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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.

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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;

— 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*

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;

— 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_definition**s.

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_item**s in its set of **items**.

WR4: The implicit representation of an **applied_area** shall contain only **representation_item**s 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.relating_shape_aspect)) AND
         (sdr.relating_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.relating_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.relating_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.relating_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.relating_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.related_shape_aspect))
        AND
        ('AIC_MACHINING_FEATURE.BOSS'
        IN TYPEOF (fcr.relating_shape_aspect))
        AND
        (fcr.related_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.relating_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_item**s.

WR4: The implicit representation of the **boss** shall contain only **representation_item**s 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**closed_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.relating_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.relating_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_representation**s 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.relating_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 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 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_aspect**s 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_relationship**s.

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_item**s 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_item**s 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 definied 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_item**s 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_hole**s 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_hole**s with one having a larger diameter than the second. The countersunk hole is the representation of two **round_hole**s, 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_hole**s 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_-feature**s 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_relationship**s that are used to relate the single features with the **composite_shape_aspect** shall be **feature_component_relationship**s.

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_feature**s 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_item**s 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.relating_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.DESCRIPTIVE_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.DESCRIPTIVE_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,
```



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        '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.DESCRIPTIVE_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.DESCRIPTIVE_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.DESCRIPTIVE_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.DESCRIPTIVE_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.DESCRIPTIVE_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.relating_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));
```

```
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
```



```
      (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));

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.DESCRIPTIVE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND (it.name = 'module or diametral pitch') AND
      ((it.description = 'module') OR
      (it.description = ' diametral pitch'))) )) = 1)) )) = 0)) )) = 0));

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.DESCRIPTIVE_REPRESENTATION_ITEM'
```

```
        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.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 'gerar', 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_item**s 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_item**s 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_-item**s 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_-item**s 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 'diameter 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'.

WR26: 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 'internal or external gear' and a **description** of either 'internal ' or 'external'.

WR27: 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_measure_with_unit** with a **name** of 'root fillet radius'.

Informal proposition:

IP1: If the **name** of the **descriptive_representation_item** is 'fit class' and the first character of the **description** is 'M', then the thread is metric.

4.2.14 face_shape_representation

A **face_shape_representation** is a type of **representation** that represents geometry defined by a portion of an associated surface.

EXPRESS specification:

```
*)
ENTITY face_shape_representation
  SUBTYPE OF (shape_representation);
   WHERE
    WR1: (SIZEOF(SELF.items) >= 1);
    WR2: (SIZEOF(QUERY ( it <* SELF.items | (NOT (
         ('AIC_MACHINING_FEATURE.FACE_SURFACE' IN TYPEOF(it)) OR
         ('AIC_MACHINING_FEATURE.ORIENTED_FACE' IN TYPEOF(it)) ))
          )) = 0);
END_ENTITY; -- face_shape_representation
(*
```

Formal propositions:

WR1: The **face_shape_representation** shall have one or more **representation_item** in its set of **items**.

WR2: The geometric element that is used to represent the **face_shape_representation** shall be a **face_surface**, **oriented_face**.

4.2.15 feature_component_definition

A **feature_component_definition** is a type of **characterized_object** that is used as a constituent of a preconceived form pattern.

EXPRESS specification:

```
*)
ENTITY feature_component_definition
  SUBTYPE OF (characterized_object);
   WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(USEDIN(pd,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE')) = 1)) ))
        = 0);
END_ENTITY; -- feature_component_definition
(*
```

Formal propositions:

WR1: The **feature_component_definition** shall be the item for which exactly one **shape_aspect** is defined.

4.2.16 feature_component_relationship

A **feature_component_relationship** is a kind of **shape_aspect_relationship** in which the **related_shape_aspect** is an implicitly represented component, such as a **taper**, of the **relating_shape_aspect**.

EXAMPLE A Chamfer may have the implicit chamfer offset amount defined with a **feature_component_relationship** and the explicit geometry for the chamfer defined with a **shape_defining_relationship**.

EXPRESS specification:

```
*)
ENTITY feature_component_relationship
    SUPERTYPE OF (ONEOF (pattern_omit_membership,pattern_offset_membership))
  SUBTYPE OF (shape_aspect_relationship);
   WHERE
    WR1: ((SIZEOF([
         'AIC_MACHINING_FEATURE.COMPOSITE_SHAPE_ASPECT',
         'AIC_MACHINING_FEATURE.REPLICATE_FEATURE',
         'AIC_MACHINING_FEATURE.TRANSITION_FEATURE',
         'AIC_MACHINING_FEATURE.MODIFIED_PATTERN'] * TYPEOF
         (SELF.relating_shape_aspect)) = 1) OR
         ('AIC_MACHINING_FEATURE.FEATURE_DEFINITION'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition)) OR
         ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition)));
END_ENTITY; -- feature_component_relationship
(*
```

Formal proposition:

WR1: The **shape_aspect** referenced as the **relating_shape_aspect** shall be of type **replicate_feature**, **transition_feature, composite_shape_aspect**, or **modified_pattern** or shall be an aspect of the shape of a **feature_definition** or a **feature_component_definition**.

4.2.17 feature_definition

A **feature_definition** is a type of **characterized_object** that is a preconceived form pattern.

EXPRESS specification:

```
*)
ENTITY feature_definition
  SUBTYPE OF (characterized_object);
   WHERE
  WR1: SIZEOF(QUERY( pdr <*
       get_property_definition_representations (SELF) |
       'AIC_MACHINING_FEATURE.SHAPE_REPRESENTATION_WITH_PARAMETERS'
       IN TYPEOF ( pdr.used_representation ) ) ) <=1;
  WR2: 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;
  WR3: SIZEOF (['AIC_MACHINING_FEATURE.BOSS',
       'AIC_MACHINING_FEATURE.TURNED_KNURL',
       'AIC_MACHINING_FEATURE.THREAD',
       'AIC_MACHINING_FEATURE.GEAR',
       'AIC_MACHINING_FEATURE.MARKING',
       'AIC_MACHINING_FEATURE.RIB_TOP',
       'AIC_MACHINING_FEATURE.ROUND_HOLE',
       'AIC_MACHINING_FEATURE.OUTSIDE_PROFILE',
       'AIC_MACHINING_FEATURE.POCKET',
       'AIC_MACHINING_FEATURE.REMOVAL_VOLUME',
       'AIC_MACHINING_FEATURE.REVOLVED_PROFILE',
       'AIC_MACHINING_FEATURE.OUTER_ROUND',
       'AIC_MACHINING_FEATURE.FLAT_FACE',
       'AIC_MACHINING_FEATURE.PROTRUSION',
       'AIC_MACHINING_FEATURE.ROUNDED_END',
       'AIC_MACHINING_FEATURE.SLOT',
       'AIC_MACHINING_FEATURE.SPHERICAL_CAP',
       'AIC_MACHINING_FEATURE.STEP',
       'AIC_MACHINING_FEATURE.COMPOUND_FEATURE',
       'AIC_MACHINING_FEATURE.REPLICATE_FEATURE',
       'AIC_MACHINING_FEATURE.EXTERNALLY_DEFINED_FEATURE_DEFINITION']
       * TYPEOF (SELF)) <= 1;
  WR4: (NOT (SIZEOF(['AIC_MACHINING_FEATURE.ROUND_HOLE',
       'AIC_MACHINING_FEATURE.BOSS',
       'AIC_MACHINING_FEATURE.OUTSIDE_PROFILE',
       'AIC_MACHINING_FEATURE.REMOVAL_VOLUME',
       'AIC_MACHINING_FEATURE.FLAT_FACE',
       'AIC_MACHINING_FEATURE.POCKET',
       'AIC_MACHINING_FEATURE.PROTRUSION',
       'AIC_MACHINING_FEATURE.RIB_TOP',
       'AIC_MACHINING_FEATURE.ROUNDED_END',
```

```
       'AIC_MACHINING_FEATURE.SLOT',
       'AIC_MACHINING_FEATURE.STEP'] * TYPEOF(SELF)) = 1))   OR
       ((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;
(*
```

Formal propositions:

WR1: The **feature_definition** shall have exactly one implicit **representation** which shall be of type **shape_representation_with_parameters**.

WR2: Exactly one **representation_item** used for the implicit representation of a **feature_definition** shall be of type **placement** with a **name** of 'orientation'. The **placement** shall define a reference location and orientation for the origin of the **feature_definition**.

WR3: The **feature_definition** may be either a **boss**, **gear, turned_knurl**, **thread**, **marking**, **rib_top**, **round_hole**, **outside_profile**, **pocket**, **removal_volume**, **revolved_profile**, **outer_round**, **flat_face**, **protrusion**, **rounded_end**, **slot**, **spherical_cap**, **step**, **compound_feature**, **replicate_feature**, or **externally_defined_feature_definition**.

WR4: If the **feature_definition** is a **boss**, **outside_profile**, **flat_face**, **removal_volume**, **protrusion**, **pocket**, **rib_top**, **round_hole**, **rounded_end**, **slot**, or **step** the **instance_feature** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

4.2.18 feature_pattern

A **feature_pattern** is a type of **replicate_feature** that relates a base feature and one or more **shape_-aspect**s which are the placement of the base feature at a specified location on the base part.

EXPRESS specification:

```
*)
ENTITY feature_pattern
  SUBTYPE OF (replicate_feature);
   WHERE
    WR1: 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 ('AIC_MACHINING_FEATURE.PLACEMENT'
         IN TYPEOF(srwp_i)) )) > 0 ) ))   > 0  )) = 0;
```



```
    WR2: 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 = 'base feature placement'))) > 1)))
         = 0))) = 0;
END_ENTITY; -- feature_pattern
(*
```

Formal propositions:

WR1: The implicit representation of a **feature_pattern** shall only contain **representation_item**s in its set of **items** that are of type **placement**.

WR2: The **feature_pattern** shall have an implicit representation defined by a **shape_representation_-with_parameters** which contains one or more **representation_item**s in its set of **items** of type **placement** with the name of 'base feature placement'.

4.2.19 fillet

A **fillet** is a type of **transition_feature** that is the representation of a circular concave transition between two **shape_aspects**. A **fillet** defines the outside profile of a part.

NOTE A Fillet is defined in ISO 10303-224:2006, 4.2.81 and a Constant_radius_fillet is defined in ISO 10303-224:2006, 4.2.45 and defines the requirement for **fillet**.

EXPRESS specification:

```
*)
ENTITY fillet
  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 = 'fillet 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;
(*
```

Formal propositions:

WR1: A **fillet** has an implicit representation if and only if it has a **description** of 'constant radius'.

WR2: If the description of the **fillet** is 'constant radius', the implicit representation shall contain at least one and at most three **representation_item**s in its set of **items**.

WR3: If the description of the **fillet** is 'constant radius', exactly one **representation_item** used for the implicit representation of the **fillet** shall be of type **measure_representation_item** and **length_-measure_with_unit** with a **name** of 'radius'.

WR4: If the description of the **fillet** is 'constant radius', at most one **representation_item** used for the implicit representation of the **fillet** shall be of type **measure_representation_item** and **length_-measure_with_unit** with a **name** of 'first offset'.

WR5: If the description of the **fillet** is 'constant radius', at most one **representation_item** used for the implicit representation of the **fillet** shall be of type **measure_representation_item** and **length_-measure_with_unit** with a **name** of 'second offset'.

WR6: The **fillet** shall have exactly one **face_shape_representation** with a **name** of 'fillet face'.

WR7: The **fillet** shall have exactly one **face_shape_representation** with a **name** of 'first face shape'.

WR8: The **fillet** shall have exactly one **face_shape_representation** with a **name** of 'second face shape'.

4.2.20 flat_face

A **flat_face** is a type of **feature_definition** that is the representation of a volume that is removed from the base shape. This removal shall be planar and representation shall be a **linear_profile** moving along a linear **path_feature_component**.

NOTE A Planar_face is defined in ISO 10303-224:2006, 4.2.171 and defines the requirement for **flat_face**.

EXPRESS specification:

```
*)
ENTITY flat_face
  SUBTYPE OF (feature_definition);
   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.DIRECTION_SHAPE_REPRESENTATION'
         IN TYPEOF(pdr.used_representation)) AND
         (pdr.used_representation.name = 'removal direction')) )) = 1)) ))
         = 0);
    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 = 'course of travel 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.relating_shape_aspect)) AND
         (sdr.relating_shape_aspect.description = 'linear') AND
         (sdr.name = 'course of travel')) )) = 1)) )) = 1)) )) = 0);
    WR3: (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 = 'removal 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))) ) |
         (('AIC_MACHINING_FEATURE.LINEAR_PROFILE'
         IN TYPEOF(sdr.relating_shape_aspect)) AND
         (sdr.name = 'removal boundary')) )) = 1)) )) = 1)) )) = 0);
    WR4: 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.CIRCULAR_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.NGON_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.RECTANGULAR_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.CLOSED_PATH_PROFILE'] *
        TYPEOF (sdr.relating_shape_aspect)) = 1) AND
        (sdr.relating_shape_aspect.description = 'boundary')))
        = 1))) <= 1))) = 0;
    WR5: 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;
    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
        (csa.name='uncut volume') AND
        (SIZEOF(QUERY ( sar <* csa.component_relationships |
        (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar)) AND (SIZEOF([
        'AIC_MACHINING_FEATURE.BOSS',
        'AIC_MACHINING_FEATURE.PROTRUSION'] * TYPEOF(sar.
        related_shape_aspect)) = 1)) )) = 1)) )) <= 1)) )) = 1;
    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.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'removal depth'))) <= 1)))
        = 0))) = 0;

END_ENTITY; -- flat_face
(*
```

Formal proposition:

WR1: The **flat_face** shall have exactly one **direction_shape_representation** with a **name** of 'removal direction'.

WR2: The **flat_face** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'course of travel occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'path feature component usage' and a **name** of 'course of travel' and a **relating_shape_aspect** that references a **path_feature_component** with a **description** of 'linear'.

WR3: The **flat_face** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'removal boundary occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **name** of 'removal boundary' and a **relating_shape_aspect** that references a **linear_profile**.

WR4: The **flat_face** shall be the basis shape for at most 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' and a **name** of 'boundary' and a **relating_shape_aspect** that references a **circular_closed_profile**, **ngon_closed_profile**, **rectangular_closed_profile**, or **closed_path_profile**.

WR5: The **flat_face** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

WR6: The **flat_face** shall have the uncut volume defined by exactly one **product_definition_shape** that is referenced by zero or more **composite_shape_aspect** with **name** of 'uncut volume' through the **of_shape**' attribute that references a **feature_component_relationship** through the **component_relationships** attribute that references either a **boss** or a **protrusion**.

WR7: The implicit representation of the **flat_face** shall have at most one **representation_item** of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'removal depth'.

Informal propositions:

IP1: The location of the **flat_face** shall be defined at one of the corners of the removal volume.

IP2: The direction of volume removal of the **flat_face** shall be in the Z direction.

IP3: The origin, X direction, and Y direction of the **path_feature_component** shall be equal to that of the **flat_face**.

IP4: The origin, X direction, Y direction of the **flat_face** shall be equal to that of the **linear_profile**.

4.2.21 gear

A **gear** is a type of **feature_definition** that is the representation of a gear shape that is applied to all or a portion of a **shape_aspect**. See ARM definition for Gear in paragraph for more information.

NOTE A Gear is defined in ISO 10303-224:2006, 4.2.88 and defines the requirement for **gear**.

EXPRESS specification:

```
*)

ENTITY gear
SUBTYPE OF (feature_definition);
WHERE
  WR1: 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) <= 13))) = 1)) = 1;

  WR2: NOT (SELF\characterized_object.description
       IN ['straight bevel gear', 'helical bevel gear',
       'spur gear', 'helical 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);

  WR3: NOT (SELF\characterized_object.description
       IN ['straight bevel gear', 'helical bevel gear',
       'spur gear', 'helical 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);

  WR4: NOT (SELF\characterized_object.description
       IN ['straight bevel gear', 'helical bevel gear',
       'spur gear', 'helical 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 = 'profile shift'))) = 1))) = 0))) = 0);

  WR5: NOT (SELF\characterized_object.description
       IN ['straight bevel gear', 'helical bevel gear',
       'spur gear', 'helical 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);

  WR6: NOT (SELF\characterized_object.description
       IN ['straight bevel gear', 'helical bevel gear',
       'spur gear', 'helical 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);

  WR7: NOT (SELF\characterized_object.description
       IN ['straight bevel gear', 'helical bevel gear',
       'spur gear', 'helical 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 = 'tip diameter'))) = 1))) = 0))) = 0);
```



```
 WR8: NOT (SELF\characterized_object.description
      IN ['straight bevel gear', 'helical bevel gear',
      'spur gear', 'helical 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.DESCRIPTIVE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND
      (it.name = 'module or diametral pitch') AND
      ((it.description ='module') OR (it.description = 'diametral pitch'))))
      = 1))) = 0))) = 0);

 WR9: NOT (SELF\characterized_object.description
      IN ['straight bevel gear', 'helical bevel gear',
      'spur gear', 'helical 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.DESCRIPTIVE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND
      (it.name = 'internal or external gear') AND
      ((it.description ='internal') OR (it.description = 'external'))))
      = 1))) = 0))) = 0);

WR10: NOT (SELF\characterized_object.description
      IN ['straight bevel gear', 'helical bevel gear',
      'spur gear', 'helical 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);

 WR11: NOT (SELF\characterized_object.description
      IN ['straight bevel gear', 'helical bevel gear',
      'spur gear', 'helical 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 = 'root fillet radius'))) <= 1))) = 0))) = 0);

WR12: NOT (SELF\characterized_object.description
      IN ['helix gear','helical bevel 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 helix angle'))) = 1))) = 0))) =  0);

WR13: NOT (SELF\characterized_object.description
      IN ['helix gear','helical bevel 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.DESCRIPTIVE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND (it.name = 'gear tooth') AND
      ((it.description = 'left hand tooth') OR
      (it.description = 'right hand tooth')))) = 1))) = 0))) = 0);

WR14: NOT (SELF\characterized_object.description
      IN ['straight bevel gear','helical bevel 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 = 'tip angle'))) = 1))) = 0))) =   0);

WR15: NOT (SELF\characterized_object.description
      IN ['straight bevel gear','helical bevel 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 = 'root angle'))) = 1))) = 0))) =  0);

 WR16: 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.' +
        '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.relating_shape_aspect))) = 1)) = 1))) = 0;

END_ENTITY;
(*
```

Formal propositions:

WR1: The implicit representation of the **gear** shall contain between ten and thirteen **representation_item**s.

WR2: Exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_representation_item** and **ratio_measure_with_unit** with a **name** of 'number of teeth'.

WR3: Exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'reference pressure angle'.

WR4: Exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'profile shift'.

WR5: Exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'nominal tooth depth'.

WR6: Exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'face width'.

WR7: Exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'tip diameter'.

WR8: Exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **descriptive_representation_item** with a **name** of 'module or diametral pitch' and a **description** of either 'module' or 'diametral pitch'.
WR9: Exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **descriptive_representation_item** with a **name** of 'internal or external gear' and a **description** of either 'internal ' or 'external pitch'.

WR10: Exactly one representation_item used for the implicit representation of the gear shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'normal attribute'.

WR11: Either zero or one **representation_item** used for the implicit representation of the gear shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'root fillet radius'.

WR12: If the **gear** has a **description** of either 'helex gear', or 'helex bevel gear', exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_-representation_item** and **length_measure_with_unit** with a **name** of 'reference helix angle'.

WR13: If the **gear** has a **description** of either 'helex gear', or 'helex bevel gear', exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **descriptive_-representation_item** with a **name** of 'gear tooth' and a **description** of either 'left hand' or 'right hand'.

WR14: If the **gear** has a **description** of either 'straight bevel gear', or 'helex bevel gear', exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_-representation_item** and **plane_measure_with_unit** with a **name** of 'root angle'.

WR15: If the **gear** has a **description** of either 'straight bevel gear', or 'helex bevel gear', exactly one **representation_item** used for the implicit representation of the **gear** shall be of type **measure_-representation_item** and **plane_measure_with_unit** with a **name** of 'tip angle'.

WR17: Exactly one **gear** 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**.

Informal propositions:

IP1: The location of the **gear** shall be at a distance from the end of a cylindrical face, and on the axis of the cylindrical face.

IP2: The Z direction of the **gear** shall be in the direction of the center axis of the cylindrical face.

4.2.22 hole_bottom

A **hole_bottom** is a type of **shape_aspect** that is the representation of the end condition for a hole **feature_definition**.

NOTE A Blind_bottom_condition is defined in ISO 10303-224:2006, 4.2.9 and a Through_bottom_condition is defined in ISO 10303-224:2006, 4.2.249 and defines the requirement for **hole_bottom**.

EXPRESS specification:

```
*)
ENTITY hole_bottom
  SUBTYPE OF (shape_aspect);
   WHERE
    WR1: ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF(SELF.of_shape.definition));
    WR2: (SELF.description IN ['through', 'flat', 'flat with radius',
         'flat with taper','spherical', 'conical']);
    WR3: ((NOT (SELF.description = 'through')) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(USEDIN(pd,
         'AIC_MACHINING_FEATURE.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 0)) ))
          = 0));
    WR4: ((NOT (SELF.description IN ['flat with radius',
         'flat with taper', 'spherical','conical'])) 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));
   WR5: ((NOT (SELF.description = 'flat')) 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) = 0)) ))
         = 0)) )) = 0));
   WR6: ((NOT (SELF.description IN ['flat with radius','spherical']))
        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)) ))
        = 0)) )) = 0));
   WR7: ((NOT (SELF.description = 'flat with taper')) 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) = 2)) ))
        = 0)) )) = 0));
   WR8: ((NOT (SELF.description = 'conical')) 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) <= 2)) ))
        = 0)) )) = 0));
   WR9: ((SELF.description = 'through') OR
        (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATING_SHAPE_ASPECT') |
        ((sar.description = 'hole bottom usage') AND
        ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar))) ) |
        ((fcr.name IN ['hole depth start','hole depth end'])) )) >= 1));
  WR10: ((NOT (SELF.description = 'flat with 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 = 'corner radius')))) = 1)) ))
        = 0)) )) = 0));
  WR11: ((NOT (SELF.description = 'spherical')) 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));
  WR12: ((NOT (SELF.description = 'conical')) 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 = 'tip radius')) )) <= 1)) ))
      = 0)) )) = 0));
WR13: ((NOT (SELF.description = 'conical')) 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 = 'tip angle')) )) = 1)) ))
      = 0)) )) = 0));
WR14: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATING_SHAPE_ASPECT') |
      ((sar.description = 'hole bottom usage') AND
      ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF(sar))) ) |
      ((fcr.related_shape_aspect.description
      ='bottom condition occurrence')
      AND ('AIC_MACHINING_FEATURE.ROUND_HOLE'
      IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)) AND
      ('AIC_MACHINING_FEATURE.HOLE_BOTTOM'
      IN TYPEOF(fcr.relating_shape_aspect)))
      )) >= 1);
WR15: ((NOT (SELF.description = 'flat with taper')) 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 = 'final diameter')))) = 1)) ))
      = 0)) )) = 0));
```

```
  WR16: ((NOT (SELF.description = 'flat with taper')) 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 =  'taper diameter')) )) = 1)) ))
        = 0)) )) = 0));
 END_ENTITY; -- hole_bottom
 (*
```

Formal propositions:

WR1: The **hole_bottom** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **description** of the **hole_bottom** shall be either 'through', 'flat', 'flat with radius', 'flat with taper', 'spherical', or 'conical'.

WR3: If the **description** of the **hole_bottom** is 'through', the **hole_bottom** shall not have any representation.

WR4: If the **description** of the **hole_bottom** is 'flat with radius', 'spherical', or 'conical', the **hole_bottom** shall have exactly one **shape_representation_with_parameters** to specify its implicit representation.

WR5: If the **description** of the **hole_bottom** is 'flat', the **hole_bottom** shall be represented implicitly by exactly zero **representation_item**.

WR6: If the **description** of the **hole_bottom** is 'flat with radius' or 'spherical', the **hole_bottom** shall be represented implicitly by exactly one **representation_item**s.

WR7: If the **description** of the **hole_bottom** is 'flat with taper', the **hole_bottom** shall be represented implicitly by exactly two **representation_item**s.

WR8: If the **description** of the **hole_bottom** is 'conical', the **hole_bottom** shall be represented implicitly by at least one and at most two **representation_item**s.

WR9: If the **description** of the **hole_bottom** is not 'through ', the **feature_component_relationship** that refers to it, shall have a **name** of either 'hole depth start ' or 'hole depth end '.

WR10: If the **description** of the **hole_bottom** is 'flat with radius', the implicit representation of the **hole_bottom** shall have exactly one **representation_item** in its **items** set which is a **measure_-representation_item** and **length_measure_with_unit** with a **name** of 'corner radius'.

WR11: If the **description** of the **hole_bottom** is 'spherical', the implicit representation of the **hole_-bottom** shall have exactly one **representation_item** in its **items** set which is a **measure_-representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR12: If the **description** of the **hole_bottom** is 'conical', the implicit representation of the **hole_bottom** shall have at most one **representation_item** in its **items** set which is a **measure_representation_item** and **length_measure_with_unit** with a **name** of 'tip radius'.

WR13: If the **description** of the **hole_bottom** is 'conical', the implicit representation of the **hole_bottom** shall have exactly one **representation_item** in its **items** set which is a **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'tip angle'.

WR14: The **hole_bottom** shall be the **relating_shape_aspect** in at least one **feature_component_relationship** with a **description** of 'hole bottom usage' in which the **related_shape_aspect** is an aspect of the shape of a **round_hole** with a **description** of 'bottom condition occurrence'.

WR15: If the **description** of the **hole_bottom** is 'flat with taper', the implicit representation of the **hole_bottom** shall have exactly one **representation_item** in its **items** set which is a **measure_representation_item** and **length_measure_with_unit** with a **name** of 'final diameter'.

WR16: If the **description** of the **hole_bottom** is 'flat with taper', the implicit representation of the **hole_bottom** shall have exactly one **representation_item** in its **items** set which is a **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'taper diameter'.

Informal propositions:

IP1: The location of the **hole_bottom** shall be at the center of the circular face that is the mating face to a **hole** feature for **spherical**, **conical**, and **flat** hole bottom types. For **flat_with_radius** and **flat_with_taper**, the location shall be at the absolute bottom.

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

4.2.23 instanced_feature

An **instanced_feature** is a type of **shape_aspect** and of **feature_definition** that is the representation of a preconceived pattern for the machining application purpose.

EXPRESS specification:

```
*)
ENTITY instanced_feature
  SUBTYPE OF (feature_definition, shape_aspect);
WHERE
  WR1: 'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION' IN
       TYPEOF (SELF.of_shape.definition);
  WR2: SELF.product_definitional;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **instanced_feature** shall be an aspect of the shape of a **product_definition**.

WR2: The **instanced_feature** shall lie on the boundary of the part.

Informal propositions:

IP1: If an **instanced_feature** has a **shape_representation** and if the **product_definition_shape** that is referenced as **of_shape** by the **instanced_feature** has a **shape_representation** then these **shape_representation**s shall have the same **geometric_representation_context**.

4.2.24 linear_profile

A **linear_profile** is a type of **shape_aspect** that is the representation of a straight line with orientation and location.

NOTE A Linear_profile is defined in ISO 10303-224:2006, 4.2.119 and defines the requirement for **linear_profile** .

EXPRESS specification:

```
*)
ENTITY linear_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 = 'profile length')) )) = 1)) ))
        = 0)) )) = 0);
END_ENTITY; -- linear_profile
(*
```

Formal propositions:

WR1: The **linear_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **linear_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 **linear_profile** shall contain two **representation_item**s in its set of **items**.

WR4: Exactly one **representation_item** used for the implicit representation of a **linear_profile** shall be of type **placement** with a **name** of 'orientation'.

WR5: Exactly one **representation_item** used for the implicit representation of a **linear_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'profile length'.

Informal propositions:

IP1: The location of the **linear_profile** shall be one end of the profile.

IP2: The X direction of the **linear_profile** shall be defined coincident to the X direction of the mating feature.

4.2.25 location_shape_representation

A **location_shape_representation** is a type of **representation** that represents a geometric position or a reference point.

EXPRESS specification:

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

Formal propositions:

WR1: The **location_shape_representation** shall have exactly one **representation_item** in its set of **items**.

WR2: The geometric element that is used to represent the **location_shape_representation** shall be a **point**.

4.2.26 marking

A **marking** is a type of **feature_definition** that is the representation of a text or symbol shapes that are applied to all or a portion of a **shape_aspect**.

NOTE A Defined_marking is defined in ISO 10303-224:2006, 4.2.60 and defines the requirement for **marking**.

EXPRESS specification:

```
*)
ENTITY marking
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: 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
         ({2 <= SIZEOF(pdr.used_representation.items) <=6} ) ))
         = 1 )) = 1;
    WR2: (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.DESCRIPTIVE_REPRESENTATION_ITEM'
```



```
     IN TYPEOF(it)) AND (it.name = 'marking text')) )) = 1)) ))
     = 0)) )) = 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(QUERY ( it <* impl_rep.used_representation.items |
     (('AIC_MACHINING_FEATURE.DESCRIPTIVE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND (it.name = 'special instructions')) )) <= 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.DESCRIPTIVE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND (it.name = 'font name')))) <= 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 = 'character height')) )) <= 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 |
     ((SIZEOF([
     'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
     'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'character spacing')) )) <= 1)) ))
     = 0)) )) = 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') |
         ((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.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
END_ENTITY; -- marking
(*
```

Formal propositions:

WR1: The implicit representation of the **marking** shall contain between two and six **representation_item**s.

WR2: Exactly one **representation_item** used for the implicit representation of the **marking** shall be of type **descriptive_representation_item** with a **name** of 'marking text'.

WR3: At most one **representation_item** used for the implicit representation of the **marking** shall be of type **descriptive_representation_item** with a **name** of 'special instructions'.

WR4: At most one **representation_item** used for the implicit representation of the **marking** shall be of type **descriptive_representation_item** with a **name** of 'font name'.

WR5: At most one **representation_item** used for the implicit representation of the **marking** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'character height'.

WR6: At most one **representation_item** used for the implicit representation of the **marking** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'character spacing'.

WR7: Exactly one **marking** 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**.

4.2.27 modified_pattern

A **modified_pattern** is a type of **shape_aspect** that represents the result of a collection of omissions and offsets of a base feature in either a **rectangular_pattern** or a **circular_pattern**.

EXPRESS specification:

```
*)
ENTITY modified_pattern
  SUBTYPE OF (shape_aspect);
   WHERE
    WR1: 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)) |
        (SIZEOF(
        ['AIC_MACHINING_FEATURE.REPLICATE_FEATURE',
        'AIC_MACHINING_FEATURE.INSTANCED_FEATURE'] *
        TYPEOF (fcr.related_shape_aspect.of_shape.definition)) >= 1)  AND
        (fcr.description = 'base shape')) ) = 1;
   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)) |
        (SIZEOF(
        ['AIC_MACHINING_FEATURE.CIRCULAR_PATTERN',
        'AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'] *
        TYPEOF(fcr.related_shape_aspect.of_shape.definition)) = 1) AND
        (fcr.description = 'base pattern')) ) = 1;
   WR3: SIZEOF(QUERY ( sar <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATING_SHAPE_ASPECT') |
        (SIZEOF(QUERY ( msar <* USEDIN(sar.related_shape_aspect,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        (SIZEOF([
        'AIC_MACHINING_FEATURE.PATTERN_OFFSET_MEMBERSHIP',
        'AIC_MACHINING_FEATURE.PATTERN_OMIT_MEMBERSHIP'] *
        TYPEOF(sar)) = 1) AND (sar.description='modified pattern')
        AND (sar :<>: msar) )) >= 1) )) = 0;
END_ENTITY; -- modified_pattern
(*
```

Formal propositions:

WR1: The **modified_pattern** shall be the **relating_shape_aspect** in exactly one **shape_aspect_-relationship** that is of type **feature_component_relationship** with a name of 'base shape' and a **related_shape_aspect** that is either of type **replicate_feature** or **instanced_feature**.

WR2: The **modified_pattern** shall be the **relating_shape_aspect** in exactly one **shape_aspect_-relationship** and has the **description** of 'base pattern', with a **related_shape_aspect** that references either a **circular_pattern** or a **rectangular_pattern**.

WR3: The **modified_pattern** shall be the **related_shape_aspect** in at least one **shape_aspect_-relationship** and has the **description** of 'modified pattern', in which the **related_shape_aspect** is the **related_shape_aspect** in a different instance of **shape_aspect_relationship** that is either a **pattern_-offset_membership** or **pattern_omit_membership**.

4.2.28 ngon_closed_profile

A **ngon_closed_profile** is a type of **shape_aspect** that represents an enclosed 2D area with location and orientation. The enclosed area is defined by three or more straight sides. The location is defined to be at the center of the enclosed area, and the orientation of the **ngon_closed_profile** is the X-Y plane with the X direction parallel to one of the sides of the ngon.

NOTE A Ngon_profile is defined in ISO 10303-224:2006, 4.2.141 and defines the requirement for **ngon_closed_-profile**.

EXPRESS specification:

```
*)
ENTITY ngon_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) >= 3)
         AND (SIZEOF(impl_rep.used_representation.items) <= 4)))) = 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 |
         (srwp_i.name = 'orientation') OR
         (srwp_i.name = 'number of sides') OR
         (srwp_i.name = 'circumscribed diameter') OR
         (srwp_i.name = 'corner radius') OR
         (srwp_i.name = 'diameter across flats')))
         = 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 |
        ('AIC_MACHINING_FEATURE.PLACEMENT' IN TYPEOF (it)) AND
        (it.name = 'orientation'))) = 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 sides'))) = 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.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND
        (it.name IN ['circumscribed diameter','diameter across flats']) ))
        = 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 |
        (SIZEOF
        (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND
        (it.name = 'corner radius'))) <= 1))) = 0))) = 0;
  END_ENTITY;
(*
```

Formal propositions:

WR1: The **ngon_closed_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **ngon_closed_profile** shall have exactly one implicit representation defined by a **shape_-representation_with_parameters**.

WR3: The **shape_representation_with_parameters** that represents the **ngon_closed_profile** shall contain at least three and at most four **representation_item**s in its set of **items**.

WR4: The implicit representation of an **ngon_closed_profile** shall contain only **representation_item**s in its set of **items** with a **name** of 'orientation', 'number of sides', 'diameter across flats', 'circumscribed diameter', and 'corner radius'.

WR5: Exactly one **representation_item** used for the implicit representation of a **ngon_closed_profile** shall be of type **placement** with a **name** of 'orientation'.

WR6: Exactly one **representation_item** used for the implicit representation of a **ngon_closed_profile** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'number of sides'.

WR7: Exactly one **representation_item** used for the implicit representation of a **ngon_closed_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'circumscribed diameter' or 'diameter across flats'.

WR8: At most one **representation_item** used for the implicit representation of a **ngon_closed_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'corner radius'.

Informal propositions:

IP1: The location of the **ngon_closed_profile** shall be defined at the center of the enclosed area.

IP2: The **ngon_closed_profile** shall be defined in the X-Y plane with one of the sides of the ngon parallel to the X direction intersecting the negative Y direction.

4.2.29 open_path_profile

An **open_path_profile** is a type of **shape_aspect** that represents a connected set of curves with a location and orientation. The start vertex and end vertex for the set of curves do not connect creating an area open on one side. The **open_path_profile** orientation is in the X-Y plane.

NOTE A General_path is defined in ISO 10303-224:2006, 4.2.94 and defines the requirement for **open_path_-profile** .

EXPRESS specification:

```
*)
ENTITY open_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);
    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.PLANAR_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation))AND
         (pdr.used_representation.name = 'profile limit') )) <= 1))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **open_path_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **open_path_profile** shall have exactly one implicit representation defined by a **shape_-representation_with_parameters**.

WR3: The **shape_representation_with_parameters** that represents the **open_path_profile** shall contain at least one and at most two **representation_item**s in its set of **items**.

WR4: Exactly one **representation_item** used for the implicit representation of an **open_path_profile** shall be of type **placement** with a **name** of 'orientation'.

WR5: The **open_path_profile** shall have exactly one **path_shape_representation**.

WR6: The **open_path_profile** shall have at most one **planar_shape_representation** with a **name** of 'profile limit'.

Informal propositions:

IP1: The **open_path_profile** shall be defined in the X-Y plane.

4.2.30 outer_round

An **outer_round** is a type of **feature_definition** that is the representation of a volume that is removed from the base shape. The **outer_round** may be represented in one of two ways. This first shall be a removal of a cylindrical volume represented by a diameter about the Z direction of the **feature_definition** placement axis. It may have a change in diameter which is represented by a **taper**. The second shall be a removal of a cylindrical volume represented by sweeping a **vee_profile** about the Z direction of the **feature_definition** placement axis.

NOTE A Outer_diameter is defined in ISO 10303-224:2006, 4.2.151 and a Outer_diameter_to_shoulder is defined in ISO 10303-224:2006, 4.2.152 and defines the requirement for **outer_round** .

EXPRESS specification:

```
*)
ENTITY outer_round
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: ((NOT (SELF\characterized_object.description = 'outer diameter')) 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) = 3) )) = 1 )) = 1));
    WR2: ((NOT (SELF\characterized_object.description
         = 'outer diameter to shoulder')) 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
         ({2 <= SIZEOF(pdr.used_representation.items) <= 3}) )= 1 )= 1));
```



```
WR3: (SELF\characterized_object.description IN
     ['outer diameter', 'outer diameter to shoulder']);
WR4: ((NOT (SELF\characterized_object.description = 'outer diameter')) 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 = 'length')) )) = 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);
WR6: ((NOT (SELF\characterized_object.description
     = 'outer diameter to shoulder')) 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 = 'v-shape 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))) ) |
     (('AIC_MACHINING_FEATURE.VEE_PROFILE'
     IN TYPEOF(sdr.relating_shape_aspect)) AND
     (sdr.relating_shape_aspect.description = 'v-shape')) )) = 1)) ))
     = 1)) )) = 0));
WR7: ((NOT (SELF\characterized_object.description = 'outer diameter')) 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 = 'reduced size occurrence') AND
```

```
          (SIZEOF(QUERY ( sdr <* 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(sdr.relating_shape_aspect)) AND
          ('AIC_MACHINING_FEATURE.OUTER_ROUND'
          IN TYPEOF(sdr.related_shape_aspect.of_shape.definition)) AND
          (sdr.name = 'reduced size'))
          ))  = 1)) ))
          <= 1)) )) = 0));
    WR8: ((NOT (SELF\characterized_object.description =
          'outer diameter to shoulder')) 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 = 'length')) )) <= 1)) ))
          = 0)) )) = 0));
    WR9: ((NOT (SELF\characterized_object.description =
          'outer diameter to shoulder')) 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 = 'feature length')) )) <= 1)) ))
          = 0)) )) = 0));
END_ENTITY; -- outer_round
(*
```

Formal proposition:

WR1: The implicit representation of the **outer_round** with **name** 'outer diameter' shall contain exactly three **representation_item**s.

WR2: The implicit representation of the **outer_round** with **name** 'outer diameter to shoulder' shall contain zero or one **representation_item**s.

WR3: The **outer_round** shall have a description of either 'outer diameter' or 'outer diameter to shoulder'.

WR4: If the description of the **outer_round** is 'outer diameter', exactly one **representation_item** used for the implicit representation of the **outer_round** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'length'.

WR5: Exactly one **representation_item** used for the implicit representation of the **outer_round** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'diameter'.

WR6: If the description of the **outer_round** is 'outer diameter to shoulder', the **outer_round** shall be the basis shape for at most one **shape_aspect** with a **description** of 'v-shape boundary occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_shape_aspect** that references a **vee_profile** with a **description** of 'v-shape'.

WR7: If the description of the **outer_round** is 'outer diameter', the **outer_round** shall be the basis shape for at most one **shape_aspect** with a description of 'reduced size occurrence' that is the **related_-shape_aspect** in exactly one **feature_component_relationship** with a **description** of 'taper usage' and a **relating_shape_aspect** that references a **taper** with a **description** of 'reduced size'.

WR8: If the description of the **outer_round** is 'outer diameter to shoulder', zero or one **representation_-item** used for the implicit representation of the **outer_round** shall be of type **measure_representation_-item** and **length_measure_with_unit** with a **name** of 'length'.

WR9: If the description of the **outer_round** is 'outer diameter to shoulder', zero or one **representation_-item** used for the implicit representation of the **outer_round** shall be of type **measure_representation_-item** and **length_measure_with_unit** with a **name** of 'feature length'.

Informal propositions:

IP1: The location of the **outer_round** shall be defined at a position in the Z direction.

IP2: The Z direction of the **outer_round** is the axis of revolution.

IP3: If the description of the **outer_round** is 'outer diameter to shoulder', the placement of the **vee_-profile** shall be along the X direction of the **outer_round** at a specified distance from the origin. The orientation of the **vee_profile** shall be in the same direction in the Y axis. The Y axis of the vee_profile shall be in the same direction as the X axis of the **outer_round**.

4.2.31 outside_profile

An **outside_profile** is a type of **feature_definition** that is the representation of the outside boundary of the base shape. This boundary may be enclosed and have either a rectangular base shape that is represented by a **rectangular_closed_profile** or it may have a non-rectangular base shape that is represented by either a **ngon_closed_profile**, **rectangular_closed_profile**, **closed_path_profile**, or a **circular_closed_profile**. If the boundary is not enclosed the base shape would be defined by a **linear_-profile**, **square_u_profile**, **partial_circular_profile**, **round_u_profile**, **vee_profile**, **tee_profile**, or an **open_path_profile**.

NOTE A General_outside_profile is defined ISO 10303-224:2006, 4.2.93, Shape_profile is defined in ISO 10303-224:2006, 4.2.220, Circular_closed_shape_profile is defined in ISO 10303-224:2006, 4.2.26, Partial_circular_-shape_profile is defined in ISO 10303-224:2006, 4.2.162, General_shape_profile is defined in ISO 10303-224:2006, 4.2.102, Rectangular_closed_shape_profile is defined in ISO 10303-224:2006, 4.2.197, and a Rectangular_open_-shape_profile is defined in ISO 10303-224:2006, 4.2.201. and defines the requirement for **outside_profile**.

EXPRESS specification:

```
*)
ENTITY outside_profile
  SUBTYPE OF (feature_definition);
   WHERE
   WR1: 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;
   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 IN ['boundary occurrence',
        'non-planar boundary occurrence',
        'partial circular boundary occurrence',
        'closed circular boundary occurrence',
        'open rectangular boundary occurrence',
        'closed rectangular boundary occurrence']) )) =1)  ))=0;
   WR3: (NOT(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 = 'boundary occurrence') )) =1)  ))=0))  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') |
```



```
      (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.CIRCULAR_CLOSED_PROFILE',
      'AIC_MACHINING_FEATURE.NGON_CLOSED_PROFILE',
      'AIC_MACHINING_FEATURE.RECTANGULAR_CLOSED_PROFILE',
      'AIC_MACHINING_FEATURE.CLOSED_PATH_PROFILE',
      'AIC_MACHINING_FEATURE.SQUARE_U_PROFILE',
      'AIC_MACHINING_FEATURE.PARTIAL_CIRCULAR_PROFILE',
      'AIC_MACHINING_FEATURE.ROUNDED_U_PROFILE',
      'AIC_MACHINING_FEATURE.LINEAR_PROFILE',
      'AIC_MACHINING_FEATURE.VEE_PROFILE',
      'AIC_MACHINING_FEATURE.TEE_PROFILE',
      'AIC_MACHINING_FEATURE.OPEN_PATH_PROFILE'] *
      TYPEOF (sdr.relating_shape_aspect)) = 1) AND
      (sdr.relating_shape_aspect.description = 'outside boundary')))
      = 1))) = 1))) = 0);
WR4: (NOT(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 IN ['complex boundary occurrence',
      'partial circular boundary occurrence',
      'closed circular boundary occurrence',
      'open rectangular boundary occurrence',
      'closed rectangular boundary occurrence']) ))=1)   ))=0)) 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') |
      NOT(SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (sar.description = 'profile floor usage') AND
      ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF (sar))) |
      (('AIC_MACHINING_FEATURE.PROFILE_FLOOR'
      IN TYPEOF (sdr.relating_shape_aspect)) AND
      ('AIC_MACHINING_FEATURE.OUTSIDE_PROFILE'
      IN TYPEOF (sdr.related_shape_aspect.of_shape.definition)))
      )) = 1))) = 0))) = 0);
WR5: (NOT(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 IN ['outside boundary',
      'complex boundary occurrence',
      'partial circular boundary occurrence',
```

```
        'closed circular boundary occurrence',
        'open rectangular boundary occurrence',
        'closed rectangular boundary occurrence']) ))=1)   ))=0)) 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') |
        (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))) |
        (SIZEOF (['AIC_MACHINING_FEATURE.PATH_FEATURE_COMPONENT'] *
        TYPEOF (sdr.relating_shape_aspect)) = 1) AND
        (sdr.name = 'profile swept shape') AND
        (sdr.relating_shape_aspect.description='linear') ))  = 1)))
        = 1))) = 0);
   WR6: (NOT(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 = 'complex boundary occurrence') ))
        =1)  ))=0))  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') |
        (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.CIRCULAR_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.NGON_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.RECTANGULAR_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.CLOSED_PATH_PROFILE',
        'AIC_MACHINING_FEATURE.SQUARE_U_PROFILE',
        'AIC_MACHINING_FEATURE.PARTIAL_CIRCULAR_PROFILE',
        'AIC_MACHINING_FEATURE.ROUNDED_U_PROFILE',
        'AIC_MACHINING_FEATURE.VEE_PROFILE',
        'AIC_MACHINING_FEATURE.TEE_PROFILE',
        'AIC_MACHINING_FEATURE.LINEAR_PROFILE',
        'AIC_MACHINING_FEATURE.OPEN_PATH_PROFILE'] *
        TYPEOF (sdr.relating_shape_aspect)) =1))  )
        = 1)))= 1))) = 0);
   WR7: (NOT(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 circular boundary occurrence') ))
      =1)  ))=0))  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') |
      (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.PARTIAL_CIRCULAR_PROFILE' IN
      TYPEOF (sdr.relating_shape_aspect))))
      = 1)))= 1))) = 0);
WR8: (NOT(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 = 'closed circular boundary occurrence') ))
      =1)  ))=0))  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') |
      (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.relating_shape_aspect))))
      = 1)))= 1))) = 0);
WR9: (NOT(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 = 'open rectangular boundary occurrence') ))
      =1)  ))=0))  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') |
      (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.SQUARE_U_PROFILE' IN
        TYPEOF (sdr.relating_shape_aspect))))
        = 1)))= 1))) = 0);
  WR10: (NOT(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 = 'closed rectangular boundary occurrence') ))
        =1)  ))=0))  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') |
        (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.relating_shape_aspect)) )) = 1)))
        = 1))) = 0);
  WR11: (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 IN ['boundary occurrence',
        'complex boundary occurrence',
        'partial circular boundary occurrence',
        'closed circular boundary occurrence',
        'open rectangular boundary occurrence',
        'closed rectangular boundary occurrence']) )) =1)  ))=0) 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)) AND
        (pdr.used_representation.name = 'removal direction')) )) = 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; -- outside_profile
(*
```

Formal proposition:

WR1: The implicit representation of the **outside_profile** shall contain exactly one **representation_item**.

WR2: The **outside_profile** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'boundary occurrence' , 'complex boundary occurrence', 'partial circular boundary occurrence', 'closed circular boundary occurrence', 'open rectangular boundary occurrence', or 'closed rectangular boundary occurrence'.

WR3: If the **outside_profile** has a **shape_aspect** with a **description** of 'boundary occurrence', then the **shape_aspect** is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_shape_aspect** that references a **circular_closed_profile**, **ngon_closed_profile**, **rectangular_closed_profile**, **closed_path_profile**, **square_u_profile**, **partial_-circular_profile**, **rounded_u_profile**, **linear_profile**, **vee_profile**, **tee_profile**, or **open_path_profile** with a **description** of 'outside boundary'.

WR4: If the **outside_profile** has a **shape_aspect** with a **description** of 'complex boundary occurrence', 'partial circular boundary occurrence', 'closed circular boundary occurrence', 'open rectangular boundary occurrence', 'closed rectangular boundary occurrence', then the **outside_profile** shall be the basis shape for exactly one **shape_aspect** that is the **related_shape_aspect** in exactly one **feature_component_-relationship** with a **description** of 'profile floor usage' and a **relating_shape_aspect** that references a **profile_floor**.

WR5: If the **outside_profile** has a **shape_aspect** with a **description** of 'outside boundary', 'complex boundary occurrence', 'partial circular boundary occurrence', 'closed circular boundary occurrence', 'open rectangular boundary occurrence', 'closed rectangular boundary occurrence', then the **outside_profile** shall be the basis shape for exactly one **shape_aspect** that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'path feature component usage' and a **relating_-shape_aspect** that references a **path_feature_component** with a **description** of 'linear'.

WR6: If the **outside_profile** has a **shape_aspect** with a **description** of 'complex boundary occurrence', then the **outside_profile** shall be the basis shape for exactly one **shape_aspect** that is the **related_-shape_aspect** in exactly one **shape_defining_relationship** with a **description** of of 'profile usage' in which the **relating_shape_aspect** is either a **circular_closed_profile**, **ngon_closed_profile**, **rectangular_closed_profile**, **closed_path_profile**, **square_u_profile**, **partial_circular_profile**, **rounded_u_profile**, **vee_profile**, **tee_profile**, **linear_profile**, or **open_path_profile**.

WR7: If the **outside_profile** has a **shape_aspect** with a **description** of 'partial circular boundary occurrence', then the **outside_profile** shall be the basis shape for exactly one **shape_aspect** 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 **partial_circular_profile**.

WR8: If the **outside_profile** has a **shape_aspect** with a **description** of 'closed circular boundary occurrence', then the **outside_profile** shall be the basis shape for exactly one **shape_aspect** 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**.

WR9: If the **outside_profile** has a **shape_aspect** with a **description** of 'open rectangular boundary occurrence', then the **outside_profile** shall be the basis shape for exactly one **shape_aspect** 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 **square_u_profile**.

WR10: If the **outside_profile** has a **shape_aspect** with a **description** of 'closed rectangular boundary occurrence', then the **outside_profile** shall be the basis shape for exactly one **shape_aspect** 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**.

WR11: If the **outside_profile** has a **shape_aspect** with a **description** of 'complex boundary occurrence', 'partial circular boundary occurrence', 'closed circular boundary occurrence', 'open rectangular boundary occurrence', 'closed rectangular boundary occurrence', then the **outside_profile** shall have exactly one **direction_shape_representation** with a **name** of 'removal direction'.

WR12: The **outside_profile** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

Informal propositions:

IP1: The **outside_profile** shall be linear along the Z-axis of the feature.

IP2: The origin, X direction, Y direction of the **profile** that defines the shape of the **outside_profile** shall be with the X and Y axes equal to those specified by the placement of the **outside_profile**.

4.2.32 partial_circular_profile

A **partial_circular_profile** is a type of **shape_aspect** that is the representation of arc of constant radius, with a location and a position. The **partial_circular_profile** is located at the arc origin , the X direction starts at the arc origin in the direction of one of the arc end points and the Y direction orthogonal in the direction of volume removal.

NOTE A Partial_circular_profile is defined in ISO 10303-224:2006, 4.2.161 and defines the requirement for **partial_circular_profile** .

EXPRESS specification:

```
*)
ENTITY partial_circular_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) >= 3)) ))
        = 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 = 'radius')))) = 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 |
        ((SIZEOF([
        'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'sweep angle')) )) = 1)) ))
        = 0)) )) = 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.PLANAR_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation))AND
         (pdr.used_representation.name = 'profile limit'))) <= 1))) = 0;
END_ENTITY; -- partial_circular_profile
(*
```

Formal propositions:

WR1: The **partial_circular_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **partial_circular_profile** shall have exactly one implicit representation defined by a **shape_-representation_with_parameters**.

WR3: The **shape_representation_with_parameters** that represents the **partial_circular_profile** shall contain at least three and at most four **representation_item**s in its set of **items**.

WR4: Exactly one **representation_item** used for the implicit representation of a **partial_circular_-profile** shall be of type **placement** with a **name** of 'orientation'.

WR5: Exactly one **representation_item** used for the implicit representation of a **partial_circular_-profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR6: Exactly one **representation_item** used for the implicit representation of a **partial_circular_-profile** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'sweep angle'.

WR7: The **partial_ciruclar_profile** shall have at most one **planar_shape_representation** with a **name** of 'profile limit'.

Informal propositions:

IP1: The location of the **partial_circular_profile** shall be at the arc origin.

IP2: The **partial_circular_profile** shall be defined with the X direction starting at the arc origin in the direction of one of the arc end points and the Y direction orthogonal.

4.2.33 path_feature_component

A **path_feature_component** is a type of **shape_aspect** that is the representation 2D or 3D curve or set of curves.

NOTE A Path is defined in ISO 10303-224:2006, 4.2.163 and defines the requirement for **path_feature_-component** .

EXPRESS specification:

```
*)
ENTITY path_feature_component
  SUBTYPE OF (shape_aspect);
   WHERE
    WR1: ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF(SELF.of_shape.definition));
    WR2: (SELF.description IN ['partial circular','complete circular',
         'linear','complex']);
    WR3: ((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.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 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: ((NOT (SELF.description = 'partial circular')) 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) = 3)) ))
         = 0)) )) = 0));
    WR6: ((NOT (SELF.description = 'partial circular')) 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));
    WR7: ((NOT (SELF.description = 'partial circular')) 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 = 'sweep angle')) )) = 1)) ))
      = 0)) )) = 0));
    WR8: ((NOT (SELF.description = 'complete circular')) 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) = 2)) ))
      = 0)) )) = 0));
    WR9: ((NOT (SELF.description = 'complete circular')) 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));
   WR10: ((NOT (SELF.description = 'linear')) 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) = 2)) ))
      = 0)) )) = 0));
   WR11: ((NOT (SELF.description = 'linear')) 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 = 'distance')) )) = 1)) ))
        = 0)) )) = 0));
   WR12: ((NOT (SELF.description = 'linear')) 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));
   WR13: ((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.PATH_SHAPE_REPRESENTATION'
        IN TYPEOF(pdr.used_representation)) AND
        (pdr.used_representation.name = 'sweep path')AND
        (SIZEOF( QUERY( srwp_i <* pdr.used_representation.items |
        (srwp_i.name = 'profile shape') )) = 1)
        ) )) = 1)) )) = 0));
END_ENTITY; -- path_feature_component
(*
```

Formal propositions:

WR1: The **path_feature_component** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **description** for the **path_feature_component** shall be either 'partial circular', 'complete circular', 'linear', or 'complex'.

WR3: If the **description** of the **path_feature_component** is 'complex', the **path_feature_component** shall have its implicit representation specified by exactly one **shape_representation_with_parameters**.

WR4: The **path_feature_component** shall have one **representation_item** used for the implicit representation specified by a **shape_representation_with_parameters**. This **shape_representation_with_parameters** shall contain exactly one **representation_item** of type **placement** with a **name** of 'orientation'.

WR5: If the **description** of the **path_feature_component** is 'partial circular', the **path_feature_component** shall have an implicit representation that contains exactly three **representation_item**s in its set of **items**.

WR6: If the **description** of the **path_feature_component** is 'partial circular', exactly one **representation_item** used for the implicit representation of the **path_feature_component** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR7: If the **description** of the **path_feature_component** is 'partial circular', exactly one **representation_item** used for the implicit representation of the **path_feature_component** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'sweep angle'.

WR8: If the **description** of the **path_feature_component** is 'complete circular', the **path_feature_component** shall have an implicit representation that contains exactly two **representation_item**s in its set of **items**.

WR9: If the **description** of the **path_feature_component** is 'complete circular', exactly one **representation_item** used for the implicit representation of the **path_feature_component** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR10: If the **description** of the **path_feature_component** is 'linear', the **path_feature_component** shall have an implicit representation that contains exactly two **representation_item**s in its set of **items**.

WR11: If the **description** of the **path_feature_component** is 'linear', exactly one **representation_item** used for the implicit representation of the **path_feature_component** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'distance'.

WR12: If the **description** of the **path_feature_component** is 'linear', the **path_feature_component** shall have exactly one **direction_shape_representation**..

WR13: If the **description** of the **path_feature_component** is 'complex', the **path_feature_component** shall have exactly one **path_shape_representation** with a **name** of 'sweep path'. This **path_shape_representation** shall contain exactly one **representation_item** with a **name** of 'profile shape'.

Informal propositions:

IP1: The location of the **path_feature_component** may be the same location used by the feature that references **path_feature_component**.

IP2: The origin, X direction, and Y direction of the **path_feature_component** may be the same as that used by the feature that references **path_feature_component**.

4.2.34 path_shape_representation

A **path_shape_representation** is a type of **representation** which represents a curved path using an ordered collection of geometric curves such that the collection of curves are continuous and directed.

EXPRESS specification:

```
*)
ENTITY path_shape_representation
  SUBTYPE OF (shape_representation);
   WHERE
    WR1: (SIZEOF(SELF.items) >= 1);
    WR2: (SIZEOF(QUERY ( i <* SELF.items | (SIZEOF([
         'AIC_MACHINING_FEATURE.BOUNDED_CURVE',
         'AIC_MACHINING_FEATURE.EDGE_CURVE',
         'AIC_MACHINING_FEATURE.PATH'] * TYPEOF(i)) =
         1) )) >= 1);
END_ENTITY; -- path_shape_representation
(*
```

Formal propositions:

WR1: The **path_shape_representation** shall have one or more **representation_item** in its set of **items**.

WR2: The geometric element that is used to represent the **path_shape_representation** shall be a **bounded_curve**, **edge_curve**,or **path**.

4.2.35 pattern_offset_membership

A **pattern_offset_membership** specifies the relationships necessary to offset a base feature from either a **rectangular_pattern** or a **circular_pattern**.

EXPRESS specification:

```
*)
ENTITY pattern_offset_membership
  SUBTYPE OF (feature_component_relationship);
   WHERE
    WR1: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
         SELF.relating_shape_aspect,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATING_SHAPE_ASPECT') |
         (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
         ((SIZEOF (QUERY( pdr <*(QUERY(pd <* USEDIN
         (fcr.related_shape_aspect.of_shape,
         'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
         'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd))) |
         SIZEOF (['AIC_MACHINING_FEATURE.CIRCULAR_PATTERN',
         'AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN']
         * TYPEOF(pdr.definition))  =1 )) = 0 )) )) = 0);
    WR2: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
         SELF.related_shape_aspect,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
         (fcr.description='modified pattern') AND
```

```
      ('AIC_MACHINING_FEATURE.MODIFIED_PATTERN'
      IN TYPEOF(fcr.relating_shape_aspect)) )) >= 1);
    WR3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
      SELF.related_shape_aspect,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
      (('AIC_MACHINING_FEATURE.MODIFIED_PATTERN'
      IN TYPEOF(fcr.relating_shape_aspect)) AND
      (NOT (SIZEOF(QUERY ( modfcr <* QUERY ( modsar <* USEDIN(
      fcr.relating_shape_aspect,'AIC_MACHINING_FEATURE.' +
      'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') |
      ((SIZEOF(['AIC_MACHINING_FEATURE.CIRCULAR_PATTERN',
      'AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'] *
      TYPEOF(modsar.related_shape_aspect.of_shape.definition)) = 1) AND
      (modsar :<>: fcr)) ) |
      (NOT (modfcr.related_shape_aspect.of_shape.definition :=:
      SELF.relating_shape_aspect.of_shape.definition)) ))
      = 0))) )) = 0);
    WR4: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(USEDIN(pd,'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 2)) )) = 0));
    WR5: ((NOT ('AIC_MACHINING_FEATURE.CIRCULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(USEDIN(pd,'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 1)) )) = 0));
    WR6: ((NOT ('AIC_MACHINING_FEATURE.CIRCULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (NOT (SIZEOF(pdr.used_representation.items) = 2)) )) = 0)) ))
      = 0));
    WR7: ((NOT ('AIC_MACHINING_FEATURE.CIRCULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      '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 = 'index number')) )) = 1)) )) = 0)) )) = 0));
```



```
 WR8: ((NOT ('AIC_MACHINING_FEATURE.CIRCULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      '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.PLANE_ANGLE_MEASURE_WITH_UNIT'
      IN TYPEOF(it)) AND (it.name = 'offset')) )) = 1)) )) = 0)) ))
      = 0));
 WR9: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      '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)) ))
      = 0)) )) = 0));
WR10: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      '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 = 'row index')) )) = 1)) )) = 0)) )) = 0));
WR11: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      '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 = 'column index')) )) = 1)) )) = 0)) )) = 0));
   WR12: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
         '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.LENGTH_MEASURE_WITH_UNIT'
         IN TYPEOF(it)) AND (it.name = 'offset distance')) )) = 1)) ))
         = 0)) )) = 0));
   WR13: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
         '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)) AND
         (pdr.used_representation.name = 'offset direction')) )) = 1)) ))
         = 0));
END_ENTITY; -- pattern_offset_membership
(*
```

Formal propositions:

WR1: The **pattern_offset_membership** shall define an offset relationship for a member of either a **circular_pattern** or a **rectangular_pattern**

WR2: The **shape_aspect** that defines the offset is defined by a **related_shape_aspect** that defines the omission in the **pattern_offset_membership.** This shall be incorporated in at least one basis shape of a **modified_pattern** by a **feature_component_relationship**with a **description** of 'modified pattern'.

WR3: The **pattern_offset_membership** shall define a set of instances such that the **related_shape_-aspect** defines the offset which is used as the **related_shape_aspect** in an instance of a **feature_-component_relationship** that relates the offset to the **modified_pattern** that incorporates all of the offsets for exactly one **circular_pattern** or **rectangular_pattern**.

NOTE Figure 1 depicts the instances defined by this constraint.

WR4: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_-membership** is a **rectangular_pattern**, **it** shall have exactly two **representation**s.

WR5: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_-membership** is a **circular_pattern**, it shall have exactly one **representation**.

WR6: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_-membership** is a **circular_pattern**, the **representation** of the **shape_aspect** referenced by the **related_-shape_aspect** of the **pattern_offset_membership** shall contain two **representation_item**s in its set of **items**.

WR7: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_-membership** is a **circular_pattern**, exactly one **representation_item** used for the representation of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_offset_membership** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'index number'.

WR8: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_-membership** is a **circular_pattern**, exactly one **representation_item** used for the representation of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_offset_membership** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'offset'.

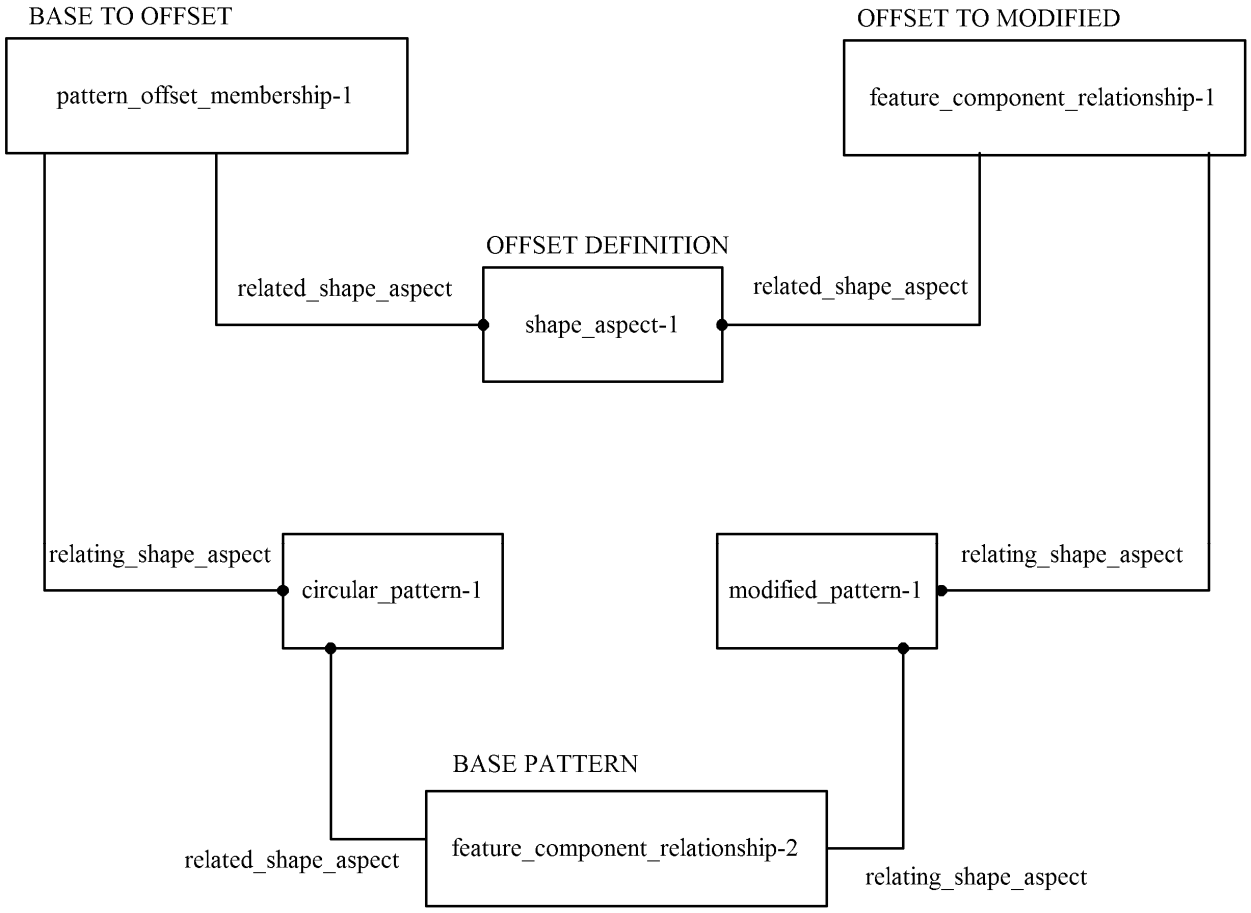

Figure 1 — Pattern offset required instances

WR9: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_-membership** is a **rectangular_pattern**, the **representation** of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_offset_membership** shall contain three **representation_item**s in its set of **items**.

WR10: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_membership** is a **rectangular_pattern**, exactly one **representation_item** used for the representation of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_offset_membership** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'row index'.

WR11: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_membership** is a **rectangular_pattern**, exactly one **representation_item** used for the representation of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_offset_membership** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'column index'.

WR12: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_membership** is a **rectangular_pattern**, exactly one **representation_item** used for the representation of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_offset_membership** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'offset distance'.

WR13: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_offset_membership** is a **rectangular_pattern**, the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_offset_membership** shall have exactly one **direction_shape_representation** with a **name** of 'offset direction'.

4.2.36 pattern_omit_membership

A **pattern_omit_membership** specifies the relationships necessary to omit a base feature from either a **rectangular_pattern** or a **circular_pattern**.

EXPRESS specification:

```
*)
ENTITY pattern_omit_membership
  SUBTYPE OF (feature_component_relationship);
   WHERE
    WR1: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
         SELF.relating_shape_aspect,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATING_SHAPE_ASPECT') |
         (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
         ((SIZEOF (QUERY( pdr <*(QUERY(pd <* USEDIN
         (fcr.related_shape_aspect.of_shape,
         'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
         'AIC_MACHINING_FEATURE.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd))) |
         SIZEOF (['AIC_MACHINING_FEATURE.CIRCULAR_PATTERN',
         'AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN']
         * TYPEOF(pdr.definition))  =1 )) = 0 )) )) = 0);
    WR2: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
         SELF.related_shape_aspect,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
```



```
      (fcr.description='modified pattern') AND
      ('AIC_MACHINING_FEATURE.MODIFIED_PATTERN'
      IN TYPEOF(fcr.relating_shape_aspect)) )) >= 1);
  WR3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
      SELF.related_shape_aspect,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
      (('AIC_MACHINING_FEATURE.MODIFIED_PATTERN'
      IN TYPEOF(fcr.relating_shape_aspect)) AND
      (NOT (SIZEOF(QUERY ( modfcr <* QUERY ( modsar <* USEDIN(
      fcr.relating_shape_aspect,'AIC_MACHINING_FEATURE.' +
      'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') |
      ((SIZEOF(['AIC_MACHINING_FEATURE.CIRCULAR_PATTERN',
      'AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'] *
      TYPEOF(modsar.related_shape_aspect.of_shape.definition)) = 1) AND
      (modsar :<>: fcr)) ) |
      (NOT (modfcr.related_shape_aspect.of_shape.definition :=:
      SELF.relating_shape_aspect.of_shape.definition)) ))
      = 0))) )) = 0);
  WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(USEDIN(pd,'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 1)) )) = 0);
  WR5: ((NOT ('AIC_MACHINING_FEATURE.CIRCULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (NOT (SIZEOF(pdr.used_representation.items) = 1)) )) = 0)) )) = 0));
  WR6: ((NOT ('AIC_MACHINING_FEATURE.CIRCULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      '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 = 'index number')) )) = 1)) )) = 0)) )) = 0));
  WR7: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'AIC_MACHINING_FEATURE.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
      'AIC_MACHINING_FEATURE.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (NOT (SIZEOF(pdr.used_representation.items) = 2)) )) = 0)) )) = 0));
```

```
    WR8: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
         '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 = 'row index')) )) = 1)) )) = 0)) )) = 0));
    WR9: ((NOT ('AIC_MACHINING_FEATURE.RECTANGULAR_PATTERN'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
         '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 = 'column index')) )) = 1)) )) = 0)) )) = 0));
END_ENTITY; -- pattern_omit_membership
 (*
```

Formal propositions:

WR1: The **pattern_omit_membership** shall define an omit relationship for a member of either a **circular_pattern** or a **rectangular_pattern**

WR2: The **related_shape_aspect** that defines the omission in the **pattern_offset_membership** shall be incorporated in at least one basis shape of a **modified_pattern** by a **feature_component_-relationship**with a **description** of 'modified pattern'.

WR3: The **pattern_omit_membership** shall define a set of entity instances such that the **related_-shape_aspect** defines the offset which is used as the **related_shape_aspect** in an instance of a **feature_-component_relationship** that relates the offset to the **modified_pattern** that incorporates all of the offsets for exactly one **circular_pattern** or **rectangular_pattern**.

NOTE Figure 2 depicts the instances defined by this constraint.

WR4: The **shape_aspect** that is referenced by **related_shape_aspect** of the **pattern_omit_membership** shall have exactly one **representation**.

WR5: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_omit_membership** is a **circular_pattern**, the **representation** of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_omit_membership** shall contain one **representation_item** in its set of **items**.

WR6: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_omit_membership** is a **circular_pattern**, exactly one **representation_item** used for the representation of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_omit_membership** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'index number'.

WR7: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_omit_membership** is a **rectangular_pattern**, the **representation** of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_omit_membership** shall contain two **representation_item**s in its set of **items**.

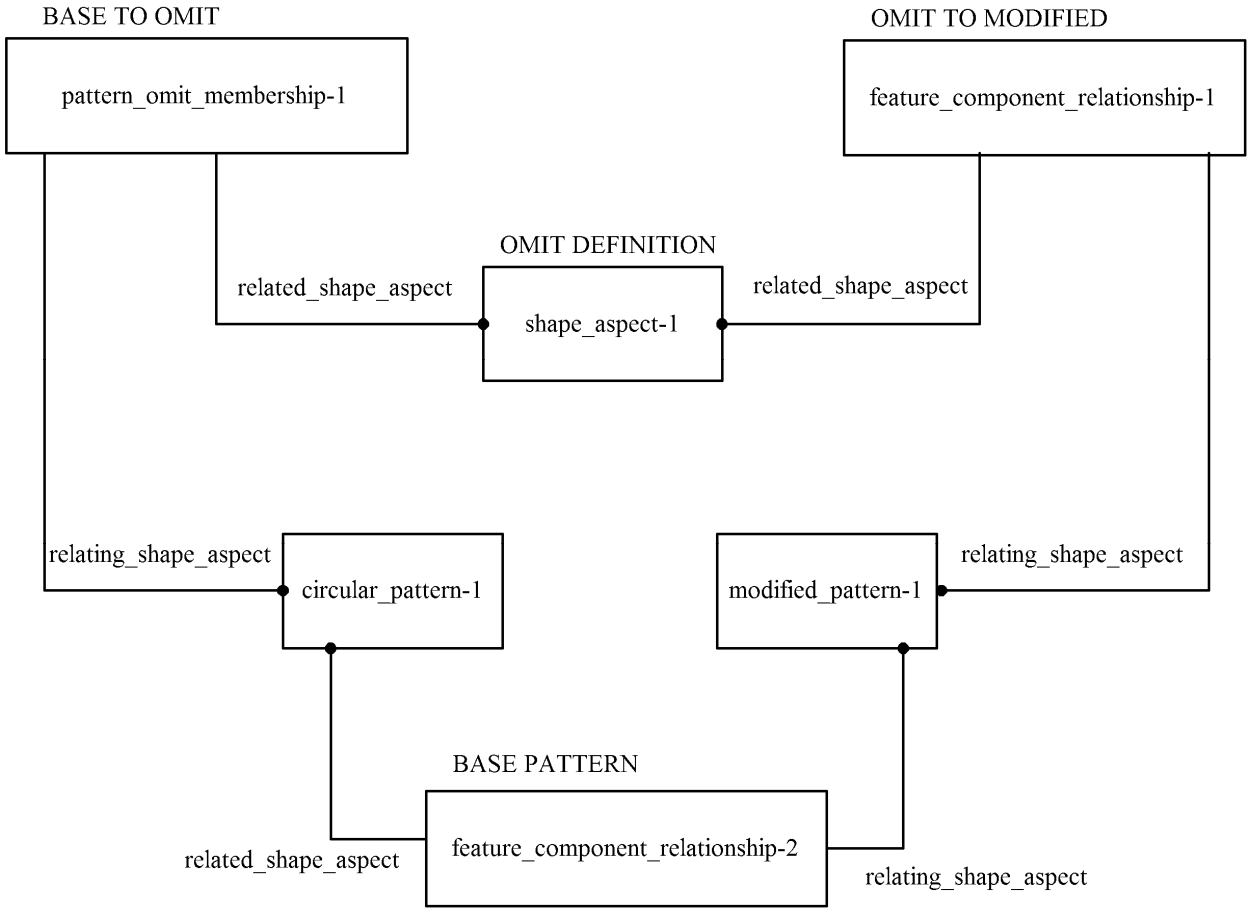

Figure 2 — Pattern omit required instances

WR8: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_omit_membership** is a **rectangular_pattern**, exactly one **representation_item** used for the representation of the **shape_aspect** referenced by the **related_shape_aspect** of the **pattern_omit_membership** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'row index'.

WR9: If the **shape_aspect** referenced by the **relating_shape_aspect** of the **pattern_omit_membership** is a **rectangular_pattern**, exactly one **representation_item** used for the representation of the **shape_-aspect** referenced by the **related_shape_aspect** of the **pattern_omit_membership** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'column index'.

4.2.37 planar_shape_representation

A **planar_shape_representation** is a type of **representation** that represents a direction vector in two or three dimensional space, and location.

EXPRESS specification:

```
*)
ENTITY planar_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
    WR1: SIZEOF (SELF.items) = 1;
    WR2: SIZEOF (QUERY (it <* SELF.items |
        ('AIC_MACHINING_FEATURE.PLANE' IN TYPEOF (it)))) = 1 ;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **planar_shape_representation** shall have exactly one **representation_item** in its set of **items**.

WR2: The geometric element that is used to represent the **planar_shape_representation** shall be a **plane**.

4.2.38 pocket

A **pocket** is a type of **feature_definition** that is the representation of a volume that is removed from the base shape. This volume may be enclosed and have either a rectangular base shape that is represented by a **rectangular_closed_profile** or it may have a non_rectangular base shape that is represented by either a **ngon_closed_profile**, **rectangular_closed_profile**, **closed_path_profile**, or a **circular_closed_profile**. If the volume is not enclosed the base shape would be defined by a **square_u_profile**, **partial_circular_-profile**, **round_u_profile**, **vee_profile**, **tee_profile**, or an **open_path_profile**. The bottom of the pocket is represented by a **pocket_bottom**.

NOTE A Cutout is defined in ISO 10303-224:2006, 4.2.50, Circular_cutout is defined in ISO 10303-224:2006, 4.2.27, General_cutout is defined in ISO 10303-224:2006, 4.2.91, General_pocket is defined in ISO 10303-224:2006, 4.2.96, Recess is defined in ISO 10303-224:2006, 4.2.193, Rectangular_closed_pocket is defined in ISO 10303-224:2006, 4.2.195, or a Rectangular_open_pocket is defined in ISO 10303-224:2006, 4.2.200. and defines the requirement for **pocket**.

EXPRESS specification:

```
*)
ENTITY pocket
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: (SELF\characterized_object.description IN
         ['closed rectangular','open rectangular', 'complex',
         'circular cutout', 'complex cutout', 'recess']);
    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 = 'pocket depth 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
         (sar.name = 'pocket depth') AND
         (('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('AIC_MACHINING_FEATURE.PATH_FEATURE_COMPONENT'
         IN TYPEOF(sdr.relating_shape_aspect)) AND
         (sdr.relating_shape_aspect.description ='linear')) ))
         = 1)) )) = 1)) )) = 0);
    WR3: SIZEOF(QUERY(pdr <* get_property_definition_representations (SELF) |
         ( 'AIC_MACHINING_FEATURE.SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF ( pdr.used_representation ) ) )) =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
         ({1 <= SIZEOF(pdr.used_representation.items) <= 2} ) )) = 1 )) = 1;
    WR5: 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;
    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 = 'fillet radius'))) <= 1)))
        = 0))) = 0;
    WR7: ((NOT (SELF\characterized_object.description IN ['complex',
        'non-circular cutout','recess'])) 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 = '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.CIRCULAR_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.NGON_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.RECTANGULAR_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.CLOSED_PATH_PROFILE',
        'AIC_MACHINING_FEATURE.SQUARE_U_PROFILE',
        'AIC_MACHINING_FEATURE.PARTIAL_CIRCULAR_PROFILE',
        'AIC_MACHINING_FEATURE.ROUNDED_U_PROFILE',
        'AIC_MACHINING_FEATURE.VEE_PROFILE',
        'AIC_MACHINING_FEATURE.TEE_PROFILE',
        'AIC_MACHINING_FEATURE.OPEN_PATH_PROFILE'] *
        TYPEOF(sdr.relating_shape_aspect)) = 1)) )) = 1)) ))
        = 1)) )) = 0));
    WR8: ((NOT (SELF\characterized_object.description =
        'closed 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 = 'closed 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))) ) |
        (('AIC_MACHINING_FEATURE.RECTANGULAR_CLOSED_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect))) )) = 1)) ))
        = 1)) )) = 0));
    WR9: ((NOT (SELF\characterized_object.description = 'open 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 = 'open 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))) ) |
        (('AIC_MACHINING_FEATURE.SQUARE_U_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect))) )) = 1)) ))
        = 1)) )) = 0));
  WR10: (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 = 'bottom condition occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'pocket bottom usage') AND
        (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (('AIC_MACHINING_FEATURE.POCKET_BOTTOM'
        IN TYPEOF(sdr.relating_shape_aspect)) AND
        ('AIC_MACHINING_FEATURE.POCKET'
        IN TYPEOF(sdr.related_shape_aspect.of_shape.definition)))
        )) = 1)) )) = 1)) )) = 0);
  WR11: ((NOT (SELF\characterized_object.description IN ['complex',
        'non-circular cutout','recess'])) 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.relating_shape_aspect)) AND
        ('AIC_MACHINING_FEATURE.POCKET'
        IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)) AND
        (fcr.related_shape_aspect.description
        IN ['angle taper','directed taper']))
        )) = 1)) ))  <= 1)) )) = 0));
  WR12: (NOT (SELF\characterized_object.description = 'circular cutout')) 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))) |
        ('AIC_MACHINING_FEATURE.CIRCULAR_CLOSED_PROFILE'
        IN TYPEOF (sdr.relating_shape_aspect))))
        = 1))) = 1))) = 0);
  WR13: (NOT (SELF\characterized_object.description IN
        ['circular cutout','complex cutout'])) 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 = 'bottom condition occurrence') AND
        (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        (sar.description = 'pocket bottom usage') AND
        ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF (sar))) |
        (('AIC_MACHINING_FEATURE.POCKET_BOTTOM'
        IN TYPEOF (sdr.relating_shape_aspect)) AND
        ('AIC_MACHINING_FEATURE.POCKET'
        IN TYPEOF (sdr.related_shape_aspect.of_shape.definition))AND
        (sdr.relating_shape_aspect.description = 'through') )
        )) = 1))) = 1))) = 0);
  WR14: (NOT (SELF\characterized_object.description = 'recess')) 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 = 'bottom condition occurrence') AND
        (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        (sar.description = 'pocket bottom usage') AND
        ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF (sar))) |
        (('AIC_MACHINING_FEATURE.POCKET_BOTTOM'
        IN TYPEOF (sdr.relating_shape_aspect)) AND
        ('AIC_MACHINING_FEATURE.POCKET'
        IN TYPEOF (sdr.related_shape_aspect.of_shape.definition)) AND
        (sdr.relating_shape_aspect.description IN ['planar','complex']) )
        )) = 1))) = 1))) = 0);
  WR15: 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;

  WR16: ((NOT (SELF\characterized_object.description IN
        ['closed rectangular','open rectangular', 'complex',
        'recess'])) 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
        (csa.name='uncut volume') AND
        (SIZEOF(QUERY ( sar <* csa.component_relationships |
        ((('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar)) AND
        (SIZEOF([
        'AIC_MACHINING_FEATURE.BOSS','AIC_MACHINING_FEATURE.PROTRUSION']
        * TYPEOF(sar.related_shape_aspect))=1)
        ) ))) = 1)) )) <= 1)) )) = 1));

  WR17: ((NOT (SELF\characterized_object.description IN
        ['closed rectangular','open 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.relating_shape_aspect)) AND
        ('AIC_MACHINING_FEATURE.POCKET'
        IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)) AND
        (fcr.related_shape_aspect.description
        IN ['angle taper','directed taper']))
        )) >= 1)) ))  <=1)) )) = 0));

END_ENTITY; -- pocket
(*
```

Formal proposition:

WR1: The **pocket** shall have a description of 'open rectangular', 'closed rectangular', 'complex', 'circular cutout', 'complex cutout', or 'recess'.

WR2: The **pocket** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'pocket depth occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'path feature component usage' and a **name** of 'pocket depth' and a **relating_shape_aspect** that references a **path_feature_component** with a **description** of 'linear'.

WR3: The **pocket** shall have exactly one implicit representation.

WR4: The implicit representation of the **pocket** shall contain between one and two **representation_item**s.

WR5: The implicit representation of the **pocket** shall contain only **representation_item**s that have a name of either 'orientation' or 'fillet radius'.

WR6: The implicit representation of the **pocket** shall have at most one **representation_item** of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'fillet radius'.

WR7: If the **pocket** has a description of 'complex', 'complex cutout', or 'recess', the **pocket** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'boundary occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_shape_aspect** that references a **circular_closed_profile**, **ngon_closed_profile**, **rectangular_closed_profile**, **closed_path_profile**, **square_u_profile**, **partial_circular_profile**, **rounded_u_profile**, **vee_profile**, **tee_profile**, or **open_path_profile**.

WR8: If the **pocket** has a description of 'closed rectangular', the **pocket** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'closed boundary occurrence' that is the **related_shape_-aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_-shape_aspect** that references a **rectangular_closed_profile**.

WR9: If the **pocket** has a description of 'open rectangular', the **pocket** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'open boundary occurrence' that is the **related_shape_-aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_-shape_aspect** that references a **square_u_profile**.

WR10: The **pocket** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'bottom condition occurrence' that is the **related_shape_aspect** in exactly one **feature_component_relationship** with a **description** of 'pocket bottom usage' and a **relating_shape_aspect** that references a **pocket_-bottom**.

WR11: If the **pocket** has a description of 'complex', 'complex cutout', or 'recess', the **pocket** 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'.

WR12: If the **pocket** has a description of 'circular cutout', the **pocket** 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' and a **relating_shape_-aspect** that references a **circular_closed_profile**.

WR13: If the **pocket** has a description of 'circular cutout',or 'complex cutout', the **pocket** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'bottom condition occurrence' that is the **related_shape_aspect** in exactly one **feature_component_relationship** with a **description** of 'pocket bottom usage' and a **relating_shape_aspect** that references a **pocket_bottom** with a **description** of 'through'.

WR14: If the **pocket** has a description of 'recess' the **pocket** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'bottom condition occurrence' that is the **related_shape_aspect** in exactly one **feature_component_relationship** with a **description** of 'pocket bottom usage' and a **relating_shape_aspect** that references a **pocket_bottom** with a **description** of 'planar' or 'complex'.

WR15: The **pocket**shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

WR16: The **pocket** shall have the uncut volume defined by exactly one **product_definition_shape** that is referenced by zero or more **composite_shape_aspect** with **name** of 'uncut volume' through the **of_shape**' attribute that references a **feature_component_relationship** through the **component_relationships** attribute that references either a **boss** or a **protrusion**.

WR17: If the **pocket** has a description of 'open rectangular'or 'closed rectangular' the **pocket** shall be the basis shape for one or more **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'.

Informal propositions:

IP1: The volume removal of the **pocket** shall be in the Z direction.

IP2: The placement of the **circular_closed_profile**, **ngon_closed_profile**, **rectangular_closed_profile**, **closed_path_profile**, **square_u_profile**, **partial_circular_profile**, **rounded_u_profile**, **vee_profile**, **tee_profile**, or **open_path_profile** that defines the shape of the **pocket** shall be with the origin, X direction, and Y direction equal to that of the **pocket**.

IP3: If the **description** of the **pocket** is 'open rectangular', the origin, X direction, Y direction of the **square_u_profile** shall be equal to that of the **pocket**.

IP4: If the **description** of the **pocket** is 'open rectangular'or 'closed rectangular' , and the number of taper usages is greater than one, then the **pocket** side that is intersected by a plane in the X direction shall be have the first **taper** applied. Additional **taper**s shall be applied to the **pocket** walls going in a clockwise direction from the X direction.

4.2.39 pocket_bottom

A **pocket_bottom** is a type of **shape_aspect** that is the representation of the end condition for a **pocket feature_definition**. See ARM definition for Pocket_bottom_condition in clause for more information.

NOTE A Pocket_bottom_condition is defined in ISO 10303-224:2006, 4.2.178, General_pocket_bottom_condition is defined in ISO 10303-224:2006, 4.2.97, Planar_pocket_bottom_condition is defined in ISO 10303-224:2006, 4.2.172, or a Through_pocket_bottom_condition is defined in ISO 10303-224:2006, 4.2.250. and defines the requirement for **pocket_bottom** .

EXPRESS specification:

```
*)
ENTITY pocket_bottom
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: 'AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF (SELF.of_shape.definition);
    WR2: SELF.description IN ['planar', 'complex', 'through'];
    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))  AND
         (pdr.used_representation.name = 'floor normal') )) = 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))  AND
         (pdr.used_representation.name = 'floor location'))) = 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)) AND
         (pdr.used_representation.name = 'floor face') )) = 1)) )) = 0));
    WR6: (NOT (SELF.description IN  ['planar', '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.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation))) = 1))) = 0));
    WR7: (NOT (SELF.description IN  ['planar', 'complex']) 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) )) = 0))) = 0));
```



```
    WR8: (NOT (SELF.description = 'through') 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))) = 0))) = 0));
    WR9: (NOT (SELF.description IN ['planar', 'complex'])) 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);
   WR10: SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (SELF,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         (sar.description = 'pocket bottom usage') AND
         ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF (sar))) |
         ((fcr.related_shape_aspect.description
         = 'bottom condition occurrence')
         AND
         ('AIC_MACHINING_FEATURE.POCKET'
         IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)) AND
         ('AIC_MACHINING_FEATURE.POCKET_BOTTOM'
         IN TYPEOF(fcr.relating_shape_aspect)) )
         )) >= 1;
   WR11: ((NOT (SELF.description IN ['planar','complex'])) OR
         (SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (SELF,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         (sar.description = 'pocket bottom usage') AND
         ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF (sar))) |
         (fcr.related_shape_aspect.description
         = 'bottom condition occurrence')
         AND
         (fcr.related_shape_aspect.name IN
         ['pocket depth start', 'pocket depth end'])
         )) = 0));
END_ENTITY;  -- Pocket_bottom
(*
```

Formal propositions:

WR1: The **pocket_bottom** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **description** of the **pocket_bottom** shall be either 'planar', 'complex', or 'through'.

WR3: If the **description** of the **pocket_bottom** is 'planar', the **pocket_bottom** shall have exactly one **direction_shape_representation** with **name** = 'floor normal'.

WR4: If the **description** of the **pocket_bottom** is 'planar', the **pocket_bottom** shall have exactly one **location_shape_representation** with **name** = 'floor location'.

WR5: If the **description** of the **pocket_bottom** is 'complex', the **pocket_bottom** shall have exactly one **face_shape_representation** with **name** = 'floor'.

WR6: If the **description** of the **pocket_bottom** is 'planar' or 'complex', the **pocket_bottom** shall have its implicit representation specified by exactly one **shape_representation_with_parameters**.

WR7: If the **description** of the **pocket_bottom** is 'planar' or 'complex', the **pocket_bottom** shall be represented implicitly by at most one **representation_item**s.

WR8: If the **description** of the **pocket_bottom** is 'through', the **pocket_bottom** shall have its implicit representation specified by exactly one **shape_representation_with_parameters**.

WR9: If the **description** of the **pocket_bottom** is 'planar' or 'complex', at most one **representation_item** used for the implicit representation of the **pocket_bottom** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR10: The **pocket_bottom** shall be the **relating_shape_aspect** in at least one **feature_component_-relationship** with a **description** of 'pocket bottom usage' in which the **related_shape_aspect** is an aspect of the shape of a **pocket** with a **description** of 'bottom condition occurrence'.

WR11: If the **description** of the **pocket_bottom** is 'planar' or 'complex',the **pocket_bottom** shall be the **relating_shape_aspect** in at least one **feature_component_relationship** with a **description** of 'pocket bottom usage' and with a **name** of 'pocket depth start', or 'pocket depth end.

Informal propositions:

IP1: The location of the **pocket_bottom** shall be at the approximate center of the mating **pocket** feature.

IP2: The **pocket_bottom** shall be defined with the volume removal in Z direction of the **pocket** feature.

4.2.40 profile_floor

A **profile_floor** is a type of **shape_aspect** that is the representation of the bottom condition for an **outside_profile feature_definition**.

NOTE A Profile_floor is defined in ISO 10303-224:2006, 4.2.183, General_profile_floor is defined in ISO 10303-224:2006, 4.2.98,or a Planar_profile_floor is defined in ISO 10303-224:2006, 4.2.173 and defines the requirement for **profile_floor** .

EXPRESS specification:

```
*)
ENTITY profile_floor
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: 'AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF (SELF.of_shape.definition);
    WR2: SELF.description IN ['planar', 'complex', 'through'];
    WR3: (NOT (SELF.description IN ['planar', '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.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation))) = 1))) = 0));
    WR4: (NOT (SELF.description IN  ['planar', 'complex'])) 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) <= 2))) = 0))) = 0);
    WR5: (NOT (SELF.description = 'through') 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))) = 0))) = 0));
    WR6: (NOT (SELF.description IN ['planar', 'complex'])) 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);
    WR7: SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (SELF,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         (sar.description = 'profile floor usage') AND
         ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP' IN
```

```
          TYPEOF (sar))) |
          (('AIC_MACHINING_FEATURE.OUTSIDE_PROFILE' IN TYPEOF
          (fcr.related_shape_aspect.of_shape.definition))AND
          ('AIC_MACHINING_FEATURE.PROFILE_FLOOR' IN TYPEOF
          (fcr.relating_shape_aspect)))
          )) >= 1;
    WR8: ((NOT (SELF.description IN ['planar','complex'])) 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.DESCRIPTIVE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'shape profile floor orientation')
          AND (it.description IN ['shape profile start','shape profile end']))
          )) =  1)) )) = 0)) )) = 0));
    WR9: (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))  AND
          (pdr.used_representation.name='floor'))) = 1))) = 1);
   WR10: (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.PLANAR_SHAPE_REPRESENTATION'
          IN TYPEOF (pdr.used_representation))  AND
          (pdr.used_representation.name='floor'))) = 1))) = 1);
END_ENTITY;   -- profile_floor
(*
```

Formal propositions:

WR1: The **profile_floor** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **description** of the **profile_floor** shall be either 'planar', 'complex', or 'through'.

WR3: If the description of the profile_floor is 'planar' or 'complex', the **profile_floor** shall have its implicit representation specified by exactly one **shape_representation_with_parameters**.

WR4: If the **description** of the **profile_floor** is 'planar' or 'complex', the **profile_floor** shall be represented implicitly by at least one and at most two **representation_item**s.

WR5: If the **description** of the **profile_floor** is 'through', the **profile_floor** the profile_floor shall have its implicit representation specified by exactly zero shape_representation_with_parameters.

WR6: If the **description** of the **profile_floor** is 'planar' or 'complex', at most one **representation_item** used for the implicit representation of the **profile_floor** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR7: The **profile_floor** shall be the **relating_shape_aspect** in at least one **feature_component_relationship** with a **description** of 'profile floor usage' in which the **related_shape_aspect** is an aspect of the shape of a **outside_profile**.

WR8: If the **description** of the **profile_floor** is 'planar' or 'complex', the implicit representation of the **profile_floor** shall have exactly one **representation_item** in its **items** set which is a **descriptive_representation_item** with a **name** of 'shape profile floor orientation' and a **description** of either 'shape profile start', or 'shape profile end'.

WR9: If the **description** of the **profile_floor** is 'complex', the **profile_floor** shall have exactly one **face_shape_representation** with name of 'floor'.

WR10: If the **description** of the **profile_floor** is 'planar', the **profile_floor** shall have exactly one **planar_shape_representation** with name of 'floor'.

4.2.41 protrusion

A **protrusion** is a type of **feature_definition** that is the representation of a volume that is extruding from the base shape. This volume shall be enclosed, except for the mating surface which may or may not be included in the definition of the volume, and have a shape defining representation.

NOTE A Protrusion is defined in ISO 10303-224:2006, 4.2.190 and defines the requirement for **protrusion** .

EXPRESS specification:

```
*)
ENTITY protrusion
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: (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);
    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 = 'shape volume occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
```

```
        ((sar.description = 'volume shape usage') AND
        (('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (sdr.relating_shape_aspect.description = 'volume shape') )) = 1)) ))
        = 1)) )) = 0);
   WR3: 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; -- protrusion
(*
```

Formal proposition:

WR1: The **protrusion** shall have an implicit representation that contains exactly one **representation_item** in its set of **items**.

WR2: The **protrusion** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'shape volume occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'volume shape usage' and **relating_shape_aspect** with a **description** of 'volume shape'.

WR3: The **protrusion** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

Informal propositions:

IP1: The representation of the **shape_aspect** that is the **relating_shape_aspect** in the **shape_defining_relationship** shall define a volume of the **protrusion**.

IP2: The location of the **protrusion** shall be at a position on the base of the feature where it mates with the part.

IP3: The Z direction of the **protrusion** shall be with in a direction away from the part.

4.2.42 rectangular_closed_profile

A **rectangular_closed_profile** is a type of **shape_aspect** that represents an enclosed 2D area with location and orientation. The enclosed area is defined by four straight sides with opposite sides equal in length. The location is defined to be at the center of the rectangle, and the orientation of the **rectangular_closed_profile** is the X-Y plane with the X direction along the length of the rectangle and the Y direction orthogonal to the X direction in the direction of the width.

NOTE A Rectangular_closed_profile is defined in ISO 10303-224:2006, 4.2.196 and defines the requirement for **rectangular_closed_profile** .

EXPRESS specification:

```
*)
ENTITY rectangular_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) >= 3)
     AND (SIZEOF(impl_rep.used_representation.items) <= 4)))) = 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 |
     (srwp_i.name = 'orientation') OR
     (srwp_i.name = 'length') OR
     (srwp_i.name = 'width') OR
     (srwp_i.name = 'corner 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 |
     ('AIC_MACHINING_FEATURE.PLACEMENT' IN TYPEOF (it)) AND
     (it.name = 'orientation'))) = 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 |
     (SIZEOF
     (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
     'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
```

```
          TYPEOF (it)) = 2) AND
          (it.name = 'width'))) = 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.LENGTH_MEASURE_WITH_UNIT'] *
          TYPEOF (it)) = 2) AND
          (it.name = 'length'))) = 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 |
          (SIZEOF
          (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
          'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
          TYPEOF (it)) = 2) AND
          (it.name = 'corner radius'))) <= 1))) = 0))) = 0;
END_ENTITY;  -- rectangular_closed_profile
(*
```

Formal propositions:

WR1: The **rectangular_closed_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **rectangular_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 **rectangular_closed_profile** shall contain at least three and at most four **representation_item**s in its set of **items**.

WR4: The implicit representation of a **rectangular_closed_profile** shall contain only **representation_item**s in its set of **items** with a **name** of 'orientation', 'length', 'width', and 'corner radius'

WR5: Exactly one **representation_item** used for the implicit representation of a **rectangular_closed_profile** shall be of type **placement** with a **name** of 'orientation'.

WR6: Exactly one **representation_item** used for the implicit representation of a **rectangular_closed_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'width'.

WR7: Exactly one **representation_item** used for the implicit representation of a **rectangular_closed_-profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'length'.

WR8: At most one **representation_item** used for the implicit representation of a **rectangular_closed_-profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'corner radius'.

Informal propositions:

IP1: The location of the **rectangular_closed_profile** shall be defined at the center of the rectangle.

IP2: The **rectangular_closed_profile** shall be defined in the X-Y plane with the length in the X direction and the width in the Y direction of the rectangle. The Xdirection is orthogonal to the Y direction.

4.2.43 rectangular_pattern

A **rectangular_pattern** is a type of **replicate_feature** that relates a base feature and one or more **shape_-aspect**s which are the placement of the base feature at a specified row and column location on the base part. A position is defined on the part and a number of base features are equally place in rows and columns.

NOTE A Rectangular_pattern is defined in ISO 10303-224:2006, 4.2.202 and defines the requirement for **rectangular_pattern**.

EXPRESS specification:

```
*)
ENTITY rectangular_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)) )) <= 5)) )) = 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.DIRECTION_SHAPE_REPRESENTATION'
         IN TYPEOF(pdr.used_representation)) AND
         (pdr.used_representation.name = 'row layout direction') ) ))
         = 1)) ))  = 0);
```

```
    WR3: (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)) AND
         (pdr.used_representation.name = 'column layout direction')) ))
         = 1)) )) = 0);
    WR4: (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);
    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(impl_rep.used_representation.items) = 5)) ))
         = 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 rows')) )) = 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.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 columns')) )) = 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 |
        ((SIZEOF([
        'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'row spacing')) )) = 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 = 'column spacing'))))= 1)) ))
        = 0)) )) = 0);
   WR10: (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; -- rectangular_pattern
(*
```

Formal propositions:

WR1: The **rectangular_pattern** shall be the **relating_shape_aspect** in no more than five **shape_-aspect_relationship**s.

WR2: The **rectangular_pattern** shall have exactly one **direction_shape_representation** with a **name** of 'row layout direction'.

WR3: The **rectangular_pattern** shall have exactly one **direction_shape_representation** with a **name** of 'column layout direction'.

WR4: The **rectangular_pattern** shall have exactly one implicit representation.

WR5: The implicit representation of the **rectangular_pattern** shall contain five **representation_item**s in its set of **items**.

WR6: The implicit representation of the **rectangular_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 rows'.

WR7: The implicit representation of the **rectangular_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 columns'.

WR8: The implicit representation of the **rectangular_pattern** shall contain exactly one **representation_item** of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'row spacing'.

WR9: The implicit representation of the **rectangular_pattern** shall contain exactly one **representation_item** of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'column spacing'.

WR10: The implicit representation of the **rectangular_pattern** shall contain exactly one **representation_item** of type **placement** with a **name** of 'orientation'.

Informal propositions:

IP1: The location of the **rectangular_pattern** shall be defined at the position of the first base feature.

IP2: The **rectangular_pattern** shall be defined in the X-Y plane.

4.2.44 removal_volume

A **removal_volume** is a type of **feature_definition** that is the representation of a volume that is removed from the base shape. This volume may or may not be enclosed but in either case shall have a shape defining representation.

NOTE A General_removal_volume is defined in ISO 10303-224:2006, 4.2.99 and defines the requirement for **removal_volume** .

EXPRESS specification:

```
*)
ENTITY removal_volume
  SUBTYPE OF (feature_definition);
   WHERE

    WR1: (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);
```



```
    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 = 'shape volume occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'volume shape usage') AND
         (('AIC_MACHINING_FEATURE.' +
         'SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (sdr.relating_shape_aspect.description = 'volume shape') )) = 1)) ))
         = 1)) )) = 0);
END_ENTITY; -- removal_volume
(*
```

Formal proposition:

WR1: The **removal_volume** shall have an implicit representation that contains exactly one **representation_item** in its set of **items**.

WR2: The **removal_volume** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'shape volume occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_-relationship** with a **description** of 'volume shape usage' and a **relating_shape_aspect** with a **description** of 'volume shape'.

Informal propositions:

IP1: The location of the **removal_volume** shall be defined at the bottom and approximate center of the removal_volume.

IP2: The Z direction of the **removal_volume** shall be in the direction of volume removal.

4.2.45 replicate_feature

A **replicate_feature** is a type of **shape_aspect** that is either a **feature_definition** or another **replicate_-feature** for the purpose of multiple representations.

EXPRESS specification:

```
*)
ENTITY replicate_feature
    SUPERTYPE OF (ONEOF (circular_pattern, rectangular_pattern,
      feature_pattern))
  SUBTYPE OF (feature_definition);
  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.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
        used_representation)) ))  = 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)) ) |
        ((SIZEOF(['AIC_MACHINING_FEATURE.REPLICATE_FEATURE',
        'AIC_MACHINING_FEATURE.INSTANCED_FEATURE'] *
        TYPEOF(fcr.related_shape_aspect)) >= 1) AND
        (fcr.name = 'pattern basis')) )) = 1);
    WR3: ((SIZEOF(QUERY ( sar <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
        + 'RELATING_SHAPE_ASPECT') |
        (NOT
         ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar))) )) +
        SIZEOF(QUERY ( sar <* USEDIN(SELF,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
        + 'RELATED_SHAPE_ASPECT') |
        (NOT
        ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar))) ))) = 0);
END_ENTITY;  -- replicate_feature
(*
```

Formal proposition:

WR1: The **replicate_feature** shall have an implicit representation that contains exactly one **representation_item** in its set of **items**.

WR2: The **replicate_feature** shall be the **relating_shape_aspect** in exactly one **shape_aspect_-relationship** that is of type **feature_component_relationship** with a name of 'pattern basis' and a **related_shape_aspect** that is either of type **replicate_feature** or **instanced_feature**.

WR3: A **replicate_feature** shall be referenced by **shape_aspect_relationship**s only if they are of type **feature_component_relationship** or **shape_defining_relationship**.

4.2.46 revolved_profile

A **revolved_profile** is a type of **feature_definition** that is the representation of a volume that is removed from the base shape. The volume of removal is defined by either sweeping a linear_profile about an axis.

NOTE A Revolved_feature is defined in ISO 10303-224:2006, 4.2.207, General_revolution is defined in ISO 10303-224:2006, 4.2.100, Groove is defined in ISO 10303-224:2006, 4.2.106, Revolved_flat is defined in ISO 10303-224:2006, 4.2.208, or a Revolved_round is defined in ISO 10303-224:2006, 4.2.209 and defines the requirement for **revolved_profile** .

EXPRESS specification:

```
*)
ENTITY revolved_profile
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: (SELF\characterized_object.description IN
         ['groove','flat','round','open profile']);
    WR2: (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);
    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(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: SIZEOF(QUERY(pdr <* get_property_definition_representations (SELF) |
         ( 'AIC_MACHINING_FEATURE.DIRECTION_SHAPE_REPRESENTATION'
         IN TYPEOF ( pdr.used_representation ) ) AND
         ( pdr.used_representation.name ='removal direction'))) =1;
    WR5: ((NOT (SELF\characterized_object.description = 'open profile')) 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 = 'outer edge shape 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.OPEN_PATH_PROFILE'
         IN TYPEOF(sdr.relating_shape_aspect)) AND
        (sdr.relating_shape_aspect.description = 'outer edge shape')) ))
         = 1)) )) = 1)) )) = 0));
   WR6: (NOT (SELF\characterized_object.description = 'flat')) 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 = 'flat edge shape 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.LINEAR_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect)) AND
        (sdr.relating_shape_aspect.description = 'flat edge shape')) ))
        = 1)) )) = 1)) )) = 0);
    WR7: ((NOT (SELF\characterized_object.description = 'round')) 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 = 'rounded edge shape 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.PARTIAL_CIRCULAR_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect)) AND
        (sdr.relating_shape_aspect.description = 'rounded edge shape')) ))
        = 1)) )) = 1)) )) = 0));
    WR8: ((NOT (SELF\characterized_object.description = 'groove')) 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 = 'sweep 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.SQUARE_U_PROFILE',
         'AIC_MACHINING_FEATURE.PARTIAL_CIRCULAR_PROFILE',
        'AIC_MACHINING_FEATURE.ROUNDED_U_PROFILE',
        'AIC_MACHINING_FEATURE.VEE_PROFILE',
        'AIC_MACHINING_FEATURE.TEE_PROFILE',
        'AIC_MACHINING_FEATURE.OPEN_PATH_PROFILE'] *
        TYPEOF(sdr.relating_shape_aspect)) = 1) AND
        (sdr.relating_shape_aspect.description = 'sweep')) )) = 1)) ))
        = 1)) )) = 0));
```



```
   WR9: 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; -- revolved_profile
(*
```

Formal propositions:

WR1: The **revolved_profile** shall have a description of 'groove', 'flat', 'round', or 'open profile'.

WR2: The **revolved_profile** shall have an implicit representation that contains exactly two **representation_item** in its set of **items**.

WR3: The **revolved_profile** shall contain exactly one **representation_item** in its set of **items** which is a **measure_representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR4: The **revolved_profile** shall have exactly one **direction_shape_representation** with a **name** of 'removal direction'.

WR5: If the **revolved_profile** has a description of 'open profile', the **revolved_profile** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'outer edge shape occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_shape_aspect** that references an **open_path_profile** with a **description** of 'outer edge shape'.

WR6: If the **revolved_profile** has a description of 'flat', the **revolved_profile** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'flat edge occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_shape_aspect** that references a **linear_profile** with a **description** of 'flat edge shape'.

WR7: If the **revolved_profile** has a description of 'round', the **revolved_profile** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'rounded edge shape occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_shape_aspect** that references an **partial_circular_profile** with a **description** of 'rounded edge shape'.

WR8: If the **revolved_profile** has a description of 'groove', the **revolved_profile** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'sweep occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_shape_aspect** that references a **square_u_profile**, **partial_circular_profile**, **rounded_u_profile**, **vee_profile**, **tee_profile**, or **open_path_profile** with a **description** of 'sweep'.

WR9: The **revolved_profile** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

Informal proposition:

IP1: If the orientation of the **revolved_profile** causes the feature to be self intersecting, the intersecting edges shall be trimmed at the axis of revolution.

IP2: If the description of the **revolved_profile** is 'open profile', then the placement of the **open_path_profile** that defines the shape of the **revolved_profile** shall be with the origin, x direction, and y direction equal to that of the **revolved_profile**.

IP3: If the description of the **revolved_profile** is 'groove', then the placement of the **linear_profile**, **square_u_profile**, **partial_circular_profile**, **rounded_u_profile**, **vee_profile**, **tee_profile**, or **open_path_profile** that defines the shape of the **revolved_profile** shall be placed a specified distance away from the origin of the **revolved_profile** along the X direction.

NOTE - The orientation of the **linear_profile**, **square_u_profile**, **partial_circular_profile**, **rounded_u_profile**, **vee_profile**, **tee_profile**, or **open_path_profile** is independent of the origin of the **revolved_profile**. The **revolved_profile** may be defined on different faces of a part dependent upon the orientation of the profile.

IP4: If the description of the **revolved_profile** is 'flat', then the placement of the **linear_profile** that defines the shape of the **revolved_profile** shall be placed a specified distance away from the origin of the **revolved_profile** along the X direction. The Y direction of the **linear_profile** shall be equal to that of the **revolved_profile**. The X direction and Z direction of the **linear_profile** shall be independent from that of the **revolved_profile**.

IP5: If the description of the **revolved_profile** is 'round', then the placement of the **partial_circular_profile** that defines the shape of the **revolved_profile** shall be placed a specified distance away from the origin of the **revolved_profile** along the X direction. The Z direction of the **partial_circular_profile** shall be equal to the Y direction of the **revolved_profile**. The X direction and Y direction of the **partial_circular_profile** shall be independent from that of the **revolved_profile**.

4.2.47 rib_top

A **rib_top** is a type of **feature_definition** that is the representation of a volume that is removed from the top of a shape. The floor of the **rib_top** is represented by a **rib_top_floor**.

NOTE A Rib_top is defined in ISO 10303-224:2006, 4.2.210 and defines the requirement for **rib_top** .

EXPRESS specification:

```
*)
ENTITY rib_top
   SUBTYPE OF (feature_definition);
  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') |
        (sa_occ.description = 'rib top condition occurrence') AND
        (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
```



```
        (sar.description = 'rib top usage') AND
        ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF (sar))) |
        (('AIC_MACHINING_FEATURE.RIB_TOP_FLOOR'
        IN TYPEOF (sdr.relating_shape_aspect)) AND
        ('AIC_MACHINING_FEATURE.RIB_TOP'
        IN TYPEOF (sdr.related_shape_aspect.of_shape.definition)) )
        )) = 1))) = 1))) = 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.DIRECTION_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation))AND
        (pdr.used_representation.name = 'removal direction'))) = 1))) = 1;
   WR3: 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;    -- rib_top
(*
```

Formal propositions:

WR1: The **rib_top** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'rib top condition occurrence' that is the **related_shape_aspect** in exactly one **feature_component_relationship** with a **description** of 'rib top usage' and a **relating_shape_aspect** that references a **rib_top_floor**.

WR2: The **rib_top** shall have exactly one **direction_shape_representation** with a **name** of 'removal direction'.

WR3: The **rib_top** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

4.2.48 rib_top_floor

A **rib_top_floor** is a type of **shape_aspect** that is the representation of the floor condition for a **rib_top feature_definition**.

NOTE A Rib_top is defined in ISO 10303-224:2006, 4.2.211 and defines the requirement for **rib_top** .

EXPRESS specification:

```
*)
ENTITY rib_top_floor
  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: SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (SELF,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATING_SHAPE_ASPECT') |
```

```
        (sar.description = 'rib top usage') AND
        ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF (sar))) |
        ((fcr.related_shape_aspect.description =
        'rib top condition occurrence')
        AND
        ('AIC_MACHINING_FEATURE.RIB_TOP' IN TYPEOF
        (fcr.related_shape_aspect.of_shape.definition)) AND
        ('AIC_MACHINING_FEATURE.RIB_TOP_FLOOR' IN TYPEOF
        (fcr.relating_shape_aspect)) )
        )) >= 1;
   WR4: (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))AND
        (pdr.used_representation.name = 'rib top face'))) = 1))) = 0);
   WR5: (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.PLANAR_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation))AND
        (pdr.used_representation.name = 'rib top face'))) = 1))) = 0);
   WR6: (NOT (SELF.description = 'planar')) 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 = '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.CIRCULAR_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.NGON_CLOSED_PROFILE',
        'AIC_MACHINING_FEATURE.RECTANGULAR_CLOSED_PROFILE',
         'AIC_MACHINING_FEATURE.CLOSED_PATH_PROFILE'] *
        TYPEOF (sdr.relating_shape_aspect)) = 1) AND
        (sdr.relating_shape_aspect.description = 'rib top floor boundary')))
        = 1))) = 1))) = 0);
END_ENTITY;  -- rib_top_floor
(*
```


Formal propositions:

WR1: The **rib_top_floor** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **description** of the **rib_top_floor** shall be either 'planar' or 'complex'.

WR3: The **rib_top_floor** shall be the **relating_shape_aspect** in at least one **feature_component_-relationship** with a **description** of 'rib top usage' in which the **related_shape_aspect** is an aspect of the shape of a **rib_top** with a **description** of 'rib top condition occurrence'.

WR4: If the **description** of the **rib_top_floor** is 'complex', the **rib_top_floor** shall have exactly one **face_shape_representation** with **name** of 'rib top face'.

WR5: If the **description** of the **rib_top_floor** is 'planar', the **rib_top_floor** shall have exactly one **planar_shape_representation** with **name** of 'rib top face'.

WR6: If the **rib_top** has a **description** of 'planar', the **boss** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'boundary occurrence' that is the **related_shape_aspect** in exactly one **feature_component_relationship** with a **description** of 'profile usage' in which the **relating_-shape_aspect** is either a **circular_closed_profile**, **rectangular_closed_profile**, **ngon_closed_profile**, or **closed_path_profile**.

Informal propositions:

IP1: The location of the **rib_top_floor** shall be at the approximate center of the mating **rib_top** feature.

IP2: The **rib_top_floor** shall be defined with the volume removal in Z direction of the **rib_top** feature.

4.2.49 round_hole

A **round_hole** is a type of **feature_definition** that is the representation of a circular enclosed volume this is removed from the base shape. The bottom of the **round_hole** is represented by a **hole_bottom**.

NOTE A **round_hole** may have a change in diameter which is represented by a **taper**. Round_hole is defined in ISO 10303-224:2006, 4.2.212 and defines the requirement for **round_hole** .

EXPRESS specification:

```
*)
ENTITY round_hole
  SUBTYPE OF (feature_definition);
   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') |
         ((sa_occ.description = 'diameter 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.relating_shape_aspect)) AND
        (sdr.name = 'diameter'))  )) = 1)) )) = 1)) )) = 0);
    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 = 'hole depth 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.relating_shape_aspect)) AND
        (sdr.name = 'hole depth') AND
        (sdr.relating_shape_aspect.description = 'linear')) )) = 1)) ))
        = 1)) )) = 0);
    WR3: (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 = 'bottom condition occurrence') AND
        (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
        'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'hole bottom usage') AND
        (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (('AIC_MACHINING_FEATURE.HOLE_BOTTOM'
        IN TYPEOF(fcr.relating_shape_aspect)) AND
        ('AIC_MACHINING_FEATURE.ROUND_HOLE'
        IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)))
        )) = 1)) )) = 1)) )) = 0);
    WR4: (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.relating_shape_aspect)) AND
        ('AIC_MACHINING_FEATURE.ROUND_HOLE'
        IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)) )
        )) = 1)) )) <= 1)) )) = 0);
```



```
  WR5: SIZEOF(QUERY(pdr <* get_property_definition_representations (SELF) |
       ( 'AIC_MACHINING_FEATURE.SHAPE_REPRESENTATION_WITH_PARAMETERS'
       IN TYPEOF ( pdr.used_representation ) ) )) =1;
END_ENTITY; -- round_hole
(*
```

Formal propositions:

WR1: The **round_hole** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'diameter occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **name** of 'diameter' and a **relating_shape_aspect** that is a **circular_closed_profile**.

WR2: The **round_hole** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'hole depth occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'path feature component usage' and a **name** of 'hole depth' in which the **relating_shape_-aspect** is a **path_feature_component** with a **description** of 'linear'.

NOTE - The specification of the hole depth places a limitation on the depth of the **round_hole** so that it will not interfere with other features of the part that are nearby.

WR3: The **round_hole** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'bottom condition occurrence' that is the **related_shape_aspect** in exactly one **feature_component_-relationship** with a **description** of 'hole bottom usage' and the **relating_shape_aspect** is a **hole_bottom**.

WR4: The **round_hole** 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** with a **description** of 'taper usage' and the **relating_shape_aspect** is a **taper**.

WR5: The **round_hole** shall contain exactly one implicit representation.

Informal propositions:

IP1: The location of the **round_hole** shall be defined at either the bottom or the top center of the hole.

IP2: The Z direction of the **round_hole** shall be in the direction of volume removal.

IP3: The origin, X direction, Y direction of the **circular_closed_profile** shall be equal to that of the **round_hole**.

IP4: The origin, X direction, Y direction of the **path_feature_component** shall be equal to that of the **round_hole**.

4.2.50 rounded_end

A **rounded_end** is a type of **feature_definition** that is the representation of a volume that is removed from the base shape. The removal shall be represented by **partial_circular_profile** swept along about a linear path represented by a **path_feature_component**.

NOTE A Rounded_end is defined in ISO 10303-224:2006, 4.2.213 and defines the requirement for **rounded_end** .

EXPRESS specification:

```
*)
ENTITY rounded_end
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: (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);
   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 = 'partial circular 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))) ) |
        (('AIC_MACHINING_FEATURE.PARTIAL_CIRCULAR_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect)) ) )) = 1)) )) = 1)) )) = 0);
   WR3: (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 = 'course of travel 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.relating_shape_aspect)) AND
        (sdr.relating_shape_aspect.description = 'linear')) )) = 1)) ))
        = 1)) )) = 0);
   WR4: 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; -- rounded_end
(*
```


Formal propositions:

WR1: The **rounded_end** shall have an implicit representation that contains exactly one **representation_item** in its set of **items**.

WR2: The **rounded_end** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'partial circular 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** references a **partial_circular_profile**.

WR3: The **rounded_end** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'course of travel occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'path feature component usage' and a **relating_shape_aspect** that references a **path_feature_component** with a **description** of 'linear'.

WR4: The **rounded_end** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

Informal propositions:

IP1: The origin, X direction, Y direction of the **partial_circular_profile** shall be equal to that of the **rounded_end**.

IP2: The origin, X direction, Y direction of the **path_feature_component** shall be equal to that of the **rounded_end**.

4.2.51 rounded_u_profile

A **rounded_u_profile** is a type of **shape_aspect** that is the representation of an arc with connected straight lines at each end, with a location and a position. The **rounded_u_profile** is located at the midpoint of the arc and positioned in the X-Y plane with the X direction tangent to the arc at the midpoint, and the Y direction orthogonal in the direction of volume removal.

NOTE A Rounded_u_profile is defined in ISO 10303-224:2006, 4.2.214 and defines the requirement for **rounded_u_profile** .

EXPRESS specification:

```
*)
ENTITY rounded_u_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)
        AND  (SIZEOF (impl_rep.used_representation.items) <= 2))))
        = 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 |
        (srwp_i.name = 'orientation') OR
        (srwp_i.name = 'depth')  ))
         = 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 = 'width'))))= 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.PLANAR_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation))AND
        (pdr.used_representation.name = 'profile limit'))) <= 1))) = 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.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND
        (it.name = 'depth'))) <= 1))) = 0))) = 0;
END_ENTITY; -- rounded_u_profile
(*
```

Formal propositions:

WR1: The **rounded_u_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **rounded_u_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 **rounded_u_profile** shall contain at least one and at most two **representation_item**s in its set of **items**.

WR4: Exactly one **representation_item** used for the implicit representation of a **rounded_u_profile** shall be of type **placement** with a **name** of 'orientation' and 'depth'.

WR5: Exactly one **representation_item** used for the implicit representation of a **rounded_u_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'width'.

WR6: The **rounded_u_profile** shall have at most one **planar_shape_representation** with a **name** of 'profile limit'.

WR7: Exactly one **representation_item** used for the implicit representation of a **rounded_u_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'depth'.

Informal propositions:

IP1: The location of the **rounded_u_profile** shall be at the midpoint of the arc.

IP2: The **rounded_u_profile** shall be defined with the X direction tangent to the arc at the midpoint, and the Y direction orthogonal in the direction of the open end of the profile.

IP3: The depth of the **rounded_u_profile** shall be defined at the midpoint of the arc and along the Y direction in the direction of the open end of the profile.

4.2.52 shape_defining_relationship

A **shape_defining_relationship** is a kind of **shape_aspect_relationship** in which the **related_shape_aspect** takes a part in the definition of the shape of the **relating_shape_aspect**.

EXAMPLE A Chamfer may have the implicit chamfer offset amount defined with a **feature_component_relationship** and the explicit geometry for the chamfer defined with a **shape_defining_relationship**.

EXPRESS specification:

```
*)
ENTITY shape_defining_relationship
  SUBTYPE OF (shape_aspect_relationship);
END_ENTITY;
(*
```

4.2.53 shape_representation_with_parameters

A **shape_representation_with_parameters** is a kind of **shape_representation** in which the shape of a **product_definition** or **shape_aspect** is defined implicitly using measurements and descriptive parameters.

EXAMPLE The shape of a box may be specified by a **shape_representation_with_parameters** by giving measurements for its height, length, and width.

EXPRESS specification:

```
*)
ENTITY shape_representation_with_parameters
  SUBTYPE OF (shape_representation);
   WHERE
    WR1: (SIZEOF(QUERY ( it <* SELF.items |
        (NOT (SIZEOF([
        'AIC_MACHINING_FEATURE.PLACEMENT',
        'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.DESCRIPTIVE_REPRESENTATION_ITEM'] *
        TYPEOF(it)) = 1)) )) = 0);
END_ENTITY; -- shape_representation_with_parameters
(*
```

Formal proposition:

WR1: The elements that specify the parameters for a **shape_representation_with_parameters** shall be of type **placement**, **measure_representation_item**, or **descriptive_representation_item**.

4.2.54 spherical_cap

A **spherical_cap** is a type of **feature_definition** that is the representation of a volume that is extruding from the base shape. The volume shall be spherical of a defined radius.

NOTE A Spherical_cap is defined in ISO 10303-224:2006, 4.2.228 and defines the requirement for **spherical_cap** .

EXPRESS specification:

```
*)
ENTITY spherical_cap
  SUBTYPE OF (feature_definition);
   WHERE

    WR1: (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)) ))
        = 0)) )) = 0);
   WR2: (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);
   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(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 = 'internal angle')))) = 1)) ))
        = 0)) )) = 0);
END_ENTITY; -- spherical_cap
(*
```

Formal propositions:

WR1: The **spherical_cap** shall have an implicit representation that contains exactly three **representation_item** in its set of **items**.

WR2: Exactly one **representation_item** used for the implicit representation of the **spherical_cap** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR3: Exactly one **representation_item** used for the implicit representation of the **spherical_cap** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'internal angle'.

Informal propositions:

IP1: The orientation of the **spherical_cap** shall be with the Z-axis away from material.

IP2: The X-axis shall define the start of the **spherical_cap** and the internal angle is measured from the X-axis.

IP3: The location of the **spherical_cap** shall be at a position on the base of the feature where it mates with the part.

IP4: The Z direction of the **spherical_cap** shall be in the direction of away from the part.

4.2.55 square_u_profile

A **square_u_profile** is a type of **shape_aspect** that is the representation of three connected straight lines, a location and a position. The **square_u_profile** is located at the midpoint of the base line and positioned in the X-Y plane with the base line on the X direction and the Y direction orthogonal in the direction of volume removal.

NOTE A Square_U_profile is defined in ISO 10303-224:2006, 4.2.231 and defines the requirement for **square_u_-profile** .

EXPRESS specification:

```
*)
ENTITY square_u_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) >= 4)
         AND  (SIZEOF (impl_rep.used_representation.items) <= 7))))
         = 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 |
      (srwp_i.name = 'orientation') OR
      (srwp_i.name = 'width') OR
      (srwp_i.name = 'first angle') OR
      (srwp_i.name = 'second angle') OR
      (srwp_i.name = 'first radius') OR
      (srwp_i.name = 'second radius') OR
      (srwp_i.name = 'profile limit') OR
      (srwp_i.name = 'depth')  ))
      = 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 |
      ('AIC_MACHINING_FEATURE.PLACEMENT' IN TYPEOF (it)) AND
      (it.name = 'orientation'))) = 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 |
      (SIZEOF
      (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
      'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2) AND
      (it.name = 'width'))) = 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.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2) AND
      (it.name = 'first radius'))) <= 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 |
        (SIZEOF
        (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND
        (it.name = 'second radius'))) <= 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.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND
        (it.name = 'first angle'))) = 1))) = 0))) = 0;
   WR10: 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 = 'second angle'))) = 1))) = 0))) = 0;
   WR11: 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.PLANAR_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation))AND
        (pdr.used_representation.name = 'profile limit'))) <= 1))) = 0;

   WR12: 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 = 'depth'))) <= 1))) = 0))) = 0;
END_ENTITY; -- Square_U_profile
(*
```

Formal propositions:

WR1: The **square_u_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **square_u_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 **square_u_profile** shall contain at least four and at most seven **representation_item**s in its set of **items**.

WR4: The implicit representation of a **square_u_profile** shall contain only **representation_-item**s in its set of **items** with a **name** of 'orientation','depth','width', 'first angle', 'second angle', 'first radius', and 'second radius'.

WR5: Exactly one **representation_item** used for the implicit representation of a **square_u_profile** shall be of type **placement** with a **name** of 'orientation'.

WR6: Exactly one **representation_item** used for the implicit representation of a **square_u_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'width'.

WR7: At most one **representation_item** used for the implicit representation of a **square_u_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'first radius'.

WR8: At most one **representation_item** used for the implicit representation of a **square_u_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'second radius'.

WR9: Exactly one **representation_item** used for the implicit representation of a **square_u_profile** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'first angle'.

WR10: Exactly one **representation_item** used for the implicit representation of a **square_u_profile** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'second angle'.

WR11: The **square_u_profile** shall have at most one **planar_shape_representation** with a **name** of 'profile limit'.

WR12: At most one **representation_item** used for the implicit representation of a **square_u_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'depth'.

Informal propositions:

IP1: The location of the **square_u_profile** shall be defined at the midpoint of the base line.

IP2: The **square_u_profile** shall be defined in the X-Y plane with the base line in the X direction and the Y direction orthogonal in the direction of the open end of the profile.

IP3: The depth of the **square_u_profile** shall be defined at the midpoint of the base line and along the Y direction in the direction of the open end of the profile.

4.2.56 step

A **step** is a type of **feature_definition** that is the representation of a volume that is removed from the base shape. This removal shall be represented by sweeping a **vee_profile** along a path represented by a **path_-feature_component**.

NOTE A Step is defined in ISO 10303-224:2006, 4.2.232 and defines the requirement for **step** .

EXPRESS specification:

```
*)
ENTITY step
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: (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);
    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 = 'course of travel 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.relating_shape_aspect)) AND
         (sdr.relating_shape_aspect.description = 'linear')) )) = 1)) ))
         = 1)) )) = 0);
    WR3: (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 = 'removal 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))) ) |
        ('AIC_MACHINING_FEATURE.VEE_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    WR4: 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;
    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
        (csa.name='uncut volume') AND
        (SIZEOF(QUERY ( sar <* csa.component_relationships |
        (('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar)) AND (SIZEOF([
        'AIC_MACHINING_FEATURE.BOSS',
        'AIC_MACHINING_FEATURE.PROTRUSION'] * TYPEOF(sar.
        related_shape_aspect)) = 1)) )) = 1)) )) <= 1)) )) = 1;
END_ENTITY; -- step
(*
```

Formal proposition:

WR1: The **step** shall have an implicit representation that contains exactly one **representation_item** in its set of **items**.

WR2: The **step** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'course of travel occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'path feature component usage' and a **relating_shape_aspect** that references a **path_-feature_component** with a **description** of 'linear'.

WR3: The **step** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'removal boundary occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'profile usage' and a **relating_shape_aspect** that references a **vee_profile**.

WR4: The **step** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

WR5: The **step** shall have the uncut volume defined by exactly one **product_definition_shape** that is referenced by zero or more **composite_shape_aspect** with **name** of 'uncut volume' through the **of_shape**' attribute that references a **feature_component_relationship** through the **component_-relationships** attribute that references either a **boss** or a **protrusion**.

Informal propositions:

IP1: The origin, X direction, Y direction of the **vee_profile** shall be equal to that of the **step**.

IP2: The origin, X direction, Y direction of the **path_feature_component** shall be equal to that of the **step**.

4.2.57 slot

A **slot** is a type of **feature_definition** that is the representation of a volume that is removed from the base shape. This removal shall be represented by sweeping either a **square_u_profile**, **partial_circular_-profile**, **round_u_profile**, **vee_profile**, **tee_profile**, or an **open_path_profile** swept along a path represented by a **path_feature_component**. Each end of the **slot** shall be represented by a **slot_end**.

NOTE A Slot is defined in ISO 10303-224:2006, 4.2.224 and defines the requirement for **slot** .

EXPRESS specification:

```
*)
  ENTITY slot
    SUBTYPE OF (feature_definition);
    WHERE
      WR1: 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;
      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 = 'swept shape 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.SQUARE_U_PROFILE',
           'AIC_MACHINING_FEATURE.PARTIAL_CIRCULAR_PROFILE',
           'AIC_MACHINING_FEATURE.ROUNDED_U_PROFILE',
           'AIC_MACHINING_FEATURE.VEE_PROFILE',
           'AIC_MACHINING_FEATURE.TEE_PROFILE',
           'AIC_MACHINING_FEATURE.OPEN_PATH_PROFILE'] *
           TYPEOF(sdr.relating_shape_aspect)) = 1) )) = 1)) )) = 1)) ))
           = 0;
      WR3: 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 = 'course of travel 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 ((sar.name =
        'course of travel') AND (
        'AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP'
        IN TYPEOF(sar)))) ) | (
        'AIC_MACHINING_FEATURE.PATH_FEATURE_COMPONENT' IN
        TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0;

WR4: 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 = 'end condition occurrence') AND
     (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
     'AIC_MACHINING_FEATURE.'+
     'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
     (((sar.description = 'slot end usage') AND
     (sar.name IN ['course of travel start','course of travel end']))
     AND
     ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
     IN TYPEOF(sar))) ) |
     ((('AIC_MACHINING_FEATURE.SLOT_END'
     IN TYPEOF(fcr.relating_shape_aspect)) AND
     (fcr.relating_shape_aspect.description
     IN ['open','radiused','flat','woodruff'])) AND
     ('AIC_MACHINING_FEATURE.SLOT'
     IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)))
      )) = 1) ) )) = 2)
      OR
     (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
     'AIC_MACHINING_FEATURE.SHAPE_ASPECT.OF_SHAPE') |
     ((sa_occ.description = 'end condition occurrence') AND
     (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
     'AIC_MACHINING_FEATURE.'+
     'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
     (((sar.description = 'slot end usage') AND
     (sar.name IN ['course of travel start','course of travel end']))
     AND
     ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
     IN TYPEOF(sar))) ) |
     ((('AIC_MACHINING_FEATURE.SLOT_END'
     IN TYPEOF(fcr.relating_shape_aspect)) AND
     (fcr.relating_shape_aspect.description IN ['loop'])) AND
     ('AIC_MACHINING_FEATURE.SLOT'
     IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)))
      )) = 1) ) )) = 1))) )) =0;
```

```
      WR5: (NOT (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 = 'end condition occurrence') AND
           (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
           'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'+
           'RELATED_SHAPE_ASPECT') |
           (((sar.description = 'slot end usage') AND
           (sar.name IN ['course of travel start','course of travel end']))
           AND
           ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
           IN TYPEOF(sar))) ) |
           ((('AIC_MACHINING_FEATURE.SLOT_END'
           IN TYPEOF(fcr.relating_shape_aspect)) AND
           (fcr.relating_shape_aspect.description IN ['loop'])) AND
           ('AIC_MACHINING_FEATURE.SLOT'
           IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)))
           )) = 1)) )) = 1)) )) =0)
           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 = 'course of travel 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
           ((sar.name = 'course of travel') AND
           ('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP'
           IN TYPEOF(sar)))) ) |
           (('AIC_MACHINING_FEATURE.PATH_FEATURE_COMPONENT'
           IN TYPEOF(sdr.relating_shape_aspect)) AND
           (sdr.relating_shape_aspect.description
           IN ['complex','complete circular']))
           )) = 1)) )) = 1)) )) = 0));

      WR6: 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; -- slot
(*
```


Formal propositions:

WR1: The implicit representation of the **slot** shall contain exactly one **representation_item**s in its set of **items**.

WR2: The **slot** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'swept shape occurance' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** 'profile usage' and a **relating_shape_aspect** that references a **square_u_profile**, **partial_-circular_profile**, **rounded_u_profile**, **vee_profile**, **tee_profile**, or **open_path_profile**.

WR3: The **slot** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'course of travel occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'path feature component usage', and a **name** of of 'course of travel' and a **relating_shape_-aspect** that references a **path_feature_component**.

WR4: The **slot** shall be the basis shape for: either exactly two **shape_aspect**s with a **description** of 'end condition occurrence' that are each the **related_shape_aspect** in exactly one **feature_component_-relationship** with a **description** of 'slot end usage' and a **relating_shape_aspect** that references a **slot_-end** if the **slot_end** has a **description** of 'open','radiused','flat','woodruff' OR exactly one **shape_aspect** with a **description** of 'end condition occurrence' that are each the **related_shape_aspect** in exactly one **feature_component_relationship** with a **description** of 'slot end usage' and a **relating_shape_aspect** that references a **slot_end** if the **slot_end** has a **description** of 'loop'.

WR5: The **slot** shall be the basis shape for exactly one **shape_aspect**s with a **description** of 'end condition occurrence' that are each the **related_shape_aspect** in exactly one **feature_component_-relationship** with a **description** of 'slot end usage' and a **relating_shape_aspect** that references a **slot_-end** if the **slot_end** has a **description** of 'loop'. And the **slot** shall be the basis shape for exactly one **shape_aspect** with a **description** of 'course of travel occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'path feature component usage', and a **name** of of 'course of travel' and a **relating_shape_aspect** that references a **path_feature_component** with a **description** of 'complex', or'complete circular'.

WR6: The **slot** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

Informal propositions:

IP1: The location of the **slot** shall be defined at one end of the **slot**.

IP2: If the **description** of the **path_feature_component** relating to the **slot** is 'linear' or 'complex', then the Z direction of the **slot** shall be in the direction of **slot** end and the volume removal in the Y direction.

IP3: If the **description** of the **path_feature_component** relating to the **slot** is 'circular' or 'partial circular', then the Z direction of the **slot** shall be the axis of revolution.

IP4: If the **description** of the **path_feature_component** relating to the **slot** is 'linear' or 'complex', then the origin, X direction, Y direction of the **square_u_profile**, **partial_circular_profile**, **rounded_u_-profile**, **vee_profile**, **tee_profile**, or **open_path_profile** shall be equal to that of the **slot**.

IP5: If the **description** of the **path_feature_component** relating to the **slot** is 'circular' or 'partial circular', then the origin, X direction, Y direction of the **square_u_profile**, **partial_circular_profile**, **rounded_u_profile**, **vee_profile**, **tee_profile**, or **open_path_profile** shall be in the X direction of the **slot** at a distance equal to the radius of the **path_feature_component** away from the origin of the slot.

IP6: The origin, X direction, Y direction of the **path_feature_component** shall be equal to that of the **slot**.

4.2.58 slot_end

A **slot_end** is a type of **shape_aspect** that is the representation of the end condition for a **slot feature_-definition**.

NOTE A Slot_end_type is defined in ISO 10303-224:2006, 4.2.225 and defines the requirement for **slot_end** .

EXPRESS specification:

```
*)
ENTITY slot_end
  SUBTYPE OF (shape_aspect);
   WHERE
WR1: 'AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
     IN TYPEOF(SELF.of_shape.definition);
WR2: SELF.description IN ['open','radiused','flat','woodruff',
     'loop'];
WR3: (NOT (SELF.description IN ['open','radiused','loop'])) 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)) )) = 0)) )) = 0);
WR4: (NOT (SELF.description IN ['flat','woodruff'])) 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);
WR5: (NOT (SELF.description IN ['flat'])) 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) = 2)) )) = 0)) )) = 0);
WR6: (NOT (SELF.description = 'flat')) 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 radius')) )) = 1)) )) = 0)) )) = 0);
WR7: (NOT (SELF.description = 'flat')) 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 radius')) )) = 1)) ))  = 0)) )) = 0);
WR8: (NOT (SELF.description = 'woodruff')) 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.LENGTH_MEASURE_WITH_UNIT'
     IN TYPEOF(it)) AND
     (it.name = 'radius')) )) = 1)) )) = 0)) )) = 0);
WR9: (NOT (SELF.description IN ['woodruff'])) 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)) )) = 0)) )) = 0);
WR10: SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
     'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
     + 'RELATING_SHAPE_ASPECT') |
     (((sar.description = 'slot end usage') AND
     (sar.name IN ['course of travel start','course of travel end'])) AND
     ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_RELATIONSHIP'
     IN TYPEOF(sar))) ) |
     (((fcr.related_shape_aspect.description = 'end condition occurrence')
     AND
     ('AIC_MACHINING_FEATURE.SLOT'
     IN TYPEOF(fcr.related_shape_aspect.of_shape.definition))) AND
     ('AIC_MACHINING_FEATURE.SLOT_END'
     IN TYPEOF(fcr.relating_shape_aspect))) )) >= 1;
END_ENTITY; -- slot_end
(*
```

Formal propositions:

WR1: The **slot_end** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **description** for the **slot_end** shall be either 'open', 'radiused', 'flat', 'loop' or 'woodruff'.

WR3: If the **description** of the **slot_end** is 'open', 'loop' or 'radiused', the **slot_end** shall not have any implicit representation.

WR4: If the **description** of the **slot_end** is 'flat' or 'woodruff, 'the **slot_end** shall have its implicit representation specified by exactly one **shape_representation_with_parameters**.

WR5: If the **description** of the **slot_end** is 'flat", the **slot_end** shall have an implicit representation that contains exactly two **representation_item** in its set of **items**.

WR6: If the **description** of the **slot_end** is 'flat', exactly one **representation_item** used for the implicit representation of the **slot_end** shall be of type **measure_representation_item** and **length_measure_-with_unit** with a **name** of 'first radius'.

WR7: If the **description** of the **slot_end** is 'flat', exactly one **representation_item** used for the implicit representation of the **slot_end** shall be of type **measure_representation_item** and **length_measure_-with_unit** with a **name** of 'second radius'.

WR8: If the **description** of the **slot_end** is 'woodruff', exactly one **representation_item** used for the implicit representation of the **slot_end** shall be of type **measure_representation_item** and **length_-measure_with_unit** with a **name** of 'radius'.

WR9: If the **description** of the **slot_end** is 'woodruff', the **slot_end** shall have an implicit representation that contains exactly one **representation_item** in its set of **items**.

WR10: The **slot_end** shall be the **relating_shape_aspect** in at least one **feature_component_-relationship** with a **description** of 'slot end usage' and with a **name** of 'course of travel start', or 'course of travel end' in which the **related_shape_aspect** is an aspect of the shape of a **slot** with a **description** of 'end condition occurrence'.

Informal propositions:

IP1: If the **description** of the **slot_end** is 'open' or 'loop', then it shall have no placement or orientation.

IP2: If the **description** of the **slot_end** is 'flat', then location shall be at the midpoint of the base line.

IP3: If the **description** of the **slot_end** is 'radiused', then location shall be at the midpoint of the radius.

IP4: If the **description** of the **slot_end** is 'woodruff', then location shall be at the point where the slot floor makes contact with the radius.

IP5: If the **description** of the **slot_end** is 'open', 'radiused', or 'woodruff', then the **slot_end** is defined with the base line in the X direction and the Y direction orthogonal in the direction of volume removal. The Z direction is coincident to that of the mating **slot** feature.

4.2.59 taper

A **taper** is a type of **shape_aspect** which represents a linear change applied to a machining feature.

NOTE An Angle_taper is defined in ISO 10303-224:2006, 4.2.2, a Directed_taper is defined in ISO 10303-224:2006, 4.2.70 and Diameter_taper is defined in ISO 10303-224:2006, 4.2.66 and defines the requirement for **taper**.

EXPRESS specification:

```
*)
ENTITY taper
  SUBTYPE OF (shape_aspect);
   WHERE
    WR1: ('AIC_MACHINING_FEATURE.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF(SELF.of_shape.definition));
    WR2: (SELF.description IN ['angle taper','diameter taper',
         'directed taper']);
    WR3: (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);
    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(impl_rep.used_representation.items) = 1)) ))
         = 0)) )) = 0);
    WR5: ((NOT (SELF.description = 'angle taper')) 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 = 'taper angle')) )) = 1)) ))
         = 0)) )) = 0));
   WR6: ((NOT (SELF.description = 'diameter taper')) 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 = 'final diameter')) )) = 1)) ))
        = 0)) )) = 0));
   WR7: ((NOT (SELF.description = 'directed taper')) 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 = 'angle')) )) = 1)) ))
        = 0)) )) = 0));
   WR8: ((NOT (SELF.description = 'directed taper')) 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)) AND
        (pdr.used_representation.name = 'direction') ))
        = 1)) )) = 0));
END_ENTITY; -- taper
(*
```

Formal propositions:

WR1: The **taper** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **description** of the **taper** shall be either 'angle taper', 'diameter taper', or 'directed taper'.

WR3: The **taper** shall have exactly one implicit representation defined by a relationship to a **shape_-representation_with_parameters**.

WR4: The **shape_representation_with_parameters** that represents the **taper** shall contain exactly one **representation_item** in its set of **items**.

WR5: The **representation_item** used for the implicit representation of an angular **taper** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'taper angle'.

WR6: The **representation_item** used for the implicit representation of a diameter **taper** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'taper diameter'.

WR7: If the **description** of the **taper** is 'directed taper', the implicit representation of the **taper** shall contain exactly one **representation_item** of type **measure_representation_item** and **plane_angle_-measure_with_unit** with a **name** of 'angle'.

WR8: If the **description** of the **taper** is 'directed taper', its shape shall be represented by exactly one **direction_shape_representation**. This **direction_shape_representation** shall have a **name** of ' direction'.

Informal proposition:

IP1: The taper angle shall be -90 degrees < taper < 90 degrees.

4.2.60 tee_profile

A **tee_profile** is a type of **shape_aspect** which is the representation of an upside down T shape with a location and a position. The **tee_profile** consist of a stem and a perpendicular cross bar. The stem has two parallel lines connected at their ends by the cross bar. The cross bar is a rectangle. The profile is symmetric about the centerline of the stem. The **tee_profile** is located at the midpoint of the side of the cross bar opposite the stem, and positioned with the side of the cross bar opposite the stem on the X direction and the profile symmetric with respect to the Y direction.

NOTE A Tee_profile is defined in ISO 10303-224:2006, 4.2.245 defines the requirement for **tee_profile** .

EXPRESS specification:

```
*)
ENTITY tee_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) >= 9)
         AND  (SIZEOF (impl_rep.used_representation.items) <= 10))))
         = 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 |
        (srwp_i.name = 'orientation') OR
        (srwp_i.name = 'width') OR
        (srwp_i.name = 'depth') OR
        (srwp_i.name = 'cross bar width') OR
        (srwp_i.name = 'cross bar depth') OR
        (srwp_i.name = 'first offset') OR
        (srwp_i.name = 'second offset') OR
        (srwp_i.name = 'first angle') OR
        (srwp_i.name = 'second angle') OR
        (srwp_i.name = '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 |
        ('AIC_MACHINING_FEATURE.PLACEMENT' IN TYPEOF (it)) AND
        (it.name = 'orientation'))) = 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 |
        (SIZEOF
        (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND  (it.name = 'width'))) = 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.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'depth'))) = 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 |
      (SIZEOF
      (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
      'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2) AND (it.name = 'cross bar width'))) = 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 = 'cross bar depth'))) = 1)))
      = 0))) = 0;
WR10: 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;
WR11: 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;
WR12: 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 = 'first angle'))) = 1)))
        = 0))) = 0;
   WR13: 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 = 'second angle'))) = 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 |
        (SIZEOF
        (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'radius'))) <= 1))) = 0))) = 0;
   WR15: 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.PLANAR_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation))AND
        (pdr.used_representation.name = 'profile limit'))) <= 1))) = 0;
END_ENTITY;   -- tee_profile
(*
```

Formal propositions:

WR1: The **tee_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **tee_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 **tee_profile** shall contain at least nine and at most ten **representation_item**s in its set of **items**.

WR4: The implicit representation of a **tee_profile** shall contain only **representation_-item**s in its set of **items** with a **name** of 'orientation', 'width', 'depth', 'cross bar width', 'cross bar depth', 'first offset', 'second offset', 'first angle', 'second angle', and 'radius'.

WR5: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **placement** with a **name** of 'orientation'.

WR6: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'width'.

WR7: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'depth'.

WR8: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'cross bar width'.

WR9: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'cross bar depth'.

WR10: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'first offset'.

WR11: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'second offset'.

WR12: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'first angle'.

WR13: Exactly one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'second angle'.

WR14: At most one **representation_item** used for the implicit representation of a **tee_profile** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'radius'.

WR15: The **tee_profile** shall have at most one **planar_shape_representation** with a **name** of 'profile limit'.

Informal propositions:

IP1: The location of the **tee_profile** shall be at the midpoint of the side of the cross bar opposite the stem.

IP2: The **tee_profile** shall be defined with the side of the cross bar opposite the stem in the X direction and the profile symmetric with respect to the Y direction.

4.2.61 thread

A **thread** is a type of **feature_definition** that is the representation of a thread shape that is applied to all or a portion of a **shape_aspect**.

NOTE A Thread is defined in ISO 10303-224:2006, 4.2.246 and defines the requirement for **thread** .

EXPRESS specification:

```
*)
ENTITY thread
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: (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
         (8 <= SIZEOF(pdr.used_representation.items)) AND
         (SIZEOF(pdr.used_representation.items) <= 11)) )) = 1) )) = 1);
    WR2: (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 = 'major diameter')) )) = 1)) ))
         = 0)) )) = 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(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 = 'minor diameter')) ))
         <= 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 |
      ((SIZEOF([
      'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
      'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT']
      * TYPEOF(it)) = 2) AND (it.name = 'pitch 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.RATIO_MEASURE_WITH_UNIT'] *
      TYPEOF(it)) = 2) AND (it.name = 'number of threads')) ))
      = 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.DESCRIPTIVE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND (it.name = 'fit class')) )) = 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.DESCRIPTIVE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND (it.name = 'form')) )) = 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.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'hand')AND
        (it.description IN ['left', 'right']) ) )) = 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 |
        (('AIC_MACHINING_FEATURE.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'qualifier')) )) <= 1)) ))
        = 0)) )) = 0);
  WR10: (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.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'thread side') AND
        ((it.description = 'internal') OR (it.description = 'external'))) ))
        = 1)) )) = 0)) )) = 0);
  WR11: (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 = 'crest')) )) <= 1)) ))
        = 0)) )) = 0);
  WR12: (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.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
 WR13: (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.'
       + '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.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 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.DESCRIPTIVE_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: (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 = 'thread runout occurrence') AND
      (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
      'AIC_MACHINING_FEATURE.SHAPE_ASPECT_RELATIONSHIP.'
      + 'RELATED_SHAPE_ASPECT') |
      ((sar.description = 'thread runout usage') AND
      (('AIC_MACHINING_FEATURE.SHAPE_DEFINING_RELATIONSHIP')
```

```
       IN TYPEOF(sar))) ) |
       ('AIC_MACHINING_FEATURE.THREAD_RUNOUT'
       IN TYPEOF(sdr.relating_shape_aspect)) )) <= 1)) )) = 1)) )) = 0);

 END_ENTITY;   -- thread
(*
```

Formal propositions:

WR1: The implicit representation of the **thread** shall contain between six and eleven **representation_item**s.

WR2: Exactly one **representation_item** used for the implicit representation of the **thread** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'major diameter'.

WR3: At most one **representation_item** used for the implicit representation of the **thread** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'minor diameter'.

WR4: Exactly one **representation_item** used for the implicit representation of the **thread** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'pitch diameter'.

WR5: Exactly one **representation_item** used for the implicit representation of the **thread** shall be of type **measure_representation_item** and **ratio_measure_with_unit** with a **name** of 'number of threads'.

WR6: Exactly one **representation_item** used for the implicit representation of the **thread** shall be of type **descriptive_representation_item** with a **name** of 'fit class'.

WR7: Exactly one **representation_item** used for the implicit representation of the **thread** shall be of type **descriptive_representation_item** with a **name** of 'form'.

WR8: Exactly one **representation_item** used for the implicit representation of the **thread** shall be of type **descriptive_representation_item** with a **name** of 'hand' and **description** of 'left' or 'right'.

WR9: At most one **representation_item** used for the implicit representation of the **thread** shall be of type **descriptive_representation_item** with a **name** of 'qualifier'.

WR10: Exactly one **representation_item** used for the implicit representation of the **thread** shall be of type **descriptive_representation_item** with a **name** of 'thread side' and a **description** of either 'internal' or 'external'.

WR11: At most one **representation_item** used for the implicit representation of the **thread** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'crest'.

WR12: The **thread** 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 exactly one **shape_defining_relationship** with a **description** of 'applied area usage' and the **relating_shape_aspect** is an **applied_area**.

WR13: Exactly one **thread** 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**.

WR14: Exactly one **representation_item** used for the implicit representation of the **thread** shall be of type **descriptive_representation_item** with a **name** of 'fit class 2'.

WR15: At most one **representation_item** used for the implicit representation of the **thread** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'nominal size'.

WR16: The **thread** shall be the basis shape for at most one **shape_aspect** with a **description** of 'thread runout occurrence' that is the **related_shape_aspect** in exactly one **shape_defining_relationship** with a **description** of 'thread runout usage' and the **relating_shape_aspect** is an **thread_runout**.

Informal propositions:

IP1: The location of the **thread** shall be at a distance from the end of a cylindrical face, and on the axis of the cylindrical face.

IP2: The Z direction of the **thread** shall be in the direction of the center axis of the cylindrical face.

IP3: If the **name** of the **descriptive_representation_item** is 'fit class' and the first character of the **description** is 'M', then the thread is metric.

4.2.62 thread_runout

An **thread_runout** is a type of **shape_aspect** that is the representation of the thread runout requirements used in the definition of the **thread feature_definition**.

NOTE A Thread_runout is defined in ISO 10303-224:2006, 4.2.7 and defines the requirement for **thread_runout**.

EXPRESS specification:

```
*)
ENTITY thread_runout
  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 (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 ['length of runout','pitch or dimension',
         'included or extra']) )) > 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 = 'length of runout')) )) = 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 |
        (('AIC_MACHINING_FEATURE.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'pitch or dimension')
        AND (it.description IN ['pitch','pitch or dimension']))
        )) =  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.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'included or extra')
        AND (it.description IN ['included','extra']))
        )) =  1)) )) = 0)) )) = 0);
END_ENTITY; -- thread_runout
(*
```


Formal propositions:

WR1: The **thread_runout** shall be an aspect of the shape of a **product_definition_shape**.

WR2: The **thread_runout** shall have its implicit representation specified by exactly one **shape_-representation_with_parameters**.

WR3: The **thread_runout** shall have an implicit representation that contains exactly three **representation_item**s in its set of **items**.

WR4: The implicit representation of an **thread_runout** shall contain only **representation_item**s in its set **name** of either'length of runout', 'pitch or dimension' or 'included or extra'

WR5: Exactly one **representation_item** used for the implicit representation of the **thread_runout** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'length of runout'.

WR6: Exactly one **representation_item** used for the implicit representation of the **thread_runout** shall be of type **descriptive_representation_item** with a **name** of 'pitch or dimension' and a description of either . 'pitch' or 'dimension'.

WR7: Exactly one **representation_item** used for the implicit representation of the **thread_runout** shall be of type **descriptive_representation_item** with a **name** of 'included or extra' and a description of either 'included' or 'extra'.

4.2.63 transition_feature

A **transition_feature** is a type of **shape_aspect** that is the representation of a transition between two **shape_aspect** entities. The placement of a **transition_feature** is dependent on the placement of the two **shape_aspect** entities.

EXPRESS specification:

```
*)
ENTITY transition_feature
    SUPERTYPE OF (ONEOF (chamfer,edge_round,fillet))
  SUBTYPE OF (shape_aspect);
   WHERE
    WR1: SIZEOF(['AIC_MACHINING_FEATURE.PRODUCT_DEFINITION',
         'AIC_MACHINING_FEATURE.COMPOUND_FEATURE']
         * TYPEOF(SELF.of_shape.definition)) = 1;
    WR2: SIZEOF(['AIC_MACHINING_FEATURE.CHAMFER',
        'AIC_MACHINING_FEATURE.EDGE_ROUND',
        'AIC_MACHINING_FEATURE.FILLET'] *
        TYPEOF(SELF)) = 1;
END_ENTITY; -- transition_feature
(*
```

Formal propositions:

WR1: The **transition_feature** shall identify an aspect of the shape of a **product_definition** or a **compound_feature**.

WR2: The **transition_feature** shall be a **fillet**, **edge_round**, or a **chamfer**.

4.2.64 turned_knurl

A **turned_knurl** is a type of **feature_definition** that is the representation of a diamond, diagonal, or straight shape that is applied to all or a portion of a **shape_aspect**.

NOTE A Turned_knurl is defined in ISO 10303-224:2006, 4.2.259 and defines the requirement for **turned_knurl** .

EXPRESS specification:

```
*)
ENTITY turned_knurl
  SUBTYPE OF (feature_definition);
   WHERE
    WR1: (SELF\characterized_object.description IN
         ['diamond','diagonal','straight']);
    WR2:  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
         ({6 <= SIZEOF(pdr.used_representation.items) <= 9}) )) = 1 )) = 1;
    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(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 teeth')) )) <= 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 |
         ((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);
    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 = 'nominal diameter')) )) = 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 | ((SIZEOF([
        'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT']
        * TYPEOF(it)) = 2) AND (it.name = 'tooth depth')) )) <= 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.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'root fillet')) )) <= 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 |
        ((SIZEOF([
        'AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.LENGTH_MEASURE_WITH_UNIT'] *
```

```
       TYPEOF(it)) = 2) AND (it.name = 'diametral pitch')) )) = 1)) ))
       = 0)) )) = 0);
  WR9: ((NOT (SELF\characterized_object.description IN
       ['diamond','diagonal'])) 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 = 'helix angle')) )) = 1)) ))
       = 0)) )) = 0));
 WR10: ((NOT (SELF\characterized_object.description = 'diagonal')) 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.DESCRIPTIVE_REPRESENTATION_ITEM'
       IN TYPEOF(it)) AND (it.name = 'helix hand')) )) = 1)) ))
       = 0)) )) = 0));
 WR11: (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.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
```



```
 WR12: (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.'
       + '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.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
END_ENTITY; -- turned_knurl
(*
```

Formal propositions:

WR1: The **description** for the **turned_knurl** shall be either 'diamond', 'diagonal', or 'straight'.

WR2: The implicit representation of the **thread** shall contain between six and nine **representation_item**s.

WR3: At most one **representation_item** used for the implicit representation of the **turned_knurl** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'number of teeth'.

WR4: Exactly one **representation_item** used for the implicit representation of the **turned_knurl** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'major diameter'.

WR5: Exactly one **representation_item** used for the implicit representation of the **turned_knurl** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'nominal diameter'.

WR6: At most one **representation_item** used for the implicit representation of the **turned_knurl** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'tooth depth'.

WR7: At most one **representation_item** used for the implicit representation of the **turned_knurl** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'root fillet'.

WR8: Exactly one **representation_item** used for the implicit representation of the **turned_knurl** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'diametral pitch'.

WR9: If the **turned_knurl** has a **description** of either 'diagonal' or 'diamond', exactly one **representation_item** used for the implicit representation of the **turned_knurl** shall be of type **measure_-representation_item** and **length_measure_with_unit** with a **name** of 'helix angle'.

WR10: If the **turned_knurl** has a **description** of 'diagonal' exactly one **representation_item** used for the implicit representation of the **turned_knurl** shall be of type **descriptive_representation_item** with a **name** of 'helix hand'.

WR11: The **turned_knurl** 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 exactly one **shape_defining_relationship** with a **description** of 'applied area usage' and a **relating_shape_aspect** that is an **applied_area**.

WR12: Exactly one **turned_knurl** 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**.

Informal propositions:

IP1: The location of the **turned_knurl** shall be at a distance from the end of a cylindrical face, and on the axis of the cylindrical face.

IP2: The Z direction of the **turned_knurl** shall be in the direction of the center axis of the cylindrical face.

4.2.65 vee_profile

A **vee_profile** is a type of **shape_aspect** that is the representation of two connected straight lines, with a location and a position. The **vee_profile** is located at the position where the two lines connect, the X direction intersects the angle between the two connected lines in the direction of volume removal, and the Y direction is orthogonal to the X direction.

NOTE A Vee_profile is defined in ISO 10303-224:2006, 4.2.260 defines the requirement for **vee_profile** .

EXPRESS specification:

```
*)
ENTITY vee_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) >= 3)
     AND  (SIZEOF (impl_rep.used_representation.items) <= 6))))
     = 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 |
     (srwp_i.name = 'orientation') OR
     (srwp_i.name = 'profile angle') OR
     (srwp_i.name = 'tilt angle') OR
     (srwp_i.name = 'profile radius')  OR
     (srwp_i.name = 'first length') OR
     (srwp_i.name = 'second length') ))
     = 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 |
     ('AIC_MACHINING_FEATURE.PLACEMENT' IN TYPEOF (it)) AND
     (it.name = 'orientation'))) = 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.LENGTH_MEASURE_WITH_UNIT'
     IN TYPEOF (it\measure_with_unit.value_component)) AND
     (it.name = 'profile radius'))) <= 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 = 'profile angle'))) = 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 |
        (SIZEOF
        (['AIC_MACHINING_FEATURE.MEASURE_REPRESENTATION_ITEM',
        'AIC_MACHINING_FEATURE.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND
        (it.name = 'tilt angle'))) = 1))) = 0))) = 0;
    WR9: 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.PLANAR_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation))AND
        (pdr.used_representation.name = 'profile limit'))) <= 1))) = 0;
    WR10: 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.LENGTH_MEASURE_WITH_UNIT'
        IN TYPEOF (it\measure_with_unit.value_component)) AND
        (it.name = 'first length'))) <= 1))) = 0))) = 0;
    WR11: 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.LENGTH_MEASURE_WITH_UNIT'
        IN TYPEOF (it\measure_with_unit.value_component)) AND
        (it.name = 'second length'))) <= 1))) = 0))) = 0;
END_ENTITY; -- vee_profile
(*
```


Formal propositions:

WR1: The **vee_profile** shall be an aspect of the shape of a **feature_component_definition**.

WR2: The **vee_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 **vee_profile** shall contain at least three and at most four **representation_item**s in its set of **items**.

WR4: The implicit representation of an **vee_profile** shall contain only **representation_-item**s in its set of **items** with a **name** of 'orientation', 'profile angle', 'tilt angle', and 'profile radius'.

WR5: Exactly one **representation_item** used for the implicit representation of a **vee_profile** shall be of type **placement** with a **name** of 'orientation'.

WR6: At most one **representation_item** used for the implicit representation of a **vee_profile** shall be of type **measure_representation_item** with a **value_component** of type **length_measure_with_unit** and a **name** of 'profile radius'.

WR7: Exactly one **representation_item** used for the implicit representation of a **vee_profile** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'profile angle'.

WR8: Exactly one **representation_item** used for the implicit representation of a **vee_profile** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'tilt angle'.

WR9: The **vee_profile** shall have at most one **planar_shape_representation** with a **name** of 'profile limit'.

WR10: At most one **representation_item** used for the implicit representation of a **vee_profile** shall be of type **measure_representation_item** with a **value_component** of type **length_measure_with_unit** and a **name** of 'first length'.

WR11: At most one **representation_item** used for the implicit representation of a **vee_profile** shall be of type **measure_representation_item** with a **value_component** of type **length_measure_with_unit** and a **name** of 'second length'.

Informal propositions:

IP1: The location of the **vee_profile** shall be at the position where the two lines connect.

IP2: The **vee_profile** shall be defined with the tilt angle measured from the X-axis and the opening of the profile in the direction of the Y-axis.

```
*)
END_SCHEMA;    -- AIC_MACHINING_FEATURE
```

(*

Annex A
(normative)
AIM short names

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

Table A.1 — AIM short names of entities

AIM Element	Short name
APPLIED_AREA	APPAR
BOSS	ADUCA
BOSS_TOP	BSSTP
CHAMFER	CHMFR
CHAMFER_OFFSET	CHMOFF
CIRCULAR_PATTERN	CRCPTT
CIRCULAR_CLOSED_PROFILE	CRCLPR
CLOSED_PATH_PROFILE	CLPTPR
COMPOSITE_HOLE	CMPHL
COMPOUND_FEATURE	CMPFTR
DIRECTION_SHAPE_REPRESENTATION	DRSHRP
EDGE_ROUND	EDGRND
EXTERNALLY_DEFINED_FEATURE_DEFINITION	EDFD
FACE_SHAPE_REPRESENTATION	FCSHRP
FEATURE_COMPONENT_DEFINITION	FTCMDF
FEATURE_COMPONENT_RELATIONSHIP	FTCMRL
FEATURE_DEFINITION	FTRDFN
FEATURE_PATTERN	FTRPTT
FILLET	FILLET
FLAT_FACE	FLTFC
GEAR	GEAR
HOLE_BOTTOM	HLBTT

Table A.1 – AIM short names of entities (continued)

AIM Element	Short name
INSTANCED_FEATURE	INSFTR
LINEAR_PROFILE	LNRPRF
LOCATION_SHAPE_REPRESENTATION	LCSHRP
MARKING	MRKNG
MODIFIED_PATTERN	MDFPTT
NGON_CLOSED_PROFILE	NGCLPR
OPEN_PATH_PROFILE	OPPTPR
OUTER_ROUND	OTRRND
OUTSIDE_PROFILE	OTSPRF
PARTIAL_CIRCULAR_PROFILE	PRCRPR
PATH_FEATURE_COMPONENT	PTFTCM
PATH_SHAPE_REPRESENTATION	PTSHRP
PATTERN_OFFSET_MEMBERSHIP	PTOFMM
PATTERN_OMIT_MEMBERSHIP	PTOMMM
PLANAR_SHAPE_REPRESENTATION	PLSHRP
POCKET	POCKET
POCKET_BOTTOM	PCKBTT
PROFILE_FLOOR	PRFFLR
PROTRUSION	PRTRSN
RECTANGULAR_CLOSED_PROFILE	RCCLPR
RECTANGULAR_PATTERN	RCTPTT
REMOVAL_VOLUME	RMVVLM
REPLICATE_FEATURE	RPLFTR
REVOLVED_PROFILE	RVLPRF
RIB_TOP	RBTP
RIB_TOP_FLOOR	RBTPFL
ROUND_HOLE	RNDHL
ROUNDED_END	RNDEND

Table A.1 – AIM short names of entities (continued)

AIM Element	Short name
ROUNDED_U_PROFILE	RNUPR
SHAPE_DEFINING_RELATIONSHIP	SHDFRL
SHAPE_REPRESENTATION_WITH_PARAMETERS	SRWP
SPHERICAL_CAP	SPHCP
SQUARE_U_PROFILE	SQUPR
STEP	STEP
SLOT	SLOT
SLOT_END	SLTEND
TAPER	TAPER
TEE_PROFILE	TPRF
THREAD	THREAD
THREAD_RUNOUT	THRRNT
TRANSITION_FEATURE	TRNFTR
TURNED_KNURL	TRNKNR
VEE_PROFILE	VPRF

Annex B
(normative)
Information object registration

B.1 Document identification

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

{iso standard 10303 part(522) version(2)}

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

B.2 Schema identification

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

{iso standard 10303 part(522) version(2) schema(1) aic-machining-feature (1)}

is assigned to aic_machining_feature expanded schema (see Annex A).

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

Annex C
(informative)
EXPRESS-G diagrams

The diagrams in this annex are generated from the short listing given in Clause 4 and correspond to the EXPRESS schemas specified in this part of ISO 10303. The diagrams use the EXPRESS-G graphical notation for the EXPRESS language. EXPRESS-G is defined in Annex D of ISO 10303-11.

NOTE The select types attribute_type, axis2_placement, derived_property_select, founded_item_select, pcurve_or_surface, product_or_formation_or_definition, reversible_topology, shell, trimming_select, and vector_or_direction are interfaced into the AIC expanded listing according to the implicit interface rules of ISO 10303-11. These select types are not referenced by other entities in this part of ISO 10303.

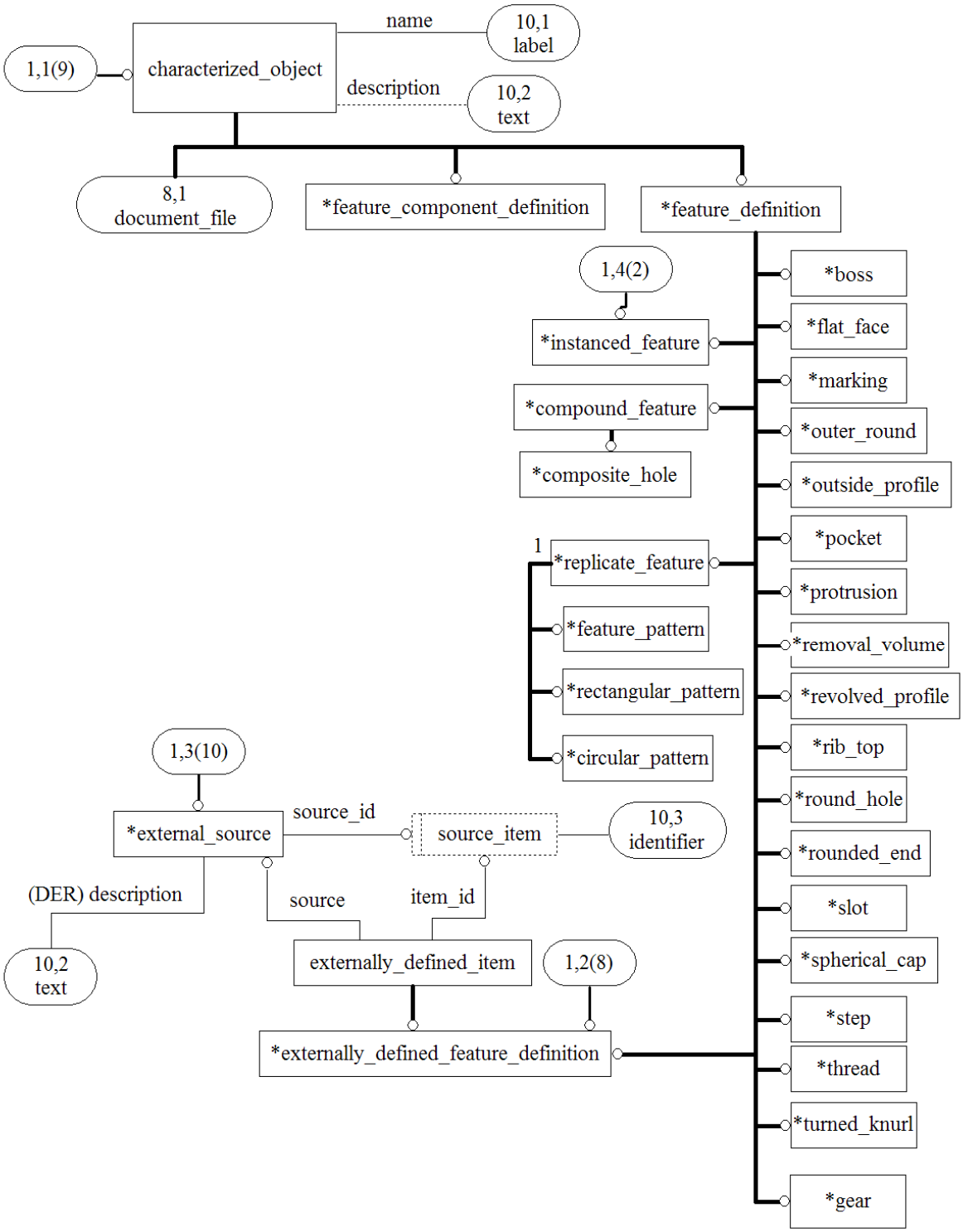

Figure C.1 — EXPRESS-G diagram of the aic_machining_feature (1 of 10)

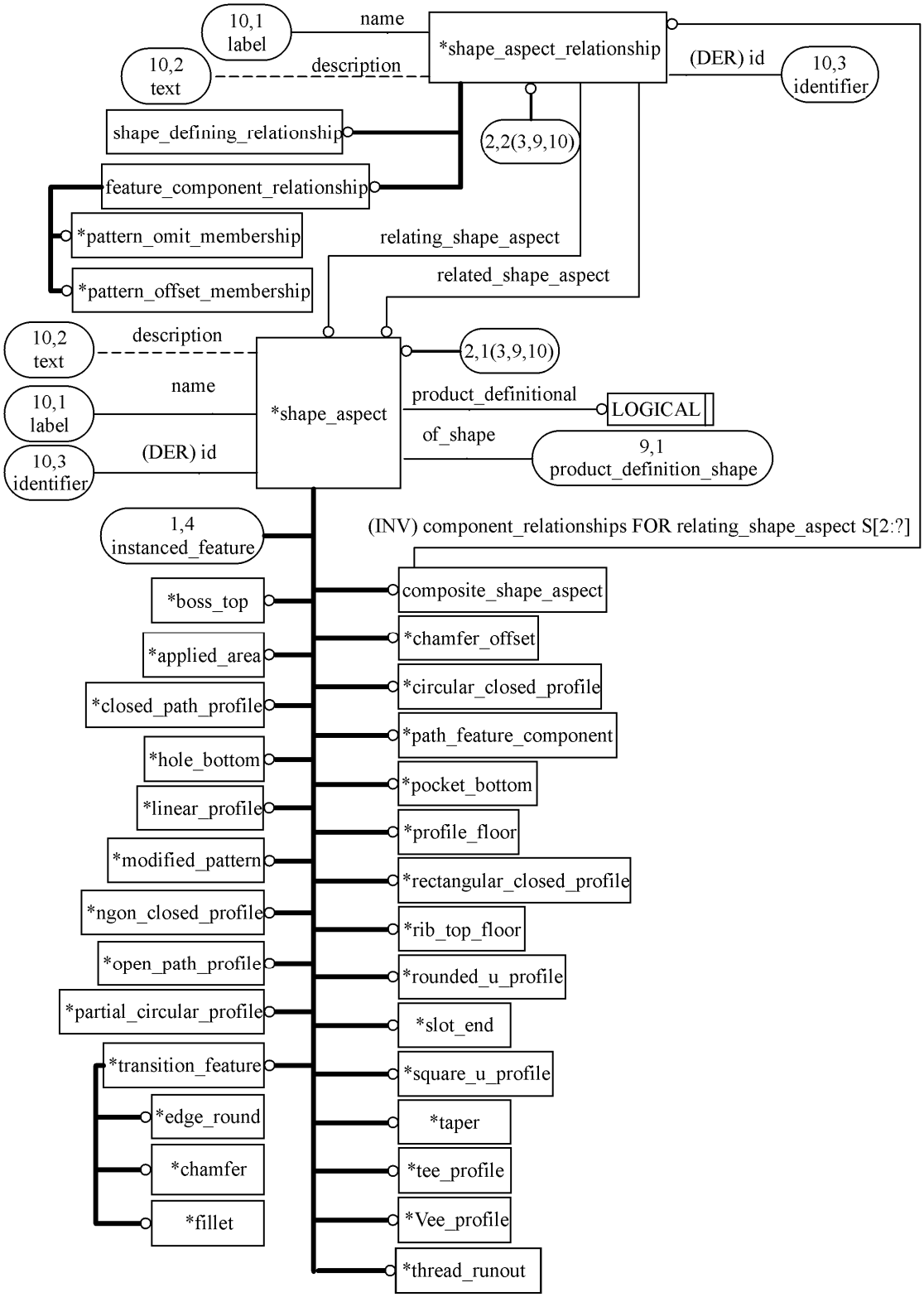

Figure C.2 — EXPRESS-G diagram of the aic_machining_feature (2 of 10)

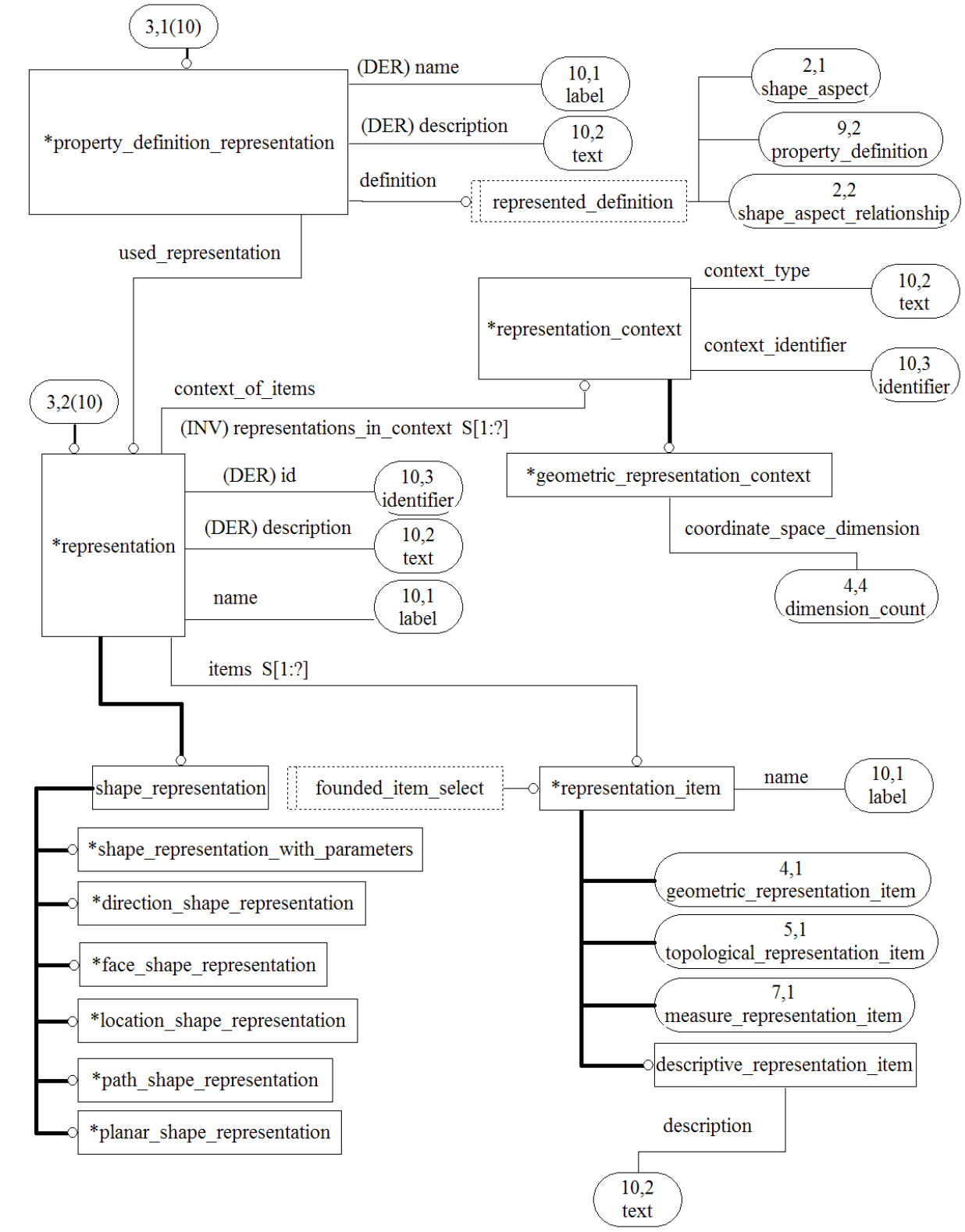

Figure C.3 — EXPRESS-G diagram of the aic_machining_feature (3 of 10)

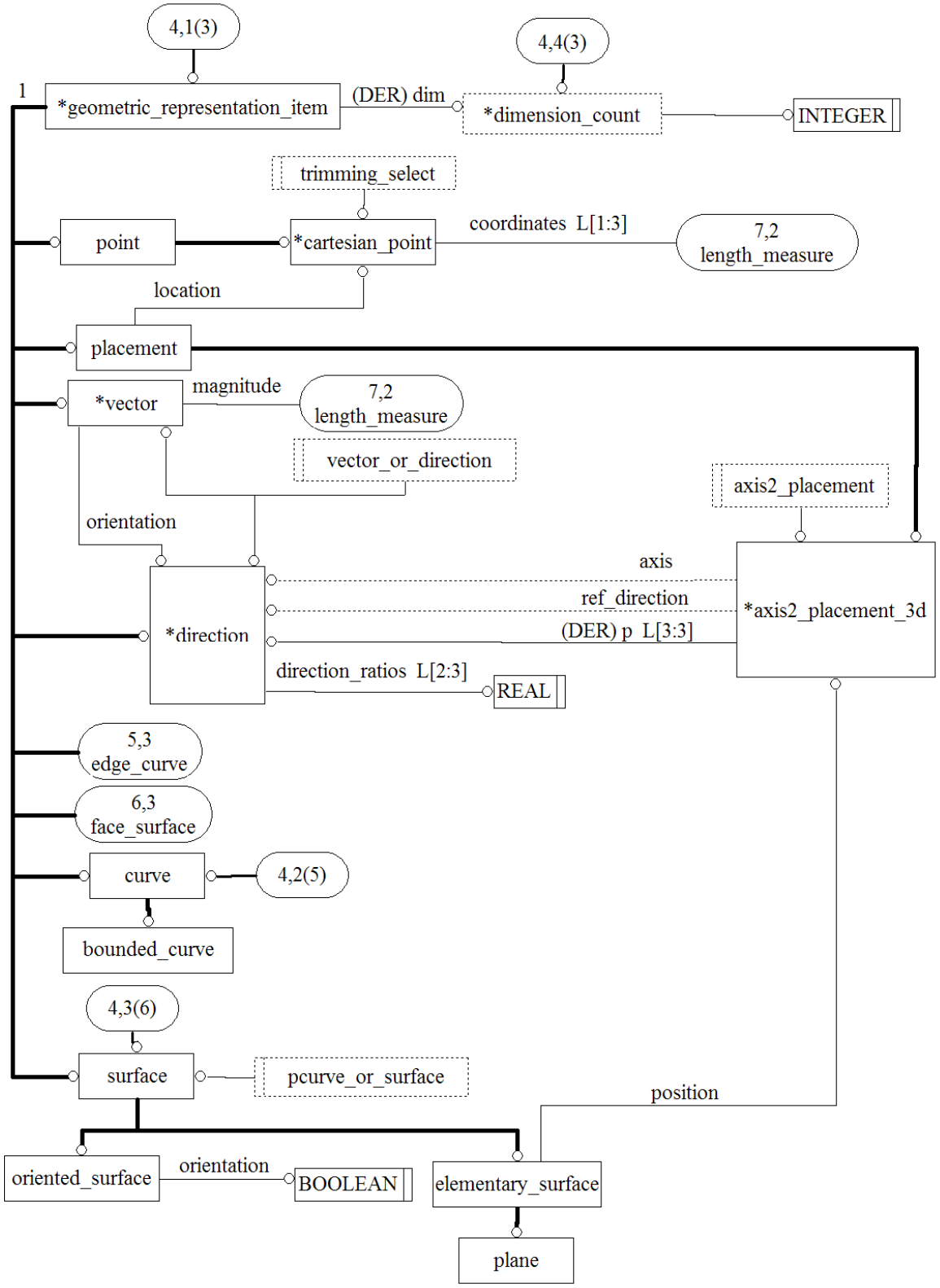

Figure C.4 — EXPRESS-G diagram of the aic_machining_feature (4 of 10)

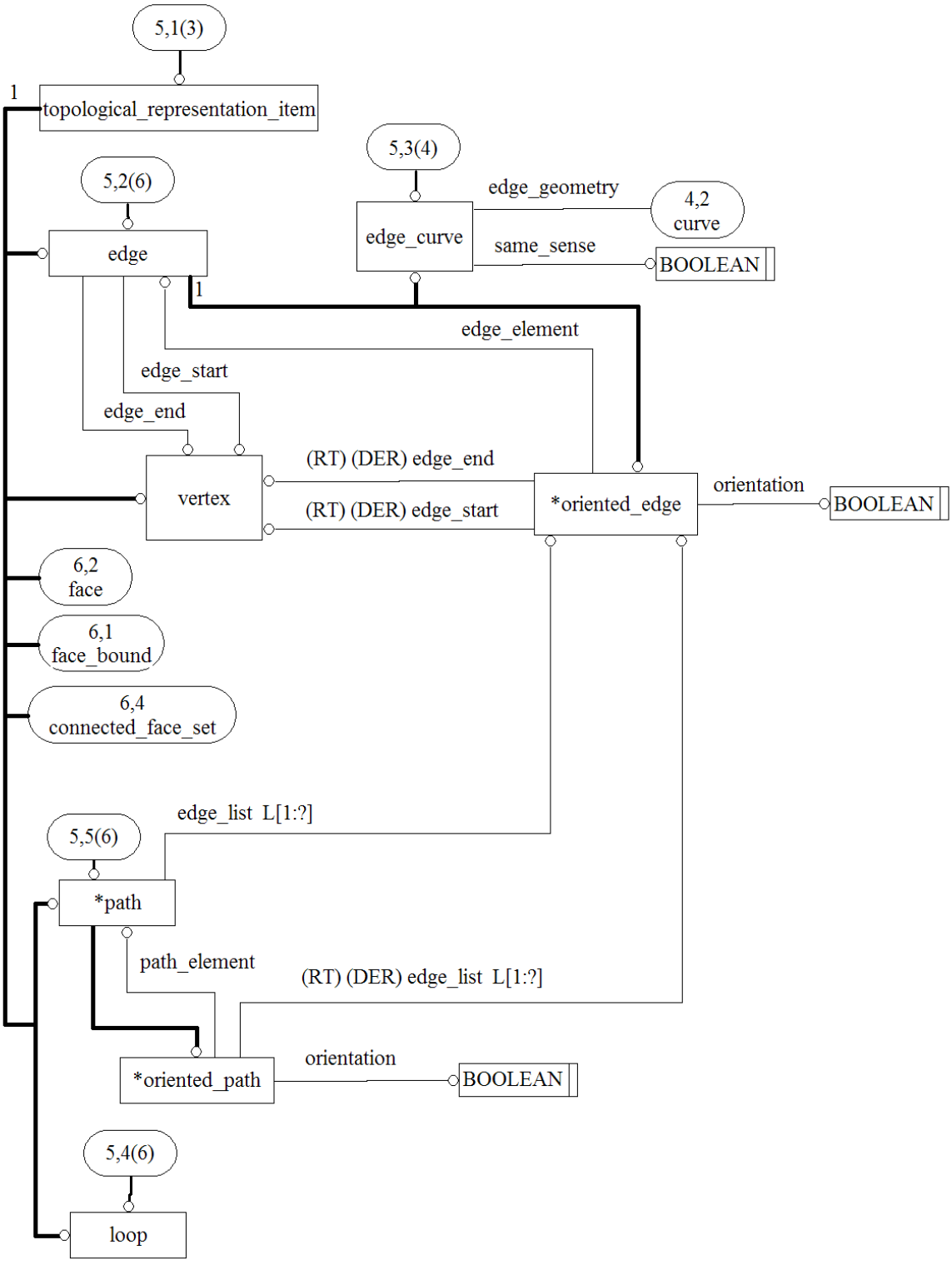

Figure C.5 — EXPRESS-G diagram of the aic_machining_feature (5 of 10)

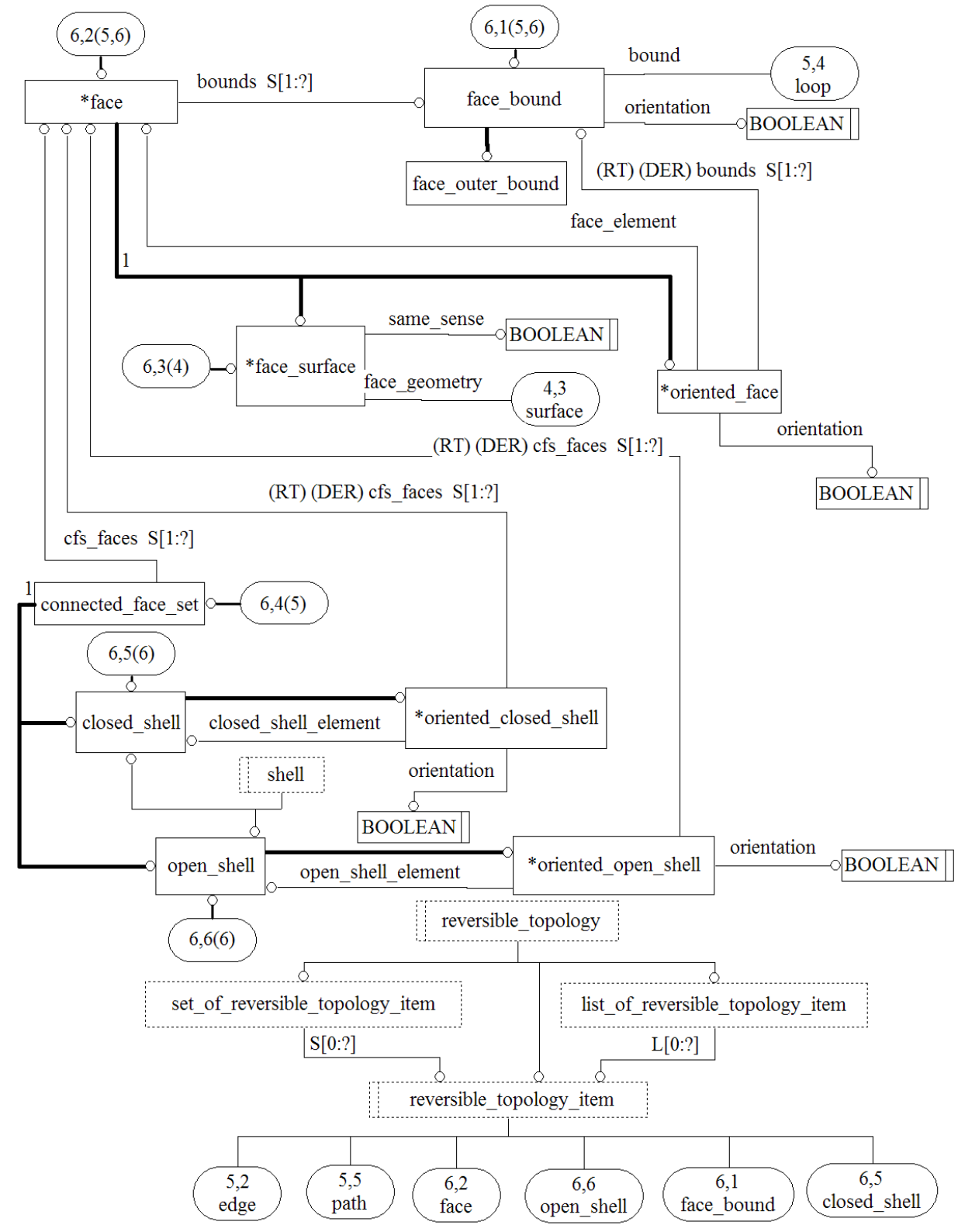

Figure C.6 — EXPRESS-G diagram of the aic_machining_feature (6 of 10)

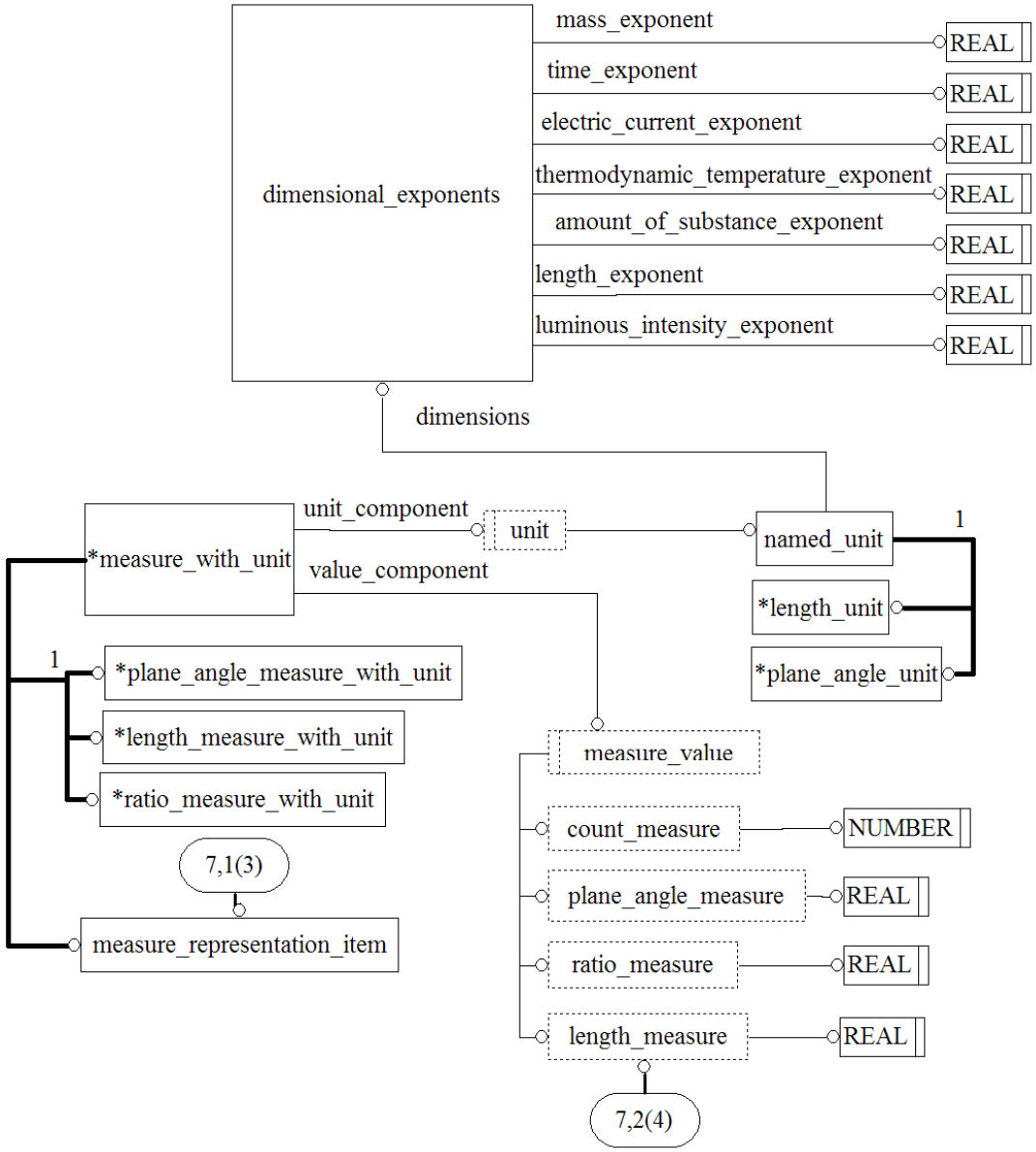

Figure C.7 — EXPRESS-G diagram of the aic_machining_feature (7 of 10)

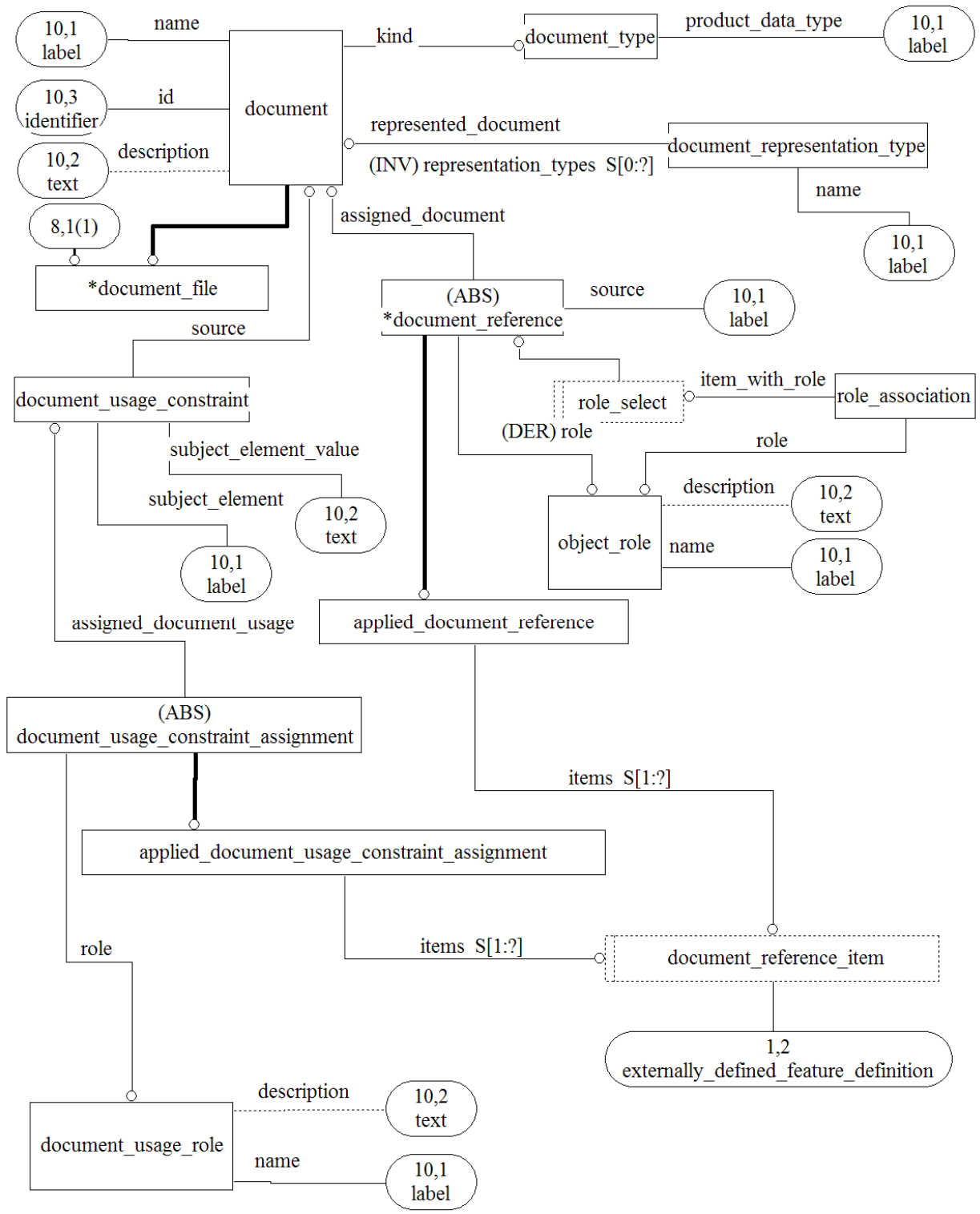

Figure C.8 — EXPRESS-G diagram of the aic_machining_feature (8 of 10)

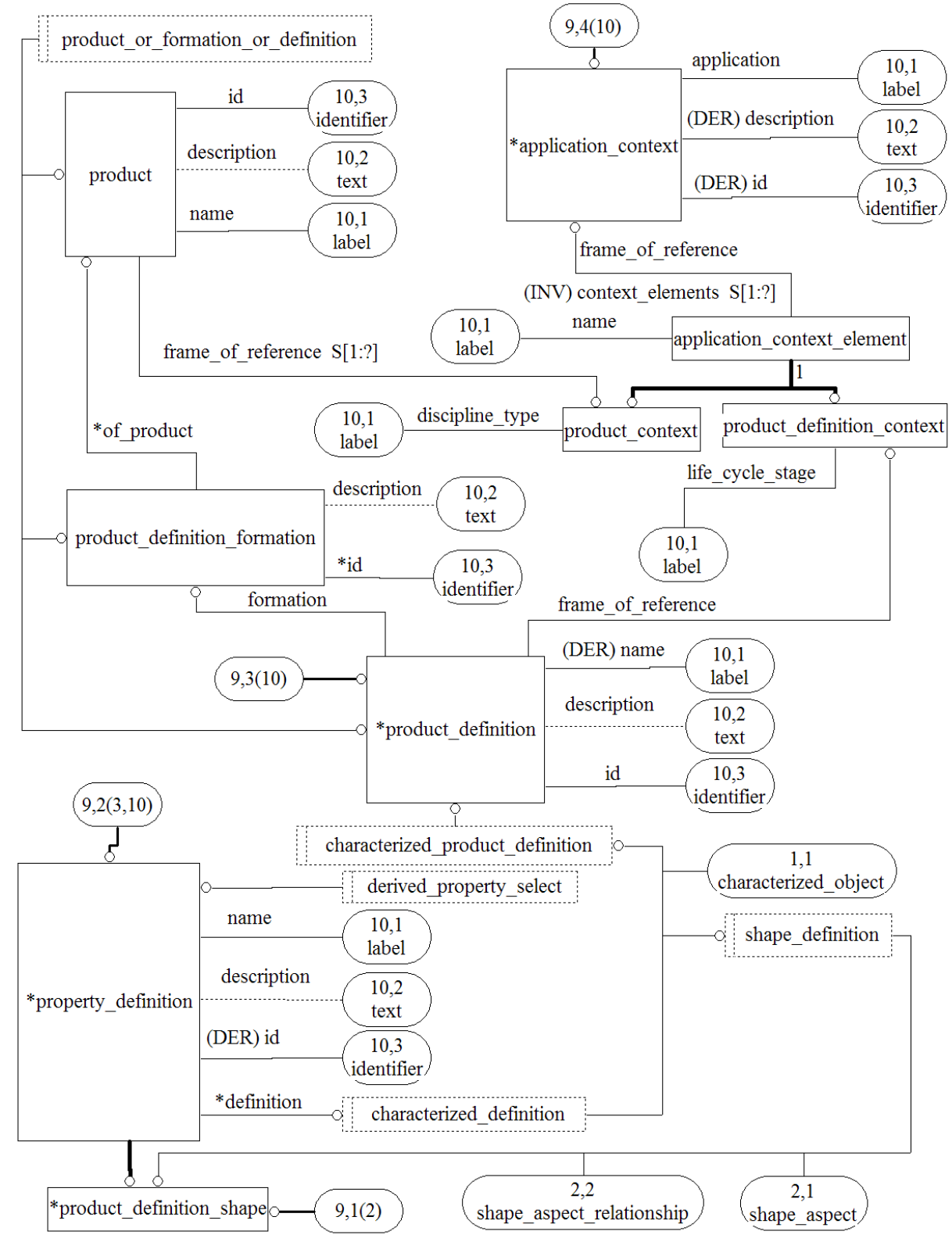

Figure C.9 — EXPRESS-G diagram of the aic_machining_feature (9 of 10)

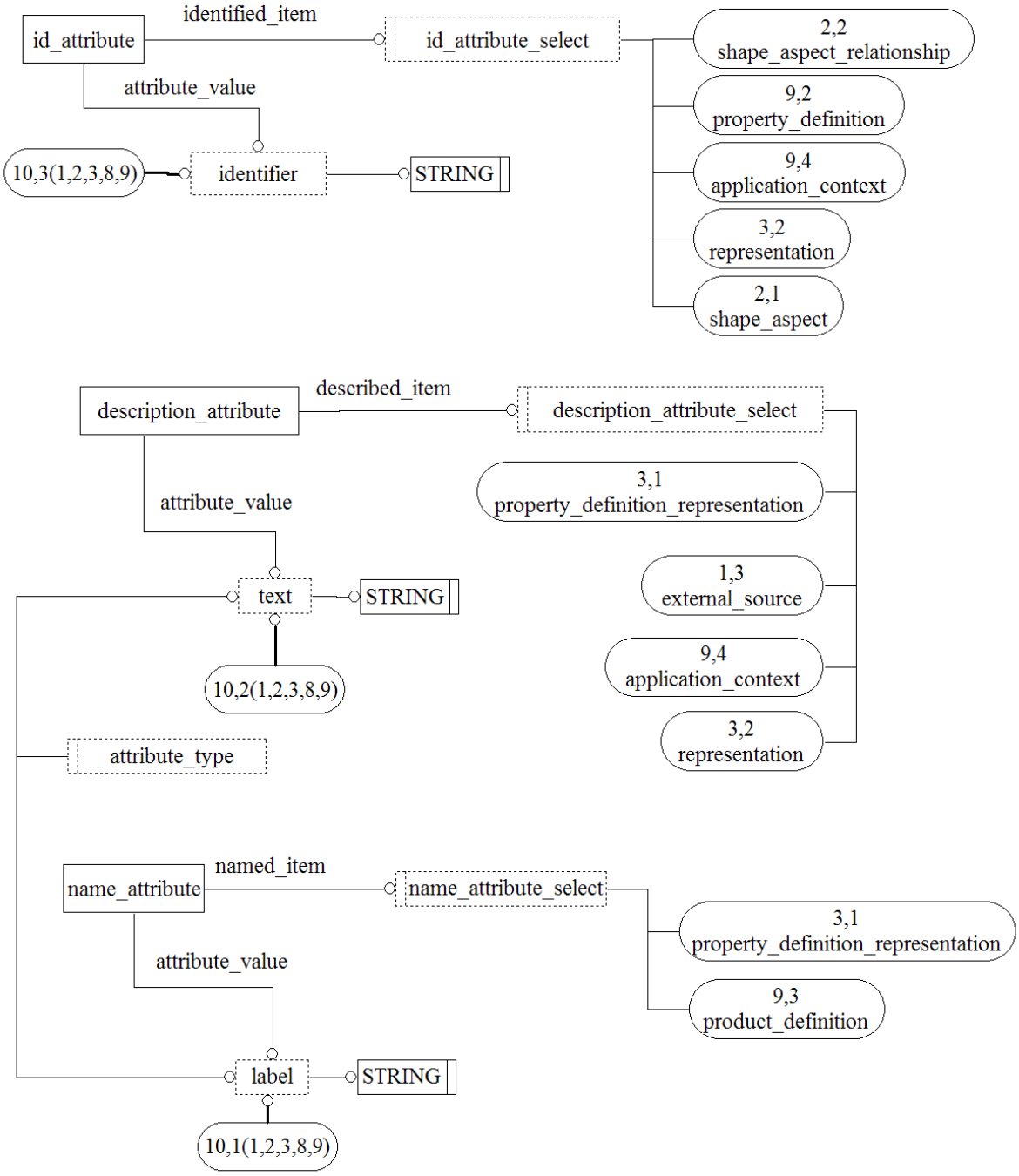

Figure C.10 — EXPRESS-G diagram of the aic_machining_feature (10 of 10)

Annex D
(informative)
Computer interpretable listings

A listing of each EXPRESS schema specified in this part of ISO 10303, without comments or other explanatory text, is available in computer-interpretable form and can be found at the following URLs:

Short names: http://www.tc184-sc4.org/Short_Names

EXPRESS: http://www.tc184-sc4.org/EXPRESS

If there is difficulty accessing these sites contact ISO Central Secretariat or contact the ISO TC 184/SC4 Secretariat directly at: sc4sec@tc184-sc4.org.

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

Annex E
(informative)
Technical discussion

E.1 externally_defined_feature_definition usage

E.1.1 General

The **externally_defined_feature_definition** entity (see 4.2.13) defines a reference to an external document that gives additonal information for a machining feature definition. This entity has local constraints that require the existence of **applied_document_reference** and **applied_document_usage_-constraint_assignment** entities. These entities are not defined in this part of ISO 10303, they are defined in the application protocol using this part. This annex recommends definitions of entities that shall appear in an application protocol to satisfy the requirements of **externally_defined_feature_definition.**

E.1.2 document_reference_item

A **document_reference_item** identifies an **externally_defined_feature_definition** to which a referenced document may be assigned. The **document_reference_item** is referenced by **applied_document_-reference** (see E.1.3) and **applied_document_usage_constraint_assignment** (see E1.4).

NOTE An application protocol may define a document_reference_item to contain a list of integrated resources necessary to fulfill the requirements of the application protocol. However the document_reference_item shall additionally contain exteranlly_defined_feature_definition to fulfill the requirements for the usage of machining features.

EXPRESS specification:

```
*)
TYPE document_reference_item = SELECT
  (externally_defined_feature_definition);
END_TYPE;
(*
```

E.1.3 applied_document_reference

An **applied_document_reference** specifies those **document_reference_item**s to which a referenced **document** is assigned.

NOTE An application protocol may define an applied_document_reference to reference a list of integrated resources necessary to fulfill the requirements of the application protocol. This part of ISO 10303 does not constrain the usage of applied_document_reference. The applied_document_reference shall be used to fulfill the requirements for the usage of machining features. However if an application protocol has additional requirements it may further constrain the applied_document_reference.

EXPRESS specification:

```
*)
ENTITY applied_document_reference
  SUBTYPE OF (document_reference);
    items : SET [1:?] OF document_reference_item;
END_ENTITY;
(*
```

Attribute definition:

items: the set of **document_reference_item**s to which a referenced document is assigned.

E.1.4 applied_document_usage_constraint_assignment

An **applied_document_usage_constraint_assignment** specifies those **document_reference_item**s to which a referenced **document** is assigned.

NOTE An application protocol may define an applied_document_usage_constraint_assignment to reference a list of integrated resources necessary to fulfill the requirements of the application protocol. This part of ISO 10303 does not constrain the usage of applied_document_usage_constraint_assignment . The applied_document_usage_-constraint_assignment shall be used to fulfill the requirements for the usage of machining features. However if an application protocol has additional requirements it may further constrain the applied_document_usage_constraint_-assignment .

EXPRESS specification:

```
*)
ENTITY applied_document_usage_constraint_assignment
  SUBTYPE OF (document_usage_constraint_assignment);
    items : SET [1:?] OF document_reference_item;
END_ENTITY;
(*
```

Attribute definition:

items: the set of **document_reference_item**s to which a referenced **document** is assigned.

E.1.5 document_file

A **document_file** is a type of **document** and **characterized_object** that is the representation of the physical document that contains the information about **marking**, **knurl**, or **thread** specifications.

NOTE An application protocol may define other integrated resources to reference a document_file necessary to fulfill the requirements of the application protocol. The document_file shall be used to fulfill the requirements for the usage of machining features. However if an application protocol has additional requirements it may further constrain the document_file.

EXPRESS specification

```
*)
 ENTITY document_file
  SUBTYPE OF (document,
              characterized_object);
  WHERE
   WR1 : SELF\characterized_object.name = '';
   WR2 : NOT EXISTS(SELF\characterized_object.description);
   WR3 : SIZEOF(QUERY(drt <* SELF\document.
         representation_types | drt.name IN ['digital','physical'])) = 1;
 END_ENTITY;
(*
```

Formal Propositions:

WR1: The name of the **characterized_object** shall not be used, use name of **document**.

WR2: The description of the **characterized_object** shall not be used, use description of **document**.

WR3: The **document** shall have exactly one **document_representation_type** with a name of either 'digital' or 'physical'.

E.1.6 restrict_document_file

The **restrict_document_file** is a global rule that restricts the use of **document_file**.

EXPRESS specification

```
*)
RULE restrict_document_file FOR(DOCUMENT_FILE);
WHERE
    WR1: SIZEOF (QUERY (df <* document_file |
       (SIZEOF(QUERY(adr<* QUERY(dr <* USEDIN(df,
   'AIC_MACHINING_FEATURE.DOCUMENT_REFERENCE.ASSIGNED_DOCUMENT') |
       'AIC_MACHINING_FEATURE.APPLIED_DOCUMENT_REFERENCE'
       IN TYPEOF(dr))|
     'AIC_MACHINING_FEATURE.EXTERNALLY_DEFINED_FEATURE_DEFINITION'
       IN TYPEOF(adr.items)
       ))=1) OR
       (SIZEOF(QUERY (duc <* USEDIN(df,
       'AIC_MACHINING_FEATURE.DOCUMENT_USAGE_CONSTRAINT.SOURCE') |
       NOT
       (SIZEOF(QUERY(aduc<* QUERY(duca <* USEDIN(duc,
    'AIC_MACHINING_FEATURE.DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT.'+
       'ASSIGNED_DOCUMENT_USAGE') |
       'AIC_MACHINING_FEATURE.'+
       'APPLIED_DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT'
       IN TYPEOF(duca))|
     'AIC_MACHINING_FEATURE.EXTERNALLY_DEFINED_FEATURE_DEFINITION'
       IN TYPEOF(aduc.items)
       ))=1))) = 0) ))=0;
    WR2: SIZEOF (QUERY (df <* document_file |
       (SIZEOF(QUERY(drt <* USEDIN(df,
```



```
       'AIC_MACHINING_FEATURE.'+
       'DOCUMENT_REPRESENTATION_TYPE.REPRESENTED_DOCUMENT') |
       (drt.name='physical')))=1)))=0;
END_RULE; -- restrict_document_file
(*
```

Formal propositions:

WR1: The **document_file** shall be either the **associated_document** in exactly one **applied_document_reference** that contains one or more **external_defined_feature_definition** in its set of **items**, or a **source** in exactly one **applied_document_usage_constraint_assignment** that contains one or more **external_defined_feature_definition** in its set of **items**.

WR2: The **document_file** shall be the **represented_file** in exactly one **document_representation_type** with **name** = 'physical'.

E.1.7 restrict_externally_defined_feature_definition

The **restrict_externally_defined_feature_definition** is a global rule that restricts the use of **externally_defined_feature_definition**.

EXPRESS specification

```
*)
RULE restrict_externally_defined_feature_definition
  FOR(EXTERNALLY_DEFINED_FEATURE_DEFINITION);
WHERE
  WR1: SIZEOF (QUERY (ex <* externally_defined_feature_definition |
       (NOT (SIZEOF(QUERY( doc <*(QUERY( adr <*USEDIN(ex,
       'AIC_MACHINING_FEATURE.APPLIED_DOCUMENT_REFERENCE.ITEMS') |
       'AIC_MACHINING_FEATURE.DOCUMENT'
       IN TYPEOF (adr.assigned_document) )) |
       'AIC_MACHINING_FEATURE.DOCUMENT_FILE' IN TYPEOF(doc) ))
       =1) OR
       NOT (SIZEOF(QUERY( doc <*(QUERY( aduc <*USEDIN(ex,
       'AIC_MACHINING_FEATURE.'+
       'APPLIED_DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT.ITEMS') |
       'AIC_MACHINING_FEATURE.DOCUMENT'
       IN TYPEOF (aduc\
       document_usage_constraint_assignment.
       assigned_document_usage.source) )) |
       'AIC_MACHINING_FEATURE.DOCUMENT_FILE' IN TYPEOF(doc) ))
       >=1))))=0;
END_RULE;
(*
```

Formal propositions:

WR1: The **externally_defined_feature_definition** shall be in the set of **items** of more than one **applied_document_reference** or exactly one **applied_document_usage_constraint_assignment** that defines the **document_file** containing the feature specification.

E.2 Machining features usage

E.2.1 General

This part of ISO 10303 contains all of the machining features defined in ISO 10303-224. Application protocols may have requirements that do not include all of the machining features defined in this part. The following example illustrates how to include all of the machining features into an application protocol.

EXAMPLE 1 USE FROM aic_machining_feature.

The following example illustrates how to include selected machining features into an application protocol.

EXAMPLE 2 USE FROM aic_machining_feature
(boss,
boss_top,
round_hole,
hole_bottom,
closed_path_profile,
rectangular,closed_profile,
shape_representation_with_parameters).

In the case when an application protocol includes all of the machining features but may have no requirements for a particular machining feature a global rule shall be written to indicate the entity is not instantiable. E.2.2 is an example of a global rule specifying there are no instances of a boss machining feature.

E.2.2 non_instantiable_boss

The **non_instantiable_boss** rule specifies that no instances of **boss** are making a reference to another entity.

EXPRESS specification:

```
*)
RULE non_instantiable_boss FOR (
            boss);
  WHERE
    WR1: (SIZEOF(QUERY ( da <* boss | (NOT (SIZEOF(
       USEDIN(da,'')) = 1)) )) = 0);
END_RULE; --   non_boss
(*
```

Argument definition:

boss: the set of all instances of **boss**.

Bibliography

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

ISO 10303-21, *Industrial automation systems and integration — Product data representation and exchange -- Part 21: Implementation methods: Clear text encoding of the exchange structure*

ISO 10303-22, *Industrial automation systems and integration — Product data representation and exchange -- Part 22: Implementation methods: Standard data access interface*

ISO 10303-43, *Industrial automation systems and integration — Product data representation and exchange -- Part 43: Integrated generic resource: Representation structures*

ISO 10303-44, *Industrial automation systems and integration — Product data representation and exchange -- Part 44: Integrated generic resource: Product structure configuration*

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