; -- closed_path_profile
  (*

```

Formal propositions:

**WR1:** The **closed\_path\_profile** shall be an aspect of the shape of a **feature\_component\_definition**.

**WR2:** The **closed\_path\_profile** shall have exactly one implicit representation defined by a relationship to a **shape\_representation\_with\_parameters**.

**WR3:** The **shape\_representation\_with\_parameters** that represents the **closed\_path\_profile** shall contain one **representation\_items** in its set of **items**.

**WR4:** Exactly one **representation\_item** used for the implicit representation of a **closed\_path\_profile** shall be of type **placement** with a **name** of 'orientation'.

**WR5:** The **closed\_path\_profile** shall have exactly one **path\_shape\_representation**.

#### Informal propositions:

**IP1:** The location of the **closed\_path\_profile** shall be defined at the approximate center of the enclosed area.

**IP2:** The **closed\_path\_profile** shall be defined in the X-Y plane.

### 4.2.9 composite\_hole

A **composite\_hole** is a feature that is the representation of two **round\_holes** for the purpose of creating two commonly used **round\_hole** combinations, the countersunk hole and the counterbore hole. The counterbore hole is the representation of two **round\_holes** with one having a larger diameter than the second. The countersunk hole is the representation of two **round\_holes**, the first having a larger diameter than the second with a linear decrease in diameter until it is the same as the second. This linear decrease shall be represented by a **taper**.

NOTE A Counterbore\_hole is defined in ISO 10303-224:2006, 4.2.46 and a Countersunk\_hole is defined in ISO 10303-224:2006, 4.2.47 and defines the requirement for **composite\_hole**.

#### EXPRESS specification:

```
*)
ENTITY composite_hole
  SUBTYPE OF (compound_feature);
  WHERE
    WR1: (SELF\characterized_object.description IN ['counterbore',
      'countersunk']);
    WR2: SIZEOF(QUERY ( pds <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
      IN TYPEOF(pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
      (('AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT'
      IN TYPEOF(csa)) AND
      (SIZEOF(QUERY ( sar <* csa.component_relationships |
      (((('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF(sar)) AND ('AIC_MACHINING_FEATURE.ROUND_HOLE'
      IN TYPEOF(sar.related_shape_aspect)))
      ))) = 2)) )) = 1)) )) = 1;
    WR3: (NOT (SELF\characterized_object.description = 'countersunk')) OR
      (SIZEOF(QUERY ( pds <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
      IN TYPEOF(pds)) AND
```

```

(SIZEOF(QUERY ( csa <* USEDIN(pds,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
(( 'AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT'
IN TYPEOF(csa)) AND
(SIZEOF(QUERY ( sar <* csa.component_relationships |
(( 'AIC_MACHINING_FEATURE.ROUND_HOLE'
IN TYPEOF(sar.related_shape_aspect)) AND
(NOT (SIZEOF(QUERY ( pds <* QUERY ( pd <*
USEDIN(sar.related_shape_aspect,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF(pd)) ) |
(NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
((sa_occ.description = 'change in diameter occurrence') AND
(SIZEOF(QUERY ( fcr2 <* QUERY ( sar2 <* USEDIN(sa_occ,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
'RELATING_SHAPE_ASPECT') |
((sar2.description = 'taper usage') AND
('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
IN TYPEOF(sar2))) ) |
('AIC_MACHINING_FEATURE.TAPER' IN TYPEOF(fcr2.related_shape_aspect))
)) = 1)) )) = 0))) )) = 0))) )) = 1)) )) = 1)) )) = 1);
END_ENTITY; -- composite_hole
(*

```

#### Formal propositions:

**WR1:** The **description** of the **composite\_hole** shall be either 'counterbore' or 'countersunk'.

**WR2:** The **composite\_hole** shall be the **relating\_shape\_aspect** in exactly two instances of **feature\_-component\_relationship** with a **related\_shape\_aspect** of type **round\_hole**.

**WR3:** If the **description** of the **composite\_hole** is 'countersunk', exactly one **round\_hole** that comprises it shall be a tapered hole.

#### Informal propositions:

**IP1:** Each **round\_holes** that comprise the **composite\_hole** shall not have diameters that are equal in length.

## 4.2.10 compound\_feature

A **compound\_feature** is a type of **feature\_definition** that is the representation of several **instanced\_-features** and their relationships to one another for the purpose of creating unique user defined features.

#### EXPRESS specification:

```

*)
ENTITY compound_feature
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: SIZEOF( QUERY( pds <* USEDIN( SELF,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |

```

```

('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF(pds)) AND
(SIZEOF( QUERY( csa <* USEDIN( pds,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
((csa.name='compound feature in solid') AND
('AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT'
IN TYPEOF(csa))) )) = 1) )) = 1;
WR2: SIZEOF( QUERY( pds <* USEDIN( SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF(pds)) AND
(SIZEOF( QUERY( csa <* USEDIN( pds,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
'AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT'
IN TYPEOF(csa) )) = 1) )) = 1;
WR3: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(( 'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF(pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
(( 'AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT'
IN TYPEOF(csa)) AND
(SIZEOF(QUERY ( fcr <* csa.component_relationships |
(NOT ( 'AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
IN TYPEOF(fcr))) )) = 0)) )) = 1)) )) = 1);
WR4: SIZEOF (QUERY (pds <* USEDIN (SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF (pds)) AND
(SIZEOF (QUERY (csa <* USEDIN (pds,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
('AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT'
IN TYPEOF (csa)) )) = 1) )) = 1;
WR5: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(( 'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF(pds)) AND
(SIZEOF(QUERY ( csa <* USEDIN(pds,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
(( 'AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT'
IN TYPEOF(csa)) AND
(SIZEOF(QUERY ( sar <* csa.component_relationships |
('AIC_MACHINING_FEATURE.THREAD'
IN TYPEOF(sar.related_shape_aspect)) )) = 0)
) )) = 1)) )) = 1);

```

```

WR6: (SIZEOF (QUERY (pds <* USEDIN (SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    ('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
    IN TYPEOF (pds)) AND (SIZEOF (QUERY (csa <* USEDIN (pds,
    'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
    ('AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT'
    IN TYPEOF (csa)) AND
    (SIZEOF (QUERY (sar <* csa.component_relationships |
    (('AIC_MACHINING_FEATURE.COMPOUND_FEATURE'
    IN TYPEOF (sar.related_shape_aspect)) AND
    (sar.related_shape_aspect\characterized_object.name <>
    SELF\characterized_object.name)) )) = 0) )) = 1) )) = 1);
END_ENTITY; -- compound_feature
(*

```

#### Formal propositions:

**WR1:** The **name** of the **compound\_feature** shall be 'compound feature in solid'.

**WR2:** Each instance of **compound\_feature** shall have a shape that has exactly one **shape\_aspect** identified on it that is of type **composite\_shape\_aspect**.

**WR3:** The **shape\_aspect\_relationships** that are used to relate the single features with the **composite\_shape\_aspect** shall be **feature\_component\_relationships**.

**WR4:** The **composite\_shape\_aspect** defining a **compound\_feature** shall be the **relating\_shape\_aspect** only in **shape\_aspect\_relationships**.

**WR5:** The **composite\_shape\_aspect** defining a **compound\_feature** shall be the **relating\_shape\_aspect** only in **shape\_aspect\_relationships** with a **related\_shape\_aspect** that is not of type **thread**.

NOTE - A **thread** feature can not be directly related to a **compound\_feature**. The **applied\_area** of the **thread** is related to a **compound\_feature**.

**WR6:** The **compound\_feature** shall only have constituent **compound\_features** of the same type.

### 4.2.11 direction\_shape\_representation

A **direction\_shape\_representation** is a type of **representation** that represents a direction vector in two or three dimensional space.

EXPRESS specification:

```

*)
ENTITY direction_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: (SIZEOF(SELF.items) = 1);
    WR2: (SIZEOF(QUERY ( it <* SELF.items |
      (NOT (
        'AIC_MACHINING_FEATURE.DIRECTION' IN TYPEOF(it))) ))
      = 0);
END_ENTITY; -- direction_shape_representation
( *

```

Formal propositions:

**WR1:** The **direction\_shape\_representation** shall have exactly one **representation\_item** in its set of **items**.

**WR2:** The geometric element that is used to represent the **direction\_shape\_representation** shall be a **direction**.

## 4.2.12 edge\_round

An **edge\_round** is a type of **transition\_feature** that is the representation of a circular convex transition between two **shape\_aspects**. An **edge\_round** defines the outside profile of a part.

NOTE An Edge\_round is defined in ISO 10303-224:2006, 4.2.73 and a Constant\_radius\_edge\_round is defined in ISO 10303-224:2006, 4.2.44 and defines the requirement for **edge\_round**.

EXPRESS specification:

```

*)
ENTITY edge_round
  SUBTYPE OF (transition_feature);
  WHERE
    WR1: (NOT (SELF\shape_aspect.description = 'constant radius')) OR
      (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
          'AIC_MACHINING_FEATURE.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
            'AIC_MACHINING_FEATURE.SHAPE_REPRESENTATION_WITH_PARAMETERS'
            IN TYPEOF (pdr.used_representation))) = 1))) = 0);
    WR2: (NOT (SELF\shape_aspect.description = 'constant radius')) OR
      (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
          'AIC_MACHINING_FEATURE.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
            'AIC_MACHINING_FEATURE.SHAPE_REPRESENTATION_WITH_PARAMETERS'
            IN TYPEOF (pdr.used_representation)) |
            (NOT (SIZEOF (impl_rep.used_representation.items) >= 1)
              AND (SIZEOF (impl_rep.used_representation.items) <= 3))))
          = 0))) = 0);

```

```

WR3: (NOT (SELF.description = 'constant radius')) OR
      (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'AIC_MACHINING_FEATURE.SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'radius')) = 1))) = 0))) = 0);

WR4: (NOT (SELF.description = 'constant radius')) OR
      (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'AIC_MACHINING_FEATURE.SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'first offset')) <= 1)))
        = 0))) = 0);

WR5: (NOT (SELF.description = 'constant radius')) OR
      (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'AIC_MACHINING_FEATURE.SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'second offset')) <= 1)))
        = 0))) = 0);

WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('AIC_MACHINING_FEATURE.FACE_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation)) AND
        (pdr.used_representation.name = 'edge round face')) <= 1))) = 0;

WR7: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('AIC_MACHINING_FEATURE.FACE_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation)) AND
        (pdr.used_representation.name = 'first face shape')) <= 1))) = 0;

```

```

WR8: SIZEOF (QUERY (pd <* USEDIN (SELF,
    'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
    NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
    'AIC_MACHINING_FEATURE.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    ('AIC_MACHINING_FEATURE.FACE_SHAPE_REPRESENTATION'
    IN TYPEOF (pdr.used_representation)) AND
    (pdr.used_representation.name = 'second face shape')))) <= 1))) = 0;
END_ENTITY; -- edge_round

(*

```

#### Formal propositions:

**WR1:** An **edge\_round** has an implicit representation if and only if it has a **description** of 'constant radius'.

**WR2:** If the description of the **edge\_round** is 'constant radius', the implicit representation shall contain at least one and at most three **representation\_items** in its set of **items**.

**WR3:** If the description of the **edge\_round** is 'constant radius', exactly one **representation\_item** used for the implicit representation of the **edge\_round** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'radius'.

**WR4:** If the description of the **edge\_round** is 'constant radius', at most one **representation\_item** used for the implicit representation of the **edge\_round** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'first offset'.

**WR5:** If the description of the **edge\_round** is 'constant radius', at most one **representation\_item** used for the implicit representation of the **edge\_round** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'second offset'.

**WR6:** The **edge\_round** shall have at most one one **face\_shape\_representation** with a **name** of 'edge round face'.

**WR7:** The **edge\_round** shall have at most one one **face\_shape\_representation** with a **name** of 'first face shape'.

**WR8:** The **edge\_round** shall have at most one one **face\_shape\_representation** with a **name** of 'second face shape'.

### 4.2.13 externally\_defined\_feature\_definition

An **externally\_defined\_feature\_definition** relates the document containing a feature specification to a **feature\_definition**.

NOTE 1 A Catalogue\_gear is defined in ISO 10303-224:2006, 4.2.18, a Catalogue\_knurl is defined in ISO 10303-224:2006, 4.2.19, a Catalogue\_marking is defined in ISO 10303-224:2006, 4.2.20 and a Catalogue\_thread is defined in ISO 10303-224:2006, 4.2.21 and defines the requirements for **externally\_defined\_feature\_definition**.

NOTE 2 Local rules for externally\_defined\_feature\_definition define constrained usage for document\_file, applied\_document\_reference, and applied\_document\_usage\_constraint\_assignment. These entities are defined in the application protocol using this part of ISO 10303. See Annex E for additional information.

#### EXPRESS specification:

\*)

```
ENTITY externally_defined_feature_definition
  SUBTYPE OF (feature_definition, externally_defined_item);
  WHERE
    WR1: (((SELF\characterized_object.description = 'thread') AND
      (SELF\externally_defined_item.item_id='external thread') AND
      (SELF\externally_defined_item.source.source_id=
        'external feature specification')) OR
      ((SELF\characterized_object.description = 'gear') AND
      (SELF\externally_defined_item.item_id='external gear') AND
      (SELF\externally_defined_item.source.source_id=
        'external feature specification')) OR
      ((SELF\characterized_object.description = 'marking') AND
      (SELF\externally_defined_item.item_id='external marking') AND
      (SELF\externally_defined_item.source.source_id=
        'external feature specification')) OR
      ((SELF\characterized_object.description = 'knurl') AND
      (SELF\externally_defined_item.item_id='external knurl') AND
      (SELF\externally_defined_item.source.source_id=
        'external feature specification')));
    WR2: ((NOT (SELF\characterized_object.description = 'thread')) OR
      (SIZEOF( QUERY( pd <* USEDIN( SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        SIZEOF( QUERY( pdr <* USEDIN( pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('AIC_MACHINING_FEATURE.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF(pdr.used_representation)) AND
        ({5 <= SIZEOF(pdr.used_representation.items) <= 10} ) ) )
        = 1 ) ) = 1));
    WR3: ((NOT (SELF\characterized_object.description = 'marking')) OR
      (SIZEOF( QUERY( pd <* USEDIN( SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        SIZEOF( QUERY( pdr <* USEDIN( pd,
        'AIC_MACHINING_FEATURE.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('AIC_MACHINING_FEATURE.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF(pdr.used_representation)) AND
```

```

        (SIZEOF(pdr.used_representation.items) = 2) )) = 1 )) = 1));
WR4: ((NOT (SELF\characterized_object.description = 'knurl')) OR
(SIZEOF( QUERY( pd <* USEDIN( SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
SIZEOF( QUERY( pdr <* USEDIN( pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) AND
(SIZEOF(pdr.used_representation.items) = 1) )) = 1 )) = 1));
WR5: (NOT (SELF\characterized_object.description IN [ 'knurl',
'thread']))) OR
(SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN
(pds, 'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
((sa_occ.description = 'partial area occurrence') AND
(SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
+ 'RELATED_SHAPE_ASPECT') |
((sar.description = 'applied area usage') AND
(('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP'
IN TYPEOF(sar))) ) |
('AIC_MACHINING_FEATURE.APPLIED_AREA'
IN TYPEOF(sdr.relatng_shape_aspect)) )) = 1)) )) <= 1)) )) = 0);

WR6: ((NOT (SELF\characterized_object.description = 'marking')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESCRPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'marking text')) )) = 1)) ))
= 0)) )) = 0));
WR7: ((NOT (SELF\characterized_object.description = 'thread')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESCRPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'removal direction') AND
((it.description = 'internal') OR
(it.description = 'external')))) )) = 1)) )) = 0)) )) = 0));
WR8: ((NOT (SELF\characterized_object.description = 'thread')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,

```

```

'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESRIPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'qualifier')) ))<= 1)) ))= 0)) ))
= 0));
WR9: ((NOT (SELF\characterized_object.description = 'thread')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESRIPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'hand')) )) = 1)) )) = 0)) ))
= 0));
WR10: ((NOT (SELF\characterized_object.description = 'thread')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESRIPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'fit class')) )) = 1)) )) =
0)) )) = 0));
WR11: ((NOT (SELF\characterized_object.description = 'thread')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESRIPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'form')) )) = 1)) )) = 0)) ))
= 0));
WR12: ((NOT (SELF\characterized_object.description = 'thread')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +

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```

'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'major diameter')) )) <= 1)) ))
= 0)) )) = 0));
WR13: ((NOT (SELF\characterized_object.description = 'thread')) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.RATIO_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'number of threads')) )) = 1)) ))
= 0)) )) = 0));
WR14: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN( pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESCRPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'fit class 2')) )) <= 1)) )) = 0)) ))
= 0);
WR15: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT']
* TYPEOF(it)) = 2) AND (it.name = 'nominal size')) ))
<= 1)) )) = 0)) )) = 0);
WR16: (NOT (SELF\characterized_object.description IN [ 'knurl',
'gear', 'thread'])) OR
(SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
('AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN

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(pds, 'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
((SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
+ 'RELATED_SHAPE_ASPECT') |
((sar.description = 'applied shape') AND
(('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP')
IN TYPEOF(sar))) ) |
('AIC_MACHINING_FEATURE.SHAPE_ASPECT'
IN TYPEOF(sdr.relatng_shape_aspect)) )) = 1)) )) <= 1)) )) = 0);
WR17: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF( QUERY( pd <* USEDIN( SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
SIZEOF( QUERY( pdr <* USEDIN( pd,
'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS'
IN TYPEOF(pdr.used_representation)) AND
(10 <= SIZEOF(pdr.used_representation.items)) AND
(SIZEOF(pdr.used_representation.items) >= 11)
)) = 1 )) = 1));

WR18: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.RATIO_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'number of teeth')) )) = 1)) ))
= 0)) )) = 0));

WR19: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND
(it.name = 'reference pressure angle')) )) = 1)) ))
= 0)) )) = 0));

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WR20: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'rake shift factor')) )) = 1)) ))
= 0)) )) = 0));

WR21: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'nominal tooth depth')) )) = 1)) ))
= 0)) )) = 0));

WR22: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'face width')) )) = 1)) ))
= 0)) )) = 0));

WR23: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN

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(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'tip diameter')) )) = 1)) ))
= 0)) )) = 0));
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WR24: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESCRPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'module or diametral pitch') AND
((it.description = 'module') OR
(it.description = ' diametral pitch')))) )) = 1)) )) = 0)) )) = 0));
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WR25: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND (it.name = 'normal attribute')) )) = 1)) ))
= 0)) )) = 0));
```

```
WR26: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
(('AIC_MACHINING_FEATURE.DESCRPTIVE_REPRESENTATION_ITEM'
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        IN TYPEOF(it)) AND (it.name = 'internal or external gear') AND
        ((it.description = 'internal') OR
        (it.description = 'external')))) )) = 1)) )) = 0)) )) = 0));

WR27: ((NOT (SELF\characterized_object.description
IN ['gear']))) OR
(SIZEOF(QUERY ( pd <* USEDIN(SELF,
'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION') |
(NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
(pd, 'AIC_MACHINING_FEATURE.' +
'PROPERTY_DEFINITION.REPRESENTATION_DEFINITION') |
(('AIC_MACHINING_FEATURE.' +
'SHAPE_REPRESENTATION_WITH_PARAMETERS')
IN TYPEOF(pdr.used_representation)) ) |
(NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
((SIZEOF([
'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
'AIC_MACHINING_FEATURE.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
TYPEOF(it)) = 2) AND
(it.name = 'root fillet radius')) )) <= 1)) ))
= 0)) )) = 0));

END_ENTITY; -- externally_defined_feature_definition
(*

```

#### Formal propositions:

**WR1:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', then the **item\_id** is 'external thread', and the **source\_id** of the **external\_source** referenced by the **source** of the **externally\_defined\_feature\_definition** is 'external feature specification'. If the **description** of the **externally\_defined\_feature\_definition** is 'marking', then the **item\_id** is 'external marking', and the **source\_id** of the **external\_source** referenced by the **source** of the **externally\_defined\_feature\_definition** is 'external feature specification'. If the **description** of the **externally\_defined\_feature\_definition** is 'knurl', then the **item\_id** is 'external knurl', and the **source\_id** of the **external\_source** referenced by the **source** of the **externally\_defined\_feature\_definition** is 'external feature specification'. If the **description** of the **externally\_defined\_feature\_definition** is 'gear', then the **item\_id** is 'external gear', and the **source\_id** of the **external\_source** referenced by the **source** of the **externally\_defined\_feature\_definition** is 'external feature specification'.

**WR2:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', the implicit representation of the **externally\_defined\_feature\_definition** shall contain between five and ten **representation\_items** in its set of **items**.

**WR3:** If the **description** of the **externally\_defined\_feature\_definition** is 'marking', the implicit representation of the **externally\_defined\_feature\_definition** shall contain exactly three **representation\_items** in its set of **items**.

**WR4:** If the **description** of the **externally\_defined\_feature\_definition** is 'knurl', the implicit representation of the **externally\_defined\_feature\_definition** shall contain exactly one **representation\_items** in its set of **items**.

**WR5:** If the **description** of the **externally\_defined\_feature\_definition** is 'marking', or 'thread' there shall be the basis shape for at most one **shape\_aspect** with a **description** of 'partial area occurrence' that is the **related\_shape\_aspect** in at most one **shape\_defining\_relationship** with a **description** of 'applied area usage' in which the **relating\_shape\_aspect** is an **applied\_area**.

**WR6:** If the **description** of the **externally\_defined\_feature\_definition** is 'marking', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **descriptive\_representation\_item** with a **name** of 'marking text'.

**WR7:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', then exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **descriptive\_representation\_item** with a **name** of 'removal direction' and a **description** of either 'internal' or 'external'.

**WR8:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', at most one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **descriptive\_representation\_item** with a **name** of 'qualifier'.

**WR9:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **descriptive\_representation\_item** with a **name** of 'hand'.

**WR10:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', at most one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **descriptive\_representation\_item** with a **name** of 'fit class'.

**WR11:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **descriptive\_representation\_item** with a **name** of 'form'.

**WR12:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', at most one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'major diameter'.

**WR13:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **ratio\_measure\_with\_unit** with a **name** of 'number of threads'.

**WR14:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', at most one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **descriptive\_representation\_item** with a **name** of 'fit class 2'.

**WR15:** If the **description** of the **externally\_defined\_feature\_definition** is 'thread', at most one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'nominal size'.

**WR16:** If the **description** of the **externally\_defined\_feature\_definition** is 'marking', 'gear' or 'thread' there shall be the basis shape for exactly one **shape\_aspect** that is the **related\_shape\_aspect** in at most one **shape\_defining\_relationship** with a description of 'applied shape' in which the **relating\_shape\_aspect** is a **shape\_aspect**.

**WR17:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', the implicit representation of the **externally\_defined\_feature\_definition** shall contain exactly nine **representation\_items** in its set of **items**.

**WR18:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **ratio\_measure\_with\_unit** with a **name** of 'number of teeth'.

**WR19:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **plane\_angle\_measure\_with\_unit** with a **name** of 'reference pressure angle'.

**WR20:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'rake shift factor'.

**WR21:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'nominal tool depth'.

**WR22:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'face width'.

**WR23:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'tip diameter'.

**WR24:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', then exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **descriptive\_representation\_item** with a **name** of 'module or diametral pitch' and a **description** of either 'module' or 'diametral pitch'.

**WR25:** If the **description** of the **externally\_defined\_feature\_definition** is 'gear', exactly one **representation\_item** used for the implicit representation of the **externally\_defined\_feature\_definition** shall be of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'normal attribute'.