# ISO TC 184/SC4/WG3 N1089

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**Industrial automation systems and integration — Product data representation and exchange — Part 238: Application Protocols: Application interpreted model for computerized numerical controllers**

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**ABSTRACT:** This document specifies an application interpreted model (AIM) based on the application reference model for milling defined by ISO 14649-10, ISO 14649-11, and ISO 14649-111.

**KEYWORDS:** data exchange, computerized numerical controler, machine tool, milling, STEP-NC.

**COMMENTS TO READER:**

From now on, this document will be tracked by a WG3 N-number, but for the moment, I am maintaining a running version number to facilitate discussion and comments. This draft can be refered to as:

## STEP-NC AIM v2.8

The UOFs are identified and the mappings for all major concepts are in place. Mappings for the various specializations of the major concepts and some parameters have not yet been fully specified. Mappings that are grey shaded indicate some areas still in discussion.

Please refer to the Change Log at the end of the document for specific status information.

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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 standardizations.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 10303 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10303-238 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

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

Each part of this International Standard 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 is a member of the application protocols series.

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

`<http://www.nist.gov/sc4/editing/step/titles/>`

Annexes A, B, C, D, E and F form a normative part of this part of ISO 10303. Annexes G, H, J and K are for information only.

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# 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 protocol series. This part of ISO 10303 specifies an application protocol (AP) for <free text description of part in new paragraph>.

This application protocol defines the context, scope, and information requirements for <AP purposes> and specifies the integrated resources necessary to satisfy these requirements.

Application protocols provide the basis for developing implementations of ISO 10303 and abstract test suites for the conformance testing of AP implementations.

Clause 1 defines the scope of the application protocol and summarizes the functionality and data covered by the AP. Clause 3 lists the words defined in this part of ISO 10303 and gives pointers to words defined elsewhere. An application activity model that is the basis for the definition of the scope is provided in annex F. The information requirements of the application are specified in clause 4 using terminology appropriate to the application. A graphical representation of the information requirements, referred to as the application reference model, is given in annex G.

Resource constructs are interpreted to meet the information requirements. This interpretation produces the application interpreted model (AIM). This interpretation, given in 5.1, shows the correspondence between the information requirements and the AIM. The short listing of the AIM specifies the interface to the integrated resources and is given in 5.2. Note that the definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes which are not imported into the AIM. The expanded listing given in Annex A contains the complete EXPRESS for the AIM without annotation. A graphical representation of the AIM is given in annex H. Additional requirements for specific implementation methods are given in annex C.

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# Industrial automation systems and integration — Product data representation and exchange — Part 238: Application protocol: Application interpreted model for computerized numerical controllers

## 1 Scope

This part of ISO 10303 specifies the application interpreted model for the information requirements defined by the ISO 14649 Data model for computerized numerical controllers.

## 2 Normative references

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

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

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

ISO 10303-41:2000, *Industrial automation systems and integration — Product data and exchange — Part 41: Integrated generic resources: Fundamentals of product description and support.*

ISO 10303-42:2000, *Industrial automation systems and integration — Product data and exchange — Part 42: Integrated generic resources: Geometric and topological representation.*

ISO 10303-43:2000, *Industrial automation systems and integration — Product data and exchange — Part 43: Integrated generic resources: Representation structures.*

ISO 10303-44:2000, *Industrial automation systems and integration — Product data and exchange — Part 44: Integrated generic resources: Product structure configuration.*

ISO 10303-45:1998, *Industrial automation systems and integration — Product data and exchange — Part 45: Integrated generic resources: Materials.*

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

ISO 10303-49:1998, *Industrial automation systems and integration — Product data and exchange — Part 49: Integrated generic resource: Process structure and properties.*

ISO 10303-203:1994, *Industrial automation systems and integration — Product data and exchange — Part 203: Application protocol: Configuration controlled 3D designs of mechanical parts and assemblies.*

ISO 10303-224:2001, *Industrial automation systems and integration — Product data and exchange — Part 224: Application protocol: Mechanical product definition for process planning using machining features.*

ISO 14649-1:—[1], *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 1: Overview and fundamental principles.*

ISO 14649-10:—[1], *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 10: General process data.*

ISO 14649-11:—[1], *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 11: Process data for milling.*

ISO 14649-111:—[1], *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 111: Tools for milling.*

## 3 Terms, definitions

This part of ISO 10303 makes use of no new terms or definitions.

## 4 Information requirements

This clause specifies the information required for computerized numerical controllers.

The information requirements are specified as a set of units of functionality, application objects, and application assertions. These assertions pertain to individual application objects and to relationships between application objects. The information requirements are defined using the terminology of the-subject area of this application protocol.

NOTE 1 A graphical representation of the information requirements is given in annex G.

NOTE 2 The information requirements correspond to those of the activities identified as being within the scope of this application protocol in annex F.

1. To be published

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NOTE 3 The mapping table specified in 5.1 shows how the integrated resources and application interpreted constructs are used to meet the information requirements of this application protocol.

The units of functionality and application objects for this part of ISO 10303 are defined by ISO 14649-10, ISO 14649-11, and ISO 14649-111.

— The measure UoF is defined by clause 4.2 of ISO 14649-10;

NOTE From clause 4.2 of ISO 14649 part 10, we can extract the following application objects:

limits_and_fits
plus_minus_value
toleranced_length_measure

— The project UoF is defined by clause 4.3 of ISO 14649-10;

NOTE From clause 4.3 of ISO 14649 part 10, we can extract the following application objects:

project
person_and_address

— The workpiece UoF is defined by clause 4.4 of ISO 14649-10;

NOTE From clause 4.4 of ISO 14649 part 10, we can extract the following application objects:

descriptive_parameter
manufacturing_feature
material
numeric_parameter
property_parameter
workpiece

— The manufacturing feature UoF is defined by clause 4.5 of ISO 14649-10;

NOTE From clause 4.5 of ISO 14649 part 10, we can extract the following application objects:

angle_taper
blind_bottom_condition
boss
catalogue_thread
chamfer
circular_closed_profile
circular_closed_shape_profile
circular_offset
circular_omit
circular_path
circular_pattern
closed_pocket
closed_profile
complete_circular_path
compound_feature
conical_hole_bottom
counterbore_hole
countersunk_hole
planar_face
planar_pocket_bottom_condition
planar_profile_floor
pocket
pocket_bottom_condition
profile
profile_feature
profile_floor
radiused_pocket_bottom_condition
radiused_slot_end_type
rectangular_closed_profile
rectangular_closed_shape_profile
rectangular_offset
rectangular_omit
rectangular_open_shape_profile
rectangular_pattern
region
region_projection

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defined_thread
diameter_taper
edge_round
flat_hole_bottom
flat_slot_end_type
flat_with_radius_hole_bottom
general_closed_profile
general_outside_profile
general_path
general_pattern
general_pocket_bottom_condition
general_profile
general_profile_floor
general_shape_profile
hole_bottom_condition
linear_path
linear_profile
loop_slot_end_type
machined_surface
machining_feature
ngon_profile
open_pocket
open_profile
open_slot_end_type
partial_area_definition
partial_circular_path
partial_circular_profile
partial_circular_shape_profile
region_surface_list
replicate_feature
round_hole
rounded_end
rounded_u_profile
shape_profile
slot
slot_end_type
specification
specification_usage_constraint
spherical_cap
spherical_hole_bottom
square_u_profile
step
surface_texture_parameter
tee_profile
thread
through_bottom_condition
through_pocket_bottom_condition
through_profile_floor
toolpath_feature
topological_region
transition_feature
travel_path
two5d_manufacturing_feature
vee_profile
woodruff_slot_end_type

— The executable UoF is defined by clause 4.6 of ISO 14649-10;

NOTE From clause 4.6 of ISO 14649 part 10, we can extract the following application objects:

and_expression
assignment
binary_boolean_expression
boolean_expression
channel
comparison_equal
comparison_expression
comparison_greater
comparison_greater_equal
comparison_less
comparison_less_equal
comparison_not_equal
cutting_component
cutting_edge_technological_data
cutting_tool
display_message
executable
if_statement
in_process_geometry
offset_vector
optional_stop
or_expression
parallel
program_stop
program_structure
rapid_movement
return_home
selective
set_mark
setup
setup_instruction
tool_body
tool_length_probing
tool_probing
tool_radius_probing
touch_probe
touch_probing
unary_boolean_expression

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machining_tool
machining_workingstep
multiple_arity_boolean_expression
nc_constant
nc_function
nc_variable
non_sequential
not_expression
wait_for_mark
while_statement
workingstep
workpiece_complete_probing
workpiece_probing
workpiece_setup
workplan
xor_expression

— The operation UoF is defined by clause 4.7 of ISO 14649-10;

NOTE From clause 4.7 of ISO 14649 part 10, we can extract the following application objects:

machine_functions
machining_operation
operation
technology
three_axes
tool_direction
toolpath_list
two_axes

— The toolpath UoF is defined by clause 4.8 of ISO 14649-10;

NOTE From clause 4.8 of ISO 14649 part 10, we can extract the following application objects:

ap_lift_path_angle
ap_lift_path_tangent
approach_lift_path
axis_trajectory
connect_direct
connect_secplane
connector
curve_with_normal_vector
cutter_contact_trajectory
cutter_location_trajectory
feedstop
parameterised_path
toolpath
toolpath_speed
trajectory

— The process data for milling UoF is defined by clause 5 of ISO 14649-11;

NOTE From ISO 14649 part 11, we can extract the following application objects:

adaptive_control
air_strategy
along_path
ap_retract_angle
ap_retract_tangent
approach_retract_strategy
back_boring
bidirectional
bidirectional_contour
boring
boring_operation
bottom_and_side_finish_milling
bottom_and_side_milling
bottom_and_side_rough_milling
center_drilling
load_tool
milling_machine_functions
milling_machining_operation
milling_technology
milling_type_operation
multistep_drilling
plane_cc_strategy
plane_cl_strategy
plane_finish_milling
plane_milling
plane_rough_milling
plunge_helix
plunge_ramp
plunge_strategy
plunge_toolaxis

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center_milling
contour_bidirectional
contour_parallel
contour_spiral
counter_sinking
drilling
drilling_operation
drilling_type_operation
drilling_type_strategy
exchange_pallet
explicit
five_axes_const_tilt_yaw
five_axes_var_tilt_yaw
freeform_operation
freeform_strategy
index_pallet
index_table
leading_line_strategy
plunge_zigzag
process_model;
process_model_list;
reaming
side_finish_milling
side_milling
side_rough_milling
tapping
thread_drilling
three_axes_tilted_tool
tolerances
tool_direction_for_milling
two5D_milling_operation
two5D_milling_strategy
unidirectional
unload_tool
uv_strategy

— The cutting tools for milling UoF is defined by clause 5 of ISO 14649-111.

NOTE From ISO 14649 part 111, we can extract the following application objects:

backside_counterbore
backside_countersink
ball_endmill
boring_tool
bullnose_endmill
centerdrill
combined_drill_and_reamer
combined_drill_and_tap
counterbore
countersink
dovetail_mill
drill
endmill
facemill
milling_cutter
milling_cutting_tool
milling_tool_body
reamer
side_mill
spade_drill
t_slot_mill
tap
tapered_drill
tapered_endmill
tapered_reamer
tapered_tap
thread_mill
threading_tool
tool_dimension
twist_drill
user_defined_tool
woodruff_keyseat_mill

# 5 Application interpreted model

## 5.1 Mapping table

This clause contains the mapping table that shows how each UoF and application object of this part of ISO 10303 (see clause 4) maps to one or more AIM constructs (see annex A). The mapping table is organized in five columns.

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Column 1) Application element: Name of an application element as it appears in the application object definition in 4.2. Application object names are written in uppercase. Attribute names and assertions are listed after the application object to which they belong and are written in lower case.

Column 2) AIM element: Name of an AIM element as it appears in the AIM (see annex A), the term 'IDENTICAL MAPPING', or the term 'PATH'. AIM entities are written in lower case. Attribute names of AIM entities are referred to as <entity name>.<attribute name>. The mapping of an application element may result in several related AIM elements. Each of these AIM elements requires a line of its own in the table. The term 'IDENTICAL MAPPING' indicates that both application objects of an application assertion map to the same AIM element. The term 'PATH' indicates that the application assertion maps to the entire reference path.

Column 3) Source: For those AIM elements that are interpreted from the integrated resources or the application interpreted constructs, this is the number of the corresponding part of ISO 10303. For those AIM elements that are created for the purpose of this part of ISO 10303, this is the number of this part. Entities or types that are defined within the integrated resources have an AIC as the source reference if the use of the entity or type for the mapping is within the scope of the AIC.

Column 4) Rules: One or more numbers may be given that refer to rules that apply to the current AIM element or reference path. For rules that are derived from relationships between application objects, the same rule is referred to by the mapping entries of all the involved AIM elements. The expanded names of the rules are listed after the table.

Column 5) Reference path: To describe fully the mapping of an application object, it may be necessary to specify a reference path through several related AIM elements. The reference path column documents the role of an AIM element relative to the AIM element in the row succeeding it. Two or more such related AIM elements define the interpretation of the integrated resources that satisfies the requirement specified by the application object. For each AIM element that has been created for use within this part of ISO 10303, a reference path up to its supertype from an integrated resource is specified.

For the expression of reference paths and the relationships between AIM elements the following notational conventions apply:

a) []: enclosed section constrains multiple AIM elements or sections of the reference path are required to satisfy an information requirement;

b) (): enclosed section constrains multiple AIM elements or sections of the reference path are identified as alternatives within the mapping to satisfy an information requirement;

c) {}: enclosed section constrains the reference path to satisfy an information requirement;

d) <>: enclosed section constrains at one or more required reference path;

e) ||: enclosed section constrains the supertype entity;

f) ->: attribute references the entity or select type given in the following row;

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g) <-: entity or select type is referenced by the attribute in the following row;

h [i]: attribute is an aggregation of which a single member is given in the following row;

i) [n]: attribute is an aggregation of which member n is given in the following row;

j) =>: entity is a supertype of the entity given in the following row;

k) <=: entity is a subtype of the entity given in the following row;

l) =: the string, select, or enumeration type is constrained to a choice or value;

m) \: the reference path expression continues on the next line.

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# Table 1 — Mapping table for measure UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| LIMITS_AND_FITS | limits_and_fits | 47 | | |
| deviation | limits_and_fits.form_variance | 47 | | |
| grade | limits_and_fits.grade | 47 | | |
| its_fitting_type | limits_and_fits.zone_variance | 47 | | |
| PLUS_MINUS_VALUE | measure_qualification | 45 | | |
| upper_limit | standard_uncertainty.uncertainty_value | 45 | | measure_qualification<br>measure_qualification.qualifiers[1] -><br>value_qualifier<br>value_qualifier = uncertainty_qualifier<br>{ uncertainty_qualifier.measure_name = ‘upper limit’ }<br>uncertainty_qualifier =><br>standard_uncertainty<br>standard_uncertainty.uncertainty_value |
| lower_limit | standard_uncertainty.uncertainty_value | 45 | | measure_qualification<br>measure_qualification.qualifiers[1] -><br>value_qualifier<br>value_qualifier = uncertainty_qualifier<br>{ uncertainty_qualifier.measure_name = ‘lower limit’ }<br>uncertainty_qualifier =><br>standard_uncertainty<br>standard_uncertainty.uncertainty_value |
| significant_digits | precision_qualifier.precision_value | 45 | | measure_qualification<br>measure_qualification.qualifiers[1] -><br>value_qualifier<br>value_qualifier = precision_qualifier<br>precision_qualifier<br>precision_qualifier.precision_value |

# Table 1 — Mapping table for measure UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| TOLERANCED_LENGTH_MEASURE | [length_measure_with_unit]<br>[measure_representation_item] | 41<br>45<br>45 | | |
| theoretical_size | length_measure_with_unit.-<br>value_component | 41 | | |
| toleranced_length_measure to<br>tolerance_select<br>(as implicit_tolerance)<br>#1: if tolerance_select is limits_and_fits<br>#2: if tolerance_select is<br>plus_minus_value | PATH | | | #2: measure_representation_item <=<br>measure_with_unit <-<br>measure_qualification.qualified_measure<br>measure_qualification |

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# Table 2 — Mapping table for project UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PERSON_AND_ADDRESS | person | 41 | | |
| its_person | IDENTICAL MAPPING | 41 | | |
| its_address | personal_address | 41 | | person <-<br>personal_address.people[i]<br>personal_address |
| PROJECT | product_definition_formation | 41 | | product_definition_formation<br>{ product_definition_formation.of_product -><br>product <-<br>product_related_product_category.products[i]<br>product_related_product_category <=<br>product_category<br>product_category.name = ‘machining project’ } |
| its_id | product.id | 41 | | product_definition_formation<br>product_definition_formation.of_product -><br>product<br>product.id |
| project to workplan<br>(as main_workplan) | PATH | | 8 | product_definition_formation <-<br>product_definition.formation<br>product_definition<br>characterized_product_definition = product_definition<br>characterized_product_definition <-<br>process_product_association.defined_product<br>process_product_association<br>process_product_association.process -><br>product_definition_process =><br>action<br>{ action.name = ‘machining’ }<br>action.chosen_method -><br>action_method =><br>machining_process_executable =><br>machining_workplan |

# Table 2 — Mapping table for project UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| project to workpiece<br>(as its_workpieces) | PATH | | | product_definition_formation <-<br>product_definition.formation<br>product_definition <-<br>product_definition_relationship.relating_product_definition<br>product_definition_relationship<br>{ product_definition_relationship.name = ‘workpiece’ }<br>product_definition_relationship.related_product_definition -><br>product_definition |
| its_owner | PATH | | 6 | product_definition_formation<br>person_and_organization_item = product_definition_formation<br>person_and_organization_item <-<br>applied_person_and_organization_assignment.items[i]<br>applied_person_and_organization_assignment <=<br>person_and_organization_assignment<br>{ person_and_organization_assignment.role -><br>person_and_organization_role<br>person_and_organization_role.name = ‘owner’ }<br>person_and_organization_assignment.-<br>assigned_person_and_organization -><br>person_and_organization<br>person_and_organization.the_person -><br>person |
| its_release | date_and_time | 41 | 7 | product_definition_formation<br>date_and_time_item = product_definition_formation<br>date_and_time_item <-<br>applied_date_and_time_assignment.items[i]<br>applied_date_and_time_assignment <=<br>date_and_time_assignment<br>{ date_and_time_assignment.role -><br>date_time_role<br>date_time_role.name = ‘release date’ }<br>date_and_time_assignment.assigned_date_and_time -><br>date_and_time |

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## Table 2 — Mapping table for project UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_status | approval | 41 | 1, 2, 3, 4 | product_definition_formation<br>approval_item = product_definition_formation<br>approval_item <-<br>applied_approval_assignment.items[i]<br>applied_approval_assignment <=<br>approval_assignment<br>approval_assignment.assigned_approval ->\n approval |

# Table 3 — Mapping table for workpiece UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| DESCRIPTIVE_PARAMETER | descriptive_representation_item | 45 | | |
| descriptive_string | descriptive_representation_item.-description | 45 | | |
| MANUFACTURING_FEATURE | shape_aspect | 41 | | |
| its_id | shape_aspect.name | | | NOTE - AP214 has both name and description for features while 224 only cares about a usage_name which maps to description. Here, its_id has a uniqueness constraint and seems semantically closer to name than description, so we mapped to name.. |
| manufacturing_feature to workpiece (as its_workpiece) | PATH | | | shape_aspect<br>shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_product_definition<br>characterized_product_definition<br>characterized_product_definition = product_definition<br>product_definition |

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## Table 3 — Mapping table for workpiece UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| manufacturing_feature to machining_operation (as its_operations) | PATH | | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>property_or_shape_select = shape_definition<br>property_or_shape_select <-<br>process_property_association.property_or_shape<br>process_property_association<br>process_property_association.process -><br>property_process <=<br>action<br>action.chosen_method -><br>{ action_method =><br>machining_feature_process }<br>action_method <-<br>action_method_relationship.relating_method<br>action_method_relationship<br>action_method_relationship.related_method ->{ action_method =><br>machining_workingstep }<br>action_method <-<br>action_method_relationship.relating_method<br>action_method_relationship<br>action_method_relationship.related_method ->action_method =><br>machining_operation |
| MATERIAL | material_designation | 45 | | |

# Table 3 — Mapping table for workpiece UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| standard_identifier | document.id | 41 | | material_designation<br>document_reference_item = material_designation<br>document_reference_item <-<br>applied_document_reference.items[i]<br>applied_document_reference <=<br>document_reference<br>document_reference.assigned_document -><br>document<br>document.id |
| material_identifier: | material_designation.name | 45 | | |
| material to property_parameter<br>(as material_property) | PATH | | | material_designation <-<br>material_designation_characterization.designation<br>material_designation_characterization<br>material_designation_characterization.property -><br>characterized_material_property=material_property_representation<br>material_property_representation <=<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation<br>representation.items[i] -><br>representation_item |
| NUMERIC_PARAMETER | measure_representation_item | 45 | | |
| its_parameter_value | measure_value | 41 | | measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value |
| its_parameter_unit | named_unit | 41 | 5 | measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.unit_component -><br>unit<br>unit = named_unit<br>named_unit |

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## Table 3 — Mapping table for workpiece UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PROPERTY_PARAMETER | representation_item | 43 | | |
| parameter_name | representation_item.name | 43 | | |
| WORKPIECE | product_definition | 41 | | |
| its_id: | product_definition.id | 41 | | |
| workpiece to material<br>(as its_material) | PATH | | | product_definition <-<br>product_definition_relationship.relating_product_definition<br>{product_definition_relationship =><br>product_definition_usage =><br>make_from_usage_option}<br>product_definition_relationship<br>product_definition_relationship.related_product_definition -><br>product_definition<br>characterized_product_definition = product_definition<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>material_designation.definitions[i]<br>material_designation |
| global_tolerance | measure_value | 41 | | |
| workpiece to workpiece<br>(as its_rawpiece) | PATH | | | product_definition <-<br>product_definition_relationship.relating_product_definition<br>{product_definition_relationship =><br>make_from_usage_option}<br>product_definition_relationship.related_product_definition -><br>product_definition |

# Table 3 — Mapping table for workpiece UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece to advanced_brep_shape_representation (as its_geometry) | advanced_brep_shape_representation | 514 | | product_definition<br>characterized_product_definition = product_definition<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>property_definition.definition<br>{ property_definition =><br>product_definition_shape }<br>property_definition<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation }<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation =><br>shape_representation =><br>advanced_brep_shape_representation |

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# Table 3 — Mapping table for workpiece UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece to bounding geometry<br>(as its_bounding_geometry)<br>#1: if bounding geometry is a block<br>#2: if bounding geometry is a right_circular_cylinder<br>#3: if bounding geometry is an advanced_brep_shape_representation | #1: block_shape_representation<br><br>#2: cylindrical_shape_representation<br><br>#3: advanced_brep_shape_representation | 224<br><br>224<br><br>514 | | product_definition <-<br>product_definition_relationship.relating_product_definition<br>{product_definition_relationship =><br>product_definition_usage =><br>make_from_usage_option}<br>product_definition_relationship<br>product_definition_relationship.related_product_definition -><br>product_definition<br>characterized_product_definition = product_definition<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>property_definition.definition<br>{ property_definition =><br>product_definition_shape }<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation }<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation =><br>shape_representation =><br><br>#1 (shape_representation_with_parameters =><br>block_shape_representation)<br><br>#2 (shape_representation_with_parameters =><br>cylindrical_shape_representation)<br><br>#3 (advanced_brep_shape_representation) |

# Table 3 — Mapping table for workpiece UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece to cartesian_point<br>(as clamping_positions) | cartesian_point | 42 | | product_definition<br>characterized_product_definition = product_definition<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>property_definition.definition<br>{ property_definition.name = ‘clamping position’ }<br>property_definition <-<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation =><br>shape_representation<br>representation.items[i]-><br>representation_item =><br>geometric_representation_item =><br>point =><br>cartesian_point |

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# Table 4 — Mapping table for manufacturing features UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| ANGLE_TAPER | taper | 224 | | taper <=<br>shape_aspect<br>{ shape_aspect.description = 'angle taper'}<br>{ shape_aspect.of_shape-><br>product_definition_shape<=<br>property_definition<br>property_definition.definition-><br>characterized_definition=characterized_object<br>characterized_object=><br>feature_component_definition} |
| angle_taper to plane_angle_measure (as angle) | PATH | | | taper <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation ->{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] ->{representation_item.name = ‘taper angle’}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| BLIND_BOTTOM_CONDITION | hole_bottom | 224 | | hole_bottom <=<br>shape_aspect<br>{shape_aspect<br>(shape_aspect.description = 'conical')<br>(shape_aspect.description = 'flat')<br>(shape_aspect.description = 'flat with radius')<br>(shape_aspect.description = 'flat with taper')<br>(shape_aspect.description = 'spherical')}<br>{shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>feature_component_definition} |
| BOSS | boss | 224 | | boss <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object<br>{characterized_object<br>(characterized_object.description = 'circular')<br>(characterized_object.description = 'complex')<br>(characterized_object.description = 'rectangular')} |

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# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| boss to closed_profile<br>(as its_boundary) | PATH | | | boss <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>(shape_aspect.description = 'circular profile occurrence')<br>(shape_aspect.description = 'enclosed profile occurrence')<br>(shape_aspect.description = 'rectangular profile occurrence')}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>(circular_closed_profile)<br>(closed_path_profile)<br>(ngon_closed_profile)<br>(rectangular_closed_profile) |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| boss to plane_angle_measure<br>(as slope) | PATH | | | boss <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'change in boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>feature_component_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'taper usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'angle taper'}<br>shape_aspect =><br>taper<br><br>NOTE - see mapping for angle taper for<br>path from here to plane angle measure |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| CATALOGUE_THREAD | externally_defined_feature_definition | 224 | | externally_defined_feature_definition <=<br>[externally_defined_item<br>{externally_definied_item.item_id->source_item<br>source_item=' external thread'}<br>{externally_definied_item.source->external_source<br>external_source.source_id->source_item<br>source_item=' external feature specification'}]<br>[{feature_definition =>instanced_feature}<br>feature_definition <=characterized_object<br>{characterized_object<br>characterized_object.description = 'thread'}] |

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# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| catalogue_thread to specification<br>(as documentation)<br><br>#1: (if specification has<br>zero constrants)<br>#2: (if specification has<br>one or more constrants) | PATH | | | #1:( externally_defined_feature_definition<br>document_reference_item = externally_defined_feature_definition<br>document_reference_item <-<br>applied_document_reference.items[i]<br>applied_document_reference <=<br>document_reference<br>document_reference.assigned_document -><br>document)<br>#2:( externally_defined_feature_definition<br>document_reference_item = externally_defined_feature_definition<br>document_reference_item <-<br>applied_document_usage_constraint_assignment.items[i]<br>applied_document_usage_constraint_assignment <=<br>document_usage_constraint_assignment<br>document_usage_constraint_assignment.assigned_document_usage<br>-><br>document_usage_constraint<br>document_usage_constraint.source-><br>document)<br>{document<-<br>document_representation_type.represented_document<br>document_representation_type}<br>{document=><br>document_file<=<br>characterized_object} |
| CHAMFER | chamfer | 224 | | chamfer <=<br>transition_feature <=<br>shape_aspect |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| chamfer to plane_angle_measure<br>(as angle_to_plane) | PATH | | | chamfer <=<br>transition_feature <=<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect ->{ shape_aspect.description = 'second offset' }<br>{ shape_aspect =><br>chamfer_offset }<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation ->{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] ->{representation_item<br>representation_item.name = 'offset angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| chamfer to toleranced_length_measure (as first_offset_amount) | PATH | | | chamfer <=<br>transition_feature <=<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>{ shape_aspect.description = 'first offset' }<br>{ shape_aspect =><br>chamfer_offset }<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'offset amount'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| CIRCULAR_CLOSED_PROFILE | circular_closed_profile | 224 | | circular_closed_profile <=<br>shape_aspect |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| circular_closed_profile to toleranced_length_measure (as diameter) | PATH | | | circular_closed_profile <= shape_aspect<br>shape_definition = shape_aspect shape_definition<br>characterized_definition = shape_definition characterized_definition <- property_definition.definition<br>property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation}<br>property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation => shape_representation_with_parameters}<br>representation representation.items[i] -> {representation_item representation_item.name = 'diameter'}<br>representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| CIRCULAR_CLOSED_SHAPE_-<br>PROFILE | outside_profile | 224 | | outside_profile <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'closed circular boundary occurrence'} |
| circular_closed_shape_profile to<br>circular_closed_profile<br>(as closed_boundary) | PATH | | | outside_profile <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'closed circular boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>shape_defining_relationship<br>shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage'}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>circular_closed_profile |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| CIRCULAR_OFFSET | shape_aspect | 41 | | [shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>shape_aspect_relationship =><br>feature_component_relationship =><br>pattern_offset_membership]<br>[shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship.relating_shape_aspect-><br>shape_aspect=><br>modified_pattern] |
| circular_offset to plane_angle_measure (as angular_offset) | PATH | | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = offset'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| index | count_measure | 41 | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'offset index'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| CIRCULAR_OMIT | shape_aspect | 41 | | [shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>shape_aspect_relationship =><br>feature_component_relationship =><br>pattern_omit_membership]<br>[shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship.relating_shape_aspect->><br>shape_aspect=><br>modified_pattern] |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| index | count_measure | 41 | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'omit index'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure |
| CIRCULAR_PATH | path_feature_component | 224 | | path_feature_component <=<br>shape_aspect<br>{ (shape_aspect.description = 'partial circular')<br>(shape_aspect.description = 'complete circular') } |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| circular_path to<br>toleranced_length_measure<br>(as radius) | PATH | | | path_feature_component <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| CIRCULAR_PATTERN | circular_pattern | 224 | | circular_pattern <=<br>replicate_feature <=<br>{feature_definition=><br>instanced_feature}<br>feature_definition<=<br>characterized_object |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| circular_pattern to plane_angle_measure (as angle_increment) | PATH | | | circular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'angular spacing'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| number_of_feature | count_measure | 41 | | circular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'number of features'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| circular_pattern to circular_offset<br>(as relocated_base_feature) | PATH | | | circular_pattern <=<br>replicate_feature <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>[shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship =><br>pattern_offset_membership}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>shape_aspect]<br>[shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>{shape_aspect_relationship.description='base pattern'}<br>shape_aspect_relationship.relating_shape_aspect-><br>shape_aspect<-<br>{shape_aspect=><br>modified_pattern}<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>{shape_aspect_relationship.description='modified pattern'}<br>shape_aspect_relationship.related_shape_aspect-><br>shape_aspect] |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| circular_pattern to circular_omit<br>(as missing_base_feature) | PATH | | | circular_pattern <=<br>replicate_feature <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>[shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship =><br>pattern_omit_membership}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>shape_aspect]<br>[shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>{shape_aspect_relationship.description='base pattern'}<br>shape_aspect_relationship.relating_shape_aspect-><br>shape_aspect<-<br>{shape_aspect=><br>modified_pattern}<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>{shape_aspect_relationship.description='modified pattern'}<br>shape_aspect_relationship.related_shape_aspect-><br>shape_aspect] |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| circular_pattern to<br>toleranced_length_measure<br>(as base_feature_diameter) | PATH | | | circular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'diameter'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| circular_pattern to plane_angle_measure (as base_feature_rotation) | PATH | | | circular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'base feature rotation'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit} |
| CLOSED_POCKET | pocket | 224 | | pocket <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| closed_pocket to closed_profile<br>(as feature_boundary) | PATH | | | pocket <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'boundary'}<br>shape_aspect =><br>(circular_closed_profile)<br>(closed_path_profile)<br>(ngon_closed_profile)<br>(rectangular_closed_profile) |
| CLOSED_PROFILE | (circular_closed_profile)<br>(closed_path_profile)<br>(ngon_closed_profile)<br>(rectangular_closed_profile) | 224<br>224<br>224<br>224 | | (circular_closed_profile <=)<br>(closed_path_profile <=)<br>(ngon_closed_profile <=)<br>(rectangular_closed_profile <=)<br>shape_aspect |
| COMPLETE_CIRCULAR_PATH | path_feature_component | 224 | | path_feature_component <=<br>shape_aspect<br>{ shape_aspect.description = 'complete circular' } |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| COMPOUND_FEATURE | compound_feature | 224 | | compound_feature <=<br>{feature_definition=><br>instanced_feature}<br>feature_definition<=<br>characterized_object<br>characterized_definition=characterized_object<-<br>property_definition.definition<br>property_definition<br>property_definition=><br>product_definition_shape<-<br>shape_aspect.of_shape<br>shape_aspect<br>shape_aspect.name = 'compound feature in solid' |
| compound_feature to<br>compound_feature_select<br>(as elements)<br><br>#1: as machining_feature<br>#2: as transition_feature | PATH | | | compound_feature <=<br>feature_definition <=<br>characterized_object<br>characterized_definition=characterized_object<-<br>property_definition.definition<br>property_definition<br>property_definition=><br>product_definition_shape<-<br>shape_aspect.of_shape<br>shape_aspect<br>{shape_aspect=><br>composite_shape_aspect}<br>shape_aspect<-<br>shape_aspect_relationship.relating_shape_aspect<br>{ shape_aspect_relationship.name = ‘tapered’ }<br>{shape_aspect_relationship=><br>feature_component_relationship}<br>shape_aspect_relationship.related_shape_aspect-><br>shape_aspect=><br>#1: (instanced_feature)<br>#2: (transition_feature) |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| CONICAL_HOLE_BOTTOM | hole_bottom | 224 | | hole_bottom <=<br>shape_aspect<br>{ shape_aspect.description = 'conical' } |
| conical_hole_bottom to<br>plane_angle_measure<br>(as tip_angle) | PATH | | | hole_bottom <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'tip angle'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| conical_hole_bottom to toleranced_length_measure (as tip_radius) | PATH | | | hole_bottom <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'tip radius'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| COUNTERBORE_HOLE | composite_hole | 224 | | composite_hole <=<br>compound_feature <=<br>instanced_feature <=<br>feature_definition <=<br>characterized_object<br>{ characterized_object.description = 'counterbore' }<br>{ characterized_definition=characterized_object<-<br>property_definition.definition<br>property_definition<br>property_definition=><br>product_definition_shape<-<br>shape_aspect.of_shape<br>shape_aspect<br>{shape_aspect=><br>composite_shape_aspect}<br>shape_aspect<-<br>shape_aspect_relationship.relating_shape_aspect<br>(shape_aspect_relationship.name = ‘large hole’)<br>(shape_aspect_relationship.name = ‘small hole’)<br>shape_aspect_relationship=><br>feature_component_relationship} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| COUNTERSUNK_HOLE | composite_hole | 224 | | composite_hole <=<br>compound_feature <=<br>instanced_feature <=<br>feature_definition <=<br>characterized_object<br>{ characterized_object.description = 'countersunk' }<br>{ characterized_definition=characterized_object<-<br>property_definition.definition<br>property_definition<br>property_definition=><br>product_definition_shape<-<br>shape_aspect.of_shape<br>shape_aspect<br>{shape_aspect=><br>composite_shape_aspect}<br>shape_aspect<-<br>shape_aspect_relationship.relating_shape_aspect<br>(shape_aspect_relationship.name = ‘tapered hole’)<br>(shape_aspect_relationship.name = ‘constant diameter hole’)<br>shape_aspect_relationship=><br>feature_component_relationship} |
| DEFINED_THREAD | thread | 224 | | thread <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| defined_thread to length_measure (as pitch_diameter) | PATH | | | thread <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'pitch diameter'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| defined_thread to length_measure (as minor_diameter) | PATH | | | thread <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'minor diameter'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| defined_thread to length_measure (as crest) | PATH | | | thread <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'crest'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| DIAMETER_TAPER | taper | 224 | | taper <=<br>shape_aspect<br>{ shape_aspect.description = 'diameter taper'}<br>{ shape_aspect.of_shape-><br>product_definition_shape<=<br>property_definition<br>property_definition.definition-><br>characterized_definition=characterized_object<br>characterized_object=><br>feature_component_definition} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| diameter_taper to<br>toleranced_length_measure<br>(as final_diameter) | PATH | | | taper <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'final diameter'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |
| EDGE_ROUND | edge_round | 224 | | edge_round <=<br>transition_feature <=<br>shape_aspect |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| edge_round to<br>toleranced_length_measure<br>(as radius) | PATH | | | edge_round <=<br>transition_feature <=<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect ->{ shape_aspect.description = 'radius' }<br>{ shape_aspect =><br>chamfer_offset }<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation ->{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] ->{representation_item<br>representation_item.name = 'radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| edge_round to<br>toleranced_length_measure<br>(as first_offset_amount) | PATH | | | edge_round <=<br>transition_feature <=<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect ->{ shape_aspect.description = 'first offset' }<br>{ shape_aspect =><br>chamfer_offset }<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation ->{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] ->{representation_item<br>representation_item.name = 'offset amount'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| edge_round to<br>toleranced_length_measure<br>(as second_offset_amount) | PATH | | | edge_round <=<br>transition_feature <=<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect ->{ shape_aspect.description = 'second offset' }<br>{ shape_aspect =><br>chamfer_offset }<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation ->{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] ->{representation_item<br>representation_item.name = 'offset amount'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| FLAT_HOLE_BOTTOM | hole_bottom | 224 | | hole_bottom <=<br>shape_aspect<br>{ shape_aspect.description = 'flat' } |
| FLAT_SLOT_END_TYPE | slot_end | 224 | | slot_end <=<br>shape_aspect<br>{ shape_aspect.description = 'flat' } |
| flat_slot_end_type to<br>toleranced_length_measure<br>(as corner_radius1) | PATH | | | slot_end <=<br>shape_aspect<br>shape_definition = shape_aspect<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item.name = 'first radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| flat_slot_end_type to toleranced_length_measure (as corner_radius2) | PATH | | | slot_end <= shape_aspect shape_definition = shape_aspect characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation_with_parameters} representation representation.items[i] -> {representation_item.name = 'second radius'} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit |
| FLAT_WITH_RADIUS_HOLE_-BOTTOM | hole_bottom | 224 | | hole_bottom <= shape_aspect { shape_aspect.description = 'flat with radius' } |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| flat_with_radius_hole_bottom to toleranced_length_measure (as corner_radius) | PATH | | | hole_bottom <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'corner radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| GENERAL_CLOSED_PROFILE | closed_path_profile | 224 | | closed_path_profile <=<br>shape_aspect |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| general_closed_profile to bounded_curve (as closed_profile_shape) | PATH | | | closed_path_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{ representation =><br>shape_representation=><br>path_shape_representation }<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>curve =><br>bounded_curve |
| GENERAL_OUTSIDE_PROFILE | outside_profile | 224 | | outside_profile <=<br>{ feature_definition =><br>instanced_feature }<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{ shape_aspect.description = 'boundary occurrence'} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| general_outside_profile to profile<br>(as feature_boundary) | PATH | | | outside_profile <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'outside boundary'}<br>shape_aspect =><br>(circular_closed_profile)<br>(closed_path_profile)<br>(ngon_closed_profile)<br>(rectangular_closed_profile)<br>(linear_profile)<br>(open_path_profile)<br>(partial_circular_profile)<br>(rounded_u_profile)<br>(square_u_profile)<br>(tee_profile)<br>(vee_profile) |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| GENERAL_PATH | path_feature_component | 224 | | path_feature_component <=<br>shape_aspect<br>{ shape_aspect.description = 'complex' } |
| general_path to bounded_curve<br>(as swept_path) | PATH | | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation<br>representation.name = 'sweep path'}<br>{ representation =><br>shape_representation=><br>path_shape_representation }<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>curve =><br>bounded_curve |
| GENERAL_PATTERN | feature_pattern | 224 | | feature_pattern <=<br>replicate_feature <=<br>{feature_definition=><br>instanced_feature}<br>feature_definition<=<br>characterized_object |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| general_pattern to axis2_placement_3d (as replicate_locations) | PATH | | | feature_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>characterized_definition=charcterized_object<br>characterized_definition<-<br>property_definition.definition<br>property_definition <-<br>{property_definition=><br>product_definition_shape}<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'base feature placement'}<br>representation_item =><br>geometric_representation_item =><br>placement =><br>axis2_placement_3d |
| GENERAL_POCKET_BOTTOM_-CONDITION | pocket_bottom | 224 | | pocket_bottom <=<br>shape_aspect<br>{ shape_aspect.description = 'complex' } |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| general_pocket_bottom_condition to region<br>(as shape)<br><br>NOTE - This is mapped to face surface representation for harmonization with AP-224/214. | PATH | | | pocket_bottom <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation ->{representation<br>representation.name = 'floor face'}<br>representation =><br>shape_representation=><br>face_shape_representation |
| GENERAL_PROFILE | open_path_profile | 224 | | open_path_profile <=<br>shape_aspect |
| general_profile to bounded_curve<br>(as its_profile) | PATH | | | open_path_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{ representation =><br>shape_representation=><br>path_shape_representation }<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>curve =><br>bounded_curve |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| GENERAL_PROFILE_FLOOR | profile_floor | 224 | | profile_floor <=<br>shape_aspect<br>{ shape_aspect.description = 'complex' } |
| general_profile_floor to face<br>(as floor) | PATH | | | profile_floor <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation<br>representation.name = 'floor'}<br>representation =><br>shape_representation=><br>face_shape_representation |
| GENERAL_SHAPE_PROFILE | outside_profile | 224 | | outside_profile <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'complex boundary occurrence'} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| general_shape_profile to profile<br>(as profile_boundary) | PATH | | | outside_profile <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'complex boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>shape_defining_relationship<br>shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage'}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'boundary'}<br>shape_aspect =><br>(circular_closed_profile)<br>(closed_path_profile)<br>(ngon_closed_profile)<br>(rectangular_closed_profile)<br>(open_path_profile)<br>(partial_circular_profile)<br>(rounded_u_profile)<br>(square_u_profile)<br>(tee_profile)<br>(vee_profile) |
| HOLE_BOTTOM_CONDITION | hole_bottom | 224 | | hole_bottom <=<br>shape_aspect |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| LINEAR_PATH | path_feature_component | 224 | | path_feature_component <=<br>shape_aspect<br>{ shape_aspect.description = 'linear' } |
| linear_path to<br>toleranced_length_measure<br>(as distance) | PATH | | | path_feature_component <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'distance'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| linear_path to direction<br>(as its_direction) | PATH | | | path_feature_component <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation =><br>shape_representation=><br>direction_shape_representation |
| LINEAR_PROFILE | linear_profile | 224 | | linear_profile <=<br>shape_aspect |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| linear_profile to numeric_parameter (as profile_length) | PATH | | | linear_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'profile length'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| LOOP_SLOT_END_TYPE | slot_end | 224 | | slot_end <=<br>shape_aspect<br>{ shape_aspect.description = 'loop' } |
| MACHINED_SURFACE | property_definition | 41 | | property_definition<br>property_definition.name<br>{ (property_definition.name = ‘bottom surface condition’)<br>(property_definition.name = ‘bottom and side surface condition’)<br>(property_definition.name = ‘side surface condition’) } |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| machined_surface to machining_feature (as its_machining_feature) | PATH | | | property_definition<br>property_definition.definition ->\<br>characterized_definition<br>characterized_definition = shape_definition<br>shape_definition<br>shape_definition = shape_aspect<br>shape_aspect =>\<br>instanced_feature |
| surface_element | property_definition.name | 41 | | property_definition<br>property_definition.name<br>{ (property_definition.name = ‘bottom surface condition’)<br>(property_definition.name = ‘bottom and side surface condition’)<br>(property_definition.name = ‘side surface condition’) } |
| MACHINING_FEATURE | instanced_feature | 224 | | instanced_feature <=<br>[shape_aspect]<br>[feature_definition <=<br>characterized_object] |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| machining_feature to elementary_surface (as depth) | PATH | | | instanced_feature <=<br>shape_aspect<br>shape_definition = shape_aspect<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>{property_definition=><br>product_definition_shape}<br>property_definition<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation .used_representation-><br>{ representation =><br>shape_representation }<br>{representation.name = ‘maximum feature limit’ }<br>representation<br>representation.items[i] -><br>representation_item =><br>elementary_surface |
| NGON_PROFILE | ngon_closed_profile | 224 | | ngon_closed_profile <=<br>shape_aspect |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| ngon_profile to<br>toleranced_length_measure<br>(as diameter) | PATH | | | ngon_closed_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>(representation_item.name = 'circumscribed diameter')<br>(representation_item.name = 'diameter across flats')}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| number_of_sides | count_measure | 41 | | ngon_closed_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'number of sides'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| circumscribed_or_across_flats | (representation_item.name = 'circumscribed diameter')<br>(representation_item.name = 'diameter across flats') | | | ngon_closed_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>representation_item<br>(representation_item.name = 'circumscribed diameter')<br>(representation_item.name = 'diameter across flats') |
| OPEN_POCKET | pocket | 224 | | pocket <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| open_pocket to open_profile<br>(as open_boundary) | PATH | | | pocket <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'boundary'}<br>shape_aspect =><br>(open_path_profile)<br>(partial_circular_profile)<br>(rounded_u_profile)<br>(square_u_profile)<br>(tee_profile)<br>(vee_profile) |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| open_pocket to open_profile<br>(as wall_boundary) | PATH | | | pocket <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'wall boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'wall boundary usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'wall boundary'}<br>shape_aspect =><br>(open_path_profile)<br>(partial_circular_profile)<br>(rounded_u_profile)<br>(square_u_profile)<br>(tee_profile)<br>(vee_profile) |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| OPEN_PROFILE | (linear_profile)<br>(open_path_profile)<br>(partial_circular_profile)<br>(rounded_u_profile)<br>(square_u_profile)<br>(tee_profile)<br>(vee_profile) | 224<br>224<br>224<br>224<br>224<br>224<br>224 | | (linear_profile <=)<br>(open_path_profile <=)<br>(partial_circular_profile <=)<br>(rounded_u_profile <=)<br>(square_u_profile <=)<br>(tee_profile <=)<br>(vee_profile <=)<br>shape_aspect |
| OPEN_SLOT_END_TYPE | slot_end | 224 | | slot_end <=<br>shape_aspect<br>{ shape_aspect.description = 'open' } |
| PARTIAL_AREA_DEFINITION | applied_area | 224 | | applied_area <=<br>shape_aspect<br>{shape_aspect<br>shape_aspect.of_shape->product_definition_shape} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| partial_area_definition to length_measure (as effective_length) | PATH | | | applied_area <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'effective length'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| partial_area_definition to<br>axis2_placement_3D<br>(as placement) | PATH | | | applied_area <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'orientation'}<br>representation_item =><br>geometric_representation_item =><br>placement =><br>axis2_placement_3d |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| partial_area_definition to length_measure (as maximum_length) | PATH | | | applied_area <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'maximum length'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |
| PARTIAL_CIRCULAR_PATH | path_feature_component | 224 | | path_feature_component <=<br>shape_aspect<br>{ shape_aspect.description = 'partial circular' } |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| partial_circular_path to<br>plane_angle_measure<br>(as sweep_angle) | PATH | | | path_feature_component <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'sweep angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| PARTIAL_CIRCULAR_PROFILE | partial_circular_profile | 224 | | partial_circular_profile <=<br>shape_aspect |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| partial_circular_profile to toleranced_length_measure (as radius) | PATH | | | partial_circular_profile <= shape_aspect<br>shape_definition = shape_aspect shape_definition<br>characterized_definition = shape_definition characterized_definition <- property_definition.definition<br>property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation}<br>property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation => shape_representation_with_parameters}<br>representation representation.items[i] -> {representation_item representation_item.name = 'radius'}<br>representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| partial_circular_profile to<br>plane_angle_measure<br>(as sweep_angle) | PATH | | | partial_circular_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'sweep angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PARTIAL_CIRCULAR_SHAPE_-<br>PROFILE | outside_profile | 224 | | outside_profile <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'partial circular boundary occurrence'} |
| partial_circular_shape_profile to<br>partial_circular_profile<br>(as open_boundary) | PATH | | | outside_profile <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'partial circular boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>shape_defining_relationship<br>shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage'}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>partial_circular_profile |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PLANAR_FACE | flat_face | 224 | | flat_face <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |
| planar_face to linear_path<br>(as course_of_travel) | PATH | | | flat_face <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'course of travel occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.name = 'course of travel']<br>[shape_aspect_relationship.description = 'path feature component usage']]}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'linear'}<br>shape_aspect =><br>path_feature_component |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| planar_face to linear_profile<br>(as removal_boundary) | PATH | | | flat_face <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'removal boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.name = 'removal boundary']<br>[shape_aspect_relationship.description = 'profile usage']]}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>linear_profile |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| planar_face to closed_profile<br>(as face_boundary) | PATH | | | flat_face <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'enclosed boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.name = 'boundary']<br>[shape_aspect_relationship.description = 'profile usage']]}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>(circular_closed_profile)<br>(ngon_closed_profile)<br>(rectangular_closed_profile)<br>(closed_path_profile) |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| planar_face to boss<br>(as its_boss) | PATH | | | flat_face <=<br>feature_definition <=<br>characterized_object<br>characterized_definition=characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape<-<br>shape_aspect.of_shape<br>{shape_aspect=><br>composite_shape_aspect}<br>shape_aspect<-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship.description='uncut area'}<br>{shape_aspect_relationship=><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect-><br>shape_aspect=><br>instanced_feature=><br>feature_definition=><br>boss |
| PLANAR_POCKET_BOTTOM_-<br>CONDITION | pocket_bottom | 224 | | pocket_bottom <=<br>shape_aspect<br>{ shape_aspect.description = 'planar' } |
| PLANAR_PROFILE_FLOOR | profile_floor | 224 | | profile_floor <=<br>shape_aspect<br>{ shape_aspect.description = 'planar' } |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| planar_profile_floor to plane<br>(as floor) | PATH | | | profile_floor <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation ->{representation<br>representation.name = 'floor'}<br>representation =><br>planar_shape_representation |
| POCKET | pocket | 224 | | pocket <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| pocket to boss<br>(as its_boss) | PATH | | | pocket <=<br>feature_definition <=<br>characterized_object<br>characterized_definition=characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape<-<br>shape_aspect.of_shape<br>{shape_aspect=><br>composite_shape_aspect}<br>shape_aspect<-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship.description='uncut area'}<br>{shape_aspect_relationship=><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect-><br>shape_aspect=><br>instanced_feature=><br>feature_definition=><br>boss |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| pocket to angle_taper<br>(as slope) | PATH | | | pocket <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'change in boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>feature_component_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'taper usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'angle taper'}<br>shape_aspect =><br>taper |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| pocket to pocket_bottom_condition (as bottom_condition) | PATH | | | pocket <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect shape_aspect.description = 'bottom condition occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {[shape_aspect_relationship => feature_component_relationship] [shape_aspect_relationship shape_aspect_relationship.description = 'pocket bottom usage']} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => pocket_bottom |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| pocket to toleranced_length_measure (as planar_radius)<br><br>NOTE - This is mapped to a property on the pocket bottom condition for harmonization with AP-224 and AP-214. | PATH | | | pocket <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{ shape_aspect_relationship =><br>feature_component_relationship }<br>shape_aspect_relationship.relating_shape_aspect -><br>{ shape_aspect =><br>pocket_bottom }<br>shape_definition = shape_aspect<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item.name = 'radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| pocket to toleranced_length_measure (as orthogonal_radius) | PATH | | | pocket <=<br>feature_definition <=<br>characterized_object<br>characterized_definition=characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item.name = ‘orthogonal fillet radius’}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| POCKET_BOTTOM_CONDITION | pocket_bottom | 224 | | pocket_bottom <=<br>shape_aspect<br>{ shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>feature_component_definition } |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PROFILE | (circular_closed_profile) | 224 | | (circular_closed_profile <=) |
| | (closed_path_profile) | 224 | | (closed_path_profile <=) |
| | (ngon_closed_profile) | 224 | | (ngon_closed_profile <=) |
| | (rectangular_closed_profile) | 224 | | (rectangular_closed_profile <=) |
| | (linear_profile) | 224 | | (linear_profile <=) |
| | (open_path_profile) | 224 | | (open_path_profile <=) |
| | (partial_circular_profile) | 224 | | (partial_circular_profile <=) |
| | (rounded_u_profile) | 224 | | (rounded_u_profile <=) |
| | (square_u_profile) | 224 | | (square_u_profile <=) |
| | (tee_profile) | 224 | | (tee_profile <=) |
| | (vee_profile) | 224 | | (vee_profile <=) |
| | | | | shape_aspect |
| | | | | {shape_aspect |
| | | | | shape_aspect.of_shape-> |
| | | | | product_definition_shape<= |
| | | | | property_definition |
| | | | | property_definition.definition-> |
| | | | | characterized_definition=characterized_object |
| | | | | characterized_object=> |
| | | | | feature_component_definition} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| profile to axis2_placement_3d<br>(as placement) | PATH | | | (circular_closed_profile <=)<br>(closed_path_profile <=)<br>(ngon_closed_profile <=)<br>(rectangular_closed_profile <=)<br>(linear_profile <=)<br>(open_path_profile <=)<br>(partial_circular_profile <=)<br>(rounded_u_profile <=)<br>(square_u_profile <=)<br>(tee_profile <=)<br>(vee_profile <=)<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'orientation'}<br>representation_item =><br>geometric_representation_item =><br>placement<br>axis2_placement_3d |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PROFILE_FEATURE | outside_profile | 224 | | outside_profile <= {feature_definition => instanced_feature} feature_definition <= characterized_object |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| profile_feature to linear_path<br>(as profile_swept_shape) | PATH | | | outside_profile<=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>(shape_aspect.description = 'outside boundary'),<br>(shape_aspect.description = 'complex boundary occurrence'),<br>(shape_aspect.description = 'partial circular boundary occurrence'),<br>(shape_aspect.description = 'closed circular boundary occurrence'),<br>(shape_aspect.description =<br>'open rectangular boundary occurrence'),<br>(shape_aspect.description = 'closed rectangular boundary occur-<br>rence')}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.name = 'profile swept shape']<br>[shape_aspect_relationship.description =<br>'path feature component usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{ shape_aspect.description = 'linear' }<br>shape_aspect =><br>path_feature_component |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PROFILE_FLOOR | profile_floor | 224 | | profile_floor <=<br>shape_aspect<br>{shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>feature_component_definition} |
| profile_floor to<br>numeric_parameter<br>(as floor_radius) | PATH | | | profile_floor <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation ->{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] ->{representation_item<br>representation_item.name = 'radius'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| start_or_end | descriptive_representation_-<br>item.description | 45 | | profile_floor <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'shape profile floor orientation'}<br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{(descriptive_representation_item.description = 'shape profile start')<br>(descriptive_representation_item.description = 'shape profile end')} |
| RADIUSED_POCKET_BOTTOM_-<br>CONDITION | pocket_bottom | 224 | | pocket_bottom <=<br>shape_aspect<br>{ shape_aspect.description = 'radiused' } |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| radiused_pocket_bottom_condition to toleranced_length_measure (as floor_radius) | PATH | | | pocket_bottom <= shape_aspect shape_definition = shape_aspect characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation_with_parameters} representation representation.items[i] -> {representation_item.name = 'pocket bottom radius'} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| radiused_pocket_bottom_condition to cartesian_point<br>(as floor_radius_center) | PATH | | | pocket_bottom <=<br>shape_aspect<br>shape_definition = shape_aspect<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{ representation =><br>shape_representation=><br>location_shape_representation }<br>{representation.name = 'pocket bottom radius location'}<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>point =><br>cartesian_point |
| RADIUSED_SLOT_END_TYPE | slot_end | 224 | | slot_end <=<br>shape_aspect<br>{ shape_aspect.description = 'radiused' } |
| RECTANGULAR_CLOSED_PROFILE | rectangular_closed_profile | 224 | | rectangular_closed_profile <=<br>shape_aspect |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rectangular_closed_profile to toleranced_length_measure (as profile_width) | PATH | | | rectangular_closed_profile <= shape_aspect<br>shape_definition = shape_aspect shape_definition<br>characterized_definition = shape_definition characterized_definition <- property_definition.definition<br>property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation}<br>property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation => shape_representation_with_parameters}<br>representation representation.items[i] -> {representation_item representation_item.name = 'width'}<br>representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rectangular_closed_profile to toleranced_length_measure (as profile_length) | PATH | | | rectangular_closed_profile <= shape_aspect<br>shape_definition = shape_aspect shape_definition<br>characterized_definition = shape_definition characterized_definition <- property_definition.definition<br>property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation}<br>property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation => shape_representation_with_parameters}<br>representation representation.items[i] -> {representation_item representation_item.name = 'length'}<br>representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| RECTANGULAR_CLOSED_SHAPE_-PROFILE | outside_profile | 224 | | outside_profile <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description =<br>'closed rectangular boundary occurrence'} |
| rectangular_closed_shape_profile to rectangular_closed_profile<br>(as closed_boundary) | PATH | | | outside_profile <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'closed rectangular boundary occur-rence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>shape_defining_relationship<br>shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage'}<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>rectangular_closed_profile |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| RECTANGULAR_OFFSET | shape_aspect | 41 | | [shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>shape_aspect_relationship =><br>feature_component_relationship =><br>pattern_offset_membership]<br>[shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship.relating_shape_aspect->><br>shape_aspect=><br>modified_pattern] |
| rectangular_offset to direction<br>(as offset_direction) | PATH | | | shape_aspect <-<br>shape_definition = shape_aspect<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>{property_definition=><br>product_definition_shape}<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation<br>representation.name = 'offset direction'}<br>representation =><br>shape_representation=><br>direction_shape_representation |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rectangular_offset to length_measure (as offset_distance) | PATH | | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'offset distance'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| row_index | count_measure | 41 | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'row index'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| column_index | count_measure | 41 | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'column index'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| RECTANGULAR_OMIT | shape_aspect | 41 | | [shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>shape_aspect_relationship =><br>feature_component_relationship =><br>pattern_omit_membership]<br>[shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship.relating_shape_aspect->><br>shape_aspect=><br>modified_pattern] |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| row_index | count_measure | 41 | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'row index'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| column_index | count_measure | 41 | | shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'column index'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| RECTANGULAR_OPEN_SHAPE_-PROFILE | outside_profile | 224 | | outside_profile <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'open rectangular boundary occurrence'} |
| rectangular_open_shape_profile to square_u_profile<br>(as open_boundary) | PATH | | | outside_profile <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'open rectangular boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>shape_defining_relationship<br>shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage'}<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>square_u_profile |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| RECTANGULAR_PATTERN | rectangular_pattern | 224 | | rectangular_pattern <=<br>replicate_feature <=<br>{feature_definition=><br>instanced_feature}<br>feature_definition<=<br>characterized_object |
| rectangular_pattern to<br>toleranced_length_measure<br>(as spacing) | PATH | | | rectangular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'column spacing'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rectangular_pattern to direction<br>(as its_direction) | PATH | | | rectangular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>{property_definition=><br>product_definition_shape}<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation<br>representation.name = 'column layout direction'}<br>representation =><br>shape_representation=><br>direction_shape_representation |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| number_of_rows | count_measure | 41 | | rectangular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'number of rows'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| number_of_columns | count_measure | 41 | | rectangular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'number of columns'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit<br>measure_with_unit.value_component -><br>measure_value<br>measure_value = count_measure<br>count_measure} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rectangular_pattern to toleranced_length_measure (as row_spacing) | PATH | | | rectangular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'row spacing'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rectangular_pattern to direction<br>(as row_layout_direction) | PATH | | | rectangular_pattern <=<br>replicate_feature <=<br>feature_definition<=<br>characterized_object<br>shape_definition = characterized_object<br>shape_definition <-<br>property_definition.definition<br>property_definition <-<br>{property_definition=><br>product_definition_shape}<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation<br>representation.name = 'row layout direction'}<br>representation =><br>shape_representation=><br>direction_shape_representation |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rectangular_pattern to<br>rectangular_offset<br>(as relocated_base_feature) | PATH | | | rectangular_pattern <=<br>replicate_feature <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>[shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship =><br>pattern_offset_membership}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>shape_aspect]<br>[shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>{shape_aspect_relationship.description='base pattern'}<br>shape_aspect_relationship.relating_shape_aspect-><br>shape_aspect<-<br>{shape_aspect=><br>modified_pattern}<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>{shape_aspect_relationship.description='modified pattern'}<br>shape_aspect_relationship.related_shape_aspect-><br>shape_aspect] |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rectangular_pattern to<br>rectangular_omit<br>(as missing_base_feature) | PATH | | | rectangular_pattern <=<br>replicate_feature <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>[shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship =><br>pattern_omit_membership}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>shape_aspect]<br>[shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>{shape_aspect_relationship.description='base pattern'}<br>shape_aspect_relationship.relating_shape_aspect-><br>shape_aspect<-<br>{shape_aspect=><br>modified_pattern}<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>{shape_aspect_relationship.description='modified pattern'}<br>shape_aspect_relationship.related_shape_aspect-><br>shape_aspect] |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| REGION | removal_volume | 224 | | removal_volume <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |
| region to axis2_placement_3d<br>(as feature_placement) | PATH | | | removal_volume <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>{ property_definition =><br>product_definition_shape }<br>property_definition<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation }<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item.name = ‘orientation’}<br>representation_item =><br>geometric_representation_item =><br>placement =><br>axis2_placement_3d |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| REGION_PROJECTION | shape_representation<br><br>IT IS NOT CLEAR IF STEP ALREADY HAS A SHAPE REP FOR THIS SORT OF THING | 41 | | shape_representation <=<br>representation <-<br>property_definition_representation.used_representation<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.definition -><br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = shape_definition<br>shape_definition<br>shape_definition = shape_aspect<br>{ shape_aspect.description = 'volume shape'}<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{ shape_aspect_relationship =><br>shape_defining_relationship }<br>{ shape_aspect_relationship.description = 'volume shape usage' }<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>shape_aspect<br>{ shape_aspect.description = 'shape volume occurrence' }<br>shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>removal_volume |
| proj_curve | surface_of_linear_extrusion.swept_curve | 42 | | |

## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| proj_dir | vector.orientation | 42 | | surface_of_linear_extrusion.extrusion_axis -><br>vector<br>vector.orientation |
| depth | | | | |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| REGION_SURFACE_LIST | geometric_set | 507 | | geometric_set <=<br>representation_item <-<br>representation.items[i]<br>{representation =><br>geometrically_bounded_surface_shape_representation }<br>representation <-<br>property_definition_representation.used_representation<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.definition -><br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = shape_definition<br>shape_definition = shape_aspect<br>{ shape_aspect.description = 'volume shape'}<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{ shape_aspect_relationship =><br>shape_defining_relationship }<br>{ shape_aspect_relationship.description = 'volume shape usage' }<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>shape_aspect<br>{ shape_aspect.description = 'shape volume occurrence' }<br>shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>removal_volume |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| region_surface_list to bounded_surface (as surface_list) | bounded_surface | 42 | | geometric_set<br>geometric_set.elements[i] -><br>geometric_set_select<br>geometric_set_select = surface<br>surface =><br>bounded_surface |
| REPLICATE_FEATURE | replicate_feature | | | replicate_feature <=<br>{feature_definition<=<br>instanced_feature}<br>feature_definition<=<br>characterized_object |
| replicate_feature to two5D_manufacturing_feature (as replicate_base_feature) | PATH | | | replicate_feature <=<br>feature_definition=><br>instanced_feature<=<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship.name='pattern basis'}<br>{shape_aspect_relationship =><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>shape_aspect =><br>instanced_feature |
| ROUND_HOLE | round_hole | 224 | | round_hole <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| round_hole to<br>toleranced_length_measure<br>(as diameter) | PATH | | | round_hole <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'diameter occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.name = 'diameter']<br>[shape_aspect_relationship.description = 'profile usage']]}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>circular_closed_profile<br><br>NOTE - see mapping for circular_closed_profile for<br>path from here to diameter measure |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| round_hole to taper_select<br>(as change_in_diameter)<br><br>#1: as angle_taper<br>#2: as diameter_taper | PATH | | | round_hole <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'change in diameter occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>feature_component_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'taper usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{ shape_aspect<br>#1: (shape_aspect.description = 'angle taper')<br>#2: (shape_aspect.description = 'diameter taper') }<br>shape_aspect =><br>taper |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| round_hole to hole_bottom_condition (as bottom_condition) | PATH | | | round_hole <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'bottom condition occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>feature_component_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'hole bottom usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>(shape_aspect.description = 'conical')<br>(shape_aspect.description = 'flat')<br>(shape_aspect.description = 'flat with radius')<br>(shape_aspect.description = 'flat with taper')<br>(shape_aspect.description = 'spherical')<br>(shape_aspect.description = 'through')}<br>shape_aspect =><br>hole_bottom |
| ROUNDED_END | rounded_end | 224 | | rounded_end <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |

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# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rounded_end to linear_path<br>(as course_of_travel) | PATH | | | rounded_end <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'course of travel occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.description = 'path feature component usage']]}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'linear'}<br>shape_aspect =><br>path_feature_component |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rounded_end to partial_circular_profile (as partial_circular_boundary) | PATH | | | rounded_end <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'partial circular boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.description = 'profile usage']]}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>partial_circular_profile |
| ROUNDED_U_PROFILE | rounded_u_profile | 224 | | rounded_u_profile <=<br>shape_aspect |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rounded_u_profile to toleranced_length_measure (as width) | PATH | | | rounded_u_profile <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation => shape_representation_with_parameters} representation representation.items[i] -> {representation_item representation_item.name = 'width'} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit |
| SHAPE_PROFILE | outside_profile | 224 | | outside_profile <= {feature_definition => instanced_feature} feature_definition <= characterized_object |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| shape_profile to profile_select<br>(as floor_condition)<br><br>#1: as profile_floor<br>#2: as through_profile_floor | PATH | | | outside_profile <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>(shape_aspect.description = 'complex boundary occurrence')<br>(shape_aspect.description = 'partial circular boundary occurrence')<br>(shape_aspect.description = 'closed circular boundary occurrence')<br>(shape_aspect.description = 'open rectangular boundary occur-<br>rence')<br>(shape_aspect.description = 'closed rectangular boundary occur-<br>rence')}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{shape_aspect_relationship =><br>feature_component_relationship<br>shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile floor usage'}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>{shape_aspect<br>#1: (shape_aspect.description = 'planar')<br>#1: (shape_aspect.description = 'complex')<br>#2: (shape_aspect.description = 'through')}<br>shape_aspect =><br>profile_floor |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| shape_profile to direction<br>(as removal_direction) | PATH | | | outside_profile <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>{property_definition=><br>product_definition_shape}<br>{product_definition_shape <-<br>shape_aspect.of_shape<br>shape_aspect<br>(shape_aspect.description = 'complex boundary occurrence'),<br>(shape_aspect.description = 'partial circular boundary occurrence'),<br>(shape_aspect.description = 'closed circular boundary occurrence'),<br>(shape_aspect.description = 'open rectangular boundary occur-<br>rence'),<br>(shape_aspect.description = 'closed rectangular boundary occur-<br>rence')}<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation<br>representation.name = 'removal direction'}<br>representation =><br>shape_representation=><br>direction_shape_representation |
| SLOT | slot | 224 | | slot <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| slot to travel_path<br>(as course_of_travel) | PATH | | | slot <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'course of travel occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.name = 'course of travel']<br>[shape_aspect_relationship.description =<br>'path feature component usage']]}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>path_feature_component |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| slot to open_profile<br>(as swept_shape) | PATH | | | slot <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'swept shape occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>(open_path_profile)<br>(partial_circular_profile)<br>(rounded_u_profile)<br>(square_u_profile)<br>(tee_profile)<br>(vee_profile) |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| slot to slot_end_type<br>(as end_conditions) | PATH | | | slot <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'end condition occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>feature_component_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'slot end usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>slot_end |
| SLOT_END_TYPE | slot_end | 224 | | slot_end <=<br>shape_aspect<br>{shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>feature_component_definition} |
| SPECIFICATION | document | 41 | | |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| specification to specification_usage_constraint (as constraint) | PATH | | | document <- document_usage_constraint.source document_usage_constraint |
| specification_id | document.id | 41 | | |
| specification_description | document.description | 41 | | |
| specification_class | document_with_class.class | 41 | | document=> document_with_class |
| SPECIFICATION_USAGE_-CONSTRAINT | document_usage_constraint | 41 | | |
| element | document_usage_constraint.-subject_element | 41 | | |
| class_id | document_usage_constraint.-subject_element_value | 41 | | |
| SPHERICAL_CAP | spherical_cap | 224 | | spherical_cap <= {feature_definition => instanced_feature} feature_definition <= characterized_object |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| spherical_cap to numeric_parameter (as internal_angle) | PATH | | | spherical_cap <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'internal angle'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| spherical_cap to numeric_parameter (as radius) | PATH | | | spherical_cap <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'radius'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit} |
| SPHERICAL_HOLE_BOTTOM | hole_bottom | 224 | | hole_bottom <=<br>shape_aspect<br>{ shape_aspect.description = 'spherical' } |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| spherical_hole_bottom to toleranced_length_measure (as radius) | PATH | | | hole_bottom <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'radius'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |
| SQUARE_U_PROFILE | square_u_profile | 224 | | square_u_profile <=<br>shape_aspect |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| square_u_profile to<br>toleranced_length_measure<br>(as width) | PATH | | | square_u_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'width'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| square_u_profile to<br>toleranced_length_measure<br>(as first_radius) | PATH | | | square_u_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'first radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| square_u_profile to plane_angle_measure (as first_angle) | PATH | | | square_u_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'first angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| square_u_profile to<br>toleranced_length_measure<br>(as second_radius) | PATH | | | square_u_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'second radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| square_u_profile to plane_angle_measure (as second_angle) | PATH | | | square_u_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'second angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| STEP | step | 224 | | step <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| step to linear_path<br>(as open_boundary) | PATH | | | step <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'course of travel occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>[shape_aspect_relationship.description = 'path feature component usage']]}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->{shape_aspect<br>shape_aspect.description = 'linear'}<br>shape_aspect =><br>path_feature_component |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| step to vee_profile<br>(as wall_boundary) | PATH | | | step <=<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>shape_aspect.of_shape<br>{shape_aspect<br>shape_aspect.description = 'removal boundary occurrence'}<br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'profile usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect -><br>shape_aspect =><br>vee_profile |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| step to boss<br>(as its_boss) | PATH | | | step <=<br>feature_definition <=<br>characterized_object<br>characterized_definition=characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape<-<br>shape_aspect.of_shape<br>{shape_aspect=><br>composite_shape_aspect}<br>shape_aspect<-<br>shape_aspect_relationship.relating_shape_aspect<br>{shape_aspect_relationship.description='uncut area'}<br>{shape_aspect_relationship=><br>feature_component_relationship}<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect-><br>shape_aspect=><br>instanced_feature=><br>feature_definition=><br>boss |
| SURFACE_TEXTURE_PARAMETER | surface_texture_representation | 214 | | surface_texture_representation <=<br>representation |
| surface_texture_parameter to<br>parameter_value<br>(as its_value) | measure_representation_item | 45 | | surface_texture_representation <=<br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item |
| parameter_name | representation_item.name | 43 | | |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| measuring_method | descriptive_representation_item.-description | 45 | | surface_texture_representation <= representation<br>representation.items[i] -><br>representation_item =><br>{representation_item.name = 'measuring method'}<br>descriptive_representation_item<br>descriptive_representation_item.description<br>{(descriptive_representation_item.description)<br>(descriptive_representation_item.description = 'ISO 4287')<br>(descriptive_representation_item.description = 'ISO 12085')<br>(descriptive_representation_item.description = 'ISO 13565')} |
| parameter_index | representation_item.name | 43 | | See NOTE 1 |
| surface_texture_parameter to machined_surface<br>(as applied_surfaces) | PATH | | | surface_texture_representation <= representation <-<br>property_definition_representation.used_representation<br>property_definition_representation<br>property_definition_representation.definition -><br>represented_definition<br>represented_definition = property_definition<br>property_definition |
| TEE_PROFILE | tee_profile | 224 | | tee_profile <= shape_aspect |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tee_profile to plane_angle_measure (as first_angle) | PATH | | | tee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'first angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tee_profile to plane_angle_measure (as second_angle) | PATH | | | tee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'second angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tee_profile to toleranced_length_measure (as cross_bar_width) | PATH | | | tee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'cross bar width'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tee_profile to toleranced_length_measure (as cross_bar_depth) | PATH | | | tee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'cross bar depth'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tee_profile to toleranced_length_measure (as radius) | PATH | | | tee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tee_profile to toleranced_length_measure (as width) | PATH | | | tee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'width'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tee_profile to toleranced_length_measure (as first_offset) | PATH | | | tee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'first offset'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tee_profile to toleranced_length_measure (as second_offset) | PATH | | | tee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'second offset'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| THREAD | (thread)<br>(externally_defined_feature_definition) | 224 | | (thread <=<br>{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object)<br>(externally_defined_feature_definition <=<br>[externally_defined_item]<br>[{feature_definition =><br>instanced_feature}<br>feature_definition <=<br>characterized_object<br>{characterized_object<br>characterized_object.description = 'thread'}]) |
| thread to partial_area_definition<br>(as partial_profile) | PATH | | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition <=<br>characterized_object<-<br>property_definition.definition<br>property_definition=><br>product_definition_shape<br>shape_aspect.of_shape->><br>shape_aspect <-<br>shape_aspect_relationship.related_shape_aspect<br>{[shape_aspect_relationship =><br>shape_defining_relationship]<br>[shape_aspect_relationship<br>shape_aspect_relationship.description = 'applied area usage']}<br>shape_aspect_relationship<br>shape_aspect_relationship.relating_shape_aspect ->><br>shape_aspect =><br>applied_area |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| thread to machining_feature<br>(as applied_shape)<br><br>NOTE: this is just to the shape to maintain harmonization with AP-224 | PATH | | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition =><br>characterized_object<-<br>property_definition.definition<br>{ property_definition=><br>product_definition_shape } |
| inner_or_outer_thread | descriptive_representation_-<br>item.description | 45 | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'thread side'}<br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{(descriptive_representation_item.description = 'internal')<br>(descriptive_representation_item.description = 'external')} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| qualifier | descriptive_representation_item | 45 | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'qualifier'}<br>representation_item =><br>descriptive_representation_item |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| fit_class | descriptive_representation_item | 45 | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'fit class'}<br>representation_item =><br>descriptive_representation_item |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| form | descriptive_representation_item | 45 | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'form'}<br>representation_item =><br>descriptive_representation_item |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| thread to partial_area_definition<br>(as major_diameter) | PATH | | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'major diameter'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| number_of_threads | ratio_measure_with_unit | | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'number of threads'}<br>representation_item =><br>measure_representation_item<br>{measure_representation_item <=<br>measure_with_unit =><br>ratio_measure_with_unit} |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| thread_hand | descriptive_representation_-<br>item.description | 45 | | (thread <=)<br>(externally_defined_feature_definition <=)<br>feature_definition <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{ representation_item.name = 'hand' }<br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{(descriptive_representation_item.description = 'left')<br>(descriptive_representation_item.description = 'right')} |
| THROUGH_BOTTOM_CONDITION | hole_bottom | 224 | | hole_bottom <=<br>shape_aspect<br>{ shape_aspect.description = 'through' }<br>{shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>feature_component_definition} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| THROUGH_POCKET_BOTTOM_-CONDITION | pocket_bottom | 224 | | pocket_bottom <=<br>shape_aspect<br>{ shape_aspect.description = 'through' } |
| THROUGH_PROFILE_FLOOR | profile_floor | 224 | | profile_floor <=<br>shape_aspect<br>{shape_aspect<br>shape_aspect.description = 'through'}<br>{shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>feature_component_definition} |
| TOOLPATH_FEATURE | instanced_feature | 224 | | instanced_feature <=<br>feature_definition <=<br>characterized_object<br>{ characterized_object.description = 'toolpath' } |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| TOPOLOGICAL_REGION | open_shell | 42 | | open_shell<br>shell = open_shell<br>shell_based_surface_model.shells[1] -> shell<br>shell_based_surface_model <=<br>representation_item <-<br>representation.items[i]<br>{representation => manifold_surface_shape_representation }<br>representation <-<br>property_definition_representation.used_representation<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.definition -><br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = shape_definition<br>shape_definition = shape_aspect<br>{ shape_aspect.description = 'volume shape'}<br>shape_aspect <-<br>shape_aspect_relationship.relating_shape_aspect<br>{ shape_aspect_relationship =><br>shape_defining_relationship }<br>{ shape_aspect_relationship.description = 'volume shape usage' }<br>shape_aspect_relationship<br>shape_aspect_relationship.related_shape_aspect -><br>shape_aspect<br>{ shape_aspect.description = 'shape volume occurrence' }<br>shape_aspect.of_shape -><br>product_definition_shape <=<br>property_definition<br>property_definition.definition -><br>characterized_definition<br>characterized_definition = characterized_object<br>characterized_object =><br>removal_volume |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| TRANSITION_FEATURE | transistion_feature | 224 | | transition_feature <=<br>shape_aspect |
| transition_feature to machining_feature (as first_feature) | PATH | | | transition_feature <=<br>shape_aspect<br>shape_definition=shape_aspect<br>shape_definition<br>characterized_definition=shape_definition<br>characterized_definition <-<br>property_definition.definition<br>{ property_definition =><br>product_definition_shape }<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{ representation.name = 'first face shape' }<br>representation =><br>shape_representation=><br>face_shape_representation<br><br>See NOTE 4 |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| transition_feature to machining_feature (as second_feature) | PATH | | | transition_feature <=<br>shape_aspect<br>shape_definition=shape_aspect<br>shape_definition<br>characterized_definition=shape_definition<br>characterized_definition <-<br>property_definition.definition<br>{ property_definition =><br>product_definition_shape }<br>property_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{ representation.name = 'second face shape' }<br>representation =><br>shape_representation=><br>face_shape_representation<br><br>See NOTE 4 |
| TRAVEL_PATH | path_feature_component | 224 | | path_feature_component <=<br>shape_aspect<br>{shape_aspect<br>shape_aspect.of_shape-><br>product_definition_shape<=<br>property_definition<br>property_definition.definition-><br>characterized_definition=characterized_object<br>characterized_object=><br>feature_component_definition} |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| travel_path to axis2_placement_3d (as placement) | PATH | | | path_feature_component <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation => shape_representation_with_parameters} representation representation.items[i] -> {representation_item representation_item.name = 'orientation'} representation_item => geometric_representation_item => placement => axis2_placement_3d |
| TWO5D_MANUFACTURING_-FEATURE | instanced_feature | 224 | | instanced_feature <= [shape_aspect] [feature_definition <= characterized_object] |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| two5d_manufacturing_feature to axis2_placement_3d (as feature_placement) | PATH | | | instanced_ feature <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition represented_definition = property_definition represented_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation => shape_representation_with_parameters} representation representation.items[i] -> {representation_item.name = ‘orientation’} representation_item => geometric_representation_item => placement => axis2_placement_3d |
| VEE_PROFILE | vee_profile | 224 | | vee_profile <= shape_aspect |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| vee_profile to<br>toleranced_length_measure<br>(as profile_radius) | PATH | | | vee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'profile radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| vee_profile to plane_angle_measure (as profile_angle) | PATH | | | vee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'profile angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

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## Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| vee_profile to plane_angle_measure (as tilt_angle) | PATH | | | vee_profile <=<br>shape_aspect<br>shape_definition = shape_aspect<br>shape_definition<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = 'tilt angle'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| WOODRUFF_SLOT_END_TYPE | slot_end | 224 | | slot_end <=<br>shape_aspect<br>{ shape_aspect.description = 'woodruff' } |

# Table 4 — Mapping table for manufacturing features UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| woodruff_slot_end_type to<br>toleranced_length_measure<br>(as radius) | PATH | | | slot_end <=<br>shape_aspect<br>shape_definition = shape_aspect<br>characterized_definition = shape_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation}<br>property_definition_representation<br>property_definition_representation.used_representation -><br>{representation =><br>shape_representation_with_parameters}<br>representation<br>representation.items[i] -><br>{representation_item.name = 'radius'}<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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# Table 5 — Mapping table for executable UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| AND_EXPRESSION | and_expression | PLIB | | and_expression <=<br>multiple_arity_boolean_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ multiple_arity_generic_expression <= ]<br>generic_expression |
| ASSIGNMENT | machining_process_executable | NEW | | machining_process_executable <=<br>action_method<br>{ action_method.description = ‘assignment’ } |
| assignment to nc_variable<br>(as lvalue) | PATH | | | machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘lvalue’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>expression_representation_item |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| assignment to rvalue<br>(as rvalue) | PATH | | | machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘rvalue’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>expression_representation_item |
| BINARY_BOOLEAN_EXPRESSION | binary_boolean_expression | PLIB | | binary_boolean_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ binary_generic_expression <= ]<br>generic_expression |
| binary_boolean_expression to<br>boolean_expression<br>(as operand1) | PATH | | | binary_boolean_expression <=<br>binary_generic_expression<br>binary_generic_expression.operands[1] -><br>generic_expression =><br>expression =><br>boolean_expression |
| binary_boolean_expression to<br>boolean_expression<br>(as operand2) | PATH | | | binary_boolean_expression <=<br>binary_generic_expression<br>binary_generic_expression.operands[2] -><br>generic_expression =><br>expression =><br>boolean_expression |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| BOOLEAN_EXPRESSION | boolean_expression | PLIB | | boolean_expression <=<br>expression <=<br>generic_expression |
| CHANNEL | representation | 43 | | representation<br>{ representation.description = ‘channel’ } |
| its_id | representation.name | 43 | | |
| COMPARISON_EQUAL | comparison_equal | PLIB | | comparison_equal <=<br>comparison_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ binary_generic_expression <= ]<br>generic_expression |
| COMPARISON_EXPRESSION | comparison_expression | PLIB | | comparison_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ binary_generic_expression <= ]<br>generic_expression |
| comparison_expression to nc_variable (as operand1) | PATH | | | comparison_expression <=<br>binary_generic_expression<br>binary_generic_expression.operands[1] -><br>generic_expression =><br>expression =><br>numeric_expression =><br>simple_numeric_expression =><br>numeric_variable |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| comparison_expression to rvalue (as operand2) | PATH | | | comparison_expression <= binary_generic_expression binary_generic_expression.operands[2] -> generic_expression => expression => numeric_expression => simple_numeric_expression => (numeric_variable) (literal_number) |
| COMPARISON_GREATER | comparison_greater | PLIB | | comparison_greater <= comparison_expression <= [ boolean_expression <= expression <= ] [ binary_generic_expression <= ] generic_expression |
| COMPARISON_GREATER_EQUAL | comparison_greater_equal | PLIB | | comparison_greater_equal <= comparison_expression <= [ boolean_expression <= expression <= ] [ binary_generic_expression <= ] generic_expression |
| COMPARISON_LESS | comparison_less | PLIB | | comparison_less <= comparison_expression <= [ boolean_expression <= expression <= ] [ binary_generic_expression <= ] generic_expression |
| COMPARISON_LESS_EQUAL | comparison_less_equal | PLIB | | comparison_less_equal <= comparison_expression <= [ boolean_expression <= expression <= ] [ binary_generic_expression <= ] generic_expression |

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## Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| COMPARISON_NOT_EQUAL | comparison_not_equal | PLIB | | comparison_not_equal <=<br>comparison_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ binary_generic_expression <= ]<br>generic_expression |
| CUTTING_COMPONENT | machining_cutting_component | | | machining_cutting_component <=<br>[action_resource]<br>[characterized_object] |
| cutting_component to length_measure<br>(as tool_offset_length) | PATH | | | machining_cutting_component <=<br>action_resource<br>characterized_resource_definition = action_resource<br>characterized_resource_definition <-<br>resource_property.resource<br>{ resource_property.name = ‘offset length’ }<br>resource_property <-<br>resource_property_representation.property<br>resource_property_representation<br>resource_property_representation.representation<br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| cutting_component to material<br>(as its_material) | PATH | | | machining_cutting_component <=<br>characterized_object<br>characterized_definition = characterized_object<br>characterized_definition <-<br>material_designation.definitions[i]<br>material_designation |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutting_component to cutting_edge_technological_data (as technological_data) | PATH | | | machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘technological data’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation representation |
| cutting_component to time_measure (as expected_tool_life) | PATH | | | machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘expected life’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => time_measure_with_unit |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutting_component to milling_technology (as its_technology) | PATH | | | machining_cutting_component <= action_resource <- requirement_for_action_resource.resources[i] requirement_for_action_resource <= action_resource_requirement { action_resource_requirement.kind -> resource_requirement_type resource_requirement_type.name = ‘cutting component’ } action_resource_requirement.operations[i] -> characterized_action_definition characterized_action_definition = action_method action_method => machining_technology |
| CUTTING_EDGE_-TECHNOLOGICAL_DATA | representation | 43 | | |
| cutting_edge_technological_data to plane_angle_measure (as cutting_angle) | PATH | | | representation representation.items[i] -> { representation_item.name = ‘cutting angle’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit |
| cutting_edge_technological_data to plane_angle_measure (as free_angle) | PATH | | | representation representation.items[i] -> { representation_item.name = ‘free angle’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutting_edge_technological_data to plane_angle_measure (as aux_angle) | PATH | | | representation<br>representation.items[i] ->{ representation_item.name = ‘aux angle’ }<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| CUTTING_TOOL | machining_tool | NEW | | machining_tool <=<br>action_resource<br>{ action_resource.kind ->action_resource_type<br>action_resource_type.name = ‘cutting tool’ } |
| cutting_tool to tool_body (as its_tool_body) | PATH | | | machining_tool <=<br>action_resource<br>characterized_resource_definition = action_resource<br>characterized_resource_definition <-<br>resource_property.resource<br>{ resource_property.name = ‘tool body’ }<br>resource_property <-<br>resource_property_representation.property<br>resource_property_representation<br>resource_property_representation.representation<br>representation =><br>machining_tool_body_representation |
| cutting_tool to cutting_component (as its_cutting_edge) | PATH | | | machining_tool <=<br>action_resource <-<br>action_resource_relationship.relating<br>action_resource_relationship<br>action_resource_relationship.related ->action_resource =><br>machining_cutting_component<br><br>See NOTE 2 |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| overall_assembly_length | length_measure_with_unit | 41 | | machining_tool <=<br>action_resource<br>characterized_resource_definition = action_resource<br>characterized_resource_definition <-<br>resource_property.resource<br>{ resource_property.name = ‘overall assembly length’ }<br>resource_property <-<br>resource_property_representation.property<br>resource_property_representation<br>resource_property_representation.representation<br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| DISPLAY_MESSAGE | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘display message’ } |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_text | descriptive_representation_item.-description | 45 | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘message text’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description |
| EXECUTABLE | machining_process_executable | NEW | | machining_process_executable <=<br>action_method |
| its_id | action_method.name | 41 | | machining_process_executable <=<br>action_method<br>action_method.name |
| IF_STATEMENT | machining_process_executable | NEW | | machining_process_executable <=<br>action_method<br>{ action_method.description = ‘if statement’ } |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| if_statement to boolean_expression<br>(as condition) | PATH | | | machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘condition’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>expression_representation_item <=<br>generic_expression =><br>expression =><br>boolean_expression |
| if_statement to executable<br>(as true_branch) | PATH | | | machining_process_executable <=<br>action_method <-<br>action_method_relationship.relating_method<br>action_method_relationship<br>{ action_method_relationship.description = ‘true branch’ }<br>action_method_relationship.related_method -><br>action_method =><br>machining_process_executable |
| if_statement to executable<br>(as false_branch) | PATH | | | machining_process_executable <=<br>action_method <-<br>action_method_relationship.relating_method<br>action_method_relationship<br>{ action_method_relationship.description = ‘false branch’ }<br>action_method_relationship.related_method -><br>action_method =><br>machining_process_executable |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| IN_PROCESS_GEOMETRY | <action_property> | 49 | | action_property<br>{ action_property.name = ‘as-is shape’ } |
| | <action_property> | 49 | | action_property<br>{ action_property.name = ‘to-be shape’ } |
| | <action_property> | 49 | | action_property<br>{ action_property.name = ‘removal shape’ } |
| in_process_geometry to advanced_brep_shape_representation (as as_is) | PATH | | | action_property <-<br>{ action_property.name = ‘as-is shape’ }<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation =><br>shape_representation =><br>advanced_brep_shape_representation |
| in_process_geometry to advanced_brep_shape_representation (as to_be) | PATH | | | action_property <-<br>{ action_property.name = ‘to-be shape’ }<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation =><br>shape_representation =><br>advanced_brep_shape_representation |
| in_process_geometry to advanced_brep_shape_representation (as removal) | PATH | | | action_property <-<br>{ action_property.name = ‘removal shape’ }<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation =><br>shape_representation =><br>advanced_brep_shape_representation |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| MACHINING_TOOL | machining_tool | NEW | | machining_tool <=<br>action_resource |
| its_id | action_resource.name | 41 | | machining_tool <=<br>action_resource<br>action_resource.name |
| MACHINING_WORKINGSTEP | machining_workingstep | NEW | | machining_workingstep <=<br>machining_process_executable <=<br>action_method |
| machining_workingstep to<br>manufacturing_feature<br>(as its_feature) | PATH | | | machining_workingstep <=<br>machining_process_executable <=<br>action_method <-<br>action_method_relationship.related_method<br>{ action_method_relationship.name = ‘final feature’ }<br>action_method_relationship<br>action_method_relationship.relating_method ->{ action_method =><br>machining_process_executable =><br>machining_feature_process }<br>action_method <-<br>action.chosen_method<br>{ action.name = ‘machining’ }<br>action =><br>property_process <-<br>process_property_association.process<br>process_property_association<br>process_property_association.property_or_shape ->property_or_shape_select<br>property_or_shape_select = shape_definition<br>shape_definition<br>shape_definition = shape_aspect<br>shape_aspect |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| machining_workingstep to manufacturing_feature (as its_process_feature) | PATH | | | machining_workingstep <=<br>machining_process_executable <=<br>action_method <-<br>action_method_relationship.related_method<br>{ action_method_relationship.name = ‘in-process feature’ }<br>action_method_relationship<br>action_method_relationship.relating_method ->{ action_method =><br>machining_process_executable =><br>machining_feature_process }<br>action_method <-<br>action.chosen_method<br>{ action.name = ‘machining’ }<br>action =><br>property_process <-<br>process_property_association.process<br>process_property_association<br>process_property_association.property_or_shape ->property_or_shape_select<br>property_or_shape_select = shape_definition<br>shape_definition<br>shape_definition = shape_aspect<br>shape_aspect |
| machining_workingstep to machining_operation (as its_operation) | PATH | | | machining_workingstep <=<br>machining_process_executable <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship.name = ‘operation’ }<br>action_method_relationship<br>action_method_relationship.related_method ->action_method =><br>machining_operation |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| machining_workingstep to<br>in_process_geometry<br>(as its_effect) | PATH | | | machining_workingstep <=<br>machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>action_property |
| MULTIPLE_ARITY_BOOLEAN_-<br>EXPRESSION | multiple_arity_boolean_expression | PLIB | | multiple_arity_boolean_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ multiple_arity_generic_expression <= ]<br>generic_expression |
| multiple_arity_boolean_expression to<br>boolean_expression<br>(as operands) | PATH | | | multiple_arity_boolean_expression <=<br>multiple_arity_generic_expression<br>multiple_arity_generic_expression.operands[i] -><br>generic_expression =><br>expression =><br>boolean_expression |
| NC_CONSTANT | [ literal_number ]<br>[ expression_representation_item ] | PLIB<br>NEW | | representation_item =><br>expression_representation_item <=<br>generic_expression =><br>expression =><br>numeric_expression =><br>simple_numeric_expression =><br>literal_number =><br>(int_literal)<br>(real_literal) |
| its_name | representation_item.name | | | |
| its_value | literal_number.the_value | | | |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| NC_FUNCTION | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method |
| NC_VARIABLE | [ numeric_variable ]<br>[ expression_representation_item ] | PLIB<br>NEW | 10 | representation_item =><br>expression_representation_item <=<br>generic_expression =><br>expression =><br>numeric_expression =><br>simple_numeric_expression =><br>numeric_variable =><br>(int_numeric_variable)<br>(real_numeric_variable) |
| its_name | representation_item.name | | | |
| initial_value | PATH | | 10 | expression_representation_item <=<br>representation_item <-<br>representation_item_relationship.relating_representation_item<br>{ representation_item_relationship.description = ‘initial value’ }<br>representation_item_relationship<br>representation_item_relationship.related_representation_item -><br>representation_item =><br>expression_representation_item <=<br>generic_expression =><br>literal_number<br>literal_number.the_value |
| NON_SEQUENTIAL | machining_process_executable | NEW | | machining_process_executable <=<br>action_method<br>{ action_method.description = ‘non-sequential’ } |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| non_sequential to executable<br>(as its_elements) | PATH | | | machining_process_executable <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship =><br>concurrent_action_method }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_process_executable |
| NOT_EXPRESSION | not_expression | PLIB | | not_expression <=<br>unary_boolean_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ unary_generic_expression <= ]<br>generic_expression |
| OFFSET_VECTOR | machining_offset_vector_representation | 43 | | machining_offset_vector_representation <=<br>representation |
| offset_vector to nc_variable<br>(as translate) | PATH | | | machining_offset_vector_representation <=<br>representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘translate’ }<br>representation_item =><br>compound_representation_item<br>compound_representation_item.item_element -><br>compound_item_definition<br>compound_item_definition = list_representation_item<br>list_representation_item[i] -><br>representation_item =><br>expression_representation_item |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| offset_vector to nc_variable<br>(as rotate) | PATH | | | machining_offset_vector_representation <=<br>representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘rotate’ }<br>representation_item =><br>compound_representation_item<br>compound_representation_item.item_element -><br>compound_item_definition<br>compound_item_definition = list_representation_item<br>list_representation_item[i] -><br>representation_item =><br>expression_representation_item |
| OPTIONAL_STOP | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘optional stop’ } |
| OR_EXPRESSION | or_expression | PLIB | | or_expression <=<br>multiple_arity_boolean_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ multiple_arity_generic_expression <= ]<br>generic_expression |
| PARALLEL | machining_process_executable | NEW | | machining_process_executable <=<br>action_method<br>{ action_method.description = ‘parallel’ } |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| parallel to executable<br>(as branches) | PATH | | | machining_process_executable <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship =><br>concurrent_action_method }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_process_executable |
| PROGRAM_STOP | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘program stop’ } |
| PROGRAM_STRUCTURE | machining_process_executable | NEW | | machining_process_executable <=<br>action_method |
| RAPID_MOVEMENT | machining_rapid_movement | NEW | | machining_rapid_movement <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method |
| RETURN_HOME | machining_rapid_movement | NEW | | machining_rapid_movement <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>{ action_method.description = ‘return home’ } |
| SELECTIVE | machining_process_executable | NEW | | machining_process_executable <=<br>action_method<br>{ action_method.description = ‘selective’ } |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| selective to executable<br>(as its_elements) | PATH | | | machining_process_executable <=<br>action_method <-<br>action_method_relationship.relating_method<br>action_method_relationship<br>{ action_method_relationship.description = ‘branch’ }<br>action_method_relationship.related_method -><br>action_method =><br>machining_process_executable |
| SET_MARK | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘set mark’ } |
| SETUP | product_definition_formation | 41 | | product_definition_formation<br>{ product_definition_formation.of_product -><br>product <-<br>product_related_product_category.products[i]<br>product_related_product_category <=<br>product_category<br>product_category.name = ‘machining setup’ } |
| its_id | product.id | 41 | | product_definition_formation<br>product_definition_formation.of_product -><br>product<br>product.id |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_origin | axis2_placement_3d | 42 | | product_definition_formation <-<br>product_definition.formation<br>product_definition<br>characterized_product_definition = product_definition<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>property_definition.definition<br>{ property_definition =><br>product_definition_shape }<br>property_definition<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>{property_definition_representation =><br>shape_definition_representation }<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation<br>representation.items[i] -><br>{representation_item<br>representation_item.name = ‘orientation’}<br>representation_item =><br>geometric_representation_item =><br>placement =><br>axis2_placement_3d |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| setup to elementary_surface<br>(as its_secplane) | elementary_surface | 42 | 9 | product_definition_formation <-<br>product_definition.formation<br>product_definition<br>characterized_product_definition = product_definition<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>property_definition.definition<br>{ property_definition.name = ‘security plane’ }<br>property_definition <-<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>surface =><br>elementary_surface |
| setup to workpiece_setup<br>(as its_workpiece_setup) | PATH | | | product_definition_formation <-<br>product_definition.formation<br>product_definition <-<br>product_definition_relationship.relating_product_definition<br>product_definition_relationship |
| SETUP_INSTRUCTION | machining_operator_instruction | NEW | | machining_operator_instruction <=<br>machining_process_executable <=<br>action_method |
| description | action_method.description | 41 | | machining_operator_instruction <=<br>machining_process_executable <=<br>action_method<br>action_method.description |

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## Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| external_document | document.id | 41 | | machining_operator_instruction <=<br>machining_process_executable <=<br>action_method<br>document_reference_item = action_method<br>document_reference_item <-<br>applied_document_reference.items[i]<br>applied_document_reference <=<br>document_reference<br>document_reference.assigned_document -><br>document<br>document.id |
| TOOL_BODY | machining_tool_body_representation | NEW | | machining_tool_body_representation <=<br>representation |
| TOOL_LENGTH_PROBING | machining_touch_probing | NEW | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>{ action_method.description = ‘tool length probing’ } |
| TOOL_PROBING | machining_touch_probing | NEW | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>{ action_method.description = ‘tool probing’ } |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tool_probing to cartesian_point<br>(as offset) | cartesian_point | 42 | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘offset’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>point =><br>cartesian_point |

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## Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tool_probing to positive_length_measure (as max_wear) | positive_length_measure | 41 | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘maximum wear’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>measure_with_unit.value_component -><br>measure_value<br>measure_value = positive_length_measure<br>positive_length_measure |
| tool_probing to machining_tool (as its_tool) | PATH | | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>supported_item = action_method<br>supported_item <-<br>action_resource.usage[i]<br>action_resource =><br>machining_tool |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| TOOL_RADIUS_PROBING | machining_touch_probing | NEW | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>{ action_method.description = ‘tool radius probing’ } |
| TOUCH_PROBE | representation | 43 | | representation<br>{ representation.description = ‘touch probe’ } |
| its_id | representation.name | 43 | | |
| TOUCH_PROBING | machining_touch_probing | NEW | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method |
| touch_probing to nc_variable<br>(as measured_offset) | PATH | | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘measured offset’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>expression_representation_item |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| UNARY_BOOLEAN_EXPRESSION | unary_boolean_expression | PLIB | | unary_boolean_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ unary_generic_expression <= ]<br>generic_expression |
| unary_boolean_expression to boolean_expression<br>(as operand) | PATH | | | unary_boolean_expression <=<br>unary_generic_expression<br>unary_generic_expression.operand -><br>generic_expression =><br>expression =><br>boolean_expression |
| WAIT_FOR_MARK | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘wait for mark’ } |
| wait_for_mark to channel<br>(as its_channel) | PATH | | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘channel’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation |
| WHILE_STATEMENT | machining_process_executable | NEW | | machining_process_executable <=<br>action_method<br>{ action_method.description = ‘while statement’ } |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| while_statement to boolean_expression (as condition) | PATH | | | machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘condition’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => expression_representation_item <= generic_expression => expression => boolean_expression |
| while_statement to executable (as body) | PATH | | | machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship.description = ‘body’ } action_method_relationship.related_method -> action_method => machining_process_executable |
| WORKINGSTEP | machining_workingstep | NEW | | machining_workingstep <= machining_process_executable <= action_method |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workingstep to elementary_surface (as its_secplane) | elementary_surface | 42 | | machining_workingstep <=<br>machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘security plane’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>surface =><br>elementary_surface |
| WORKPIECE_COMPLETE_PROBING | machining_touch_probing | NEW | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>{ action_method.description = ‘workpiece complete probing’ } |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece_complete_probing to workpiece (as its_workpiece) | PATH | | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method <-<br>action.chosen_method<br>{ action.name = ‘workpiece complete probing’ }<br>action =><br>product_definition_process<br>process_product_association.process -><br>process_product_association<br>process_product_association.defined_product<br>characterized_product_definition <-<br>characterized_product_definition = product_definition<br>product_definition |
| workpiece_complete_probing to toleranced_length_measure (as probing_distance) | PATH | | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘probing distance’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>[length_measure_with_unit]<br>[measure_representation_item]<br>[qualified_representation_item] |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece_complete_probing to touch_probe (as its_probe) | PATH | | | machining_touch_probing <= [ machining_operation <= ] [ machining_process_executable <= ] action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘probe’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation |
| workpiece_complete_probing to offset_vector (as computed_offset) | PATH | | | machining_touch_probing <= [ machining_operation <= ] [ machining_process_executable <= ] action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘computed offset’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation => machining_offset_vector_representation |
| WORKPIECE_PROBING | machining_touch_probing | NEW | | machining_touch_probing <= [ machining_operation <= ] [ machining_process_executable <= ] action_method { action_method.description = ‘workpiece probing’ } |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| start_position | axis2_placement_3d | 42 | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘start position’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>placement =><br>axis2_placement_3d |
| workpiece_probing to<br>workpiece (as its_workpiece) | PATH | | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method <-<br>action.chosen_method<br>{ action.name = ‘workpiece probing’ }<br>action =><br>product_definition_process<br>process_product_association.process -><br>process_product_association<br>process_product_association.defined_product<br>characterized_product_definition <-<br>characterized_product_definition = product_definition<br>product_definition |

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## Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| direction | direction | 42 | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation =><br>shape_representation =><br>direction_shape_representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece_probing to<br>toleranced_length_measure<br>(as expected_value) | PATH | | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘expected value’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>[length_measure_with_unit]<br>[measure_representation_item]<br>[qualified_representation_item] |
| workpiece_probing to<br>touch_probe<br>(as its_probe) | PATH | | | machining_touch_probing <=<br>[ machining_operation <= ]<br>[ machining_process_executable <= ]<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘probe’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation |
| WORKPIECE_SETUP | product_definition_relationship | 41 | | product_definition_relationship<br>{ product_definition_relationship.name = ‘workpiece’ } |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece_setup to<br>workpiece (as its_workpiece) | PATH | | | product_definition_relationship<br>product_definition_relationship.related_product_definition ->
product_definition |
| its_origin | axis2_placement_3d | 42 | | product_definition_relationship<br>characterized_product_definition = product_definition_relationship<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition =><br>product_definition_shape <-<br>context_dependent_shape_representation.-<br>represented_product_relation<br>context_dependent_shape_representation<br>context_dependent_shape_representation.-<br>representation_relation -><br>[ shape_representation_relationship ]<br>[ representation_relationship_with_transformation ]<br>representation_relationship_with_transformation.-<br>transformation_operator -><br>transformation<br>transformation = item_defined_transformation<br>item_defined_transformation<br>item_defined_transformation.transform_item_2 -><br>representation_item =><br>axis2_placement_3d<br><br>See NOTE 3 |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece_setup to<br>offset_vector<br>(as its_offset) | PATH | | | product_definition_relationship<br>characterized_product_definition = product_definition_relationship<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition<br>{ property_definition.name = ‘computed offset’ }<br>property_definition <-<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation =><br>machining_offset_vector_representation |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece_setup to<br>restricted_area_select<br>(as its_restricted_area)<br><br>#1: if restricted_area is a block<br><br>#2: if restricted_area is a<br>right_circular_cylinder<br><br>#3: if restricted_area is an<br>advanced_brep_shape_representation<br><br>#4: if restricted_area is a<br>bounded_surface | PATH | | | product_definition_relationship<br>characterized_product_definition = product_definition_relationship<br>characterized_product_definition<br>characterized_definition = characterized_product_definition<br>characterized_definition <-<br>property_definition.definition<br>property_definition<br>{ property_definition.name = ‘restricted area’ }<br>property_definition <-<br>represented_definition = property_definition<br>represented_definition <-<br>property_definition_representation.definition<br>property_definition_representation<br>property_definition_representation.used_representation -><br>representation =><br>shape_representation =><br><br>#1 (shape_representation_with_parameters =><br>block_shape_representation)<br><br>#2 (shape_representation_with_parameters =><br>cylindrical_shape_representation)<br><br>#3 (advanced_brep_shape_representation)<br><br>#4 ( geometrically_bounded_surface_shape_representation <=<br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_set<br>geometric_set.elements[i] -><br>geometric_set_select<br>geometric_set_select = surface<br>surface =><br>bounded_surface) |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workpiece_setup to setup_instruction (as its_instructions) | PATH | | | product_definition_relationship<br>characterized_product_definition = product_definition_relationship<br>characterized_product_definition <-<br>process_product_association.defined_product<br>process_product_association<br>process_product_association.process -><br>product_definition_process <=<br>action<br>{ action.name = ‘setup’ }<br>action.chosen_method -><br>{ action_method =><br>machining_process_executable }<br>{ action_method.description = ‘setup’ }<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship =><br>serial_action_method =><br>sequential_method }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_process_executable =><br>machining_operator_instruction |
| WORKPLAN | machining_workplan | NEW | | machining_workplan <=<br>machining_process_executable <=<br>action_method |

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# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workplan to executable<br>(as its_elements) | PATH | | | machining_workplan <=<br>machining_process_executable <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship =><br>serial_action_method =><br>sequential_method }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_process_executable |
| workplan to channel<br>(as its_channel) | PATH | | | machining_workplan <=<br>machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘channel’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation |

# Table 5 — Mapping table for executable UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| workplan to setup<br>(as its_setup) | PATH | | | machining_workplan <=<br>machining_process_executable <=<br>action_method <-<br>action.chosen_method<br>{ action.name = ‘setup’ }<br>action =><br>product_definition_process <-<br>process_product_association.process<br>process_product_association<br>process_product_association.defined_product -><br>characterized_product_definition<br>characterized_product_definition = product_definition<br>product_definition<br>product_definition.formation -><br>product_definition_formation |
| workplan to in_process_geometry<br>(as its_effect) | PATH | | | machining_workplan <=<br>machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>action_property |
| XOR_EXPRESSION | xor_expression | PLIB | | xor_expression <=<br>binary_boolean_expression <=<br>[ boolean_expression <=<br>expression <= ]<br>[ binary_generic_expression <= ]<br>generic_expression |

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# Table 6 — Mapping table for operation UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| MACHINE_FUNCTIONS | machining_functions | NEW | | machining_functions <=<br>action_method |
| MACHINING_OPERATION | machining_operation | NEW | | machining_operation <=<br>action_method |
| its_id | action_method.name | 41 | | machining_operation <=<br>action_method<br>action_method.name |
| retract_plane | length_measure_with_unit | 41 | | machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘retract plane’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 6 — Mapping table for operation UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cut_start_point | cartesian_point | 42 | | machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘cut start point’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>point =><br>cartesian_point |
| machining_operation to machining_tool (as its_tool) | PATH | | | machining_operation <=<br>action_method<br>supported_item = action_method<br>supported_item <-<br>action_resource.usage[i]<br>action_resource =><br>machining_tool |
| machining_operation to technology (as its_technology) | PATH | | | machining_operation <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘technology’ }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_technology |

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# Table 6 — Mapping table for operation UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| machining_operation to machine_functions (as its_machine_functions) | PATH | | | machining_operation <= action_method <- action_method_relationship.relating_method { action_method_relationship action_method_relationship.name = ‘machine functions’ } action_method_relationship action_method_relationship.related_method -> action_method => machining_functions |
| OPERATION | machining_operation | NEW | | machining_operation <= action_method <- |
| operation to toolpath sequence (as its_toolpath) | PATH | | | machining_operation <= action_method <- action_method_relationship.relating_method { action_method_relationship action_method_relationship.name = ‘toolpath’ } action_method_relationship => serial_action_method => sequential_method } action_method_relationship action_method_relationship.related_method -> action_method => machining_toolpath |

# Table 6 — Mapping table for operation UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| operation to tool_direction<br>(as its_tool_direction) | PATH | | | machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘tool direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation =><br>machining_tool_direction_representation |
| TECHNOLOGY | machining_technology | NEW | | machining_technology <=<br>action_method |
| feedrate | measure_with_unit | 41 | | machining_technology <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘feedrate’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit |

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# Table 6 — Mapping table for operation UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| feedrate_reference | descriptive_representation_item | 45 | | machining_technology <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘feedrate reference’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{( descriptive_representation_item.description = \<br>‘tool center point’)<br>(descriptive_representation_item.description = \<br>‘cutter contact point’)} |
| THREE_AXES | machining_tool_direction_representation | NEW | | machining_tool_direction_representation <=<br>representation<br>{representation.name = ‘three axes’ } |
| TOOL_DIRECTION | machining_tool_direction_representation | NEW | | machining_tool_direction_representation <=<br>representation |
| TOOLPATH_LIST | NOT MAPPED, operation to toolpaths handled in operation | | | |
| TWO_AXES | machining_tool_direction_representation | NEW | | machining_tool_direction_representation <=<br>representation<br>{representation.name = ‘two axes’ } |

# Table 7 — Mapping table for toolpath UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| TOOLPATH | machining_toolpath | NEW | | machining_toolpath <=<br>action_method |
| its_priority | descriptive_representation_item | 45 | | machining_toolpath <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘priority’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘required’ )<br>(descriptive_representation_item.description = ‘suggested’ ) } |

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# Table 7 — Mapping table for toolpath UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_type | | | | machining_toolpath <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘trajectory type’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘approach’ )<br>(descriptive_representation_item.description = ‘lift’ )<br>(descriptive_representation_item.description = ‘connect’ )<br>(descriptive_representation_item.description = ‘non-contact’ )<br>(descriptive_representation_item.description = ‘contact’ )<br>(descriptive_representation_item.description = ‘trajectory path’ ) } |
| its_speed | | | | machining_toolpath <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘speed profile’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation =><br>machining_toolpath_speed_profile_representation |

# Table 7 — Mapping table for toolpath UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| toolpath to machining_technology<br>(as its_technology) | PATH | | | machining_toolpath <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘technology’ }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_technology |
| toolpath to machine_functions<br>(as its_machine_functions) | PATH | | | machining_toolpath <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘machine functions’ }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_functions |
| | | | | |

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# Table 8 — Mapping table for process data for milling UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| ADAPTIVE_CONTROL | machining_adaptive_control_strategy | NEW | | machining_adaptive_control_strategy <=<br>machining_strategy <=<br>action_method |
| AIR_STRATEGY | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ (action_method.description = ‘approach retract angle’)<br>(action_method.description = ‘approach retract tangent’) } |
| ALONG_PATH | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘along path’ } |
| along_path to toolpath sequence<br>(as path) | PATH | | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘toolpath’ }<br>action_method_relationship =><br>serial_action_method =><br>sequential_method }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_toolpath |
| AP_RETRACT_ANGLE | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘approach retract angle’ } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| angle | plane_angle_measure_with_unit | 41 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘travel angle’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| travel_length | length_measure_with_unit | 41 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘travel length’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| AP_RETRACT_TANGENT | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘approach retract tangent’ } |
| radius | length_measure_with_unit | 41 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘travel radius’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| APPROACH_RETRACT_STRATEGY | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| tool_orientation | direction | 42 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘tool orientation’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |
| BACK_BORING | back_boring_operation | NEW | | back_boring_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method |
| BIDIRECTIONAL | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘bidirectional’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| feed_direction | direction | 42 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘feed direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |
| stepover_direction | descriptive_representation_item.-<br>description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘stepover direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘left’ )<br>(descriptive_representation_item.description = ‘right’ ) } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_stroke_connection_strategy | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘connection strategy’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘straight line’ )<br>(descriptive_representation_item.description = ‘lift shift plunge’ )<br>(descriptive_representation_item.description = ‘degouge’ )<br>(descriptive_representation_item.description = ‘loop back’ ) } |
| BIDIRECTIONAL_CONTOUR | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘bidirectional contour’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| feed_direction | direction | 42 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘feed direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |
| stepover_direction | descriptive_representation_item.-<br>description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘stepover direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘left’ )<br>(descriptive_representation_item.description = ‘right’ ) } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rotation_direction | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘rotation direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘clockwise’ )<br>(descriptive_representation_item.description = \<br>‘counterclockwise’ ) } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| spiral_cutmode | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘spiral cutmode’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘climb’ )<br>(descriptive_representation_item.description = ‘conventional’ ) } |
| BORING | boring_operation | NEW | | boring_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘boring’ } |
| BORING_OPERATION | boring_operation | NEW | | boring_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| spindle_stop_at_bottom | descriptive_representation_item.-description | 45 | | boring_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘spindle stop’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description =<br>‘spindle stop at bottom’ )<br>(descriptive_representation_item.description =<br>‘spindle nonstop’ ) } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| depth_of_testcut | length_measure_with_unit | 41 | | boring_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘testcut depth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| waiting_position | cartesian_point | 42 | | boring_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘waiting position’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>point =><br>cartesian_point |
| BOTTOM_AND_SIDE_FINISH_ MILLING | bottom_and_side_milling_operation | NEW | | bottom_and_side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘finish milling’ } |
| BOTTOM_AND_SIDE_MILLING | bottom_and_side_milling_operation | NEW | | bottom_and_side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| axial_cutting_depth | length_measure_with_unit | 41 | | bottom_and_side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘axial cutting depth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| radial_cutting_depth | length_measure_with_unit | 41 | | bottom_and_side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘radial cutting depth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| allowance_side | length_measure_with_unit | 41 | | bottom_and_side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘allowance side’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| allowance_bottom | length_measure_with_unit | 41 | | bottom_and_side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘allowance bottom’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| BOTTOM_AND_SIDE_ROUGH_ MILLING | bottom_and_side_milling_operation | NEW | | bottom_and_side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘rough milling’ } |
| CENTER_DRILLING | drilling_operation | NEW | | drilling_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘center drilling’ } |
| CENTER_MILLING | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘center milling’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| CONTOUR_BIDIRECTIONAL | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘contour bidirectional’ } |
| feed_direction | direction | 42 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘feed direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |

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# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| stepover_direction | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘stepover direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘left’ )<br>(descriptive_representation_item.description = ‘right’ ) } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rotation_direction | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘rotation direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘clockwise’ )<br>(descriptive_representation_item.description = \<br>‘counterclockwise’ ) } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| spiral_cutmode | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘spiral cutmode’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘climb’ )<br>(descriptive_representation_item.description = ‘conventional’ ) } |
| CONTOUR_PARALLEL | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘contour parallel’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rotation_direction | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘rotation direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘clockwise’ )<br>(descriptive_representation_item.description = \<br>‘counterclockwise’ ) } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutmode | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘cutmode’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘climb’ )<br>(descriptive_representation_item.description = ‘conventional’ ) } |
| CONTOUR_SPIRAL | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘contour spiral’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| rotation_direction | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘rotation direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘clockwise’ )<br>(descriptive_representation_item.description = \<br>‘counterclockwise’ ) } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutmode | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘cutmode’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘climb’ )<br>(descriptive_representation_item.description = ‘conventional’ ) } |
| COUNTER_SINKING | drilling_operation | NEW | | drilling_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘counter sinking’ } |
| DRILLING | drilling_operation | NEW | | drilling_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘drilling’ } |
| DRILLING_OPERATION | drilling_operation | NEW | | drilling_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| DRILLING_TYPE_OPERATION | drilling_type_operation | NEW | | drilling_type_operation <=<br>machining_operation <=<br>action_method |
| cutting_depth | length_measure_with_unit | 41 | | drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘cutting depth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| previous_diameter | length_measure_with_unit | 41 | | drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘previous diameter’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| dwell_time_bottom | time_measure_with_unit | 41 | | drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘dwell time bottom’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>time_measure_with_unit |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| feed_on_retract | ratio_measure_with_unit | 41 | | drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘feed on retract’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>ratio_measure_with_unit |
| drilling_type_operation to<br>drilling_type_strategy<br>(as its_machining_strategy) | PATH | | | drilling_type_operation <=<br>machining_operation <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘machining strategy’ }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_strategy =><br>drilling_type_strategy |
| DRILLING_TYPE_STRATEGY | drilling_type_strategy | NEW | | drilling_type_strategy <=<br>machining_strategy <=<br>action_method |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| reduced_cut_at_start | ratio_measure_with_unit | 41 | | drilling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘reduced cut at start’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>ratio_measure_with_unit |
| reduced_feed_at_start | ratio_measure_with_unit | 41 | | drilling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘reduced feed at start’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>ratio_measure_with_unit |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| depth_of_start | length_measure_with_unit | 41 | | drilling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘depth of start’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| reduced_cut_at_end | ratio_measure_with_unit | 41 | | drilling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘reduced cut at end’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>ratio_measure_with_unit |

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# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| reduced_feed_at_end | ratio_measure_with_unit | 41 | | drilling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘reduced feed at end’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>ratio_measure_with_unit |
| depth_of_end | length_measure_with_unit | 41 | | drilling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘depth of end’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| EXCHANGE_PALLET | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘exchange pallet’ } |
| EXPLICIT | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘explicit’ } |
| FIVE_AXES_CONST_TILT_YAW | machining_tool_direction_representation | NEW | | machining_tool_direction_representation <=<br>representation<br>{representation.name = ‘five axes const tilt yaw’ } |
| tilt_angle | plane_angle_measure_with_unit | 41 | | machining_tool_direction_representation <=<br>representation<br>representation.items[i] ->{ representation_item<br>representation_item.name = ‘tool direction tilt angle’ }<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| yaw_angle | plane_angle_measure_with_unit | 41 | | machining_tool_direction_representation <=<br>representation<br>representation.items[i] ->{ representation_item<br>representation_item.name = ‘tool direction yaw angle’ }<br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| FIVE_AXES_VAR_TILT_YAW | machining_tool_direction_representation | NEW | | machining_tool_direction_representation <=<br>representation<br>{representation.name = ‘five axes var tilt yaw’ } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| FREEFORM_OPERATION | freeform_milling_operation | NEW | | freeform_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method |
| freeform_operation to freeform_strategy (as its_machining_strategy) | PATH | | | freeform_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘machining strategy’ }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_strategy =><br>milling_type_strategy =><br>freeform_milling_strategy |
| FREEFORM_STRATEGY | freeform_milling_strategy | NEW | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| pathmode | descriptive_representation_item.-description | 45 | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘pathmode’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘forward’ )<br>(descriptive_representation_item.description = ‘zigzag’ ) } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutmode | descriptive_representation_item.-description | 45 | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘cutmode’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘climb’ )<br>(descriptive_representation_item.description = ‘conventional’ ) } |
| freeform_strategy to tolerances<br>(as its_milling_tolerances) | PATH | | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘milling tolerances’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation =><br>freeform_milling_tolerance_representation |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| stepover | length_measure_with_unit | 41 | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘stepover length’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| INDEX_PALLET | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘index pallet’ } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_index | parameter_value | 41 | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘pallet index’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>measure_with_unit.value_component -><br>measure_value<br>measure_value = parameter_value<br>parameter_value |
| INDEX_TABLE | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘index table’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_index | parameter_value | 41 | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘table index’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>measure_with_unit.value_component -><br>measure_value<br>measure_value = parameter_value<br>parameter_value |
| LEADING_LINE_STRATEGY | freeform_milling_strategy | NEW | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘leading line’ } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_line | bounded_curve | 42 | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘leading line’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>curve =><br>bounded_curve |
| LOAD_TOOL | machining_nc_function | NEW | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>{ action_method.description = ‘load tool’ } |
| load_tool to machining_tool<br>(as its_tool) | PATH | | | machining_nc_function <=<br>machining_process_executable <=<br>action_method<br>supported_item = action_method<br>supported_item <-<br>action_resource.usage[i]<br>action_resource =><br>machining_tool |
| MILLING_MACHINE_FUNCTIONS | machining_functions | NEW | | machining_functions <=<br>action_method<br>{ action_method.description = ‘milling’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| coolant | descriptive_representation_item.-description | 45 | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘coolant’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘coolant on’ )<br>(descriptive_representation_item.description = ‘coolant off’ ) } |
| coolant_pressure | measure_with_unit | 41 | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘coolant pressure’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| mist | descriptive_representation_item.-description | 45 | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘mist’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘mist on’ )<br>(descriptive_representation_item.description = ‘mist off’ ) } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| through_spindle_coolant | descriptive_representation_item.-description | 45 | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘through spindle coolant’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘through spindle coolant on’ )<br>(descriptive_representation_item.description = \<br>‘through spindle coolant off’ ) } |
| through_pressure | measure_with_unit | 41 | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘through spindle pressure’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| axis_clamping | descriptive_representation_item.-description | 45 | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘axis clamping’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>compound_representation_item<br>compound_representation_item.item_element -><br>compound_item_definition<br>compound_item_definition = list_representation_item<br>list_representation_item[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description |

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# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| chip_removal | descriptive_representation_item.-description | 45 | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘chip removal’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘chip removal on’ )<br>(descriptive_representation_item.description = \<br>‘chip removal off’ ) } |
| oriented_spindle_stop | direction | 42 | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘oriented spindle stop’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_process_model | PATH | | | machining_functions <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘process model’ }<br>action_method_relationship =><br>serial_action_method =><br>sequential_method }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_process_model |
| milling_machine_functions to<br>property_parameter<br>(as other_functions) | PATH | | | machining_functions <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘other functions’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>compound_representation_item<br>compound_representation_item.item_element -><br>compound_item_definition<br>compound_item_definition = set_representation_item<br>list_representation_item[i] -><br>representation_item |
| MILLING_MACHINING_OPERATION | machining_operation | NEW | | machining_operation <=<br>action_method |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| overcut_length | length_measure_with_unit | 41 | | machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘overcut length’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| MILLING_TECHNOLOGY | machining_technology | NEW | | machining_technology <=<br>action_method<br>{ action_method.description = ‘milling’ } |
| cutspeed | measure_with_unit | 41 | | machining_technology <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘cutspeed’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| spindle | measure_with_unit | 41 | | machining_technology <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘spindle’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit |
| feedrate_per_tooth | length_measure_with_unit | 41 | | machining_technology <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘feedrate per tooth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| synchronize_spindle_with_feed | descriptive_representation_item.-description | 45 | | machining_technology <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘synchronize spindle with feed’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘synchronized’ )<br>(descriptive_representation_item.description = \<br>‘not synchronized’ ) } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| inhibit_feedrate_override | descriptive_representation_item.-description | 45 | | machining_technology <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘inhibit feedrate override’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘override allowed’ )<br>(descriptive_representation_item.description = \<br>‘override not allowed’ ) } |

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# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| inhibit_spindle_override | descriptive_representation_item.-description | 45 | | machining_technology <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘inhibit spindle override’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘override allowed’ )<br>(descriptive_representation_item.description = \<br>‘override not allowed’ ) } |
| milling_technology to adaptive_control (as its_adaptive_control) | PATH | | | machining_technology <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘adaptive control’ }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_strategy =><br>machining_adaptive_control_strategy |
| MILLING_TYPE_OPERATION | milling_type_operation | NEW | | milling_type_operation <=<br>machining_operation <=<br>action_method |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| milling_type_operation to approach_retract_strategy (as approach) | PATH | | | milling_type_operation <= machining_operation <= action_method <- action_method_relationship.relating_method { action_method_relationship action_method_relationship.name = ‘approach strategy’ } action_method_relationship action_method_relationship.related_method -> action_method => machining_strategy => machining_approach_retract_strategy |
| milling_type_operation to approach_retract_strategy (as retract) | PATH | | | milling_type_operation <= machining_operation <= action_method <- action_method_relationship.relating_method { action_method_relationship action_method_relationship.name = ‘retract strategy’ } action_method_relationship action_method_relationship.related_method -> action_method => machining_strategy => machining_approach_retract_strategy |
| MULTISTEP_DRILLING | drilling_operation | NEW | | drilling_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = ‘multistep drilling’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| retract_distance | length_measure_with_unit | 41 | | drilling_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘retract distance’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| first_depth | length_measure_with_unit | 41 | | drilling_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘first depth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| depth_of_step | length_measure_with_unit | 41 | | drilling_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘depth of step’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| dwell_time_step | time_measure_with_unit | 41 | | drilling_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘dwell time step’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>time_measure_with_unit |
| PLANE_CC_STRATEGY | freeform_milling_strategy | NEW | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘plane cutter contact’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_plane_normal | direction | 42 | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘plane normal’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |
| PLANE_CL_STRATEGY | freeform_milling_strategy | NEW | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘plane cutter location’ } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_plane_normal | direction | 42 | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘plane normal’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |
| PLANE_FINISH_MILLING | plane_milling_operation | NEW | | plane_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘finish milling’ } |
| PLANE_MILLING | plane_milling_operation | NEW | | plane_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| axial_cutting_depth | length_measure_with_unit | 41 | | plane_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘axial cutting depth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| allowance_bottom | length_measure_with_unit | 41 | | plane_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘allowance bottom’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| PLANE_ROUGH_MILLING | plane_milling_operation | NEW | | plane_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘rough milling’ } |
| PLUNGE_HELIX | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘plunge helix’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| radius | length_measure_with_unit | 41 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘plunge radius’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| angle | plane_angle_measure_with_unit | 41 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘plunge angle’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PLUNGE_RAMP | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘plunge ramp’ } |
| angle | plane_angle_measure_with_unit | 41 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘plunge angle’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| PLUNGE_STRATEGY | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ (action_method.description = ‘plunge helix’)<br>(action_method.description = ‘plunge ramp’)<br>(action_method.description = ‘plunge toolaxis’)<br>(action_method.description = ‘plunge zigzag’) } |
| PLUNGE_TOOLAXIS | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘plunge toolaxis’ } |

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# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| PLUNGE_ZIGZAG | machining_approach_retract_strategy | NEW | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘plunge zigzag’ } |
| angle | plane_angle_measure_with_unit | 41 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘plunge angle’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| width | length_measure_with_unit | 41 | | machining_approach_retract_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘plunge width’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| PROCESS_MODEL | machining_process_model | NEW | | machining_process_model <=<br>action_method |
| ini_data_file | descriptive_representation_item | 45 | | machining_process_model <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘initialization data’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| its_type | machining_process_model.description | | | |
| PROCESS_MODEL_LIST | NOT MAPPED, machine functions to process model handled in machine functions | | | |
| REAMING | boring_operation | NEW | | boring_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = ‘reaming’ } |
| SIDE_FINISH_MILLING | side_milling_operation | NEW | | side_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = ‘finish milling’ } |
| SIDE_MILLING | side_milling_operation | NEW | | side_milling_operation <= milling_type_operation <= machining_operation <= action_method |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| axial_cutting_depth | length_measure_with_unit | 41 | | side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘axial cutting depth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| radial_cutting_depth | length_measure_with_unit | 41 | | side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘radial cutting depth’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| allowance_side | length_measure_with_unit | 41 | | side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘allowance side’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| SIDE_ROUGH_MILLING | side_milling_operation | NEW | | side_milling_operation <=<br>milling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘rough milling’ } |
| TAPPING | tapping_operation | NEW | | tapping_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘tapping’ } |

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# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| compensation_chuck | descriptive_representation_item.-description | 45 | | tapping_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘compensation chuck’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description =<br>‘compensation chuck used’ )<br>(descriptive_representation_item.description =<br>‘compensation chuck not used’ ) } |
| THREAD_DRILLING | tapping_operation | NEW | | tapping_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>{ action_method.description = ‘thread drilling’ } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| helical_movement_on_forward | descriptive_representation_item.-description | 45 | | tapping_operation <=<br>drilling_type_operation <=<br>machining_operation <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘helical movement on forward’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description =<br>‘helical movement on forward’ )<br>(descriptive_representation_item.description =<br>‘no helical movement on forward’ ) } |
| THREE_AXES_TILTED_TOOL | machining_tool_direction_representation | NEW | | machining_tool_direction_representation <=<br>representation<br>{representation.name = ‘three axes tilted tool’ } |
| tool_direction | direction | 42 | | machining_tool_direction_representation <=<br>representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘tool direction orientation’ }<br>representation_item =><br>geometric_representation_item =><br>direction |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| TOLERANCES | freeform_milling_tolerance_-representation | NEW | | freeform_milling_tolerance_representation <= representation |
| chordal_tolerance | length_measure_with_unit | 41 | | freeform_milling_tolerance_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = 'chordal tolerance' }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| scallop_height | length_measure_with_unit | 41 | | freeform_milling_tolerance_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = 'scallop height' }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| TOOL_DIRECTION_FOR_MILLING | machining_tool_direction_representation | NEW | | machining_tool_direction_representation <= representation |
| TWO5D_MILLING_OPERATION | milling_type_operation | NEW | | milling_type_operation <=<br>machining_operation <=<br>action_method |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| two5d_milling_operation to<br>two5d_milling_strategy<br>(as its_machining_strategy) | PATH | | | milling_type_operation <=<br>machining_operation <=<br>action_method <-<br>action_method_relationship.relating_method<br>{ action_method_relationship<br>action_method_relationship.name = ‘machining strategy’ }<br>action_method_relationship<br>action_method_relationship.related_method -><br>action_method =><br>machining_strategy =><br>milling_type_strategy |
| TWO5D_MILLING_STRATEGY | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ (action_method.description = ‘bidirectional’)<br>(action_method.description = ‘bidirectional contour’)<br>(action_method.description = ‘center milling’)<br>(action_method.description = ‘contour bidirectional’)<br>(action_method.description = ‘contour parallel’)<br>(action_method.description = ‘contour spiral’)<br>(action_method.description = ‘explicit’)<br>(action_method.description = ‘unidirectional’) } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| overlap | ratio_measure_with_unit | 41 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘overlap ratio’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>ratio_measure_with_unit |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| allow_multiple_passes | descriptive_representation_item.-description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘multiple passes’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = \<br>‘multiple passes allowed’ )<br>(descriptive_representation_item.description = \<br>‘multiple passes not allowed’ ) } |
| UNIDIRECTIONAL | milling_type_strategy | NEW | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>{ action_method.description = ‘unidirectional’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| feed_direction | direction | 42 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘feed direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |
| cutmode | descriptive_representation_item.-<br>description | 45 | | milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘cutmode’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘climb’ )<br>(descriptive_representation_item.description = ‘conventional’ ) } |

# Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| UNLOAD_TOOL | machining_nc_function | NEW | | machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘unload tool’ } |
| unload_tool to machining_tool (as its_tool) | PATH | | | machining_nc_function <= machining_process_executable <= action_method supported_item = action_method supported_item <- action_resource.usage[i] action_resource => machining_tool |
| UV_STRATEGY | freeform_milling_strategy | NEW | | freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘uv’ } |

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## Table 8 — Mapping table for process data for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| forward_direction | direction | 42 | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘forward direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |
| sideward_direction | direction | 42 | | freeform_milling_strategy <=<br>milling_type_strategy <=<br>machining_strategy <=<br>action_method<br>characterized_action_definition = action_method<br>characterized_action_definition <-<br>action_property.definition<br>{ action_property.name = ‘sideward direction’ }<br>action_property <-<br>action_property_representation.property<br>action_property_representation<br>action_property_representation.representation -><br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |

# Table 9 — Mapping table for cutting tools for milling UoF

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| BACKSIDE_COUNTERBORE | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘backside counterbore’ } |
| BACKSIDE_COUNTERSINK | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘backside countersink’ } |
| BALL_ENDMILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘ball endmill’ } |
| BORING_TOOL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘boring tool’ } |
| retract_movement_forbidden | descriptive_representation_item.-description | 45 | | machining_tool_body_representation <= representation representation.items[i] -> { representation_item representation_item.name = ‘retract movement’ } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘permitted’ ) (descriptive_representation_item.description = ‘forbidden’ ) } |
| BULLNOSE_ENDMILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘bullnose endmill’ } |
| CENTERDRILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘centerdrill’ } |

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## Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| COMBINED_DRILL_AND_REAMER | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘combined drill and reamer’ } |
| drill_length | length_measure_with_unit | 41 | | machining_tool_body_representation <= representation representation.items[i] -> { representation_item representation_item.name = ‘drill length’ } representation_item => measure_representation_item measure_representation_item <= measure_with_unit => length_measure_with_unit |
| COMBINED_DRILL_AND_TAP | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘combined drill and tap’ } |
| drill_length | length_measure_with_unit | 41 | | machining_tool_body_representation <= representation representation.items[i] -> { representation_item representation_item.name = ‘drill length’ } representation_item => measure_representation_item measure_representation_item <= measure_with_unit => length_measure_with_unit |
| COUNTERBORE | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { (representation.name = ‘counterbore’) (representation.name = ‘backside counterbore’) } |

# Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| COUNTERSINK | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { (representation.name = ‘countersink’) (representation.name = ‘backside countersink’) } |
| countersink_radius | length_measure_with_unit | 41 | | machining_tool_body_representation <= representation representation.items[i] -> { representation_item representation_item.name = ‘countersink radius’ } representation_item => measure_representation_item measure_representation_item <= measure_with_unit => length_measure_with_unit |
| DOVETAIL_MILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘dovetail mill’ } |
| included_angle | plane_angle_measure_with_unit | 41 | | machining_tool_body_representation <= representation representation.items[i] -> { representation_item representation_item.name = ‘included angle’ } representation_item => measure_representation_item measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit |
| DRILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { (representation.name = ‘spade drill’) (representation.name = ‘tapered drill’) } (representation.name = ‘twist drill’) } |

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## Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| ENDMILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { (representation.name = ‘endmill’) (representation.name = ‘ball endmill’) (representation.name = ‘bullnose endmill’) (representation.name = ‘tapered endmill’) } |
| FACEMILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { representation.name = ‘facemill’ } |
| MILLING_CUTTER | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation { (representation.name = ‘ball endmill’) (representation.name = ‘bullnose endmill’) (representation.name = ‘dovetail mill’) (representation.name = ‘endmill’) (representation.name = ‘facemill’) } (representation.name = ‘tapered endmill’) (representation.name = ‘tee slot mill’) (representation.name = ‘thread mill’) (representation.name = ‘side mill’) (representation.name = ‘woodruff keyseat mill’) } |
| MILLING_CUTTING_TOOL | machining_tool | NEW | | machining_tool <= action_resource { action_resource.kind -> action_resource_type action_resource_type.name = ‘milling cutting tool’ } |

# Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| direction_for_spindle_orientation | direction | 42 | | machining_tool <=<br>action_resource<br>characterized_resource_definition = action_resource<br>characterized_resource_definition <-<br>resource_property.resource<br>{ resource_property.name = ‘direction for spindle orientation’ }<br>resource_property <-<br>resource_property_representation.property<br>resource_property_representation<br>resource_property_representation.representation<br>representation<br>representation.items[i] -><br>representation_item =><br>geometric_representation_item =><br>direction |
| tool_holder_diameter_for_<br>spindle_orientation | length_measure_with_unit | 41 | | machining_tool <=<br>action_resource<br>characterized_resource_definition = action_resource<br>characterized_resource_definition <-<br>resource_property.resource<br>{ resource_property.name =<br>‘tool holder diameter for spindle orientation’ }<br>resource_property <-<br>resource_property_representation.property<br>resource_property_representation<br>resource_property_representation.representation<br>representation<br>representation.items[i] -><br>representation_item =><br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| MILLING_TOOL_BODY | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ (representation.name = ‘backside counterbore’)<br>(representation.name = ‘backside countersink’)<br>(representation.name = ‘ball endmill’)<br>(representation.name = ‘boring tool’)<br>(representation.name = ‘bullnose endmill’)<br>(representation.name = ‘centerdrill’)<br>(representation.name = ‘combined drill and reamer’)<br>(representation.name = ‘combined drill and tap’)<br>(representation.name = ‘counterbore’)<br>(representation.name = ‘countersink’)<br>(representation.name = ‘dovetail mill’)<br>(representation.name = ‘endmill’)<br>(representation.name = ‘facemill’)<br>(representation.name = ‘reamer’)<br>(representation.name = ‘side mill’)<br>(representation.name = ‘spade drill’)<br>(representation.name = ‘tap’)<br>(representation.name = ‘tapered drill’)<br>(representation.name = ‘tapered endmill’)<br>(representation.name = ‘tapered reamer’)<br>(representation.name = ‘tapered tap’)<br>(representation.name = ‘tee slot mill’)<br>(representation.name = ‘thread mill’)<br>(representation.name = ‘threading tool’)<br>(representation.name = ‘twist drill’)<br>(representation.name = ‘user defined milling tool’)<br>(representation.name = ‘woodruff keyseat mill’) } |

# Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| dimension | PATH | | | machining_tool_body_representation <= representation <- representation_relationship.rep_1 representation_relationship representation_relationship.rep_2 -> representation => machining_tool_dimension_representation |
| number_of_teeth | count_measure | 41 | | machining_tool_body_representation <= representation representation.items[i] -> { representation_item representation_item.name = 'number of teeth' } representation_item => measure_representation_item <= measure_with_unit => measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure |
| hand_of_cut: | descriptive_representation_item.-description | 45 | | machining_tool_body_representation <= representation representation.items[i] -> { representation_item representation_item.name = 'hand of cut' } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = 'left' ) (descriptive_representation_item.description = 'right' ) (descriptive_representation_item.description = 'neutral' ) } |

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## Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| coolant_through_tool | descriptive_representation_item.-description | 45 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘coolant through tool’ }<br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description<br>{ (descriptive_representation_item.description = ‘supported’ )<br>(descriptive_representation_item.description = ‘not supported’ ) } |
| pilot_length | length_measure_with_unit | 41 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘pilot length’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| REAMER | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ (representation.name = ‘reamer’)<br>(representation.name = ‘combined drill and reamer’)<br>(representation.name = ‘tapered reamer’) } |
| SIDE_MILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = ‘side mill’ } |

# Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutter width | length_measure_with_unit | 41 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘cutter width’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| SPADE_DRILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = ‘spade drill’ } |
| T_SLOT_MILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = ‘tee slot mill’ } |
| cutting_thickness | length_measure_with_unit | 41 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘cutting thickness’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| TAP | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ (representation.name = ‘tap’)<br>(representation.name = ‘combined drill and tap’)<br>(representation.name = ‘tapered tap’) } |

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## Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| TAPERED_DRILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = ‘tapered drill’ } |
| taper_angle | plane_angle_measure_with_unit | 41 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘taper angle’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| TAPERED_ENDMILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = ‘tapered endmill’ } |
| taper_angle | plane_angle_measure_with_unit | 41 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘taper angle’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| TAPERED_REAMER | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = ‘tapered reamer’ } |

# Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| taper_angle | plane_angle_measure_with_unit | 41 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = 'taper angle' }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| TAPERED_TAP | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = 'tapered tap' } |
| taper_angle | plane_angle_measure_with_unit | 41 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = 'taper angle' }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| THREAD_MILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = 'thread mill' } |
| THREADING_TOOL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = 'threading tool' } |
| TOOL_DIMENSION | machining_tool_dimension_representation | NEW | | machining_tool_dimension_representation <= representation |

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## Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| diameter | length_measure_with_unit | 41 | | machining_tool_dimension_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘diameter’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| tool_top_angle | plane_angle_measure_with_unit | 41 | | machining_tool_dimension_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘tool top angle’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |
| tool_circumference_angle | plane_angle_measure_with_unit | 41 | | machining_tool_dimension_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘tool circumference angle’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>plane_angle_measure_with_unit |

# Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutting_edge_length: | length_measure_with_unit | 41 | | machining_tool_dimension_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘cutting edge length’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| edge_radius | length_measure_with_unit | 41 | | machining_tool_dimension_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘edge radius’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| edge_center_vertical | length_measure_with_unit | 41 | | machining_tool_dimension_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘edge center vertical’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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## Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| edge_center_horizontal | length_measure_with_unit | 41 | | machining_tool_dimension_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘edge center horizontal’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |
| TWIST_DRILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ (representation.name = ‘twist drill’)<br>(representation.name = ‘tapered drill’) } |
| USER_DEFINED_TOOL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = ‘user defined milling tool’ } |
| identifier | descriptive_representation_item.-description | 45 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘tool identifier’ }<br>representation_item =><br>descriptive_representation_item<br>descriptive_representation_item.description |
| WOODRUFF_KEYSEAT_MILL | machining_tool_body_representation | NEW | | machining_tool_body_representation <= representation<br>{ representation.name = ‘woodruff keyseat mill’ } |

# Table 9 — Mapping table for cutting tools for milling UoF (continued)

| Application element | AIM element | Source | Rules | Reference path |
|---|---|---|---|---|
| cutter width | length_measure_with_unit | 41 | | machining_tool_body_representation <= representation<br>representation.items[i] -><br>{ representation_item<br>representation_item.name = ‘cutter width’ }<br>representation_item =><br>measure_representation_item<br>measure_representation_item <=<br>measure_with_unit =><br>length_measure_with_unit |

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The following rules are referenced in the preceding tables:

1) approval_requires_approval_date_time.
2) approval_requires_approval_person_organization
3) approval_requires_assignment
4) dependent_instantiable_approval_status
5) dependent_instantiable_named_unit
6) machining_project_requires_owner
7) machining_project_requires_release_date
8) machining_project_requires_workplan
9) machining_setup_requires_security_plane
10) nc_variable_compatible_initial_value

The following notes are referenced in the preceding tables:

1) The ARM attribute 'parameter_index' maps to the same attribute of representation_item as the ARM attribute 'parameter_name'. If the 'parameter_index' is present, it shall be appended to the representation_item.name representing the 'parameter_name'.

2) The ARM attribute 'its_cutting_edge' is defined as a list, but list ordering is not encoded by the mapping. If ordering is desired, the cutting components shall be ordered by tool offset length from smallest to largest offset.

3) The item_defined_transformation locates the workpiece within a setup in a manner similar to an assembly. Here transform_item_1 refers to the workpiece placement and transform_item_2 refers to the setup placement. Previous APs have not clearly stated which side of the item_defined_transform refers to the enclosing assembly, which has led to confusion.

4) Transition features are defined by ISO 14649-10 to relate two features, but for compatibility with AP-224 and AP-214, transition features have been mapped to relate two face_shape_representations instead.

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## 5.2 AIM EXPRESS short listing

```
SCHEMA integrated_cnc_schema;

USE FROM action_schema                                          -- 10303-41
    (action,
     action_method,
     action_method_relationship,
     action_resource,
     action_resource_relationship,
     action_resource_type);

USE FROM aic_advanced_brep                                      -- 10303-514
    (advanced_brep_shape_representation);

USE FROM aic_geometric_tolerances                               -- 10303-519
    (angularity_tolerance,
     circular_runout_tolerance,
     coaxiality_tolerance,
     common_datum,
     concentricity_tolerance,
     cylindricity_tolerance,
     flatness_tolerance,
     line_profile_tolerance,
     parallelism_tolerance,
     perpendicularity_tolerance,
     position_tolerance,
     roundness_tolerance,
     straightness_tolerance,
     surface_profile_tolerance,
     symmetry_tolerance,
     total_runout_tolerance);

USE FROM aic_geometrically_bounded_surface                      -- 10303-507
    (geometrically_bounded_surface_shape_representation);

USE FROM aic_manifold_surface                                   -- 10303-509
    (manifold_surface_shape_representation);

USE FROM aic_topologically_bounded_surface                      -- 10303-511
    (advanced_face);

USE FROM application_context_schema                             -- 10303-41
    (application_context,
     application_context_element,
     application_protocol_definition,
     product_context,
     product_definition_context);

USE FROM approval_schema                                        -- 10303-41
    (approval,
     approval_date_time,
     approval_person_organization,
```

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```
     approval_status);

USE FROM date_time_schema                                   -- 10303-41
    (calendar_date,
     date,
     date_and_time,
     ordinal_date,
     week_of_year_and_day_date);

USE FROM document_schema                                    -- 10303-41
    (document);

USE FROM effectivity_schema                                 -- 10303-41
    (dated_effectivity,
     effectivity,
     lot_effectivity,
     serial_numbered_effectivity,
     time_interval_based_effectivity);

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

USE FROM geometric_model_schema                             -- 10303-42
    (block,
     right_circular_cylinder);

USE FROM geometry_schema                                    -- 10303-42
    (bounded_curve,
     bounded_surface,
     elementary_surface);

USE FROM group_schema                                       -- 10303-41
    (group,
     group_relationship);

USE FROM iso13584_expressions_schema                        -- 13584-20
    (and_expression,
     binary_boolean_expression,
     boolean_expression,
     comparison_equal,
     comparison_expression,
     comparison_greater,
     comparison_greater_equal,
     comparison_less,
     comparison_less_equal,
     comparison_not_equal,
     expression,
     int_literal,
     int_numeric_variable,
     literal_number,
     multiple_arity_boolean_expression,
     not_expression,
     numeric_expression,
     numeric_variable,
```

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```
     or_expression,
     real_literal,
     real_numeric_variable,
     simple_numeric_expression,
     unary_boolean_expression,
     xor_expression);

USE FROM iso13584_generic_expressions_schema                    -- 13584-20
    (binary_generic_expression,
     generic_expression);

USE FROM management_resources_schema                            -- 10303-41
    (approval_assignment,
     classification_role,
     date_and_time_assignment,
     document_reference,
     document_usage_constraint_assignment,
     effectivity_assignment,
     group_assignment,
     person_and_organization_assignment,
     security_classification_assignment);

USE FROM material_property_definition_schema                    -- 10303-45
    (material_designation,
     material_designation_characterization,
     material_property);

USE FROM material_property_representation_schema                -- 10303-45
    (material_property_representation);

USE FROM measure_schema                                         -- 10303-41
    (context_dependent_measure,
     context_dependent_unit,
     conversion_based_unit,
     count_measure,
     derived_unit,
     descriptive_measure,
     global_unit_assigned_context,
     length_measure_with_unit,
     length_unit,
     measure_with_unit,
     named_unit,
     parameter_value,
     plane_angle_measure_with_unit,
     plane_angle_unit,
     positive_plane_angle_measure,
     ratio_measure,
     ratio_measure_with_unit,
     ratio_unit,
     si_unit,
     solid_angle_measure,
     solid_angle_measure_with_unit,
     solid_angle_unit,
     time_measure,
```

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```
     time_measure_with_unit,
     time_unit);

USE FROM method_definition_schema                                -- 10303-49
    (concurrent_action_method,
     sequential_method,
     serial_action_method);

USE FROM person_organization_schema                              -- 10303-41
    (organizational_address,
     person,
     person_and_organization,
     personal_address);

USE FROM process_property_representation_schema                  -- 10303-49
    (action_property_representation,
     resource_property_representation);

USE FROM process_property_schema                                 -- 10303-49
    (action_property,
     action_resource_requirement,
     process_product_association,
     process_property_association,
     property_process,
     requirement_for_action_resource,
     resource_property,
     resource_requirement_type);

USE FROM product_definition_schema                               -- 10303-41
    (product,
     product_category,
     product_category_relationship,
     product_definition,
     product_definition_formation,
     product_definition_relationship,
     product_definition_with_associated_documents,
     product_related_product_category);

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

USE FROM product_property_representation_schema                  -- 10303-41
    (context_dependent_shape_representation,
     property_definition_representation,
     shape_definition_representation,
     shape_representation,
     shape_representation_relationship);

USE FROM product_structure_schema                                -- 10303-44
```

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```
    (make_from_usage_option,
     next_assembly_usage_occurrence);

USE FROM qualified_measure_schema                                -- 10303-45
    (descriptive_representation_item,
     expanded_uncertainty,
     measure_qualification,
     measure_representation_item,
     precision_qualifier,
     qualified_representation_item,
     qualitative_uncertainty,
     standard_uncertainty,
     uncertainty_qualifier,
     value_qualifier);

USE FROM representation_schema                                   -- 10303-43
    (compound_representation_item,
     global_uncertainty_assigned_context,
     item_defined_transformation,
     list_representation_item,
     representation,
     representation_item,
     representation_item_relationship,
     representation_relationship,
     representation_relationship_with_transformation,
     set_representation_item);

USE FROM security_classification_schema                          -- 10303-41
    (security_classification,
     security_classification_level);

USE FROM shape_aspect_definition_schema                          -- 10303-47
    (datum_target);

USE FROM shape_dimension_schema                                  -- 10303-47
    (angular_location,
     angular_size,
     dimensional_characteristic_representation,
     dimensional_location_with_path,
     dimensional_size,
     dimensional_size_with_path,
     shape_dimension_representation);

USE FROM shape_tolerance_schema                                  -- 10303-47
    (limits_and_fits,
     plus_minus_tolerance,
     tolerance_value);
```

### 5.2.1 Fundamental concepts and assumptions

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## 5.2.2 Integrated CNC types

### 5.2.2.1 approval_item

An **approval_item** identifies an **action_method**, **action_method_relationship**, **action_property**, **material_designation**, **product_definition_formation**, **requirement_for_action_resource**, or **resource_property** to which an **approval** may be assigned.

EXPRESS specification:

```
*)
TYPE approval_item = SELECT (
        action_method,
        action_method_relationship,
        action_property,
        material_designation,
        product_definition_formation,
        requirement_for_action_resource,
        resource_property
        );
END_TYPE;
(*
```

### 5.2.2.2 date_and_time_item

A **date_and_time_item** identifies an **approval_person_organization**, **approval_status**, **effectivity**, **material_designation**, **person_and_organization**, **product_definition_formation**, **security_classification**, or **security_classification_level** to which a referenced **date_and_time** may be assigned.

EXPRESS specification:

```
*)
TYPE date_and_time_item = SELECT (
        approval_person_organization,
        approval_status,
        effectivity,
        material_designation,
        person_and_organization,
        product_definition_formation,
        security_classification,
        security_classification_level
        );
END_TYPE;
(*
```

### 5.2.2.3 document_reference_item

A **document_reference_item** identifies an **action_method**, **externally_defined_feature_definition**, **material_designation**, **dimensional_characteristic_representation**, or **property_definition** to which a referenced **document** may be assigned.

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EXPRESS specification:

```
*)
TYPE document_reference_item = SELECT (
        action_method,
        externally_defined_feature_definition,
        material_designation,
        dimensional_characteristic_representation,
        property_definition
        );
END_TYPE;
(*
```

### 5.2.2.4 effectivity_item

An **effectivity_item** identifies an **action_method**, **action_method_relationship**, **action_property**, **material_designation**, **product_definition_formation**, **requirement_for_action_resource**, or **resource_property** to which an **effectivity** may be assigned.

EXPRESS specification:

```
*)
TYPE effectivity_item = SELECT (
        action_method,
        action_method_relationship,
        action_property,
        material_designation,
        product_definition_formation,
        requirement_for_action_resource,
        resource_property
        );
END_TYPE;
(*
```

### 5.2.2.5 group_item

A **group_item** identifies an **instanced_feature**, **replicate_feature**, or **transition_feature** to which a referenced **group** may be assigned.

EXPRESS specification:

```
*)
TYPE group_item = SELECT (
        instanced_feature,
        replicate_feature,
        transition_feature
        );
END_TYPE;
(*
```

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#### 5.2.2.6 person_and_organization_item

A **person_and_organization_item** identifies a **product_definition_formation** to which a referenced **person_and_organization** may be assigned.

EXPRESS specification:

```
*)
TYPE person_and_organization_item = SELECT (
        product_definition_formation
        );
END_TYPE;
(*
```

#### 5.2.2.7 security_classification_item

A **security_classification_item** identifies a **product_definition_formation** to which a referenced **security_classification** may be assigned.

EXPRESS specification:

```
*)
TYPE security_classification_item = SELECT (
        product_definition_formation
        );
END_TYPE;
(*
```

### 5.2.3 Integrated CNC entities

#### 5.2.3.1 Integrated CNC entity definitions

#### 5.2.3.1.1 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** subtypes.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY applied_area
SUBTYPE OF (shape_aspect);
WHERE
wr1: ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF(SELF.of_shape));
wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

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```
       (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
       'INTEGRATED_CNC_SCHEMA.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       (('INTEGRATED_CNC_SCHEMA.' +
       'SHAPE_REPRESENTATION_WITH_PARAMETERS')
       IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
       (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
       'INTEGRATED_CNC_SCHEMA.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
       'INTEGRATED_CNC_SCHEMA.' +
       '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (SIZEOF( QUERY( pdr <* USEDIN( pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.' +
        '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
       (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
       TYPEOF(it)) = 2) AND (it.name = 'effective length')) )) = 1)) ))
         = 0)) )) <= 1);
wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'maximum length')) )) <= 1)) ))
```

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```
         = 0)) )) = 0);
wr7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(it))  AND (it.name = 'orientation')) )) = 1)) ))
         = 0)) )) = 0);
END_ENTITY; -- applied_area
(*
```

Formal propositions:

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

**WR2**: The **applied_area** shall have its implicit representation specified by exactly one **shape_representation_with_parameters**.

**WR3**: The **applied_area** shall have an implicit representation that contains at least two and at most three **representation_items** in its set of **items**.

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

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

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

**WR7**: Exactly one **representation_item** used for the implicit representation of the **applied_area** shall be of type **placement** with a name of 'orientation'.

Informal propositions:

**IP1**: When applied to a **knurl**, the **length_measure_with_unit** with **name** of 'effective length' defines the overall length of the **knurl**.

### 5.2.3.1.2 applied_approval_assignment

An **applied_approval_assignment** specifies those **approval_item** instances to which a referenced **approval** is assigned.

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EXPRESS specification:

```
*)
ENTITY applied_approval_assignment
  SUBTYPE OF (approval_assignment);
  items : SET [1:?] OF approval_item;
END_ENTITY;
(*
```

Attribute definition:

**items**: the set of **approval_item** instances to which a referenced approval is assigned.

### 5.2.3.1.3 applied_date_and_time_assignment

An **applied_date_and_time_assignment** specifies those **date_and_time_item** instances to which a referenced **date_and_time** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_date_and_time_assignment
  SUBTYPE OF (date_and_time_assignment);
  items : SET[1:?] OF date_and_time_item;
END_ENTITY;
(*
```

Attribute definition:

**items**: the set of **date_and_time_item** instances to which a referenced **date_and_time** is assigned.

### 5.2.3.1.4 applied_document_reference

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

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** instances to which a referenced **document** is assigned.

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### 5.2.3.1.5 applied_document_usage_constraint_assignment

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

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** instances to which a referenced **document** is assigned.

### 5.2.3.1.6 applied_effectivity_assignment

An **applied_effectivity_assignment** specifies those **effectivity_item** instances to which a referenced **effectivity** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_effectivity_assignment
  SUBTYPE OF (effectivity_assignment);
  items : SET[1:?] OF effectivity_item;
END_ENTITY;
(*
```

Attribute definition:

**items**: the set of **effectivity_item** instances to which a referenced **effectivity** is assigned.

### 5.2.3.1.7 applied_group_assignment

An **applied_group_assignment** specifies those **group_item** instances to which a referenced **group** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_group_assignment
  SUBTYPE OF (group_assignment);
  items : SET [1:?] OF group_item;
END_ENTITY;
(*
```

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Attribute definition:

**items**: the set of **group_item** instances to which a referenced **group** is assigned.

### 5.2.3.1.8 applied_person_and_organization_assignment

An **applied_person_and_organization_assignment** specifies those **person_and_organization_item** instances to which a referenced **person_and_organization** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_person_and_organization_assignment
  SUBTYPE OF (person_and_organization_assignment);
  items : SET [1:?] OF person_and_organization_item;
END_ENTITY;
(*
```

Attribute definition:

**items**: the set of **person_and_organization_item** instances to which a referenced **person_and_organization** is assigned.

### 5.2.3.1.9 applied_security_classification_assignment

An **applied_security_classification_assignment** specifies those **security_classification_item** instances to which a referenced **security_classification** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_security_classification_assignment
  SUBTYPE OF (security_classification_assignment);
  items : SET [1:?] OF security_classification_item;
END_ENTITY;
(*
```

Attribute definition:

**items**: the set of **security_classification_item** instances to which a referenced **security_classification** is assigned.

### 5.2.3.1.10 back_boring_operation

A **back_boring_operation** is a type of **drilling_type_operation** that represents the details of a machining step in which in a tool passes through an existing hole in the workpiece and enlarges the hole from the back of the workpiece. See the ARM definition for Back_boring_operation in ISO 14649-11 for more information.

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EXPRESS specification:

```
*)
ENTITY back_boring_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
           (amr.name = 'machine functions') AND NOT
           (verify_required_action_property
                (amr.related, 'oriented spindle stop')))));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **back_boring_operation** is the **relating** of an **action_method_relationship** in which **name** is 'machine functions' and **related** is the **definition** of exactly one **action_property** with a **name** of 'oriented spindle stop'.

NOTE This corresponds to local constraint **WR1** on ARM entity **Back_boring** in ISO 14649-11.

### 5.2.3.1.11 block_shape_representation

A **block_shape_representation** specifies the representation of a shape that is a rectangular volume defined as a rectangular area of a defined length. The enclosed area is defined by four straight sides with opposite sides equal in length.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY block_shape_representation
  SUBTYPE OF (shape_representation_with_parameters);
  WHERE
    wr1: (SIZEOF(SELF.items) = 4);
    wr2: (SIZEOF(QUERY ( it <* SELF.items |
         (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1);
    wr3: (SIZEOF(QUERY ( it <* SELF.items |
         ((SIZEOF(
         ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2) AND (it.name = 'length')) )) = 1);
    wr4: (SIZEOF(QUERY ( it <* SELF.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'width')) )) = 1);
    wr5: (SIZEOF(QUERY ( it <* SELF.items |
         ((SIZEOF([
```

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```
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'height')) )) = 1);
END_ENTITY; -- block_shape_representation
(*
```

Formal propositions:

**WR1**: The **block_shape_representation** shall contain exactly four **representation_items** in its set of **items**.

**WR2**: One of the **representation_items** used for the implicit representation of a **block_shape_representation** shall be of type **placement** with a **name** of 'orientation'.

**WR3**: One of the **representation_items** used for the implicit representation of a **block_shape_representation** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'length'.

**WR4**: One of the **representation_items** used for the implicit representation of a **block_shape_representation** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'width'.

**WR5**: One of the **representation_items** used for the implicit representation of a **block_shape_representation** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'height'.

Informal propositions:

**IP1**: The **block_shape_representation** shall be defined at the center of the rectangular area in the X-Y plane with the width of the rectangle in the X direction, the height of the rectangle in the Y direction, and the length of the rectangle in the Z direction.

### 5.2.3.1.12 boring_operation

A **boring_operation** is a type of **drilling_type_operation** that represents the details of a drilling step in which in an existing hole is enlarged. See the ARM definitions for Boring_operation, Boring, and Reaming in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY boring_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['boring','reaming']);

  WR2:  (verify_required_action_property        (SELF, 'spindle stop')) AND
        (verify_enumeration_action_property     (SELF, 'spindle stop',
         ['spindle stop at bottom', 'spindle nonstop']));
```

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```
  WR3:  (verify_optional_action_property        (SELF, 'testcut depth')) AND
        (verify_length_measure_action_property  (SELF, 'testcut depth'));

  WR4:  (verify_optional_action_property        (SELF, 'waiting position')) AND
        (verify_rep_item_for_action_property    (SELF, 'waiting position',
         ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT']));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **description** of the **boring_operation** shall be either 'boring' or 'reaming'.

**WR2**: The **boring_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'spindle stop', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of either 'spindle stop at bottom' or 'spindle nonstop'.

**WR3**: The **boring_operation** shall be the **definition** of at most one **action_property** with a **name** of 'testcut depth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR4**: The **boring_operation** shall be the **definition** of at most one **action_property** with a **name** of 'waiting position', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **cartesian_point**.

### 5.2.3.1.13 boss

A **boss** is a type of **feature_definition** that is an enclosed shape protrusion with a reference location and position.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
         TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (sa_occ.description = 'boss height occurrence') AND
         (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
```

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```
      (sar.description = 'path feature component usage') AND
      ('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_DEFINING_RELATIONSHIP' IN TYPEOF (sar))) |
      ('INTEGRATED_CNC_SCHEMA.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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
       SIZEOF( QUERY( pdr <* USEDIN( pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      ('INTEGRATED_CNC_SCHEMA.'+
      '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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      SIZEOF( QUERY( pdr <* USEDIN( pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      ('INTEGRATED_CNC_SCHEMA.'+
      '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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS'
      IN TYPEOF (pdr.used_representation)) |
      NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
      (SIZEOF (
      ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
      'INTEGRATED_CNC_SCHEMA.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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
      IN TYPEOF (pd)) |
      NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
      'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
      (sa_occ.description = 'circular profile occurrence') AND
      (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
      'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (sar.description = 'profile usage') AND
```

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```
     ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
     IN TYPEOF (sar))) |
     'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE'
     IN TYPEOF (sdr.relating_shape_aspect))) = 1))) = 1))) = 0);
WR7: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
     TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (sa_occ.description = 'top condition occurrence') AND
     (SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATED_SHAPE_ASPECT') |
     (sar.description = 'boss top usage') AND
     ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
     IN TYPEOF (sar))) |'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
     TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (sa_occ.description = 'change in diameter occurrence') AND
     (SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATED_SHAPE_ASPECT') |
     (sar.description = 'taper usage') AND
     ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
     IN TYPEOF (sar))) | 'INTEGRATED_CNC_SCHEMA.TAPER'
     IN TYPEOF (fcr.related_shape_aspect)) )= 1))) <= 1))) = 0);
WR9: (NOT (SELF\characterized_object.description = 'complex')) OR
     (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
     TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (sa_occ.description = 'enclosed boundary occurrence') AND
     (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATED_SHAPE_ASPECT') |
     (sar.description = 'profile usage') AND
     ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
     IN TYPEOF (sar))) |
     SIZEOF (['INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

```
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (sa_occ.description = 'change in boundary occurrence') AND
         (SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         (sar.description = 'taper usage') AND
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF (sar))) |
         ('INTEGRATED_CNC_SCHEMA.TAPER'
         IN TYPEOF (fcr.related_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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (sa_occ.description = 'rectangular profile occurrence') AND
         (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (sar.description = 'profile usage') AND
         ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
         IN TYPEOF (sar))) |
         'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE'
         IN TYPEOF (sdr.relating_shape_aspect))) = 1))) = 1))) = 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 one or two **representation_items**.

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

**WR5**: The implicit representation of the **boss** shall have at most one **representation_item** of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'fillet radius'.

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**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**.

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**.

### 5.2.3.1.14 boss_top

A **boss_top** is a type of **shape_aspect** that is the end condition for a boss **feature_definition**.

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NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY boss_top
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       (('INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION')
         IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
    WR4: ((NOT (SELF.description = 'planar')) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.LOCATION_SHAPE_REPRESENTATION')
         IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
    WR5: (NOT (SELF.description = 'complex')) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.'+
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION')
         IN TYPEOF(pdr.used_representation) )) = 1)) )) = 0);
    WR6: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'  +
         'RELATING_SHAPE_ASPECT') |
         ((sar.description = 'boss top usage') AND
         (sar.name  IN ['boss height start','boss height end']))AND
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)))  |
         ((fcr.related_shape_aspect.description =
         'top condition occurrence') AND
         ('INTEGRATED_CNC_SCHEMA.BOSS'
         IN TYPEOF(fcr.related_shape_aspect.of_shape.definition))) ))
         >= 1);
    WR7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
```

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```
          'SHAPE_REPRESENTATION_WITH_PARAMETERS')
          IN TYPEOF(pdr.used_representation)) )) <= 1)) )) = 0);
    WR8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
          (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
          (('INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
          NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS'
          IN TYPEOF (pdr.used_representation)) |
          NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
          (SIZEOF (
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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.

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**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.

### 5.2.3.1.15 bottom_and_side_milling_operation

A **bottom_and_side_milling_operation** is a **milling_type_operation** that represents a 2.5D milling step in which material is removed both parallel and perpendicular to the cutting tool axis. See the ARM definitions for Bottom_and_side_milling_operation and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY bottom_and_side_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['rough milling','finish milling']);

  WR2:  (verify_optional_action_property   (SELF, 'axial cutting depth')) AND
        (verify_length_measure_action_property (SELF, 'axial cutting depth'));

  WR3:  (verify_optional_action_property   (SELF, 'radial cutting depth')) AND
        (verify_length_measure_action_property (SELF, 'radial cutting depth'));

  WR4:  (verify_optional_action_property        (SELF, 'allowance side')) AND
        (verify_length_measure_action_property  (SELF, 'allowance side'));

  WR5:  (verify_optional_action_property        (SELF, 'allowance bottom')) AND
        (verify_length_measure_action_property  (SELF, 'allowance bottom'));

  WR6:  NOT (SELF.description = 'rough milling') OR
        ((verify_required_action_property (SELF, 'allowance side')) AND
         (verify_required_action_property (SELF, 'allowance bottom')));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **description** of the **bottom_and_side_milling_operation** shall be either 'rough milling' or 'finish milling'.

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**WR2**: The **bottom_and_side_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'axial cutting depth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

**WR3**: The **bottom_and_side_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'radial cutting depth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

**WR4**: The **bottom_and_side_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'allowance side', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

**WR5**: The **bottom_and_side_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'allowance bottom', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

**WR6**: If the **description** of the **bottom_and_side_milling_operation** is 'rough milling', the **bottom_and_side_milling_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'allowance side' and exactly one **action_property** with a **name** of 'allowance bottom'.

NOTE This corresponds to local constraints **WR1** and **WR2** on the ARM entity **Bottom_and_side_rough_milling** in ISO 14649-11.

### 5.2.3.1.16 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY chamfer
  SUBTYPE OF (transition_feature);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
       'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
```

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```
         'RELATING_SHAPE_ASPECT') |
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) ) |
         (('INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET'
         IN TYPEOF(fcr.related_shape_aspect)) AND
         (fcr.related_shape_aspect.description = 'first offset')) )) = 1);
    WR3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) ) |
         (('INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET'
         IN TYPEOF(fcr.related_shape_aspect)) AND
         (fcr.related_shape_aspect.description = 'second offset')) )) = 1);
END_ENTITY; -- chamfer
(*
```

Formal propositions:

**WR1**: The **chamfer** shall have exactly one **face_shape_representation** 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.

### 5.2.3.1.17 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY chamfer_offset
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: (SELF.description IN ['first offset','second offset']);
    WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
    WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

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```
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'offset amount')) OR
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
```

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```
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'FEATURE_COMPONENT_RELATIONSHIP')
         IN TYPEOF(sar)) ) |
         ('INTEGRATED_CNC_SCHEMA.CHAMFER'
         IN TYPEOF(sdr.relating_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 exactly 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 exactly 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**.

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### 5.2.3.1.18 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'diameter')) )) = 1)) ))
         =  0)) )) = 0);
END_ENTITY; -- circular_closed_profile
(*
```

Formal propositions:

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

**WR2**: The **circular_closed_profile** shall have exactly one implicit representation defined by a relationship to a **shape_representation_with_parameters**.

**WR3**: The **shape_representation_with_parameters** that represents the **circular_closed_profile** shall contain two **representation_items** in its set of **items**.

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

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

Informal propositions:

**IP1**: The location of the **circular_closed_profile** shall be defined at the center of the circle.

**IP2**: The **circular_closed_profile** shall be definied in the X-Y plane.

### 5.2.3.1.19 circular_pattern

A **circular_pattern** is a type of **replicate_feature** that relates a base feature and one or more **shape_aspects** which are the placement of the base feature at a specified circular location on the base part. A diameter is defined with a placement on the part and a number of base features are equally spaced around this diameter.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY circular_pattern
  SUBTYPE OF (replicate_feature);
  WHERE
```

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```
WR1: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN
     (pds,'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     ((SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
     + 'RELATING_SHAPE_ASPECT') |
     ((('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
     IN TYPEOF(sar))) ) |
     ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT'
     IN TYPEOF(sdr.related_shape_aspect)) )) = 1)) )) <= 3)) )) = 0);
WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF(
     ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'diameter')) )) <= 1)) ))
     = 0)) )) = 0);
WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
```

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```
         ((SIZEOF(
         ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'base feature rotation')) ))
         <= 1)) )) = 0)) )) = 0);
    WR6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
         IN TYPEOF(it)) AND
         ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF(
         ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'angular spacing'))))= 1)) ))
         = 0)) )) = 0);
    WR8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
         = 0)) )) = 0);
END_ENTITY; -- circular_pattern
(*
```

Formal propositions:

**WR1**: The **circular_pattern** shall be the **relating_shape_aspect** in no more than three **shape_aspect_ relationships**.

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**WR2**: The **circular_pattern** shall have exactly one implicit representation.

**WR3**: The implicit representation of the **circular_pattern** shall contain between two and five **representation_items** in its set of **items**.

**WR4**: The implicit representation of the **circular_pattern** shall contain at most one **representation_item** of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'diameter'.

**WR5**: The implicit representation of the **circular_pattern** shall contain at most one **representation_item** of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'base feature rotation'.

**WR6**: The implicit representation of the **circular_pattern** shall contain exactly one **representation_item** of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'number of features'.

**WR7**: The implicit representation of the **circular_pattern** shall contain exactly one **representation_item** of type **measure_representation_item** and **plane_angle_measure_with_unit** with a **name** of 'angular spacing'.

**WR8**: The implicit representation of the **circular_pattern** shall contain exactly one **representation_item** of type **placement** with a **name** of 'orientation'.

Informal propositions:

**IP1**: The location of the **circular_pattern** shall be defined at the center of the circle.

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

### 5.2.3.1.20 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY closed_path_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF(SELF.of_shape.definition));
    WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
```

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```
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
         'DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
    WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
         = 0)) )) = 0);
    WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
         'DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.PATH_SHAPE_REPRESENTATION')
         IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
END_ENTITY; -- closed_path_profile
(*
```

Formal propositions:

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

**WR2**: The **closed_path_profile** shall have exactly one implicit representation defined by a relationship to a **shape_representation_with_parameters**.

**WR3**: The **shape_representation_with_parameters** that represents the **closed_path_profile** shall contain one **representation_items** in its set of **items**.

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**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.

### 5.2.3.1.21 composite_hole

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
         IN TYPEOF (csa)) AND
         (SIZEOF (QUERY (sar <*  csa.component_relationships |
         ('INTEGRATED_CNC_SCHEMA.ROUND_HOLE'
         IN TYPEOF (sar.related_shape_aspect))
         AND
         NOT(SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN
         (sar.related_shape_aspect,
       'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) |
         (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'change in diameter occurrence')  AND
         (SIZEOF(QUERY ( fcr2 <* QUERY ( sar2 <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         ((sar2.description = 'taper usage') AND
         (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
         IN TYPEOF(sar2))) ) |
         ('INTEGRATED_CNC_SCHEMA.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_ componet_relationship** with a **related_shape_aspect** of type **round_hole**.

**WR3**: If the description of the **composite_hole** is 'countersunk', exactly one **round_hole** that comprises it shall be a tapered hole.

Informal propositions:

**IP1**: Each **round_holes** that comprise the **composite_hole** shall not have diameters that are equal in length.

## 5.2.3.1.22 compound_feature

A **compound_feature** is a type of **feature_definition** that is the representation of several **instanced_ features** and their relationships to one another for the purpose of creating unique user-defined features.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
```

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```
ENTITY compound_feature
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: SIZEOF( QUERY( pds <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
          IN TYPEOF(pds))  AND
         (SIZEOF( QUERY( csa <* USEDIN( pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((csa.name='compound feature in solid') AND
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
         IN TYPEOF(csa))) )) = 1)  )) = 1;
    WR2: SIZEOF( QUERY( pds <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
          IN TYPEOF(pds))  AND
         (SIZEOF( QUERY( csa <* USEDIN( pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
         IN TYPEOF(csa) )) = 1)  )) = 1;
    WR3: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
         IN TYPEOF(csa)) AND
         (SIZEOF(QUERY ( fcr <* csa.component_relationships |
         (NOT ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(fcr))) )) = 0)) )) = 1)) )) = 1);
    WR4: SIZEOF (QUERY (pds <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')|
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pds)) AND
         (SIZEOF (QUERY (csa <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE')|
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
         IN TYPEOF (csa)) AND
         (SIZEOF (QUERY (sar <*  csa.component_relationships |
         (SIZEOF ([
         'INTEGRATED_CNC_SCHEMA.INSTANCED_FEATURE',
         'INTEGRATED_CNC_SCHEMA.TRANSITION_FEATURE',
         'INTEGRATED_CNC_SCHEMA.APPLIED_AREA'] *
         TYPEOF (sar.related_shape_aspect)) = 1) )) = 2)  )) = 1) )) = 1;
    WR5: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pds)) AND
         (SIZEOF(QUERY ( csa <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
         IN TYPEOF(csa)) AND
         (SIZEOF(QUERY ( sar <* csa.component_relationships |
         ('INTEGRATED_CNC_SCHEMA.THREAD'
```

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

Formal propositions:

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

**WR2**: Each instance of **compound_feature** shall have a shape that has exactly one **shape_aspect** identified on it that is of type **composite_shape_aspect**.

**WR3**: The **shape_aspect_relationships** that are used to relate the single features with the **composite_shape_aspect** shall be **feature_component_relationships**.

**WR4**: The **composite_shape_aspect** defining a **compound_feature** shall be the **relating_shape_aspect** only in **shape_aspect_relationships** with a **related_shape_aspect** that is of type **instanced_feature**, **applied_area**, or **transition_feature**.

**WR5**: The **composite_shape_aspect** defining a **compound_feature** shall be the **relating_shape_aspect** only in **shape_aspect_relationships** with a **related_shape_aspect** that is not of type thread.

NOTE - A **thread** feature can not be directly related to a **compound_feature**. The **applied_area** of the thread is related to a **compound_feature**.

**WR6**: The **compound_feature** shall only have constituent **compound_features** of the same type.

### 5.2.3.1.23 cylindrical_shape_representation

A **cylindrical_shape_representation** specifies representation of a shape that is a cylindrical volume defined as a circular area of a defined length. The enclosed area is defined by a circle with a specified radius.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
```

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```
ENTITY cylindrical_shape_representation
  SUBTYPE OF (shape_representation_with_parameters);
  WHERE
    WR1: (SIZEOF(SELF.items) = 3);
    WR2: (SIZEOF(QUERY ( it <* SELF.items | ((
         'INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1);
    WR3: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2) AND (it.name = 'length')) )) = 1);
    WR4: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2) AND (it.name = 'diameter')) )) = 1);
END_ENTITY; -- cylindrical_shape_representation
(*
```

Formal propositions:

**WR1**: The **cylindrical_shape_representation** shall contain exactly three **representation_items** in its set of **items**.

**WR2**: One of the **representation_items** used for the implicit representation of a **cylindrical_shape_representation** shall be of type **placement** with a **name** of 'orientation'.

**WR3**: One of the **representation_items** used for the implicit representation of a **cylindrical_shape_representation** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'length'.

**WR4**: One of the **representation_items** used for the implicit representation of a **cylindrical_shape_representation** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'diameter'.

Informal propositions:

**IP1**: The location of the **cylindrical_shape_representation** shall be defined to be at the center of the circle that defines the cylinder.

**IP2**: The **cylindrical_shape_representation** shall be definied by forming a circular profile in the X-Y plane, and the length along the z direction.

### 5.2.3.1.24 direction_shape_representation

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

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EXPRESS specification:

```
*)
ENTITY direction_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: (SIZEOF(SELF.items) = 1);
    WR2: (SIZEOF(QUERY ( it <* SELF.items |
         (NOT (
         'INTEGRATED_CNC_SCHEMA.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.

### 5.2.3.1.25 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)

ENTITY document_file
  SUBTYPE OF (characterized_object, document);
  WHERE
    WR1: (SIZEOF(QUERY(adr<* QUERY(dr <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.DOCUMENT_REFERENCE.ASSIGNED_DOCUMENT') |
         'INTEGRATED_CNC_SCHEMA.APPLIED_DOCUMENT_REFERENCE'
         IN TYPEOF(dr))|
        'INTEGRATED_CNC_SCHEMA.EXTERNALLY_DEFINED_FEATURE_DEFINITION'
         IN TYPEOF(adr.items)
         ))=1) OR
         (SIZEOF(QUERY (duc <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.DOCUMENT_USAGE_CONSTRAINT.SOURCE') |
         NOT
         (SIZEOF(QUERY(aduc<* QUERY(duca <* USEDIN(duc,
         'INTEGRATED_CNC_SCHEMA.DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT.'+
         'ASSIGNED_DOCUMENT_USAGE') |
         'INTEGRATED_CNC_SCHEMA.'+
         'APPLIED_DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT'
```

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```
         IN TYPEOF(duca))|
        'INTEGRATED_CNC_SCHEMA.EXTERNALLY_DEFINED_FEATURE_DEFINITION'
         IN TYPEOF(aduc.items)
         ))=1))) = 0);
    WR2: (SIZEOF(QUERY(drt <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.'+
         'DOCUMENT_REPRESENTATION_TYPE.REPRESENTED_DOCUMENT') |
         (drt.name='physical')))=1);
END_ENTITY; -- 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 a **name** of 'physical'.

## 5.2.3.1.26 drilling_operation

A **drilling_operation** is a type of **drilling_type_operation** that represents the details of a machining step in which in which material is removed perpendicular to the cutting tool axis. See the ARM definitions for Drilling_operation and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY drilling_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['drilling','counter sinking',
         'center drilling', 'multistep drilling']);

  WR2:  NOT (SELF.description = 'multistep drilling') OR
        ((verify_required_action_property       (SELF, 'retract distance')) AND
         (verify_length_measure_action_property (SELF, 'retract distance')) AND

         (verify_required_action_property       (SELF, 'first depth')) AND
         (verify_length_measure_action_property (SELF, 'first depth')) AND

         (verify_required_action_property       (SELF, 'depth of step')) AND
         (verify_length_measure_action_property (SELF, 'depth of step')) AND

         (verify_optional_action_property       (SELF, 'dwell time step')) AND
         (verify_time_measure_action_property   (SELF, 'dwell time step')));
END_ENTITY;
(*
```

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Formal propositions:

**WR1**: The **description** of the **drilling_operation** shall be either 'drilling','counter sinking', 'center drilling', or 'multistep drilling'.

**WR2**: If the **description** of the **drilling_operation** is 'multistep drilling', **drilling_operation** shall satisfy the following conditions:

— the **drilling_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'retract distance', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**;

— the **drilling_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'first depth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**;

— the **drilling_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'depth of step', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**;

— the **drilling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'dwell time step', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **time_measure_with_unit**.

## 5.2.3.1.27 drilling_type_operation

A **drilling_type_operation** is a type of **machining_operation** that represents the details of a machining step in which the machine axes are generally only moved parallel to the axis of rotation of the cutting tool. See the ARM definitions for Drilling_type_operation and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY drilling_type_operation
  SUBTYPE OF (machining_operation);
  WHERE
  WR1:  (verify_optional_action_property        (SELF, 'overcut length')) AND
        (verify_length_measure_action_property  (SELF, 'overcut length'));

  WR2:  (verify_optional_action_property        (SELF, 'cutting depth')) AND
        (verify_length_measure_action_property  (SELF, 'cutting depth'));

  WR3:  (verify_optional_action_property        (SELF, 'previous diameter')) AND
        (verify_length_measure_action_property  (SELF, 'previous diameter'));

  WR4:  (verify_optional_action_property        (SELF, 'dwell time bottom')) AND
        (verify_time_measure_action_property    (SELF, 'dwell time bottom'));
```

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```
  WR5:  (verify_optional_action_property        (SELF, 'feed on retract')) AND
        (verify_ratio_measure_action_property   (SELF, 'feed on retract'));

  WR6:  ((verify_optional_relating_amr  (SELF, 'machining strategy')) AND
         (verify_related_type_for_amr   (SELF, 'machining strategy',
          ['INTEGRATED_CNC_SCHEMA.DRILLING_TYPE_STRATEGY']))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **drilling_type_operation** shall be the **definition** of at most one **action_property** with a **name** of 'overcut length', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR2**: The **drilling_type_operation** shall be the **definition** of at most one **action_property** with a **name** of 'cutting depth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR3**: The **drilling_type_operation** shall be the **definition** of at most one **action_property** with a **name** of 'previous diameter', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR4**: The **drilling_type_operation** shall be the **definition** of at most one **action_property** with a **name** of 'dwell time bottom', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **time_measure_with_unit**.

**WR5**: The **drilling_type_operation** shall be the **definition** of at most one **action_property** with a **name** of 'feed on retract', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **ratio_measure_with_unit**.

**WR6**: The **drilling_type_operation** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'machining strategy', in which the **related** is of type **drilling_type_strategy**.

### 5.2.3.1.28 drilling_type_strategy

A **drilling_type_strategy** is a type of **machining_strategy** that represents the approach used to determine the motion of the cutting tool during a drilling operation. See the ARM definition for Drilling_type_strategy in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY drilling_type_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  (verify_optional_action_property  (SELF, 'reduced cut at start')) AND
        (verify_ratio_measure_action_property (SELF, 'reduced cut at start'));
```

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```
  WR2:  (verify_optional_action_property  (SELF, 'reduced feed at start')) AND
        (verify_ratio_measure_action_property (SELF, 'reduced feed at start'));

  WR3:  (verify_optional_action_property        (SELF, 'depth of start')) AND
        (verify_length_measure_action_property  (SELF, 'depth of start'));

  WR4:  (verify_optional_action_property    (SELF, 'reduced cut at end')) AND
        (verify_ratio_measure_action_property (SELF, 'reduced cut at end'));

  WR5:  (verify_optional_action_property  (SELF, 'reduced feed at end')) AND
        (verify_ratio_measure_action_property (SELF, 'reduced feed at end'));

  WR6:  (verify_optional_action_property        (SELF, 'depth of end')) AND
        (verify_length_measure_action_property  (SELF, 'depth of end'));

  WR7:  (verify_required_action_property (SELF, 'depth of start')) OR
        ((0 = SIZEOF (get_action_property (SELF, 'reduced cut at start'))) AND
         (0 = SIZEOF (get_action_property (SELF, 'reduced feed at start'))));

  WR8:  (verify_required_action_property (SELF, 'depth of end')) OR
        ((0 = SIZEOF (get_action_property (SELF, 'reduced cut at end'))) AND
         (0 = SIZEOF (get_action_property (SELF, 'reduced feed at end'))));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **drilling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'reduced cut at start', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **ratio_measure_with_unit**.

**WR2**: The **drilling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'reduced feed at start', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **ratio_measure_with_unit**.

**WR3**: The **drilling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'depth of start', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR4**: The **drilling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'reduced cut at end', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **ratio_measure_with_unit**.

**WR5**: The **drilling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'reduced feed at end', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **ratio_measure_with_unit**.

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**WR6**: The **drilling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'depth of end', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR7**: Either the **drilling_type_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'depth of start', or the **drilling_type_strategy** shall be the **definition** of no **action_properties** with a **name** of either 'reduced cut at start' or 'reduced feed at start'.

NOTE This corresponds to local constraint **WR1** on ARM entity **Drilling_type_strategy** in ISO 14649-11.

**WR8**: Either the **drilling_type_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'depth of end', or the **drilling_type_strategy** shall be the **definition** of no **action_properties** with a **name** of either 'reduced cut at end' or 'reduced feed at end'.

NOTE This corresponds to local constraint **WR2** on ARM entity **Drilling_type_strategy** in ISO 14649-11.

### 5.2.3.1.29 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY edge_round
  SUBTYPE OF (transition_feature);
  WHERE
    WR1: (NOT (SELF\shape_aspect.description = 'constant radius')) OR
         (SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <*  USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.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,
```

```
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'second offset'))) <= 1)))
        = 0))) = 0);
   WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation)) AND
        (pdr.used_representation.name = 'edge round face'))) = 1))) = 0;
   WR7: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation)) AND
```

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

Formal propositions:

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

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

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

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

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

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

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

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

### 5.2.3.1.30 expression_representation_item

An **expression_representation_item** is a **representation_item** and **generic_expression** where a particular expression value is represented.

NOTE The **expression_representation_item** definition ties together **representation_item** and the PLIB ISO 13584-20 expression definitions for use in represetations. Using a complex instance, one can combine a subtype of **generic_expression** with **expression_representation_item** to produce a expression that can appear in the representation of a property. This technique is analogous to the way **measure_representation_item** is com-

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bined with a **measure_with_unit** subtype, such as **length_measure_with_unit**, in the representation of a property.

EXPRESS specification:

```
*)
ENTITY expression_representation_item
  SUBTYPE OF (representation_item, generic_expression);
END_ENTITY;
(*
```

### 5.2.3.1.31 externally_defined_feature_definition

An **externally_defined_feature_definition** relates the document containing a feature specification to a **feature_definition**.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

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 = '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF(pdr.used_representation)) AND
         ({8 <= SIZEOF(pdr.used_representation.items) <= 10} ) ))
         = 1  )) = 1));
    WR3: ((NOT (SELF\characterized_object.description = 'marking')) OR
         (SIZEOF( QUERY( pd <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
```

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```
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     SIZEOF( QUERY( pdr <* USEDIN( pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     '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,
    'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN
     (pds,'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     ((sa_occ.description = 'partial area occurrence') AND
     (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
     + 'RELATED_SHAPE_ASPECT') |
     ((sar.description = 'applied area usage') AND
     (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
     IN TYPEOF(sar))) ) |
     ('INTEGRATED_CNC_SCHEMA.APPLIED_AREA'
     IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) <= 1)) )) = 0);
WR6: (NOT (SIZEOF(QUERY( doc <*(QUERY( adr <*USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.APPLIED_DOCUMENT_REFERENCE.ITEMS') |
     'INTEGRATED_CNC_SCHEMA.DOCUMENT'
      IN TYPEOF (adr.assigned_document) )) |
     'INTEGRATED_CNC_SCHEMA.DOCUMENT_FILE' IN TYPEOF(doc) ))
      =1) OR
      NOT (SIZEOF(QUERY( doc <*(QUERY( aduc <*USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.'+
     'APPLIED_DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT.ITEMS') |
     'INTEGRATED_CNC_SCHEMA.DOCUMENT'
      IN TYPEOF (aduc\
      document_usage_constraint_assignment.
      assigned_document_usage.source) )) |
     'INTEGRATED_CNC_SCHEMA.DOCUMENT_FILE' IN TYPEOF(doc) ))
      >=1));
WR7: ((NOT (SELF\characterized_object.description = 'marking')) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
     (pd,'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.'+
```

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```
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'marking text')) )) = 1)) ))
        = 0)) )) = 0));
WR8: ((NOT (SELF\characterized_object.description = 'thread')) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
        (pd,'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'removal direction') AND
        ((it.description = 'internal') OR
        (it.description = 'external'))) )) = 1)) )) = 0)) )) = 0));
WR9: ((NOT (SELF\characterized_object.description = 'thread')) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
         (pd,'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
         IN TYPEOF(it)) AND (it.name = 'qualifier')) ))<= 1)) ))= 0)) ))
         = 0));
WR10: ((NOT (SELF\characterized_object.description = 'thread')) OR
         (SIZEOF(QUERY ( pd <*  USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
         (pd,'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
         IN TYPEOF(it)) AND (it.name = 'hand')) )) = 1)) )) = 0)) ))
         = 0));
WR11: ((NOT (SELF\characterized_object.description = 'thread')) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
         (pd,'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
```

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```
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND (it.name = 'fit class')) )) = 1)) )) =
      0)) )) = 0));
WR12: ((NOT (SELF\characterized_object.description = 'thread')) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
      (pd,'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND (it.name = 'form')) )) = 1)) )) = 0)) ))
      = 0));
WR13: ((NOT (SELF\characterized_object.description = 'thread')) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
      (pd,'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      ((SIZEOF([
      'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
      'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF(it)) = 2) AND (it.name = 'major diameter')) )) = 1)) ))
      = 0)) )) = 0));
WR14: ((NOT (SELF\characterized_object.description = 'thread')) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN
      (pd,'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      ((SIZEOF([
      'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
      'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT'] *
      TYPEOF(it)) = 2) AND (it.name = 'number of threads')) )) = 1)) ))
      = 0)) )) = 0));
WR15: (NOT (SELF\characterized_object.description IN [ 'knurl',
      'thread'])) OR
      (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
      IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN
```

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```
          (pds,'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
          ((SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
          + 'RELATED_SHAPE_ASPECT') |
          ((sar.description = 'applied shape') AND
          (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
          IN TYPEOF(sar))) ) |
          ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT'
          IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) <= 1)) )) = 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'.

**WR2**: If the **description** of the **externally_defined_feature_definition** is 'thread', the implicit representation of the **externally_defined_feature_definition** shall contain between one and ten **representation_items** in its set of **items**.

**WR3**: If the **description** of the **externally_defined_feature_definition** is 'marking', the implicit representation of the **externally_defined_feature_definition** shall contain exactly three **representation_items** in its set of **items**.

**WR4**: If the **description** of the **externally_defined_feature_definition** is 'knurl', the implicit representation of the **externally_defined_feature_definition** shall contain exactly one **representation_items** in its set of **items**.

**WR5**: If the **description** of the **externally_defined_feature_definition** is 'marking', or 'thread' there shall be the basis shape for at most one **shape_aspect** with a **description** of 'partial area occurrence' that is the **related_shape_aspect** in at most one **shape_defining_relationship** with a description of 'applied area usage' in which the **relating_shape_aspect** is an **applied_area**.

**WR6**: 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.

**WR7**: 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'.

**WR8**: 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_defini-**

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**tion** shall be of type **descriptive_representation_item** with a **name** of 'removal direction' and a **description** of either 'internal' or 'external'.

**WR9**: 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'.

**WR10**: 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'.

**WR11**: 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'.

**WR12**: 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'.

**WR13**: 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'.

**WR14**: 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'.

**WR15**: If the **description** of the **externally_defined_feature_definition** is 'marking', 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**.

Informal propositions:

**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.

### 5.2.3.1.32 face_shape_representation

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

*)

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

### 5.2.3.1.33 feature_component_definition

A **face_shape_representation_relationship** is a type of **representation_relationship** that is the representation of several **face_shape_representations** and their relationship to one another.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

Formal propositions:

**WR1**: The **face_shape_representation_relationship** shall have only **face_shape_representation** in its **rep_1**.

**WR2**: The **face_shape_representation_relationship** shall have only **face_shape_representation** in its **rep_2**.

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### 5.2.3.1.34 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**.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

Formal propositions:

**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**.

### 5.2.3.1.35 feature_definition

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY feature_definition
  SUBTYPE OF (characterized_object);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

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```
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
    WR2: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        ('INTEGRATED_CNC_SCHEMA.PLACEMENT'
        IN TYPEOF (it)) AND (it.name = 'orientation'))) = 1))) = 0))) = 0;
    WR3: SIZEOF (['INTEGRATED_CNC_SCHEMA.BOSS',
        'INTEGRATED_CNC_SCHEMA.TURNED_KNURL',
        'INTEGRATED_CNC_SCHEMA.THREAD',
        'INTEGRATED_CNC_SCHEMA.MARKING',
        'INTEGRATED_CNC_SCHEMA.RIB_TOP',
        'INTEGRATED_CNC_SCHEMA.ROUND_HOLE',
        'INTEGRATED_CNC_SCHEMA.OUTSIDE_PROFILE',
        'INTEGRATED_CNC_SCHEMA.POCKET',
        'INTEGRATED_CNC_SCHEMA.REMOVAL_VOLUME',
        'INTEGRATED_CNC_SCHEMA.REVOLVED_PROFILE',
        'INTEGRATED_CNC_SCHEMA.OUTER_ROUND',
        'INTEGRATED_CNC_SCHEMA.FLAT_FACE',
        'INTEGRATED_CNC_SCHEMA.PROTRUSION',
        'INTEGRATED_CNC_SCHEMA.ROUNDED_END',
        'INTEGRATED_CNC_SCHEMA.SLOT',
        'INTEGRATED_CNC_SCHEMA.SPHERICAL_CAP',
        'INTEGRATED_CNC_SCHEMA.STEP',
        'INTEGRATED_CNC_SCHEMA.COMPOUND_FEATURE',
        'INTEGRATED_CNC_SCHEMA.REPLICATE_FEATURE',
        'INTEGRATED_CNC_SCHEMA.EXTERNALLY_DEFINED_FEATURE_DEFINITION']
        * TYPEOF (SELF)) = 1;
    WR4: (NOT (SIZEOF (['INTEGRATED_CNC_SCHEMA.ROUND_HOLE',
        'INTEGRATED_CNC_SCHEMA.BOSS',
        'INTEGRATED_CNC_SCHEMA.OUTSIDE_PROFILE',
        'INTEGRATED_CNC_SCHEMA.REMOVAL_VOLUME',
        'INTEGRATED_CNC_SCHEMA.FLAT_FACE',
        'INTEGRATED_CNC_SCHEMA.POCKET',
        'INTEGRATED_CNC_SCHEMA.PROTRUSION',
        'INTEGRATED_CNC_SCHEMA.RIB_TOP',
        'INTEGRATED_CNC_SCHEMA.ROUNDED_END',
        'INTEGRATED_CNC_SCHEMA.SLOT',
        'INTEGRATED_CNC_SCHEMA.STEP']
        * TYPEOF (SELF)) = 1)) OR
        (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
        'DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
```

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```
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation))AND
         (pdr.used_representation.name = 'maximum feature limit'))) = 1)))
         <= 1);
END_ENTITY; -- feature_definition
(*
```

Formal propositions:

**WR1**: The **feature_definition** shall have exactly one implicit representation.

**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** shall be either a **boss**, **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**, **rounded_end**, **slot**, **step** the **instance_feature** shall have at most one **planar_shape_representation** with a **name** of 'maximum feature limit'.

### 5.2.3.1.36 feature_pattern

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY feature_pattern
  SUBTYPE OF (replicate_feature);
  WHERE
    WR1: SIZEOF( QUERY( pd <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF(pdr.used_representation)) AND
         (SIZEOF( QUERY( srwp_i <* pdr.used_representation.items |
         NOT ('INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(srwp_i)) )) > 0 ) ))   > 0  )) = 0;
    WR2: SIZEOF (QUERY (pd <* USEDIN (SELF,
```

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```
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation)) |
         NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
         ('INTEGRATED_CNC_SCHEMA.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_items** 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_items** in its set of items of type **placement** with the **name** of 'base feature placement'.

### 5.2.3.1.37 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 This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

EXPRESS specification:

```
*)
ENTITY fillet
  SUBTYPE OF (transition_feature);
  WHERE
    WR1: (NOT (SELF\shape_aspect.description = 'constant radius')) OR
         (SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <*  USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.'+
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
```

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```
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.'+
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.'+
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF (it)) = 2) AND (it.name = 'second offset'))) <= 1)))
     = 0))) = 0);

WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
```

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```
         'DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation)) AND
         (pdr.used_representation.name = 'fillet face'))) = 1))) = 0;
    WR7: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
         'DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation)) AND
         (pdr.used_representation.name = 'first face shape'))) = 1))) = 0;
    WR8: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
         'DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation)) AND
         (pdr.used_representation.name = 'second face shape'))) = 1))) = 0;
END_ENTITY; -- fillet
(*
```

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_items** 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'.

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

### 5.2.3.1.38 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY flat_face
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'course of travel occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'path feature component usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'removal boundary occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'profile usage') AND
```

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```
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (('INTEGRATED_CNC_SCHEMA.LINEAR_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect)) AND
        (sdr.name = 'removal boundary')) )) = 1)) )) = 1)) )) = 0);
   WR4: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF (pd)) |
        NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        (sa_occ.description = 'enclosed boundary occurrence') AND
        (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        (sar.description = 'profile usage') AND
        ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
        IN TYPEOF (sar))) |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
        'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
        'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
        'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE'] *
        TYPEOF (sdr.relating_shape_aspect)) = 1) AND
        (sdr.relating_shape_aspect.description = 'boundary')))
        = 1))) <= 1))) = 0;
END_ENTITY; -- flat_face
(*
```

Formal propositions:

**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**.

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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**.

### 5.2.3.1.39 freeform_milling_operation

A **freeform_milling_operation** is a **milling_type_operation** that describes a milling step in which material is removed to create freeform surface geometry. See the ARM definition for Freeform_ milling_operation in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY freeform_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (verify_related_type_for_amr   (SELF, 'machining strategy',
          ['INTEGRATED_CNC_SCHEMA.FREEFORM_MILLING_STRATEGY']));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: Any **action_method_relationship** with a **name** of 'machining strategy', in which **relating** refers to the **freeform_milling_operation**, shall have a **related** of type **freeform_milling_strategy**.

### 5.2.3.1.40 freeform_milling_strategy

A **freeform_milling_strategy** is a type of **milling_type_strategy** that represents the approach used to determine the motion of the cutting tool during a freeform milling operation. See the ARM definitions for Freeform_strategy and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY freeform_milling_strategy
  SUBTYPE OF (milling_type_strategy);
  WHERE
  WR1:  NOT (SELF.description IN ['leading line', 'plane cutter contact',
          'plane cutter location', 'uv']) OR
        ((verify_required_action_property       (SELF, 'pathmode')) AND
         (verify_enumeration_action_property    (SELF, 'pathmode',
           ['forward', 'zigzag'])) AND
```

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```
         (verify_required_action_property       (SELF, 'cutmode')) AND
         (verify_enumeration_action_property    (SELF, 'cutmode',
           ['climb', 'conventional'])) AND

        (verify_required_action_property      (SELF, 'milling tolerances')) AND
         (0 = SIZEOF (QUERY (prop <* get_action_property
          (SELF, 'milling tolerances') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
           'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
           ('INTEGRATED_CNC_SCHEMA.FREEFORM_MILLING_TOLERANCE_REPRESENTATION'
                 IN TYPEOF(prep.representation)) )))
         ))) AND

         (verify_optional_action_property       (SELF, 'stepover length')) AND
         (verify_length_measure_action_property (SELF, 'stepover length')) );

  WR2:  NOT (SELF.description = 'leading line') OR
        ((verify_required_action_property       (SELF, 'leading line')) AND
         (verify_rep_item_for_action_property   (SELF, 'leading line',
           ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) );

  WR3:  NOT (SELF.description IN ['plane cutter contact',
        'plane cutter location']) OR
        ((verify_required_action_property       (SELF, 'plane normal')) AND
         (verify_rep_item_for_action_property   (SELF, 'plane normal',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) );

  WR4:  NOT (SELF.description = 'uv') OR
        ((verify_required_action_property  (SELF, 'forward direction')) AND
         (verify_rep_item_for_action_property   (SELF, 'forward direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

         (verify_required_action_property  (SELF, 'sideward direction')) AND
         (verify_rep_item_for_action_property   (SELF, 'sideward direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: If the **description** of the **freeform_milling_strategy** is either 'leading line', 'plane cutter contact', 'plane cutter location', or 'uv', the **freeform_milling_strategy** shall satisfy the following conditions:

— the **freeform_milling_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'pathmode', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'forward' or 'zigzag';

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— the **freeform_milling_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'cutmode', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'climb' or 'conventional';

— the **freeform_milling_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'milling tolerances', and the **representation** used to describe the **action_property** shall be of type **freeform_milling_tolerance_representation**;

— the **freeform_milling_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'stepover length', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR2**: If the **description** of the **freeform_milling_strategy** is 'leading line', the **freeform_milling_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'leading line', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **bounded_curve**.

**WR3**: If the **description** of the **freeform_milling_strategy** is either 'plane cutter contact' or 'plane cutter location', the **freeform_milling_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'plane normal', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**.

**WR4**: If the **description** of the **freeform_milling_strategy** is 'uv', the **freeform_milling_strategy** shall satisfy the following conditions:

— the **freeform_milling_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'forward direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **freeform_milling_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'sideward direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**.

### 5.2.3.1.41 freeform_milling_tolerance_representation

A **freeform_milling_tolerance_representation** is a type of **representation** that represents surface approximation tolerance parameters for freeform machining. See the ARM definition for Tolerances in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY freeform_milling_tolerance_representation
  SUBTYPE OF (representation);
```

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```
  WHERE
  WR1:  ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'chordal tolerance')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'chordal tolerance') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );
  WR2:  ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'scallop height')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'scallop height') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **items** set shall contain exactly one **representation_item** with a **name** of 'chordal tolerance', which shall be of type **measure_representation_item** and **length_measure_with_unit** .

**WR2**: The **items** set shall contain exactly one **representation_item** with a **name** of 'scallop height', which shall be of type **measure_representation_item** and **length_measure_with_unit** .

### 5.2.3.1.42 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY hole_bottom
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 0)) ))
```

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```
      = 0));
WR4: ((NOT (SELF.description IN ['flat with radius',
     'flat with taper', 'spherical','conical'])) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
WR5: ((NOT (SELF.description = 'flat')) OR
     (SIZEOF(QUERY ( pd <*  USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF (impl_rep.used_representation.items) >= 1)
```

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```
     AND  (SIZEOF (impl_rep.used_representation.items) <= 2)) ))
     = 0)) )) = 0));
WR9: ((SELF.description = 'through') OR
     (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATING_SHAPE_ASPECT') |
     ((sar.description = 'hole bottom usage') AND
     ('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'tip radius')) )) <= 1)) ))
```

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```
     = 0)) )) = 0));
WR13: ((NOT (SELF.description = 'conical')) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'tip angle')) )) = 1)) ))
     = 0)) )) = 0));
WR14: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATING_SHAPE_ASPECT') |
     ((sar.description = 'hole bottom usage') AND
     ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
     IN TYPEOF(sar))) ) |
   ((fcr.related_shape_aspect.description ='bottom condition occurrence')
     AND ('INTEGRATED_CNC_SCHEMA.ROUND_HOLE'
     IN TYPEOF(fcr.related_shape_aspect.of_shape.definition))) )) >= 1);
WR15: ((NOT (SELF.description = 'flat with taper')) OR (SIZEOF(
     QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name =  'taper diameter')) )) = 1)) ))
```

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```
         = 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_items**.

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

**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_items**.

**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'.

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**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.

### 5.2.3.1.43 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.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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.

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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_representations** shall have the same **geometric_representation_context**.

## 5.2.3.1.44 linear_profile

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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_items** 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.

### 5.2.3.1.45 location_shape_representation

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY location_shape_representation
```

```
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: (SIZEOF(SELF.items) = 1);
    WR2: (SIZEOF(QUERY ( it <* SELF.items |
        (NOT ('INTEGRATED_CNC_SCHEMA.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**.

## 5.2.3.1.46 machining_adaptive_control_strategy

A **machining_adaptive_control_strategy** is a type of **machining_strategy** that represents a strategy that may vary depending on additional parameters and possibly on information gathered while the machining process is being executed. See the ARM definition for Adaptive_control in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY machining_adaptive_control_strategy
  SUBTYPE OF (machining_strategy);
END_ENTITY;
(*
```

## 5.2.3.1.47 machining_approach_retract_strategy

A **machining_approach_retract_strategy** is a type of **machining_strategy** that represents the manner in which a cutting tool approaches the workpiece at the beginning of a machining process step or retracts from the workpiece at the end of a machining process step. See the ARM definitions for Approach_retract_strategy and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY machining_approach_retract_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  (SELF.description IN ['along path',
         'approach retract angle', 'approach retract tangent',
         'plunge helix', 'plunge ramp', 'plunge toolaxis',
         'plunge zigzag']);

  WR2:  (verify_optional_action_property       (SELF, 'tool orientation')) AND
```

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```
        (verify_rep_item_for_action_property   (SELF, 'tool orientation',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION']));

  WR3:  NOT (SELF.description = 'along path') OR
        ((1 <= SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
                amr.name = 'toolpath'))) AND

         (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
                (amr.name = 'toolpath') AND NOT
                (('INTEGRATED_CNC_SCHEMA.SEQUENTIAL_METHOD'
                   IN TYPEOF (amr)) AND
                 ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH'
                   IN TYPEOF (amr.related_method))) )))
        );

  WR4:  NOT (SELF.description = 'approach retract angle') OR
        ((verify_required_action_property       (SELF, 'travel angle')) AND
         (verify_angle_measure_action_property  (SELF, 'travel angle')) AND

         (verify_required_action_property       (SELF, 'travel length')) AND
         (verify_length_measure_action_property (SELF, 'travel length')));

  WR5:  NOT (SELF.description = 'approach retract tangent') OR
        ((verify_required_action_property       (SELF, 'travel radius')) AND
         (verify_length_measure_action_property (SELF, 'travel radius')));

  WR6:  NOT (SELF.description IN ['plunge helix', 'plunge ramp',
         'plunge zigzag']) OR
        ((verify_required_action_property       (SELF, 'plunge angle')) AND
         (verify_angle_measure_action_property  (SELF, 'plunge angle')));

  WR7:  NOT (SELF.description = 'plunge helix') OR
        ((verify_required_action_property       (SELF, 'plunge radius')) AND
         (verify_length_measure_action_property (SELF, 'plunge radius')));

  WR8:  NOT (SELF.description = 'plunge zigzag') OR
        ((verify_required_action_property       (SELF, 'plunge width')) AND
         (verify_length_measure_action_property (SELF, 'plunge width')));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **description** of the **machining_approach_retract_strategy** shall be either 'along path', 'approach retract angle', 'approach retract tangent', 'plunge helix', 'plunge ramp', 'plunge toolaxis', or 'plunge zigzag'.

**WR2**: The **machining_approach_retract_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'tool orientation', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**.

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**WR3**: If the **description** of the **machining_approach_retract_strategy** is 'along path', the **machining_approach_retract_strategy** shall be the **relating** of at least one **sequential_method** with a **name** of 'toolpath', in which **related** is of type **machining_toolpath**.

**WR4**: If the **description** of the **machining_approach_retract_strategy** is 'approach retract angle', the **machining_approach_retract_strategy** shall satisfy the following conditions:

— the **machining_approach_retract_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'travel angle', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **plane_angle_measure_with_unit**;

— the **machining_approach_retract_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'travel length', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR5**: If the **description** of the **machining_approach_retract_strategy** is 'approach retract tangent', the **machining_approach_retract_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'travel radius', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR6**: If the **description** of the **machining_approach_retract_strategy** is either 'plunge helix', 'plunge ramp', or 'plunge zigzag', the **machining_approach_retract_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'plunge angle', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **plane_angle_measure_with_unit**.

**WR7**: If the **description** of the **machining_approach_retract_strategy** is 'plunge helix', the **machining_approach_retract_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'plunge radius', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR8**: If the **description** of the **machining_approach_retract_strategy** is 'plunge zigzag', the **machining_approach_retract_strategy** shall be the **definition** of exactly one **action_property** with a **name** of 'plunge width', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

Informal propositions:

**IP1**: All **sequential_method** instances with a **name** of 'toolpath' which refer to the same **machining_approach_retract_strategy** through the **relating** attribute shall have unique **sequence_position** values.

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### 5.2.3.1.48 machining_cutting_component

A **machining_cutting_component** is a type of **action_resource** and **characterized_object** that represents the cutting edge characteristics of a tool for machining. See the ARM definition for Cutting_ component in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_cutting_component
  SUBTYPE OF (action_resource,characterized_object);
  WHERE
  WR1: ((1 = SIZEOF (get_resource_property (SELF,
           'offset length'))) AND

        -- must have a resource rep with a length
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'offset length') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                    TYPEOF(it)) = 2) ))) )))
         ))) );

  WR2: (1 >= SIZEOF (USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.' +
           'MATERIAL_DESIGNATION.DEFINITIONS')));

  WR3: ((1 >= SIZEOF (get_resource_property (SELF,
           'technological data'))) AND

        -- must have a resource rep with a length
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'technological data') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |

                ((1 >= SIZEOF (QUERY ( it <* prep.representation.items |
                  (it.name = 'cutting angle')))) AND
                 (0 = SIZEOF (QUERY ( it <* prep.representation.items |
                  (it.name = 'cutting angle') AND NOT (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                    TYPEOF(it)) = 2))))
                ) AND
                ((1 >= SIZEOF (QUERY ( it <* prep.representation.items |
                  (it.name = 'free angle')))) AND
                 (0 = SIZEOF (QUERY ( it <* prep.representation.items |
                  (it.name = 'free angle') AND NOT (SIZEOF([
```

```
                  'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                  'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                   TYPEOF(it)) = 2))))
               ) AND
               ((1 >= SIZEOF (QUERY ( it <* prep.representation.items |
                 (it.name = 'aux angle')))) AND
                (0 = SIZEOF (QUERY ( it <* prep.representation.items |
                 (it.name = 'aux angle') AND NOT (SIZEOF([
                  'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                  'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                   TYPEOF(it)) = 2))))
               )
            )))
         ))) );

  WR4: ((1 >= SIZEOF (get_resource_property (SELF,
          'expected life'))) AND

        -- must have a resource rep with a length
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
          'expected life') |
          NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
               'INTEGRATED_CNC_SCHEMA.' +
               'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
               (0 < SIZEOF (QUERY (it <* prep.representation.items |
                (SIZEOF([
                  'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                  'INTEGRATED_CNC_SCHEMA.TIME_MEASURE_WITH_UNIT'] *
                   TYPEOF(it)) = 2) ))) )))
         ))) );

  WR5: (1 >= SIZEOF (QUERY (arr <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.REQUIREMENT_FOR_ACTION_RESOURCE.RESOURCES') |
          (arr.kind.name = 'cutting component') AND
          (0 < SIZEOF (QUERY (mt <* arr.operations |
           'INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY' IN TYPEOF (mt))))
        )));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **machining_cutting_component** is the **resource** of exactly one **resource_property** with a **name** of 'offset length', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR2**: The **machining_cutting_component** appears in the set of **definitions** of at most one **material_ designation**.

**WR3**: The **machining_cutting_component** is the **resource** of at most one **resource_property** with a **name** of 'technological data', and the **representation** used to describe the **resource_property** shall contain at most one each of **representation_items** with names 'cutting angle', 'free angle', and 'aux

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angle'. The **representation_items** shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**.

**WR4**: The **machining_cutting_component** is the **resource** of at most one **resource_property** with a **name** of 'expected life', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **time_measure_with_unit**.

**WR5**: The **machining_cutting_component** appears in the set of **resources** in at least one **action_resource_requirement** in which the **resource_requirement_type** has a **name** of 'cutting tool' and the set of **operations** contains exactly one **machining_technology**

## 5.2.3.1.49 machining_feature_process

A **machining_touch_probing** is a type of **machining_process_executable** that represents a set of steps in a machining process that result in a manufacturing feature. See the ARM definition for Manufacturing_feature in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_feature_process
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  (1 = SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'machining')))) AND
        (0 = SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'machining') AND NOT
          ('INTEGRATED_CNC_SCHEMA.PROPERTY_PROCESS' IN TYPEOF (act))
        )));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **machining_feature_process** shall be the **chosen_method** of exactly one **property_process** with a **name** of 'machining'.

## 5.2.3.1.50 machining_functions

A **machining_functions** instance is a type of **action_method** that represents settings on the machine tool which is to execute a machining process. See the ARM definitions for Machine_functions in ISO 14649-10 and Milling_machine_functions in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY machining_functions
  SUBTYPE OF (action_method);
```

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```
  WHERE
  WR1:  NOT (SELF.description = 'milling') OR
        ((verify_required_action_property       (SELF, 'coolant')) AND
         (verify_enumeration_action_property    (SELF, 'coolant',
           ['coolant on', 'coolant off'])) AND

         (verify_optional_action_property       (SELF, 'coolant pressure')) AND
         (verify_rep_item_for_action_property   (SELF, 'coolant pressure',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'])) AND

         (verify_optional_action_property       (SELF, 'mist')) AND
         (verify_enumeration_action_property    (SELF, 'mist',
           ['mist on', 'mist off'])) AND

         (verify_required_action_property
           (SELF, 'through spindle coolant')) AND
         (verify_enumeration_action_property
           (SELF, 'through spindle coolant',
           ['through spindle coolant on', 'through spindle coolant off'])) AND

         (verify_optional_action_property
           (SELF, 'through spindle pressure')) AND
         (verify_rep_item_for_action_property
           (SELF, 'through spindle pressure',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'])) AND

         (verify_optional_action_property     (SELF, 'axis clamping')) AND
         (0 = SIZEOF (QUERY (prop <* get_action_property
           (SELF, 'axis clamping') | NOT
           (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
              'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
             (1 = SIZEOF (QUERY (it <* prep.representation.items |
                (('INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'
                   IN TYPEOF(it)) AND
                 ('INTEGRATED_CNC_SCHEMA.LIST_REPRESENTATION_ITEM'
                   IN TYPEOF(it.item_element)) AND
                 (0 = SIZEOF (QUERY (ie <* it.item_element | NOT
                   ('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
                     IN TYPEOF(ie)) )))
             ))))
           )))
         ))) AND

         (verify_required_action_property       (SELF, 'chip removal')) AND
         (verify_enumeration_action_property    (SELF, 'chip removal',
           ['chip removal on', 'chip removal off'])) AND

         (verify_optional_action_property (SELF, 'oriented spindle stop')) AND
         (verify_rep_item_for_action_property (SELF, 'oriented spindle stop',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

         (verify_related_type_for_amr    (SELF, 'process model',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_MODEL'])) AND
         (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
```

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```
            (amr.name = 'process model') AND NOT
            ('INTEGRATED_CNC_SCHEMA.SEQUENTIAL_METHOD' IN TYPEOF (amr)) ))) AND

         (verify_optional_action_property   (SELF, 'other functions')) AND
         (0 = SIZEOF (QUERY (prop <* get_action_property
            (SELF, 'other functions') | NOT
           (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
              'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
             (1 = SIZEOF (QUERY (it <* prep.representation.items |
                (('INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'
                   IN TYPEOF(it)) AND
                 ('INTEGRATED_CNC_SCHEMA.SET_REPRESENTATION_ITEM'
                   IN TYPEOF(it.item_element)))
             )))
           )))
         )))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: If the **description** of the **machining_functions** is 'milling', the **machining_functions** shall satisfy the following conditions:

— the **machining_functions** shall be the **definition** of exactly one **action_property** with a **name** of 'coolant', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'coolant on' or 'coolant off';

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'coolant pressure', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item**;

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'mist', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'mist on' or 'mist off';

— the **machining_functions** shall be the **definition** of exactly one **action_property** with a **name** of 'through spindle coolant', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'through spindle coolant on' or 'through spindle coolant off';

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'through spindle pressure', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item**;

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— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'axis clamping', and the **representation** used to describe the **action_property** shall contain exactly one **compound_representation_item**, in which the **item_element** is of type **list_representation_item** and contains only instances of type **descriptive_representation_item**;

— the **machining_functions** shall be the **definition** of exactly one **action_property** with a **name** of 'chip removal', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'chip removal on' or 'chip removal off';

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'oriented spindle stop', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— any **action_method_relationship** with a **name** of 'process model', in which **relating** refers to the **machining_functions**, shall be of type **sequential_method** and shall have a **related** of type **machining_process_model**;

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'other functions', and the **representation** used to describe the **action_property** shall contain exactly one **compound_representation_item**, in which the **item_element** is of type **set_representation_item**.

Informal propositions:

**IP1**: All **sequential_method** instances with a **name** of 'process model' which refer to the same **machining_functions** through the **relating** attribute shall have unique **sequence_position** values.

### 5.2.3.1.51 machining_nc_function

A **machining_nc_function** is a type of **machining_process_executable** that represents a step in a machining process. See the ARM definitions for NC_function and subtypes in ISO 14649-10 and ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY machining_nc_function
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  (SELF.description IN ['display message',
        'optional stop', 'program stop', 'set mark', 'wait for mark',
        'exchange pallet', 'index pallet', 'load tool', 'unload tool']);

  WR2:  NOT (SELF.description = 'display message') OR
        ((verify_required_action_property       (SELF, 'message text')) AND
```

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```
        (verify_descriptive_action_property    (SELF, 'message text')));

  WR3:  NOT (SELF.description = 'wait for mark') OR
        ((verify_required_action_property       (SELF, 'channel')));

  WR4:  NOT (SELF.description = 'index pallet') OR
        ((verify_required_action_property       (SELF, 'pallet index')) AND
         (verify_parameter_action_property      (SELF, 'pallet index')));

  WR5:  NOT (SELF.description = 'index table') OR
        ((verify_required_action_property       (SELF, 'table index')) AND
         (verify_parameter_action_property      (SELF, 'table index')));

  WR6:  NOT (SELF.description = 'load tool') OR
        (1 = SIZEOF (QUERY (mt <*
         USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE.USAGE') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL' in TYPEOF(mt)))));

  WR7:  NOT (SELF.description = 'unload tool') OR
        (1 >= SIZEOF (QUERY (mt <*
         USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE.USAGE') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL' in TYPEOF(mt)))));

END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **description** of the **machining_nc_function** shall be either 'display message', 'optional stop', 'program stop', 'set mark', 'wait for mark', 'exchange pallet', 'index pallet', 'load tool', or 'unload tool'.

**WR2**: If the **description** of the **machining_nc_function** is 'display message', the **machining_nc_function** shall be the **definition** of exactly one **action_property** with a **name** of 'message text', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item**.

**WR3**: If the **description** of the **machining_nc_function** is 'wait for mark', the **machining_nc_function** shall be the **definition** of exactly one **action_property** with a **name** of 'channel'.

**WR4**: If the **description** of the **machining_nc_function** is 'index pallet', the **machining_nc_function** shall be the **definition** of exactly one **action_property** with a **name** of 'pallet index', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** in which the **value_component** is of type **parameter_value**.

**WR5**: If the **description** of the **machining_nc_function** is 'index table', the **machining_nc_function** shall be the **definition** of exactly one **action_property** with a **name** of 'pallet table', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** in which the **value_component** is of type **parameter_value**.

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**WR6**: If the **description** of the **machining_nc_function** is 'load tool', the **machining_nc_function** shall appear in the **usage** set of exactly one **machining_tool**.

**WR7**: If the **description** of the **machining_nc_function** is 'unload tool', the **machining_nc_function** shall appear in the **usage** set of at most one **machining_tool**.

### 5.2.3.1.52 machining_offset_vector_representation

A **machining_offset_vector_representation** is a type of **representation** that identifies NC variables that will hold the translation and rotation of a machining workpiece. See the ARM definitions for Offset_vector and NC_variable in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_offset_vector_representation
  SUBTYPE OF (representation);
  WHERE
  WR1: (1 = SIZEOF (QUERY ( it <* SELF.items | (it.name = 'translate')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items | (it.name = 'translate') AND NOT
         (('INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
          ('INTEGRATED_CNC_SCHEMA.LIST_REPRESENTATION_ITEM'
            IN TYPEOF(it.item_element)) AND
          (SIZEOF(it.item_element) = 3) AND
          (0 = SIZEOF (QUERY (ie <* it.item_element | NOT
           (('INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM'
              IN TYPEOF(ie)) AND
            ('INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE' IN TYPEOF(ie))))))
         )
        )));

  WR2: (1 >= SIZEOF (QUERY ( it <* SELF.items | (it.name = 'rotate')))) AND
       (0  = SIZEOF (QUERY ( it <* SELF.items | (it.name = 'rotate') AND NOT
         (('INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM' IN TYPEOF(it))
AND
          ('INTEGRATED_CNC_SCHEMA.LIST_REPRESENTATION_ITEM'
            IN TYPEOF(it.item_element)) AND
          (SIZEOF(it.item_element) = 3) AND
          (0 = SIZEOF (QUERY (ie <* it.item_element | NOT
           (('INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM' IN
TYPEOF(ie)) AND
            ('INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE' IN TYPEOF(ie))))))
         )
        )));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **items** set shall contain exactly one **representation_item** with a **name** of 'translate', which shall be of type **compound_representation_item** with a **item_element** of type **list_representation_**

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**item**. This list shall contain exactly three members, and all members shall be of type **expression_representation_item** and **numeric_variable**.

**WR2**: The **items** set shall contain at most one **representation_item** with a **name** of 'rotate', which shall be of type **compound_representation_item** with a **item_element** of type **list_representation_item**. This list shall contain exactly three members, and all members shall be of type **expression_representation_item** and **numeric_variable**.

### 5.2.3.1.53 machining_operation

A **machining_operation** is a type of **action_method** that represents the manufacturing details of a step of a machining process. See the ARM definitions for Operation and subtypes in ISO 14649-10 and ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY machining_operation
  SUBTYPE OF (action_method);
  WHERE
  WR1: ((verify_related_type_for_amr    (SELF, 'toolpath',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH'])) AND

        (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
            (amr.name = 'toolpath') AND NOT
            ('INTEGRATED_CNC_SCHEMA.SEQUENTIAL_METHOD' IN TYPEOF (amr)) )))
       );

  WR2: ((verify_optional_action_property       (SELF, 'tool direction')) AND
      (0 = SIZEOF (QUERY (prop <* get_action_property (SELF, 'tool direction') |
        NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
             'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
             ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_DIRECTION_REPRESENTATION'
               IN TYPEOF(prep.representation)) )))
         )))
        );

  WR3:  ('INTEGRATED_CNC_SCHEMA.MACHINING_RAPID_MOVEMENT' IN TYPEOF(SELF)) OR
        ('INTEGRATED_CNC_SCHEMA.MACHINING_TOUCH_PROBING' IN TYPEOF(SELF)) OR
        ((verify_optional_action_property       (SELF, 'retract plane')) AND
         (verify_length_measure_action_property (SELF, 'retract plane')) AND

         (verify_optional_action_property       (SELF, 'cut start point')) AND
         (verify_rep_item_for_action_property   (SELF, 'cut start point',
          ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT'])) AND

         (1 = SIZEOF (QUERY (mt <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE.USAGE') |
          ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL' in TYPEOF(mt))))) AND

         (verify_required_relating_amr  (SELF, 'technology')) AND
         (verify_related_type_for_amr   (SELF, 'technology',
```

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```
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY'])) AND

         (verify_required_relating_amr  (SELF, 'machine functions')) AND
         (verify_related_type_for_amr   (SELF, 'machine functions',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS']))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: Any **action_method_relationship** with a **name** of 'toolpath', in which **relating** refers to the **machining_operation**, shall be of type **sequential_method** and shall have a **related** of type **machining_toolpath**.

**WR2**: The **machining_operation** shall be the **definition** of at most one **action_property** with a **name** of 'tool direction', and the **representation** used to describe the **action_property** shall be of type **machining_tool_direction_representation**.

**WR3**: If the **machining_operation** is not also a instance of either **machining_rapid_movement** or **machining_touch_probing**, the **machining_operation** shall satisfy the following conditions:

— the **machining_operation** shall be the **definition** of at most one **action_property** with a **name** of 'retract plane', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**;

— the **machining_operation** shall be the **definition** of at most one **action_property** with a **name** of 'cut start point', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **cartesian_point**;

— the **machining_operation** shall appear in the **usage** set of exactly one **machining_tool**;

— the **machining_operation** shall be the **relating** of exactly one **action_method_relationship** with a **name** of 'technology', in which the **related** is of type **machining_technology**;

— the **machining_operation** shall be the **relating** of exactly one **action_method_relationship** with a **name** of 'machine functions', in which the **related** is of type **machining_functions**.

Informal propositions:

**IP1**: All **sequential_method** instances with a **name** of 'toolpath' which refer to the same **machining_operation** through the **relating** attribute shall have unique **sequence_position** values.

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### 5.2.3.1.54 machining_operator_instruction

A **machining_operator_instruction** is a type of **machining_process_executable** that represents instructions to the human operator of a machining process. See the ARM definition for Setup_instruction in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_operator_instruction
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  EXISTS (self.description) OR
        (0 < SIZEOF (USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.' +
                'APPLIED_DOCUMENT_REFERENCE.ITEMS'))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: Either the description of the **machining_operator_instruction** shall have a value, or the **machining_operator_instruction** shall appear in the **items** list of at least one **applied_document_reference**.

NOTE This corresponds to local constraint **WR1** on the ARM entity **Setup_instruction** in ISO 14649-10.

### 5.2.3.1.55 machining_process_executable

A **machining_process_executable** is a type of **action_method** that represents an executable step in a machining process. See the ARM definitions for Executable and subtypes in ISO 14649-10 for more information

EXPRESS specification:

```
*)
ENTITY machining_process_executable
  SUBTYPE OF (action_method);
  WHERE
  WR1:  NOT (0 = SIZEOF (TYPEOF (SELF) *
            ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS',
             'INTEGRATED_CNC_SCHEMA.MACHINING_NC_FUNCTION',
             'INTEGRATED_CNC_SCHEMA.MACHINING_OPERATOR_INSTRUCTION',
             'INTEGRATED_CNC_SCHEMA.MACHINING_RAPID_MOVEMENT',
             'INTEGRATED_CNC_SCHEMA.MACHINING_TOUCH_PROBING',
             'INTEGRATED_CNC_SCHEMA.MACHINING_WORKINGSTEP',
             'INTEGRATED_CNC_SCHEMA.MACHINING_WORKPLAN']
        )) OR
        (SELF.description IN ['assignment', 'if statement',
                'non-sequential', 'parallel', 'selective',
                'while statement']);
```

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```
  WR2:  NOT (SELF.description = 'assignment') OR
        ((verify_required_action_property       (SELF, 'lvalue')) AND
         (verify_rep_item_for_action_property   (SELF, 'lvalue',
          ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'])) AND

         (verify_required_action_property       (SELF, 'rvalue')) AND
         (verify_rep_item_for_action_property   (SELF, 'rvalue',
          ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM']));

  WR3:  NOT (SELF.description = 'if statement') OR
        ((verify_required_action_property       (SELF, 'condition')) AND
         (verify_rep_item_for_action_property   (SELF, 'condition',
          ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.BOOLEAN_EXPRESSION'])) AND

         (verify_required_relating_amr  (SELF, 'true branch')) AND
         (verify_related_type_for_amr   (SELF, 'true branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE'])) AND

         (verify_optional_relating_amr  (SELF, 'false branch')) AND
         (verify_related_type_for_amr   (SELF, 'false branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );

  WR4:  NOT (SELF.description = 'while statement') OR
        ((verify_required_action_property       (SELF, 'condition')) AND
         (verify_rep_item_for_action_property   (SELF, 'condition',
          ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.BOOLEAN_EXPRESSION'])) AND

         (verify_required_relating_amr  (SELF, 'body')) AND
         (verify_related_type_for_amr   (SELF, 'body',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );

  WR5:  NOT (SELF.description IN ['non-sequential', 'parallel']) OR
        (2 <= SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
                ('INTEGRATED_CNC_SCHEMA.CONCURRENT_ACTION_METHOD'
                 IN TYPEOF (amr)) AND
                ('INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE'
                 IN TYPEOF (amr.related_method))))
        );

  WR6:  NOT (SELF.description = 'selective') OR
        ((2 <= SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
                amr.name = 'branch'))) AND
         (verify_related_type_for_amr   (SELF, 'branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );
END_ENTITY;
(*
```

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Formal propositions:

**WR1**: If the **machining_process_executable** is exactly of type **machining_process_executable** and not an instance of any of the subtypes **machining_workingstep**, **machining_workplan**, **machining_feature_process**, **machining_operator_instruction**, **machining_rapid_movement**, **machining_touch_probing**, or **machining_nc_function**, the **description** of the **machining_process_executable** shall be either 'assignment', 'if statement', 'non-sequential', 'parallel', 'selective', or 'while statement'.

**WR2**: If the **description** of the **machining_process_executable** is 'assignment', the **machining_process_executable** shall satisfy the following conditions:

— the **machining_process_executable** shall be the **definition** of exactly one **action_property** with a **name** of 'lvalue', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **expression_representation_item** and **numeric_variable**;

— the **machining_process_executable** shall be the **definition** of exactly one **action_property** with a **name** of 'rvalue', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **expression_representation_item**.

**WR3**: If the **description** of the **machining_process_executable** is 'if statement', the **machining_process_executable** shall satisfy the following conditions:

— the **machining_process_executable** shall be the **definition** of exactly one **action_property** with a **name** of 'condition', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **expression_representation_item** and **boolean_expression**;

— the **machining_process_executable** shall be the **relating** of exactly one **action_method_relationship** with a **name** of 'true branch', in which the **related** is of type **machining_process_executable**;

— the **machining_process_executable** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'false branch', in which the **related** is of type **machining_process_executable**.

**WR4**: If the **description** of the **machining_process_executable** is 'while statement', the **machining_process_executable** shall satisfy the following conditions:

— the **machining_process_executable** shall be the **definition** of exactly one **action_property** with a **name** of 'condition', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **expression_representation_item** and **boolean_expression**;

— the **machining_process_executable** shall be the **relating** of exactly one **action_method_relationship** with a **name** of 'body', in which the **related** is of type **machining_process_executable**.

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**WR5**: If the **description** of the **machining_process_executable** is either 'non-sequential' or 'parallel', the **machining_process_executable** shall be the **relating** of at least two **concurrent_action_method** instances, in which the **related** is of type **machining_process_executable**.

**WR6**: If the **description** of the **machining_process_executable** is 'selective', the **machining_process_executable** shall be the **relating** of at least two **action_method_relationship** instances with a **name** of 'branch', in which the **related** is of type **machining_process_executable**.

Informal propositions:

**IP1**: The **name** of a **machining_process_executable** shall be unique within the machining process.

## 5.2.3.1.56 machining_process_model

A **machining_process_model** is a type of **action_method** that represents process control settings on the machine tool which is to execute a machining process. See the ARM definition for Process_model in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY machining_process_model
  SUBTYPE OF (action_method);
  WHERE
  WR1: (verify_required_action_property    (SELF, 'initialization data')) AND
       (verify_descriptive_action_property (SELF, 'initialization data'));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **machining_process_model** shall be the **definition** of exactly one **action_property** with a **name** of 'initialization data', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item**.

## 5.2.3.1.57 machining_rapid_movement

A **machining_rapid_movement** is a type of **machining_process_executable** and **machining_operation** that represents a rapid motion of the machine axes in a machining process. See the ARM definitions for Rapid_movement and subtypes in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_rapid_movement
  SUBTYPE OF (machining_process_executable, machining_operation);
  WHERE
  WR1:  ((verify_required_action_property       (SELF, 'security plane')) AND
         (verify_rep_item_for_action_property   (SELF, 'security plane',
          ['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE'])));
```

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```
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **machining_rapid_movement** shall be the **definition** of exactly one **action_property** with a **name** of 'security plane', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **elementary_surface**.

### 5.2.3.1.58 machining_strategy

A **machining_strategy** is a type of **action_method** that represents a particular approach used to perform some aspect of a step in a machining process.

EXPRESS specification:

```
*)
ENTITY machining_strategy
  SUBTYPE OF (action_method);
END_ENTITY;
(*
```

### 5.2.3.1.59 machining_technology

A **machining_technology** is a type of **action_method** that represents technological parameters that govern a portion of a machining process. See the ARM definitions for Technology in ISO 14649-10 and Milling_technology in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY machining_technology
  SUBTYPE OF (action_method);
  WHERE
  WR1:  (verify_optional_action_property     (SELF, 'feedrate')) AND
        (verify_rep_item_for_action_property (SELF, 'feedrate',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM']));

  WR2:  (verify_required_action_property     (SELF, 'feedrate reference')) AND
        (verify_enumeration_action_property  (SELF, 'feedrate reference',
         ['tool center point', 'cutter contact point']));

  WR3:  NOT (SELF.description = 'milling') OR
        ((verify_optional_action_property     (SELF, 'cutspeed')) AND
         (verify_rep_item_for_action_property (SELF, 'cutspeed',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM])) AND

         (verify_optional_action_property     (SELF, 'spindle')) AND
         (verify_rep_item_for_action_property (SELF, 'spindle',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM])) AND
```

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```
         (verify_optional_action_property  (SELF, 'feedrate per tooth')) AND
         (verify_length_measure_action_property
           (SELF, 'feedrate per tooth')) AND

         (verify_required_action_property
           (SELF, 'synchronize spindle with feed')) AND
         (verify_enumeration_action_property
           (SELF, 'synchronize spindle with feed',
           ['synchronized', 'not synchronized'])) AND

         (verify_required_action_property
           (SELF, 'inhibit feedrate override')) AND
         (verify_enumeration_action_property
           (SELF, 'inhibit feedrate override',
           ['override allowed', 'override not allowed'])) AND

         (verify_required_action_property
           (SELF, 'inhibit spindle override')) AND
         (verify_enumeration_action_property
           (SELF, 'inhibit spindle override',
           ['override allowed', 'override not allowed'])) AND

         (verify_optional_relating_amr  (SELF, 'adaptive control')) AND
         (verify_related_type_for_amr   (SELF, 'adaptive control',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_STRATEGY']))
        );

  WR4:  NOT (SELF.description = 'milling') OR
        ((verify_required_action_property (SELF, 'cutspeed') XOR
          verify_required_action_property (SELF, 'spindle')) OR
         (verify_required_relating_amr    (SELF, 'adaptive control'))
        );

  WR5:  NOT (SELF.description = 'milling') OR
        ((verify_required_action_property (SELF, 'feedrate') XOR
          verify_required_action_property (SELF, 'feedrate per tooth')) OR
         (verify_required_relating_amr    (SELF, 'adaptive control'))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **machining_technology** shall be the **definition** of at most one **action_property** with a **name** of 'feedrate', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item**.

**WR2**: The **machining_technology** shall be the **definition** of exactly one **action_property** with a **name** of 'feedrate reference', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'tool center point' or 'cutter contact point'.

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**WR3**: If the **description** of the **machining_technology** is 'milling', the **machining_technology** shall satisfy the following conditions:

— the **machining_technology** shall be the **definition** of at most one **action_property** with a **name** of 'cutspeed', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item**;

— the **machining_technology** shall be the **definition** of at most one **action_property** with a **name** of 'spindle', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item**;

— the **machining_technology** shall be the **definition** of at most one **action_property** with a **name** of 'feedrate per tooth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**;

— the **machining_technology** shall be the **definition** of exactly one **action_property** with a **name** of 'synchronize spindle with feed', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'synchronized' or 'not synchronized';

— the **machining_technology** shall be the **definition** of exactly one **action_property** with a **name** of 'inhibit feedrate override', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'override allowed' or 'override not allowed';

— the **machining_technology** shall be the **definition** of exactly one **action_property** with a **name** of 'inhibit spindle override', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'override allowed' or 'override not allowed';

— the **machining_technology** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'adaptive control', in which the **related** is of type **machining_adaptive_control_strategy**.

**WR4**: Either the **machining_technology** shall be the **definition** of exactly one **action_property** with a **name** of either 'cutspeed' or 'spindle', or else the **machining_technology** shall be the **relating** of exactly one **action_method_relationship** with a **name** of 'adaptive control'.

NOTE This corresponds to local constraint **WR1** on the ARM entity **Milling_technology** in ISO 14649-11

**WR5**: Either the **machining_technology** shall be the **definition** of exactly one **action_property** with a **name** of either 'feedrate' or 'feedrate per tooth', or else the **machining_technology** shall be the **relating** of exactly one **action_method_relationship** with a **name** of 'adaptive control'.

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NOTE This corresponds to local constraint **WR2** on the ARM entity **Milling_technology** in ISO 14649-11

### 5.2.3.1.60 machining_tool

A **machining_tool** is a type of **action_resource** that represents tool requirements for machining. See the ARM definitions for Machining_tool and Cutting_tool in ISO 14649-10, and Milling_cutting_tool subtype defined in ISO 14649-111 for more information.

EXPRESS specification:

```
*)
ENTITY machining_tool
  SUBTYPE OF (action_resource);
  WHERE
  WR1: NOT (action_resource.kind.name IN ['cutting tool',
                'milling cutting tool']) OR
        (
        -- REQUIRED tool body
        (1 = SIZEOF (get_resource_property (SELF, 'tool body'))) AND

        -- must have a tool body representation
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF, 'tool body') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_BODY_REPRESENTATION'
                 IN TYPEOF(prep.representation)) )))
         ))) AND

        -- Must have at least one cutting component
        -- note that this is a set, not a list.
        (0 < SIZEOF (QUERY (arr <* USEDIN (SELF,
      'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE_RELATIONSHIP.RELATING_RESOURCE') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_CUTTING_COMPONENT'
          IN TYPEOF (arr.related)) ))) AND

        -- OPTIONAL overall assembly length
        (1 >= SIZEOF (get_resource_property (SELF,
           'overall assembly length'))) AND

        -- must have a resource rep with a length
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'overall assembly length') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                    TYPEOF(it)) = 2) ))) )))
         )))
```

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```
        );

  WR2: NOT (action_resource.kind.name = 'milling cutting tool') OR
        (
        -- OPTIONAL direction for spindle orientation
        (1 >= SIZEOF (get_resource_property (SELF,
           'direction for spindle orientation'))) AND

        -- must have a resource rep with a direction
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'direction for spindle orientation') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 ('INTEGRATED_CNC_SCHEMA.DIRECTION' IN TYPEOF(it)) ))) )))
        ))) AND

        -- OPTIONAL tool holder diameter for spindle orientation
        (1 >= SIZEOF (get_resource_property (SELF,
           'tool holder diameter for spindle orientation')) ) AND

        -- must have a resource rep with a length
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'tool holder diameter for spindle orientation') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                    TYPEOF(it)) = 2) ))) )))
         )))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of either 'cutting tool' or 'milling cutting tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is the **resource** of exactly one **resource_property** with a **name** of 'tool body', and the **representation** used to describe the **resource_property** shall be of type **machining_tool_body_representation**;

— the **machining_tool** is the **relating** in at least one **action_resource_relationship** in which the **related** is of type **machining_cutting_component**;

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— the **machining_tool** is the **resource** of at most one **resource_property** with a **name** of 'overall assembly length', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

**WR2**: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is the **resource** of at most one **resource_property** with a **name** of 'direction for spindle orientation', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **direction**;

— the **machining_tool** is the **resource** of at most one **resource_property** with a **name** of 'tool holder diameter for spindle orientation', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

Informal propositions:

**IP1**: The **machining_tool name** shall be unique.

### 5.2.3.1.61 machining_tool_body_representation

A **machining_tool_body_representation** is a type of **representation** that represents the body configuration of a tool for machining. See the ARM definitions for Tool_body in ISO 14649-10 and the Milling_tool_body subtypes in ISO 14649-111 for more information.

EXPRESS specification:

```
*)
ENTITY machining_tool_body_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  NOT (SELF.name IN ['backside counterbore', 'backside countersink',
        'ball endmill', 'boring tool', 'bullnose endmill', 'centerdrill',
        'combined drill and reamer', 'combined drill and tap', 'counterbore',
        'countersink','dovetail mill', 'endmill', 'facemill', 'reamer',
        'side mill', 'spade drill', 'tap', 'tapered drill', 'tapered endmill',
        'tapered reamer', 'tapered tap', 'tee slot mill', 'thread mill',
        'threading tool', 'twist drill', 'user defined milling tool',
        'woodruff keyseat mill'])
        OR (

        (1 = SIZEOF (QUERY (rr <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.REPRESENTATION_RELATIONSHIP.REP_1') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_DIMENSION_REPRESENTATION'
          IN TYPEOF(rr.rep_2))))
        ) AND
        ((1 >= SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'number of teeth')))) AND
```

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```
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'number of teeth') AND NOT
         (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
           IN TYPEOF(it)) AND
          ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
           IN TYPEOF(it.value_component))))))
       ) AND
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'hand of cut')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'hand of cut') AND NOT
         (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
           IN TYPEOF(it)) AND
          (it.description IN ['left', 'right', 'neutral']))))))
       ) AND
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'coolant through tool')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'coolant through tool') AND NOT
         (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
           IN TYPEOF(it)) AND
          (it.description IN ['supported', 'not supported']))))))
       ) AND
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'pilot length')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'pilot length') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
       ) );

WR2:  NOT (SELF.name = 'boring tool') OR
       ((1 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'retract movement')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'retract movement') AND NOT
         (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
           IN TYPEOF(it)) AND
          (it.description IN ['permitted', 'forbidden']))))))
       );

WR3:  NOT (SELF.name IN ['combined drill and reamer',
        'combined drill and tap']) OR
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'drill length')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'drill length') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
       );

WR4:  NOT (SELF.name IN ['countersink', 'backside countersink']) OR
```

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```
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'countersink radius')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'countersink radius') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
       );

  WR5:  NOT (SELF.name = 'dovetail mill') OR
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'included angle')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'included angle') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
       );

  WR6:  NOT (SELF.name IN ['side mill', 'woodruff keyseat mill']) OR
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'cutter width')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'cutter width') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
       );

  WR7:  NOT (SELF.name = 'tee slot mill') OR
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'cutting thickness')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'cutting thickness') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
       );

  WR8:  NOT (SELF.name IN ['tapered drill', 'tapered endmill',
        'tapered reamer', 'tapered tap']) OR
       ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'taper angle')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'taper angle') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
       );

  WR9:  NOT (SELF.name = 'user defined milling tool') OR
       ((1 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'tool identifier')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
```

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```
          (it.name = 'tool identifier') AND NOT
          (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
            IN TYPEOF(it))))))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: If the **name** of the **machining_tool_dimension_representation** is either 'backside counterbore', 'backside countersink', 'ball endmill', 'boring tool', 'bullnose endmill', 'centerdrill', 'combined drill and reamer', 'combined drill and tap', 'counterbore', 'countersink', 'dovetail mill', 'endmill', 'facemill', 'reamer', 'side mill', 'spade drill', 'tap', 'tapered drill', 'tapered endmill', 'tapered reamer', 'tapered tap', 'tee slot mill', 'thread mill', 'threading tool', 'twist drill', 'user defined milling tool', or 'woodruff keyseat mill', the **machining_tool_body_representation** shall be the **rep_1** in exactly one **representation_relationship** with a **rep_2** that references a **machining_tool_dimension_representation**. In addition, the **items** set shall contain the following items:

— at most one **representation_item** with a **name** of 'number of teeth', which shall be type **measure_representation_item** with a **value_component** of type **count_measure**;

— at most one **representation_item** with a **name** of 'hand of cut', which shall be of type **descriptive_representation_item** with a **description** of 'left', 'right', or 'neutral';

— at most one **representation_item** with a **name** of 'coolant through tool', which shall be of type **descriptive_representation_item** with a **description** of 'supported', or 'not supported';

— at most one **representation_item** with a **name** of 'pilot length', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR2**: If the **name** of the **machining_tool_body_representation** is 'boring tool', the **items** set shall contain exactly one **representation_item** with a **name** of 'retract movement', which shall be of type **descriptive_representation_item** with a **description** of 'permitted' or 'forbidden'.

**WR3**: If the **name** of the **machining_tool_body_representation** is either 'combined drill and reamer' or 'combined drill and tap', the **items** set shall contain at most one **representation_item** with a **name** of 'drill length', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR4**: If the **name** of the **machining_tool_body_representation** is either 'countersink' or 'backside countersink', the **items** set shall contain at most one **representation_item** with a **name** of 'countersink radius', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR5**: If the **name** of the **machining_tool_body_representation** is 'dovetail mill', the **items** set shall contain at most one **representation_item** with a **name** of 'included angle', which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**.

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**WR6**: If the **name** of the **machining_tool_body_representation** is either 'side mill' or 'woodruff key-seat mill', the **items** set shall contain at most one **representation_item** with a **name** of 'cutter width', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR7**: If the **name** of the **machining_tool_body_representation** is 'tee slot mill', the **items** set shall contain at most one **representation_item** with a **name** of 'cutting thickness', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR8**: If the **name** of the **machining_tool_body_representation** is either 'tapered drill', 'tapered end-mill', 'tapered reamer', or 'tapered tap', the **items** set shall contain at most one **representation_item** with a **name** of 'taper angle', which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**.

**WR9**: If the **name** of the **machining_tool_body_representation** is 'user defined milling tool', the **items** set shall contain exactly one **representation_item** with a **name** of 'tool identifier', which shall be of type **descriptive_representation_item**.

### 5.2.3.1.62 machining_tool_dimension_representation

A **machining_tool_dimension_representation** is a type of **representation** that represents the dimensional characteristics of a milling tool body configuration. See the ARM definition for Tool_dimension in ISO 14649-111 for more information.

EXPRESS specification:

```
*)
ENTITY machining_tool_dimension_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'diameter')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'diameter') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );

  WR2:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool top angle')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool top angle') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );

  WR3:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool circumference angle')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool circumference angle') AND NOT (SIZEOF([
```

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```
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR4:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'cutting edge length')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'cutting edge length') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR5:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'edge radius')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'edge radius') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR6:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'edge center vertical')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'edge center vertical') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR7:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'edge center horizontal')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'edge center horizontal') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR8:  (0 = SIZEOF (QUERY (rr <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.REPRESENTATION_RELATIONSHIP.REP_2') |
       ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_BODY_REPRESENTATION'
        IN TYPEOF(rr.rep_1)) AND (rr.rep_1.name = 'ball endmill')))
      ) OR (verify_ball_endmill_edge_dimensions (SELF));


WR9:  (0 = SIZEOF (QUERY (rr <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.REPRESENTATION_RELATIONSHIP.REP_2') |
       ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_BODY_REPRESENTATION'
        IN TYPEOF(rr.rep_1)) AND
       (rr.rep_1.name IN ['bullnose endmill', 'ball endmill']))
      ) OR (
```

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```
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool top angle') AND NOT
          (it.value_component = 0)))
         ) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool circumference angle') AND NOT
          (it.value_component = 0)))
         )
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **items** set shall contain exactly one **representation_item** with a **name** of 'diameter', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR2**: The **items** set shall contain at most one **representation_item** with a **name** of 'tool top angle', which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**.

**WR3**: The **items** set shall contain at most one **representation_item** with a **name** of 'tool circumference angle', which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**.

**WR4**: The **items** set shall contain at most one **representation_item** with a **name** of 'cutting edge length', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR5**: The **items** set shall contain at most one **representation_item** with a **name** of 'edge radius', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR6**: The **items** set shall contain at most one **representation_item** with a **name** of 'edge center vertical', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR7**: The **items** set shall contain at most one **representation_item** with a **name** of 'edge center horizontal', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

**WR8**: If the **machining_tool_dimension_representation** is the **rep_2** in a **representation_relationship** in which the **rep_1** is a **machining_tool_body_representation** with a **name** of 'ball endmill', then, if present, the conditions tested by the **verify_ball_endmill_edge_dimensions** shall be satisfied.

NOTE This corresponds to the local constraints **WR1**, **WR2** and **WR3** on the ARM entity **Ball_endmill** in ISO 14649-111

**WR9**: If the **machining_tool_dimension_representation** is the **rep_2** in a **representation_relationship** in which the **rep_1** is a **machining_tool_body_representation** with a **name** of 'bullnose endmill' or 'ball endmill', then, if present, the **representation_item** with a **name** of 'tool top angle' shall have a **value_component** of 0 and the **representation_item** with a **name** of 'tool circumference angle' shall have a **value_component** of 0.

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NOTE This corresponds to the local constraints **WR1** and **WR2** on the ARM entity **Bullnose_endmill** and the local constraints **WR4** and **WR5** on the ARM entity **Ball_endmill** in ISO 14649-111

### 5.2.3.1.63 machining_tool_direction_representation

A **machining_tool_direction_representation** is a type of **representation** that represents direction of the cutting tool for freeform machining. See the ARM definition for Tool_direction in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_tool_direction_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  (SELF.name IN ['two axes', 'three axes', 'three axes tilted tool',
        'five axes const tilt yaw', 'five axes var tilt yaw']);

  WR2:  NOT (SELF.name = 'three axes tilted tool') OR
        ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction orientation')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction orientation') AND NOT
          ('INTEGRATED_CNC_SCHEMA.DIRECTION' IN TYPEOF(it)))))
        );

  WR3:  NOT (SELF.name = 'five axes const tilt yaw') OR
        ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction tilt angle')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction tilt angle') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2)))) AND
         (1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction yaw angle')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction yaw angle') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
         );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **name** of the **machining_tool_direction_representation** shall be either 'two axes', 'three axes', 'three axes tilted tool', 'five axes const tilt yaw', or 'five axes var tilt yaw'.

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**WR2**: If the **name** of the **machining_tool_direction_representation** is 'three axes tilted tool', the **items** set shall contain exactly one **representation_item** with a **name** of 'tool direction orientation', which shall be of type **direction**.

**WR3**: If the **name** of the **machining_tool_direction_representation** is 'five axes const tilt yaw', the **items** set shall contain exactly one **representation_item** with a **name** of 'tool direction tilt angle', which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**, and the **items** set shall also contain exactly one **representation_item** with a **name** of 'tool direction yaw angle', which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**.

### 5.2.3.1.64 machining_toolpath

A **machining_toolpath** is a type of **action_method** that restricts a step in a machining process to use a specific movement of the machine axes. See the ARM definitions for Toolpath and subtypes in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_toolpath
  SUBTYPE OF (action_method);
  WHERE
  WR1:  (verify_required_action_property        (SELF, 'priority')) AND
        (verify_enumeration_action_property     (SELF, 'priority',
         ['required', 'suggested']));

  WR2:  (verify_required_action_property        (SELF, 'trajectory type')) AND
        (verify_enumeration_action_property     (SELF, 'trajectory type',
         ['approach', 'lift', 'connect', 'non-contact', 'contact',
          'trajectory path']));

  WR3: ((verify_optiona_action_property        (SELF, 'speed profile')) AND
       (0 = SIZEOF (QUERY (prop <* get_action_property (SELF, 'speed profile') |
         NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
              'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
       'INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION'
                 IN TYPEOF(prep.representation)) )))
         )))
        );

  WR4:  (verify_optional_relating_amr   (SELF, 'technology')) AND
        (verify_related_type_for_amr    (SELF, 'technology',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY']));

  WR5:  (verify_optional_relating_amr   (SELF, 'machine functions')) AND
        (verify_related_type_for_amr    (SELF, 'machine functions',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS']));
END_ENTITY;
(*
```

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Formal propositions:

**WR1**: The **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of 'priority', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'required' or 'suggested'.

**WR2**: The **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of 'trajectory type', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'approach', 'lift', 'connect', 'non-contact', 'contact', or 'trajectory path'.

**WR3**: The **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'speed profile', and the **representation** used to describe the **action_property** shall be of type **machining_toolpath_speed_profile_representation**.

**WR4**: The **machining_toolpath** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'technology', in which the **related** is of type **machining_technology**.

**WR5**: The **machining_toolpath** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'machine functions', in which the **related** is of type **machining_functions**.

## 5.2.3.1.65 machining_toolpath_speed_profile_representation

A **machining_toolpath_speed_profile_representation** is a type of **representation** that represents the variation of feedrate as the machine axes move through a tool path. See the ARM definition for Toolpath_speedprofile in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_toolpath_speed_profile_representation
  SUBTYPE OF (representation);
END_ENTITY;
(*
```

## 5.2.3.1.66 machining_touch_probing

A **machining_touch_probing** is a type of **machining_process_executable** and **machining_operation** that represents a measurement step in a machining process. See the ARM definitions for Touch_probing and subtypes in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_touch_probing
  SUBTYPE OF (machining_process_executable, machining_operation);
  WHERE
  WR1:  (SELF.description IN ['workpiece probing', 'workpiece complete probing',
         'tool length probing', 'tool radius probing']);
```

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```
WR2:  ((verify_required_action_property       (SELF, 'security plane')) AND
       (verify_rep_item_for_action_property   (SELF, 'security plane',
        ['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE'])));

WR3:  ((verify_required_action_property       (SELF, 'measured offset')) AND
       (verify_rep_item_for_action_property   (SELF, 'measured offset',
        ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'])));

WR4:  NOT (SELF.description = 'workpiece probing') OR
      ((verify_required_action_property       (SELF, 'start position')) AND
       (verify_rep_item_for_action_property   (SELF, 'start position',
        ['INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D'])) AND

      (1 = SIZEOF (QUERY (act <*
        USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
        (act.name = 'workpiece probing')))) AND
      (0 = SIZEOF (QUERY (act <*
        USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
        (act.name = 'workpiece probing') AND NOT
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_PROCESS'
          IN TYPEOF (act))))) AND

       (verify_required_action_property       (SELF, 'direction')) AND
       (verify_rep_item_for_action_property   (SELF, 'direction',
        ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

       (verify_required_action_property       (SELF, 'expected value')) AND
       (verify_rep_item_for_action_property   (SELF, 'expected value',
        ['INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT',
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.QUALIFIED_REPRESENTATION_ITEM'])) AND

       (verify_required_action_property       (SELF, 'probe'))
      );

WR5:  NOT (SELF.description = 'workpiece complete probing') OR
      ((1 = SIZEOF (QUERY (act <*
        USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
        (act.name = 'workpiece complete probing')))) AND
       (0 = SIZEOF (QUERY (act <*
        USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
        (act.name = 'workpiece complete probing') AND NOT
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_PROCESS'
          IN TYPEOF (act))))) AND

       (verify_required_action_property       (SELF, 'probing distance')) AND
       (verify_rep_item_for_action_property   (SELF, 'probing distance',
        ['INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT',
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.QUALIFIED_REPRESENTATION_ITEM'])) AND

       (verify_required_action_property    (SELF, 'probe')) AND
```

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```
         (verify_required_action_property    (SELF, 'computed offset')) AND
         (0 = SIZEOF (QUERY (prop <* get_action_property
             (SELF, 'computed offset') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
             'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
             ('INTEGRATED_CNC_SCHEMA.MACHINING_OFFSET_VECTOR_REPRESENTATION'
                 IN TYPEOF(prep.representation)) )))
         )))
        );

  WR6:  NOT (SELF.description IN ['tool length probing', 'tool radius probing'])
OR
        ((verify_required_action_property       (SELF, 'offset')) AND
         (verify_rep_item_for_action_property   (SELF, 'offset',
          ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT'])) AND

         (verify_required_action_property       (SELF, 'maximum wear')) AND
         (verify_length_measure_action_property (SELF, 'maximum wear')) AND

         (1 = SIZEOF (QUERY (mt <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE.USAGE') |
          ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL' in TYPEOF(mt)))))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **description** of the **machining_touch_probing** shall be either 'workpiece probing', 'workpiece complete probing', 'tool length probing', or 'tool radius probing'.

**WR2**: The **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'security plane', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **elementary_surface**.

**WR3**: The **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'measured offset', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **expression_representation_item** and **numeric_variable**.

**WR4**: If the **description** of the **machining_touch_probing** is 'workpiece probing', the **machining_touch_probing** shall satisfy the following conditions:

— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'start position', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **axis2_placement_3d**;

— the **machining_touch_probing** shall be the **chosen_method** of exactly one **product_definition_process** with a **name** of 'workpiece probing';

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— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'expected value', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **length_measure_with_unit**, **measure_representation_item**, and **qualified_representation_item**;

— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'probe'.

**WR5**: If the **description** of the **machining_touch_probing** is 'workpiece complete probing', the **machining_touch_probing** shall satisfy the following conditions:

— the **machining_touch_probing** shall be the **chosen_method** of exactly one **product_definition_process** with a **name** of 'workpiece complete probing';

— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'probing distance', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **length_measure_with_unit**, **measure_representation_item**, and **qualified_representation_item**;

— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'probe';

— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'computed offset', and the **representation** used to describe the **action_property** shall be of type **machining_offset_vector_representation**.

**WR6**: If the **description** of the **machining_touch_probing** is either 'tool length probing' or 'tool radius probing', the **machining_touch_probing** shall satisfy the following conditions:

— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'offset', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **cartesian_point**;

— the **machining_touch_probing** shall be the **definition** of exactly one **action_property** with a **name** of 'maximum wear', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **length_measure_with_unit** and **measure_representation_item**;

— the **machining_touch_probing** shall appear in the **usage** set of exactly one **machining_tool**.

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### 5.2.3.1.67 machining_workingstep

A **machining_workingstep** is a type of **machining_process_executable** that represents a step in a machining process. See the ARM definition for Machining_workingstep in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_workingstep
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  ((verify_required_action_property       (SELF, 'security plane')) AND
         (verify_rep_item_for_action_property   (SELF, 'security plane',
          ['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE'])));

  WR2:  ((verify_required_relating_amr  (SELF, 'final feature')) AND
         (verify_related_type_for_amr   (SELF, 'final feature',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS']))
        );

  WR3:  ((verify_optional_relating_amr  (SELF, 'in-process feature')) AND
         (verify_related_type_for_amr   (SELF, 'in-process feature',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS']))
        );

  WR4:  ((verify_required_relating_amr  (SELF, 'operation')) AND
         (verify_related_type_for_amr   (SELF, 'operation',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION']))
        );

  WR5:  (verify_optional_in_process_geometry (SELF));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **machining_workingstep** shall be the **definition** of exactly one **action_property** with a **name** of 'security plane', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **elementary_surface**.

**WR2**: The **machining_workingstep** shall be the **relating** of exactly one **action_method_relationship** with a **name** of 'final feature', in which the **related** is of type **machining_feature_process**.

**WR3**: The **machining_workingstep** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'in-process feature', in which the **related** is of type **machining_feature_process**.

**WR4**: The **machining_workingstep** shall be the **relating** of exactly one **action_method_relationship** with a **name** of 'operation', in which the **related** is of type **machining_operation**.

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**WR5**: The **machining_workingstep** shall satisfy the conditions tested by the function **verify_optional_in_process_geometry**. Refer to the definition of the function **verify_optional_in_process_geometry** for more information.

### 5.2.3.1.68 machining_workplan

A **machining_workplan** is a type of **machining_process_executable** that represents a sequence of steps in a machining process. See the ARM definition for Manufacturing_feature in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_workplan
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  (1 <= SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
          ('INTEGRATED_CNC_SCHEMA.SEQUENTIAL_METHOD' IN TYPEOF (amr)) AND
          ('INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE'
                 IN TYPEOF (amr.related_method))))
        );

  WR2:  (verify_optional_action_property (SELF, 'channel'));

  WR3:  (1 >= SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'setup')))) AND
        (0 = SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'setup') AND NOT
          ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_PROCESS' IN TYPEOF (act))
        )));

  WR4:  (verify_optional_in_process_geometry (SELF));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **machining_workplan** shall be the **relating** of at least one **sequential_method**, in which the **related** is of type **machining_process_executable**.

**WR2**: The **machining_workplan** shall be the **definition** of at most one **action_property** with a **name** of 'channel'.

**WR3**: The **machining_workplan** shall be the **chosen_method** of at most one **product_definition_process** with a **name** of 'setup'.

**WR4**: The **machining_workplan** shall satisfy the conditions tested by the function **verify_optional_in_process_geometry**. Refer to the definition of the function **verify_optional_in_process_geometry** for more information.

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Informal propositions:

**IP1**: All **sequential_method** instances which refer to the same **machining_workplan** through the **relating** attribute shall have unique **sequence_position** values.

## 5.2.3.1.69 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 This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

EXPRESS specification:

```
*)
ENTITY marking
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: SIZEOF( QUERY( pd <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <*
         QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
         IN TYPEOF(it)) AND (it.name = 'marking text')) )) = 1)) ))
         = 0)) )) = 0);
    WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
         IN TYPEOF(it)) AND (it.name = 'special instructions')) )) <= 1)) ))
```

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```
     = 0)) )) = 0);
WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND (it.name = 'font name')))) <= 1))))
     = 0)) )) = 0);
WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'character height')) )) <= 1)) ))
     = 0)) )) = 0);
WR6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'character spacing')) )) <= 1)) ))
     = 0)) )) = 0);
WR7: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF(pd)) ) |
     (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     ((SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
     + 'RELATED_SHAPE_ASPECT') |
     ((sar.description = 'applied shape') AND
     (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
     IN TYPEOF(sar))) ) |
     ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT'
```

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```
         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_ items**.

**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**.

### 5.2.3.1.70 milling_type_operation

A **milling_type_operation** is a type of **machining_operation** that represents the details of a milling step of a machining process. See the ARM definitions for Milling_type_operation and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY milling_type_operation
  SUBTYPE OF (machining_operation);
  WHERE
  WR1:  (verify_optional_action_property        (SELF, 'overcut length')) AND
        (verify_length_measure_action_property  (SELF, 'overcut length'));

  WR2:  ((verify_optional_relating_amr  (SELF, 'approach strategy')) AND
         (verify_related_type_for_amr   (SELF, 'approach strategy',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );
```

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```
  WR3:  ((verify_optional_relating_amr  (SELF, 'retract strategy')) AND
         (verify_related_type_for_amr   (SELF, 'retract strategy',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR4:  ((verify_optional_relating_amr  (SELF, 'machining strategy')) AND
         (verify_related_type_for_amr   (SELF, 'machining strategy',
          ['INTEGRATED_CNC_SCHEMA.MILLING_TYPE_STRATEGY']))
        );
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **milling_type_operation** shall be the **definition** of at most one **action_property** with a **name** of 'overcut length', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**

**WR2**: The **milling_type_operation** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'approach strategy', in which the **related** is of type **machining_approach_retract_strategy**.

**WR3**: The **milling_type_operation** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'retract strategy', in which the **related** is of type **machining_approach_retract_strategy**.

**WR4**: The **milling_type_operation** shall be the **relating** of at most one **action_method_relationship** with a **name** of 'machining strategy', in which the **related** is of type **milling_type_strategy**.

### 5.2.3.1.71 milling_type_strategy

A **milling_type_strategy** is a type of **machining_strategy** that represents the approach used to determine the motion of the cutting tool during a milling operation. See the ARM definitions for Two5D_milling_strategy, Freeform_strategy, and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY milling_type_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  NOT (SELF.description IN ['bidirectional', 'bidirectional contour',
          'center milling', 'contour bidirectional', 'contour parallel',
          'contour spiral', 'explicit', 'unidirectional']) OR
     ((verify_optional_action_property       (SELF, 'overlap ratio')) AND
      (verify_ratio_measure_action_property  (SELF, 'overlap ratio')) AND

      (verify_optional_action_property       (SELF, 'multiple passes')) AND
      (verify_enumeration_action_property    (SELF, 'multiple passes',
          ['multiple passes allowed', 'multiple passes not allowed'])) );
```

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```
  WR2:  NOT (SELF.description = 'bidirectional') OR
     ((verify_optional_action_property       (SELF, 'feed direction')) AND
      (verify_rep_item_for_action_property   (SELF, 'feed direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

      (verify_optional_action_property       (SELF, 'stepover direction')) AND
      (verify_enumeration_action_property    (SELF, 'stepover direction',
           ['left', 'right'])) AND

      (verify_optional_action_property       (SELF, 'connection strategy')) AND
      (verify_enumeration_action_property    (SELF, 'connection strategy',
           ['straight line', 'lift shift plunge', 'degouge', 'loop back'])) );

  WR3:  NOT (SELF.description IN ['bidirectional contour',
                 'contour bidirectional']) OR
      ((verify_optional_action_property       (SELF, 'feed direction')) AND
       (verify_rep_item_for_action_property   (SELF, 'feed direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

       (verify_optional_action_property       (SELF, 'stepover direction')) AND
       (verify_enumeration_action_property    (SELF, 'stepover direction',
           ['left', 'right'])) AND

       (verify_optional_action_property       (SELF, 'rotation direction')) AND
       (verify_enumeration_action_property    (SELF, 'rotation direction',
           ['clockwise', 'counterclockwise'])) AND

       (verify_optional_action_property       (SELF, 'spiral cutmode')) AND
       (verify_enumeration_action_property    (SELF, 'spiral cutmode',
           ['climb', 'conventional'])) );

  WR4:  NOT (SELF.description IN ['contour parallel', 'contour spiral']) OR
      ((verify_optional_action_property       (SELF, 'rotation direction')) AND
       (verify_enumeration_action_property    (SELF, 'rotation direction',
           ['clockwise', 'counterclockwise'])) AND

       (verify_optional_action_property       (SELF, 'cutmode')) AND
       (verify_enumeration_action_property    (SELF, 'cutmode',
           ['climb', 'conventional'])) );

  WR5:  NOT (SELF.description = 'unidirectional') OR
        ((verify_optional_action_property       (SELF, 'feed direction')) AND
         (verify_rep_item_for_action_property   (SELF, 'feed direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

         (verify_optional_action_property       (SELF, 'cutmode')) AND
         (verify_enumeration_action_property    (SELF, 'cutmode',
           ['climb', 'conventional'])) );
END_ENTITY;
(*
```

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Formal propositions:

**WR1**: If the **description** of the **milling_type_strategy** is either 'bidirectional', 'bidirectional contour', 'center milling', 'contour bidirectional', 'contour parallel', 'contour spiral', 'explicit', or 'unidirectional', the **milling_type_strategy** shall satisfy the following conditions:

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'overlap ratio', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **ratio_measure_with_unit**;

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'multiple passes', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'multiple passes allowed' or 'multiple passes not allowed'.

**WR2**: If the **description** of the **milling_type_strategy** is 'bidirectional', the **milling_type_strategy** shall satisfy the following conditions:

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'feed direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'stepover direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'left' or 'right';

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'connection strategy', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'straight line', 'lift shift plunge', 'degouge', or 'loop back'.

**WR3**: If the **description** of the **milling_type_strategy** is either 'bidirectional contour' or 'contour bidirectional', the **milling_type_strategy** shall satisfy the following conditions:

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'feed direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'stepover direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'left' or 'right';

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— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'rotation direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'clockwise' or 'counterclockwise';

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'spiral cutmode', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'climb' or 'conventional'.

**WR4**: If the **description** of the **milling_type_strategy** is either 'contour parallel' or 'contour spiral', the **milling_type_strategy** shall satisfy the following conditions:

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'rotation direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'clockwise' or 'counterclockwise';

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'cutmode', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'climb' or 'conventional'.

**WR5**: If the **description** of the **milling_type_strategy** is 'unidirectional', the **milling_type_strategy** shall satisfy the following conditions:

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'feed direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **milling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'cutmode', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'climb' or 'conventional'.

### 5.2.3.1.72 modified_pattern

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

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EXPRESS specification:

```
*)
ENTITY modified_pattern
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: SIZEOF( QUERY (fcr <* QUERY(sar <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF (sar)) |
         (SIZEOF(
         ['INTEGRATED_CNC_SCHEMA.REPLICATE_FEATURE',
         'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF (sar)) |
         (SIZEOF(
         ['INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
         'INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'] *
         TYPEOF(fcr.related_shape_aspect.of_shape.definition)) = 1) AND
         (fcr.description = 'base pattern')) ) = 1;
    WR3: SIZEOF(QUERY ( sar <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         (SIZEOF(QUERY ( msar <* USEDIN(sar.related_shape_aspect,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (SIZEOF([
         'INTEGRATED_CNC_SCHEMA.PATTERN_OFFSET_MEMBERSHIP',
         'INTEGRATED_CNC_SCHEMA.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

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**related_shape_aspect** in a different instance of **shape_aspect_relationship** that is either a **pattern_offset_membership** or **pattern_omit_membership**.

### 5.2.3.1.73 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
     = SIZEOF(pdr.used_representation.items))  )) = 1 )) = 1;
WR5: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     ('INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF (it)) AND
     (it.name = 'orientation'))) = 1))) = 0))) = 0;
WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     ('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
     IN TYPEOF (it)) AND
     ('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
      NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF (it)) = 2) AND
```

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```
        (it.name = 'corner radius'))) <= 1))) = 0))) = 0;
END_ENTITY; -- ngon_closed_profile
(*
```

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_items** in its set of **items**.

**WR4**: The implicit representation of an **ngon_closed_profile** shall contain only **representation_items** 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.

### 5.2.3.1.74 ngon_shape_representation

An **ngon_shape_representation** specifies representation of a shape that is a volume defined as a ngon area of a defined length. The enclosed area is defined by three or more straight sides.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

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EXPRESS specification:

```
*)
ENTITY ngon_shape_representation
  SUBTYPE OF (shape_representation_with_parameters);
  WHERE
    WR1: (SIZEOF(SELF.items) = 5);
    WR2: (SIZEOF(QUERY ( it <* SELF.items |
         (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1);
    WR3: (SIZEOF(QUERY ( it <* SELF.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'length')) )) = 1);
    WR4: (SIZEOF(QUERY ( it <* SELF.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'corner radius')) )) = 1);
    WR5: SIZEOF (QUERY (it <* SELF.items |
         (SIZEOF
         (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF (it)) = 2) AND
       (it.name IN ['circumscribed diameter','diameter across flats']) ))= 1;
    WR6: (SIZEOF(QUERY ( it <* SELF.items |
         (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
         IN TYPEOF(it)) AND
         ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
         IN TYPEOF(it\measure_with_unit.value_component)) AND
         (it.name = 'number of sides')) )) = 1);
END_ENTITY; -- ngon_shape_representation
(*
```

Formal propositions:

**WR1**: The **ngon_shape_representation** shall contain exactly five **representation_items** in its set of **items**.

**WR2**: One of the **representation_items** used for the implicit representation of a **ngon_shape_representation** shall be of type **placement** with a **name** of 'orientation'.

**WR3**: One of the **representation_items** used for the implicit representation of a **ngon_shape_representation** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'length'.

**WR4**: One of the **representation_items** used for the implicit representation of a **ngon_shape_representation** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'corner radius'.

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**WR5**: One of the **representation_items** used for the implicit representation of a **ngon_shape_representation** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'circumscribed diameter' or 'diameter across flats'.

**WR6**: One of the **representation_items** used for the implicit representation of a **ngon_shape_representation** shall be of type **measure_representation_item** with a **value_component** of type **count_measure** and a **name** of 'number of sides'.

Informal propositions:

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

**IP2**: The **ngon_shape_representation** shall be defined with the enclosed area in the X-Y plane with one of the sides of the ngon parallel to the X direction intersecting the negative Y axis. The length is along the Z direction.

### 5.2.3.1.75 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
    WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(it)) AND
         (it.name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PATH_SHAPE_REPRESENTATION'
         IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
    WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation))AND
         (pdr.used_representation.name = 'profile limit') )) <= 1))) = 0;
END_ENTITY;  -- open_path_profile
(*
```

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_items** 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.

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### 5.2.3.1.76 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 This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

EXPRESS specification:

```
*)
ENTITY outer_round
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: ((NOT (SELF\characterized_object.description = 'outer diameter')) OR
         (SIZEOF( QUERY( pd <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF(pdr.used_representation)) AND
         (SIZEOF (pdr.used_representation.items) = 2) )) = 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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
```

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```
         TYPEOF(it)) = 2) AND (it.name = 'length')) )) = 1)) ))
         = 0)) )) = 0));
    WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF
         (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
         TYPEOF(pd)) ) |
         (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'v-shape boundary occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'profile usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'reduced size occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'taper usage') AND
         (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.TAPER'
         IN TYPEOF(sdr.relating_shape_aspect)) AND
         (sdr.name = 'reduced size')) ))  = 1)) ))
         <= 1)) )) = 0));
END_ENTITY; -- outer_round
(*
```

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Formal propositions:

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

**WR2**: The implicit representation of the **outer_round** with name 'outer diameter to shoulder' shall contain exactly two **representation_items**.

**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'.

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**.

## 5.2.3.1.77 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**.

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NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)

ENTITY outside_profile
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: SIZEOF( QUERY( pd <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (sa_occ.description = 'boundary occurrence') )) =1)  ))=0))  OR
         (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (sar.description = 'profile usage') AND
         ('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_DEFINING_RELATIONSHIP' IN TYPEOF (sar))) |
         (SIZEOF (['INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
         'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
         'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
         'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE',
         'INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
```

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```
     'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
     'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
     'INTEGRATED_CNC_SCHEMA.LINEAR_PROFILE',
     'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
     'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     NOT(SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATED_SHAPE_ASPECT') |
     (sar.description = 'profile floor usage') AND
     ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
     IN TYPEOF (sar))) |
     'INTEGRATED_CNC_SCHEMA.PROFILE_FLOOR'
     IN TYPEOF (sdr.relating_shape_aspect))) = 1))) = 0))) = 0);
WR5: (NOT(SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
```

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```
        'RELATED_SHAPE_ASPECT') |
        (sar.description = 'path feature component usage') AND
        ('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_DEFINING_RELATIONSHIP' IN TYPEOF (sar))) |
        (SIZEOF (['INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF (pd)) |
        NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        (sa_occ.description = 'complex boundary occurrence') ))
        =1)  ))=0))  OR
        (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF (pd)) |
        NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        (sar.description = 'profile usage') AND
        ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
        IN TYPEOF (sar))) |
        (SIZEOF (['INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
        'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
        'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
        'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE',
        'INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
        'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
        'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
        'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
        'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
        'INTEGRATED_CNC_SCHEMA.LINEAR_PROFILE',
        'INTEGRATED_CNC_SCHEMA.OPEN_PATH_PROFILE'] *
        TYPEOF (sdr.relating_shape_aspect)) =1))  )
        = 1)))= 1))) = 0);
    WR7: (NOT(SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF (pd)) |
        NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        (sa_occ.description = 'partial circular boundary occurrence') ))
        =1)  ))=0))  OR
        (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF (pd)) |
```

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```
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATED_SHAPE_ASPECT') |
     (sar.description = 'profile usage') AND
     ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
     IN TYPEOF (sar))) |
     ('INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE' IN
     TYPEOF (sdr.relating_shape_aspect))))
     = 1)))= 1))) = 0);
WR8: (NOT(SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (sa_occ.description = 'closed circular boundary occurrence') ))
     =1)  ))=0))  OR
     (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATED_SHAPE_ASPECT') |
     (sar.description = 'profile usage') AND
     ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
     IN TYPEOF (sar))) |
     ('INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE' IN
     TYPEOF (sdr.relating_shape_aspect))))
     = 1)))= 1))) = 0);
WR9: (NOT(SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (sa_occ.description = 'open rectangular boundary occurrence') ))
     =1)  ))=0))  OR
     (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF (pd)) |
     NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATED_SHAPE_ASPECT') |
     (sar.description = 'profile usage') AND
     ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
     IN TYPEOF (sar))) |
```

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```
         ('INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE' IN
         TYPEOF (sdr.relating_shape_aspect))))
         = 1)))= 1))) = 0);
   WR10: (NOT(SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (sa_occ.description = 'closed rectangular boundary occurrence') ))
         =1)  ))=0))  OR
         (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (sar.description = 'profile usage') AND
         ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
         IN TYPEOF (sar))) |
         ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE' IN
         TYPEOF (sdr.relating_shape_aspect)) )) = 1)))
         = 1))) = 0);
   WR11: (SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION'
         IN TYPEOF(pdr.used_representation)) AND
         (pdr.used_representation.name = 'removal direction')) )) = 1)) ))
         = 0);
END_ENTITY; -- outside_profile
(*
```

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Formal propositions:

**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**.

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**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'.

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**.

## 5.2.3.1.78 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
     IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
     = 0)) )) = 0);
WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'radius')))) = 1)) ))
     = 0)) )) = 0);
WR6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'sweep angle')) )) = 1)) ))
     = 0)) )) = 0);
WR7: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION'
     IN TYPEOF (pdr.used_representation))AND
```

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```
         (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_items** 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.

### 5.2.3.1.79 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY path_feature_component
  SUBTYPE OF (shape_aspect);
  WHERE
```

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```
WR1: ('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
WR4: ((SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
     IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
     = 0)) )) = 0));
WR5: ((NOT (SELF.description = 'partial circular')) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

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```
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        '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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN( pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        '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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
```

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```
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION'
        IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
   WR13: ((NOT (SELF.description = 'complex')) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.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'.

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**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_items** 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_items** 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_items** 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**.

## 5.2.3.1.80 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.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

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EXPRESS specification:

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

## 5.2.3.1.81 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**.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
        SELF.related_shape_aspect,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
        (fcr.description='modified pattern') AND
        ('INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN'
        IN TYPEOF(fcr.relating_shape_aspect)) )) >= 1);
   WR3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
        SELF.related_shape_aspect,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
        (('INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN'
        IN TYPEOF(fcr.relating_shape_aspect)) AND
        (NOT (SIZEOF(QUERY ( modfcr <* QUERY ( modsar <* USEDIN(
        fcr.relating_shape_aspect,'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') |
        ((SIZEOF(['INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
        'INTEGRATED_CNC_SCHEMA.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 ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
        IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 2)) )) = 0));
   WR5n: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN'
        IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 1)) )) = 0));
   WR6: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN'
        IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (NOT (SIZEOF(pdr.used_representation.items) = 2)) )) = 0)) ))
        = 0));
   WR7: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN'
        IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
```

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```
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND
      ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
      IN TYPEOF(it\measure_with_unit.value_component)) AND
      (it.name = 'index number')) )) = 1)) )) = 0)) )) = 0));
 WR8: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      (('INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'
      IN TYPEOF(it)) AND (it.name = 'offset')) )) = 1)) )) = 0)) ))
      = 0));
 WR9: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')|
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(impl_rep.used_representation.items ) = 3)) ))
      = 0)) )) = 0));
WR10: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')|
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
      IN TYPEOF(it)) AND
      ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
      IN TYPEOF(it\measure_with_unit.value_component)) AND
      (it.name = 'row index')) )) = 1)) )) = 0)) )) = 0));
WR11: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
      IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
      (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
```

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```
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
         IN TYPEOF(it)) AND
         ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
         IN TYPEOF(it\measure_with_unit.value_component)) AND
         (it.name = 'column index')) )) = 1)) )) = 0)) )) = 0));
   WR12: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'
         IN TYPEOF(it)) AND (it.name = 'offset distance')) )) = 1)) ))
         = 0)) )) = 0));
   WR13: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.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 entity instances such that the **related_shape_aspect** defines the offset which is used as the **related_shape_aspect** in an instance of a

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**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**.

**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 representations.

**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_items** 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'.

**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_items** 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

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**pattern_offset_membership** shall have exactly one **direction_shape_representation** with a **name** of 'offset direction'.

### 5.2.3.1.82 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**.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY pattern_omit_membership
  SUBTYPE OF (feature_component_relationship);
  WHERE
    WR1: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
         SELF.relating_shape_aspect,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATING_SHAPE_ASPECT') |
         (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
         ((SIZEOF (QUERY( pdr <*(QUERY(pd <* USEDIN
         (fcr.related_shape_aspect.of_shape,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd))) |
         SIZEOF (['INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
         'INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN']
         * TYPEOF(pdr.definition))  =1 )) = 0 )) )) = 0);
    WR2: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
         SELF.related_shape_aspect,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
         (fcr.description='modified pattern') AND
         ('INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN'
         IN TYPEOF(fcr.relating_shape_aspect)) )) >= 1);
    WR3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(
         SELF.related_shape_aspect,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) AND (sar :<>: SELF)) ) |
         (('INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN'
         IN TYPEOF(fcr.relating_shape_aspect)) AND
         (NOT (SIZEOF(QUERY ( modfcr <* QUERY ( modsar <* USEDIN(
         fcr.relating_shape_aspect,'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') |
         ((SIZEOF(['INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
         'INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'] *
```

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```
     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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 1)) )) = 0);
WR5: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN'
     IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (NOT (SIZEOF(pdr.used_representation.items) = 1)) )) = 0)) )) = 0));
WR6: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN'
     IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND
     ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
     IN TYPEOF(it\measure_with_unit.value_component)) AND
     (it.name = 'index number')) )) = 1)) )) = 0)) )) = 0));
WR7: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
     IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (NOT (SIZEOF(pdr.used_representation.items) = 2)) )) = 0)) )) = 0));
WR8: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
     IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
```

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```
         IN TYPEOF(it\measure_with_unit.value_component)) AND
         (it.name = 'row index')) )) = 1)) )) = 0)) )) = 0));
    WR9: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'
         IN TYPEOF(SELF.relating_shape_aspect.of_shape.definition))) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
         IN TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.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_omit_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**.

**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_items** in its set of **items**.

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**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'.

## 5.2.3.1.83 placed_datum_target_feature

A **placed_datum_target_feature** is a type of **datum_target** that represents the implicit definition.

NOTE This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

EXPRESS specification:

```
*)
ENTITY placed_datum_target_feature
  SUBTYPE OF (datum_target);
  WHERE
  WR1 : (SELF.description IN ['point','line','rectangle','circle']);
  WR2 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
  WR3 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* dtm_rep.used_representation.items |
        (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
        IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
        = 0)) )) = 0);
  WR4 : ((NOT (SELF.description = 'point')) OR
        (SIZEOF(QUERY ( pd <*  USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( dtm_rep <*
        QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
```

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```
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(dtm_rep.used_representation.items) = 1)) ))
        = 0)) )) = 0));
  WR5 : ((NOT (SELF.description IN ['line','circle'])) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(dtm_rep.used_representation.items) = 2)) ))
         = 0)) )) = 0));
  WR6 : ((NOT (SELF.description = 'rectangle')) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(dtm_rep.used_representation.items) = 3)) ))
        = 0)) )) = 0));
  WR7 : ((NOT (SELF.description = 'circle')) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* dtm_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'target diameter')) ))
        = 1)) )) = 0)) )) = 0));
  WR8 : ((NOT (SELF.description = 'line')) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* dtm_rep.used_representation.items |
        ((SIZEOF([
```

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```
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'target length')))) = 1)) ))
        = 0)) )) = 0));
  WR9 : ((NOT (SELF.description = 'rectangle')) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* dtm_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'target length')))) = 1)) ))
        = 0)) )) = 0));
  WR10: ((NOT (SELF.description = 'rectangle')) OR
        (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* dtm_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it)) = 2) AND (it.name = 'target width'))))= 1))))
        = 0)) ))=0));
END_ENTITY; -- placed_datum_target_feature
(*
```

Formal propositions:

**WR1**: The **description** for the **placed_datum_target_feature** shall be either 'point', 'line', 'rectangle' or 'circle'.

**WR2**: A **placed_datum_target_feature** shall have exactly one implicit representation.

**WR3**: Exactly one **representation_item** used for the representation of the **placed_datum_target_feature** shall be of type **placement** with a name of 'orientation'.

**WR4**: If the **placed_datum_target_feature** is a point, the representation shall contain exactly one **representation_item** in its set of **items**.

**WR5**: If the **placed_datum_target_feature** is a line or circle, the representation shall contain exactly two **representation_items** in its set of **items**.

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**WR6**: If the **placed_datum_target_feature** is a rectangle, the representation shall contain exactly three **representation_items** in its set of items.

**WR7**: If the **description** of the **placed_datum_target_feature** is 'circle', exactly one **representation_item** used for the implicit representation of the **placed_datum_target_feature** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'target diameter'.

**WR8**: If the **description** of the **placed_datum_target_feature** is 'line', exactly one **representation_item** used for the implicit representation of the **placed_datum_target_feature** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'target length'.

**WR9**: If the **description** of the **placed_datum_target_feature** is 'rectangle', exactly one **representation_item** used for the implicit representation of the **placed_datum_target_feature** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'target length'.

**WR10**: If the **description** of the **placed_datum_target_feature** is 'rectangle', exactly one **representation_item** used for the implicit representation of the **placed_datum_target_feature** shall be of type **measure_representation_item** and **length_measure_with_unit** with a **name** of 'target width'.

### 5.2.3.1.84 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.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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**.

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### 5.2.3.1.85 plane_milling_operation

A **plane_milling_operation** is a **milling_type_operation** that represents a 2.5D milling step in which material is removed perpendicular to the cutting tool axis. See the ARM definitions for Plane_milling_ operation and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY plane_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['rough milling','finish milling']);

  WR2:  (verify_optional_action_property  (SELF, 'axial cutting depth')) AND
        (verify_length_measure_action_property (SELF, 'axial cutting depth'));

  WR3:  (verify_optional_action_property       (SELF, 'allowance bottom')) AND
        (verify_length_measure_action_property  (SELF, 'allowance bottom'));

  WR4:  NOT (SELF.description = 'rough milling') OR
        (verify_required_action_property (SELF, 'allowance bottom'));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **description** of the **plane_milling_operation** shall be either 'rough milling' or 'finish milling'.

**WR2**: The **plane_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'axial cutting depth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

**WR3**: The **plane_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'allowance bottom', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

**WR4**: If the **description** of the **plane_milling_operation** is 'rough milling', the **plane_milling_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'allowance bottom'.

NOTE This corresponds to local constraint **WR1** on the ARM entity **Plane_rough_milling** in ISO 14649-11.

### 5.2.3.1.86 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

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**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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'pocket depth occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'path feature component usage')  AND
         (sar.name = 'pocket depth') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.PATH_FEATURE_COMPONENT'
         IN TYPEOF(sdr.relating_shape_aspect)) AND
         (sdr.relating_shape_aspect.description ='linear')) ))
         = 1)) )) = 1)) )) = 0);
    WR3: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation))) = 1))) = 0;
    WR4: SIZEOF( QUERY( pd <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
```

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```
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF (
     ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
     ((sa_occ.description = 'boundary occurrence') AND
     (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATED_SHAPE_ASPECT') |
     ((sar.description = 'profile usage') AND
     (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
     IN TYPEOF(sar))) ) | ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
     'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
     'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
     'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE',
     'INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
     'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
     'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
     'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
     'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
     IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
```

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```
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((sa_occ.description = 'closed boundary occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'profile usage') AND
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((sa_occ.description = 'open boundary occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'profile usage') AND
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (('INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect))) )) = 1)) ))
        = 1)) )) = 0));
  WR10: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((sa_occ.description = 'bottom condition occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'pocket bottom usage') AND
        (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        ('INTEGRATED_CNC_SCHEMA.POCKET_BOTTOM'
        IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
  WR11: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((sa_occ.description = 'change in boundary occurrence') AND
        (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATING_SHAPE_ASPECT') |
        ((sar.description = 'taper usage') AND
        (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (('INTEGRATED_CNC_SCHEMA.TAPER'
```

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```
      IN TYPEOF(fcr.related_shape_aspect)) 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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pd)) | NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
      'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
      (sa_occ.description = 'enclosed boundary occurrence') AND
      (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
      'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (sar.description = 'profile usage') AND
      ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
      IN TYPEOF (sar))) |
      ('INTEGRATED_CNC_SCHEMA.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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pd)) | NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
      'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
      (sa_occ.description = 'bottom condition occurrence') AND
      (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
      'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (sar.description = 'pocket bottom usage') AND
      ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF (sar))) |
      ('INTEGRATED_CNC_SCHEMA.POCKET_BOTTOM'
      IN TYPEOF (sdr.relating_shape_aspect)) 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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pd)) |
      NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
      'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
      (sa_occ.description = 'bottom condition occurrence') AND
      (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
      'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
      'RELATED_SHAPE_ASPECT') |
      (sar.description = 'pocket bottom usage') AND
      ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
      IN TYPEOF (sar))) |
      ('INTEGRATED_CNC_SCHEMA.POCKET_BOTTOM'
      IN TYPEOF (sdr.relating_shape_aspect)) AND
```

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```
        (sdr.relating_shape_aspect.description IN ['planar','complex']))
        = 1))) = 1))) = 0);
END_ENTITY; -- pocket
(*
```

Formal propositions:

**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_items**.

**WR5**: The implicit representation of the **pocket** shall contain only **representation_items** 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**: 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_**

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**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'.

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**.

## 5.2.3.1.87 pocket_bottom

A **pocket_bottom** is a type of **shape_aspect** that is the representation of the end condition for a pocket **feature_definition**.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY pocket_bottom
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: 'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

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```
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation))) = 1))) = 0));
   WR7: (NOT (SELF.description IN  ['planar', 'complex']) OR
        (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        '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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation))) = 0))) = 0));
   WR9: (NOT (SELF.description IN ['planar', 'complex'])) OR
```

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```
        (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'radius'))) <= 1))) = 0))) = 0);
   WR10: SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATING_SHAPE_ASPECT') |
        (sar.description = 'pocket bottom usage') AND
        ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF (sar))) |
        (fcr.related_shape_aspect.description =
        'bottom condition occurrence') AND
        ('INTEGRATED_CNC_SCHEMA.POCKET'
        IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)))) >= 1;
   WR11: ((NOT (SELF.description IN ['planar','complex'])) OR
         (SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATING_SHAPE_ASPECT') |
        (sar.description = 'pocket bottom usage') AND
        ('INTEGRATED_CNC_SCHEMA.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 a **name** of 'floor normal'.

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

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

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**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_items**.

**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.

## 5.2.3.1.88 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY profile_floor
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: 'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
```

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```
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation))) = 1))) = 0));
WR4: (NOT (SELF.description IN  ['planar', 'complex'])) OR
     (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation))) = 0))) = 0));
WR6: (NOT (SELF.description IN ['planar', 'complex'])) OR
     (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF (it)) = 2) AND (it.name = 'radius'))) = 1))) = 0))) = 0);
WR7: SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
     'RELATING_SHAPE_ASPECT') |
     (sar.description = 'profile floor usage') AND
     ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
     TYPEOF (sar))) |
     'INTEGRATED_CNC_SCHEMA.OUTSIDE_PROFILE' IN TYPEOF
     (fcr.related_shape_aspect.of_shape.definition))) >= 1;
WR8: ((NOT (SELF.description IN ['planar','complex'])) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')
     | (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
     used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
```

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```
         impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.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_items**.

**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_**

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**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'.

### 5.2.3.1.89 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 This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

EXPRESS specification:

```
*)
ENTITY protrusion
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'shape volume occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'volume shape usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (sdr.relating_shape_aspect.description = 'volume shape') )) = 1)) ))
         = 1)) )) = 0);
END_ENTITY; -- protrusion
(*
```

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Formal propositions:

**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'.

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.

## 5.2.3.1.90 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     '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,'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION.DEFINITION') |
     SIZEOF( QUERY( pdr <* USEDIN( pd, 'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     ('INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF (it)) AND
     (it.name = 'orientation'))) = 1))) = 0))) = 0;
WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF (it)) = 2) AND
     (it.name = 'width'))) = 1))) = 0))) = 0;
WR7: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
```

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```
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND
        (it.name = 'length'))) = 1))) = 0))) = 0;
    WR8: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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_items** in its set of **items**.

**WR4**: The implicit representation of a **rectangular_closed_profile** shall contain only **representation_items** 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'.

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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 X direction is orthogonal to the Y direction.

### 5.2.3.1.91 rectangular_pattern

A **rectangular_pattern** is a type of **replicate_feature** that relates a base feature and one or more **shape_aspects** which are the placement of the base feature at a specified 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY rectangular_pattern
  SUBTYPE OF (replicate_feature);
  WHERE
    WR1: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN
         (pds,'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATING_SHAPE_ASPECT') |
         ((('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT'
         IN TYPEOF(sdr.related_shape_aspect)) )) = 1)) )) <= 5)) )) = 0);
    WR2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION'
         IN TYPEOF(pdr.used_representation)) AND
         (pdr.used_representation.name = 'row layout direction') ) ))
         = 1)) ))  = 0);
    WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION'
         IN TYPEOF(pdr.used_representation)) AND
         (pdr.used_representation.name = 'column layout direction')) ))
```

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```
     = 1)) )) = 0);
WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
     'DEFINITION') | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND
     ('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND
     ('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN( pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
```

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```
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'row spacing')) )) = 1)) ))
         = 0)) )) = 0);
    WR9: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'column spacing'))))= 1)) ))
         = 0)) )) = 0);
   wr10: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.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_relationships**.

**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_items** in its set of **items**.

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**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.

### 5.2.3.1.92 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY removal_volume
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         '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,
```

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```
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'shape volume occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'volume shape usage') AND
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (sdr.relating_shape_aspect.description = 'volume shape') )) = 1)) ))
         = 1)) )) = 0);
END_ENTITY; -- removal_volume
(*
```

Formal propositions:

**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

### 5.2.3.1.93 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.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')
         | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
```

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```
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
         used_representation)) ))  = 1)) )) = 0);
    WR2: (SIZEOF(QUERY ( fcr <* QUERY ( sar <*
         USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATING_SHAPE_ASPECT') |
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar)) ) |
         ((SIZEOF(['INTEGRATED_CNC_SCHEMA.REPLICATE_FEATURE',
         'INTEGRATED_CNC_SCHEMA.INSTANCED_FEATURE'] *
         TYPEOF(fcr.related_shape_aspect)) >= 1) AND
         (fcr.name = 'pattern basis')) )) = 1);
    WR3: ((SIZEOF(QUERY ( sar <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATING_SHAPE_ASPECT') |
         (NOT
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar))) )) +
         SIZEOF(QUERY ( sar <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
         + 'RELATED_SHAPE_ASPECT') |
         (NOT
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF(sar))) ))) = 0);
END_ENTITY;  -- replicate_feature
(*
```

Formal propositions:

**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_relationships** only if they are of type **feature_component_relationship** or **shape_defining_relationship**.

## 5.2.3.1.94 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**, **partial_circular_profile**, **open_path_profile**, or **open_profile** about an axis.

NOTE This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

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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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'radius')))) = 1)) ))
         = 0)) )) = 0);
    WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION'
         IN TYPEOF(pdr.used_representation)) AND
         (pdr.used_representation.name = 'removal direction')) )) = 1)) ))
         = 0);
    WR5: ((NOT (SELF\characterized_object.description = 'open profile')) OR
         (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'outer edge shape occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'profile usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
```

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```
        IN TYPEOF(sar))) ) |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')|
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        (( sa_occ.description = 'flat edge shape occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'profile usage') AND
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((sa_occ.description = 'rounded edge shape occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'profile usage') AND
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((sa_occ.description = 'sweep occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'profile usage') AND
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        ((SIZEOF(['INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
        'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
```

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```
         'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
         'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
         'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
         'INTEGRATED_CNC_SCHEMA.OPEN_PATH_PROFILE'] *
         TYPEOF(sdr.relating_shape_aspect)) = 1) AND
         (sdr.relating_shape_aspect.description = 'sweep')) )) = 1)) ))
         = 1)) )) = 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'.

**WR4**: 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'.

**WR5**: 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'.

**WR6**: 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'.

**WR7**: 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'.

Informal propositions:

**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.

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**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**.

### 5.2.3.1.95 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 This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

EXPRESS specification:

```
*)
ENTITY rib_top
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (sa_occ.description = 'rib top condition occurrence') AND
         (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (sar.description = 'rib top usage') AND
```

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```
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF (sar))) |
         'INTEGRATED_CNC_SCHEMA.RIB_TOP_FLOOR'
         IN TYPEOF (sdr.relating_shape_aspect))) = 1))) = 1))) = 0;
    WR2: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation))AND
         (pdr.used_representation.name = 'removal direction'))) = 1))) = 1;
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'.

## 5.2.3.1.96 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 This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

EXPRESS specification:

```
*)
ENTITY rib_top_floor
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: 'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
         TYPEOF (SELF.of_shape.definition);
    WR2: SELF.description IN ['planar', 'complex'];
    WR3: SIZEOF (QUERY (fcr <* QUERY (sar <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') |
         (sar.description = 'rib top usage') AND
         ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
         IN TYPEOF (sar))) |
         (fcr.related_shape_aspect.description =
         'rib top condition occurrence')
         AND
```

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```
         ('INTEGRATED_CNC_SCHEMA.RIB_TOP' IN TYPEOF
         (fcr.related_shape_aspect.of_shape.definition)))) >= 1;
    WR4: (NOT (SELF.description = 'complex')) OR
         (SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF (pd)) |
         NOT (SIZEOF (QUERY (sa_occ <* USEDIN (pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         (sa_occ.description = 'boundary occurrence') AND
         (SIZEOF (QUERY (sdr <* QUERY (sar <* USEDIN (sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         (sar.description = 'profile usage') AND
         ('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP'
         IN TYPEOF (sar))) |
         (SIZEOF (['INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
         'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
         'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
         'INTEGRATED_CNC_SCHEMA.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'.

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**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.

### 5.2.3.1.97 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. A **round_hole** may have a change in diameter which is represented by a taper.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY round_hole
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')|
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'diameter occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'profile usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE'
         IN TYPEOF(sdr.relating_shape_aspect)) AND
         (sdr.name = 'diameter'))  )) = 1)) )) = 1)) )) = 0);
    WR2: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
```

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```
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'hole depth occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'path feature component usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'bottom condition occurrence') AND
         (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'hole bottom usage') AND
         (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         ('INTEGRATED_CNC_SCHEMA.HOLE_BOTTOM'
         IN TYPEOF(fcr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    WR4: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'change in diameter occurrence') AND
         (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'taper usage') AND
         (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         ('INTEGRATED_CNC_SCHEMA.TAPER'
         IN TYPEOF(fcr.relating_shape_aspect)) )) = 1)) )) <= 1)) )) = 0);
    WR5: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation))) = 1))) = 0;
END_ENTITY; -- round_hole
(*
```

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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**.

## 5.2.3.1.98 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
```

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```
ENTITY rounded_end
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'partial circular boundary occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'profile usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE'
         IN TYPEOF(sdr.relating_shape_aspect)) ) )) = 1)) )) = 1)) )) = 0);
    WR3: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'course of travel occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'path feature component usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.PATH_FEATURE_COMPONENT'
         IN TYPEOF(sdr.relating_shape_aspect)) AND
         (sdr.relating_shape_aspect.description = 'linear')) )) = 1)) ))
         = 1)) )) = 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_**

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**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'.

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**.

## 5.2.3.1.99 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
    WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         (('INTEGRATED_CNC_SCHEMA.PLACEMENT'
         IN TYPEOF(it)) AND (it.name = 'orientation')) )) = 1)) ))
         = 0)) )) = 0);
    WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF(it)) = 2) AND (it.name = 'width'))))= 1))))= 0))))= 0);
    WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation))AND
         (pdr.used_representation.name = 'profile limit'))) <= 1))) = 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 exactly two **representation_items** 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'.

**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'.

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

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.

## 5.2.3.1.100 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**.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

## 5.2.3.1.101 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([
         'INTEGRATED_CNC_SCHEMA.PLACEMENT',
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'] *
         TYPEOF(it)) = 1)) )) = 0);
```

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```
END_ENTITY; -- shape_representation_with_parameters
(*
```

Formal propositions:

**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**.

## 5.2.3.1.102 side_milling_operation

A **side_milling_operation** is a **milling_type_operation** that represents a 2.5D milling step in which material is removed parallel to the cutting tool axis. See the ARM definitions for Side_milling_operation and subtypes in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY side_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['rough milling','finish milling']);

  WR2:  (verify_optional_action_property   (SELF, 'axial cutting depth')) AND
        (verify_length_measure_action_property (SELF, 'axial cutting depth'));

  WR3:  (verify_optional_action_property   (SELF, 'radial cutting depth')) AND
        (verify_length_measure_action_property (SELF, 'radial cutting depth'));

  WR4:  (verify_optional_action_property        (SELF, 'allowance side')) AND
        (verify_length_measure_action_property  (SELF, 'allowance side'));

  WR5:  NOT (SELF.description = 'rough milling') OR
        (verify_required_action_property (SELF, 'allowance side'));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **description** of the **side_milling_operation** shall be either 'rough milling' or 'finish milling'.

**WR2**: The **side_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'axial cutting depth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

**WR3**: The **side_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'radial cutting depth', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

**WR4**: The **side_milling_operation** shall be the **definition** of at most one **action_property** with a **name** of 'allowance side', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit.**

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**WR5**: If the **description** of the **side_milling_operation** is 'rough milling', the **side_milling_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'allowance side'.

NOTE This corresponds to local constraint **WR1** on the ARM entity **Side_rough_milling** in ISO 14649-11.

### 5.2.3.1.103 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY slot
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'swept shape occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'profile usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         ((SIZEOF(['INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
         'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
         'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
         'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
         'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
         'INTEGRATED_CNC_SCHEMA.OPEN_PATH_PROFILE'] *
         TYPEOF(sdr.relating_shape_aspect)) = 1)) )) = 1)) ))
         = 1)) )) = 0);
```

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```
    WR3: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'course of travel occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'path feature component usage') AND
         ((sar.name = 'course of travel') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) )) |
         ('INTEGRATED_CNC_SCHEMA.PATH_FEATURE_COMPONENT'
         IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    WR4: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'end condition occurrence') AND
         (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'slot end usage') AND
         (sar.name IN ['course of travel start','course of travel end']) AND
         (('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.SLOT_END'
         IN TYPEOF(fcr.relating_shape_aspect)) )  ))
         = 1)) )) = 2)) )) = 0);
END_ENTITY; -- slot
(*
```

Formal propositions:

**WR1**: The implicit representation of the **slot** shall contain exactly one **representation_items** 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 exactly two **shape_aspects** with a **description** of 'end condition occurrence' that are each the **related_shape_aspect** in exactly one **feature_component_rela-**

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**tionship** with a **description** of 'slot end usage' and a **relating_shape_aspect** that references a **slot_end** with a **description** of 'end condition'.

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**.

## 5.2.3.1.104 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY slot_end
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF(SELF.of_shape.definition));
    WR2: (SELF.description IN ['open','radiused','flat','woodruff']);
    WR3: ((NOT (SELF.description IN ['open','radiused'])) OR
         (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
```

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```
     IN TYPEOF(pdr.used_representation)) )) = 0)) )) = 0));
WR4: ((NOT (SELF.description IN ['flat','woodruff'])) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
WR5: ((NOT (SELF.description IN ['flat'])) OR
     (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     '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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

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```
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        '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,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATING_SHAPE_ASPECT') |
        ((sar.description = 'slot end usage') AND
        (sar.name IN ['course of travel start','course of travel end']) AND
        ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
        IN TYPEOF(sar))) ) |
        ((fcr.related_shape_aspect.description='end condition occurrence')
        AND
        ('INTEGRATED_CNC_SCHEMA.SLOT'
        IN TYPEOF(fcr.related_shape_aspect.of_shape.definition))) ))
        >= 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', or 'woodruff'.

**WR3**: If the **description** of the **slot_end** is 'open' 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**.

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**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', 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.

## 5.2.3.1.105 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY spherical_cap
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
```

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

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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.

## 5.2.3.1.106 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY square_u_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: 'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION'
         IN TYPEOF (SELF.of_shape.definition);
    WR2: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation))) = 1))) = 0;
    WR3: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation)) |
         (NOT (SIZEOF (impl_rep.used_representation.items) >= 4)
         AND  (SIZEOF (impl_rep.used_representation.items) <= 6))))
         = 0))) = 0;
    WR4: SIZEOF( QUERY( pd <* USEDIN( SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd, 'INTEGRATED_CNC_SCHEMA.' +
```

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```
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     ('INTEGRATED_CNC_SCHEMA.'+
     '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') ))
      = SIZEOF(pdr.used_representation.items)) )) = 1 )) = 1;
WR5: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     ('INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF (it)) AND
     (it.name = 'orientation'))) = 1))) = 0))) = 0;
WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF (it)) = 2) AND
     (it.name = 'width'))) = 1))) = 0))) = 0;
WR7: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
     TYPEOF (it)) = 2) AND
     (it.name = 'first radius'))) <= 1))) = 0))) = 0;
WR8: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

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```
         NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation)) |
         NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
         (SIZEOF
         (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
         TYPEOF (it)) = 2) AND
         (it.name = 'second radius'))) <= 1))) = 0))) = 0;
    WR9: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation)) |
         NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
         (SIZEOF
         (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
         TYPEOF (it)) = 2) AND
         (it.name = 'first angle'))) = 1))) = 0))) = 0;
   WR10: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS'
         IN TYPEOF (pdr.used_representation)) |
         NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
         (SIZEOF
         (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
         TYPEOF (it)) = 2) AND
         (it.name = 'second angle'))) = 1))) = 0))) = 0;
   WR11: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
         'DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation))AND
         (pdr.used_representation.name = 'profile limit'))) <= 1))) = 0;
END_ENTITY; -- square_u_profile
(*
```

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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 six **representation_items** in its set of **items**.

**WR4**: The implicit representation of a **square_u_profile** shall contain only **representation_items** in its set of **items** with a **name** of 'orientation','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'.

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.

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### 5.2.3.1.107 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY step
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'course of travel occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'path feature component usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
         (('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
         IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
         ((sa_occ.description = 'removal boundary occurrence') AND
         (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') |
         ((sar.description = 'profile usage') AND
         (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
         IN TYPEOF(sar))) ) |
```

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```
        ('INTEGRATED_CNC_SCHEMA.VEE_PROFILE'
        IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
END_ENTITY; -- step
(*
```

Formal propositions:

**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**.

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**.

## 5.2.3.1.108 surface_texture_representation

A **surface_texture_representation** is a type of **representation** that represents a surface texture such as roughness or waviness. The kind of surface texture that is represented is given in the names of the **representation_items**. The method or standard according to which the surface texture is represented is specified in the description of the **descriptive_representation_item**.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-214.

EXPRESS specification:

```
*)
ENTITY surface_texture_representation
  SUBTYPE OF (representation);
END_ENTITY;
(*
```

## 5.2.3.1.109 taper

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

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

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EXPRESS specification:

```
*)
ENTITY taper
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: ('INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) )) = 1)) )) = 0);
    WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
```

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```
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.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'.

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**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 propositions:

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

## 5.2.3.1.110 tapping_operation

A **tapping_operation** is a type of **drilling_type_operation** that represents the details of a drilling step in which in internal threads are cut. See the ARM definitions for Tapping and Thread_drilling in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY tapping_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['tapping','thread drilling']);

  WR2:  NOT (SELF.description = 'tapping') OR
        ((verify_required_action_property    (SELF, 'compensation chuck')) AND
         (verify_enumeration_action_property (SELF, 'compensation chuck',
          ['compensation chuck used', 'compensation chuck not used']));

  WR3:  NOT (SELF.description = 'thread drilling') OR
        ((verify_required_action_property
           (SELF, 'helical movement on forward')) AND
         (verify_enumeration_action_property
           (SELF, 'helical movement on forward',
             ['helical movement on forward',
              'no helical movement on forward']));
END_ENTITY;
(*
```

Formal propositions:

**WR1**: The **description** of the **tapping_operation** shall be either 'tapping' or 'thread drilling'.

**WR2**: If the **description** of the **tapping_operation** is 'tapping', the **tapping_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'compensation chuck', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of either 'compensation chuck used' or 'compensation chuck not used'.

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**WR2**: If the **description** of the **tapping_operation** is 'thread drilling', the **tapping_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'helical movement on forward', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of either 'helical movement on forward' or 'no helical movement on forward'.

### 5.2.3.1.111 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
        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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        ('INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF (it)) AND
        (it.name = 'orientation'))) = 1))) = 0))) = 0;
    WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND  (it.name = 'width'))) = 1))) = 0))) = 0;
    WR7: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'depth'))) = 1))) = 0))) = 0;
    WR8: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
```

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```
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'cross bar width'))) = 1)))
        = 0))) = 0;
 WR9: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'cross bar depth'))) = 1)))
        = 0))) = 0;
WR10: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'first offset'))) = 1)))
        = 0))) = 0;
WR11: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'second offset'))) = 1)))
        = 0))) = 0;
WR12: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
```

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```
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'first angle'))) = 1)))
        = 0))) = 0;
   WR13: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'second angle'))) = 1)))
        = 0))) = 0;
   WR14: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS'
        IN TYPEOF (pdr.used_representation)) |
        NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
        (SIZEOF
        (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND (it.name = 'radius'))) <= 1))) = 0))) = 0;
   WR15: SIZEOF (QUERY (pd <* USEDIN (SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
        'DEFINITION') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION'
        IN TYPEOF (pdr.used_representation))AND
        (pdr.used_representation.name = 'profile limit'))) <= 1))) = 0;
END_ENTITY;  -- tee_profile
(*
```

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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_items** in its set of items.

**WR4**: The implicit representation of a **tee_profile** shall contain only **representation_items** 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'.

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**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.

### 5.2.3.1.112 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

```
*)
ENTITY thread
  SUBTYPE OF (feature_definition);
  WHERE
    WR1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ((('INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         (('INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS')
         IN TYPEOF(pdr.used_representation)) ) |
         (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
         ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']
         * TYPEOF(it)) = 2) AND (it.name = 'major diameter')) )) = 1)) ))
         = 0)) )) = 0);
    WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
```

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```
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']
     * TYPEOF(it)) = 2) AND (it.name = 'minor diameter')) ))
     <= 1)) )) = 0)) )) = 0);
WR4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN( pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']
     * TYPEOF(it)) = 2) AND (it.name = 'pitch diameter')) )) = 1)) ))
     = 0)) )) = 0);
WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT'] *
     TYPEOF(it)) = 2) AND (it.name = 'number of threads')) ))
     = 1)) )) = 0)) )) = 0);
WR6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN( pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND (it.name = 'fit class')) )) = 1)) )) = 0)) ))
     = 0);
WR7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
```

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```
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'form')) )) = 1)) )) = 0)) ))
        = 0);
   WR8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN( pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'qualifier')) )) <= 1)) ))
        = 0)) )) = 0);
  WR10: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN( pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        (('INTEGRATED_CNC_SCHEMA.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,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
        'INTEGRATED_CNC_SCHEMA.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_REPRESENTATION_WITH_PARAMETERS')
```

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```
        IN TYPEOF(pdr.used_representation)) ) |
        (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
        ((SIZEOF([
        'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
        'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']
        * TYPEOF(it)) = 2) AND (it.name = 'crest')) )) <= 1)) ))
        = 0)) )) = 0);
   WR12: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) |
        (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((sa_occ.description = 'partial area occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
        + 'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'applied area usage') AND
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        ('INTEGRATED_CNC_SCHEMA.APPLIED_AREA'
        IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
   WR13: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) |
        (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
        + 'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'applied shape') AND
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT'
        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_ items**.

**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'.

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**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**.

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.

## 5.2.3.1.113 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.

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NOTE This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

## 5.2.3.1.114 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 This definition is not used by this part of ISO 10303 but has been provided for harmonization with ISO 10303-224

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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         SIZEOF( QUERY( pdr <* USEDIN( pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.'+
         'SHAPE_REPRESENTATION_WITH_PARAMETERS' IN
         TYPEOF(pdr.used_representation)) AND
         ({6 <= SIZEOF(pdr.used_representation.items) <= 9}) )) = 1 )) = 1;
```

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```
WR3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
     IN TYPEOF(it)) AND
     ('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.'
     + 'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']
     * TYPEOF(it)) = 2) AND (it.name = 'major diameter'))))= 1)) ))
     = 0)) )) = 0);
WR5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
     'INTEGRATED_CNC_SCHEMA.'
     + 'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (('INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS')
     IN TYPEOF(pdr.used_representation)) ) |
     (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
     ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']
     * TYPEOF(it)) = 2) AND (it.name = 'nominal diameter')) )) = 1)) ))
     = 0)) )) = 0);
WR6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' +
     'DEFINITION') | (NOT (SIZEOF(QUERY ( impl_rep <*
     QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.'
     + 'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
     used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
     impl_rep.used_representation.items | ((SIZEOF([
     'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']
     * TYPEOF(it)) = 2) AND (it.name = 'tooth depth')) )) <= 1)) ))
```

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```
      = 0)) )) = 0);
 WR7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      ((SIZEOF([
      'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
      'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF(it)) = 2) AND (it.name = 'root fillet')) )) <= 1)) ))
      = 0)) )) = 0);
 WR8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
      ((SIZEOF([
      'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
      'INTEGRATED_CNC_SCHEMA.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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')
      | (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(
      pd,'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
      'INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
      used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
      impl_rep.used_representation.items | ((SIZEOF([
      'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
      'INTEGRATED_CNC_SCHEMA.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,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
      (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
      'INTEGRATED_CNC_SCHEMA.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      (('INTEGRATED_CNC_SCHEMA.' +
      'SHAPE_REPRESENTATION_WITH_PARAMETERS')
      IN TYPEOF(pdr.used_representation)) ) |
      (NOT (SIZEOF(QUERY ( it <* impl_rep.used_representation.items |
```

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```
        (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'helix hand')) )) = 1)) ))
        = 0)) )) = 0));
   WR11: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((sa_occ.description = 'partial area occurrence') AND
        (SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
        'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'applied area usage') AND
        (('INTEGRATED_CNC_SCHEMA.' +
        'SHAPE_DEFINING_RELATIONSHIP') IN TYPEOF(sar))) ) |
        ('INTEGRATED_CNC_SCHEMA.APPLIED_AREA'
        IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
   WR12: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) ) |
        (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') |
        ((SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
        'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.'
        + 'RELATED_SHAPE_ASPECT') |
        ((sar.description = 'applied shape') AND
        (('INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP')
        IN TYPEOF(sar))) ) |
        ('INTEGRATED_CNC_SCHEMA.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_ items**.

**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'.

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**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.

## 5.2.3.1.115 value_range

A **value_range** is a type of **compound_representation_item** that specifies a range of values defined by two **measure_representation_items**, one with a name of 'upper limit' and the other with a name of 'lower limit'.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-214.

EXPRESS specification:

```
*)
ENTITY value_range
  SUBTYPE OF (compound_representation_item);
```

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```
END_ENTITY;
(*
```

### 5.2.3.1.116 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 This definition has been harmonized with the equivalent definition in ISO 10303-224.

EXPRESS specification:

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

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```
     = SIZEOF(pdr.used_representation.items)) )) = 1 )) = 1;
WR5: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     ('INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF (it)) AND
     (it.name = 'orientation'))) = 1))) = 0))) = 0;
WR6: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     ('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
     IN TYPEOF (it)) AND
     ('INTEGRATED_CNC_SCHEMA.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,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
     TYPEOF (it)) = 2) AND
     (it.name = 'profile angle'))) = 1))) = 0))) = 0;
WR8: SIZEOF (QUERY (pd <* USEDIN (SELF,
     'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
     NOT (SIZEOF (QUERY (impl_rep <* QUERY (pdr <* USEDIN (pd,
     'INTEGRATED_CNC_SCHEMA.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     'INTEGRATED_CNC_SCHEMA.' +
     'SHAPE_REPRESENTATION_WITH_PARAMETERS'
     IN TYPEOF (pdr.used_representation)) |
     NOT (SIZEOF (QUERY (it <* impl_rep.used_representation.items |
     (SIZEOF
     (['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
     'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
     TYPEOF (it)) = 2) AND
     (it.name = 'tilt angle'))) = 1))) = 0))) = 0;
```

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```
    WR9: SIZEOF (QUERY (pd <* USEDIN (SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
         NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
         ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION'
         IN TYPEOF (pdr.used_representation))AND
         (pdr.used_representation.name = 'profile limit'))) <= 1))) = 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_items** in its set of **items**.

**WR4**: The implicit representation of an **vee_profile** shall contain only **representation_items** 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'.

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.

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#### 5.2.3.2 Integrated CNC imported entity modifications

#### 5.2.3.3 application_context

The base definition of the **application_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **application_context** entity:

— application_context_requires_ap_definition (See 5.2.4.1).

#### 5.2.3.4 application_protocol_definition

The base definition of the **application_protocol_definition** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **application_protocol_definition** entity:

— application_context_requires_ap_definition (See 5.2.4.1).

#### 5.2.3.5 approval

The base definition of the **approval** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **approval** entity:

— approval_requires_approval_date_time (See 5.2.4.2);

— approval_requires_approval_person_organization (See 5.2.4.3);

— approval_requires_assignment (See 5.2.4.4).

#### 5.2.3.6 approval_assignment

The base definition of the **approval_assignment** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

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Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **approval_assignment** entity:

— approval_requires_assignment (See 5.2.4.4).

### 5.2.3.7 approval_date_time

The base definition of the **approval_date_time** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **approval_date_time** entity:

— approval_requires_approval_date_time (See 5.2.4.2).

### 5.2.3.8 approval_person_organization

The base definition of the **approval_person_organization** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **approval_person_organization** entity:

— approval_requires_approval_person_organization (See 5.2.4.3).

### 5.2.3.9 approval_status

The base definition of the **approval_status** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **approval_status** entity:

— dependent_instantiable_approval_status (See 5.2.4.5).

### 5.2.3.10 named_unit

The base definition of the **named_unit** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

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Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **named_unit** entity:

— dependent_instantiable_named_unit (See 5.2.4.6).

### 5.2.3.11 numeric_variable

The base definition of the **numeric_variable** entity is given in ISO 13584-20. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **numeric_variable** entity:

— nc_variable_compatible_initial_value (See 5.2.4.11).

### 5.2.3.12 process_product_association

The base definition of the **process_product_association** entity is given in ISO 10303-49. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **process_product_association** entity:

— machining_project_requires_workplan (See 5.2.4.9).

### 5.2.3.13 product

The base definition of the **product** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **product** entity:

— product_requires_version (See 5.2.4.12).

### 5.2.3.14 product_definition_formation

The base definition of the **product_definition_formation** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

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Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **product_definition_formation** entity:

— machining_project_requires_owner (See 5.2.4.7);

— machining_project_requires_release_date (See 5.2.4.8);

— machining_project_requires_workplan (See 5.2.4.9);

— machining_setup_requires_security_plane (See 5.2.4.10);

— product_requires_version (See 5.2.4.12).

### 5.2.3.15 property_definition

The base definition of the **property_definition** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **property_definition** entity:

— machining_setup_requires_security_plane (See 5.2.4.10).

### 5.2.3.16 representation_item_relationship

The base definition of the **representation_item_relationship** entity is given in ISO 10303-43. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **representation_item_relationship** entity:

— nc_variable_compatible_initial_value (See 5.2.4.11).

### 5.2.3.17 security_classification

The base definition of the **security_classification** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

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Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **security_classification** entity:

— security_classification_requires_assignment (See 5.2.4.13).

### 5.2.3.18 security_classification_assignment

The base definition of the **security_classification_assignment** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **security_classification_assignment** entity:

— security_classification_requires_assignment (See 5.2.4.13).

## 5.2.4 Integrated CNC rules

### 5.2.4.1 application_context_requires_ap_definition

The **application_context_requires_ap_definition** rule specifies that each instance of **application_context** shall be referenced by exactly one **application_protocol_definition** that specifies this part of ISO 10303.

EXPRESS specification:

```
*)
RULE application_context_requires_ap_definition FOR
  (application_context, application_protocol_definition);
WHERE
  WR1:  (0 = SIZEOF (QUERY (ac <* application_context | NOT
           (1 = SIZEOF (QUERY (apd <* application_protocol_definition |
                (apd.application :=: ac) AND
                (apd.application_interpreted_model_schema_name =
                 'integrated_cnc_schema'))))
        )));
END_RULE;
(*
```

Argument definitions:

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

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

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Formal propositions:

**WR1**: For each instance of **application_context**, there shall be exactly one instance of **application_protocol_definition** that references the instance of **application_context** as its **application** with a value of 'integrated_cnc_schema' as its **application_interpreted_model_schema_name**.

### 5.2.4.2 approval_requires_approval_date_time

The **approval_requires_approval_date_time** rule specifies that each instance of **approval** shall be referenced by exactly one **approval_date_time**.

EXPRESS specification:

```
*)
RULE approval_requires_approval_date_time FOR
  (approval, approval_date_time);
WHERE
  WR1:  (0 = SIZEOF (QUERY (app <* approval | NOT
           (1 = SIZEOF (QUERY (adt <* approval_date_time |
               (app :=: adt.dated_approval))))
        )));
END_RULE;
(*
```

Argument definitions:

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

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

Formal propositions:

**WR1**: For each instance of **approval**, there shall be exactly one instance of **approval_date_time** in which the **approval** appears as the **dated_approval** attribute.

### 5.2.4.3 approval_requires_approval_person_organization

The **approval_requires_approval_person_organization** specifies that each instance of **approval** shall be referenced by at least one **approval_person_organization**.

EXPRESS specification:

```
*)
RULE approval_requires_approval_person_organization FOR
  (approval, approval_person_organization);
WHERE
  WR1:  (0 = SIZEOF (QUERY (app <* approval | NOT
           (1 <= SIZEOF (QUERY (apo <* approval_person_organization |
               (app :=: apo.authorized_approval))))
        )));
```

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```
END_RULE;
(*
```

Argument definitions:

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

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

Formal propositions:

**WR1**: For each instance of **approval**, there shall be at least one instance of **approval_person_organization** in which the **approval** appears as the **authorized_approval**.

### 5.2.4.4 approval_requires_assignment

The **approval_requires_assignment** specifies that each instance of **approval** shall be referenced by at least one **approval_assignment**.

EXPRESS specification:

```
*)
RULE approval_requires_assignment FOR
  (approval, approval_assignment);
WHERE
  WR1:  (0 = SIZEOF (QUERY (app <* approval | NOT
           (1 <= SIZEOF (QUERY (aa <* approval_assignment |
               (app :=: aa.assigned_approval))))
        )));
END_RULE;
(*
```

Argument definitions:

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

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

Formal propositions:

**WR1**: For each instance of **approval**, there shall be at least one instance of **approval_assignment** in which the **approval** appears as the **assigned_approval**.

### 5.2.4.5 dependent_instantiable_approval_status

The **dependent_instantiable_approval_status** rule specifies that each instance of **approval_status** is dependent on its usage to define another entity.

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EXPRESS specification:

```
*)
RULE dependent_instantiable_approval_status FOR (approval_status);
WHERE
  WR1:  (0 = SIZEOF (QUERY (ast <* approval_status | NOT
           (1 <= SIZEOF (USEDIN (ast, '')))
        )));
END_RULE;
(*
```

Argument definitions:

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

Formal propositions:

**WR1**: For each instance of **approval_status**, there shall be at least one reference to the **approval_status** instance from an attribute of another entity.

### 5.2.4.6 dependent_instantiable_named_unit

The **dependent_instantiable_named_unit** rule specifies that each instance of **named_unit** is dependent on its usage to define another entity.

EXPRESS specification:

```
*)
RULE dependent_instantiable_named_unit FOR (named_unit);
WHERE
  WR1:  (0 = SIZEOF (QUERY (nu <* named_unit | NOT
           (1 <= SIZEOF (USEDIN (nu, '')))
        )));
END_RULE;
(*
```

Argument definitions:

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

Formal propositions:

**WR1**: For each instance of **named_unit**, there shall be at least one reference to the **named_unit** instance from an attribute of another entity.

### 5.2.4.7 machining_project_requires_owner

The **machining_project_requires_owner** rule specifies that each instance of **product_definition_formation** that is categorized as a 'machining project' shall be assigned at most one **person_and_organization** with the role of 'owner'.

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EXPRESS specification:

```
*)
RULE machining_project_requires_owner FOR
  (product_definition_formation);
WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* product_definition_formation |
          -- it is machining project
          (0 < SIZEOF (QUERY (prpc <* USEDIN (pdf.of_product,
             'INTEGRATED_CNC_SCHEMA.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
               (prpc.name = 'machining project'))))  AND NOT

          -- it has at most one associated owner.
          (1 >= SIZEOF (QUERY (poa <* USEDIN (pdf,
             'INTEGRATED_CNC_SCHEMA.' +
             'APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT.ITEMS') |
               (poa.role.name = 'owner'))))
        )));
END_RULE;
(*
```

Argument definitions:

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

Formal propositions:

**WR1**: If a **product_definition_formation** refers to a **product** that is referenced by an instance of **product_related_product_category** with a name of 'machining project', the **product_definition_formation** shall appear in the **items** set of at most one instance of **applied_person_and_organization_assignment product_definition_formation** in which **role** refers to a **person_and_organization_role** with a **name** of 'owner'.

### 5.2.4.8 machining_project_requires_release_date

The **machining_project_requires_release_date** rule specifies that each instance of **product_definition_formation** that is categorized as a 'machining project' shall be assigned at most one **date_and_time** with the role of 'release date'.

EXPRESS specification:

```
*)
RULE machining_project_requires_release_date FOR
  (product_definition_formation);
WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* product_definition_formation |
          -- it is machining project
          (0 < SIZEOF (QUERY (prpc <* USEDIN (pdf.of_product,
             'INTEGRATED_CNC_SCHEMA.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
```

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```
               (prpc.name = 'machining project'))))  AND NOT

          -- it has at most one associated release date.
          (1 >= SIZEOF (QUERY (dta <* USEDIN (pdf,
             'INTEGRATED_CNC_SCHEMA.' +
             'APPLIED_DATE_AND_TIME_ASSIGNMENT.ITEMS') |
               (dta.role.name = 'release date'))))
        )));
END_RULE;
(*
```

Argument definitions:

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

Formal propositions:

**WR1**: If a **product_definition_formation** refers to a **product** that is referenced by an instance of **product_related_product_category** with a name of 'machining project', the **product_definition_formation** shall appear in the **items** set of at most one instance of **applied_date_and_time_assignment product_definition_formation** in which **role** refers to a **date_and_time_role** with a **name** of 'release date'.

### 5.2.4.9 machining_project_requires_workplan

The **machining_project_requires_workplan** rule specifies that each instance of **product_definition_formation** that is categorized as a 'machining project' shall be associated with exactly one **machining_workplan**.

EXPRESS specification:

```
*)
RULE machining_project_requires_workplan FOR
  (product_definition_formation, process_product_association);
WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* product_definition_formation |
          -- it is machining project
          (0 < SIZEOF (QUERY (prpc <* USEDIN (pdf.of_product,
             'INTEGRATED_CNC_SCHEMA.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
               (prpc.name = 'machining project'))))  AND NOT

          -- it has one associated workplan.
          (1 = SIZEOF (QUERY (ppa <* process_product_association |
             (ppa.process.name = 'machining') AND
             (ppa.defined_product.formation = pdf) AND
             ('INTEGRATED_CNC_SCHEMA.MACHINING_WORKPLAN'
               IN TYPEOF (ppa.process.chosen_method)))))
        )));
END_RULE;
(*
```

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Argument definitions:

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

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

Formal propositions:

**WR1**: If a **product_definition_formation** refers to a **product** that is referenced by an instance of **product_related_product_category** with a name of 'machining project', then exactly one **process_product_association** in which the **process** shall have a **name** of 'machining' and a **chosen_method** of type **machining_workplan**, shall refer to the **product_definition_formation**.

### 5.2.4.10 machining_setup_requires_security_plane

The **machining_setup_requires_security_plane** rule specifies that each instance of **product_definition_formation** that is categorized as a 'machining setup' shall be associated with exactly one security plane **property_definition**.

EXPRESS specification:

```
*)
RULE machining_setup_requires_security_plane FOR
  (product_definition_formation, property_definition);
WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* product_definition_formation |
          -- it is machining setup
          (0 < SIZEOF (QUERY (prpc <* USEDIN (pdf.of_product,
             'INTEGRATED_CNC_SCHEMA.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
               (prpc.name = 'machining setup'))))  AND NOT

          -- it has one associated security plane.
          (1 = SIZEOF (QUERY (pd <* property_definition |
             (pd.name = 'security plane') AND
             (pd.definition.formation = pdf) )))
        )));
END_RULE;
(*
```

Argument definitions:

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

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

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Formal propositions:

**WR1**: If a **product_definition_formation** refers to a **product** that is referenced by an instance of **product_related_product_category** with a name of 'machining setup', then exactly one **property_definition** with a **name** of 'security plane' shall refer to the **product_definition_formation**.

### 5.2.4.11 nc_variable_compatible_initial_value

The **nc_variable_compatible_initial_value** rule specifies that each instance of **numeric_variable** shall be associated with at most one initial value, given by a **literal_value**. Furthermore, the initial value shall be of type **int_literal** if the **numeric_variable** is of type **int_numeric_variable**, and of type **real_literal** if the **numeric_variable** is of type **real_numeric_variable**.

EXPRESS specification:

```
*)
RULE nc_variable_compatible_initial_value FOR
  (numeric_variable, representation_item_relationship);
WHERE
  -- each nc_variable has at most one one initial value
  WR1: (0 = SIZEOF (QUERY (nv <* numeric_variable | NOT
            (1 >= SIZEOF (QUERY (rir <* representation_item_relationship |
                   (rir.description = 'initial value')  AND
                   (rir.relating_representation_item = nv)))))));


  -- the types on either side of the initial value relationship must match
  -- each nc_variable has at most one one initial value
  WR2: (0 = SIZEOF (QUERY (rir <* representation_item_relationship |
            (rir.description = 'initial value')  AND NOT
            ((('INTEGRATED_CNC_SCHEMA.INT_NUMERIC_VARIABLE'
                IN TYPEOF (rir.relating_representation_item)) AND
              ('INTEGRATED_CNC_SCHEMA.INT_LITERAL'
                IN TYPEOF (rir.related_representation_item)))
             OR
            ((('INTEGRATED_CNC_SCHEMA.REAL_NUMERIC_VARIABLE'
                IN TYPEOF (rir.relating_representation_item)) AND
              ('INTEGRATED_CNC_SCHEMA.REAL_LITERAL'
                IN TYPEOF (rir.related_representation_item)))))))));
END_RULE;
(*
```

Argument definitions:

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

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

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Formal propositions:

**WR1**: Each instance of **numeric_variable** shall appear as **relating** in at most one **representation_item_relationship** in which the **name** is 'initial value'.

**WR2**: Each instance **representation_item_relationship** in which the **name** is 'initial value' shall have either **relating** of type **int_numeric_variable** and **related** of type **int_literal** or **relating** of type **real_numeric_variable** and **related** of type **real_literal**.

### 5.2.4.12 product_requires_version

The **product_requires_version** rule specifies that each instance of **product** shall be referenced by at least one instance of **product_definition_formation**.

EXPRESS specification:

```
*)
RULE product_requires_version FOR (product, product_definition_formation);
WHERE
  WR1:  (0 = SIZEOF (QUERY (prod <* product  | NOT
           (1 <= SIZEOF (QUERY (pdf <* product_definition_formation |
               (prod :=: pdf.of_product))))
        )));
END_RULE;
(*
```

Argument definitions:

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

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

Formal propositions:

**WR1**: For each instance of **product**, there shall be at least one instance of **product_definition_formation** that contains an **of_product** attribute value equal to the **product**.

### 5.2.4.13 security_classification_requires_assignment

The **security_classification_requires_assignment** specifies that each instance of **security_classification** shall be referenced by at least one **security_classification_assignment**.

EXPRESS specification:

```
*)
RULE security_classification_requires_assignment FOR
  (security_classification, security_classification_assignment);
WHERE
  WR1:  (0 = SIZEOF (QUERY (sc <* security_classification  | NOT
           (1 <= SIZEOF (QUERY (sca <* security_classification_assignment |
```

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```
                (sc :=: sca.assigned_security_classification))))
        )));
END_RULE;
(*
```

Argument definitions:

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

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

Formal propositions:

**WR1**: For each instance of **security_classification**, there shall be at least one instance of **security_classification_assignment** in which the **security_classification** appears as the **assigned_security_classification**.

## 5.2.5 Integrated CNC functions

### 5.2.5.1 get_action_property

The **get_action_property** function returns the set of **action_property** instances that refer to the input **characterized_action_definition** and have a **name** equal to the input parameter **prop_name**.

EXPRESS specification:

```
*)
FUNCTION get_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): SET OF action_property;

    RETURN (bag_to_set (QUERY (ap <*
        USEDIN (cad, 'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY.DEFINITION') |
        (ap.name = prop_name))));
END_FUNCTION;
(*
```

Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to return.

**prop_name:** the string that appears as the **name** of the **action_property** instances to return.

### 5.2.5.2 get_related_amr

The **get_related_amr** function returns the set of **action_method_relationship** instances in which the input **action_method** appears as the **related_method**.

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EXPRESS specification:

```
*)
FUNCTION get_related_amr (am: action_method)
        : SET OF action_method_relationship;

    RETURN (bag_to_set (USEDIN (am,
       'INTEGRATED_CNC_SCHEMA.ACTION_METHOD_RELATIONSHIP.RELATED_METHOD')));
END_FUNCTION;
(*
```

Argument definitions:

**am:** the **action_method** that appears as the **related_method** of the **action_method_relationship** instances to return.

### 5.2.5.3 get_relating_amr

The **get_relating_amr** function returns the set of **action_method_relationship** instances in which the input **action_method** appears as the **relating_method**.

EXPRESS specification:

```
*)
FUNCTION get_relating_amr (am: action_method)
        : SET OF action_method_relationship;

    RETURN (bag_to_set (USEDIN (am,
       'INTEGRATED_CNC_SCHEMA.ACTION_METHOD_RELATIONSHIP.RELATING_METHOD')));
END_FUNCTION;
(*
```

Argument definitions:

**am:** the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to return.

### 5.2.5.4 get_resource_property

The **get_resource_property** function returns the set of **resource_property** instances that refer to the input **characterized_resource_definition** and have a **name** equal to the input parameter **prop_name**.

EXPRESS specification:

```
*)
FUNCTION get_resource_property (
        crd:            characterized_resource_definition;
        prop_name:      STRING
        ): SET OF resource_property;

    RETURN (bag_to_set (QUERY (rp <*
```

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```
        USEDIN (crd, 'INTEGRATED_CNC_SCHEMA.RESOURCE_PROPERTY.RESOURCE') |
        (rp.name = prop_name))));
END_FUNCTION;
(*
```

Argument definitions:

**crd:** the **characterized_resource_definition** that appears as the **resource** of the **resource_property** instances to return.

**prop_name:** the string that appears as the **name** of the **resource_property** instances to return.

### 5.2.5.5 verify_angle_measure_action_property

The **verify_angle_measure_action_property** function evaluates each **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **action_properties** have an associated **representation** in which the **items** set contains a **representation_item** that is of type **measure_representation_item** and **plane_angle_measure_with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_angle_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property(cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

### 5.2.5.6 verify_ball_endmill_edge_dimensions

The **verify_ball_endmill_edge_dimensions** function the **representation_items** in the **items** set of the input **machining_tool_dimension_representation** and returns true if and only if the 'edge center vertical', 'edge center horizontal', and 'edge radius' items meet certain value requirements.

EXPRESS specification:

```
*)
```

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```
FUNCTION verify_ball_endmill_edge_dimensions (
        rep:            machining_tool_dimension_representation
        ): BOOLEAN;

    LOCAL
      diameter : length_measure;
      dia_items : SET OF REPRESENTATION_ITEM :=
        QUERY (it <* rep.items | (it.name = 'diameter'));
    END_LOCAL;

    diameter := dia_items[1].value_component;

    RETURN
         ((0 = SIZEOF (QUERY ( it <* rep.items |
           (it.name = 'edge center horizontal') AND NOT
           (it.value_component = 0))))
          AND
          (0 = SIZEOF (QUERY ( it <* rep.items |
           (it.name = 'edge center vertical') AND NOT
           (it.value_component = diameter/2))))
          AND
          (0 = SIZEOF (QUERY ( it <* rep.items |
           (it.name = 'edge radius') AND NOT
           (it.value_component = diameter/2))))
          );
END_FUNCTION;
(*
```

Argument definitions:

**rep:** the **machining_tool_dimension_representation** to examine.

### 5.2.5.7 verify_descriptive_action_property

The **verify_descriptive_action_property** function evaluates each **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **action_properties** have an associated **representation** in which the **items** set contains a **representation_item** that is of type **descriptive_representation_item**.

EXPRESS specification:

```
*)
FUNCTION verify_descriptive_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property(cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']));
END_FUNCTION;
(*
```

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Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

### 5.2.5.8 verify_enumeration_action_property

The **verify_enumeration_action_property** function evaluates each **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **action_properties** have an associated **representation** in which the **items** set contains a **descriptive_representation_item** with a **description** value that appears in the **prop_values** set of strings.

EXPRESS specification:

```
*)
FUNCTION verify_enumeration_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING;
        prop_values:    SET OF STRING
        ): BOOLEAN;

    RETURN (0 = SIZEOF (QUERY (prop <* get_action_property (cad, prop_name) |
        NOT (
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |

           (0 < SIZEOF (QUERY (it <* prep.representation.items |
               (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
                (it.description IN prop_values))
           )))
        )))
    ))));
END_FUNCTION;
(*
```

Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

**prop_values:** the set of string values that the **description** attribute of a **descriptive_representation_item** is to be compared against.

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### 5.2.5.9 verify_length_measure_action_property

The **verify_length_measure_action_property** function evaluates each **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **action_properties** have an associated **representation** in which the **items** set contains a **representation_item** that is of type **measure_representation_item** and **length_measure_with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_length_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property (cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

### 5.2.5.10 verify_optional_action_property

The **verify_optional_action_property** function returns true if and only if there is at most one **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**.

EXPRESS specification:

```
*)
FUNCTION verify_optional_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (1 >= SIZEOF (get_action_property (cad, prop_name)));
END_FUNCTION;
(*
```

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Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

### 5.2.5.11 verify_optional_in_process_geometry

The **verify_optional_in_process_geometry** function returns true if and only if the input **machining_process_executable** satisfies the following conditions:

— the **machining_process_executable** is **definition** of at most one **action_property** with a **name** of 'as-is shape', and the **representation** used to describe the **action_property** is of type **advanced_brep_shape_representation**;

— the **machining_process_executable** is **definition** of at most one **action_property** with a **name** of 'to-be shape', and the **representation** used to describe the **action_property** is of type **advanced_brep_shape_representation**;

— the **machining_process_executable** is **definition** of at most one **action_property** with a **name** of 'removal shape', and the **representation** used to describe the **action_property** is of type **advanced_brep_shape_representation**.

EXPRESS specification:

```
*)
FUNCTION verify_optional_in_process_geometry (
        mpe:            machining_process_executable
        ): BOOLEAN;

    RETURN
      ((verify_optional_action_property (mpe, 'as-is shape')) AND
       (verify_optional_action_property (mpe, 'to-be shape')) AND
       (verify_optional_action_property (mpe, 'removal shape')) AND

        -- All properties need advanced brep shape reps
       (0 = SIZEOF (QUERY (prop <*
         USEDIN (mpe, 'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY.DEFINITION') |
         ((prop.name IN ['as-is shape', 'to-be shape', 'removal shape']) AND
          (0 = SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
             'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
             ('INTEGRATED_CNC_SCHEMA.ADVANCED_BREP_SHAPE_REPRESENTATION'
               IN TYPEOF (prep.representation))))))
          )))
      );
END_FUNCTION;
(*
```

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Argument definitions:

**mpe:** the **machining_process_executable** to examine.

### 5.2.5.12 verify_optional_relating_amr

The **verify_optional_relating_amr** function returns true if and only if there is at most one **action_method_relationship** in which the input **action_method** appears as the **relating_method** and the input parameter **prop_name** appears as the **name**.

EXPRESS specification:

```
*)
FUNCTION verify_optional_relating_amr (
        am:             action_method;
        rel_name:       STRING
        ): BOOLEAN;

    RETURN (1 >= SIZEOF (QUERY (amr <* get_relating_amr (am) |
                amr.name = rel_name)));
END_FUNCTION;
(*
```

Argument definitions:

**am:** the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

**rel_name:** the string that appears as the **name** of the **action_method_relationship** instances to examine.

### 5.2.5.13 verify_parameter_action_property

The **verify_time_measure_action_property** function evaluates each **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **action_properties** have an associated **representation** in which the **items** set contains a **measure_representation_item** with a **value_component** of type **parameter_value**.

EXPRESS specification:

```
*)
FUNCTION verify_parameter_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (0 = SIZEOF (QUERY (prop <* get_action_property (cad, prop_name) |
        NOT (
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
```

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```
                'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |

           (0 < SIZEOF (QUERY (it <* prep.representation.items |
               (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
                ('INTEGRATED_CNC_SCHEMA.PARAMETER_VALUE'
                  IN TYPEOF(it.value_component)))
           )))
        )))
    )));
END_FUNCTION;
(*
```

Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

### 5.2.5.14 verify_ratio_measure_action_property

The **verify_ratio_measure_action_property** function evaluates each **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **action_properties** have an associated **representation** in which the **items** set contains a **representation_item** that is of type **measure_representation_item** and **ratio_measure_with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_ratio_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property (cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

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### 5.2.5.15 verify_related_type_for_amr

The **verify_related_type_for_amr** function evaluates each **action_method_relationship** instances in which the input **action_method** appears as the **relating_method** and the **name** is equal to the input parameter **rel_name**. The function returns true if and only if all such **action_method_relationship** have a **related_method** that is of all types which appear in the **types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_related_type_for_amr (
        am:             action_method;
        rel_name:       STRING;
        types:          SET OF STRING
        ): BOOLEAN;

   RETURN  (0 = SIZEOF (QUERY (amr <* get_relating_amr (am) |
            (amr.name = rel_name) AND NOT
            (SIZEOF(types * TYPEOF(amr.related_method)) = SIZEOF(types))
        )));
END_FUNCTION;

(*
```

Argument definitions:

**am:** the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

**rel_name:** the string that appears as the **name** of the **action_method_relationship** instances to examine.

**types:** the set of type names.

### 5.2.5.16 verify_rep_item_for_action_property

The **verify_rep_item_for_action_property** function evaluates each **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **action_properties** have an associated **representation** in which the **items** set contains a **representation_item** that is of all types which appear in the **prop_ types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_rep_item_for_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING;
        prop_types:     SET OF STRING
        ): BOOLEAN;
```

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```
    -- All properties have matching representations.  The reason we test
    -- for "nothing matching the negation" rather than "something matching
    -- the positive" is so that we return true if there are no properties.
    RETURN (0 = SIZEOF (QUERY (prop <* get_action_property (cad, prop_name) |
        NOT (
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |

           (0 < SIZEOF (QUERY (it <* prep.representation.items |
               (SIZEOF(prop_types * TYPEOF(it)) = SIZEOF(prop_types))))
           )))
        ))
    )));
END_FUNCTION;
(*
```

Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

**prop_types:** the set of type names.

### 5.2.5.17 verify_required_action_property

The **verify_required_action_property** function returns true if and only if there is exactly one **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**.

EXPRESS specification:

```
*)
FUNCTION verify_required_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (1 = SIZEOF (get_action_property (cad, prop_name)));
END_FUNCTION;
(*
```

Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

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### 5.2.5.18 verify_required_relating_amr

The **verify_required_relating_amr** function returns true if and only if there is exactly one **action_method_relationship** in which the input **action_method** appears as the **relating_method** and the input parameter **prop_name** appears as the **name**.

EXPRESS specification:

```
*)
FUNCTION verify_required_relating_amr (
        am:             action_method;
        rel_name:       STRING
        ): BOOLEAN;

    RETURN (1 = SIZEOF (QUERY (amr <* get_relating_amr (am) |
                 amr.name = rel_name)));
END_FUNCTION;
(*
```

Argument definitions:

**am:** the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

**rel_name:** the string that appears as the **name** of the **action_method_relationship** instances to examine.

### 5.2.5.19 verify_time_measure_action_property

The **verify_time_measure_action_property** function evaluates each **action_property** that refers to the input **characterized_action_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **action_properties** have an associated **representation** in which the **items** set contains a **representation_item** that is of type **measure_representation_item** and **time_measure_with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_time_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property(cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.TIME_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

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Argument definitions:

**cad:** the **characterized_action_definition** that appears as the **definition** of the **action_property** instances to examine.

**prop_name:** the string that appears as the **name** of the **action_property** instances to examine.

*)
```
END_SCHEMA;
```

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# Annex A
(normative)

# AIM EXPRESS expanded listing

The following EXPRESS is the expanded form of the short form schema given in 5.2. In the event of any discrepancy between the short form and this expanded listing, the expanded listing shall be used.

```
SCHEMA integrated_cnc_schema;

CONSTANT
  dummy_gri : geometric_representation_item :=
        representation_item('') || geometric_representation_item();
  dummy_tri : topological_representation_item :=
        representation_item('') || topological_representation_item();
END_CONSTANT;

TYPE ahead_or_behind = ENUMERATION OF
  (ahead,
   exact,
   behind);
END_TYPE; -- 10303-41: date_time_schema

TYPE angle_relator = ENUMERATION OF
  (equal,
   large,
   small);
END_TYPE; -- 10303-47: shape_dimension_schema

TYPE approval_item = SELECT
  (action_method,
   action_method_relationship,
   action_property,
   material_designation,
   product_definition_formation,
   requirement_for_action_resource,
   resource_property);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE attribute_type = SELECT
  (label,
   text);
END_TYPE; -- 10303-41: management_resources_schema

TYPE axis2_placement = SELECT
  (axis2_placement_2d,
   axis2_placement_3d);
END_TYPE; -- 10303-42: geometry_schema

TYPE b_spline_curve_form = ENUMERATION OF
```

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```
  (polyline_form,
   circular_arc,
   elliptic_arc,
   parabolic_arc,
   hyperbolic_arc,
   unspecified);
END_TYPE; -- 10303-42: geometry_schema

TYPE b_spline_surface_form = ENUMERATION OF
  (plane_surf,
   cylindrical_surf,
   conical_surf,
   spherical_surf,
   toroidal_surf,
   surf_of_revolution,
   ruled_surf,
   generalised_cone,
   quadric_surf,
   surf_of_linear_extrusion,
   unspecified);
END_TYPE; -- 10303-42: geometry_schema

TYPE boolean_operand = SELECT
  (solid_model,
   csg_primitive);
END_TYPE; -- 10303-42: geometric_model_schema

TYPE characterized_action_definition = SELECT
  (action,
   action_method,
   action_method_relationship);
END_TYPE; -- 10303-49: process_property_schema

TYPE characterized_definition = SELECT
  (characterized_object,
   characterized_product_definition,
   shape_definition);
END_TYPE; -- 10303-41: product_property_definition_schema

TYPE characterized_material_property = SELECT
  (material_property_representation);
END_TYPE; -- 10303-45: material_property_definition_schema

TYPE characterized_product_definition = SELECT
  (product_definition,
   product_definition_relationship);
END_TYPE; -- 10303-41: product_property_definition_schema

TYPE characterized_resource_definition = SELECT
  (action_resource,
   action_resource_relationship,
   action_resource_requirement);
END_TYPE; -- 10303-49: process_property_schema
```

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```
TYPE compound_item_definition = SELECT
  (list_representation_item,
   set_representation_item);
END_TYPE; -- 10303-43: representation_schema

TYPE configuration_design_item = SELECT
  (product_definition,
   product_definition_formation);
END_TYPE; -- 10303-44: configuration_management_schema

TYPE context_dependent_measure = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE count_measure = NUMBER;
END_TYPE; -- 10303-41: measure_schema

TYPE csg_primitive = SELECT
  (block,
   right_circular_cylinder);
END_TYPE; -- 10303-42: geometric_model_schema

TYPE csg_select = SELECT
  (csg_primitive);
END_TYPE; -- 10303-42: geometric_model_schema

TYPE curve_on_surface = SELECT
  (pcurve,
   surface_curve,
   composite_curve_on_surface);
END_TYPE; -- 10303-42: geometry_schema

TYPE date_and_time_item = SELECT
  (approval_person_organization,
   approval_status,
   effectivity,
   material_designation,
   person_and_organization,
   product_definition_formation,
   security_classification,
   security_classification_level);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE date_time_or_event_occurrence = SELECT
  (date_time_select);
END_TYPE; -- 10303-41: date_time_schema

TYPE date_time_select = SELECT
  (date,
   local_time,
   date_and_time);
END_TYPE; -- 10303-41: date_time_schema

TYPE day_in_month_number = INTEGER;
WHERE
```

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```
  wr1: ((1 <= SELF) AND (SELF <= 31));
END_TYPE; -- 10303-41: date_time_schema

TYPE day_in_week_number = INTEGER;
WHERE
  wr1: ((1 <= SELF) AND (SELF <= 7));
END_TYPE; -- 10303-41: date_time_schema

TYPE day_in_year_number = INTEGER;
WHERE
  wr1: ((1 <= SELF) AND (SELF <= 366));
END_TYPE; -- 10303-41: date_time_schema

TYPE derived_property_select = SELECT
  (property_definition,
   action_property,
   resource_property);
END_TYPE; -- 10303-41: product_property_definition_schema

TYPE description_attribute_select = SELECT
  (application_context,
   approval_role,
   date_time_role,
   context_dependent_shape_representation,
   effectivity,
   external_source,
   person_and_organization_role,
   person_and_organization,
   property_definition_representation,
   representation);
END_TYPE; -- 10303-41: basic_attribute_schema

TYPE descriptive_measure = STRING;
END_TYPE; -- 10303-41: measure_schema

TYPE dimension_count = INTEGER;
WHERE
  wr1: (SELF > 0);
END_TYPE; -- 10303-42: geometry_schema

TYPE dimensional_characteristic = SELECT
  (dimensional_location,
   dimensional_size);
END_TYPE; -- 10303-47: shape_dimension_schema

TYPE document_reference_item = SELECT
  (action_method,
   externally_defined_feature_definition,
   material_designation,
   dimensional_characteristic_representation,
   property_definition);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE effectivity_item = SELECT
```

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```
  (action_method,
   action_method_relationship,
   action_property,
   material_designation,
   product_definition_formation,
   requirement_for_action_resource,
   resource_property);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE founded_item_select = SELECT
  (founded_item,
   representation_item);
END_TYPE; -- 10303-43: representation_schema

TYPE geometric_set_select = SELECT
  (point,
   curve,
   surface);
END_TYPE; -- 10303-42: geometric_model_schema

TYPE group_item = SELECT
  (instanced_feature,
   replicate_feature,
   transition_feature);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE hour_in_day = INTEGER;
WHERE
  wr1: ((0 <= SELF) AND (SELF < 24));
END_TYPE; -- 10303-41: date_time_schema

TYPE id_attribute_select = SELECT
  (action,
   address,
   product_category,
   property_definition,
   shape_aspect,
   shape_aspect_relationship,
   application_context,
   group,
   representation);
END_TYPE; -- 10303-41: basic_attribute_schema

TYPE identifier = STRING;
END_TYPE; -- 10303-41: support_resource_schema

TYPE knot_type = ENUMERATION OF
  (uniform_knots,
   quasi_uniform_knots,
   piecewise_bezier_knots,
   unspecified);
END_TYPE; -- 10303-42: geometry_schema

TYPE label = STRING;
```

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```
END_TYPE; -- 10303-41: support_resource_schema

TYPE length_measure = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE limit_condition = ENUMERATION OF
  (maximum_material_condition,
   least_material_condition,
   regardless_of_feature_size);
END_TYPE; -- 10303-47: shape_aspect_definition_schema

TYPE list_of_reversible_topology_item = LIST [0:?] OF
            reversible_topology_item;
END_TYPE; -- 10303-42: topology_schema

TYPE list_representation_item = LIST [1:?] OF representation_item;
END_TYPE; -- 10303-43: representation_schema

TYPE measure_value = SELECT
  (length_measure,
   time_measure,
   plane_angle_measure,
   solid_angle_measure,
   ratio_measure,
   parameter_value,
   context_dependent_measure,
   descriptive_measure,
   positive_length_measure,
   positive_plane_angle_measure,
   count_measure);
END_TYPE; -- 10303-41: measure_schema

TYPE minute_in_hour = INTEGER;
WHERE
  wr1: ((0 <= SELF) AND (SELF <= 59));
END_TYPE; -- 10303-41: date_time_schema

TYPE month_in_year_number = INTEGER;
WHERE
  wr1: ((1 <= SELF) AND (SELF <= 12));
END_TYPE; -- 10303-41: date_time_schema

TYPE name_attribute_select = SELECT
  (address,
   context_dependent_shape_representation,
   derived_unit,
   effectivity,
   person_and_organization,
   product_definition,
   property_definition_representation);
END_TYPE; -- 10303-41: basic_attribute_schema

TYPE parameter_value = REAL;
END_TYPE; -- 10303-41: measure_schema
```

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```
TYPE pcurve_or_surface = SELECT
  (pcurve,
   surface);
END_TYPE; -- 10303-42: geometry_schema

TYPE person_and_organization_item = SELECT
  (product_definition_formation);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE person_organization_select = SELECT
  (person,
   organization,
   person_and_organization);
END_TYPE; -- 10303-41: person_organization_schema

TYPE plane_angle_measure = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE positive_length_measure = length_measure;
WHERE
  wr1: (SELF > 0);
END_TYPE; -- 10303-41: measure_schema

TYPE positive_plane_angle_measure = plane_angle_measure;
WHERE
  wr1: (SELF > 0);
END_TYPE; -- 10303-41: measure_schema

TYPE preferred_surface_curve_representation = ENUMERATION OF
  (curve_3d,
   pcurve_s1,
   pcurve_s2);
END_TYPE; -- 10303-42: geometry_schema

TYPE process_or_process_relationship = SELECT
  (product_definition_process,
   property_process,
   relationship_with_condition);
END_TYPE; -- 10303-49: method_definition_schema

TYPE product_or_formation_or_definition = SELECT
  (product,
   product_definition_formation,
   product_definition);
END_TYPE; -- 10303-41: document_schema

TYPE property_or_shape_select = SELECT
  (property_definition,
   shape_definition);
END_TYPE; -- 10303-49: process_property_schema

TYPE ratio_measure = REAL;
END_TYPE; -- 10303-41: measure_schema
```

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```
TYPE relationship_with_condition = SELECT
  (action_method_relationship);
END_TYPE; -- 10303-49: method_definition_schema

TYPE represented_definition = SELECT
  (property_definition,
   shape_aspect,
   shape_aspect_relationship);
END_TYPE; -- 10303-41: product_property_representation_schema

TYPE reversible_topology = SELECT
  (reversible_topology_item,
   list_of_reversible_topology_item,
   set_of_reversible_topology_item);
END_TYPE; -- 10303-42: topology_schema

TYPE reversible_topology_item = SELECT
  (edge,
   path,
   face,
   face_bound,
   closed_shell,
   open_shell);
END_TYPE; -- 10303-42: topology_schema

TYPE role_select = SELECT
  (approval_assignment,
   approval_date_time,
   document_reference,
   effectivity_assignment,
   group_assignment,
   security_classification_assignment);
END_TYPE; -- 10303-41: basic_attribute_schema

TYPE second_in_minute = REAL;
WHERE
  wr1: ((0 <= SELF) AND (SELF <= 60));
END_TYPE; -- 10303-41: date_time_schema

TYPE security_classification_item = SELECT
  (product_definition_formation);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE set_of_reversible_topology_item = SET [0:?] OF
            reversible_topology_item;
END_TYPE; -- 10303-42: topology_schema

TYPE set_representation_item = SET [1:?] OF representation_item;
END_TYPE; -- 10303-43: representation_schema

TYPE shape_definition = SELECT
  (product_definition_shape,
   shape_aspect,
```

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```
   shape_aspect_relationship);
END_TYPE; -- 10303-41: product_property_definition_schema

TYPE shape_tolerance_select = SELECT
  (geometric_tolerance,
   plus_minus_tolerance);
END_TYPE; -- 10303-47: shape_tolerance_schema

TYPE shell = SELECT
  (open_shell,
   closed_shell);
END_TYPE; -- 10303-42: topology_schema

TYPE si_prefix = ENUMERATION OF
  (exa,
   peta,
   tera,
   giga,
   mega,
   kilo,
   hecto,
   deca,
   deci,
   centi,
   milli,
   micro,
   nano,
   pico,
   femto,
   atto);
END_TYPE; -- 10303-41: measure_schema

TYPE si_unit_name = ENUMERATION OF
  (metre,
   gram,
   second,
   ampere,
   kelvin,
   mole,
   candela,
   radian,
   steradian,
   hertz,
   newton,
   pascal,
   joule,
   watt,
   coulomb,
   volt,
   farad,
   ohm,
   siemens,
   weber,
   tesla,
```

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```
   henry,
   degree_celsius,
   lumen,
   lux,
   becquerel,
   gray,
   sievert);
END_TYPE; -- 10303-41: measure_schema

TYPE solid_angle_measure = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE source_item = SELECT
  (identifier);
END_TYPE; -- 10303-41: external_reference_schema

TYPE supported_item = SELECT
  (action,
   action_method);
END_TYPE; -- 10303-41: action_schema

TYPE surface_boundary = SELECT
  (boundary_curve,
   degenerate_pcurve);
END_TYPE; -- 10303-42: geometry_schema

TYPE surface_model = SELECT
  (shell_based_surface_model);
END_TYPE; -- 10303-42: geometric_model_schema

TYPE text = STRING;
END_TYPE; -- 10303-41: support_resource_schema

TYPE time_measure = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE tolerance_method_definition = SELECT
  (tolerance_value,
   limits_and_fits);
END_TYPE; -- 10303-47: shape_tolerance_schema

TYPE transformation = SELECT
  (item_defined_transformation,
   functionally_defined_transformation);
END_TYPE; -- 10303-43: representation_schema

TYPE transition_code = ENUMERATION OF
  (discontinuous,
   continuous,
   cont_same_gradient,
   cont_same_gradient_same_curvature);
END_TYPE; -- 10303-42: geometry_schema

TYPE trimming_preference = ENUMERATION OF
```

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```
  (cartesian,
   parameter,
   unspecified);
END_TYPE; -- 10303-42: geometry_schema

TYPE trimming_select = SELECT
  (cartesian_point,
   parameter_value);
END_TYPE; -- 10303-42: geometry_schema

TYPE unit = SELECT
  (named_unit,
   derived_unit);
END_TYPE; -- 10303-41: measure_schema

TYPE value_qualifier = SELECT
  (precision_qualifier,
   type_qualifier,
   uncertainty_qualifier);
END_TYPE; -- 10303-45: qualified_measure_schema

TYPE vector_or_direction = SELECT
  (vector,
   direction);
END_TYPE; -- 10303-42: geometry_schema

TYPE week_in_year_number = INTEGER;
WHERE
  wr1: ((1 <= SELF) AND (SELF <= 53));
END_TYPE; -- 10303-41: date_time_schema

TYPE year_number = INTEGER;
END_TYPE; -- 10303-41: date_time_schema

ENTITY action;
    name          : label;
    description   : OPTIONAL text;
    chosen_method : action_method;
  DERIVE
    id : identifier := get_id_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
              'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: action_schema

ENTITY action_method;
    name        : label;
    description : OPTIONAL text;
    consequence : text;
    purpose     : text;
END_ENTITY; -- 10303-41: action_schema

ENTITY action_method_relationship;
    name            : label;
```

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```
    description     : OPTIONAL text;
    relating_method : action_method;
    related_method  : action_method;
END_ENTITY; -- 10303-41: action_schema

ENTITY action_property;
    name        : label;
    description : text;
    definition  : characterized_action_definition;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY action_property_representation;
    name           : label;
    description    : text;
    property       : action_property;
    representation : representation;
END_ENTITY; -- 10303-49: process_property_representation_schema

ENTITY action_resource;
    name        : label;
    description : OPTIONAL text;
    usage       : SET [1:?] OF supported_item;
    kind        : action_resource_type;
END_ENTITY; -- 10303-41: action_schema

ENTITY action_resource_relationship;
    name              : label;
    description       : OPTIONAL text;
    relating_resource : action_resource;
    related_resource  : action_resource;
END_ENTITY; -- 10303-41: action_schema

ENTITY action_resource_requirement;
    name        : label;
    description : text;
    kind        : resource_requirement_type;
    operations  : SET [1:?] OF characterized_action_definition;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY action_resource_type;
    name : label;
END_ENTITY; -- 10303-41: action_schema

ENTITY address;
    internal_location       : OPTIONAL label;
    street_number           : OPTIONAL label;
    street                  : OPTIONAL label;
    postal_box              : OPTIONAL label;
    town                    : OPTIONAL label;
    region                  : OPTIONAL label;
    postal_code             : OPTIONAL label;
    country                 : OPTIONAL label;
    facsimile_number        : OPTIONAL label;
    telephone_number        : OPTIONAL label;
```

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```
    electronic_mail_address : OPTIONAL label;
    telex_number            : OPTIONAL label;
  DERIVE
    name : label := get_name_value(SELF);
    url  : identifier := get_id_value(SELF);
  WHERE
    wr1: (EXISTS(internal_location) OR EXISTS(street_number) OR EXISTS(
             street) OR EXISTS(postal_box) OR EXISTS(town) OR EXISTS(
             region) OR EXISTS(postal_code) OR EXISTS(country) OR EXISTS(
             facsimile_number) OR EXISTS(telephone_number) OR EXISTS(
             electronic_mail_address) OR EXISTS(telex_number));
END_ENTITY; -- 10303-41: person_organization_schema

ENTITY advanced_brep_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(QUERY ( it <* SELF.items | (NOT (SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MANIFOLD_SOLID_BREP',
             'INTEGRATED_CNC_SCHEMA.FACETED_BREP',
             'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM',
             'INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D'] * TYPEOF(it)) =
             1)) )) = 0);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | (SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MANIFOLD_SOLID_BREP',
             'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM'] * TYPEOF(it)) = 1) )) >
              0);
    wr3: (SIZEOF(QUERY ( msb <* QUERY ( it <* SELF.items | (
             'INTEGRATED_CNC_SCHEMA.MANIFOLD_SOLID_BREP' IN TYPEOF(it)) )
              | (NOT (SIZEOF(QUERY ( csh <* msb_shells(msb) | (NOT (
             SIZEOF(QUERY ( fcs <* csh\connected_face_set.cfs_faces | (
             NOT ('INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fcs))) ))
             = 0)) )) = 0)) )) = 0);
    wr4: (SIZEOF(QUERY ( msb <* QUERY ( it <* items | (
             'INTEGRATED_CNC_SCHEMA.MANIFOLD_SOLID_BREP' IN TYPEOF(it)) )
              | ('INTEGRATED_CNC_SCHEMA.ORIENTED_CLOSED_SHELL' IN TYPEOF(
             msb\manifold_solid_brep.outer)) )) = 0);
    wr5: (SIZEOF(QUERY ( brv <* QUERY ( it <* items | (
             'INTEGRATED_CNC_SCHEMA.BREP_WITH_VOIDS' IN TYPEOF(it)) ) | (
             NOT (SIZEOF(QUERY ( csh <* brv\brep_with_voids.voids | csh\
             oriented_closed_shell.orientation )) = 0)) )) = 0);
    wr6: (SIZEOF(QUERY ( mi <* QUERY ( it <* items | (
             'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' IN TYPEOF(it)) ) | (NOT
             ('INTEGRATED_CNC_SCHEMA.ADVANCED_BREP_SHAPE_REPRESENTATION'
             IN TYPEOF(mi\mapped_item.mapping_source.
             mapped_representation))) )) = 0);
END_ENTITY; -- 10303-514: aic_advanced_brep

ENTITY advanced_face
  SUBTYPE OF (face_surface);
  WHERE
    wr1 : (SIZEOF(['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE',
              'INTEGRATED_CNC_SCHEMA.B_SPLINE_SURFACE',
              'INTEGRATED_CNC_SCHEMA.SWEPT_SURFACE'] * TYPEOF(
              face_geometry)) = 1);
```

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```
wr2 : (SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (SIZEOF(QUERY ( oe <* elp_fbnds.bound\path.
          edge_list | (NOT ('INTEGRATED_CNC_SCHEMA.EDGE_CURVE' IN
          TYPEOF(oe\oriented_edge.edge_element))) )) = 0)) )) = 0);
wr3 : (SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (SIZEOF(QUERY ( oe <* elp_fbnds.bound\path.
          edge_list | (NOT (SIZEOF(['INTEGRATED_CNC_SCHEMA.LINE',
          'INTEGRATED_CNC_SCHEMA.CONIC',
          'INTEGRATED_CNC_SCHEMA.POLYLINE',
          'INTEGRATED_CNC_SCHEMA.SURFACE_CURVE',
          'INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE'] * TYPEOF(oe.
          edge_element\edge_curve.edge_geometry)) = 1)) )) = 0)) )) =
           0);
wr4 : (SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (SIZEOF(QUERY ( oe <* elp_fbnds.bound\path.
          edge_list | (NOT (('INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN
          TYPEOF(oe\edge.edge_start)) AND (
          'INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT' IN TYPEOF(oe\edge.
          edge_start\vertex_point.vertex_geometry)) AND (
          'INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(oe\edge.
          edge_end)) AND ('INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT' IN
          TYPEOF(oe\edge.edge_end\vertex_point.vertex_geometry)))) ))
          = 0)) )) = 0);
wr5 : (SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | ('INTEGRATED_CNC_SCHEMA.ORIENTED_PATH' IN TYPEOF(
          elp_fbnds.bound)) )) = 0);
wr6 : ((NOT ('INTEGRATED_CNC_SCHEMA.SWEPT_SURFACE' IN TYPEOF(
          face_geometry))) OR (SIZEOF(['INTEGRATED_CNC_SCHEMA.LINE',
          'INTEGRATED_CNC_SCHEMA.CONIC',
          'INTEGRATED_CNC_SCHEMA.POLYLINE',
          'INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE'] * TYPEOF(
          face_geometry\swept_surface.swept_curve)) = 1));
wr7 : (SIZEOF(QUERY ( vlp_fbnds <* QUERY ( bnds <* bounds | (
          'INTEGRATED_CNC_SCHEMA.VERTEX_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (('INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(
          vlp_fbnds\face_bound.bound\vertex_loop.loop_vertex)) AND (
          'INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT' IN TYPEOF(vlp_fbnds
          \face_bound.bound\vertex_loop.loop_vertex\vertex_point.
          vertex_geometry)))) )) = 0);
wr8 : (SIZEOF(QUERY ( bnd <* bounds | (NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP',
          'INTEGRATED_CNC_SCHEMA.VERTEX_LOOP'] * TYPEOF(bnd.bound)) =
           1)) )) = 0);
wr9 : (SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (SIZEOF(QUERY ( oe <* elp_fbnds.bound\path.
          edge_list | (('INTEGRATED_CNC_SCHEMA.SURFACE_CURVE' IN
          TYPEOF(oe\oriented_edge.edge_element\edge_curve.
          edge_geometry)) AND (NOT (SIZEOF(QUERY ( sc_ag <* oe.
          edge_element\edge_curve.edge_geometry\surface_curve.
```

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```
              associated_geometry | (NOT ('INTEGRATED_CNC_SCHEMA.PCURVE'
              IN TYPEOF(sc_ag))) )) = 0))) )) = 0)) )) = 0);
    wr10: (((NOT ('INTEGRATED_CNC_SCHEMA.SWEPT_SURFACE' IN TYPEOF(
              face_geometry))) OR (NOT ('INTEGRATED_CNC_SCHEMA.POLYLINE'
              IN TYPEOF(face_geometry\swept_surface.swept_curve))) OR (
              SIZEOF(face_geometry\swept_surface.swept_curve\polyline.
              points) >= 3)) AND (SIZEOF(QUERY ( elp_fbnds <*
              QUERY ( bnds <* bounds | ('INTEGRATED_CNC_SCHEMA.EDGE_LOOP'
              IN TYPEOF(bnds.bound)) ) | (NOT (SIZEOF(QUERY ( oe <*
              elp_fbnds.bound\path.edge_list | ((
              'INTEGRATED_CNC_SCHEMA.POLYLINE' IN TYPEOF(oe\oriented_edge
              .edge_element\edge_curve.edge_geometry)) AND (NOT (SIZEOF(
              oe\oriented_edge.edge_element\edge_curve.edge_geometry\
              polyline.points) >= 3))) )) = 0)) )) = 0));
END_ENTITY; -- 10303-511: aic_topologically_bounded_surface

ENTITY and_expression
  SUBTYPE OF (multiple_arity_boolean_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY angular_location
  SUBTYPE OF (dimensional_location);
    angle_selection : angle_relator;
END_ENTITY; -- 10303-47: shape_dimension_schema

ENTITY angular_size
  SUBTYPE OF (dimensional_size);
    angle_selection : angle_relator;
END_ENTITY; -- 10303-47: shape_dimension_schema

ENTITY angularity_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
  WHERE
    wr1: (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
             datum_system) < 3);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY apex
  SUBTYPE OF (derived_shape_aspect);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY application_context;
    application : label;
  DERIVE
    description : text := get_description_value(SELF);
    id          : identifier := get_id_value(SELF);
  INVERSE
    context_elements : SET [1:?] OF application_context_element FOR
                           frame_of_reference;
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
```

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END_ENTITY; -- 10303-41: application_context_schema

ENTITY application_context_element
  SUPERTYPE OF (ONEOF (product_context,product_definition_context));
    name               : label;
    frame_of_reference : application_context;
END_ENTITY; -- 10303-41: application_context_schema

ENTITY application_protocol_definition;
    status                                  : label;
    application_interpreted_model_schema_name : label;
    application_protocol_year               : year_number;
    application                             : application_context;
END_ENTITY; -- 10303-41: application_context_schema

ENTITY applied_approval_assignment
  SUBTYPE OF (approval_assignment);
    items : SET [1:?] OF approval_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_area
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             SELF.of_shape));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT ((2 <= SIZEOF(impl_rep.
             used_representation.items)) AND (SIZEOF(impl_rep.
             used_representation.items) <= 3))) )) = 0)) )) = 0);
    wr4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
```

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```
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'effective length')) )) = 1)) )) =
            0)) )) <= 1);
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'maximum length')) )) <= 1)) )) = 0)) ))
            = 0);
    wr7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
            name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_date_and_time_assignment
  SUBTYPE OF (date_and_time_assignment);
    items : SET [1:?] OF date_and_time_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_document_reference
  SUBTYPE OF (document_reference);
    items : SET [1:?] OF document_reference_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_document_usage_constraint_assignment
  SUBTYPE OF (document_usage_constraint_assignment);
    items : SET [1:?] OF document_reference_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_effectivity_assignment
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  SUBTYPE OF (effectivity_assignment);
    items : SET [1:?] OF effectivity_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_group_assignment
  SUBTYPE OF (group_assignment);
    items : SET [1:?] OF group_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_person_and_organization_assignment
  SUBTYPE OF (person_and_organization_assignment);
    items : SET [1:?] OF person_and_organization_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_security_classification_assignment
  SUBTYPE OF (security_classification_assignment);
    items : SET [1:?] OF security_classification_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY approval;
    status : approval_status;
    level  : label;
END_ENTITY; -- 10303-41: approval_schema

ENTITY approval_assignment
  ABSTRACT SUPERTYPE;
    assigned_approval : approval;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY approval_date_time;
    date_time      : date_time_select;
    dated_approval : approval;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- 10303-41: approval_schema

ENTITY approval_person_organization;
    person_organization : person_organization_select;
    authorized_approval : approval;
    role                : approval_role;
END_ENTITY; -- 10303-41: approval_schema

ENTITY approval_role;
    role : label;
  DERIVE
    description : text := get_description_value(SELF);
```

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  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
              'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: approval_schema

ENTITY approval_status;
    name : label;
END_ENTITY; -- 10303-41: approval_schema

ENTITY assembly_component_usage
  SUPERTYPE OF (next_assembly_usage_occurrence)
  SUBTYPE OF (product_definition_usage);
    reference_designator : OPTIONAL identifier;
END_ENTITY; -- 10303-44: product_structure_schema

ENTITY axis1_placement
  SUBTYPE OF (placement);
    axis : OPTIONAL direction;
  DERIVE
    z : direction := NVL(normalise(axis),dummy_gri || direction([0,0,1]));
  WHERE
    wr1: (SELF\geometric_representation_item.dim = 3);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY axis2_placement_2d
  SUBTYPE OF (placement);
    ref_direction : OPTIONAL direction;
  DERIVE
    p : LIST [2:2] OF direction := build_2axes(ref_direction);
  WHERE
    wr1: (SELF\geometric_representation_item.dim = 2);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY axis2_placement_3d
  SUBTYPE OF (placement);
    axis          : OPTIONAL direction;
    ref_direction : OPTIONAL direction;
  DERIVE
    p : LIST [3:3] OF direction := build_axes(axis,ref_direction);
  WHERE
    wr1: (SELF\placement.location.dim = 3);
    wr2: ((NOT EXISTS(axis)) OR (axis.dim = 3));
    wr3: ((NOT EXISTS(ref_direction)) OR (ref_direction.dim = 3));
    wr4: ((NOT EXISTS(axis)) OR (NOT EXISTS(ref_direction)) OR (
              cross_product(axis,ref_direction).magnitude > 0));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY b_spline_curve
  SUPERTYPE OF (ONEOF (uniform_curve,b_spline_curve_with_knots,
      quasi_uniform_curve,bezier_curve) ANDOR rational_b_spline_curve)
  SUBTYPE OF (bounded_curve);
    degree              : INTEGER;
    control_points_list : LIST [2:?] OF cartesian_point;
    curve_form          : b_spline_curve_form;
```

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```
    closed_curve        : LOGICAL;
    self_intersect      : LOGICAL;
  DERIVE
    upper_index_on_control_points : INTEGER := SIZEOF(
                                        control_points_list) - 1;
    control_points                : ARRAY [0:
                                        upper_index_on_control_points] OF
                                         cartesian_point := list_to_array(
                                        control_points_list,0,
                                        upper_index_on_control_points);
  WHERE
    wr1: (('INTEGRATED_CNC_SCHEMA.UNIFORM_CURVE' IN TYPEOF(SELF)) OR (
              'INTEGRATED_CNC_SCHEMA.QUASI_UNIFORM_CURVE' IN TYPEOF(SELF))
              OR ('INTEGRATED_CNC_SCHEMA.BEZIER_CURVE' IN TYPEOF(SELF)) OR
               ('INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE_WITH_KNOTS' IN
              TYPEOF(SELF)));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY b_spline_curve_with_knots
  SUBTYPE OF (b_spline_curve);
    knot_multiplicities : LIST [2:?] OF INTEGER;
    knots               : LIST [2:?] OF parameter_value;
    knot_spec           : knot_type;
  DERIVE
    upper_index_on_knots : INTEGER := SIZEOF(knots);
  WHERE
    wr1: constraints_param_b_spline(degree,upper_index_on_knots,
              upper_index_on_control_points,knot_multiplicities,knots);
    wr2: (SIZEOF(knot_multiplicities) = upper_index_on_knots);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY b_spline_surface
  SUPERTYPE OF (ONEOF (b_spline_surface_with_knots,uniform_surface,
      quasi_uniform_surface,bezier_surface) ANDOR
      rational_b_spline_surface)
  SUBTYPE OF (bounded_surface);
    u_degree            : INTEGER;
    v_degree            : INTEGER;
    control_points_list : LIST [2:?] OF LIST [2:?] OF cartesian_point;
    surface_form        : b_spline_surface_form;
    u_closed            : LOGICAL;
    v_closed            : LOGICAL;
    self_intersect      : LOGICAL;
  DERIVE
    u_upper        : INTEGER := SIZEOF(control_points_list) - 1;
    v_upper        : INTEGER := SIZEOF(control_points_list[1]) - 1;
    control_points : ARRAY [0:u_upper] OF ARRAY [0:v_upper] OF
                         cartesian_point := make_array_of_array(
                        control_points_list,0,u_upper,0,v_upper);
  WHERE
    wr1: (('INTEGRATED_CNC_SCHEMA.UNIFORM_SURFACE' IN TYPEOF(SELF)) OR (
              'INTEGRATED_CNC_SCHEMA.QUASI_UNIFORM_SURFACE' IN TYPEOF(SELF))
              OR ('INTEGRATED_CNC_SCHEMA.BEZIER_SURFACE' IN TYPEOF(SELF))
              OR ('INTEGRATED_CNC_SCHEMA.B_SPLINE_SURFACE_WITH_KNOTS' IN
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             TYPEOF(SELF)));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY b_spline_surface_with_knots
  SUBTYPE OF (b_spline_surface);
    u_multiplicities : LIST [2:?] OF INTEGER;
    v_multiplicities : LIST [2:?] OF INTEGER;
    u_knots          : LIST [2:?] OF parameter_value;
    v_knots          : LIST [2:?] OF parameter_value;
    knot_spec        : knot_type;
  DERIVE
    knot_u_upper : INTEGER := SIZEOF(u_knots);
    knot_v_upper : INTEGER := SIZEOF(v_knots);
  WHERE
    wr1: constraints_param_b_spline(SELF\b_spline_surface.u_degree,
             knot_u_upper,SELF\b_spline_surface.u_upper,u_multiplicities,
             u_knots);
    wr2: constraints_param_b_spline(SELF\b_spline_surface.v_degree,
             knot_v_upper,SELF\b_spline_surface.v_upper,v_multiplicities,
             v_knots);
    wr3: (SIZEOF(u_multiplicities) = knot_u_upper);
    wr4: (SIZEOF(v_multiplicities) = knot_v_upper);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY back_boring_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
           (amr.name = 'machine functions') AND NOT
           (verify_required_action_property
                (amr.related_method, 'oriented spindle stop')))));
END_ENTITY;

ENTITY bezier_curve
  SUBTYPE OF (b_spline_curve);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY bezier_surface
  SUBTYPE OF (b_spline_surface);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY binary_boolean_expression
  ABSTRACT SUPERTYPE OF (xor_expression)
  SUBTYPE OF (boolean_expression, binary_generic_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY binary_generic_expression
  ABSTRACT SUPERTYPE
  SUBTYPE OF (generic_expression);
    operands : LIST [2:2] OF generic_expression;
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY binary_numeric_expression
  ABSTRACT SUPERTYPE
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  SUBTYPE OF (numeric_expression, binary_generic_expression);
    SELF\binary_generic_expression.operands : LIST [2:2] OF
                                                  numeric_expression;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY block
  SUBTYPE OF (geometric_representation_item);
    position : axis2_placement_3d;
    x        : positive_length_measure;
    y        : positive_length_measure;
    z        : positive_length_measure;
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY block_shape_representation
  SUBTYPE OF (shape_representation_with_parameters);
  WHERE
    wr1: (SIZEOF(SELF.items) = 4);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | ((
             'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
             name = 'orientation')) )) = 1);
    wr3: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'length')) )) = 1);
    wr4: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'width')) )) = 1);
    wr5: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'height')) )) = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY boolean_expression
  ABSTRACT SUPERTYPE OF (ONEOF (unary_boolean_expression,
      binary_boolean_expression,multiple_arity_boolean_expression,
      comparison_expression))
  SUBTYPE OF (expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY boring_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['boring','reaming']);

  WR2:  (verify_required_action_property        (SELF, 'spindle stop')) AND
        (verify_enumeration_action_property     (SELF, 'spindle stop',
         ['spindle stop at bottom', 'spindle nonstop']));

  WR3:  (verify_optional_action_property        (SELF, 'testcut depth')) AND
        (verify_length_measure_action_property  (SELF, 'testcut depth'));

  WR4:  (verify_optional_action_property        (SELF, 'waiting position')) AND
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        (verify_rep_item_for_action_property    (SELF, 'waiting position',
         ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT']));
END_ENTITY;

ENTITY boss
  SUBTYPE OF (feature_definition);
  WHERE
    wr1 : (SELF\characterized_object.description IN ['circular',
              'complex','rectangular']);
    wr2 : (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'boss height occurrence') AND (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'path feature component usage') AND ((
              'INTEGRATED_CNC_SCHEMA.' + 'SHAPE_DEFINING_RELATIONSHIP')
              IN TYPEOF(sar))) ) | ((
              'INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) AND (1 <= SIZEOF(pdr.
              used_representation.items)) AND (SIZEOF(pdr.
              used_representation.items) <= 2)) )) = 1) )) = 1);
    wr4 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
              'INTEGRATED_CNC_SCHEMA.' +
              '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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
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            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'circular profile occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | (
            'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE' IN TYPEOF(
            sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0));
wr7 : (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'top condition occurrence') AND (SIZEOF(
            QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'boss top usage') AND (
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'change in diameter occurrence') AND (SIZEOF(
            QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description = 'taper usage')
            AND ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
            IN TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.TAPER' IN
            TYPEOF(fcr.related_shape_aspect)) )) = 1)) )) <= 1)) )) = 0));
wr9 : ((NOT (SELF\characterized_object.description = 'complex')) OR
            (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'enclosed boundary occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
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              'profile usage') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | (SIZEOF([
              'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
              'INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'change in boundary occurrence') AND (SIZEOF(
              QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | ((sar.description =
              'taper usage') AND (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar))) ) | (('INTEGRATED_CNC_SCHEMA.TAPER' IN
              TYPEOF(fcr.related_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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'rectangular profile occurrence') AND (
              SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'profile usage') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | (
              'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE' IN
              TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY boss_top
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
             TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
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wr4: ((NOT (SELF.description = 'planar')) OR (SIZEOF(QUERY ( pd <*
         USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
         'INTEGRATED_CNC_SCHEMA.LOCATION_SHAPE_REPRESENTATION' IN
         TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
wr5: ((NOT (SELF.description = 'complex')) OR (SIZEOF(QUERY ( pd <*
         USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
         'INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION' IN TYPEOF(
         pdr.used_representation)) )) = 1)) )) = 0));
wr6: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATING_SHAPE_ASPECT') | ((sar.description =
         'boss top usage') AND (sar.name IN ['boss height start',
         'boss height end']) AND (
         'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
         TYPEOF(sar))) ) | ((fcr.related_shape_aspect.description =
         'top condition occurrence') AND (
         'INTEGRATED_CNC_SCHEMA.BOSS' IN TYPEOF(fcr.
         related_shape_aspect.of_shape.definition))) )) >= 1);
wr7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
         used_representation)) )) <= 1)) )) = 0);
wr8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
         'INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
         used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
         impl_rep.used_representation.items | ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
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            it)) = 2) AND (it.name = 'top radius')) )) <= 1)) )) = 0)) ))
            = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY bottom_and_side_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['rough milling','finish milling']);

  WR2:  (verify_optional_action_property    (SELF, 'axial cutting depth')) AND
        (verify_length_measure_action_property (SELF, 'axial cutting depth'));

  WR3:  (verify_optional_action_property (SELF, 'radial cutting depth')) AND
        (verify_length_measure_action_property (SELF, 'radial cutting depth'));

  WR4:  (verify_optional_action_property        (SELF, 'allowance side')) AND
        (verify_length_measure_action_property  (SELF, 'allowance side'));

  WR5:  (verify_optional_action_property        (SELF, 'allowance bottom')) AND
        (verify_length_measure_action_property  (SELF, 'allowance bottom'));

  WR6:  NOT (SELF.description = 'rough milling') OR
        ((verify_required_action_property (SELF, 'allowance side')) AND
         (verify_required_action_property (SELF, 'allowance bottom')));
END_ENTITY;

ENTITY boundary_curve
  SUBTYPE OF (composite_curve_on_surface);
  WHERE
    wr1: SELF\composite_curve.closed_curve;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY bounded_curve
  SUPERTYPE OF (ONEOF (polyline,b_spline_curve,trimmed_curve,
      bounded_pcurve,bounded_surface_curve,composite_curve))
  SUBTYPE OF (curve);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY bounded_pcurve
  SUBTYPE OF (pcurve, bounded_curve);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE' IN TYPEOF(SELF\pcurve.
            reference_to_curve.items[1]));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY bounded_surface
  SUPERTYPE OF (ONEOF (b_spline_surface,rectangular_trimmed_surface,
      curve_bounded_surface,rectangular_composite_surface))
  SUBTYPE OF (surface);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY bounded_surface_curve
  SUBTYPE OF (surface_curve, bounded_curve);
  WHERE
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    wr1: ('INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE' IN TYPEOF(SELF\
              surface_curve.curve_3d));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY brep_with_voids
  SUBTYPE OF (manifold_solid_brep);
    voids : SET [1:?] OF oriented_closed_shell;
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY calendar_date
  SUBTYPE OF (date);
    day_component   : day_in_month_number;
    month_component : month_in_year_number;
  WHERE
    wr1: valid_calendar_date(SELF);
END_ENTITY; -- 10303-41: date_time_schema

ENTITY cartesian_point
  SUBTYPE OF (point);
    coordinates : LIST [1:3] OF length_measure;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY cartesian_transformation_operator
  SUPERTYPE OF (cartesian_transformation_operator_3d)
  SUBTYPE OF (geometric_representation_item,
      functionally_defined_transformation);
    axis1        : OPTIONAL direction;
    axis2        : OPTIONAL direction;
    local_origin : cartesian_point;
    scale        : OPTIONAL REAL;
  DERIVE
    scl : REAL := NVL(scale,1);
  WHERE
    wr1: (scl > 0);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY cartesian_transformation_operator_3d
  SUBTYPE OF (cartesian_transformation_operator);
    axis3 : OPTIONAL direction;
  DERIVE
    u : LIST [3:3] OF direction := base_axis(3,SELF\
           cartesian_transformation_operator.axis1,SELF\
           cartesian_transformation_operator.axis2,axis3);
  WHERE
    wr1: (SELF\geometric_representation_item.dim = 3);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY centre_of_symmetry
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: (SIZEOF(QUERY ( sadr <* SELF\derived_shape_aspect.
              deriving_relationships | (NOT (
              'INTEGRATED_CNC_SCHEMA.SYMMETRIC_SHAPE_ASPECT' IN TYPEOF(
              sadr\shape_aspect_relationship.related_shape_aspect))) )) =
```

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```
            0);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY chamfer
  SUBTYPE OF (transition_feature);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.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,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATING_SHAPE_ASPECT') | (
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
             TYPEOF(sar)) ) | (('INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET' IN
              TYPEOF(fcr.related_shape_aspect)) AND (fcr.
             related_shape_aspect.description = 'first offset')) )) = 1);
    wr3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATING_SHAPE_ASPECT') | (
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
             TYPEOF(sar)) ) | (('INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET' IN
              TYPEOF(fcr.related_shape_aspect)) AND (fcr.
             related_shape_aspect.description = 'second offset')) )) = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY chamfer_offset
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: (SELF.description IN ['first offset','second offset']);
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
```

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```
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | (((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'offset amount')) OR ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | (('INTEGRATED_CNC_SCHEMA.' +
            'FEATURE_COMPONENT_RELATIONSHIP') IN TYPEOF(sar)) ) | (
            'INTEGRATED_CNC_SCHEMA.CHAMFER' IN TYPEOF(sdr.
            relating_shape_aspect)) )) = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema
```

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```
ENTITY characterized_object;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: product_property_definition_schema

ENTITY circle
  SUBTYPE OF (conic);
    radius : positive_length_measure;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY circular_closed_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
              TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              '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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((
              'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
              name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
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            it)) = 2) AND (it.name = 'diameter')) )) = 1)) )) = 0)) )) =
             0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY circular_pattern
  SUBTYPE OF (replicate_feature);
  WHERE
    wr1: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
             QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATING_SHAPE_ASPECT') | (
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
             TYPEOF(sar)) ) | ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT' IN
             TYPEOF(sdr.related_shape_aspect)) )) = 1) )) <= 3)) )) = 0);
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'diameter')) )) <= 1)) )) = 0)) ))
             = 0);
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
```

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```
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2) AND (it.name = 'base feature rotation')) ))
            <= 1)) )) = 0)) )) = 0);
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2) AND (it.name = 'angular spacing')) )) = 1)) ))
            = 0)) )) = 0);
    wr8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
            name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY circular_runout_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
  WHERE
    wr1: (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
            datum_system) <= 2);
END_ENTITY; -- 10303-519: aic_geometric_tolerances
```

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ENTITY classification_role;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY closed_path_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
             TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
              | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((
             'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
             name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
              | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.PATH_SHAPE_REPRESENTATION' IN TYPEOF(
             pdr.used_representation)) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY closed_shell
  SUBTYPE OF (connected_face_set);
END_ENTITY; -- 10303-42: topology_schema

ENTITY coaxiality_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
  WHERE
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    wr1: (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
              datum_system) <= 2);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY common_datum
  SUBTYPE OF (composite_shape_aspect, datum);
  WHERE
    wr1: (SIZEOF(SELF.component_relationships) = 2);
    wr2: (SIZEOF(QUERY ( sar <* SELF.component_relationships | (NOT ((
              'INTEGRATED_CNC_SCHEMA.DATUM' IN TYPEOF(sar.
              related_shape_aspect)) AND (NOT (
              'INTEGRATED_CNC_SCHEMA.COMMON_DATUM' IN TYPEOF(sar.
              related_shape_aspect))))) )) = 0);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY comparison_equal
  SUBTYPE OF (comparison_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY comparison_expression
  ABSTRACT SUPERTYPE OF (ONEOF (comparison_equal,comparison_greater,
      comparison_greater_equal,comparison_less,comparison_less_equal,
      comparison_not_equal))
  SUBTYPE OF (boolean_expression, binary_generic_expression);
    SELF\binary_generic_expression.operands : LIST [2:2] OF expression;
  WHERE
    wr1: ((((’INTEGRATED_CNC_SCHEMA.NUMERIC_EXPRESSION’ IN TYPEOF(SELF\
              binary_generic_expression.operands[1])) AND
              ’INTEGRATED_CNC_SCHEMA.NUMERIC_EXPRESSION’) IN TYPEOF(SELF\
              binary_generic_expression.operands[2])) OR ((
              ’INTEGRATED_CNC_SCHEMA.BOOLEAN_EXPRESSION’ IN TYPEOF(SELF\
              binary_generic_expression.operands[1])) AND (
              ’INTEGRATED_CNC_SCHEMA.BOOLEAN_EXPRESSION’ IN TYPEOF(SELF\
              binary_generic_expression.operands[2]))));
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY comparison_greater
  SUBTYPE OF (comparison_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY comparison_greater_equal
  SUBTYPE OF (comparison_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY comparison_less
  SUBTYPE OF (comparison_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY comparison_less_equal
  SUBTYPE OF (comparison_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY comparison_not_equal
  SUBTYPE OF (comparison_expression);
```

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```
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY composite_curve
  SUBTYPE OF (bounded_curve);
    segments       : LIST [1:?] OF composite_curve_segment;
    self_intersect : LOGICAL;
  DERIVE
    n_segments   : INTEGER := SIZEOF(segments);
    closed_curve : LOGICAL := segments[n_segments].transition <>
                       discontinuous;
  WHERE
    wr1: (((NOT closed_curve) AND (SIZEOF(QUERY ( temp <* segments | (
              temp.transition = discontinuous) )) = 1)) OR (closed_curve
              AND (SIZEOF(QUERY ( temp <* segments | (temp.transition =
              discontinuous) )) = 0)));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY composite_curve_on_surface
  SUPERTYPE OF (boundary_curve)
  SUBTYPE OF (composite_curve);
  DERIVE
    basis_surface : SET [0:2] OF surface := get_basis_surface(SELF);
  WHERE
    wr1: (SIZEOF(basis_surface) > 0);
    wr2: constraints_composite_curve_on_surface(SELF);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY composite_curve_segment
  SUBTYPE OF (founded_item);
    transition   : transition_code;
    same_sense   : BOOLEAN;
    parent_curve : curve;
  INVERSE
    using_curves : BAG [1:?] OF composite_curve FOR segments;
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE' IN TYPEOF(parent_curve));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY composite_hole
  SUBTYPE OF (compound_feature);
  WHERE
    wr1: (SELF\characterized_object.description IN ['counterbore',
              'countersunk']);
    wr2: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((
              'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT' IN TYPEOF(csa))
              AND (SIZEOF(QUERY ( sar <* csa.component_relationships | ((
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar)) AND ('INTEGRATED_CNC_SCHEMA.ROUND_HOLE' IN
              TYPEOF(sar.related_shape_aspect))) )) = 2)) )) = 1)) )) = 1);
    wr3: ((NOT (SELF\characterized_object.description = 'countersunk'))
```

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```
              OR (SIZEOF(QUERY ( pds <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((
              'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT' IN TYPEOF(csa))
              AND (SIZEOF(QUERY ( sar <* csa.component_relationships | ((
              'INTEGRATED_CNC_SCHEMA.ROUND_HOLE' IN TYPEOF(sar.
              related_shape_aspect)) AND (NOT (SIZEOF(QUERY ( pds <*
              QUERY ( pd <* USEDIN(sar.related_shape_aspect,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'change in diameter occurrence') AND (SIZEOF(
              QUERY ( fcr2 <* QUERY ( sar2 <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | ((sar2.description =
              'taper usage') AND (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar2))) ) | ('INTEGRATED_CNC_SCHEMA.TAPER' IN TYPEOF(
              fcr2.related_shape_aspect)) )) = 1)) )) = 0)) )) = 0))) )) =
               1)) )) = 1)) )) = 1));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY composite_shape_aspect
  SUBTYPE OF (shape_aspect);
  INVERSE
    component_relationships : SET [2:?] OF shape_aspect_relationship FOR
                                  relating_shape_aspect;
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY compound_feature
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((csa.name
              = 'compound feature in solid') AND (
             'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT' IN TYPEOF(csa))) ))
              = 1)) )) = 1);
    wr2: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (
              'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT' IN TYPEOF(csa)) ))
              = 1)) )) = 1);
    wr3: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
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```
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((
            'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT' IN TYPEOF(csa))
            AND (SIZEOF(QUERY ( fcr <* csa.component_relationships | (
            NOT ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
            IN TYPEOF(fcr))) )) = 0)) )) = 1)) )) = 1);
    wr4: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((
            'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT' IN TYPEOF(csa))
            AND (SIZEOF(QUERY ( sar <* csa.component_relationships | (
            SIZEOF(['INTEGRATED_CNC_SCHEMA.INSTANCED_FEATURE',
            'INTEGRATED_CNC_SCHEMA.TRANSITION_FEATURE',
            'INTEGRATED_CNC_SCHEMA.APPLIED_AREA'] * TYPEOF(sar.
            related_shape_aspect)) = 1) )) = 2)) )) = 1)) )) = 1);
    wr5: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((
            'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT' IN TYPEOF(csa))
            AND (SIZEOF(QUERY ( sar <* csa.component_relationships | (
            'INTEGRATED_CNC_SCHEMA.THREAD' IN TYPEOF(sar.
            related_shape_aspect)) )) = 0)) )) = 1)) )) = 1);
    wr6: (SIZEOF(QUERY ( pds <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pds)) AND (SIZEOF(QUERY ( csa <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((
            'INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT' IN TYPEOF(csa))
            AND (SIZEOF(QUERY ( sar <* csa.component_relationships | ((
            'INTEGRATED_CNC_SCHEMA.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; -- 10303-238: integrated_cnc_schema

ENTITY compound_representation_item
  SUBTYPE OF (representation_item);
    item_element : compound_item_definition;
END_ENTITY; -- 10303-43: representation_schema

ENTITY concentricity_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
  WHERE
    wr1: (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
            datum_system) = 1);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY concurrent_action_method
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-49: method_definition_schema
```

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```
ENTITY conic
  SUPERTYPE OF (ONEOF (circle,ellipse,hyperbola,parabola))
  SUBTYPE OF (curve);
    position : axis2_placement;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY conical_surface
  SUBTYPE OF (elementary_surface);
    radius     : length_measure;
    semi_angle : plane_angle_measure;
  WHERE
    wr1: (radius >= 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY connected_face_set
  SUPERTYPE OF (ONEOF (closed_shell,open_shell))
  SUBTYPE OF (topological_representation_item);
    cfs_faces : SET [1:?] OF face;
END_ENTITY; -- 10303-42: topology_schema

ENTITY context_dependent_shape_representation;
    representation_relation      : shape_representation_relationship;
    represented_product_relation : product_definition_shape;
  DERIVE
    description : text := get_description_value(SELF);
    name        : label := get_name_value(SELF);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_RELATIONSHIP' IN
             TYPEOF(SELF.represented_product_relation.definition));
    wr2: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
    wr3: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: product_property_representation_schema

ENTITY context_dependent_unit
  SUBTYPE OF (named_unit);
    name : label;
END_ENTITY; -- 10303-41: measure_schema

ENTITY conversion_based_unit
  SUBTYPE OF (named_unit);
    name              : label;
    conversion_factor : measure_with_unit;
END_ENTITY; -- 10303-41: measure_schema

ENTITY coordinated_universal_time_offset;
    hour_offset   : INTEGER;
    minute_offset : OPTIONAL INTEGER;
    sense         : ahead_or_behind;
  DERIVE
    actual_minute_offset : INTEGER := NVL(minute_offset,0);
  WHERE
    wr1: ((0 <= hour_offset) AND (hour_offset < 24));
```

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    wr2: ((0 <= actual_minute_offset) AND (actual_minute_offset <= 59));
    wr3: (NOT (((hour_offset <> 0) OR (actual_minute_offset <> 0)) AND (
             sense = exact)));
END_ENTITY; -- 10303-41: date_time_schema

ENTITY curve
  SUPERTYPE OF (ONEOF (line,conic,pcurve,surface_curve,offset_curve_3d,
      curve_replica))
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY curve_bounded_surface
  SUBTYPE OF (bounded_surface);
    basis_surface  : surface;
    boundaries     : SET [1:?] OF boundary_curve;
    implicit_outer : BOOLEAN;
  WHERE
    wr1: ((NOT implicit_outer) OR (SIZEOF(QUERY ( temp <* boundaries | (
             'INTEGRATED_CNC_SCHEMA.OUTER_BOUNDARY_CURVE' IN TYPEOF(temp)) ))
             = 0));
    wr2: ((NOT implicit_outer) OR (
             'INTEGRATED_CNC_SCHEMA.BOUNDED_SURFACE' IN TYPEOF(
             basis_surface)));
    wr3: (SIZEOF(QUERY ( temp <* boundaries | (
             'INTEGRATED_CNC_SCHEMA.OUTER_BOUNDARY_CURVE' IN TYPEOF(temp)) ))
             <= 1);
    wr4: (SIZEOF(QUERY ( temp <* boundaries | (temp\
             composite_curve_on_surface.basis_surface[1] <> SELF.
             basis_surface) )) = 0);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY curve_replica
  SUBTYPE OF (curve);
    parent_curve   : curve;
    transformation : cartesian_transformation_operator;
  WHERE
    wr1: (transformation.dim = parent_curve.dim);
    wr2: acyclic_curve_replica(SELF,parent_curve);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY cylindrical_shape_representation
  SUBTYPE OF (shape_representation_with_parameters);
  WHERE
    wr1: (SIZEOF(SELF.items) = 3);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | ((
             'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
             name = 'orientation')) )) = 1);
    wr3: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'length')) )) = 1);
    wr4: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
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             it)) = 2) AND (it.name = 'diameter')) )) = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY cylindrical_surface
  SUBTYPE OF (elementary_surface);
    radius : positive_length_measure;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY cylindricity_tolerance
  SUBTYPE OF (geometric_tolerance);
  WHERE
    wr1: (NOT (('INTEGRATED_CNC_SCHEMA.' +
             'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)));
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY data_environment;
    name        : label;
    description : text;
    elements    : SET [1:?] OF property_definition_representation;
END_ENTITY; -- 10303-45: material_property_representation_schema

ENTITY date
  SUPERTYPE OF (ONEOF (calendar_date,ordinal_date,
      week_of_year_and_day_date));
    year_component : year_number;
END_ENTITY; -- 10303-41: date_time_schema

ENTITY date_and_time;
    date_component : date;
    time_component : local_time;
END_ENTITY; -- 10303-41: date_time_schema

ENTITY date_and_time_assignment
  ABSTRACT SUPERTYPE;
    assigned_date_and_time : date_and_time;
    role                   : date_time_role;
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY date_time_role;
    name : label;
  DERIVE
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: date_time_schema

ENTITY dated_effectivity
  SUBTYPE OF (effectivity);
    effectivity_end_date   : OPTIONAL date_time_or_event_occurrence;
    effectivity_start_date : date_time_or_event_occurrence;
END_ENTITY; -- 10303-41: effectivity_schema

ENTITY datum
```

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  SUBTYPE OF (shape_aspect);
    identification : identifier;
  INVERSE
    established_by_relationships : SET [1:?] OF
                                       shape_aspect_relationship FOR
                                     related_shape_aspect;
  WHERE
    wr1: (SIZEOF(QUERY ( x <* SELF\datum.established_by_relationships |
              (SIZEOF(TYPEOF(x\shape_aspect_relationship.
              relating_shape_aspect) * [
              'INTEGRATED_CNC_SCHEMA.DATUM_FEATURE',
              'INTEGRATED_CNC_SCHEMA.DATUM_TARGET']) <> 1) )) = 0);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY datum_feature
  SUBTYPE OF (shape_aspect);
  INVERSE
    feature_basis_relationship : shape_aspect_relationship FOR
                                     relating_shape_aspect;
  WHERE
    wr1: (SIZEOF(QUERY ( sar <* bag_to_set(USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT')) | (NOT (
              'INTEGRATED_CNC_SCHEMA.DATUM' IN TYPEOF(sar\
              shape_aspect_relationship.related_shape_aspect))) )) = 0);
    wr2: (SELF\shape_aspect.product_definitional = TRUE);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY datum_reference;
    precedence       : INTEGER;
    referenced_datum : datum;
  WHERE
    wr1: (precedence > 0);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY datum_target
  SUBTYPE OF (shape_aspect);
    target_id : identifier;
  INVERSE
    target_basis_relationship : shape_aspect_relationship FOR
                                     relating_shape_aspect;
  WHERE
    wr1: (SIZEOF(QUERY ( sar <* bag_to_set(USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT')) | (NOT (
              'INTEGRATED_CNC_SCHEMA.DATUM' IN TYPEOF(sar\
              shape_aspect_relationship.related_shape_aspect))) )) = 0);
    wr2: (SELF\shape_aspect.product_definitional = TRUE);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY definitional_representation
  SUBTYPE OF (representation);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.PARAMETRIC_REPRESENTATION_CONTEXT' IN
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             TYPEOF(SELF\representation.context_of_items));
END_ENTITY; -- 10303-43: representation_schema

ENTITY degenerate_pcurve
  SUBTYPE OF (point);
    basis_surface      : surface;
    reference_to_curve : definitional_representation;
  WHERE
    wr1: (SIZEOF(reference_to_curve\representation.items) = 1);
    wr2: ('INTEGRATED_CNC_SCHEMA.CURVE' IN TYPEOF(reference_to_curve\
             representation.items[1]));
    wr3: (reference_to_curve\representation.items[1]\
             geometric_representation_item.dim = 2);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY degenerate_toroidal_surface
  SUBTYPE OF (toroidal_surface);
    select_outer : BOOLEAN;
  WHERE
    wr1: (major_radius < minor_radius);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY derived_shape_aspect
  SUPERTYPE OF (ONEOF (apex,centre_of_symmetry,geometric_alignment,
      geometric_intersection,parallel_offset,perpendicular_to,extension,
      tangent))
  SUBTYPE OF (shape_aspect);
  INVERSE
    deriving_relationships : SET [1:?] OF shape_aspect_relationship FOR
                                relating_shape_aspect;
  WHERE
    wr1: (SIZEOF(QUERY ( dr <* SELF\derived_shape_aspect.
             deriving_relationships | (NOT (('INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_ASPECT_DERIVING_RELATIONSHIP') IN TYPEOF(dr))) )) = 0);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY derived_unit;
    elements : SET [1:?] OF derived_unit_element;
  DERIVE
    name : label := get_name_value(SELF);
  WHERE
    wr1: ((SIZEOF(elements) > 1) OR ((SIZEOF(elements) = 1) AND (
             elements[1].exponent <> 1)));
    wr2: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: measure_schema

ENTITY derived_unit_element;
    unit     : named_unit;
    exponent : REAL;
END_ENTITY; -- 10303-41: measure_schema

ENTITY description_attribute;
    attribute_value : text;
```

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    described_item  : description_attribute_select;
END_ENTITY; -- 10303-41: basic_attribute_schema

ENTITY descriptive_representation_item
  SUBTYPE OF (representation_item);
    description : text;
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY dimension_related_tolerance_zone_element;
    related_dimension : dimensional_location;
    related_element   : tolerance_zone_definition;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY dimensional_characteristic_representation;
    dimension      : dimensional_characteristic;
    representation : shape_dimension_representation;
END_ENTITY; -- 10303-47: shape_dimension_schema

ENTITY dimensional_exponents;
    length_exponent                    : REAL;
    mass_exponent                      : REAL;
    time_exponent                      : REAL;
    electric_current_exponent          : REAL;
    thermodynamic_temperature_exponent : REAL;
    amount_of_substance_exponent       : REAL;
    luminous_intensity_exponent        : REAL;
END_ENTITY; -- 10303-41: measure_schema

ENTITY dimensional_location
  SUPERTYPE OF (ONEOF (angular_location,dimensional_location_with_path))
  SUBTYPE OF (shape_aspect_relationship);
END_ENTITY; -- 10303-47: shape_dimension_schema

ENTITY dimensional_location_with_path
  SUBTYPE OF (dimensional_location);
    path : shape_aspect;
END_ENTITY; -- 10303-47: shape_dimension_schema

ENTITY dimensional_size
  SUPERTYPE OF (ONEOF (angular_size,dimensional_size_with_path));
    applies_to : shape_aspect;
    name       : label;
  WHERE
    wr1: (applies_to.product_definitional = TRUE);
END_ENTITY; -- 10303-47: shape_dimension_schema

ENTITY dimensional_size_with_path
  SUBTYPE OF (dimensional_size);
    path : shape_aspect;
END_ENTITY; -- 10303-47: shape_dimension_schema

ENTITY direction
  SUBTYPE OF (geometric_representation_item);
    direction_ratios : LIST [2:3] OF REAL;
```

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  WHERE
    wr1: (SIZEOF(QUERY ( tmp <* direction_ratios | (tmp <> 0) )) > 0);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY direction_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(SELF.items) = 1);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | (NOT (
             'INTEGRATED_CNC_SCHEMA.DIRECTION' IN TYPEOF(it))) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY document;
    id          : identifier;
    name        : label;
    description : OPTIONAL text;
    kind        : document_type;
  INVERSE
    representation_types : SET [0:?] OF document_representation_type FOR
                               represented_document;
END_ENTITY; -- 10303-41: document_schema

ENTITY document_file
  SUBTYPE OF (characterized_object, document);
  WHERE
    wr1: ((SIZEOF(QUERY ( adr <* QUERY ( dr <*
USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.DOCUMENT_REFERENCE.ASSIGNED_DOCUMENT')
              | ('INTEGRATED_CNC_SCHEMA.APPLIED_DOCUMENT_REFERENCE' IN
             TYPEOF(dr)) ) |
('INTEGRATED_CNC_SCHEMA.EXTERNALLY_DEFINED_FEATURE_DEFINITION'
             IN TYPEOF(adr.items)) )) = 1) OR (SIZEOF(QUERY ( duc <*
             USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.DOCUMENT_USAGE_CONSTRAINT.SOURCE') |
             (NOT (SIZEOF(QUERY ( aduc <* QUERY ( duca <*
USEDIN(duc,'INTEGRATED_CNC_SCHEMA.DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT.'
             + 'ASSIGNED_DOCUMENT_USAGE') | (('INTEGRATED_CNC_SCHEMA.' +
             'APPLIED_DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT') IN TYPEOF(
             duca)) ) |
('INTEGRATED_CNC_SCHEMA.EXTERNALLY_DEFINED_FEATURE_DEFINITION'
             IN TYPEOF(aduc.items)) )) = 1)) )) = 0));
    wr2: (SIZEOF(QUERY ( drt <* USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DOCUMENT_REPRESENTATION_TYPE.REPRESENTED_DOCUMENT') | (drt.
             name = 'physical') )) = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY document_reference
  ABSTRACT SUPERTYPE;
    assigned_document : document;
    source            : label;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
```

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END_ENTITY; -- 10303-41: management_resources_schema

ENTITY document_representation_type;
    name                 : label;
    represented_document : document;
END_ENTITY; -- 10303-41: document_schema

ENTITY document_type;
    product_data_type : label;
END_ENTITY; -- 10303-41: document_schema

ENTITY document_usage_constraint;
    source                : document;
    subject_element       : label;
    subject_element_value : text;
END_ENTITY; -- 10303-41: document_schema

ENTITY document_usage_constraint_assignment
  ABSTRACT SUPERTYPE;
    assigned_document_usage : document_usage_constraint;
    role                    : document_usage_role;
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY document_usage_role;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY drilling_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['drilling','counter sinking',
         'center drilling', 'multistep drilling']);

  WR2:  NOT (SELF.description = 'multistep drilling') OR
        ((verify_required_action_property       (SELF, 'retract distance')) AND
         (verify_length_measure_action_property (SELF, 'retract distance')) AND

         (verify_required_action_property       (SELF, 'first depth')) AND
         (verify_length_measure_action_property (SELF, 'first depth')) AND

         (verify_required_action_property       (SELF, 'depth of step')) AND
         (verify_length_measure_action_property (SELF, 'depth of step')) AND

         (verify_optional_action_property       (SELF, 'dwell time step')) AND
         (verify_time_measure_action_property   (SELF, 'dwell time step')));
END_ENTITY;

ENTITY drilling_type_operation
  SUBTYPE OF (machining_operation);
  WHERE
  WR1:  (verify_optional_action_property        (SELF, 'overcut length')) AND
        (verify_length_measure_action_property  (SELF, 'overcut length'));
```

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```
  WR2:  (verify_optional_action_property        (SELF, 'cutting depth')) AND
        (verify_length_measure_action_property  (SELF, 'cutting depth'));

  WR3:  (verify_optional_action_property        (SELF, 'previous diameter')) AND
        (verify_length_measure_action_property  (SELF, 'previous diameter'));

  WR4:  (verify_optional_action_property        (SELF, 'dwell time bottom')) AND
        (verify_time_measure_action_property    (SELF, 'dwell time bottom'));

  WR5:  (verify_optional_action_property        (SELF, 'feed on retract')) AND
        (verify_ratio_measure_action_property   (SELF, 'feed on retract'));

  WR6:  ((verify_optional_relating_amr  (SELF, 'machining strategy')) AND
         (verify_related_type_for_amr   (SELF, 'machining strategy',
          ['INTEGRATED_CNC_SCHEMA.DRILLING_TYPE_STRATEGY']))
        );
END_ENTITY;

ENTITY drilling_type_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  (verify_optional_action_property  (SELF, 'reduced cut at start')) AND
        (verify_ratio_measure_action_property (SELF, 'reduced cut at start'));

  WR2:  (verify_optional_action_property  (SELF, 'reduced feed at start')) AND
        (verify_ratio_measure_action_property (SELF, 'reduced feed at start'));

  WR3:  (verify_optional_action_property        (SELF, 'depth of start')) AND
        (verify_length_measure_action_property  (SELF, 'depth of start'));

  WR4:  (verify_optional_action_property      (SELF, 'reduced cut at end')) AND
        (verify_ratio_measure_action_property (SELF, 'reduced cut at end'));

  WR5:  (verify_optional_action_property    (SELF, 'reduced feed at end')) AND
        (verify_ratio_measure_action_property (SELF, 'reduced feed at end'));

  WR6:  (verify_optional_action_property        (SELF, 'depth of end')) AND
        (verify_length_measure_action_property  (SELF, 'depth of end'));

  WR7:  (verify_required_action_property (SELF, 'depth of start')) OR
        ((0 = SIZEOF (get_action_property (SELF, 'reduced cut at start'))) AND
         (0 = SIZEOF (get_action_property (SELF, 'reduced feed at start'))));

  WR8:  (verify_required_action_property (SELF, 'depth of end')) OR
        ((0 = SIZEOF (get_action_property (SELF, 'reduced cut at end'))) AND
         (0 = SIZEOF (get_action_property (SELF, 'reduced feed at end'))));
END_ENTITY;

ENTITY edge
  SUPERTYPE OF (ONEOF (edge_curve,oriented_edge))
  SUBTYPE OF (topological_representation_item);
    edge_start : vertex;
    edge_end   : vertex;
END_ENTITY; -- 10303-42: topology_schema
```

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```
ENTITY edge_curve
  SUBTYPE OF (edge, geometric_representation_item);
    edge_geometry : curve;
    same_sense    : BOOLEAN;
END_ENTITY; -- 10303-42: topology_schema

ENTITY edge_loop
  SUBTYPE OF (loop, path);
  DERIVE
    ne : INTEGER := SIZEOF(SELF\path.edge_list);
  WHERE
    wr1: (SELF\path.edge_list[1].edge_start :=: SELF\path.edge_list[ne].
             edge_end);
END_ENTITY; -- 10303-42: topology_schema

ENTITY edge_round
  SUBTYPE OF (transition_feature);
  WHERE
    wr1: ((NOT (SELF\shape_aspect.description = 'constant radius')) OR (
             SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
             ('INTEGRATED_CNC_SCHEMA.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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
            ('INTEGRATED_CNC_SCHEMA.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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
            ('INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
             IN TYPEOF(pdr.used_representation)) ) | (NOT (SIZEOF(
             QUERY ( it <* impl_rep.used_representation.items | ((SIZEOF(
             ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
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            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
           ('INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
            IN TYPEOF(pdr.used_representation)) ) | (NOT (SIZEOF(
            QUERY ( it <* impl_rep.used_representation.items | ((SIZEOF(
            ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
           ('INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
            IN TYPEOF(pdr.used_representation)) ) | (NOT (SIZEOF(
            QUERY ( it <* impl_rep.used_representation.items | ((SIZEOF(
            ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'second offset')) )) <= 1)) )) = 0)) ))
            = 0));
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION' IN TYPEOF(
            pdr.used_representation)) AND (pdr.used_representation.name
            = 'edge round face')) )) = 1)) )) = 0);
    wr7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION' IN TYPEOF(
            pdr.used_representation)) AND (pdr.used_representation.name
            = 'first face shape')) )) = 1)) )) = 0);
    wr8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION' IN TYPEOF(
            pdr.used_representation)) AND (pdr.used_representation.name
            = 'second face shape')) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY effectivity
  SUPERTYPE OF (ONEOF (serial_numbered_effectivity,dated_effectivity,
      lot_effectivity,time_interval_based_effectivity));
    id : identifier;
  DERIVE
    name        : label := get_name_value(SELF);
    description : text := get_description_value(SELF);
```

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  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: effectivity_schema

ENTITY effectivity_assignment
  ABSTRACT SUPERTYPE;
    assigned_effectivity : effectivity;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY elementary_surface
  SUPERTYPE OF (ONEOF (plane,cylindrical_surface,conical_surface,
      spherical_surface,toroidal_surface))
  SUBTYPE OF (surface);
    position : axis2_placement_3d;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY ellipse
  SUBTYPE OF (conic);
    semi_axis_1 : positive_length_measure;
    semi_axis_2 : positive_length_measure;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY environment;
    syntactic_representation : generic_variable;
    semantics                : variable_semantics;
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY evaluated_degenerate_pcurve
  SUBTYPE OF (degenerate_pcurve);
    equivalent_point : cartesian_point;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY expanded_uncertainty
  SUBTYPE OF (standard_uncertainty);
    coverage_factor : REAL;
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY expression
  ABSTRACT SUPERTYPE OF (ONEOF (numeric_expression,boolean_expression))
  SUBTYPE OF (generic_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY expression_representation_item
  SUBTYPE OF (representation_item, generic_expression);
END_ENTITY;
```

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ENTITY extension
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: (SIZEOF(SELF\derived_shape_aspect.deriving_relationships) = 1);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY external_source;
    source_id : source_item;
  DERIVE
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
              'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: external_reference_schema

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 = '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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) AND (8 <= SIZEOF(pdr.
              used_representation.items)) AND (SIZEOF(pdr.
              used_representation.items) <= 10)) )) = 1) )) = 1));
    wr3 : ((NOT (SELF\characterized_object.description = 'marking')) OR
              (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
              'INTEGRATED_CNC_SCHEMA.' +
              '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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
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            'INTEGRATED_CNC_SCHEMA.' +
            '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,'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')
             | ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
            TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'partial area occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'applied area usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.APPLIED_AREA' IN
            TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) <= 1)) )) =
            0));
wr6 : ((NOT (SIZEOF(QUERY ( doc <* QUERY ( adr <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.APPLIED_DOCUMENT_REFERENCE.ITEMS')
             | ('INTEGRATED_CNC_SCHEMA.DOCUMENT' IN TYPEOF(adr.
            assigned_document)) ) | (
            'INTEGRATED_CNC_SCHEMA.DOCUMENT_FILE' IN TYPEOF(doc)) )) =
            1)) OR (NOT (SIZEOF(QUERY ( doc <* QUERY ( aduc <* USEDIN(
            SELF,'INTEGRATED_CNC_SCHEMA.' +
            'APPLIED_DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT.ITEMS') | (
            'INTEGRATED_CNC_SCHEMA.DOCUMENT' IN TYPEOF(aduc\
            document_usage_constraint_assignment.
            assigned_document_usage.source)) ) | (
            'INTEGRATED_CNC_SCHEMA.DOCUMENT_FILE' IN TYPEOF(doc)) )) >=
             1)));
wr7 : ((NOT (SELF\characterized_object.description = 'marking')) OR
            (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND (it.name = 'marking text')) )) = 1)) )) = 0)) ))
            = 0));
wr8 : ((NOT (SELF\characterized_object.description = 'thread')) OR (
            SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
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          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'removal direction') AND ((it.
          description = 'internal') OR (it.description = 'external'))) ))
          = 1)) )) = 0)) )) = 0));
wr9 : ((NOT (SELF\characterized_object.description = 'thread')) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'qualifier')) )) <= 1)) )) = 0)) ))
          = 0));
wr10: ((NOT (SELF\characterized_object.description = 'thread')) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'hand')) )) = 1)) )) = 0)) )) =
          0));
wr11: ((NOT (SELF\characterized_object.description = 'thread')) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'fit class')) )) = 1)) )) = 0)) ))
          = 0));
wr12: ((NOT (SELF\characterized_object.description = 'thread')) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
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              'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
              TYPEOF(it)) AND (it.name = 'form')) )) = 1)) )) = 0)) )) =
              0));
    wr13: ((NOT (SELF\characterized_object.description = 'thread')) OR (
              SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
              it)) = 2) AND (it.name = 'major diameter')) )) = 1)) )) = 0)) ))
              = 0));
    wr14: ((NOT (SELF\characterized_object.description = 'thread')) OR (
              SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT'] * TYPEOF(
              it)) = 2) AND (it.name = 'number of threads')) )) = 1)) ))
              = 0)) )) = 0));
    wr15: ((NOT (SELF\characterized_object.description IN ['knurl',
              'thread'])) OR (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(
              SELF,'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')
               | ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN
              TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'applied shape') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT' IN
              TYPEOF(sdr.relating_shape_aspect)) )) = 1) )) <= 1)) )) = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY externally_defined_item;
    item_id : source_item;
    source  : external_source;
END_ENTITY; -- 10303-41: external_reference_schema

ENTITY face
  SUPERTYPE OF (ONEOF (face_surface,oriented_face))
  SUBTYPE OF (topological_representation_item);
```

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```
    bounds : SET [1:?] OF face_bound;
  WHERE
    wr1: (NOT mixed_loop_type_set(list_to_set(list_face_loops(SELF))));
    wr2: (SIZEOF(QUERY ( temp <* bounds | (
             'INTEGRATED_CNC_SCHEMA.FACE_OUTER_BOUND' IN TYPEOF(temp)) ))
             <= 1);
END_ENTITY; -- 10303-42: topology_schema

ENTITY face_bound
  SUBTYPE OF (topological_representation_item);
    bound       : loop;
    orientation : BOOLEAN;
END_ENTITY; -- 10303-42: topology_schema

ENTITY face_outer_bound
  SUBTYPE OF (face_bound);
END_ENTITY; -- 10303-42: topology_schema

ENTITY face_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(SELF.items) >= 1);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | (NOT ((
             'INTEGRATED_CNC_SCHEMA.FACE_SURFACE' IN TYPEOF(it)) OR (
             'INTEGRATED_CNC_SCHEMA.ORIENTED_FACE' IN TYPEOF(it)))) )) =
             0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY face_surface
  SUBTYPE OF (face, geometric_representation_item);
    face_geometry : surface;
    same_sense    : BOOLEAN;
  WHERE
    wr1: (NOT ('INTEGRATED_CNC_SCHEMA.ORIENTED_SURFACE' IN TYPEOF(
             face_geometry)));
END_ENTITY; -- 10303-42: topology_schema

ENTITY feature_component_definition
  SUBTYPE OF (characterized_object);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE')) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY feature_component_relationship
  SUPERTYPE OF (ONEOF (pattern_omit_membership,pattern_offset_membership))
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1: ((SIZEOF(['INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT',
             'INTEGRATED_CNC_SCHEMA.REPLICATE_FEATURE',
             'INTEGRATED_CNC_SCHEMA.TRANSITION_FEATURE',
             'INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN'] * TYPEOF(SELF.
```

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```
             relating_shape_aspect)) = 1) OR (
             'INTEGRATED_CNC_SCHEMA.FEATURE_DEFINITION' IN TYPEOF(SELF.
             relating_shape_aspect.of_shape.definition)) OR (
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
             TYPEOF(SELF.relating_shape_aspect.of_shape.definition)));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY feature_definition
  SUBTYPE OF (characterized_object);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((
             'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
             name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr3: (SIZEOF(['INTEGRATED_CNC_SCHEMA.BOSS',
             'INTEGRATED_CNC_SCHEMA.TURNED_KNURL',
             'INTEGRATED_CNC_SCHEMA.THREAD',
             'INTEGRATED_CNC_SCHEMA.MARKING',
             'INTEGRATED_CNC_SCHEMA.RIB_TOP',
             'INTEGRATED_CNC_SCHEMA.ROUND_HOLE',
             'INTEGRATED_CNC_SCHEMA.OUTSIDE_PROFILE',
             'INTEGRATED_CNC_SCHEMA.POCKET',
             'INTEGRATED_CNC_SCHEMA.REMOVAL_VOLUME',
             'INTEGRATED_CNC_SCHEMA.REVOLVED_PROFILE',
             'INTEGRATED_CNC_SCHEMA.OUTER_ROUND',
             'INTEGRATED_CNC_SCHEMA.FLAT_FACE',
             'INTEGRATED_CNC_SCHEMA.PROTRUSION',
             'INTEGRATED_CNC_SCHEMA.ROUNDED_END',
             'INTEGRATED_CNC_SCHEMA.SLOT',
             'INTEGRATED_CNC_SCHEMA.SPHERICAL_CAP',
             'INTEGRATED_CNC_SCHEMA.STEP',
             'INTEGRATED_CNC_SCHEMA.COMPOUND_FEATURE',

'INTEGRATED_CNC_SCHEMA.REPLICATE_FEATURE','INTEGRATED_CNC_SCHEMA.EXTERNALLY_DEF
INED_FEATURE_DEFINITION']
             * TYPEOF(SELF)) = 1);
    wr4: ((NOT (SIZEOF(['INTEGRATED_CNC_SCHEMA.ROUND_HOLE',
             'INTEGRATED_CNC_SCHEMA.BOSS',
             'INTEGRATED_CNC_SCHEMA.OUTSIDE_PROFILE',
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              'INTEGRATED_CNC_SCHEMA.REMOVAL_VOLUME',
              'INTEGRATED_CNC_SCHEMA.FLAT_FACE',
              'INTEGRATED_CNC_SCHEMA.POCKET',
              'INTEGRATED_CNC_SCHEMA.PROTRUSION',
              'INTEGRATED_CNC_SCHEMA.RIB_TOP',
              'INTEGRATED_CNC_SCHEMA.ROUNDED_END',
              'INTEGRATED_CNC_SCHEMA.SLOT','INTEGRATED_CNC_SCHEMA.STEP'] *
               TYPEOF(SELF)) = 1)) OR (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
               | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.
              used_representation.name = 'maximum feature limit')) )) = 1)) ))
              <= 1));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY feature_pattern
  SUBTYPE OF (replicate_feature);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) AND (SIZEOF(QUERY ( srwp_i <* pdr.
              used_representation.items | (NOT (
              'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(srwp_i))) )) > 0)) ))
              > 0) )) = 0);
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((
              'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
              name = 'base feature placement')) )) > 1)) )) = 0)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY fillet
  SUBTYPE OF (transition_feature);
  WHERE
    wr1: ((NOT (SELF\shape_aspect.description = 'constant radius')) OR (
              SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
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```
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
          it)) = 2) AND (it.name = 'second offset')) )) <= 1)) )) = 0)) ))
          = 0));
```

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```
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
               | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION' IN TYPEOF(
              pdr.used_representation)) AND (pdr.used_representation.name
              = 'fillet face')) )) = 1)) )) = 0);
    wr7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
               | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION' IN TYPEOF(
              pdr.used_representation)) AND (pdr.used_representation.name
              = 'first face shape')) )) = 1)) )) = 0);
    wr8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
               | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION' IN TYPEOF(
              pdr.used_representation)) AND (pdr.used_representation.name
              = 'second face shape')) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY flat_face
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'course of travel occurrence') AND (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'path feature component usage') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | ((
              'INTEGRATED_CNC_SCHEMA.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);
```

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```
    wr3: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'removal boundary occurrence') AND (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'profile usage') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | (('INTEGRATED_CNC_SCHEMA.LINEAR_PROFILE'
              IN TYPEOF(sdr.relating_shape_aspect)) AND (sdr.name =
              'removal boundary')) )) = 1)) )) = 1)) )) = 0);
    wr4: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'enclosed boundary occurrence') AND (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'profile usage') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
              'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
              'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
              'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE'] * TYPEOF(sdr.
              relating_shape_aspect)) = 1) AND (sdr.relating_shape_aspect.
              description = 'boundary')) )) = 1)) )) <= 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY flatness_tolerance
  SUBTYPE OF (geometric_tolerance);
  WHERE
    wr1: (NOT (('INTEGRATED_CNC_SCHEMA.' +
              'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)));
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY founded_item;
END_ENTITY; -- 10303-43: representation_schema

ENTITY freeform_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (verify_related_type_for_amr   (SELF, 'machining strategy',
          ['INTEGRATED_CNC_SCHEMA.FREEFORM_MILLING_STRATEGY']));
END_ENTITY;

ENTITY freeform_milling_strategy
  SUBTYPE OF (milling_type_strategy);
  WHERE
```

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```
  WR1:  NOT (SELF.description IN ['leading line', 'plane cutter contact',
          'plane cutter location', 'uv']) OR
        ((verify_required_action_property       (SELF, 'pathmode')) AND
         (verify_enumeration_action_property    (SELF, 'pathmode',
           ['forward', 'zigzag'])) AND

         (verify_required_action_property       (SELF, 'cutmode')) AND
         (verify_enumeration_action_property    (SELF, 'cutmode',
           ['climb', 'conventional'])) AND

        (verify_required_action_property      (SELF, 'milling tolerances')) AND
         (0 = SIZEOF (QUERY (prop <*
           get_action_property (SELF, 'milling tolerances') | NOT
           (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
             'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
            ('INTEGRATED_CNC_SCHEMA.FREEFORM_MILLING_TOLERANCE_REPRESENTATION'
                 IN TYPEOF(prep.representation)) )))
         ))) AND

         (verify_optional_action_property       (SELF, 'stepover length')) AND
         (verify_length_measure_action_property (SELF, 'stepover length')) );

  WR2:  NOT (SELF.description = 'leading line') OR
        ((verify_required_action_property       (SELF, 'leading line')) AND
         (verify_rep_item_for_action_property   (SELF, 'leading line',
           ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) );

  WR3:  NOT (SELF.description IN ['plane cutter contact',
        'plane cutter location']) OR
        ((verify_required_action_property       (SELF, 'plane normal')) AND
         (verify_rep_item_for_action_property   (SELF, 'plane normal',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) );

  WR4:  NOT (SELF.description = 'uv') OR
        ((verify_required_action_property      (SELF, 'forward direction')) AND
         (verify_rep_item_for_action_property   (SELF, 'forward direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

         (verify_required_action_property   (SELF, 'sideward direction')) AND
         (verify_rep_item_for_action_property   (SELF, 'sideward direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) );
END_ENTITY;

ENTITY freeform_milling_tolerance_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'chordal tolerance')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'chordal tolerance') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );
```

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  WR2:  ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'scallop height')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'scallop height') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );
END_ENTITY;

ENTITY functionally_defined_transformation;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-43: representation_schema

ENTITY generic_expression
  ABSTRACT SUPERTYPE OF (ONEOF (simple_generic_expression,
      unary_generic_expression,binary_generic_expression,
      multiple_arity_generic_expression));
  WHERE
    wr1: is_acyclic(SELF);
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY generic_literal
  ABSTRACT SUPERTYPE
  SUBTYPE OF (simple_generic_expression);
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY generic_variable
  ABSTRACT SUPERTYPE
  SUBTYPE OF (simple_generic_expression);
  INVERSE
    interpretation : environment FOR syntactic_representation;
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY geometric_alignment
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: (SIZEOF(SELF\derived_shape_aspect.deriving_relationships) > 1);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY geometric_intersection
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: (SIZEOF(SELF\derived_shape_aspect.deriving_relationships) > 1);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY geometric_representation_context
  SUBTYPE OF (representation_context);
    coordinate_space_dimension : dimension_count;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY geometric_representation_item
  SUPERTYPE OF (ONEOF (point,direction,vector,placement,
```

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```
      cartesian_transformation_operator,curve,surface,edge_curve,
      face_surface,vertex_point,solid_model,right_circular_cylinder,block,
      shell_based_surface_model,geometric_set))
  SUBTYPE OF (representation_item);
  DERIVE
    dim : dimension_count := dimension_of(SELF);
  WHERE
    wr1: (SIZEOF(QUERY ( using_rep <* using_representations(SELF) | (
             NOT (
             'INTEGRATED_CNC_SCHEMA.GEOMETRIC_REPRESENTATION_CONTEXT' IN
             TYPEOF(using_rep.context_of_items))) )) = 0);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY geometric_set
  SUBTYPE OF (geometric_representation_item);
    elements : SET [1:?] OF geometric_set_select;
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY geometric_tolerance;
    name                    : label;
    description             : text;
    magnitude               : measure_with_unit;
    toleranced_shape_aspect : shape_aspect;
  WHERE
    wr1: (('NUMBER' IN TYPEOF(magnitude\measure_with_unit.
             value_component)) AND (magnitude\measure_with_unit.
             value_component >= 0));
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY geometric_tolerance_relationship;
    name                        : label;
    description                 : text;
    relating_geometric_tolerance : geometric_tolerance;
    related_geometric_tolerance  : geometric_tolerance;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY geometric_tolerance_with_datum_reference
  SUBTYPE OF (geometric_tolerance);
    datum_system : SET [1:?] OF datum_reference;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY geometric_tolerance_with_defined_unit
  SUBTYPE OF (geometric_tolerance);
    unit_size : measure_with_unit;
  WHERE
    wr1: (('NUMBER' IN TYPEOF(unit_size\measure_with_unit.
             value_component)) AND (unit_size\measure_with_unit.
             value_component > 0));
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY geometrically_bounded_surface_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(QUERY ( it <* SELF.items | (NOT (SIZEOF([
```

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```
            'INTEGRATED_CNC_SCHEMA.GEOMETRIC_SET',
            'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM',
            'INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D'] * TYPEOF(it)) =
            1)) )) = 0);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | (SIZEOF([
            'INTEGRATED_CNC_SCHEMA.GEOMETRIC_SET',
            'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM'] * TYPEOF(it)) = 1) )) >
             0);
    wr3: (SIZEOF(QUERY ( mi <* QUERY ( it <* SELF.items | (
            'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' IN TYPEOF(it)) ) | (NOT
            ((('INTEGRATED_CNC_SCHEMA.' +
            'GEOMETRICALLY_BOUNDED_SURFACE_SHAPE_REPRESENTATION') IN
            TYPEOF(mi\mapped_item.mapping_source.mapped_representation))
            AND (SIZEOF(QUERY ( mr_it <* mi\mapped_item.mapping_source.
            mapped_representation.items | (
            'INTEGRATED_CNC_SCHEMA.GEOMETRIC_SET' IN TYPEOF(mr_it)) )) >
             0))) )) = 0);
    wr4: (SIZEOF(QUERY ( gs <* QUERY ( it <* SELF.items | (
            'INTEGRATED_CNC_SCHEMA.GEOMETRIC_SET' IN TYPEOF(it)) ) | (
            NOT (SIZEOF(QUERY ( pnt <* QUERY ( gsel <* gs\geometric_set.
            elements | ('INTEGRATED_CNC_SCHEMA.POINT' IN TYPEOF(gsel)) )
             | (NOT gbsf_check_point(pnt)) )) = 0)) )) = 0);
    wr5: (SIZEOF(QUERY ( gs <* QUERY ( it <* SELF.items | (
            'INTEGRATED_CNC_SCHEMA.GEOMETRIC_SET' IN TYPEOF(it)) ) | (
            NOT (SIZEOF(QUERY ( cv <* QUERY ( gsel <* gs\geometric_set.
            elements | ('INTEGRATED_CNC_SCHEMA.CURVE' IN TYPEOF(gsel)) )
             | (NOT gbsf_check_curve(cv)) )) = 0)) )) = 0);
    wr6: (SIZEOF(QUERY ( gs <* QUERY ( it <* SELF.items | (
            'INTEGRATED_CNC_SCHEMA.GEOMETRIC_SET' IN TYPEOF(it)) ) | (
            NOT (SIZEOF(QUERY ( sf <* QUERY ( gsel <* gs\geometric_set.
            elements | ('INTEGRATED_CNC_SCHEMA.SURFACE' IN TYPEOF(gsel)) )
             | (NOT gbsf_check_surface(sf)) )) = 0)) )) = 0);
    wr7: (SIZEOF(QUERY ( gs <* QUERY ( it <* SELF.items | (
            'INTEGRATED_CNC_SCHEMA.GEOMETRIC_SET' IN TYPEOF(it)) ) | (
            SIZEOF(QUERY ( gsel <* gs\geometric_set.elements | (
            'INTEGRATED_CNC_SCHEMA.SURFACE' IN TYPEOF(gsel)) )) > 0) ))
            > 0);
END_ENTITY; -- 10303-507: aic_geometrically_bounded_surface

ENTITY global_uncertainty_assigned_context
  SUBTYPE OF (representation_context);
    uncertainty : SET [1:?] OF uncertainty_measure_with_unit;
END_ENTITY; -- 10303-43: representation_schema

ENTITY global_unit_assigned_context
  SUBTYPE OF (representation_context);
    units : SET [1:?] OF unit;
END_ENTITY; -- 10303-41: measure_schema

ENTITY group;
    name        : label;
    description : OPTIONAL text;
  DERIVE
    id : identifier := get_id_value(SELF);
```

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  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
              'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: group_schema

ENTITY group_assignment
  ABSTRACT SUPERTYPE;
    assigned_group : group;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
              'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY group_relationship;
    name           : label;
    description    : OPTIONAL text;
    relating_group : group;
    related_group  : group;
END_ENTITY; -- 10303-41: group_schema

ENTITY hole_bottom
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : ('INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
              '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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) )) = 1)) )) = 0));
    wr5 : ((NOT (SELF.description = 'flat')) OR (SIZEOF(QUERY ( pd <*
              USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(impl_rep.
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          used_representation.items) = 0)) )) = 0)) )) = 0));
wr6 : ((NOT (SELF.description IN ['flat with radius','spherical']))
          OR (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATING_SHAPE_ASPECT') | ((sar.description =
          'hole bottom usage') AND (
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
          it)) = 2) AND (it.name = 'corner radius')) )) = 1)) )) = 0)) ))
          = 0));
```

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wr11: ((NOT (SELF.description = 'spherical')) OR (SIZEOF(
          QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2) AND (it.name = 'tip angle')) )) = 1)) )) =
           0)) )) = 0));
wr14: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATING_SHAPE_ASPECT') | ((sar.description =
          'hole bottom usage') AND (
          'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
          TYPEOF(sar))) ) | ((fcr.related_shape_aspect.description =
          'bottom condition occurrence') AND (
          'INTEGRATED_CNC_SCHEMA.ROUND_HOLE' IN TYPEOF(fcr.
          related_shape_aspect.of_shape.definition))) )) >= 1);
wr15: ((NOT (SELF.description = 'flat with taper')) OR (SIZEOF(
          QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
```

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```
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
              TYPEOF(it)) = 2) AND (it.name = 'taper diameter')) )) = 1)) ))
              = 0)) )) = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY hyperbola
  SUBTYPE OF (conic);
    semi_axis      : positive_length_measure;
    semi_imag_axis : positive_length_measure;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY id_attribute;
    attribute_value : identifier;
    identified_item : id_attribute_select;
END_ENTITY; -- 10303-41: basic_attribute_schema

ENTITY instanced_feature
  SUBTYPE OF (feature_definition, shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION' IN TYPEOF(SELF.
              of_shape.definition));
    wr2: SELF.product_definitional;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY int_literal
  SUBTYPE OF (literal_number);
    SELF\literal_number.the_value : INTEGER;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY int_numeric_variable
  SUBTYPE OF (numeric_variable);
END_ENTITY; -- 13584-20: iso13584_expressions_schema
```

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ENTITY intersection_curve
  SUBTYPE OF (surface_curve);
  WHERE
    wr1: (SIZEOF(SELF\surface_curve.associated_geometry) = 2);
    wr2: (associated_surface(SELF\surface_curve.associated_geometry[1])
             <> associated_surface(SELF\surface_curve.associated_geometry
             [2]));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY item_defined_transformation;
    name             : label;
    description      : OPTIONAL text;
    transform_item_1 : representation_item;
    transform_item_2 : representation_item;
END_ENTITY; -- 10303-43: representation_schema

ENTITY length_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.LENGTH_UNIT' IN TYPEOF(SELF\
             measure_with_unit.unit_component));
END_ENTITY; -- 10303-41: measure_schema

ENTITY length_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 1) AND (SELF\
             named_unit.dimensions.mass_exponent = 0) AND (SELF\
             named_unit.dimensions.time_exponent = 0) AND (SELF\
             named_unit.dimensions.electric_current_exponent = 0) AND (
             SELF\named_unit.dimensions.
             thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
             .dimensions.amount_of_substance_exponent = 0) AND (SELF\
             named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- 10303-41: measure_schema

ENTITY limits_and_fits;
    form_variance : label;
    zone_variance : label;
    grade         : label;
    source        : text;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY line
  SUBTYPE OF (curve);
    pnt : cartesian_point;
    dir : vector;
  WHERE
    wr1: (dir.dim = pnt.dim);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY line_profile_tolerance
  SUBTYPE OF (geometric_tolerance);
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  WHERE
    wr1: ((NOT (('INTEGRATED_CNC_SCHEMA.' +
              'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)))
              OR (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
              datum_system) <= 3));
    wr2: (SIZEOF(QUERY ( sar <* USEDIN(SELF\geometric_tolerance.
              toleranced_shape_aspect,'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') | (sar.
              name IN ['affected plane association',
              'resulting intersection curve association']) )) = 1);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY linear_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
              TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              '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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((
              'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
              name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
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             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'profile length')) )) = 1)) )) = 0)) ))
             = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY literal_number
  ABSTRACT SUPERTYPE OF (ONEOF (int_literal,real_literal))
  SUBTYPE OF (simple_numeric_expression, generic_literal);
    the_value : NUMBER;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY local_time;
    hour_component   : hour_in_day;
    minute_component : OPTIONAL minute_in_hour;
    second_component : OPTIONAL second_in_minute;
    zone             : coordinated_universal_time_offset;
  WHERE
    wr1: valid_time(SELF);
END_ENTITY; -- 10303-41: date_time_schema

ENTITY location_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(SELF.items) = 1);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | (NOT (
             'INTEGRATED_CNC_SCHEMA.POINT' IN TYPEOF(it))) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY loop
  SUPERTYPE OF (ONEOF (vertex_loop,edge_loop))
  SUBTYPE OF (topological_representation_item);
END_ENTITY; -- 10303-42: topology_schema

ENTITY lot_effectivity
  SUBTYPE OF (effectivity);
    effectivity_lot_id   : identifier;
    effectivity_lot_size : measure_with_unit;
END_ENTITY; -- 10303-41: effectivity_schema

ENTITY machining_adaptive_control_strategy
  SUBTYPE OF (machining_strategy);
END_ENTITY;

ENTITY machining_approach_retract_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  (SELF.description IN ['along path',
         'approach retract angle', 'approach retract tangent',
         'plunge helix', 'plunge ramp', 'plunge toolaxis',
         'plunge zigzag']);

  WR2:  (verify_optional_action_property       (SELF, 'tool orientation')) AND
        (verify_rep_item_for_action_property   (SELF, 'tool orientation',
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```
          ['INTEGRATED_CNC_SCHEMA.DIRECTION']));

  WR3:  NOT (SELF.description = 'along path') OR
        ((1 <= SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
                amr.name = 'toolpath'))) AND

         (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
                (amr.name = 'toolpath') AND NOT
                (('INTEGRATED_CNC_SCHEMA.SEQUENTIAL_METHOD'
                   IN TYPEOF (amr)) AND
                 ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH'
                   IN TYPEOF (amr.related_method))) )))
        );

  WR4:  NOT (SELF.description = 'approach retract angle') OR
        ((verify_required_action_property       (SELF, 'travel angle')) AND
         (verify_angle_measure_action_property  (SELF, 'travel angle')) AND

         (verify_required_action_property       (SELF, 'travel length')) AND
         (verify_length_measure_action_property (SELF, 'travel length')));

  WR5:  NOT (SELF.description = 'approach retract tangent') OR
        ((verify_required_action_property       (SELF, 'travel radius')) AND
         (verify_length_measure_action_property (SELF, 'travel radius')));

  WR6:  NOT (SELF.description IN ['plunge helix', 'plunge ramp',
         'plunge zigzag']) OR
        ((verify_required_action_property       (SELF, 'plunge angle')) AND
         (verify_angle_measure_action_property  (SELF, 'plunge angle')));

  WR7:  NOT (SELF.description = 'plunge helix') OR
        ((verify_required_action_property       (SELF, 'plunge radius')) AND
         (verify_length_measure_action_property (SELF, 'plunge radius')));

  WR8:  NOT (SELF.description = 'plunge zigzag') OR
        ((verify_required_action_property       (SELF, 'plunge width')) AND
         (verify_length_measure_action_property (SELF, 'plunge width')));
END_ENTITY;

ENTITY machining_cutting_component
  SUBTYPE OF (action_resource,characterized_object);
  WHERE
  WR1: ((1 = SIZEOF (get_resource_property (SELF,
          'offset length'))) AND

        -- must have a resource rep with a length
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'offset length') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
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```
                 'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                  TYPEOF(it)) = 2) ))) )))
       ))) );

WR2: (1 >= SIZEOF (USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.' +
         'MATERIAL_DESIGNATION.DEFINITIONS')));

WR3: ((1 >= SIZEOF (get_resource_property (SELF,
         'technological data'))) AND

      -- must have a resource rep with a length
      (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
         'technological data') |
         NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
              'INTEGRATED_CNC_SCHEMA.' +
              'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |

              ((1 >= SIZEOF (QUERY ( it <* prep.representation.items |
                (it.name = 'cutting angle')))) AND
               (0 = SIZEOF (QUERY ( it <* prep.representation.items |
                (it.name = 'cutting angle') AND NOT (SIZEOF([
                 'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                 'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                  TYPEOF(it)) = 2))))
              ) AND
              ((1 >= SIZEOF (QUERY ( it <* prep.representation.items |
                (it.name = 'free angle')))) AND
               (0 = SIZEOF (QUERY ( it <* prep.representation.items |
                (it.name = 'free angle') AND NOT (SIZEOF([
                 'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                 'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                  TYPEOF(it)) = 2))))
              ) AND
              ((1 >= SIZEOF (QUERY ( it <* prep.representation.items |
                (it.name = 'aux angle')))) AND
               (0 = SIZEOF (QUERY ( it <* prep.representation.items |
                (it.name = 'aux angle') AND NOT (SIZEOF([
                 'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                 'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                  TYPEOF(it)) = 2))))
              )
          )))
       ))) );

WR4: ((1 >= SIZEOF (get_resource_property (SELF,
         'expected life'))) AND

      -- must have a resource rep with a length
      (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
         'expected life') |
         NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
              'INTEGRATED_CNC_SCHEMA.' +
              'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
              (0 < SIZEOF (QUERY (it <* prep.representation.items |
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                 (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.TIME_MEASURE_WITH_UNIT'] *
                    TYPEOF(it)) = 2) ))) )))
         ))) );

  WR5: (1 >= SIZEOF (QUERY (arr <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.REQUIREMENT_FOR_ACTION_RESOURCE.RESOURCES') |
          (arr.kind.name = 'cutting component') AND
          (0 < SIZEOF (QUERY (mt <* arr.operations |
           'INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY' IN TYPEOF (mt))))
        )));
END_ENTITY;

ENTITY machining_feature_process
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  (1 = SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'machining')))) AND
        (0 = SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'machining') AND NOT
          ('INTEGRATED_CNC_SCHEMA.PROPERTY_PROCESS' IN TYPEOF (act))
        )));
END_ENTITY;

ENTITY machining_functions
  SUBTYPE OF (action_method);
  WHERE
  WR1:  NOT (SELF.description = 'milling') OR
        ((verify_required_action_property       (SELF, 'coolant')) AND
         (verify_enumeration_action_property    (SELF, 'coolant',
           ['coolant on', 'coolant off'])) AND

         (verify_optional_action_property       (SELF, 'coolant pressure')) AND
         (verify_rep_item_for_action_property   (SELF, 'coolant pressure',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'])) AND

         (verify_optional_action_property       (SELF, 'mist')) AND
         (verify_enumeration_action_property    (SELF, 'mist',
           ['mist on', 'mist off'])) AND

         (verify_required_action_property
           (SELF, 'through spindle coolant')) AND
         (verify_enumeration_action_property
           (SELF, 'through spindle coolant',
           ['through spindle coolant on', 'through spindle coolant off'])) AND

         (verify_optional_action_property
           (SELF, 'through spindle pressure')) AND
         (verify_rep_item_for_action_property
           (SELF, 'through spindle pressure',
           ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'])) AND
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        (verify_optional_action_property       (SELF, 'axis clamping')) AND
        (0 = SIZEOF (QUERY (prop <*
          get_action_property (SELF, 'axis clamping') | NOT
          (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
             'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
            (1 = SIZEOF (QUERY (it <* prep.representation.items |
               (('INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
                ('INTEGRATED_CNC_SCHEMA.LIST_REPRESENTATION_ITEM'
                  IN TYPEOF(it.item_element)) AND
                (0 = SIZEOF (QUERY (ie <* it.item_element | NOT
                  ('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
                   IN TYPEOF(ie)) )))
            ))))
          )))
        ))) AND

        (verify_required_action_property       (SELF, 'chip removal')) AND
        (verify_enumeration_action_property    (SELF, 'chip removal',
          ['chip removal on', 'chip removal off'])) AND

        (verify_optional_action_property
          (SELF, 'oriented spindle stop')) AND
        (verify_rep_item_for_action_property
          (SELF, 'oriented spindle stop',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

        (verify_related_type_for_amr    (SELF, 'process model',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_MODEL'])) AND
        (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
            (amr.name = 'process model') AND NOT
            ('INTEGRATED_CNC_SCHEMA.SEQUENTIAL_METHOD'
              IN TYPEOF (amr)) ))) AND

        (verify_optional_action_property (SELF, 'other functions')) AND
        (0 = SIZEOF (QUERY (prop <* get_action_property
                            (SELF, 'other functions') | NOT
          (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
             'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
            (1 = SIZEOF (QUERY (it <* prep.representation.items |
               (('INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
                ('INTEGRATED_CNC_SCHEMA.SET_REPRESENTATION_ITEM'
                  IN TYPEOF(it.item_element)))
            )))
          )))
        )))
       );
END_ENTITY;

ENTITY machining_nc_function
  SUBTYPE OF (machining_process_executable);
  WHERE
```

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```
  WR1:  (SELF.description IN ['display message',
        'optional stop', 'program stop', 'set mark', 'wait for mark',
        'exchange pallet', 'index pallet', 'load tool', 'unload tool']);

  WR2:  NOT (SELF.description = 'display message') OR
        ((verify_required_action_property       (SELF, 'message text')) AND
         (verify_descriptive_action_property    (SELF, 'message text')));

  WR3:  NOT (SELF.description = 'wait for mark') OR
        ((verify_required_action_property       (SELF, 'channel')));

  WR4:  NOT (SELF.description = 'index pallet') OR
        ((verify_required_action_property       (SELF, 'pallet index')) AND
         (verify_parameter_action_property      (SELF, 'pallet index')));

  WR5:  NOT (SELF.description = 'index table') OR
        ((verify_required_action_property       (SELF, 'table index')) AND
         (verify_parameter_action_property      (SELF, 'table index')));

  WR6:  NOT (SELF.description = 'load tool') OR
        (1 = SIZEOF (QUERY (mt <*
         USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE.USAGE') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL' in TYPEOF(mt)))));

  WR7:  NOT (SELF.description = 'unload tool') OR
        (1 >= SIZEOF (QUERY (mt <*
         USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE.USAGE') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL' in TYPEOF(mt)))));

END_ENTITY;

ENTITY machining_offset_vector_representation
  SUBTYPE OF (representation);
  WHERE
  WR1: (1 = SIZEOF (QUERY ( it <* SELF.items | (it.name = 'translate')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items | (it.name = 'translate') AND NOT
         (('INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
          ('INTEGRATED_CNC_SCHEMA.LIST_REPRESENTATION_ITEM'
            IN TYPEOF(it.item_element)) AND
          (SIZEOF(it.item_element) = 3) AND
          (0 = SIZEOF (QUERY (ie <* it.item_element | NOT
           (('INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM'
              IN TYPEOF(ie)) AND
            ('INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'
              IN TYPEOF(ie))))))
         )
        )));

  WR2: (1 >= SIZEOF (QUERY ( it <* SELF.items | (it.name = 'rotate')))) AND
       (0  = SIZEOF (QUERY ( it <* SELF.items | (it.name = 'rotate') AND NOT
         (('INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
          ('INTEGRATED_CNC_SCHEMA.LIST_REPRESENTATION_ITEM'
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            IN TYPEOF(it.item_element)) AND
          (SIZEOF(it.item_element) = 3) AND
          (0 = SIZEOF (QUERY (ie <* it.item_element | NOT
           (('INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM'
              IN TYPEOF(ie)) AND
            ('INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'
              IN TYPEOF(ie))))))
         )
        )));
END_ENTITY;

ENTITY machining_operation
  SUBTYPE OF (action_method);
  WHERE
  WR1: ((verify_related_type_for_amr    (SELF, 'toolpath',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH'])) AND

        (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
            (amr.name = 'toolpath') AND NOT
            ('INTEGRATED_CNC_SCHEMA.SEQUENTIAL_METHOD' IN TYPEOF (amr)) )))
       );

  WR2:  ((verify_optional_action_property (SELF, 'tool direction')) AND
         (0 = SIZEOF (QUERY (prop <*
            get_action_property (SELF, 'tool direction') | NOT
            (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.'+
               'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
               ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_DIRECTION_REPRESENTATION'
                 IN TYPEOF(prep.representation)) )))
         )))
        );

  WR3:  ('INTEGRATED_CNC_SCHEMA.MACHINING_RAPID_MOVEMENT' IN TYPEOF(SELF)) OR
        ('INTEGRATED_CNC_SCHEMA.MACHINING_TOUCH_PROBING' IN TYPEOF(SELF)) OR
        ((verify_optional_action_property       (SELF, 'retract plane')) AND
         (verify_length_measure_action_property (SELF, 'retract plane')) AND

         (verify_optional_action_property       (SELF, 'cut start point')) AND
         (verify_rep_item_for_action_property   (SELF, 'cut start point',
          ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT'])) AND

         (1 = SIZEOF (QUERY (mt <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE.USAGE') |
          ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL' in TYPEOF(mt))))) AND

         (verify_required_relating_amr  (SELF, 'technology')) AND
         (verify_related_type_for_amr   (SELF, 'technology',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY'])) AND

         (verify_required_relating_amr  (SELF, 'machine functions')) AND
         (verify_related_type_for_amr   (SELF, 'machine functions',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS']))
        );
END_ENTITY;
```

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```
ENTITY machining_operator_instruction
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  EXISTS (self.description) OR
        (0 < SIZEOF (USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.' +
                'APPLIED_DOCUMENT_REFERENCE.ITEMS'))
        );
END_ENTITY;

ENTITY machining_process_executable
  SUBTYPE OF (action_method);
  WHERE
  WR1:  NOT (0 = SIZEOF (TYPEOF (SELF) *
            ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS',
             'INTEGRATED_CNC_SCHEMA.MACHINING_NC_FUNCTION',
             'INTEGRATED_CNC_SCHEMA.MACHINING_OPERATOR_INSTRUCTION',
             'INTEGRATED_CNC_SCHEMA.MACHINING_RAPID_MOVEMENT',
             'INTEGRATED_CNC_SCHEMA.MACHINING_TOUCH_PROBING',
             'INTEGRATED_CNC_SCHEMA.MACHINING_WORKINGSTEP',
             'INTEGRATED_CNC_SCHEMA.MACHINING_WORKPLAN']
        )) OR
        (SELF.description IN ['assignment', 'if statement',
                'non-sequential', 'parallel', 'selective',
                'while statement']);

  WR2:  NOT (SELF.description = 'assignment') OR
        ((verify_required_action_property       (SELF, 'lvalue')) AND
         (verify_rep_item_for_action_property   (SELF, 'lvalue',
          ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'])) AND

         (verify_required_action_property       (SELF, 'rvalue')) AND
         (verify_rep_item_for_action_property   (SELF, 'rvalue',
          ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM']));

  WR3:  NOT (SELF.description = 'if statement') OR
        ((verify_required_action_property       (SELF, 'condition')) AND
         (verify_rep_item_for_action_property   (SELF, 'condition',
          ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.BOOLEAN_EXPRESSION'])) AND

         (verify_required_relating_amr  (SELF, 'true branch')) AND
         (verify_related_type_for_amr   (SELF, 'true branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE'])) AND

         (verify_optional_relating_amr  (SELF, 'false branch')) AND
         (verify_related_type_for_amr   (SELF, 'false branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );

  WR4:  NOT (SELF.description = 'while statement') OR
        ((verify_required_action_property       (SELF, 'condition')) AND
         (verify_rep_item_for_action_property   (SELF, 'condition',
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          ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.BOOLEAN_EXPRESSION'])) AND

         (verify_required_relating_amr  (SELF, 'body')) AND
         (verify_related_type_for_amr   (SELF, 'body',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );

  WR5:  NOT (SELF.description IN ['non-sequential', 'parallel']) OR
        (2 <= SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
                ('INTEGRATED_CNC_SCHEMA.CONCURRENT_ACTION_METHOD'
                 IN TYPEOF (amr)) AND
                ('INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE'
                 IN TYPEOF (amr.related_method))))
        );

  WR6:  NOT (SELF.description = 'selective') OR
        ((2 <= SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
                amr.name = 'branch'))) AND
         (verify_related_type_for_amr   (SELF, 'branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );
END_ENTITY;

ENTITY machining_process_model
  SUBTYPE OF (action_method);
  WHERE
  WR1:  (verify_required_action_property    (SELF, 'initialization data')) AND
        (verify_descriptive_action_property (SELF, 'initialization data'));
END_ENTITY;

ENTITY machining_rapid_movement
  SUBTYPE OF (machining_process_executable, machining_operation);
  WHERE
  WR1:  ((verify_required_action_property       (SELF, 'security plane')) AND
         (verify_rep_item_for_action_property   (SELF, 'security plane',
          ['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE'])));
END_ENTITY;

ENTITY machining_strategy
  SUBTYPE OF (action_method);
END_ENTITY;

ENTITY machining_technology
  SUBTYPE OF (action_method);
  WHERE
  WR1:  (verify_optional_action_property        (SELF, 'feedrate')) AND
        (verify_rep_item_for_action_property    (SELF, 'feedrate',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM']));

  WR2:  (verify_required_action_property
          (SELF, 'feedrate reference')) AND
        (verify_enumeration_action_property
          (SELF, 'feedrate reference',
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          ['tool center point', 'cutter contact point']));

  WR3:  NOT (SELF.description = 'milling') OR
        ((verify_optional_action_property       (SELF, 'cutspeed')) AND
         (verify_rep_item_for_action_property   (SELF, 'cutspeed',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM])) AND

         (verify_optional_action_property       (SELF, 'spindle')) AND
         (verify_rep_item_for_action_property   (SELF, 'spindle',
          ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM])) AND

         (verify_optional_action_property
           (SELF, 'feedrate per tooth')) AND
         (verify_length_measure_action_property
           (SELF, 'feedrate per tooth')) AND

         (verify_required_action_property
           (SELF, 'synchronize spindle with feed')) AND
         (verify_enumeration_action_property
           (SELF, 'synchronize spindle with feed',
           ['synchronized', 'not synchronized'])) AND

         (verify_required_action_property
           (SELF, 'inhibit feedrate override')) AND
         (verify_enumeration_action_property
           (SELF, 'inhibit feedrate override',
           ['override allowed', 'override not allowed'])) AND

         (verify_required_action_property
           (SELF, 'inhibit spindle override')) AND
         (verify_enumeration_action_property
           (SELF, 'inhibit spindle override',
           ['override allowed', 'override not allowed'])) AND

         (verify_optional_relating_amr  (SELF, 'adaptive control')) AND
         (verify_related_type_for_amr   (SELF, 'adaptive control',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_STRATEGY']))
        );

  WR4:  NOT (SELF.description = 'milling') OR
        ((verify_required_action_property (SELF, 'cutspeed') XOR
          verify_required_action_property (SELF, 'spindle')) OR
         (verify_required_relating_amr    (SELF, 'adaptive control'))
        );

  WR5:  NOT (SELF.description = 'milling') OR
        ((verify_required_action_property (SELF, 'feedrate') XOR
          verify_required_action_property (SELF, 'feedrate per tooth')) OR
         (verify_required_relating_amr    (SELF, 'adaptive control'))
        );
END_ENTITY;

ENTITY machining_tool
  SUBTYPE OF (action_resource);
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```
  WHERE
  WR1: NOT (action_resource.kind.name IN ['cutting tool',
               'milling cutting tool']) OR
        (
        -- REQUIRED tool body
        (1 = SIZEOF (get_resource_property (SELF, 'tool body'))) AND

        -- must have a tool body representation
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF, 'tool body') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_BODY_REPRESENTATION'
                 IN TYPEOF(prep.representation)) )))
         ))) AND

        -- Must have at least one cutting component
        -- note that this is a set, not a list.
        (0 < SIZEOF (QUERY (arr <* USEDIN (SELF,

'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE_RELATIONSHIP.RELATING_RESOURCE') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_CUTTING_COMPONENT'
          IN TYPEOF (arr.related)) ))) AND

        -- OPTIONAL overall assembly length
        (1 >= SIZEOF (get_resource_property (SELF,
           'overall assembly length'))) AND

        -- must have a resource rep with a length
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'overall assembly length') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                    TYPEOF(it)) = 2) ))) )))
         )))
        );

  WR2: NOT (action_resource.kind.name = 'milling cutting tool') OR
        (
        -- OPTIONAL direction for spindle orientation
        (1 >= SIZEOF (get_resource_property (SELF,
           'direction for spindle orientation'))) AND

        -- must have a resource rep with a direction
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'direction for spindle orientation') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
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                (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 ('INTEGRATED_CNC_SCHEMA.DIRECTION' IN TYPEOF(it)) ))) )))
        ))) AND

        -- OPTIONAL tool holder diameter for spindle orientation
        (1 >= SIZEOF (get_resource_property (SELF,
           'tool holder diameter for spindle orientation')) ) AND

        -- must have a resource rep with a length
        (0 = SIZEOF (QUERY (prop <* get_resource_property (SELF,
           'tool holder diameter for spindle orientation') |
           NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
                (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                    TYPEOF(it)) = 2) ))) )))
         )))
        );
END_ENTITY;

ENTITY machining_tool_body_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  NOT (SELF.name IN ['backside counterbore', 'backside countersink',
        'ball endmill', 'boring tool', 'bullnose endmill', 'centerdrill',
        'combined drill and reamer', 'combined drill and tap', 'counterbore',
        'countersink','dovetail mill', 'endmill', 'facemill', 'reamer',
        'side mill', 'spade drill', 'tap', 'tapered drill', 'tapered endmill',
        'tapered reamer', 'tapered tap', 'tee slot mill', 'thread mill',
        'threading tool', 'twist drill', 'user defined milling tool',
        'woodruff keyseat mill'])
        OR (

        (1 = SIZEOF (QUERY (rr <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.REPRESENTATION_RELATIONSHIP.REP_1') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_DIMENSION_REPRESENTATION'
          IN TYPEOF(rr.rep_2))))
        ) AND
        ((1 >= SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'number of teeth')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'number of teeth') AND NOT
          (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
           ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
            IN TYPEOF(it.value_component))))))
        ) AND
        ((1 >= SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'hand of cut')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'hand of cut') AND NOT
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        (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND
         (it.description IN ['left', 'right', 'neutral']))))
      ) AND
      ((1 >= SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'coolant through tool')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'coolant through tool') AND NOT
        (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND
         (it.description IN ['supported', 'not supported']))))
      ) AND
      ((1 >= SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'pilot length')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'pilot length') AND NOT (SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2))))
      ) );

WR2:  NOT (SELF.name = 'boring tool') OR
      ((1 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'retract movement')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'retract movement') AND NOT
        (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND
         (it.description IN ['permitted', 'forbidden']))))
      );

WR3:  NOT (SELF.name IN ['combined drill and reamer',
       'combined drill and tap']) OR
      ((1 >= SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'drill length')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'drill length') AND NOT (SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2))))
      );

WR4:  NOT (SELF.name IN ['countersink', 'backside countersink']) OR
      ((1 >= SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'countersink radius')))) AND
       (0 = SIZEOF (QUERY ( it <* SELF.items |
        (it.name = 'countersink radius') AND NOT (SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2))))
      );

WR5:  NOT (SELF.name = 'dovetail mill') OR
      ((1 >= SIZEOF (QUERY ( it <* SELF.items |
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          (it.name = 'included angle')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'included angle') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );

  WR6:  NOT (SELF.name IN ['side mill', 'woodruff keyseat mill']) OR
        ((1 >= SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'cutter width')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'cutter width') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );

  WR7:  NOT (SELF.name = 'tee slot mill') OR
        ((1 >= SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'cutting thickness')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'cutting thickness') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );

  WR8:  NOT (SELF.name IN ['tapered drill', 'tapered endmill',
         'tapered reamer', 'tapered tap']) OR
        ((1 >= SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'taper angle')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'taper angle') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );

  WR9:  NOT (SELF.name = 'user defined milling tool') OR
        ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool identifier')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool identifier') AND NOT
          (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
            IN TYPEOF(it))))))
        );
END_ENTITY;

ENTITY machining_tool_dimension_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'diameter')))) AND
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        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'diameter') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR2:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'tool top angle')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'tool top angle') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR3:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'tool circumference angle')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'tool circumference angle') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR4:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'cutting edge length')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'cutting edge length') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR5:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'edge radius')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'edge radius') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR6:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'edge center vertical')))) AND
        (0 = SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'edge center vertical') AND NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
           TYPEOF(it)) = 2))))
      );

WR7:  ((1 >= SIZEOF (QUERY ( it <* SELF.items |
         (it.name = 'edge center horizontal')))) AND
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         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'edge center horizontal') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
        );

  WR8:  (0 = SIZEOF (QUERY (rr <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.REPRESENTATION_RELATIONSHIP.REP_2') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_BODY_REPRESENTATION'
          IN TYPEOF(rr.rep_1)) AND (rr.rep_1.name = 'ball endmill')))
        ) OR (verify_ball_endmill_edge_dimensions (SELF));


  WR9:  (0 = SIZEOF (QUERY (rr <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.REPRESENTATION_RELATIONSHIP.REP_2') |
         ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_BODY_REPRESENTATION'
          IN TYPEOF(rr.rep_1)) AND
         (rr.rep_1.name IN ['bullnose endmill', 'ball endmill'])))
        ) OR (
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool top angle') AND NOT
          (it.value_component = 0)))
         ) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool circumference angle') AND NOT
          (it.value_component = 0)))
         )
        );
END_ENTITY;

ENTITY machining_tool_direction_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  (SELF.name IN ['two axes', 'three axes', 'three axes tilted tool',
        'five axes const tilt yaw', 'five axes var tilt yaw']);

  WR2:  NOT (SELF.name = 'three axes tilted tool') OR
        ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction orientation')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction orientation') AND NOT
          ('INTEGRATED_CNC_SCHEMA.DIRECTION' IN TYPEOF(it)))))
        );

  WR3:  NOT (SELF.name = 'five axes const tilt yaw') OR
        ((1 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction tilt angle')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction tilt angle') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2)))) AND
         (1 = SIZEOF (QUERY ( it <* SELF.items |
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          (it.name = 'tool direction yaw angle')))) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'tool direction yaw angle') AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))))
         );
END_ENTITY;

ENTITY machining_toolpath
  SUBTYPE OF (action_method);
  WHERE
  WR1:  (verify_required_action_property        (SELF, 'priority')) AND
        (verify_enumeration_action_property     (SELF, 'priority',
         ['required', 'suggested']));

  WR2:  (verify_required_action_property        (SELF, 'trajectory type')) AND
        (verify_enumeration_action_property     (SELF, 'trajectory type',
         ['approach', 'lift', 'connect', 'non-contact',
          'contact', 'trajectory path']));


  WR3:  ((verify_optional_action_property        (SELF, 'speed profile')) AND
         (0 = SIZEOF (QUERY (prop <*
           get_action_property (SELF, 'speed profile') | NOT
           (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
                ('INTEGRATED_CNC_SCHEMA.' +
                 'MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION'
                 IN TYPEOF(prep.representation)) )))
         )))
        );

  WR4:  (verify_optional_relating_amr   (SELF, 'technology')) AND
        (verify_related_type_for_amr    (SELF, 'technology',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY']));


  WR5:  (verify_optional_relating_amr   (SELF, 'machine functions')) AND
        (verify_related_type_for_amr    (SELF, 'machine functions',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS']));
END_ENTITY;

ENTITY machining_toolpath_speed_profile_representation
  SUBTYPE OF (representation);
END_ENTITY;

ENTITY machining_touch_probing
  SUBTYPE OF (machining_process_executable, machining_operation);
  WHERE
  WR1:  (SELF.description IN ['tool length probing', 'tool radius probing',
          'workpiece probing', 'workpiece complete probing']);
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WR2:  ((verify_required_action_property       (SELF, 'security plane')) AND
       (verify_rep_item_for_action_property   (SELF, 'security plane',
        ['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE'])));

WR3:  ((verify_required_action_property       (SELF, 'measured offset')) AND
       (verify_rep_item_for_action_property   (SELF, 'measured offset',
        ['INTEGRATED_CNC_SCHEMA.EXPRESSION_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'])));

WR4:  NOT (SELF.description = 'workpiece probing') OR
      ((verify_required_action_property       (SELF, 'start position')) AND
       (verify_rep_item_for_action_property   (SELF, 'start position',
        ['INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D')) AND

      (1 = SIZEOF (QUERY (act <*
        USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
        (act.name = 'workpiece probing')))) AND
      (0 = SIZEOF (QUERY (act <*
        USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
        (act.name = 'workpiece probing') AND NOT
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_PROCESS'
          IN TYPEOF (act))))) AND

       (verify_required_action_property       (SELF, 'direction')) AND
       (verify_rep_item_for_action_property   (SELF, 'direction',
        ['INTEGRATED_CNC_SCHEMA.DIRECTION')) AND

       (verify_required_action_property       (SELF, 'expected value')) AND
       (verify_rep_item_for_action_property   (SELF, 'expected value',
        ['INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT',
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.QUALIFIED_REPRESENTATION_ITEM')) AND

       (verify_required_action_property       (SELF, 'probe'))
      );

WR5:  NOT (SELF.description = 'workpiece complete probing') OR
      ((1 = SIZEOF (QUERY (act <*
        USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
        (act.name = 'workpiece complete probing')))) AND
       (0 = SIZEOF (QUERY (act <*
        USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
        (act.name = 'workpiece complete probing') AND NOT
        ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_PROCESS'
          IN TYPEOF (act))))) AND

       (verify_required_action_property       (SELF, 'probing distance')) AND
       (verify_rep_item_for_action_property   (SELF, 'probing distance',
        ['INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT',
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.QUALIFIED_REPRESENTATION_ITEM')) AND

       (verify_required_action_property       (SELF, 'probe')) AND
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         (verify_required_action_property       (SELF, 'computed offset')) AND
         (0 = SIZEOF (QUERY (prop <*
            get_action_property (SELF, 'computed offset') | NOT
            (0 < SIZEOF (QUERY (prep <* USEDIN (prop,
                'INTEGRATED_CNC_SCHEMA.' +
                'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
                ('INTEGRATED_CNC_SCHEMA.' +
                 'MACHINING_OFFSET_VECTOR_REPRESENTATION'
                  IN TYPEOF(prep.representation)) )))
         )))
        );

  WR6:  NOT (SELF.description IN ['tool length probing',
          'tool radius probing']) OR
        ((verify_required_action_property       (SELF, 'offset')) AND
         (verify_rep_item_for_action_property   (SELF, 'offset',
          ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT'])) AND

         (verify_required_action_property       (SELF, 'maximum wear')) AND
         (verify_length_measure_action_property (SELF, 'maximum wear')) AND

         (1 = SIZEOF (QUERY (mt <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE.USAGE') |
          ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL' in TYPEOF(mt)))))
        );
END_ENTITY;

ENTITY machining_workingstep
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  ((verify_required_action_property       (SELF, 'security plane')) AND
         (verify_rep_item_for_action_property   (SELF, 'security plane',
          ['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE'])));

  WR2:  ((verify_required_relating_amr  (SELF, 'final feature')) AND
         (verify_related_type_for_amr   (SELF, 'final feature',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS']))
        );

  WR3:  ((verify_optional_relating_amr  (SELF, 'in-process feature')) AND
         (verify_related_type_for_amr   (SELF, 'in-process feature',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS']))
        );

  WR4:  ((verify_required_relating_amr  (SELF, 'operation')) AND
         (verify_related_type_for_amr   (SELF, 'operation',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION']))
        );

  WR5:  (verify_optional_in_process_geometry (SELF));
END_ENTITY;

ENTITY machining_workplan
  SUBTYPE OF (machining_process_executable);
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  WHERE
  WR1:  (1 <= SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
          ('INTEGRATED_CNC_SCHEMA.SEQUENTIAL_METHOD' IN TYPEOF (amr)) AND
          ('INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE'
                 IN TYPEOF (amr.related_method))))
        );

  WR2:  (verify_optional_action_property (SELF, 'channel'));

  WR3:  (1 >= SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'setup')))) AND
        (0 = SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'setup') AND NOT
          ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_PROCESS' IN TYPEOF (act))
        )));

  WR4:  (verify_optional_in_process_geometry (SELF));
END_ENTITY;

ENTITY make_from_usage_option
  SUBTYPE OF (product_definition_usage);
    ranking           : INTEGER;
    ranking_rationale : text;
    quantity          : measure_with_unit;
  WHERE
    wr1: ((NOT ('NUMBER' IN TYPEOF(quantity.value_component))) OR (
             quantity.value_component > 0));
END_ENTITY; -- 10303-44: product_structure_schema

ENTITY manifold_solid_brep
  SUBTYPE OF (solid_model);
    outer : closed_shell;
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY manifold_surface_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1 : (SIZEOF(QUERY ( it <* SELF.items | (NOT (SIZEOF([
               'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL',
               'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM',
               'INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D'] * TYPEOF(it)) =
                1)) )) = 0);
    wr2 : (SIZEOF(QUERY ( it <* SELF.items | (SIZEOF([
               'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL',
               'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM'] * TYPEOF(it)) = 1) ))
               > 0);
    wr3 : (SIZEOF(QUERY ( mi <* QUERY ( it <* SELF.items | (
               'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' IN TYPEOF(it)) ) | (NOT
               (('INTEGRATED_CNC_SCHEMA.MANIFOLD_SURFACE_SHAPE_REPRESENTATION'
               IN TYPEOF(mi\mapped_item.mapping_source.
               mapped_representation)) AND (SIZEOF(QUERY ( mr_it <* mi\
               mapped_item.mapping_source.mapped_representation.items | (
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          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(mr_it)) )) > 0))) )) = 0);
wr4 : (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( sh <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.OPEN_SHELL',
          'INTEGRATED_CNC_SCHEMA.ORIENTED_CLOSED_SHELL',
          'INTEGRATED_CNC_SCHEMA.CLOSED_SHELL'] * TYPEOF(sh)) = 1)) ))
          = 0)) )) = 0);
wr5 : (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
          QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT (
          'INTEGRATED_CNC_SCHEMA.FACE_SURFACE' IN TYPEOF(fa))) )) = 0)) ))
          = 0)) )) = 0);
wr6 : (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
          QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
          'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR
          msf_surface_check(fa\face_surface.face_geometry))) )) = 0)) ))
          = 0)) )) = 0);
wr7 : (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
          QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
          'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR (
          SIZEOF(QUERY ( bnds <* fa.bounds | (NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP',
          'INTEGRATED_CNC_SCHEMA.VERTEX_LOOP'] * TYPEOF(bnds.bound))
          = 1)) )) = 0))) )) = 0)) )) = 0)) )) = 0);
wr8 : (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
          QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
          'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR (
          SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* fa.bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (SIZEOF(QUERY ( oe <* elp_fbnds\path.edge_list | (
          NOT ('INTEGRATED_CNC_SCHEMA.EDGE_CURVE' IN TYPEOF(oe.
          edge_element))) )) = 0)) )) = 0))) )) = 0)) )) = 0)) )) = 0);
wr9 : (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
          QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
          'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR (
          SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* fa.bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
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            | (NOT (SIZEOF(QUERY ( oe_cv <* QUERY ( oe <* elp_fbnds\
          path.edge_list | ('INTEGRATED_CNC_SCHEMA.EDGE_CURVE' IN
          TYPEOF(oe.edge_element)) ) | (NOT (SIZEOF([
          'INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE',
          'INTEGRATED_CNC_SCHEMA.CONIC',
          'INTEGRATED_CNC_SCHEMA.CURVE_REPLICA',
          'INTEGRATED_CNC_SCHEMA.LINE',
          'INTEGRATED_CNC_SCHEMA.OFFSET_CURVE_3D',
          'INTEGRATED_CNC_SCHEMA.PCURVE',
          'INTEGRATED_CNC_SCHEMA.POLYLINE',
          'INTEGRATED_CNC_SCHEMA.SURFACE_CURVE'] * TYPEOF(oe_cv.
          edge_element\edge_curve.edge_geometry)) = 1)) )) = 0)) )) =
           0))) )) = 0)) )) = 0)) )) = 0);
wr10: (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
          QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
          'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR (
          SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* fa.bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (SIZEOF(QUERY ( oe <* elp_fbnds\path.edge_list | (
          NOT msf_curve_check(oe.edge_element\edge_curve.
          edge_geometry)) )) = 0)) )) = 0))) )) = 0)) )) = 0)) )) = 0);
wr11: (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
          QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
          'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR (
          SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* fa.bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (SIZEOF(QUERY ( oe <* elp_fbnds\path.edge_list | (
          NOT (('INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(oe.
          edge_element.edge_start)) AND (
          'INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(oe.
          edge_element.edge_end)))) )) = 0)) )) = 0))) )) = 0)) )) =
          0)) )) = 0);
wr12: (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
          'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
          TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
          shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
          QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
          'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR (
          SIZEOF(QUERY ( elp_fbnds <* QUERY ( bnds <* fa.bounds | (
          'INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN TYPEOF(bnds.bound)) )
           | (NOT (SIZEOF(QUERY ( oe <* elp_fbnds\path.edge_list | (
          NOT ((SIZEOF(['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT',
          'INTEGRATED_CNC_SCHEMA.DEGENERATE_PCURVE',
          'INTEGRATED_CNC_SCHEMA.POINT_ON_CURVE',
          'INTEGRATED_CNC_SCHEMA.POINT_ON_SURFACE'] * TYPEOF(oe.
          edge_element.edge_start\vertex_point.vertex_geometry)) = 1)
          AND (SIZEOF(['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT',
          'INTEGRATED_CNC_SCHEMA.DEGENERATE_PCURVE',
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              'INTEGRATED_CNC_SCHEMA.POINT_ON_CURVE',
              'INTEGRATED_CNC_SCHEMA.POINT_ON_SURFACE'] * TYPEOF(oe.
              edge_element.edge_end\vertex_point.vertex_geometry)) = 1))) ))
              = 0)) )) = 0))) )) = 0)) )) = 0)) )) = 0);
    wr13: (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
              'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
              TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
              shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
              QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
              'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR (
              SIZEOF(QUERY ( vlp_fbnds <* QUERY ( bnds <* fa.bounds | (
              'INTEGRATED_CNC_SCHEMA.VERTEX_LOOP' IN TYPEOF(bnds.bound)) )
               | (NOT ('INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(
              vlp_fbnds\vertex_loop.loop_vertex))) )) = 0))) )) = 0)) ))
              = 0)) )) = 0);
    wr14: (SIZEOF(QUERY ( sbsm <* QUERY ( it <* SELF.items | (
              'INTEGRATED_CNC_SCHEMA.SHELL_BASED_SURFACE_MODEL' IN
              TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( cfs <* sbsm\
              shell_based_surface_model.sbsm_boundary | (NOT (SIZEOF(
              QUERY ( fa <* cfs\connected_face_set.cfs_faces | (NOT ((
              'INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(fa)) OR (
              SIZEOF(QUERY ( vlp_fbnds <* QUERY ( bnds <* fa.bounds | (
              'INTEGRATED_CNC_SCHEMA.VERTEX_LOOP' IN TYPEOF(bnds.bound)) )
               | (NOT (SIZEOF(['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT',
              'INTEGRATED_CNC_SCHEMA.DEGENERATE_PCURVE',
              'INTEGRATED_CNC_SCHEMA.POINT_ON_CURVE',
              'INTEGRATED_CNC_SCHEMA.POINT_ON_SURFACE'] * TYPEOF(
              vlp_fbnds\vertex_loop.loop_vertex\vertex_point.
              vertex_geometry)) = 1)) )) = 0))) )) = 0)) )) = 0)) )) = 0);
END_ENTITY; -- 10303-509: aic_manifold_surface

ENTITY mapped_item
  SUBTYPE OF (representation_item);
    mapping_source : representation_map;
    mapping_target : representation_item;
  WHERE
    wr1: acyclic_mapped_representation(using_representations(SELF),[SELF]);
END_ENTITY; -- 10303-43: representation_schema

ENTITY marking
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) AND (2 <= SIZEOF(pdr.
             used_representation.items)) AND (SIZEOF(pdr.
             used_representation.items) <= 6)) )) = 1) )) = 1);
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
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          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'marking text')) )) = 1)) )) = 0)) ))
          = 0);
wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'special instructions')) )) <= 1)) ))
          = 0)) )) = 0);
wr4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'font name')) )) <= 1)) )) = 0)) ))
          = 0);
wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
          it)) = 2) AND (it.name = 'character height')) )) <= 1)) )) =
           0)) )) = 0);
wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
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            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'character spacing')) )) <= 1)) ))
            = 0)) )) = 0);
    wr7: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'applied shape') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT' IN
            TYPEOF(sdr.relating_shape_aspect)) )) = 1) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY material_designation;
    name        : label;
    definitions : SET [1:?] OF characterized_definition;
END_ENTITY; -- 10303-45: material_property_definition_schema

ENTITY material_designation_characterization;
    name        : label;
    description : text;
    designation : material_designation;
    property    : characterized_material_property;
END_ENTITY; -- 10303-45: material_property_definition_schema

ENTITY material_property
  SUBTYPE OF (property_definition);
  UNIQUE
    ur1 : name, definition;
  WHERE
    wr1: (('INTEGRATED_CNC_SCHEMA.CHARACTERIZED_OBJECT' IN TYPEOF(SELF\
            property_definition.definition)) OR (SIZEOF(bag_to_set(
            USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) -
            QUERY ( temp <* bag_to_set(USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'MATERIAL_PROPERTY_REPRESENTATION') IN TYPEOF(temp)) )) = 0));
END_ENTITY; -- 10303-45: material_property_definition_schema

ENTITY material_property_representation
  SUBTYPE OF (property_definition_representation);
    dependent_environment : data_environment;
END_ENTITY; -- 10303-45: material_property_representation_schema

ENTITY measure_qualification;
    name              : label;
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    description       : text;
    qualified_measure : measure_with_unit;
    qualifiers        : SET [1:?] OF value_qualifier;
  WHERE
    wr1: (SIZEOF(QUERY ( temp <* qualifiers | (
             'INTEGRATED_CNC_SCHEMA.PRECISION_QUALIFIER' IN TYPEOF(temp)) ))
             < 2);
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY measure_representation_item
  SUBTYPE OF (representation_item, measure_with_unit);
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY measure_with_unit
  SUPERTYPE OF (ONEOF (length_measure_with_unit,time_measure_with_unit,
      plane_angle_measure_with_unit,solid_angle_measure_with_unit,
      ratio_measure_with_unit));
    value_component : measure_value;
    unit_component  : unit;
  WHERE
    wr1: valid_units(SELF);
END_ENTITY; -- 10303-41: measure_schema

ENTITY milling_type_operation
  SUBTYPE OF (machining_operation);
  WHERE
  WR1:  (verify_optional_action_property        (SELF, 'overcut length')) AND
        (verify_length_measure_action_property  (SELF, 'overcut length'));

  WR2:  ((verify_optional_relating_amr  (SELF, 'approach strategy')) AND
         (verify_related_type_for_amr   (SELF, 'approach strategy',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR3:  ((verify_optional_relating_amr  (SELF, 'retract strategy')) AND
         (verify_related_type_for_amr   (SELF, 'retract strategy',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR4:  ((verify_optional_relating_amr  (SELF, 'machining strategy')) AND
         (verify_related_type_for_amr   (SELF, 'machining strategy',
          ['INTEGRATED_CNC_SCHEMA.MILLING_TYPE_STRATEGY']))
        );
END_ENTITY;

ENTITY milling_type_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  NOT (SELF.description IN ['bidirectional', 'bidirectional contour',
          'center milling', 'contour bidirectional', 'contour parallel',
          'contour spiral', 'explicit', 'unidirectional']) OR
        ((verify_optional_action_property       (SELF, 'overlap ratio')) AND
         (verify_ratio_measure_action_property  (SELF, 'overlap ratio')) AND
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        (verify_optional_action_property       (SELF, 'multiple passes')) AND
        (verify_enumeration_action_property    (SELF, 'multiple passes',
         ['multiple passes allowed', 'multiple passes not allowed'])) );

  WR2:  NOT (SELF.description = 'bidirectional') OR
       ((verify_optional_action_property       (SELF, 'feed direction')) AND
        (verify_rep_item_for_action_property   (SELF, 'feed direction',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

        (verify_optional_action_property    (SELF, 'stepover direction')) AND
        (verify_enumeration_action_property (SELF, 'stepover direction',
          ['left', 'right'])) AND

        (verify_optional_action_property    (SELF, 'connection strategy')) AND
        (verify_enumeration_action_property (SELF, 'connection strategy',
          ['straight line', 'lift shift plunge', 'degouge', 'loop back'])) );

  WR3:  NOT (SELF.description IN ['bidirectional contour',
                'contour bidirectional']) OR
       ((verify_optional_action_property       (SELF, 'feed direction')) AND
        (verify_rep_item_for_action_property   (SELF, 'feed direction',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

        (verify_optional_action_property    (SELF, 'stepover direction')) AND
        (verify_enumeration_action_property (SELF, 'stepover direction',
          ['left', 'right'])) AND

        (verify_optional_action_property    (SELF, 'rotation direction')) AND
        (verify_enumeration_action_property (SELF, 'rotation direction',
          ['clockwise', 'counterclockwise'])) AND

        (verify_optional_action_property    (SELF, 'spiral cutmode')) AND
        (verify_enumeration_action_property (SELF, 'spiral cutmode',
          ['climb', 'conventional'])) );

  WR4:  NOT (SELF.description IN ['contour parallel', 'contour spiral']) OR
       ((verify_optional_action_property    (SELF, 'rotation direction')) AND
        (verify_enumeration_action_property (SELF, 'rotation direction',
          ['clockwise', 'counterclockwise'])) AND

        (verify_optional_action_property    (SELF, 'cutmode')) AND
        (verify_enumeration_action_property (SELF, 'cutmode',
          ['climb', 'conventional'])) );

  WR5:  NOT (SELF.description = 'unidirectional') OR
       ((verify_optional_action_property       (SELF, 'feed direction')) AND
        (verify_rep_item_for_action_property   (SELF, 'feed direction',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

        (verify_optional_action_property       (SELF, 'cutmode')) AND
        (verify_enumeration_action_property    (SELF, 'cutmode',
          ['climb', 'conventional'])) );
END_ENTITY;
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ENTITY modified_geometric_tolerance
  SUBTYPE OF (geometric_tolerance);
    modifier : limit_condition;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY modified_pattern
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar)) ) | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.REPLICATE_FEATURE',
              'INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar)) ) | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
              'INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'] * TYPEOF(fcr.
              related_shape_aspect.of_shape.definition)) = 1) AND (fcr.
              description = 'base pattern')) )) = 1);
    wr3: (SIZEOF(QUERY ( sar <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | (SIZEOF(QUERY ( msar <* USEDIN(
              sar.related_shape_aspect,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.PATTERN_OFFSET_MEMBERSHIP',
              'INTEGRATED_CNC_SCHEMA.PATTERN_OMIT_MEMBERSHIP'] * TYPEOF(
              sar)) = 1) AND (sar.description = 'modified pattern') AND (
              sar :<>: msar)) )) >= 1) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY multiple_arity_boolean_expression
  ABSTRACT SUPERTYPE OF (ONEOF (and_expression,or_expression))
  SUBTYPE OF (boolean_expression, multiple_arity_generic_expression);
    SELF\multiple_arity_generic_expression.operands : LIST [2:?] OF
boolean_expression;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY multiple_arity_generic_expression
  ABSTRACT SUPERTYPE
  SUBTYPE OF (generic_expression);
    operands : LIST [2:?] OF generic_expression;
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY multiple_arity_numeric_expression
  ABSTRACT SUPERTYPE
  SUBTYPE OF (numeric_expression, multiple_arity_generic_expression);
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    SELF\multiple_arity_generic_expression.operands : LIST [2:?] OF
numeric_expression;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY name_attribute;
    attribute_value : label;
    named_item      : name_attribute_select;
END_ENTITY; -- 10303-41: basic_attribute_schema

ENTITY named_unit
  SUPERTYPE OF (ONEOF (si_unit,conversion_based_unit,
      context_dependent_unit) ANDOR ONEOF (length_unit,time_unit,
      plane_angle_unit,solid_angle_unit,ratio_unit));
    dimensions : dimensional_exponents;
END_ENTITY; -- 10303-41: measure_schema

ENTITY next_assembly_usage_occurrence
  SUBTYPE OF (assembly_component_usage);
END_ENTITY; -- 10303-44: product_structure_schema

ENTITY ngon_closed_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
             TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
             'INTEGRATED_CNC_SCHEMA.' +
             '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.
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```
            used_representation.items))) )) = 1) )) = 1);
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
            name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'corner radius')) )) <= 1)) )) = 0)) ))
            = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY ngon_shape_representation
```

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```
  SUBTYPE OF (shape_representation_with_parameters);
  WHERE
    wr1: (SIZEOF(SELF.items) = 5);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | ((
             'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
             name = 'orientation')) )) = 1);
    wr3: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'length')) )) = 1);
    wr4: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'corner radius')) )) = 1);
    wr5: (SIZEOF(QUERY ( it <* SELF.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name IN ['circumscribed diameter',
             'diameter across flats'])) )) = 1);
    wr6: (SIZEOF(QUERY ( it <* SELF.items | ((
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
             TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE' IN
             TYPEOF(it\measure_with_unit.value_component)) AND (it.name =
              'number of sides')) )) = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY not_expression
  SUBTYPE OF (unary_boolean_expression);
    SELF\unary_generic_expression.operand : boolean_expression;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY numeric_expression
  ABSTRACT SUPERTYPE OF (ONEOF (simple_numeric_expression,
      unary_numeric_expression,binary_numeric_expression,
      multiple_arity_numeric_expression))
  SUBTYPE OF (expression);
  DERIVE
    is_int       : BOOLEAN := is_int_expr(SELF);
    sql_mappable : BOOLEAN := is_sql_mappable(SELF);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY numeric_variable
  SUPERTYPE OF (ONEOF (int_numeric_variable,real_numeric_variable))
  SUBTYPE OF (simple_numeric_expression, variable);
  WHERE
    wr1: (('INTEGRATED_CNC_SCHEMA.INT_NUMERIC_VARIABLE' IN TYPEOF(SELF))
             OR ('INTEGRATED_CNC_SCHEMA.REAL_NUMERIC_VARIABLE' IN TYPEOF(
             SELF)));
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY object_role;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: basic_attribute_schema
```

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```
ENTITY offset_curve_3d
  SUBTYPE OF (curve);
    basis_curve    : curve;
    distance       : length_measure;
    self_intersect : LOGICAL;
    ref_direction  : direction;
  WHERE
    wr1: ((basis_curve.dim = 3) AND (ref_direction.dim = 3));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY offset_surface
  SUBTYPE OF (surface);
    basis_surface  : surface;
    distance       : length_measure;
    self_intersect : LOGICAL;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY open_path_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
             TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((
             'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
             name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
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            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PATH_SHAPE_REPRESENTATION' IN TYPEOF(
            pdr.used_representation)) )) = 1)) )) = 0);
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.
            used_representation.name = 'profile limit')) )) <= 1)) )) =
            0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY open_shell
  SUBTYPE OF (connected_face_set);
END_ENTITY; -- 10303-42: topology_schema

ENTITY or_expression
  SUBTYPE OF (multiple_arity_boolean_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY ordinal_date
  SUBTYPE OF (date);
    day_component : day_in_year_number;
  WHERE
    wr1: (((NOT leap_year(SELF.year_component)) AND (1 <= day_component)
            AND (day_component <= 365)) OR (leap_year(SELF.
            year_component) AND (1 <= day_component) AND (day_component
            <= 366)));
END_ENTITY; -- 10303-41: date_time_schema

ENTITY organization;
    id          : OPTIONAL identifier;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: person_organization_schema

ENTITY organizational_address
  SUBTYPE OF (address);
    organizations : SET [1:?] OF organization;
    description   : OPTIONAL text;
END_ENTITY; -- 10303-41: person_organization_schema

ENTITY oriented_closed_shell
  SUBTYPE OF (closed_shell);
    closed_shell_element : closed_shell;
    orientation          : BOOLEAN;
  DERIVE
    SELF\connected_face_set.cfs_faces : SET [1:?] OF face :=
                                        conditional_reverse(SELF.
                                        orientation,SELF.
                                        closed_shell_element.cfs_faces);
```

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```
  WHERE
    wr1: (NOT ('INTEGRATED_CNC_SCHEMA.ORIENTED_CLOSED_SHELL' IN TYPEOF(
             SELF.closed_shell_element)));
END_ENTITY; -- 10303-42: topology_schema

ENTITY oriented_edge
  SUBTYPE OF (edge);
    edge_element : edge;
    orientation  : BOOLEAN;
  DERIVE
    SELF\edge.edge_start : vertex := boolean_choose(SELF.orientation,
                              SELF.edge_element.edge_start,SELF.
                              edge_element.edge_end);
    SELF\edge.edge_end   : vertex := boolean_choose(SELF.orientation,
                              SELF.edge_element.edge_end,SELF.
                              edge_element.edge_start);
  WHERE
    wr1: (NOT ('INTEGRATED_CNC_SCHEMA.ORIENTED_EDGE' IN TYPEOF(SELF.
             edge_element)));
END_ENTITY; -- 10303-42: topology_schema

ENTITY oriented_face
  SUBTYPE OF (face);
    face_element : face;
    orientation  : BOOLEAN;
  DERIVE
    SELF\face.bounds : SET [1:?] OF face_bound := conditional_reverse(
                         SELF.orientation,SELF.face_element.bounds);
  WHERE
    wr1: (NOT ('INTEGRATED_CNC_SCHEMA.ORIENTED_FACE' IN TYPEOF(SELF.
             face_element)));
END_ENTITY; -- 10303-42: topology_schema

ENTITY oriented_open_shell
  SUBTYPE OF (open_shell);
    open_shell_element : open_shell;
    orientation        : BOOLEAN;
  DERIVE
    SELF\connected_face_set.cfs_faces : SET [1:?] OF face :=
                                           conditional_reverse(SELF.
                                           orientation,SELF.
                                           open_shell_element.cfs_faces);
  WHERE
    wr1: (NOT ('INTEGRATED_CNC_SCHEMA.ORIENTED_OPEN_SHELL' IN TYPEOF(
             SELF.open_shell_element)));
END_ENTITY; -- 10303-42: topology_schema

ENTITY oriented_path
  SUBTYPE OF (path);
    path_element : path;
    orientation  : BOOLEAN;
  DERIVE
    SELF\path.edge_list : LIST [1:?] OF UNIQUE oriented_edge :=
                            conditional_reverse(SELF.orientation,SELF.
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                              path_element.edge_list);
  WHERE
    wr1: (NOT ('INTEGRATED_CNC_SCHEMA.ORIENTED_PATH' IN TYPEOF(SELF.
             path_element)));
END_ENTITY; -- 10303-42: topology_schema

ENTITY outer_boundary_curve
  SUBTYPE OF (boundary_curve);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY outer_round
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: ((NOT (SELF\characterized_object.description = 'outer diameter'))
             OR (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('INTEGRATED_CNC_SCHEMA.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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
             IN TYPEOF(pdr.used_representation)) AND (SIZEOF(pdr.
             used_representation.items) = 2)) )) = 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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
             it)) = 2) AND (it.name = 'length')) )) = 1)) )) = 0)) )) = 0));
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((SIZEOF([
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            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'v-shape boundary occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | (('INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'reduced size occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description = 'taper usage')
            AND ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
            IN TYPEOF(sar))) ) | (('INTEGRATED_CNC_SCHEMA.TAPER' IN
            TYPEOF(sdr.relating_shape_aspect)) AND (sdr.name =
            'reduced size')) )) = 1)) )) <= 1)) )) = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY outside_profile
  SUBTYPE OF (feature_definition);
  WHERE
    wr1 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('INTEGRATED_CNC_SCHEMA.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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (sa_occ.
             description IN ['boundary occurrence',
             'non-planar boundary occurrence',
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          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (sa_occ.
          description = 'boundary occurrence') )) = 1)) )) = 0)) OR (
          SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
          QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATED_SHAPE_ASPECT') | ((sar.description =
          'profile usage') AND (('INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_DEFINING_RELATIONSHIP') IN TYPEOF(sar))) ) | ((
          SIZEOF(['INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
          'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
          'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
          'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE',
          'INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
          'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
          'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
          'INTEGRATED_CNC_SCHEMA.LINEAR_PROFILE',
          'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
          'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (NOT (
          SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATED_SHAPE_ASPECT') | ((sar.description =
          'profile floor usage') AND (
          'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
          TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.PROFILE_FLOOR' IN
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            TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 0)) )) =
           0));
wr5 : ((NOT (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
           'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
           'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
           pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
           'INTEGRATED_CNC_SCHEMA.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,
           'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
           'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
           pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
           'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
           QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
           'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
           'RELATED_SHAPE_ASPECT') | ((sar.description =
           'path feature component usage') AND ((
           'INTEGRATED_CNC_SCHEMA.' + 'SHAPE_DEFINING_RELATIONSHIP')
           IN TYPEOF(sar))) ) | ((SIZEOF([
           'INTEGRATED_CNC_SCHEMA.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,
           'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
           'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
           pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
           'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (sa_occ.
           description = 'complex boundary occurrence') )) = 1)) )) =
           0)) OR (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
           'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
           'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
           pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
           'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
           QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
           'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
           'RELATED_SHAPE_ASPECT') | ((sar.description =
           'profile usage') AND (
           'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
           TYPEOF(sar))) ) | (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
           'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
           'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
           'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE',
           'INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
           'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
           'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
           'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
           'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
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          'INTEGRATED_CNC_SCHEMA.LINEAR_PROFILE',
          'INTEGRATED_CNC_SCHEMA.OPEN_PATH_PROFILE'] * TYPEOF(sdr.
          relating_shape_aspect)) = 1) )) = 1) )) = 1)) )) = 0));
wr7 : ((NOT (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (sa_occ.
          description = 'partial circular boundary occurrence') )) =
          1)) )) = 0)) OR (SIZEOF(QUERY ( pds <* QUERY ( pd <*
          USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
          QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATED_SHAPE_ASPECT') | ((sar.description =
          'profile usage') AND (
          'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
          TYPEOF(sar))) ) | (
          'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE' IN TYPEOF(
          sdr.relating_shape_aspect)) )) = 1) )) = 1)) )) = 0));
wr8 : ((NOT (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (sa_occ.
          description = 'closed circular boundary occurrence') )) = 1)) ))
          = 0)) OR (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
          QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATED_SHAPE_ASPECT') | ((sar.description =
          'profile usage') AND (
          'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
          TYPEOF(sar))) ) | (
          'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE' IN TYPEOF(
          sdr.relating_shape_aspect)) )) = 1) )) = 1)) )) = 0));
wr9 : ((NOT (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (sa_occ.
          description = 'open rectangular boundary occurrence') )) =
          1)) )) = 0)) OR (SIZEOF(QUERY ( pds <* QUERY ( pd <*
          USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
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              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'profile usage') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE'
              IN TYPEOF(sdr.relating_shape_aspect)) )) = 1) )) = 1)) )) =
               0));
    wr10: ((NOT (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (sa_occ.
              description = 'closed rectangular boundary occurrence') ))
              = 1)) )) = 0)) OR (SIZEOF(QUERY ( pds <* QUERY ( pd <*
              USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'profile usage') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | (
              'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE' IN
              TYPEOF(sdr.relating_shape_aspect)) )) = 1) )) = 1)) )) = 0));
    wr11: ((SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.
              used_representation.name = 'removal direction')) )) = 1)) ))
              = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY parabola
  SUBTYPE OF (conic);
    focal_dist : length_measure;
  WHERE
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    wr1: (focal_dist <> 0);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY parallel_offset
  SUBTYPE OF (derived_shape_aspect);
    offset : measure_with_unit;
  WHERE
    wr1: (SIZEOF(SELF\derived_shape_aspect.deriving_relationships) = 1);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY parallelism_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
  WHERE
    wr1: (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
             datum_system) < 3);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY parametric_representation_context
  SUBTYPE OF (representation_context);
END_ENTITY; -- 10303-43: representation_schema

ENTITY partial_circular_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
             TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((
             'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
             name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
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    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
              it)) = 2) AND (it.name = 'radius')) )) = 1)) )) = 0)) )) = 0);
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
              TYPEOF(it)) = 2) AND (it.name = 'sweep angle')) )) = 1)) ))
              = 0)) )) = 0);
    wr7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.
              used_representation.name = 'profile limit')) )) <= 1)) )) =
              0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY path
  SUPERTYPE OF (ONEOF (edge_loop,oriented_path))
  SUBTYPE OF (topological_representation_item);
    edge_list : LIST [1:?] OF UNIQUE oriented_edge;
  WHERE
    wr1: path_head_to_tail(SELF);
END_ENTITY; -- 10303-42: topology_schema

ENTITY path_feature_component
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : ('INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
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          NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) )) = 1)) )) = 0));
wr4 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
          name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
wr5 : ((NOT (SELF.description = 'partial circular')) OR (SIZEOF(
          QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2) AND (it.name = 'sweep angle')) )) = 1)) ))
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          = 0)) )) = 0));
wr8 : ((NOT (SELF.description = 'complete circular')) OR (SIZEOF(
          QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
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              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) )) = 1)) )) = 0));
    wr13: ((NOT (SELF.description = 'complex')) OR (SIZEOF(
              QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.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; -- 10303-238: integrated_cnc_schema

ENTITY path_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(SELF.items) >= 1);
    wr2: (SIZEOF(QUERY ( i <* SELF.items | (SIZEOF([
             'INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE',
             'INTEGRATED_CNC_SCHEMA.EDGE_CURVE',
             'INTEGRATED_CNC_SCHEMA.PATH'] * TYPEOF(i)) = 1) )) >= 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY pattern_offset_membership
  SUBTYPE OF (feature_component_relationship);
  WHERE
    wr1 : (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF.
              relating_shape_aspect,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | ((
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar)) AND (sar :<>: SELF)) ) | (SIZEOF(
              QUERY ( pdr <* QUERY ( pd <* USEDIN(fcr.
              related_shape_aspect.of_shape,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (SIZEOF(['INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
              'INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'] * TYPEOF(pdr.
              definition)) = 1) )) = 0) )) = 0);
    wr2 : (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF.
              related_shape_aspect,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar)) AND (sar :<>: SELF)) ) | ((fcr.description =
              'modified pattern') AND (
              'INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN' IN TYPEOF(fcr.
              relating_shape_aspect))) )) >= 1);
    wr3 : (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF.
              related_shape_aspect,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
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            'RELATED_SHAPE_ASPECT') | ((
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar)) AND (sar :<>: SELF)) ) | ((
            'INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN' IN TYPEOF(fcr.
            relating_shape_aspect)) AND (NOT (SIZEOF(QUERY ( modfcr <*
            QUERY ( modsar <* USEDIN(fcr.relating_shape_aspect,
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') | ((
            SIZEOF(['INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
            'INTEGRATED_CNC_SCHEMA.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 ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
            SELF.relating_shape_aspect.of_shape.definition))) OR (
            SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 2)) ))
            = 0));
wr5n: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN' IN TYPEOF(SELF
            .relating_shape_aspect.of_shape.definition))) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 1)) ))
            = 0));
wr6 : ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN' IN TYPEOF(SELF
            .relating_shape_aspect.of_shape.definition))) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (NOT (
            SIZEOF(pdr.used_representation.items) = 2)) )) = 0)) )) = 0));
wr7 : ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN' IN TYPEOF(SELF
            .relating_shape_aspect.of_shape.definition))) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE' IN
            TYPEOF(it\measure_with_unit.value_component)) AND (it.name
            = 'index number')) )) = 1)) )) = 0)) )) = 0));
wr8 : ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN' IN TYPEOF(SELF
            .relating_shape_aspect.of_shape.definition))) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
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          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT' IN
          TYPEOF(it)) AND (it.name = 'offset')) )) = 1)) )) = 0)) ))
          = 0));
wr9 : ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
          SELF.relating_shape_aspect.of_shape.definition))) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(impl_rep.
          used_representation.items) = 3)) )) = 0)) )) = 0));
wr10: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
          SELF.relating_shape_aspect.of_shape.definition))) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE' IN
          TYPEOF(it\measure_with_unit.value_component)) AND (it.name
          = 'row index')) )) = 1)) )) = 0)) )) = 0));
wr11: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
          SELF.relating_shape_aspect.of_shape.definition))) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE' IN
          TYPEOF(it\measure_with_unit.value_component)) AND (it.name
          = 'column index')) )) = 1)) )) = 0)) )) = 0));
wr12: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
          SELF.relating_shape_aspect.of_shape.definition))) OR (
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              SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((
              'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT' IN TYPEOF(
              it)) AND (it.name = 'offset distance')) )) = 1)) )) = 0)) ))
              = 0));
    wr13: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
              SELF.relating_shape_aspect.of_shape.definition))) OR (
              SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.
              used_representation.name = 'offset direction')) )) = 1)) ))
              = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY pattern_omit_membership
  SUBTYPE OF (feature_component_relationship);
  WHERE
    wr1: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF.
             relating_shape_aspect,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATING_SHAPE_ASPECT') | ((
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
             TYPEOF(sar)) AND (sar :<>: SELF)) ) | (SIZEOF(
             QUERY ( pdr <* QUERY ( pd <* USEDIN(fcr.related_shape_aspect
             .of_shape,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             pd)) ) | (SIZEOF(['INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
             'INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN'] * TYPEOF(pdr.
             definition)) = 1) )) = 0) )) = 0);
    wr2: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF.
             related_shape_aspect,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATED_SHAPE_ASPECT') | ((
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
             TYPEOF(sar)) AND (sar :<>: SELF)) ) | ((fcr.description =
             'modified pattern') AND (
             'INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN' IN TYPEOF(fcr.
             relating_shape_aspect))) )) >= 1);
    wr3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF.
             related_shape_aspect,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATED_SHAPE_ASPECT') | ((
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          'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
          TYPEOF(sar)) AND (sar :<>: SELF)) ) | ((
          'INTEGRATED_CNC_SCHEMA.MODIFIED_PATTERN' IN TYPEOF(fcr.
          relating_shape_aspect)) AND (NOT (SIZEOF(QUERY ( modfcr <*
          QUERY ( modsar <* USEDIN(fcr.relating_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') | ((
          SIZEOF(['INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 1)) )) =
           0);
wr5: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN' IN TYPEOF(SELF.
          relating_shape_aspect.of_shape.definition))) OR (SIZEOF(
          QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (NOT (
          SIZEOF(pdr.used_representation.items) = 1)) )) = 0)) )) = 0));
wr6: ((NOT ('INTEGRATED_CNC_SCHEMA.CIRCULAR_PATTERN' IN TYPEOF(SELF.
          relating_shape_aspect.of_shape.definition))) OR (SIZEOF(
          QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE' IN
          TYPEOF(it\measure_with_unit.value_component)) AND (it.name =
           'index number')) )) = 1)) )) = 0)) )) = 0));
wr7: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
          SELF.relating_shape_aspect.of_shape.definition))) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (NOT (
          SIZEOF(pdr.used_representation.items) = 2)) )) = 0)) )) = 0));
wr8: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
          SELF.relating_shape_aspect.of_shape.definition))) OR (
          SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
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             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
             TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE' IN
             TYPEOF(it\measure_with_unit.value_component)) AND (it.name =
              'row index')) )) = 1)) )) = 0)) )) = 0));
    wr9: ((NOT ('INTEGRATED_CNC_SCHEMA.RECTANGULAR_PATTERN' IN TYPEOF(
             SELF.relating_shape_aspect.of_shape.definition))) OR (
             SIZEOF(QUERY ( pd <* USEDIN(SELF.related_shape_aspect,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
             TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE' IN
             TYPEOF(it\measure_with_unit.value_component)) AND (it.name =
              'column index')) )) = 1)) )) = 0)) )) = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY pcurve
  SUBTYPE OF (curve);
    basis_surface      : surface;
    reference_to_curve : definitional_representation;
  WHERE
    wr1: (SIZEOF(reference_to_curve\representation.items) = 1);
    wr2: ('INTEGRATED_CNC_SCHEMA.CURVE' IN TYPEOF(reference_to_curve\
             representation.items[1]));
    wr3: (reference_to_curve\representation.items[1]\
             geometric_representation_item.dim = 2);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY perpendicular_to
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: (SIZEOF(SELF\derived_shape_aspect.deriving_relationships) = 1);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY perpendicularity_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
  WHERE
    wr1: (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
             datum_system) <= 3);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY person;
    id            : identifier;
```

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```
    last_name     : OPTIONAL label;
    first_name    : OPTIONAL label;
    middle_names  : OPTIONAL LIST [1:?] OF label;
    prefix_titles : OPTIONAL LIST [1:?] OF label;
    suffix_titles : OPTIONAL LIST [1:?] OF label;
  WHERE
    wr1: (EXISTS(last_name) OR EXISTS(first_name));
END_ENTITY; -- 10303-41: person_organization_schema

ENTITY person_and_organization;
    the_person       : person;
    the_organization : organization;
  DERIVE
    name        : label := get_name_value(SELF);
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: person_organization_schema

ENTITY person_and_organization_assignment
  ABSTRACT SUPERTYPE;
    assigned_person_and_organization : person_and_organization;
    role                             : person_and_organization_role;
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY person_and_organization_role;
    name : label;
  DERIVE
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: person_organization_schema

ENTITY personal_address
  SUBTYPE OF (address);
    people      : SET [1:?] OF person;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: person_organization_schema

ENTITY placed_datum_target_feature
  SUBTYPE OF (datum_target);
  WHERE
    wr1 : (SELF.description IN ['point','line','rectangle','circle']);
    wr2 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
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            used_representation)) )) = 1)) )) = 0);
    wr3 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            dtm_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
            name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr4 : ((NOT (SELF.description = 'point')) OR (SIZEOF(QUERY ( pd <*
            USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(dtm_rep.
            used_representation.items) = 1)) )) = 0)) )) = 0));
    wr5 : ((NOT (SELF.description IN ['line','circle'])) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(dtm_rep.
            used_representation.items) = 2)) )) = 0)) )) = 0));
    wr6 : ((NOT (SELF.description = 'rectangle')) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(dtm_rep.
            used_representation.items) = 3)) )) = 0)) )) = 0));
    wr7 : ((NOT (SELF.description = 'circle')) OR (SIZEOF(QUERY ( pd <*
            USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            dtm_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
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            it)) = 2) AND (it.name = 'target diameter')) )) = 1)) )) =
            0)) )) = 0));
    wr8 : ((NOT (SELF.description = 'line')) OR (SIZEOF(QUERY ( pd <*
            USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            dtm_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'target length')) )) = 1)) )) = 0)) ))
            = 0));
    wr9 : ((NOT (SELF.description = 'rectangle')) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            dtm_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'target length')) )) = 1)) )) = 0)) ))
            = 0));
    wr10: ((NOT (SELF.description = 'rectangle')) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( dtm_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            dtm_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'target width')) )) = 1)) )) = 0)) ))
            = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY placement
  SUPERTYPE OF (ONEOF (axis1_placement,axis2_placement_2d,
      axis2_placement_3d))
  SUBTYPE OF (geometric_representation_item);
    location : cartesian_point;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY planar_shape_representation
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  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(SELF.items) = 1);
    wr2: (SIZEOF(QUERY ( it <* SELF.items | (NOT (
              'INTEGRATED_CNC_SCHEMA.PLANE' IN TYPEOF(it))) )) = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY plane
  SUBTYPE OF (elementary_surface);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY plane_angle_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_UNIT' IN TYPEOF(SELF\
              measure_with_unit.unit_component));
END_ENTITY; -- 10303-41: measure_schema

ENTITY plane_angle_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
              named_unit.dimensions.mass_exponent = 0) AND (SELF\
              named_unit.dimensions.time_exponent = 0) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0) AND (
              SELF\named_unit.dimensions.
              thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
              .dimensions.amount_of_substance_exponent = 0) AND (SELF\
              named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- 10303-41: measure_schema

ENTITY plane_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['rough milling','finish milling']);

  WR2:  (verify_optional_action_property    (SELF, 'axial cutting depth')) AND
        (verify_length_measure_action_property (SELF, 'axial cutting depth'));

  WR3:  (verify_optional_action_property        (SELF, 'allowance bottom')) AND
        (verify_length_measure_action_property  (SELF, 'allowance bottom'));

  WR4:  NOT (SELF.description = 'rough milling') OR
        (verify_required_action_property (SELF, 'allowance bottom'));
END_ENTITY;

ENTITY plus_minus_tolerance;
    range                : tolerance_method_definition;
    toleranced_dimension : dimensional_characteristic;
  UNIQUE
    ur1 : toleranced_dimension;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY pocket
```

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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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'pocket depth occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'path feature component usage') AND (sar.name =
            'pocket depth') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ((
            'INTEGRATED_CNC_SCHEMA.PATH_FEATURE_COMPONENT' IN TYPEOF(
            sdr.relating_shape_aspect)) AND (sdr.relating_shape_aspect.
            description = 'linear')) )) = 1)) )) = 1)) )) = 0);
  wr3 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) )) = 1)) )) = 0);
  wr4 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) AND (1 <= SIZEOF(pdr.
            used_representation.items)) AND (SIZEOF(pdr.
            used_representation.items) <= 2)) )) = 1) )) = 1);
  wr5 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
            'INTEGRATED_CNC_SCHEMA.' +
            '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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
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            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'boundary occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | (SIZEOF([
            'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
            'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
            'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
            'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE',
            'INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
            'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
            'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
            'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
            'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'closed boundary occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | (
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
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          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
          description = 'open boundary occurrence') AND (SIZEOF(
          QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATED_SHAPE_ASPECT') | ((sar.description =
          'profile usage') AND (
          'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
          TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE'
          IN TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) ))
          = 0));
wr10: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
          description = 'bottom condition occurrence') AND (SIZEOF(
          QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATED_SHAPE_ASPECT') | ((sar.description =
          'pocket bottom usage') AND (
          'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
          TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.POCKET_BOTTOM' IN
           TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) =
          0);
wr11: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
          description = 'change in boundary occurrence') AND (SIZEOF(
          QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATING_SHAPE_ASPECT') | ((sar.description =
          'taper usage') AND (
          'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
          TYPEOF(sar))) ) | (('INTEGRATED_CNC_SCHEMA.TAPER' IN
          TYPEOF(fcr.related_shape_aspect)) 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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
          pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
          description = 'enclosed boundary occurrence') AND (SIZEOF(
          QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
          'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
          'RELATED_SHAPE_ASPECT') | ((sar.description =
          'profile usage') AND (
          'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
          TYPEOF(sar))) ) | (
          'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE' IN TYPEOF(
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              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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'bottom condition occurrence') AND (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'pocket bottom usage') AND (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar))) ) | (('INTEGRATED_CNC_SCHEMA.POCKET_BOTTOM'
              IN TYPEOF(sdr.relating_shape_aspect)) 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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'bottom condition occurrence') AND (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'pocket bottom usage') AND (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar))) ) | (('INTEGRATED_CNC_SCHEMA.POCKET_BOTTOM'
              IN TYPEOF(sdr.relating_shape_aspect)) AND (sdr.
              relating_shape_aspect.description IN ['planar','complex'])) ))
              = 1)) )) = 1)) )) = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY pocket_bottom
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : ('INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
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          NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) )) = 1)) )) = 0));
wr7 : ((NOT (SELF.description IN ['planar','complex'])) OR (SIZEOF(
          QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) )) = 0)) )) = 0));
wr9 : ((NOT (SELF.description IN ['planar','complex'])) OR (SIZEOF(
          QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
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              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
              it)) = 2) AND (it.name = 'radius')) )) <= 1)) )) = 0)) )) =
               0));
    wr10: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | ((sar.description =
              'pocket bottom usage') AND (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar))) ) | ((fcr.related_shape_aspect.description =
              'bottom condition occurrence') AND (
              'INTEGRATED_CNC_SCHEMA.POCKET' IN TYPEOF(fcr.
              related_shape_aspect.of_shape.definition))) )) >= 1);
    wr11: ((NOT (SELF.description IN ['planar','complex'])) OR (SIZEOF(
              QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | ((sar.description =
              'pocket bottom usage') AND (
              'INTEGRATED_CNC_SCHEMA.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; -- 10303-238: integrated_cnc_schema

ENTITY point
  SUPERTYPE OF (ONEOF (cartesian_point,point_on_curve,point_on_surface,
      degenerate_pcurve))
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY point_on_curve
  SUBTYPE OF (point);
    basis_curve     : curve;
    point_parameter : parameter_value;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY point_on_surface
  SUBTYPE OF (point);
    basis_surface     : surface;
    point_parameter_u : parameter_value;
    point_parameter_v : parameter_value;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY polyline
  SUBTYPE OF (bounded_curve);
    points : LIST [2:?] OF cartesian_point;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY position_tolerance
  SUBTYPE OF (geometric_tolerance);
  WHERE
    wr1: ((NOT (('INTEGRATED_CNC_SCHEMA.' +
              'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)))
```

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```
             OR (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
             datum_system) <= 3));
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY precision_qualifier;
    precision_value : INTEGER;
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY process_product_association;
    name            : label;
    description     : text;
    defined_product : characterized_product_definition;
    process         : product_definition_process;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY process_property_association;
    name              : label;
    description       : text;
    process           : property_process;
    property_or_shape : property_or_shape_select;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY product;
    id                 : identifier;
    name               : label;
    description        : OPTIONAL text;
    frame_of_reference : SET [1:?] OF product_context;
END_ENTITY; -- 10303-41: product_definition_schema

ENTITY product_category;
    name        : label;
    description : OPTIONAL text;
  DERIVE
    id : identifier := get_id_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: product_definition_schema

ENTITY product_category_relationship;
    name         : label;
    description  : OPTIONAL text;
    category     : product_category;
    sub_category : product_category;
  WHERE
    wr1: acyclic_product_category_relationship(SELF,[SELF.sub_category]);
END_ENTITY; -- 10303-41: product_definition_schema

ENTITY product_context
  SUBTYPE OF (application_context_element);
    discipline_type : label;
END_ENTITY; -- 10303-41: application_context_schema

ENTITY product_definition;
```

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    id                 : identifier;
    description        : OPTIONAL text;
    formation          : product_definition_formation;
    frame_of_reference : product_definition_context;
  DERIVE
    name : label := get_name_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
              'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: product_definition_schema

ENTITY product_definition_context
  SUBTYPE OF (application_context_element);
    life_cycle_stage : label;
END_ENTITY; -- 10303-41: application_context_schema

ENTITY product_definition_formation;
    id          : identifier;
    description : OPTIONAL text;
    of_product  : product;
  UNIQUE
    ur1 : id, of_product;
END_ENTITY; -- 10303-41: product_definition_schema

ENTITY product_definition_process
  SUBTYPE OF (action);
    identification : identifier;
  INVERSE
    product_definitions : SET [1:?] OF process_product_association FOR
                              process;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY product_definition_relationship;
    id                          : identifier;
    name                        : label;
    description                 : OPTIONAL text;
    relating_product_definition : product_definition;
    related_product_definition  : product_definition;
END_ENTITY; -- 10303-41: product_definition_schema

ENTITY product_definition_shape
  SUBTYPE OF (property_definition);
  UNIQUE
    ur1 : definition;
  WHERE
    wr1: (SIZEOF([
              'INTEGRATED_CNC_SCHEMA.CHARACTERIZED_PRODUCT_DEFINITION',
              'INTEGRATED_CNC_SCHEMA.CHARACTERIZED_OBJECT'] * TYPEOF(SELF\
              property_definition.definition)) > 0);
END_ENTITY; -- 10303-41: product_property_definition_schema

ENTITY product_definition_usage
  SUPERTYPE OF (ONEOF (make_from_usage_option,assembly_component_usage))
  SUBTYPE OF (product_definition_relationship);
```

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```
  UNIQUE
    ur1 : id, relating_product_definition, related_product_definition;
  WHERE
    wr1: acyclic_product_definition_relationship(SELF,[SELF\
             product_definition_relationship.related_product_definition],
             'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_USAGE');
END_ENTITY; -- 10303-44: product_structure_schema

ENTITY product_definition_with_associated_documents
  SUBTYPE OF (product_definition);
    documentation_ids : SET [1:?] OF document;
END_ENTITY; -- 10303-41: product_definition_schema

ENTITY product_related_product_category
  SUBTYPE OF (product_category);
    products : SET [1:?] OF product;
END_ENTITY; -- 10303-41: product_definition_schema

ENTITY profile_floor
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : ('INTEGRATED_CNC_SCHEMA.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,
               'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
               NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
               'INTEGRATED_CNC_SCHEMA.' +
               'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
               'INTEGRATED_CNC_SCHEMA.' +
               'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
               used_representation)) )) = 1)) )) = 0));
    wr4 : ((NOT (SELF.description IN ['planar','complex'])) OR (SIZEOF(
               QUERY ( pd <* USEDIN(SELF,
               'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
               NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
               'INTEGRATED_CNC_SCHEMA.' +
               'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
               'INTEGRATED_CNC_SCHEMA.' +
               '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,
               'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
               NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
               'INTEGRATED_CNC_SCHEMA.' +
               'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
               'INTEGRATED_CNC_SCHEMA.' +
               'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
               used_representation)) )) = 0)) )) = 0));
    wr6 : ((NOT (SELF.description IN ['planar','complex'])) OR (SIZEOF(
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```
            QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'radius')) )) = 1)) )) = 0)) )) =
            0));
    wr7 : (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATING_SHAPE_ASPECT') | ((sar.description =
            'profile floor usage') AND (
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.OUTSIDE_PROFILE'
            IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)) ))
            >= 1);
    wr8 : ((NOT (SELF.description IN ['planar','complex'])) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.
            used_representation.name = 'floor')) )) = 1)) )) = 1));
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END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY projected_zone_definition
  SUBTYPE OF (tolerance_zone_definition);
    projection_end   : shape_aspect;
    projected_length : measure_with_unit;
  WHERE
    wr1: (('NUMBER' IN TYPEOF(projected_length\measure_with_unit.
             value_component)) AND (projected_length\measure_with_unit.
             value_component > 0));
    wr2: (derive_dimensional_exponents(projected_length\
             measure_with_unit.unit_component) = dimensional_exponents(1,
             0,0,0,0,0,0));
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY property_definition;
    name        : label;
    description : OPTIONAL text;
    definition  : characterized_definition;
  DERIVE
    id : identifier := get_id_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: product_property_definition_schema

ENTITY property_definition_representation;
    definition          : represented_definition;
    used_representation : representation;
  DERIVE
    description : text := get_description_value(SELF);
    name        : label := get_name_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: product_property_representation_schema

ENTITY property_process
  SUBTYPE OF (action);
    identification : identifier;
  INVERSE
    properties : SET [1:?] OF process_property_association FOR process;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY protrusion
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
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            'INTEGRATED_CNC_SCHEMA.' +
            '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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'shape volume occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'volume shape usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | (sdr.relating_shape_aspect.description =
            'volume shape') )) = 1)) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY qualified_representation_item
  SUBTYPE OF (representation_item);
    qualifiers : SET [1:?] OF value_qualifier;
  WHERE
    wr1: (SIZEOF(QUERY ( temp <* qualifiers | (
            'INTEGRATED_CNC_SCHEMA.PRECISION_QUALIFIER' IN TYPEOF(temp)) ))
            < 2);
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY qualitative_uncertainty
  SUBTYPE OF (uncertainty_qualifier);
    uncertainty_value : text;
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY quasi_uniform_curve
  SUBTYPE OF (b_spline_curve);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY quasi_uniform_surface
  SUBTYPE OF (b_spline_surface);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY ratio_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.RATIO_UNIT' IN TYPEOF(SELF\
            measure_with_unit.unit_component));
END_ENTITY; -- 10303-41: measure_schema

ENTITY ratio_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
            named_unit.dimensions.mass_exponent = 0) AND (SELF\
            named_unit.dimensions.time_exponent = 0) AND (SELF\
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              named_unit.dimensions.electric_current_exponent = 0) AND (
              SELF\named_unit.dimensions.
              thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
              .dimensions.amount_of_substance_exponent = 0) AND (SELF\
              named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- 10303-41: measure_schema

ENTITY rational_b_spline_curve
  SUBTYPE OF (b_spline_curve);
    weights_data : LIST [2:?] OF REAL;
  DERIVE
    weights : ARRAY [0:upper_index_on_control_points] OF REAL :=
                  list_to_array(weights_data,0,
                  upper_index_on_control_points);
  WHERE
    wr1: (SIZEOF(weights_data) = SIZEOF(SELF\b_spline_curve.
              control_points_list));
    wr2: curve_weights_positive(SELF);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY rational_b_spline_surface
  SUBTYPE OF (b_spline_surface);
    weights_data : LIST [2:?] OF LIST [2:?] OF REAL;
  DERIVE
    weights : ARRAY [0:u_upper] OF ARRAY [0:v_upper] OF REAL :=
                  make_array_of_array(weights_data,0,u_upper,0,v_upper);
  WHERE
    wr1: ((SIZEOF(weights_data) = SIZEOF(SELF\b_spline_surface.
              control_points_list)) AND (SIZEOF(weights_data[1]) = SIZEOF(
              SELF\b_spline_surface.control_points_list[1])));
    wr2: surface_weights_positive(SELF);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY real_literal
  SUBTYPE OF (literal_number);
    SELF\literal_number.the_value : REAL;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY real_numeric_variable
  SUBTYPE OF (numeric_variable);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY rectangular_closed_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
              TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
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            used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            '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,'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION.DEFINITION') | (SIZEOF(QUERY ( pdr <*
            USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
(('INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
            name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'width')) )) = 1)) )) = 0)) )) = 0);
    wr7: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
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            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'length')) )) = 1)) )) = 0)) )) = 0);
    wr8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'corner radius')) )) <= 1)) )) = 0)) ))
            = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY rectangular_composite_surface
  SUBTYPE OF (bounded_surface);
    segments : LIST [1:?] OF LIST [1:?] OF surface_patch;
  DERIVE
    n_u : INTEGER := SIZEOF(segments);
    n_v : INTEGER := SIZEOF(segments[1]);
  WHERE
    wr1: (SIZEOF(QUERY ( s <* segments | (n_v <> SIZEOF(s)) )) = 0);
    wr2: constraints_rectangular_composite_surface(SELF);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY rectangular_pattern
  SUBTYPE OF (replicate_feature);
  WHERE
    wr1 : (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar)) ) | ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT' IN
              TYPEOF(sdr.related_shape_aspect)) )) = 1) )) <= 5)) )) = 0);
    wr2 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.
              used_representation.name = 'row layout direction')) )) = 1)) ))
              = 0);
    wr3 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
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            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.
            used_representation.name = 'column layout direction')) )) =
             1)) )) = 0);
wr4 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
             | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) )) = 1)) )) = 0);
wr5 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            '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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
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              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
              it)) = 2) AND (it.name = 'row spacing')) )) = 1)) )) = 0)) ))
              = 0);
    wr9 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
              it)) = 2) AND (it.name = 'column spacing')) )) = 1)) )) = 0)) ))
              = 0);
    wr10: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
              impl_rep.used_representation.items | ((
              'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
              name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY rectangular_trimmed_surface
  SUBTYPE OF (bounded_surface);
    basis_surface : surface;
    u1            : parameter_value;
    u2            : parameter_value;
    v1            : parameter_value;
    v2            : parameter_value;
    usense        : BOOLEAN;
    vsense        : BOOLEAN;
  WHERE
    wr1: (u1 <> u2);
    wr2: (v1 <> v2);
    wr3: ((('INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE' IN TYPEOF(
              basis_surface)) AND (NOT ('INTEGRATED_CNC_SCHEMA.PLANE' IN
              TYPEOF(basis_surface)))) OR (
              'INTEGRATED_CNC_SCHEMA.SURFACE_OF_REVOLUTION' IN TYPEOF(
              basis_surface)) OR (usense = (u2 > u1)));
    wr4: (('INTEGRATED_CNC_SCHEMA.SPHERICAL_SURFACE' IN TYPEOF(
              basis_surface)) OR ('INTEGRATED_CNC_SCHEMA.TOROIDAL_SURFACE'
              IN TYPEOF(basis_surface)) OR (vsense = (v2 > v1)));
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END_ENTITY; -- 10303-42: geometry_schema

ENTITY referenced_modified_datum
  SUBTYPE OF (datum_reference);
    modifier : limit_condition;
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY removal_volume
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              '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,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
              description = 'shape volume occurrence') AND (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'volume shape usage') AND (('INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_DEFINING_RELATIONSHIP') IN TYPEOF(sar))) ) | (sdr.
              relating_shape_aspect.description = 'volume shape') )) = 1)) ))
              = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY reparametrised_composite_curve_segment
  SUBTYPE OF (composite_curve_segment);
    param_length : parameter_value;
  WHERE
    wr1: (param_length > 0);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY replicate_feature
  SUPERTYPE OF (ONEOF (circular_pattern,rectangular_pattern,
      feature_pattern))
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) )) = 1)) )) = 0);
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    wr2: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATING_SHAPE_ASPECT') | (
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
             TYPEOF(sar)) ) | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.REPLICATE_FEATURE',
             'INTEGRATED_CNC_SCHEMA.INSTANCED_FEATURE'] * TYPEOF(fcr.
             related_shape_aspect)) >= 1) AND (fcr.name = 'pattern basis')) ))
             = 1);
    wr3: ((SIZEOF(QUERY ( sar <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATING_SHAPE_ASPECT') | (NOT (
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
             TYPEOF(sar))) )) + SIZEOF(QUERY ( sar <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATED_SHAPE_ASPECT') | (NOT (
             'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
             TYPEOF(sar))) ))) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY representation;
    name             : label;
    items            : SET [1:?] OF representation_item;
    context_of_items : representation_context;
  DERIVE
    id          : identifier := get_id_value(SELF);
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- 10303-43: representation_schema

ENTITY representation_context;
    context_identifier : identifier;
    context_type       : text;
  INVERSE
    representations_in_context : SET [1:?] OF representation FOR
                                     context_of_items;
END_ENTITY; -- 10303-43: representation_schema

ENTITY representation_item;
    name : label;
  WHERE
    wr1: (SIZEOF(using_representations(SELF)) > 0);
END_ENTITY; -- 10303-43: representation_schema

ENTITY representation_item_relationship;
    name                         : label;
    description                  : OPTIONAL text;
    relating_representation_item : representation_item;
    related_representation_item  : representation_item;
END_ENTITY; -- 10303-43: representation_schema
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ENTITY representation_map;
    mapping_origin        : representation_item;
    mapped_representation : representation;
  INVERSE
    map_usage : SET [1:?] OF mapped_item FOR mapping_source;
  WHERE
    wr1: item_in_context(SELF.mapping_origin,SELF.mapped_representation.
             context_of_items);
END_ENTITY; -- 10303-43: representation_schema

ENTITY representation_relationship;
    name        : label;
    description : OPTIONAL text;
    rep_1       : representation;
    rep_2       : representation;
END_ENTITY; -- 10303-43: representation_schema

ENTITY representation_relationship_with_transformation
  SUBTYPE OF (representation_relationship);
    transformation_operator : transformation;
  WHERE
    wr1: (SELF\representation_relationship.rep_1.context_of_items :<>:
             SELF\representation_relationship.rep_2.context_of_items);
END_ENTITY; -- 10303-43: representation_schema

ENTITY requirement_for_action_resource
  SUBTYPE OF (action_resource_requirement);
    resources : SET [1:?] OF action_resource;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY resource_property;
    name        : label;
    description : text;
    resource    : characterized_resource_definition;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY resource_property_representation;
    name           : label;
    description    : text;
    property       : resource_property;
    representation : representation;
END_ENTITY; -- 10303-49: process_property_representation_schema

ENTITY resource_requirement_type;
    name        : label;
    description : text;
END_ENTITY; -- 10303-49: process_property_schema

ENTITY revolved_profile
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SELF\characterized_object.description IN ['groove','flat',
             'round','open profile']);
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wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
         'INTEGRATED_CNC_SCHEMA.' +
         '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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
         'INTEGRATED_CNC_SCHEMA.' +
         'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
         used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
         impl_rep.used_representation.items | ((SIZEOF([
         'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
         it)) = 2) AND (it.name = 'radius')) )) = 1)) )) = 0)) )) = 0);
wr4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
         'INTEGRATED_CNC_SCHEMA.' +
         'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
         'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
         TYPEOF(pdr.used_representation)) AND (pdr.
         used_representation.name = 'removal direction')) )) = 1)) ))
         = 0);
wr5: ((NOT (SELF\characterized_object.description = 'open profile'))
         OR (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
         pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
         description = 'outer edge shape occurrence') AND (SIZEOF(
         QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
         'RELATED_SHAPE_ASPECT') | ((sar.description =
         'profile usage') AND (
         'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
         TYPEOF(sar))) ) | ((
         'INTEGRATED_CNC_SCHEMA.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,
         'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
         'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
         pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
         'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
         description = 'flat edge shape occurrence') AND (SIZEOF(
         QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
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            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | (('INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'rounded edge shape occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ((
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'sweep occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
            'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
            'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
            'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
            'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
            'INTEGRATED_CNC_SCHEMA.OPEN_PATH_PROFILE'] * TYPEOF(sdr.
            relating_shape_aspect)) = 1) AND (sdr.relating_shape_aspect.
            description = 'sweep')) )) = 1)) )) = 1)) )) = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY rib_top
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
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            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'rib top condition occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'rib top usage') AND (
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.RIB_TOP_FLOOR' IN
            TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.
            used_representation.name = 'removal direction')) )) = 1)) ))
            = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY rib_top_floor
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
            TYPEOF(SELF.of_shape.definition));
    wr2: (SELF.description IN ['planar','complex']);
    wr3: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATING_SHAPE_ASPECT') | ((sar.description =
            'rib top usage') AND (
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ((fcr.related_shape_aspect.description =
            'rib top condition occurrence') AND (
            'INTEGRATED_CNC_SCHEMA.RIB_TOP' IN TYPEOF(fcr.
            related_shape_aspect.of_shape.definition))) )) >= 1);
    wr4: ((NOT (SELF.description = 'complex')) OR (SIZEOF(QUERY ( pd <*
            USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.
            used_representation.name = 'rib top face')) )) = 1)) )) = 0));
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    wr6: ((NOT (SELF.description = 'planar')) OR (SIZEOF(QUERY ( pds <*
             QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
             description = 'boundary occurrence') AND (SIZEOF(
             QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATED_SHAPE_ASPECT') | ((sar.description =
             'profile usage') AND (
             'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
             TYPEOF(sar))) ) | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE',
             'INTEGRATED_CNC_SCHEMA.NGON_CLOSED_PROFILE',
             'INTEGRATED_CNC_SCHEMA.RECTANGULAR_CLOSED_PROFILE',
             'INTEGRATED_CNC_SCHEMA.CLOSED_PATH_PROFILE'] * TYPEOF(sdr.
             relating_shape_aspect)) = 1) AND (sdr.relating_shape_aspect.
             description = 'rib top floor boundary')) )) = 1)) )) = 1)) ))
             = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY right_circular_cylinder
  SUBTYPE OF (geometric_representation_item);
    position : axis1_placement;
    height   : positive_length_measure;
    radius   : positive_length_measure;
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY role_association;
    role           : object_role;
    item_with_role : role_select;
END_ENTITY; -- 10303-41: basic_attribute_schema

ENTITY round_hole
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
             description = 'diameter occurrence') AND (SIZEOF(
             QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATED_SHAPE_ASPECT') | ((sar.description =
             'profile usage') AND (
             'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
             TYPEOF(sar))) ) | ((
             'INTEGRATED_CNC_SCHEMA.CIRCULAR_CLOSED_PROFILE' IN TYPEOF(
             sdr.relating_shape_aspect)) AND (sdr.name = 'diameter')) ))
             = 1)) )) = 1)) )) = 0);
    wr2: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
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            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'hole depth occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'path feature component usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ((
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'bottom condition occurrence') AND (SIZEOF(
            QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'hole bottom usage') AND (
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.HOLE_BOTTOM' IN
            TYPEOF(fcr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    wr4: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'change in diameter occurrence') AND (SIZEOF(
            QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description = 'taper usage')
            AND ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
            IN TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.TAPER' IN
            TYPEOF(fcr.relating_shape_aspect)) )) = 1)) )) <= 1)) )) = 0);
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY rounded_end
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
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            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            '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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'partial circular boundary occurrence') AND (
            SIZEOF(QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | (
            'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE' IN TYPEOF(
            sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'course of travel occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'path feature component usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ((
            'INTEGRATED_CNC_SCHEMA.PATH_FEATURE_COMPONENT' IN TYPEOF(sdr
            .relating_shape_aspect)) AND (sdr.relating_shape_aspect.
            description = 'linear')) )) = 1)) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY rounded_u_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
            TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
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            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            '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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
            name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
    wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'width')) )) = 1)) )) = 0)) )) = 0);
    wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.
            used_representation.name = 'profile limit')) )) <= 1)) )) =
            0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY roundness_tolerance
  SUBTYPE OF (geometric_tolerance);
  WHERE
    wr1: (NOT (('INTEGRATED_CNC_SCHEMA.' +
            'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)));
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY runout_zone_definition
  SUBTYPE OF (tolerance_zone_definition);
    orientation : runout_zone_orientation;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY runout_zone_orientation;
    angle : measure_with_unit;
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END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY runout_zone_orientation_reference_direction
  SUBTYPE OF (runout_zone_orientation);
    orientation_defining_relationship : shape_aspect_relationship;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY seam_curve
  SUBTYPE OF (surface_curve);
  WHERE
    wr1: (SIZEOF(SELF\surface_curve.associated_geometry) = 2);
    wr2: (associated_surface(SELF\surface_curve.associated_geometry[1])
             = associated_surface(SELF\surface_curve.associated_geometry[
             2]));
    wr3: ('INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(SELF\surface_curve.
             associated_geometry[1]));
    wr4: ('INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(SELF\surface_curve.
             associated_geometry[2]));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY security_classification;
    name           : label;
    purpose        : text;
    security_level : security_classification_level;
END_ENTITY; -- 10303-41: security_classification_schema

ENTITY security_classification_assignment
  ABSTRACT SUPERTYPE;
    assigned_security_classification : security_classification;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY security_classification_level;
    name : label;
END_ENTITY; -- 10303-41: security_classification_schema

ENTITY sequential_method
  SUBTYPE OF (serial_action_method);
    sequence_position : count_measure;
END_ENTITY; -- 10303-49: method_definition_schema

ENTITY serial_action_method
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-49: method_definition_schema

ENTITY serial_numbered_effectivity
  SUBTYPE OF (effectivity);
    effectivity_start_id : identifier;
    effectivity_end_id   : OPTIONAL identifier;
END_ENTITY; -- 10303-41: effectivity_schema
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ENTITY shape_aspect;
    name                 : label;
    description          : OPTIONAL text;
    of_shape             : product_definition_shape;
    product_definitional : LOGICAL;
  DERIVE
    id : identifier := get_id_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: product_property_definition_schema

ENTITY shape_aspect_deriving_relationship
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.DERIVED_SHAPE_ASPECT' IN TYPEOF(SELF\
             shape_aspect_relationship.relating_shape_aspect));
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY shape_aspect_relationship;
    name                  : label;
    description           : OPTIONAL text;
    relating_shape_aspect : shape_aspect;
    related_shape_aspect  : shape_aspect;
  DERIVE
    id : identifier := get_id_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'INTEGRATED_CNC_SCHEMA.' +
             'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- 10303-41: product_property_definition_schema

ENTITY shape_defining_relationship
  SUBTYPE OF (shape_aspect_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY shape_definition_representation
  SUBTYPE OF (property_definition_representation);
  WHERE
    wr1: (('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             SELF.definition)) OR (
             'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINITION' IN TYPEOF(SELF.
             definition.definition)));
    wr2: ('INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION' IN TYPEOF(SELF.
             used_representation));
END_ENTITY; -- 10303-41: product_property_representation_schema

ENTITY shape_dimension_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(QUERY ( temp <* SELF\representation.items | (NOT (
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
             TYPEOF(temp))) )) = 0);
    wr2: (SIZEOF(SELF\representation.items) <= 3);
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    wr3: (SIZEOF(QUERY ( pos_mri <* QUERY ( real_mri <* SELF\
             representation.items | ('REAL' IN TYPEOF(real_mri\
             measure_with_unit.value_component)) ) | (NOT (pos_mri\
             measure_with_unit.value_component > 0)) )) = 0);
END_ENTITY; -- 10303-47: shape_dimension_schema

ENTITY shape_representation
  SUBTYPE OF (representation);
END_ENTITY; -- 10303-41: product_property_representation_schema

ENTITY shape_representation_relationship
  SUBTYPE OF (representation_relationship);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION' IN (TYPEOF(SELF\
             representation_relationship.rep_1) + TYPEOF(SELF\
             representation_relationship.rep_2)));
END_ENTITY; -- 10303-41: product_property_representation_schema

ENTITY shape_representation_with_parameters
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(QUERY ( it <* SELF.items | (NOT (SIZEOF([
             'INTEGRATED_CNC_SCHEMA.PLACEMENT',
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'] *
             TYPEOF(it)) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY shell_based_surface_model
  SUBTYPE OF (geometric_representation_item);
    sbsm_boundary : SET [1:?] OF shell;
  WHERE
    wr1: constraints_geometry_shell_based_surface_model(SELF);
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY si_unit
  SUBTYPE OF (named_unit);
    prefix : OPTIONAL si_prefix;
    name   : si_unit_name;
  DERIVE
    SELF\named_unit.dimensions : dimensional_exponents :=
                                     dimensions_for_si_unit(name);
END_ENTITY; -- 10303-41: measure_schema

ENTITY side_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['rough milling','finish milling']);

  WR2:  (verify_optional_action_property   (SELF, 'axial cutting depth')) AND
        (verify_length_measure_action_property(SELF, 'axial cutting depth'));

  WR3:  (verify_optional_action_property   (SELF, 'radial cutting depth')) AND
        (verify_length_measure_action_property(SELF, 'radial cutting depth'));
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  WR4:  (verify_optional_action_property        (SELF, 'allowance side')) AND
        (verify_length_measure_action_property  (SELF, 'allowance side'));

  WR5:  NOT (SELF.description = 'rough milling') OR
        (verify_required_action_property (SELF, 'allowance side'));
END_ENTITY;

ENTITY simple_generic_expression
  ABSTRACT SUPERTYPE OF (ONEOF (generic_literal,generic_variable))
  SUBTYPE OF (generic_expression);
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY simple_numeric_expression
  ABSTRACT SUPERTYPE OF (ONEOF (literal_number,numeric_variable))
  SUBTYPE OF (numeric_expression, simple_generic_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY slot
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
             description = 'swept shape occurrence') AND (SIZEOF(
             QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATED_SHAPE_ASPECT') | ((sar.description =
             'profile usage') AND (
             'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
             TYPEOF(sar))) ) | (SIZEOF([
             'INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE',
             'INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE',
             'INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE',
             'INTEGRATED_CNC_SCHEMA.VEE_PROFILE',
             'INTEGRATED_CNC_SCHEMA.TEE_PROFILE',
             'INTEGRATED_CNC_SCHEMA.OPEN_PATH_PROFILE'] * TYPEOF(sdr.
             relating_shape_aspect)) = 1) )) = 1)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
             pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
             'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
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            description = 'course of travel occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'path feature component usage') AND (sar.name =
            'course of travel') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | (
            'INTEGRATED_CNC_SCHEMA.PATH_FEATURE_COMPONENT' IN TYPEOF(sdr
            .relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    wr4: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'end condition occurrence') AND (SIZEOF(
            QUERY ( fcr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'slot end usage') AND (sar.name IN ['course of travel start',
            'course of travel end']) AND (
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.SLOT_END' IN
            TYPEOF(fcr.relating_shape_aspect)) )) = 1)) )) = 2)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY slot_end
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
              TYPEOF(SELF.of_shape.definition));
    wr2 : (SELF.description IN ['open','radiused','flat','woodruff']);
    wr3 : ((NOT (SELF.description IN ['open','radiused'])) OR (SIZEOF(
              QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) )) = 0)) )) = 0));
    wr4 : ((NOT (SELF.description IN ['flat','woodruff'])) OR (SIZEOF(
              QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) )) = 1)) )) = 0));
    wr5 : ((NOT (SELF.description IN ['flat'])) OR (SIZEOF(
              QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
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          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
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              used_representation)) ) | (NOT (SIZEOF(impl_rep.
              used_representation.items) = 1)) )) = 0)) )) = 0));
    wr10: (SIZEOF(QUERY ( fcr <* QUERY ( sar <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATING_SHAPE_ASPECT') | ((sar.description =
              'slot end usage') AND (sar.name IN [
              'course of travel start','course of travel end']) AND (
              'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
              TYPEOF(sar))) ) | ((fcr.related_shape_aspect.description =
              'end condition occurrence') AND (
              'INTEGRATED_CNC_SCHEMA.SLOT' IN TYPEOF(fcr.
              related_shape_aspect.of_shape.definition))) )) >= 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY solid_angle_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.SOLID_ANGLE_UNIT' IN TYPEOF(SELF\
             measure_with_unit.unit_component));
END_ENTITY; -- 10303-41: measure_schema

ENTITY solid_angle_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
             named_unit.dimensions.mass_exponent = 0) AND (SELF\
             named_unit.dimensions.time_exponent = 0) AND (SELF\
             named_unit.dimensions.electric_current_exponent = 0) AND (
             SELF\named_unit.dimensions.
             thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
             .dimensions.amount_of_substance_exponent = 0) AND (SELF\
             named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- 10303-41: measure_schema

ENTITY solid_model
  SUPERTYPE OF (manifold_solid_brep)
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY spherical_cap
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             '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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
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            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'radius')) )) = 1)) )) = 0)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2) AND (it.name = 'internal angle')) )) = 1)) ))
            = 0)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY spherical_surface
  SUBTYPE OF (elementary_surface);
    radius : positive_length_measure;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY square_u_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
              TYPEOF(SELF.of_shape.definition));
    wr2 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) )) = 1)) )) = 0);
    wr3 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) ) | ((NOT (SIZEOF(impl_rep.
              used_representation.items) >= 4)) AND (SIZEOF(impl_rep.
              used_representation.items) <= 6)) )) = 0)) )) = 0);
    wr4 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
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            SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
            'INTEGRATED_CNC_SCHEMA.' +
            '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')) )) = SIZEOF(pdr.
            used_representation.items))) )) = 1) )) = 1);
wr5 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
            name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
wr6 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'width')) )) = 1)) )) = 0)) )) = 0);
wr7 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'first radius')) )) <= 1)) )) = 0)) ))
            = 0);
wr8 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
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                used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
                impl_rep.used_representation.items | ((SIZEOF([
                'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
                it)) = 2) AND (it.name = 'second radius')) )) <= 1)) )) = 0)) ))
                = 0);
    wr9 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
                NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
                'INTEGRATED_CNC_SCHEMA.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
                'INTEGRATED_CNC_SCHEMA.' +
                'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
                used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
                impl_rep.used_representation.items | ((SIZEOF([
                'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                TYPEOF(it)) = 2) AND (it.name = 'first angle')) )) = 1)) ))
                = 0)) )) = 0);
    wr10: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
                NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
                'INTEGRATED_CNC_SCHEMA.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
                'INTEGRATED_CNC_SCHEMA.' +
                'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
                used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
                impl_rep.used_representation.items | ((SIZEOF([
                'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                TYPEOF(it)) = 2) AND (it.name = 'second angle')) )) = 1)) ))
                = 0)) )) = 0);
    wr11: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
                 | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
                'INTEGRATED_CNC_SCHEMA.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
                'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
                TYPEOF(pdr.used_representation)) AND (pdr.
                used_representation.name = 'profile limit')) )) <= 1)) )) =
                 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY standard_uncertainty
  SUPERTYPE OF (expanded_uncertainty)
  SUBTYPE OF (uncertainty_qualifier);
    uncertainty_value : REAL;
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY step
  SUBTYPE OF (feature_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
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            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            '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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'course of travel occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'path feature component usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ((
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
            description = 'removal boundary occurrence') AND (SIZEOF(
            QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT') | ((sar.description =
            'profile usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
            TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.VEE_PROFILE' IN
            TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY straightness_tolerance
  SUBTYPE OF (geometric_tolerance);
  WHERE
    wr1: (NOT (('INTEGRATED_CNC_SCHEMA.' +
            'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)));
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY surface
  SUPERTYPE OF (ONEOF (elementary_surface,swept_surface,bounded_surface,
      offset_surface,surface_replica))
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY surface_curve
  SUPERTYPE OF (ONEOF (intersection_curve,seam_curve) ANDOR
      bounded_surface_curve)
  SUBTYPE OF (curve);
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    curve_3d              : curve;
    associated_geometry   : LIST [1:2] OF pcurve_or_surface;
    master_representation : preferred_surface_curve_representation;
  DERIVE
    basis_surface : SET [1:2] OF surface := get_basis_surface(SELF);
  WHERE
    wr1: (curve_3d.dim = 3);
    wr2: (('INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(associated_geometry[
             1])) OR (master_representation <> pcurve_s1));
    wr3: (('INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(associated_geometry[
             2])) OR (master_representation <> pcurve_s2));
    wr4: (NOT ('INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(curve_3d)));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY surface_of_linear_extrusion
  SUBTYPE OF (swept_surface);
    extrusion_axis : vector;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY surface_of_revolution
  SUBTYPE OF (swept_surface);
    axis_position : axis1_placement;
  DERIVE
    axis_line : line := representation_item('') ||
                    geometric_representation_item() || curve() || line(
                    axis_position.location,representation_item('') ||
                    geometric_representation_item() || vector(
                    axis_position.z,1));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY surface_patch
  SUBTYPE OF (founded_item);
    parent_surface : bounded_surface;
    u_transition   : transition_code;
    v_transition   : transition_code;
    u_sense        : BOOLEAN;
    v_sense        : BOOLEAN;
  INVERSE
    using_surfaces : BAG [1:?] OF rectangular_composite_surface FOR
                         segments;
  WHERE
    wr1: (NOT ('INTEGRATED_CNC_SCHEMA.CURVE_BOUNDED_SURFACE' IN TYPEOF(
             parent_surface)));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY surface_profile_tolerance
  SUBTYPE OF (geometric_tolerance);
  WHERE
    wr1: ((NOT (('INTEGRATED_CNC_SCHEMA.' +
             'GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE') IN TYPEOF(SELF)))
             OR (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
             datum_system) <= 3));
END_ENTITY; -- 10303-519: aic_geometric_tolerances
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ENTITY surface_replica
  SUBTYPE OF (surface);
    parent_surface : surface;
    transformation : cartesian_transformation_operator_3d;
  WHERE
    wr1: acyclic_surface_replica(SELF,parent_surface);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY surface_texture_representation
  SUBTYPE OF (representation);
END_ENTITY;  -- 10303-214: automotive_design

ENTITY swept_surface
  SUPERTYPE OF (ONEOF (surface_of_linear_extrusion,surface_of_revolution))
  SUBTYPE OF (surface);
    swept_curve : curve;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY symmetric_shape_aspect
  SUBTYPE OF (shape_aspect);
  INVERSE
    basis_relationships : SET [1:?] OF shape_aspect_relationship FOR
                              relating_shape_aspect;
  WHERE
    wr1: (SIZEOF(QUERY ( x <* SELF\symmetric_shape_aspect.
             basis_relationships | (
             'INTEGRATED_CNC_SCHEMA.CENTRE_OF_SYMMETRY' IN TYPEOF(x\
             shape_aspect_relationship.related_shape_aspect)) )) >= 1);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY symmetry_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
  WHERE
    wr1: (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
             datum_system) <= 3);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY tangent
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: (SIZEOF(SELF\derived_shape_aspect.deriving_relationships) = 1);
END_ENTITY; -- 10303-47: shape_aspect_definition_schema

ENTITY taper
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.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,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
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          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) )) = 1)) )) = 0);
wr4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2) AND (it.name = 'angle')) )) = 1)) )) = 0)) ))
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            = 0));
    wr8: ((NOT (SELF.description = 'directed taper')) OR (SIZEOF(
            QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.
            used_representation.name = 'direction')) )) = 1)) )) = 0));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY tapping_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['tapping','thread drilling']);

  WR2:  NOT (SELF.description = 'tapping') OR
        ((verify_required_action_property    (SELF, 'compensation chuck')) AND
         (verify_enumeration_action_property (SELF, 'compensation chuck',
          ['compensation chuck used', 'compensation chuck not used'])));

  WR3:  NOT (SELF.description = 'thread drilling') OR
        ((verify_required_action_property
           (SELF, 'helical movement on forward')) AND
         (verify_enumeration_action_property
           (SELF, 'helical movement on forward',
          ['helical movement on forward', 'no helical movement on forward'])));
END_ENTITY;

ENTITY tee_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
              TYPEOF(SELF.of_shape.definition));
    wr2 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
              used_representation)) )) = 1)) )) = 0);
    wr3 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
              'INTEGRATED_CNC_SCHEMA.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
              'INTEGRATED_CNC_SCHEMA.' +
              '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,
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          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
          'INTEGRATED_CNC_SCHEMA.' +
          '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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
          name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
wr6 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
          it)) = 2) AND (it.name = 'width')) )) = 1)) )) = 0)) )) = 0);
wr7 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
          it)) = 2) AND (it.name = 'depth')) )) = 1)) )) = 0)) )) = 0);
wr8 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
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            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'cross bar width')) )) = 1)) )) =
            0)) )) = 0);
wr9 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'cross bar depth')) )) = 1)) )) =
            0)) )) = 0);
wr10: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'first offset')) )) = 1)) )) = 0)) ))
            = 0);
wr11: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'second offset')) )) = 1)) )) = 0)) ))
            = 0);
wr12: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
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```
                used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
                impl_rep.used_representation.items | ((SIZEOF([
                'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                TYPEOF(it)) = 2) AND (it.name = 'first angle')) )) = 1)) ))
                = 0)) )) = 0);
    wr13: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
                NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
                'INTEGRATED_CNC_SCHEMA.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
                'INTEGRATED_CNC_SCHEMA.' +
                'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
                used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
                impl_rep.used_representation.items | ((SIZEOF([
                'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
                TYPEOF(it)) = 2) AND (it.name = 'second angle')) )) = 1)) ))
                = 0)) )) = 0);
    wr14: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
                NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
                'INTEGRATED_CNC_SCHEMA.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
                'INTEGRATED_CNC_SCHEMA.' +
                'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
                used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
                impl_rep.used_representation.items | ((SIZEOF([
                'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
                it)) = 2) AND (it.name = 'radius')) )) <= 1)) )) = 0)) )) =
                 0);
    wr15: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
                 | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
                'INTEGRATED_CNC_SCHEMA.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
                'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
                TYPEOF(pdr.used_representation)) AND (pdr.
                used_representation.name = 'profile limit')) )) <= 1)) )) =
                 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY thread
  SUBTYPE OF (feature_definition);
  WHERE
    wr1 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
                SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
                'INTEGRATED_CNC_SCHEMA.' +
                'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
                used_representation)) AND (8 <= SIZEOF(pdr.
                used_representation.items)) AND (SIZEOF(pdr.
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            used_representation.items) <= 11)) )) = 1) )) = 1);
    wr2 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'major diameter')) )) = 1)) )) = 0)) ))
            = 0);
    wr3 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'minor diameter')) )) <= 1)) )) =
            0)) )) = 0);
    wr4 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'pitch diameter')) )) = 1)) )) = 0)) ))
            = 0);
    wr5 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'number of threads')) )) = 1)) ))
            = 0)) )) = 0);
    wr6 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
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          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'fit class')) )) = 1)) )) = 0)) ))
          = 0);
wr7 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'form')) )) = 1)) )) = 0)) )) =
          0);
wr8 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'qualifier')) )) <= 1)) )) = 0)) ))
          = 0);
wr10: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
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                used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
                impl_rep.used_representation.items | ((
                'INTEGRATED_CNC_SCHEMA.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,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
                NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
                'INTEGRATED_CNC_SCHEMA.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
                'INTEGRATED_CNC_SCHEMA.' +
                'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
                used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
                impl_rep.used_representation.items | ((SIZEOF([
                'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
                it)) = 2) AND (it.name = 'crest')) )) <= 1)) )) = 0)) )) =
                0);
    wr12: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
                'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
                pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
                'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
                description = 'partial area occurrence') AND (SIZEOF(
                QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
                'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
                'RELATED_SHAPE_ASPECT') | ((sar.description =
                'applied area usage') AND (
                'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
                TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.APPLIED_AREA' IN
                TYPEOF(sdr.relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    wr13: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
                'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
                'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
                pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
                'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
                QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
                'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
                'RELATED_SHAPE_ASPECT') | ((sar.description =
                'applied shape') AND (
                'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
                TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT' IN
                TYPEOF(sdr.relating_shape_aspect)) )) = 1) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY time_interval;
    id          : identifier;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: date_time_schema

ENTITY time_interval_based_effectivity
  SUBTYPE OF (effectivity);
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    effectivity_period : time_interval;
END_ENTITY; -- 10303-41: effectivity_schema

ENTITY time_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.TIME_UNIT' IN TYPEOF(SELF\
             measure_with_unit.unit_component));
END_ENTITY; -- 10303-41: measure_schema

ENTITY time_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
             named_unit.dimensions.mass_exponent = 0) AND (SELF\
             named_unit.dimensions.time_exponent = 1) AND (SELF\
             named_unit.dimensions.electric_current_exponent = 0) AND (
             SELF\named_unit.dimensions.
             thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
             .dimensions.amount_of_substance_exponent = 0) AND (SELF\
             named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- 10303-41: measure_schema

ENTITY tolerance_value;
    lower_bound : measure_with_unit;
    upper_bound : measure_with_unit;
  WHERE
    wr1: (upper_bound\measure_with_unit.value_component > lower_bound\
             measure_with_unit.value_component);
    wr2: (upper_bound\measure_with_unit.unit_component = lower_bound\
             measure_with_unit.unit_component);
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY tolerance_zone
  SUBTYPE OF (shape_aspect);
    defining_tolerance : SET [1:?] OF geometric_tolerance;
    form               : tolerance_zone_form;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY tolerance_zone_definition
  SUPERTYPE OF (ONEOF (projected_zone_definition,runout_zone_definition));
    zone       : tolerance_zone;
    boundaries : SET [1:?] OF shape_aspect;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY tolerance_zone_form;
    name : label;
END_ENTITY; -- 10303-47: shape_tolerance_schema

ENTITY topological_representation_item
  SUPERTYPE OF (ONEOF (vertex,edge,face_bound,face,connected_face_set,
      loop ANDOR path))
  SUBTYPE OF (representation_item);
END_ENTITY; -- 10303-42: topology_schema
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ENTITY toroidal_surface
  SUBTYPE OF (elementary_surface);
    major_radius : positive_length_measure;
    minor_radius : positive_length_measure;
END_ENTITY; -- 10303-42: geometry_schema

ENTITY total_runout_tolerance
  SUBTYPE OF (geometric_tolerance_with_datum_reference);
  WHERE
    wr1: (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
             datum_system) <= 2);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY transition_feature
  SUPERTYPE OF (ONEOF (chamfer,edge_round,fillet))
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: (SIZEOF(['INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION',
             'INTEGRATED_CNC_SCHEMA.COMPOUND_FEATURE'] * TYPEOF(SELF.
             of_shape.definition)) = 1);
    wr2: (SIZEOF(['INTEGRATED_CNC_SCHEMA.CHAMFER',
             'INTEGRATED_CNC_SCHEMA.EDGE_ROUND',
             'INTEGRATED_CNC_SCHEMA.FILLET'] * TYPEOF(SELF)) = 1);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY trimmed_curve
  SUBTYPE OF (bounded_curve);
    basis_curve           : curve;
    trim_1                : SET [1:2] OF trimming_select;
    trim_2                : SET [1:2] OF trimming_select;
    sense_agreement       : BOOLEAN;
    master_representation : trimming_preference;
  WHERE
    wr1: ((HIINDEX(trim_1) = 1) OR (TYPEOF(trim_1[1]) <> TYPEOF(trim_1[2])));
    wr2: ((HIINDEX(trim_2) = 1) OR (TYPEOF(trim_2[1]) <> TYPEOF(trim_2[2])));
END_ENTITY; -- 10303-42: geometry_schema

ENTITY turned_knurl
  SUBTYPE OF (feature_definition);
  WHERE
    wr1 : (SELF\characterized_object.description IN ['diamond',
             'diagonal','straight']);
    wr2 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) AND (6 <= SIZEOF(pdr.
             used_representation.items)) AND (SIZEOF(pdr.
             used_representation.items) <= 9)) )) = 1) )) = 1);
    wr3 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
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          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND ('INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
          it)) = 2) AND (it.name = 'major diameter')) )) = 1)) )) = 0)) ))
          = 0);
wr5 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
          it)) = 2) AND (it.name = 'nominal diameter')) )) = 1)) )) =
           0)) )) = 0);
wr6 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.' + 'DEFINITION')
           | (NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(
          pd,'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
          it)) = 2) AND (it.name = 'tooth depth')) )) <= 1)) )) = 0)) ))
          = 0);
wr7 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
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            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] * TYPEOF(
            it)) = 2) AND (it.name = 'root fillet')) )) <= 1)) )) = 0)) ))
            = 0);
wr8 : (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((SIZEOF([
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
            'INTEGRATED_CNC_SCHEMA.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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
            'INTEGRATED_CNC_SCHEMA.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
            'INTEGRATED_CNC_SCHEMA.' +
            'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
            used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
            impl_rep.used_representation.items | ((
            'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND (it.name = 'helix hand')) )) = 1)) )) = 0)) ))
            = 0));
wr11: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
            'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
            pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | ((sa_occ.
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```
              description = 'partial area occurrence') AND (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'applied area usage') AND (('INTEGRATED_CNC_SCHEMA.' +
              'SHAPE_DEFINING_RELATIONSHIP') IN TYPEOF(sar))) ) | (
              'INTEGRATED_CNC_SCHEMA.APPLIED_AREA' IN TYPEOF(sdr.
              relating_shape_aspect)) )) = 1)) )) = 1)) )) = 0);
    wr12: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
              'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_SHAPE' IN TYPEOF(
              pd)) ) | (NOT (SIZEOF(QUERY ( sa_occ <* USEDIN(pds,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT.OF_SHAPE') | (SIZEOF(
              QUERY ( sdr <* QUERY ( sar <* USEDIN(sa_occ,
              'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
              'RELATED_SHAPE_ASPECT') | ((sar.description =
              'applied shape') AND (
              'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN
              TYPEOF(sar))) ) | ('INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT' IN
              TYPEOF(sdr.relating_shape_aspect)) )) = 1) )) = 1)) )) = 0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY type_qualifier;
    name : label;
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY unary_boolean_expression
  ABSTRACT SUPERTYPE OF (not_expression)
  SUBTYPE OF (boolean_expression, unary_generic_expression);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY unary_generic_expression
  ABSTRACT SUPERTYPE
  SUBTYPE OF (generic_expression);
    operand : generic_expression;
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY unary_numeric_expression
  ABSTRACT SUPERTYPE
  SUBTYPE OF (numeric_expression, unary_generic_expression);
    SELF\unary_generic_expression.operand : numeric_expression;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY uncertainty_measure_with_unit
  SUBTYPE OF (measure_with_unit);
    name        : label;
    description : OPTIONAL text;
  WHERE
    wr1: valid_measure_value(SELF\measure_with_unit.value_component);
END_ENTITY; -- 10303-43: representation_schema

ENTITY uncertainty_qualifier
  SUPERTYPE OF (ONEOF (standard_uncertainty,qualitative_uncertainty));
    measure_name : label;
```

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```
    description  : text;
END_ENTITY; -- 10303-45: qualified_measure_schema

ENTITY uniform_curve
  SUBTYPE OF (b_spline_curve);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY uniform_surface
  SUBTYPE OF (b_spline_surface);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY value_range
  SUBTYPE OF (compound_representation_item);
END_ENTITY;  -- 10303-214: automotive_design

ENTITY variable
  ABSTRACT SUPERTYPE OF (numeric_variable)
  SUBTYPE OF (generic_variable);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

ENTITY variable_semantics
  ABSTRACT SUPERTYPE;
END_ENTITY; -- 13584-20: iso13584_generic_expressions_schema

ENTITY vector
  SUBTYPE OF (geometric_representation_item);
    orientation : direction;
    magnitude   : length_measure;
  WHERE
    wr1: (magnitude >= 0);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY vee_profile
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN
             TYPEOF(SELF.of_shape.definition));
    wr2: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) )) = 1)) )) = 0);
    wr3: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | ((NOT (SIZEOF(impl_rep.
             used_representation.items) >= 3)) AND (SIZEOF(impl_rep.
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          used_representation.items) <= 4)) )) = 0)) )) = 0);
wr4: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          SIZEOF(QUERY ( pdr <* USEDIN(pd,'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (((
          'INTEGRATED_CNC_SCHEMA.' +
          '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')) )) =
          SIZEOF(pdr.used_representation.items))) )) = 1) )) = 1);
wr5: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(it)) AND (it.
          name = 'orientation')) )) = 1)) )) = 0)) )) = 0);
wr6: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (
          'INTEGRATED_CNC_SCHEMA.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,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
          'INTEGRATED_CNC_SCHEMA.' +
          'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
          used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
          impl_rep.used_representation.items | ((SIZEOF([
          'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
          'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
          TYPEOF(it)) = 2) AND (it.name = 'profile angle')) )) = 1)) ))
          = 0)) )) = 0);
wr8: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
          NOT (SIZEOF(QUERY ( impl_rep <* QUERY ( pdr <* USEDIN(pd,
          'INTEGRATED_CNC_SCHEMA.' +
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             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.' +
             'SHAPE_REPRESENTATION_WITH_PARAMETERS') IN TYPEOF(pdr.
             used_representation)) ) | (NOT (SIZEOF(QUERY ( it <*
             impl_rep.used_representation.items | ((SIZEOF([
             'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
             'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
             TYPEOF(it)) = 2) AND (it.name = 'tilt angle')) )) = 1)) )) =
              0)) )) = 0);
    wr9: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') | (
             NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((
             'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
             TYPEOF(pdr.used_representation)) AND (pdr.
             used_representation.name = 'profile limit')) )) <= 1)) )) =
             0);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY vertex
  SUBTYPE OF (topological_representation_item);
END_ENTITY; -- 10303-42: topology_schema

ENTITY vertex_loop
  SUBTYPE OF (loop);
    loop_vertex : vertex;
END_ENTITY; -- 10303-42: topology_schema

ENTITY vertex_point
  SUBTYPE OF (vertex, geometric_representation_item);
    vertex_geometry : point;
END_ENTITY; -- 10303-42: topology_schema

ENTITY week_of_year_and_day_date
  SUBTYPE OF (date);
    week_component : week_in_year_number;
    day_component  : OPTIONAL day_in_week_number;
END_ENTITY; -- 10303-41: date_time_schema

ENTITY xor_expression
  SUBTYPE OF (binary_boolean_expression);
    SELF\binary_generic_expression.operands : LIST [2:2] OF
                                                  boolean_expression;
END_ENTITY; -- 13584-20: iso13584_expressions_schema

RULE application_context_requires_ap_definition FOR
  (application_context, application_protocol_definition);
WHERE
  WR1:  (0 = SIZEOF (QUERY (ac <* application_context | NOT
           (1 = SIZEOF (QUERY (apd <* application_protocol_definition |
                (apd.application :=: ac) AND
                (apd.application_interpreted_model_schema_name =
                 'integrated_cnc_schema'))))
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        )));
END_RULE;

RULE approval_requires_approval_date_time FOR
  (approval, approval_date_time);
WHERE
  WR1:  (0 = SIZEOF (QUERY (app <* approval | NOT
           (1 = SIZEOF (QUERY (adt <* approval_date_time |
               (app :=: adt.dated_approval))))
        )));
END_RULE;

RULE approval_requires_approval_person_organization FOR
  (approval, approval_person_organization);
WHERE
  WR1:  (0 = SIZEOF (QUERY (app <* approval | NOT
           (1 <= SIZEOF (QUERY (apo <* approval_person_organization |
               (app :=: apo.authorized_approval))))
        )));
END_RULE;

RULE approval_requires_assignment FOR
  (approval, approval_assignment);
WHERE
  WR1:  (0 = SIZEOF (QUERY (app <* approval | NOT
           (1 <= SIZEOF (QUERY (aa <* approval_assignment |
               (app :=: aa.assigned_approval))))
        )));
END_RULE;

RULE compatible_dimension FOR (cartesian_point, direction,
           representation_context, geometric_representation_context);

WHERE
  wr1: (SIZEOF(QUERY ( x <* cartesian_point | (SIZEOF(QUERY ( y <*
           geometric_representation_context | (item_in_context(x,y) AND (
           HIINDEX(x.coordinates) <> y.coordinate_space_dimension)) )) >
           0) )) = 0);
  wr2: (SIZEOF(QUERY ( x <* direction | (SIZEOF(QUERY ( y <*
           geometric_representation_context | (item_in_context(x,y) AND (
           HIINDEX(x.direction_ratios) <> y.coordinate_space_dimension)) ))
           > 0) )) = 0);

END_RULE; -- 10303-42: geometry_schema

RULE dependent_instantiable_approval_status FOR (approval_status);
WHERE
  WR1:  (0 = SIZEOF (QUERY (ast <* approval_status | NOT
           (1 <= SIZEOF (USEDIN (ast, ''))))
        )));
END_RULE;

RULE dependent_instantiable_named_unit FOR (named_unit);
WHERE
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```
  WR1:  (0 = SIZEOF (QUERY (nu <* named_unit | NOT
           (1 <= SIZEOF (USEDIN (nu, '')))
        )));
END_RULE;

RULE machining_project_requires_owner FOR
  (product_definition_formation);
WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* product_definition_formation |
          -- it is machining project
          (0 < SIZEOF (QUERY (prpc <* USEDIN (pdf.of_product,
             'INTEGRATED_CNC_SCHEMA.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
               (prpc.name = 'machining project'))))  AND NOT

          -- it has at most one associated owner.
          (1 >= SIZEOF (QUERY (poa <* USEDIN (pdf,
             'INTEGRATED_CNC_SCHEMA.' +
             'APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT.ITEMS') |
               (poa.role.name = 'owner'))))
        )));
END_RULE;

RULE machining_project_requires_release_date FOR
  (product_definition_formation);
WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* product_definition_formation |
          -- it is machining project
          (0 < SIZEOF (QUERY (prpc <* USEDIN (pdf.of_product,
             'INTEGRATED_CNC_SCHEMA.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
               (prpc.name = 'machining project'))))  AND NOT

          -- it has at most one associated release date.
          (1 >= SIZEOF (QUERY (dta <* USEDIN (pdf,
             'INTEGRATED_CNC_SCHEMA.' +
             'APPLIED_DATE_AND_TIME_ASSIGNMENT.ITEMS') |
               (dta.role.name = 'release date'))))
        )));
END_RULE;

RULE machining_project_requires_workplan FOR
  (product_definition_formation, process_product_association);
WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* product_definition_formation |
          -- it is machining project
          (0 < SIZEOF (QUERY (prpc <* USEDIN (pdf.of_product,
             'INTEGRATED_CNC_SCHEMA.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
               (prpc.name = 'machining project'))))  AND NOT

          -- it has one associated workplan.
          (1 = SIZEOF (QUERY (ppa <* process_product_association |
             (ppa.process.name = 'machining') AND
```

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```
            (ppa.defined_product.formation = pdf) AND
            ('INTEGRATED_CNC_SCHEMA.MACHINING_WORKPLAN'
              IN TYPEOF (ppa.process.chosen_method)))))
        )));
END_RULE;

RULE machining_setup_requires_security_plane FOR
  (product_definition_formation, property_definition);
WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* product_definition_formation |
          -- it is machining setup
          (0 < SIZEOF (QUERY (prpc <* USEDIN (pdf.of_product,
             'INTEGRATED_CNC_SCHEMA.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
               (prpc.name = 'machining setup'))))  AND NOT

          -- it has one associated security plane.
          (1 = SIZEOF (QUERY (pd <* property_definition |
             (pd.name = 'security plane') AND
             (pd.definition.formation = pdf) )))
        )));
END_RULE;

RULE nc_variable_compatible_initial_value FOR
  (numeric_variable, representation_item_relationship);
WHERE
  -- each nc_variable has at most one one initial value
  WR1: (0 = SIZEOF (QUERY (nv <* numeric_variable | NOT
            (1 >= SIZEOF (QUERY (rir <* representation_item_relationship |
                   (rir.description = 'initial value')  AND
                   (rir.relating_representation_item = nv)))))));


  -- the types on either side of the initial value relationship must match
  -- each nc_variable has at most one one initial value
  WR2: (0 = SIZEOF (QUERY (rir <* representation_item_relationship |
            (rir.description = 'initial value')  AND NOT
            ((('INTEGRATED_CNC_SCHEMA.INT_NUMERIC_VARIABLE'
                IN TYPEOF (rir.relating_representation_item)) AND
              ('INTEGRATED_CNC_SCHEMA.INT_LITERAL'
                IN TYPEOF (rir.related_representation_item)))
             OR
            ((('INTEGRATED_CNC_SCHEMA.REAL_NUMERIC_VARIABLE'
                IN TYPEOF (rir.relating_representation_item)) AND
              ('INTEGRATED_CNC_SCHEMA.REAL_LITERAL'
                IN TYPEOF (rir.related_representation_item))))))));
END_RULE;

RULE product_requires_version FOR
  (product, product_definition_formation);
WHERE
  WR1:  (0 = SIZEOF (QUERY (prod <* product  | NOT
           (1 <= SIZEOF (QUERY (pdf <* product_definition_formation |
               (prod :=: pdf.of_product))))
```

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```
        )));
END_RULE;

RULE security_classification_requires_assignment FOR
  (security_classification, security_classification_assignment);
WHERE
  WR1:  (0 = SIZEOF (QUERY (sc <* security_classification  | NOT
           (1 <= SIZEOF (QUERY (sca <* security_classification_assignment |
               (sc :=: sca.assigned_security_classification))))
        )));
END_RULE;

FUNCTION acyclic(
             arg1: generic_expression;
             arg2: SET OF generic_expression
    ): BOOLEAN;

  LOCAL
    result : BOOLEAN;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.SIMPLE_GENERIC_EXPRESSION' IN TYPEOF(arg1)
       THEN
    RETURN(TRUE);
  END_IF;
  IF arg1 IN arg2 THEN
    RETURN(FALSE);
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.UNARY_GENERIC_EXPRESSION' IN TYPEOF(arg1)
       THEN
    RETURN(acyclic(arg1\unary_generic_expression.operand,arg2 + [arg1]));
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.BINARY_GENERIC_EXPRESSION' IN TYPEOF(arg1)
       THEN
    RETURN(acyclic(arg1\binary_generic_expression.operands[1],arg2 + [
        arg1]) AND acyclic(arg1\binary_generic_expression.operands[2],
        arg2 + [arg1]));
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.MULTIPLE_ARITY_GENERIC_EXPRESSION' IN
      TYPEOF(arg1) THEN
    result := TRUE;
    REPEAT i := 1 TO SIZEOF(arg1\multiple_arity_generic_expression.
        operands) BY 1;
      result := result AND acyclic(arg1\
          multiple_arity_generic_expression.operands[i],arg2 + [arg1]);
    END_REPEAT;
    RETURN(result);
  END_IF;

END_FUNCTION; -- 13584-20: iso13584_generic_expressions_schema

FUNCTION acyclic_curve_replica(
             rep: curve_replica;
             parent: curve
    ): BOOLEAN;
```

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```
  IF NOT ('INTEGRATED_CNC_SCHEMA.CURVE_REPLICA' IN TYPEOF(parent)) THEN
    RETURN(TRUE);
  END_IF;
  IF parent :=: rep THEN
    RETURN(FALSE);
  ELSE
    RETURN(acyclic_curve_replica(rep,parent\curve_replica.parent_curve));
  END_IF;

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION acyclic_mapped_representation(
             parent_set: SET OF representation;
             children_set: SET OF representation_item
    ): BOOLEAN;

  LOCAL
    x : SET OF representation_item;
    y : SET OF representation_item;
  END_LOCAL;
  x := QUERY ( z <* children_set | ('INTEGRATED_CNC_SCHEMA.MAPPED_ITEM'
      IN TYPEOF(z)) );
  IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
      IF x[i]\mapped_item.mapping_source.mapped_representation IN
          parent_set THEN
        RETURN(FALSE);
      END_IF;
      IF NOT acyclic_mapped_representation(parent_set + x[i]\mapped_item
          .mapping_source.mapped_representation,x[i]\mapped_item.
          mapping_source.mapped_representation.items) THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_IF;
  x := children_set - x;
  IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
      y := QUERY ( z <* bag_to_set(USEDIN(x[i],'')) | (
          'INTEGRATED_CNC_SCHEMA.REPRESENTATION_ITEM' IN TYPEOF(z)) );
      IF NOT acyclic_mapped_representation(parent_set,y) THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_IF;
  RETURN(TRUE);

END_FUNCTION; -- 10303-43: representation_schema

FUNCTION acyclic_product_category_relationship(
             relation: product_category_relationship;
             children: SET OF product_category
    ): BOOLEAN;
```

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```
  LOCAL
    x              : SET OF product_category_relationship;
    local_children : SET OF product_category;
  END_LOCAL;
  REPEAT i := 1 TO HIINDEX(children) BY 1;
    IF relation.category :=: children[i] THEN
      RETURN(FALSE);
    END_IF;
  END_REPEAT;
  x := bag_to_set(USEDIN(relation.category,'INTEGRATED_CNC_SCHEMA.' +
      'PRODUCT_CATEGORY_RELATIONSHIP.SUB_CATEGORY'));
  local_children := children + relation.category;
  IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
      IF NOT acyclic_product_category_relationship(x[i],local_children)
           THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_IF;
  RETURN(TRUE);

END_FUNCTION; -- 10303-41: product_definition_schema

FUNCTION acyclic_product_definition_relationship(
             relation: product_definition_relationship;
             relatives: SET [1:?] OF product_definition;
             specific_relation: STRING
    ): BOOLEAN;

  LOCAL
    x : SET OF product_definition_relationship;
  END_LOCAL;
  IF relation.relating_product_definition IN relatives THEN
    RETURN(FALSE);
  END_IF;
  x := QUERY ( pd <* bag_to_set(USEDIN(relation.
      relating_product_definition,'INTEGRATED_CNC_SCHEMA.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.' + 'RELATED_PRODUCT_DEFINITION'))
       | (specific_relation IN TYPEOF(pd)) );
  REPEAT i := 1 TO HIINDEX(x) BY 1;
    IF NOT acyclic_product_definition_relationship(x[i],relatives +
        relation.relating_product_definition,specific_relation) THEN
      RETURN(FALSE);
    END_IF;
  END_REPEAT;
  RETURN(TRUE);

END_FUNCTION; -- 10303-41: product_definition_schema

FUNCTION acyclic_surface_replica(
             rep: surface_replica;
             parent: surface
    ): BOOLEAN;
```

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```
  IF NOT ('INTEGRATED_CNC_SCHEMA.SURFACE_REPLICA' IN TYPEOF(parent))
       THEN
    RETURN(TRUE);
  END_IF;
  IF parent :=: rep THEN
    RETURN(FALSE);
  ELSE
    RETURN(acyclic_surface_replica(rep,parent\surface_replica.
        parent_surface));
  END_IF;

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION associated_surface(
             arg: pcurve_or_surface
    ): surface;

  LOCAL
    surf : surface;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(arg) THEN
    surf := arg.basis_surface;
  ELSE
    surf := arg;
  END_IF;
  RETURN(surf);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION bag_to_set(
             the_bag: BAG OF GENERIC:intype
    ): SET OF GENERIC:intype;

  LOCAL
    the_set : SET OF GENERIC:intype := [];
  END_LOCAL;
  IF SIZEOF(the_bag) > 0 THEN
    REPEAT i := 1 TO HIINDEX(the_bag) BY 1;
      the_set := the_set + the_bag[i];
    END_REPEAT;
  END_IF;
  RETURN(the_set);

END_FUNCTION; -- 10303-41: support_resource_schema

FUNCTION base_axis(
             dim: INTEGER;
             axis1, axis2, axis3: direction
    ): LIST [2:3] OF direction;

  LOCAL
    u      : LIST [2:3] OF direction;
    d1     : direction;
    d2     : direction;
```

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```
    factor : REAL;
  END_LOCAL;
  IF dim = 3 THEN
    d1 := NVL(normalise(axis3),dummy_gri || direction([0,0,1]));
    d2 := first_proj_axis(d1,axis1);
    u := [d2,second_proj_axis(d1,d2,axis2),d1];
  ELSE
    IF EXISTS(axis1) THEN
      d1 := normalise(axis1);
      u := [d1,orthogonal_complement(d1)];
      IF EXISTS(axis2) THEN
        factor := dot_product(axis2,u[2]);
        IF factor < 0 THEN
          u[2].direction_ratios[1] := -u[2].direction_ratios[1];
          u[2].direction_ratios[2] := -u[2].direction_ratios[2];
        END_IF;
      END_IF;
    ELSE
      IF EXISTS(axis2) THEN
        d1 := normalise(axis2);
        u := [orthogonal_complement(d1),d1];
        u[1].direction_ratios[1] := -u[1].direction_ratios[1];
        u[1].direction_ratios[2] := -u[1].direction_ratios[2];
      ELSE
        u := [dummy_gri || direction([1,0]),dummy_gri || direction([0,1])];
      END_IF;
    END_IF;
  END_IF;
  RETURN(u);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION boolean_choose(
             b: BOOLEAN;
             choice1: GENERIC:item;
             choice2: GENERIC:item
    ): GENERIC:item;
  IF b THEN
    RETURN(choice1);
  ELSE
    RETURN(choice2);
  END_IF;

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION build_2axes(
             ref_direction: direction
    ): LIST [2:2] OF direction;

  LOCAL
    d : direction := NVL(normalise(ref_direction),dummy_gri ||
         direction([1,0]));
  END_LOCAL;
  RETURN([d,orthogonal_complement(d)]);
```

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```
END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION build_axes(
             axis, ref_direction: direction
    ): LIST [3:3] OF direction;

  LOCAL
    d1 : direction;
    d2 : direction;
  END_LOCAL;
  d1 := NVL(normalise(axis),dummy_gri || direction([0,0,1]));
  d2 := first_proj_axis(d1,ref_direction);
  RETURN([d2,normalise(cross_product(d1,d2)).orientation,d1]);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION closed_shell_reversed(
             a_shell: closed_shell
    ): oriented_closed_shell;

  LOCAL
    the_reverse : oriented_closed_shell;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.ORIENTED_CLOSED_SHELL' IN TYPEOF(a_shell)
       THEN
    the_reverse := dummy_tri || connected_face_set(a_shell\
        connected_face_set.cfs_faces) || closed_shell() ||
        oriented_closed_shell(a_shell\oriented_closed_shell.
        closed_shell_element,NOT a_shell\oriented_closed_shell.
        orientation);
  ELSE
    the_reverse := dummy_tri || connected_face_set(a_shell\
        connected_face_set.cfs_faces) || closed_shell() ||
        oriented_closed_shell(a_shell,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION conditional_reverse(
             p: BOOLEAN;
             an_item: reversible_topology
    ): reversible_topology;
  IF p THEN
    RETURN(an_item);
  ELSE
    RETURN(topology_reversed(an_item));
  END_IF;

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION constraints_composite_curve_on_surface(
             c: composite_curve_on_surface
```

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```
    ): BOOLEAN;

  LOCAL
    n_segments : INTEGER := SIZEOF(c.segments);
  END_LOCAL;
  REPEAT k := 1 TO n_segments BY 1;
    IF (NOT ('INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(c\composite_curve.
        segments[k].parent_curve))) AND (NOT (
        'INTEGRATED_CNC_SCHEMA.SURFACE_CURVE' IN TYPEOF(c\composite_curve
        .segments[k].parent_curve))) AND (NOT (
        'INTEGRATED_CNC_SCHEMA.COMPOSITE_CURVE_ON_SURFACE' IN TYPEOF(c\
        composite_curve.segments[k].parent_curve))) THEN
      RETURN(FALSE);
    END_IF;
  END_REPEAT;
  RETURN(TRUE);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION constraints_geometry_shell_based_surface_model(
             m: shell_based_surface_model
    ): BOOLEAN;

  LOCAL
    result : BOOLEAN := TRUE;
  END_LOCAL;
  REPEAT j := 1 TO SIZEOF(m.sbsm_boundary) BY 1;
    IF (NOT ('INTEGRATED_CNC_SCHEMA.OPEN_SHELL' IN TYPEOF(m.
        sbsm_boundary[j]))) AND (NOT (
        'INTEGRATED_CNC_SCHEMA.CLOSED_SHELL' IN TYPEOF(m.sbsm_boundary[j])))
         THEN
      result := FALSE;
      RETURN(result);
    END_IF;
  END_REPEAT;
  RETURN(result);

END_FUNCTION; -- 10303-42: geometric_model_schema

FUNCTION constraints_param_b_spline(
             degree: INTEGER;
             up_knots: INTEGER;
             up_cp: INTEGER;
             knot_mult: LIST OF INTEGER;
             knots: LIST OF parameter_value
    ): BOOLEAN;

  LOCAL
    k      : INTEGER;
    sum    : INTEGER;
    result : BOOLEAN := TRUE;
  END_LOCAL;
  sum := knot_mult[1];
  REPEAT i := 2 TO up_knots BY 1;
```

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```
    sum := sum + knot_mult[i];
  END_REPEAT;
  IF (degree < 1) OR (up_knots < 2) OR (up_cp < degree) OR (sum <> (
      degree + up_cp + 2)) THEN
    result := FALSE;
    RETURN(result);
  END_IF;
  k := knot_mult[1];
  IF (k < 1) OR (k > (degree + 1)) THEN
    result := FALSE;
    RETURN(result);
  END_IF;
  REPEAT i := 2 TO up_knots BY 1;
    IF (knot_mult[i] < 1) OR (knots[i] <= knots[i - 1]) THEN
      result := FALSE;
      RETURN(result);
    END_IF;
    k := knot_mult[i];
    IF (i < up_knots) AND (k > degree) THEN
      result := FALSE;
      RETURN(result);
    END_IF;
    IF (i = up_knots) AND (k > (degree + 1)) THEN
      result := FALSE;
      RETURN(result);
    END_IF;
  END_REPEAT;
  RETURN(result);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION constraints_rectangular_composite_surface(
             s: rectangular_composite_surface
    ): BOOLEAN;
  REPEAT i := 1 TO s.n_u BY 1;
    REPEAT j := 1 TO s.n_v BY 1;
      IF NOT (('INTEGRATED_CNC_SCHEMA.B_SPLINE_SURFACE' IN TYPEOF(s.
          segments[i][j].parent_surface)) OR (
          'INTEGRATED_CNC_SCHEMA.RECTANGULAR_TRIMMED_SURFACE' IN TYPEOF(s
          .segments[i][j].parent_surface))) THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  REPEAT i := 1 TO s.n_u - 1 BY 1;
    REPEAT j := 1 TO s.n_v BY 1;
      IF s.segments[i][j].u_transition = discontinuous THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  REPEAT i := 1 TO s.n_u BY 1;
    REPEAT j := 1 TO s.n_v - 1 BY 1;
      IF s.segments[i][j].v_transition = discontinuous THEN
```

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```
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  RETURN(TRUE);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION cross_product(
             arg1, arg2: direction
    ): vector;

  LOCAL
    v2     : LIST [3:3] OF REAL;
    v1     : LIST [3:3] OF REAL;
    mag    : REAL;
    res    : direction;
    result : vector;
  END_LOCAL;
  IF (NOT EXISTS(arg1)) OR (arg1.dim = 2) OR (NOT EXISTS(arg2)) OR (arg2
      .dim = 2) THEN
    RETURN(?);
  ELSE
    BEGIN
      v1 := normalise(arg1).direction_ratios;
      v2 := normalise(arg2).direction_ratios;
      res := dummy_gri || direction([(v1[2] * v2[3]) - (v1[3] * v2[2]),(
          v1[3] * v2[1]) - (v1[1] * v2[3]),(v1[1] * v2[2]) - (v1[2] * v2[
          1])]);
      mag := 0;
      REPEAT i := 1 TO 3 BY 1;
        mag := mag + (res.direction_ratios[i] * res.direction_ratios[i]);
      END_REPEAT;
      IF mag > 0 THEN
        result := dummy_gri || vector(res,SQRT(mag));
      ELSE
        result := dummy_gri || vector(arg1,0);
      END_IF;
      RETURN(result);
    END;
  END_IF;

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION curve_weights_positive(
             b: rational_b_spline_curve
    ): BOOLEAN;

  LOCAL
    result : BOOLEAN := TRUE;
  END_LOCAL;
  REPEAT i := 0 TO b.upper_index_on_control_points BY 1;
    IF b.weights[i] <= 0 THEN
      result := FALSE;
```

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```
      RETURN(result);
    END_IF;
  END_REPEAT;
  RETURN(result);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION derive_dimensional_exponents(
             x: unit
    ): dimensional_exponents;

  LOCAL
    result : dimensional_exponents := dimensional_exponents(0,0,0,0,0,0,
              0);
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.DERIVED_UNIT' IN TYPEOF(x) THEN
    REPEAT i := LOINDEX(x.elements) TO HIINDEX(x.elements) BY 1;
      result.length_exponent := result.length_exponent + (x.elements[i].
          exponent * x.elements[i].unit.dimensions.length_exponent);
      result.mass_exponent := result.mass_exponent + (x.elements[i].
          exponent * x.elements[i].unit.dimensions.mass_exponent);
      result.time_exponent := result.time_exponent + (x.elements[i].
          exponent * x.elements[i].unit.dimensions.time_exponent);
      result.electric_current_exponent := result.
          electric_current_exponent + (x.elements[i].exponent * x.
          elements[i].unit.dimensions.electric_current_exponent);
      result.thermodynamic_temperature_exponent := result.
          thermodynamic_temperature_exponent + (x.elements[i].exponent *
          x.elements[i].unit.dimensions.
          thermodynamic_temperature_exponent);
      result.amount_of_substance_exponent := result.
          amount_of_substance_exponent + (x.elements[i].exponent * x.
          elements[i].unit.dimensions.amount_of_substance_exponent);
      result.luminous_intensity_exponent := result.
          luminous_intensity_exponent + (x.elements[i].exponent * x.
          elements[i].unit.dimensions.luminous_intensity_exponent);
    END_REPEAT;
  ELSE
    result := x.dimensions;
  END_IF;
  RETURN(result);

END_FUNCTION; -- 10303-41: measure_schema

FUNCTION dimension_of(
             item: geometric_representation_item
    ): dimension_count;

  LOCAL
    x   : SET OF representation;
    y   : representation_context;
    dim : dimension_count;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT' IN TYPEOF(item) THEN
```

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```
    dim := SIZEOF(item\cartesian_point.coordinates);
    RETURN(dim);
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.DIRECTION' IN TYPEOF(item) THEN
    dim := SIZEOF(item\direction.direction_ratios);
    RETURN(dim);
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.VECTOR' IN TYPEOF(item) THEN
    dim := SIZEOF(item\vector.orientation\direction.direction_ratios);
    RETURN(dim);
  END_IF;
  x := using_representations(item);
  y := x[1].context_of_items;
  dim := y\geometric_representation_context.coordinate_space_dimension;
  RETURN(dim);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION dimensions_for_si_unit(
             n: si_unit_name
    ): dimensional_exponents;
  CASE n OF
    metre         :         RETURN(dimensional_exponents(1,0,0,0,0,0,0));
    gram          :         RETURN(dimensional_exponents(0,1,0,0,0,0,0));
    second        :         RETURN(dimensional_exponents(0,0,1,0,0,0,0));
    ampere        :         RETURN(dimensional_exponents(0,0,0,1,0,0,0));
    kelvin        :         RETURN(dimensional_exponents(0,0,0,0,1,0,0));
    mole          :         RETURN(dimensional_exponents(0,0,0,0,0,1,0));
    candela       :         RETURN(dimensional_exponents(0,0,0,0,0,0,1));
    radian        :         RETURN(dimensional_exponents(0,0,0,0,0,0,0));
    steradian     :         RETURN(dimensional_exponents(0,0,0,0,0,0,0));
    hertz         :         RETURN(dimensional_exponents(0,0,-1,0,0,0,0));
    newton        :         RETURN(dimensional_exponents(1,1,-2,0,0,0,0));
    pascal        :         RETURN(dimensional_exponents(-1,1,-2,0,0,0,0));
    joule         :         RETURN(dimensional_exponents(2,1,-2,0,0,0,0));
    watt          :         RETURN(dimensional_exponents(2,1,-3,0,0,0,0));
    coulomb       :         RETURN(dimensional_exponents(0,0,1,1,0,0,0));
    volt          :         RETURN(dimensional_exponents(2,1,-3,-1,0,0,0));
    farad         :         RETURN(dimensional_exponents(-2,-1,4,1,0,0,0));
    ohm           :         RETURN(dimensional_exponents(2,1,-3,-2,0,0,0));
    siemens       :         RETURN(dimensional_exponents(-2,-1,3,2,0,0,0));
    weber         :         RETURN(dimensional_exponents(2,1,-2,-1,0,0,0));
    tesla         :         RETURN(dimensional_exponents(0,1,-2,-1,0,0,0));
    henry         :         RETURN(dimensional_exponents(2,1,-2,-2,0,0,0));
    degree_celsius  :         RETURN(dimensional_exponents(0,0,0,0,1,0,0));
    lumen         :         RETURN(dimensional_exponents(0,0,0,0,0,0,1));
    lux           :         RETURN(dimensional_exponents(-2,0,0,0,0,0,1));
    becquerel     :         RETURN(dimensional_exponents(0,0,-1,0,0,0,0));
    gray          :         RETURN(dimensional_exponents(2,0,-2,0,0,0,0));
    sievert       :         RETURN(dimensional_exponents(2,0,-2,0,0,0,0));
    OTHERWISE     :         RETURN(?);
    END_CASE;

END_FUNCTION; -- 10303-41: measure_schema
```

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```
FUNCTION dot_product(
             arg1, arg2: direction
    ): REAL;

  LOCAL
    ndim   : INTEGER;
    scalar : REAL;
    vec1   : direction;
    vec2   : direction;
  END_LOCAL;
  IF (NOT EXISTS(arg1)) OR (NOT EXISTS(arg2)) THEN
    scalar := ?;
  ELSE
    IF arg1.dim <> arg2.dim THEN
      scalar := ?;
    ELSE
      BEGIN
        vec1 := normalise(arg1);
        vec2 := normalise(arg2);
        ndim := arg1.dim;
        scalar := 0;
        REPEAT i := 1 TO ndim BY 1;
          scalar := scalar + (vec1.direction_ratios[i] * vec2.
              direction_ratios[i]);
        END_REPEAT;
      END;
    END_IF;
  END_IF;
  RETURN(scalar);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION edge_reversed(
             an_edge: edge
    ): oriented_edge;

  LOCAL
    the_reverse : oriented_edge;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.ORIENTED_EDGE' IN TYPEOF(an_edge) THEN
    the_reverse := dummy_tri || edge(an_edge.edge_end,an_edge.edge_start)
        || oriented_edge(an_edge\oriented_edge.edge_element,NOT an_edge\
        oriented_edge.orientation);
  ELSE
    the_reverse := dummy_tri || edge(an_edge.edge_end,an_edge.edge_start)
        || oriented_edge(an_edge,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION face_bound_reversed(
             a_face_bound: face_bound
```

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```
    ): face_bound;

  LOCAL
    the_reverse : face_bound;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.FACE_OUTER_BOUND' IN TYPEOF(a_face_bound)
       THEN
    the_reverse := dummy_tri || face_bound(a_face_bound\face_bound.bound,
        NOT a_face_bound\face_bound.orientation) || face_outer_bound();
  ELSE
    the_reverse := dummy_tri || face_bound(a_face_bound.bound,NOT
        a_face_bound.orientation);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION face_reversed(
             a_face: face
    ): oriented_face;

  LOCAL
    the_reverse : oriented_face;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.ORIENTED_FACE' IN TYPEOF(a_face) THEN
    the_reverse := dummy_tri || face(set_of_topology_reversed(a_face.
        bounds)) || oriented_face(a_face\oriented_face.face_element,NOT
        a_face\oriented_face.orientation);
  ELSE
    the_reverse := dummy_tri || face(set_of_topology_reversed(a_face.
        bounds)) || oriented_face(a_face,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION first_proj_axis(
             z_axis, arg: direction
    ): direction;

  LOCAL
    x_vec  : vector;
    v      : direction;
    z      : direction;
    x_axis : direction;
  END_LOCAL;
  IF NOT EXISTS(z_axis) THEN
    RETURN(?);
  ELSE
    z := normalise(z_axis);
    IF NOT EXISTS(arg) THEN
      IF z.direction_ratios <> [1,0,0] THEN
        v := dummy_gri || direction([1,0,0]);
      ELSE
```

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```
        v := dummy_gri || direction([0,1,0]);
      END_IF;
    ELSE
      IF arg.dim <> 3 THEN
        RETURN(?);
      END_IF;
      IF cross_product(arg,z).magnitude = 0 THEN
        RETURN(?);
      ELSE
        v := normalise(arg);
      END_IF;
    END_IF;
    x_vec := scalar_times_vector(dot_product(v,z),z);
    x_axis := vector_difference(v,x_vec).orientation;
    x_axis := normalise(x_axis);
  END_IF;
  RETURN(x_axis);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION gbsf_check_curve(
             cv: representation_item
    ): BOOLEAN;
  IF SIZEOF(['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE',
      'INTEGRATED_CNC_SCHEMA.CONIC','INTEGRATED_CNC_SCHEMA.CURVE_REPLICA',
      'INTEGRATED_CNC_SCHEMA.LINE',
      'INTEGRATED_CNC_SCHEMA.OFFSET_CURVE_3D'] * TYPEOF(cv)) > 1 THEN
    RETURN(FALSE);
  END_IF;
  IF SIZEOF(['INTEGRATED_CNC_SCHEMA.CIRCLE',
      'INTEGRATED_CNC_SCHEMA.ELLIPSE',
      'INTEGRATED_CNC_SCHEMA.TRIMMED_CURVE'] * TYPEOF(cv)) = 1 THEN
    RETURN(TRUE);
  ELSE
    IF (('INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE' IN TYPEOF(cv)) AND (cv\
        b_spline_curve.self_intersect = FALSE)) OR (cv\b_spline_curve.
        self_intersect = UNKNOWN) THEN
      RETURN(TRUE);
    ELSE
      IF (('INTEGRATED_CNC_SCHEMA.COMPOSITE_CURVE' IN TYPEOF(cv)) AND (
          cv\composite_curve.self_intersect = FALSE)) OR (cv\
          composite_curve.self_intersect = UNKNOWN) THEN
        RETURN(SIZEOF(QUERY ( seg <* cv\composite_curve.segments | (NOT
            gbsf_check_curve(seg.parent_curve)) )) = 0);
      ELSE
        IF 'INTEGRATED_CNC_SCHEMA.CURVE_REPLICA' IN TYPEOF(cv) THEN
          RETURN(gbsf_check_curve(cv\curve_replica.parent_curve));
        ELSE
          IF ('INTEGRATED_CNC_SCHEMA.OFFSET_CURVE_3D' IN TYPEOF(cv)) AND
               ((cv\offset_curve_3d.self_intersect = FALSE) OR (cv\
              offset_curve_3d.self_intersect = UNKNOWN)) AND (NOT (
              'INTEGRATED_CNC_SCHEMA.POLYLINE' IN TYPEOF(cv\
              offset_curve_3d.basis_curve))) THEN
            RETURN(gbsf_check_curve(cv\offset_curve_3d.basis_curve));
```

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```
          ELSE
            IF 'INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(cv) THEN
              RETURN(gbsf_check_curve(cv\pcurve.reference_to_curve\
                  representation.items[1]) AND gbsf_check_surface(cv\
                  pcurve.basis_surface));
            ELSE
              IF 'INTEGRATED_CNC_SCHEMA.POLYLINE' IN TYPEOF(cv) THEN
                IF SIZEOF(cv\polyline.points) >= 3 THEN
                  RETURN(TRUE);
                END_IF;
              ELSE
                IF 'INTEGRATED_CNC_SCHEMA.SURFACE_CURVE' IN TYPEOF(cv)
                     THEN
                  IF gbsf_check_curve(cv\surface_curve.curve_3d) THEN
                    REPEAT i := 1 TO SIZEOF(cv\surface_curve.
                        associated_geometry) BY 1;
                      IF 'INTEGRATED_CNC_SCHEMA.SURFACE' IN TYPEOF(cv\
                          surface_curve.associated_geometry[i]) THEN
                        IF NOT gbsf_check_surface(cv\surface_curve.
                            associated_geometry[i]) THEN
                          RETURN(FALSE);
                        END_IF;
                      ELSE
                        IF 'INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(cv\
                            surface_curve.associated_geometry[i]) THEN
                          IF NOT gbsf_check_curve(cv\surface_curve.
                              associated_geometry[i]) THEN
                            RETURN(FALSE);
                          END_IF;
                        END_IF;
                      END_IF;
                    END_REPEAT;
                    RETURN(TRUE);
                  END_IF;
                END_IF;
              END_IF;
            END_IF;
          END_IF;
        END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- 10303-507: aic_geometrically_bounded_surface

FUNCTION gbsf_check_point(
             pnt: point
    ): BOOLEAN;
  IF 'INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT' IN TYPEOF(pnt) THEN
    RETURN(TRUE);
  ELSE
    IF 'INTEGRATED_CNC_SCHEMA.POINT_ON_CURVE' IN TYPEOF(pnt) THEN
      RETURN(gbsf_check_curve(pnt\point_on_curve.basis_curve));
```

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```
    ELSE
      IF 'INTEGRATED_CNC_SCHEMA.POINT_ON_SURFACE' IN TYPEOF(pnt) THEN
        RETURN(gbsf_check_surface(pnt\point_on_surface.basis_surface));
      ELSE
        IF 'INTEGRATED_CNC_SCHEMA.DEGENERATE_PCURVE' IN TYPEOF(pnt)
             THEN
          RETURN(gbsf_check_curve(pnt\degenerate_pcurve.
              reference_to_curve\representation.items[1]) AND
              gbsf_check_surface(pnt\degenerate_pcurve.basis_surface));
        END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- 10303-507: aic_geometrically_bounded_surface

FUNCTION gbsf_check_surface(
             sf: surface
    ): BOOLEAN;
  IF (('INTEGRATED_CNC_SCHEMA.B_SPLINE_SURFACE' IN TYPEOF(sf)) AND (sf\
      b_spline_surface.self_intersect = FALSE)) OR (sf\b_spline_surface.
      self_intersect = UNKNOWN) THEN
    RETURN(TRUE);
  ELSE
    IF SIZEOF(['INTEGRATED_CNC_SCHEMA.SPHERICAL_SURFACE',
        'INTEGRATED_CNC_SCHEMA.TOROIDAL_SURFACE',
        'INTEGRATED_CNC_SCHEMA.CURVE_BOUNDED_SURFACE',
        'INTEGRATED_CNC_SCHEMA.RECTANGULAR_TRIMMED_SURFACE'] * TYPEOF(sf))
        = 1 THEN
      RETURN(TRUE);
    ELSE
      IF (('INTEGRATED_CNC_SCHEMA.OFFSET_SURFACE' IN TYPEOF(sf)) AND (sf
          \offset_surface.self_intersect = FALSE)) OR (sf\offset_surface.
          self_intersect = UNKNOWN) THEN
        RETURN(gbsf_check_surface(sf\offset_surface.basis_surface));
      ELSE
        IF 'INTEGRATED_CNC_SCHEMA.RECTANGULAR_COMPOSITE_SURFACE' IN
            TYPEOF(sf) THEN
          REPEAT i := 1 TO SIZEOF(sf\rectangular_composite_surface.
              segments) BY 1;
            REPEAT j := 1 TO SIZEOF(sf\rectangular_composite_surface.
                segments[i]) BY 1;
              IF NOT gbsf_check_surface(sf\rectangular_composite_surface
                  .segments[i][j].parent_surface) THEN
                RETURN(FALSE);
              END_IF;
            END_REPEAT;
          END_REPEAT;
          RETURN(TRUE);
        ELSE
          IF 'INTEGRATED_CNC_SCHEMA.SURFACE_REPLICA' IN TYPEOF(sf) THEN
            RETURN(gbsf_check_surface(sf\surface_replica.parent_surface));
          ELSE
```

```
            IF 'INTEGRATED_CNC_SCHEMA.SURFACE_OF_REVOLUTION' IN TYPEOF(
                sf) THEN
              RETURN(gbsf_check_curve(sf\swept_surface.swept_curve));
            END_IF;
          END_IF;
        END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- 10303-507: aic_geometrically_bounded_surface

FUNCTION get_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): SET OF action_property;

    RETURN (bag_to_set (QUERY (ap <*
        USEDIN (cad, 'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY.DEFINITION') |
        (ap.name = prop_name))));
END_FUNCTION;

FUNCTION get_basis_surface(
             c: curve_on_surface
    ): SET [0:2] OF surface;

  LOCAL
    surfs : SET [0:2] OF surface;
    n     : INTEGER;
  END_LOCAL;
  surfs := [];
  IF 'INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(c) THEN
    surfs := [c\pcurve.basis_surface];
  ELSE
    IF 'INTEGRATED_CNC_SCHEMA.SURFACE_CURVE' IN TYPEOF(c) THEN
      n := SIZEOF(c\surface_curve.associated_geometry);
      REPEAT i := 1 TO n BY 1;
        surfs := surfs + associated_surface(c\surface_curve.
            associated_geometry[i]);
      END_REPEAT;
    END_IF;
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.COMPOSITE_CURVE_ON_SURFACE' IN TYPEOF(c)
       THEN
    n := SIZEOF(c\composite_curve.segments);
    surfs := get_basis_surface(c\composite_curve.segments[1].
        parent_curve);
    IF n > 1 THEN
      REPEAT i := 2 TO n BY 1;
        surfs := surfs * get_basis_surface(c\composite_curve.segments[i]
            .parent_curve);
      END_REPEAT;
    END_IF;
```

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```
  END_IF;
  RETURN(surfs);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION get_description_value(
             obj: description_attribute_select
    ): text;

  LOCAL
    description_bag : BAG OF description_attribute := USEDIN(obj,
                        'INTEGRATED_CNC_SCHEMA.' +
                        'DESCRIPTION_ATTRIBUTE.' + 'DESCRIBED_ITEM');
  END_LOCAL;
  IF SIZEOF(description_bag) = 1 THEN
    RETURN(description_bag[1].attribute_value);
  ELSE
    RETURN(?);
  END_IF;

END_FUNCTION; -- 10303-41: basic_attribute_schema

FUNCTION get_id_value(
             obj: id_attribute_select
    ): identifier;

  LOCAL
    id_bag : BAG OF id_attribute := USEDIN(obj,'INTEGRATED_CNC_SCHEMA.'
              + 'ID_ATTRIBUTE.' + 'IDENTIFIED_ITEM');
  END_LOCAL;
  IF SIZEOF(id_bag) = 1 THEN
    RETURN(id_bag[1].attribute_value);
  ELSE
    RETURN(?);
  END_IF;

END_FUNCTION; -- 10303-41: basic_attribute_schema

FUNCTION get_name_value(
             obj: name_attribute_select
    ): label;

  LOCAL
    name_bag : BAG OF name_attribute := USEDIN(obj,
                'INTEGRATED_CNC_SCHEMA.' + 'NAME_ATTRIBUTE.' +
                'NAMED_ITEM');
  END_LOCAL;
  IF SIZEOF(name_bag) = 1 THEN
    RETURN(name_bag[1].attribute_value);
  ELSE
    RETURN(?);
  END_IF;

END_FUNCTION; -- 10303-41: basic_attribute_schema
```

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```
FUNCTION get_related_amr (am: action_method)
        : SET OF action_method_relationship;

    RETURN (bag_to_set (USEDIN (am,
       'INTEGRATED_CNC_SCHEMA.ACTION_METHOD_RELATIONSHIP.RELATED_METHOD')));
END_FUNCTION;

FUNCTION get_relating_amr (am: action_method)
        : SET OF action_method_relationship;

    RETURN (bag_to_set (USEDIN (am,
       'INTEGRATED_CNC_SCHEMA.ACTION_METHOD_RELATIONSHIP.RELATING_METHOD')));
END_FUNCTION;

FUNCTION get_resource_property (
        crd:            characterized_resource_definition;
        prop_name:      STRING
        ): SET OF resource_property;

    RETURN (bag_to_set (QUERY (rp <*
        USEDIN (crd, 'INTEGRATED_CNC_SCHEMA.RESOURCE_PROPERTY.RESOURCE') |
        (rp.name = prop_name))));
END_FUNCTION;

FUNCTION get_role(
             obj: role_select
    ): object_role;

  LOCAL
    role_bag : BAG OF role_association := USEDIN(obj,
                'INTEGRATED_CNC_SCHEMA.' + 'ROLE_ASSOCIATION.' +
                'ITEM_WITH_ROLE');
  END_LOCAL;
  IF SIZEOF(role_bag) = 1 THEN
    RETURN(role_bag[1].role);
  ELSE
    RETURN(?);
  END_IF;

END_FUNCTION; -- 10303-41: basic_attribute_schema

FUNCTION is_acyclic(
             arg: generic_expression
    ): BOOLEAN;
  RETURN(acyclic(arg,[]));

END_FUNCTION; -- 13584-20: iso13584_generic_expressions_schema

FUNCTION is_int_expr(
             arg: numeric_expression
    ): BOOLEAN;

  LOCAL
```

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```
    i : INTEGER;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.INT_LITERAL' IN TYPEOF(arg) THEN
    RETURN(TRUE);
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.REAL_LITERAL' IN TYPEOF(arg) THEN
    RETURN(FALSE);
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.INT_NUMERIC_VARIABLE' IN TYPEOF(arg) THEN
    RETURN(TRUE);
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.REAL_NUMERIC_VARIABLE' IN TYPEOF(arg) THEN
    RETURN(FALSE);
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- 13584-20: iso13584_expressions_schema

FUNCTION is_sql_mappable(
             arg: expression
    ): BOOLEAN;

  LOCAL
    i : INTEGER;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.SIMPLE_NUMERIC_EXPRESSION' IN TYPEOF(arg)
       THEN
    RETURN(TRUE);
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.NOT_EXPRESSION' IN TYPEOF(arg) THEN
    RETURN(is_sql_mappable(arg\unary_generic_expression.operand));
  END_IF;
  IF ('INTEGRATED_CNC_SCHEMA.XOR_EXPRESSION' IN TYPEOF(arg)) THEN
    RETURN(FALSE);
  END_IF;
  IF ('INTEGRATED_CNC_SCHEMA.AND_EXPRESSION' IN TYPEOF(arg)) OR (
      'INTEGRATED_CNC_SCHEMA.OR_EXPRESSION' IN TYPEOF(arg)) THEN
    REPEAT i := 1 TO SIZEOF(arg\multiple_arity_boolean_expression.
        operands) BY 1;
      IF NOT is_sql_mappable(arg\multiple_arity_boolean_expression.
          operands[i]) THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
    RETURN(TRUE);
  END_IF;
  IF ('INTEGRATED_CNC_SCHEMA.COMPARISON_EQUAL' IN TYPEOF(arg)) OR (
      'INTEGRATED_CNC_SCHEMA.COMPARISON_GREATER' IN TYPEOF(arg)) OR (
      'INTEGRATED_CNC_SCHEMA.COMPARISON_GREATER_EQUAL' IN TYPEOF(arg)) OR
       ('INTEGRATED_CNC_SCHEMA.COMPARISON_LESS' IN TYPEOF(arg)) OR (
      'INTEGRATED_CNC_SCHEMA.COMPARISON_LESS_EQUAL' IN TYPEOF(arg)) OR (
      'INTEGRATED_CNC_SCHEMA.COMPARISON_NOT_EQUAL' IN TYPEOF(arg))  THEN
    RETURN(is_sql_mappable(arg\comparison_expression.operands[1]) AND
        is_sql_mappable(arg\comparison_expression.operands[2]));
```

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```
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- 13584-20: iso13584_expressions_schema

FUNCTION item_in_context(
             item: representation_item;
             cntxt: representation_context
    ): BOOLEAN;

  LOCAL
    y : BAG OF representation_item;
  END_LOCAL;
  IF SIZEOF(USEDIN(item,'INTEGRATED_CNC_SCHEMA.REPRESENTATION.ITEMS') *
      cntxt.representations_in_context) > 0 THEN
    RETURN(TRUE);
  ELSE
    y := QUERY ( z <* USEDIN(item,'') | (
        'INTEGRATED_CNC_SCHEMA.REPRESENTATION_ITEM' IN TYPEOF(z)) );
    IF SIZEOF(y) > 0 THEN
      REPEAT i := 1 TO HIINDEX(y) BY 1;
        IF item_in_context(y[i],cntxt) THEN
          RETURN(TRUE);
        END_IF;
      END_REPEAT;
    END_IF;
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- 10303-43: representation_schema

FUNCTION leap_year(
             year: year_number
    ): BOOLEAN;
  IF (((year MOD 4) = 0) AND ((year MOD 100) <> 0)) OR ((year MOD 400) =
      0) THEN
    RETURN(TRUE);
  ELSE
    RETURN(FALSE);
  END_IF;

END_FUNCTION; -- 10303-41: date_time_schema

FUNCTION list_face_loops(
             f: face
    ): LIST [0:?] OF loop;

  LOCAL
    loops : LIST [0:?] OF loop := [];
  END_LOCAL;
  REPEAT i := 1 TO SIZEOF(f.bounds) BY 1;
    loops := loops + f.bounds[i].bound;
  END_REPEAT;
  RETURN(loops);
```

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```
END_FUNCTION; -- 10303-42: topology_schema

FUNCTION list_of_topology_reversed(
             a_list: list_of_reversible_topology_item
    ): list_of_reversible_topology_item;

  LOCAL
    the_reverse : list_of_reversible_topology_item;
  END_LOCAL;
  the_reverse := [];
  REPEAT i := 1 TO SIZEOF(a_list) BY 1;
    the_reverse := topology_reversed(a_list[i]) + the_reverse;
  END_REPEAT;
  RETURN(the_reverse);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION list_to_array(
             lis: LIST [0:?] OF GENERIC:t;
             low: INTEGER;
             u: INTEGER
    ): ARRAY OF GENERIC:t;

  LOCAL
    n   : INTEGER;
    res : ARRAY [low:u] OF GENERIC:t;
  END_LOCAL;
  n := SIZEOF(lis);
  IF n <> ((u - low) + 1) THEN
    RETURN(?);
  ELSE
    res := [lis[1]];
    REPEAT i := 2 TO n BY 1;
      res[(low + i) - 1] := lis[i];
    END_REPEAT;
    RETURN(res);
  END_IF;

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION list_to_set(
             l: LIST [0:?] OF GENERIC:t
    ): SET OF GENERIC:t;

  LOCAL
    s : SET OF GENERIC:t := [];
  END_LOCAL;
  REPEAT i := 1 TO SIZEOF(l) BY 1;
    s := s + l[i];
  END_REPEAT;
  RETURN(s);

END_FUNCTION; -- 10303-42: topology_schema
```

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```
FUNCTION make_array_of_array(
             lis: LIST [1:?] OF LIST [1:?] OF GENERIC:t;
             low1: INTEGER;
             u1: INTEGER;
             low2: INTEGER;
             u2: INTEGER
    ): ARRAY OF ARRAY OF GENERIC:t;

  LOCAL
    res : ARRAY [low1:u1] OF ARRAY [low2:u2] OF GENERIC:t;
  END_LOCAL;
  IF ((u1 - low1) + 1) <> SIZEOF(lis) THEN
    RETURN(?);
  END_IF;
  IF ((u2 - low2) + 1) <> SIZEOF(lis[1]) THEN
    RETURN(?);
  END_IF;
  res := [list_to_array(lis[1],low2,u2)];
  REPEAT i := 2 TO HIINDEX(lis) BY 1;
    IF ((u2 - low2) + 1) <> SIZEOF(lis[i]) THEN
      RETURN(?);
    END_IF;
    res[(low1 + i) - 1] := list_to_array(lis[i],low2,u2);
  END_REPEAT;
  RETURN(res);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION mixed_loop_type_set(
             l: SET [0:?] OF loop
    ): LOGICAL;

  LOCAL
    poly_loop_type : LOGICAL;
  END_LOCAL;
  IF SIZEOF(l) <= 1 THEN
    RETURN(FALSE);
  END_IF;
  poly_loop_type := 'INTEGRATED_CNC_SCHEMA.POLY_LOOP' IN TYPEOF(l[1]);
  REPEAT i := 2 TO SIZEOF(l) BY 1;
    IF ('INTEGRATED_CNC_SCHEMA.POLY_LOOP' IN TYPEOF(l[i])) <>
        poly_loop_type THEN
      RETURN(TRUE);
    END_IF;
  END_REPEAT;
  RETURN(FALSE);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION msb_shells(
             brep: manifold_solid_brep
    ): SET [1:?] OF closed_shell;
  IF SIZEOF(QUERY ( msbtype <* TYPEOF(brep) | (msbtype LIKE
```

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```
      '*BREP_WITH_VOIDS') )) >= 1 THEN
    RETURN(brep\brep_with_voids.voids + brep.outer);
  ELSE
    RETURN([brep.outer]);
  END_IF;

END_FUNCTION; -- 10303-42: geometric_model_schema

FUNCTION msf_curve_check(
             cv: representation_item
    ): BOOLEAN;
  IF SIZEOF(['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE',
      'INTEGRATED_CNC_SCHEMA.CONIC','INTEGRATED_CNC_SCHEMA.CURVE_REPLICA',
      'INTEGRATED_CNC_SCHEMA.LINE',
      'INTEGRATED_CNC_SCHEMA.OFFSET_CURVE_3D'] * TYPEOF(cv)) > 1 THEN
    RETURN(FALSE);
  END_IF;
  IF (('INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE' IN TYPEOF(cv)) AND (cv\
      b_spline_curve.self_intersect = FALSE)) OR (cv\b_spline_curve.
      self_intersect = UNKNOWN) THEN
    RETURN(TRUE);
  ELSE
    IF SIZEOF(['INTEGRATED_CNC_SCHEMA.CONIC',
        'INTEGRATED_CNC_SCHEMA.LINE'] * TYPEOF(cv)) = 1 THEN
      RETURN(TRUE);
    ELSE
      IF 'INTEGRATED_CNC_SCHEMA.CURVE_REPLICA' IN TYPEOF(cv) THEN
        RETURN(msf_curve_check(cv\curve_replica.parent_curve));
      ELSE
        IF ('INTEGRATED_CNC_SCHEMA.OFFSET_CURVE_3D' IN TYPEOF(cv)) AND (
            (cv\offset_curve_3d.self_intersect = FALSE) OR (cv\
            offset_curve_3d.self_intersect = UNKNOWN)) AND (NOT (
            'INTEGRATED_CNC_SCHEMA.POLYLINE' IN TYPEOF(cv\offset_curve_3d
            .basis_curve))) THEN
          RETURN(msf_curve_check(cv\offset_curve_3d.basis_curve));
        ELSE
          IF 'INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(cv) THEN
            RETURN(msf_curve_check(cv\pcurve.reference_to_curve\
                representation.items[1]) AND msf_surface_check(cv\pcurve.
                basis_surface));
          ELSE
            IF 'INTEGRATED_CNC_SCHEMA.SURFACE_CURVE' IN TYPEOF(cv) THEN
              IF msf_curve_check(cv\surface_curve.curve_3d) THEN
                REPEAT i := 1 TO SIZEOF(cv\surface_curve.
                    associated_geometry) BY 1;
                  IF 'INTEGRATED_CNC_SCHEMA.SURFACE' IN TYPEOF(cv\
                      surface_curve.associated_geometry[i]) THEN
                    IF NOT msf_surface_check(cv\surface_curve.
                        associated_geometry[i]) THEN
                      RETURN(FALSE);
                    END_IF;
                  ELSE
                    IF 'INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(cv\
                        surface_curve.associated_geometry[i]) THEN
```

```
                      IF NOT msf_curve_check(cv\surface_curve.
                          associated_geometry[i]) THEN
                        RETURN(FALSE);
                      END_IF;
                    END_IF;
                  END_IF;
                END_REPEAT;
                RETURN(TRUE);
              END_IF;
            ELSE
              IF 'INTEGRATED_CNC_SCHEMA.POLYLINE' IN TYPEOF(cv) THEN
                IF SIZEOF(cv\polyline.points) >= 3 THEN
                  RETURN(TRUE);
                END_IF;
              END_IF;
            END_IF;
          END_IF;
        END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- 10303-509: aic_manifold_surface

FUNCTION msf_surface_check(
             surf: surface
    ): BOOLEAN;
  IF 'INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE' IN TYPEOF(surf) THEN
    RETURN(TRUE);
  ELSE
    IF 'INTEGRATED_CNC_SCHEMA.SWEPT_SURFACE' IN TYPEOF(surf) THEN
      RETURN(msf_curve_check(surf\swept_surface.swept_curve));
    ELSE
      IF (('INTEGRATED_CNC_SCHEMA.OFFSET_SURFACE' IN TYPEOF(surf)) AND (
          surf\offset_surface.self_intersect = FALSE)) OR (surf\
          offset_surface.self_intersect = UNKNOWN) THEN
        RETURN(msf_surface_check(surf\offset_surface.basis_surface));
      ELSE
        IF 'INTEGRATED_CNC_SCHEMA.SURFACE_REPLICA' IN TYPEOF(surf) THEN
          RETURN(msf_surface_check(surf\surface_replica.parent_surface));
        ELSE
          IF (('INTEGRATED_CNC_SCHEMA.B_SPLINE_SURFACE' IN TYPEOF(surf))
              AND (surf\b_spline_surface.self_intersect = FALSE)) OR (
              surf\b_spline_surface.self_intersect = UNKNOWN) THEN
            RETURN(TRUE);
          END_IF;
        END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- 10303-509: aic_manifold_surface
```

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```
FUNCTION normalise(
             arg: vector_or_direction
    ): vector_or_direction;

  LOCAL
    ndim   : INTEGER;
    v      : direction;
    vec    : vector;
    mag    : REAL;
    result : vector_or_direction;
  END_LOCAL;
  IF NOT EXISTS(arg) THEN
    result := ?;
  ELSE
    ndim := arg.dim;
    IF 'INTEGRATED_CNC_SCHEMA.VECTOR' IN TYPEOF(arg) THEN
      BEGIN
        v := dummy_gri || direction(arg.orientation.direction_ratios);
        IF arg.magnitude = 0 THEN
          RETURN(?);
        ELSE
          vec := dummy_gri || vector(v,1);
        END_IF;
      END;
    ELSE
      v := dummy_gri || direction(arg.direction_ratios);
    END_IF;
    mag := 0;
    REPEAT i := 1 TO ndim BY 1;
      mag := mag + (v.direction_ratios[i] * v.direction_ratios[i]);
    END_REPEAT;
    IF mag > 0 THEN
      mag := SQRT(mag);
      REPEAT i := 1 TO ndim BY 1;
        v.direction_ratios[i] := v.direction_ratios[i] / mag;
      END_REPEAT;
      IF 'INTEGRATED_CNC_SCHEMA.VECTOR' IN TYPEOF(arg) THEN
        vec.orientation := v;
        result := vec;
      ELSE
        result := v;
      END_IF;
    ELSE
      RETURN(?);
    END_IF;
  END_IF;
  RETURN(result);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION open_shell_reversed(
             a_shell: open_shell
    ): oriented_open_shell;
```

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```
  LOCAL
    the_reverse : oriented_open_shell;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.ORIENTED_OPEN_SHELL' IN TYPEOF(a_shell)
       THEN
    the_reverse := dummy_tri || connected_face_set(a_shell\
        connected_face_set.cfs_faces) || open_shell() ||
        oriented_open_shell(a_shell\oriented_open_shell.
        open_shell_element,NOT a_shell\oriented_open_shell.orientation);
  ELSE
    the_reverse := dummy_tri || connected_face_set(a_shell\
        connected_face_set.cfs_faces) || open_shell() ||
        oriented_open_shell(a_shell,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION orthogonal_complement(
             vec: direction
    ): direction;

  LOCAL
    result : direction;
  END_LOCAL;
  IF (vec.dim <> 2) OR (NOT EXISTS(vec)) THEN
    RETURN(?);
  ELSE
    result := dummy_gri || direction([-vec.direction_ratios[2],vec.
        direction_ratios[1]]);
    RETURN(result);
  END_IF;

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION path_head_to_tail(
             a_path: path
    ): BOOLEAN;

  LOCAL
    n : INTEGER;
    p : BOOLEAN := TRUE;
  END_LOCAL;
  n := SIZEOF(a_path.edge_list);
  REPEAT i := 2 TO n BY 1;
    p := p AND (a_path.edge_list[i - 1].edge_end :=: a_path.edge_list[i]
        .edge_start);
  END_REPEAT;
  RETURN(p);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION path_reversed(
```

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```
            a_path: path
    ): oriented_path;

  LOCAL
    the_reverse : oriented_path;
  END_LOCAL;
  IF 'INTEGRATED_CNC_SCHEMA.ORIENTED_PATH' IN TYPEOF(a_path) THEN
    the_reverse := dummy_tri || path(list_of_topology_reversed(a_path.
        edge_list)) || oriented_path(a_path\oriented_path.path_element,
        NOT a_path\oriented_path.orientation);
  ELSE
    the_reverse := dummy_tri || path(list_of_topology_reversed(a_path.
        edge_list)) || oriented_path(a_path,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION scalar_times_vector(
            scalar: REAL;
            vec: vector_or_direction
    ): vector;

  LOCAL
    v      : direction;
    mag    : REAL;
    result : vector;
  END_LOCAL;
  IF (NOT EXISTS(scalar)) OR (NOT EXISTS(vec)) THEN
    RETURN(?);
  ELSE
    IF 'INTEGRATED_CNC_SCHEMA.VECTOR' IN TYPEOF(vec) THEN
      v := dummy_gri || direction(vec.orientation.direction_ratios);
      mag := scalar * vec.magnitude;
    ELSE
      v := dummy_gri || direction(vec.direction_ratios);
      mag := scalar;
    END_IF;
    IF mag < 0 THEN
      REPEAT i := 1 TO SIZEOF(v.direction_ratios) BY 1;
        v.direction_ratios[i] := -v.direction_ratios[i];
      END_REPEAT;
      mag := -mag;
    END_IF;
    result := dummy_gri || vector(normalise(v),mag);
  END_IF;
  RETURN(result);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION second_proj_axis(
            z_axis, x_axis, arg: direction
    ): direction;
```

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```
  LOCAL
    temp   : vector;
    v      : direction;
    y_axis : vector;
  END_LOCAL;
  IF NOT EXISTS(arg) THEN
    v := dummy_gri || direction([0,1,0]);
  ELSE
    v := arg;
  END_IF;
  temp := scalar_times_vector(dot_product(v,z_axis),z_axis);
  y_axis := vector_difference(v,temp);
  temp := scalar_times_vector(dot_product(v,x_axis),x_axis);
  y_axis := vector_difference(y_axis,temp);
  y_axis := normalise(y_axis);
  RETURN(y_axis.orientation);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION set_of_topology_reversed(
             a_set: set_of_reversible_topology_item
    ): set_of_reversible_topology_item;

  LOCAL
    the_reverse : set_of_reversible_topology_item;
  END_LOCAL;
  the_reverse := [];
  REPEAT i := 1 TO SIZEOF(a_set) BY 1;
    the_reverse := the_reverse + topology_reversed(a_set[i]);
  END_REPEAT;
  RETURN(the_reverse);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION shell_reversed(
             a_shell: shell
    ): shell;
  IF 'INTEGRATED_CNC_SCHEMA.OPEN_SHELL' IN TYPEOF(a_shell) THEN
    RETURN(open_shell_reversed(a_shell));
  ELSE
    IF 'INTEGRATED_CNC_SCHEMA.CLOSED_SHELL' IN TYPEOF(a_shell) THEN
      RETURN(closed_shell_reversed(a_shell));
    ELSE
      RETURN(?);
    END_IF;
  END_IF;

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION surface_weights_positive(
             b: rational_b_spline_surface
    ): BOOLEAN;

  LOCAL
```

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```
    result : BOOLEAN := TRUE;
  END_LOCAL;
  REPEAT i := 0 TO b.u_upper BY 1;
    REPEAT j := 0 TO b.v_upper BY 1;
      IF b.weights[i][j] <= 0 THEN
        result := FALSE;
        RETURN(result);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  RETURN(result);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION topology_reversed(
             an_item: reversible_topology
    ): reversible_topology;
  IF 'INTEGRATED_CNC_SCHEMA.EDGE' IN TYPEOF(an_item) THEN
    RETURN(edge_reversed(an_item));
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.PATH' IN TYPEOF(an_item) THEN
    RETURN(path_reversed(an_item));
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.FACE_BOUND' IN TYPEOF(an_item) THEN
    RETURN(face_bound_reversed(an_item));
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.FACE' IN TYPEOF(an_item) THEN
    RETURN(face_reversed(an_item));
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.SHELL' IN TYPEOF(an_item) THEN
    RETURN(shell_reversed(an_item));
  END_IF;
  IF 'SET' IN TYPEOF(an_item) THEN
    RETURN(set_of_topology_reversed(an_item));
  END_IF;
  IF 'LIST' IN TYPEOF(an_item) THEN
    RETURN(list_of_topology_reversed(an_item));
  END_IF;
  RETURN(?);

END_FUNCTION; -- 10303-42: topology_schema

FUNCTION using_items(
             item: founded_item_select;
             checked_items: SET OF founded_item_select
    ): SET OF founded_item_select;

  LOCAL
    next_items      : SET OF founded_item_select;
    new_check_items : SET OF founded_item_select;
    result_items    : SET OF founded_item_select;
  END_LOCAL;
  result_items := [];
  new_check_items := checked_items + item;
```

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```
  next_items := QUERY ( z <* bag_to_set(USEDIN(item,'')) | ((
      'INTEGRATED_CNC_SCHEMA.REPRESENTATION_ITEM' IN TYPEOF(z)) OR (
      'INTEGRATED_CNC_SCHEMA.FOUNDED_ITEM' IN TYPEOF(z))) );
  IF SIZEOF(next_items) > 0 THEN
    REPEAT i := 1 TO HIINDEX(next_items) BY 1;
      IF NOT (next_items[i] IN new_check_items) THEN
        result_items := result_items + next_items[i] + using_items(
            next_items[i],new_check_items);
      END_IF;
    END_REPEAT;
  END_IF;
  RETURN(result_items);

END_FUNCTION; -- 10303-43: representation_schema

FUNCTION using_representations(
             item: founded_item_select
    ): SET OF representation;

  LOCAL
    results            : SET OF representation;
    intermediate_items : SET OF founded_item_select;
    result_bag         : BAG OF representation;
  END_LOCAL;
  results := [];
  result_bag := USEDIN(item,'INTEGRATED_CNC_SCHEMA.REPRESENTATION.ITEMS');
  IF SIZEOF(result_bag) > 0 THEN
    REPEAT i := 1 TO HIINDEX(result_bag) BY 1;
      results := results + result_bag[i];
    END_REPEAT;
  END_IF;
  intermediate_items := using_items(item,[]);
  IF SIZEOF(intermediate_items) > 0 THEN
    REPEAT i := 1 TO HIINDEX(intermediate_items) BY 1;
      result_bag := USEDIN(intermediate_items[i],
          'INTEGRATED_CNC_SCHEMA.REPRESENTATION.ITEMS');
      IF SIZEOF(result_bag) > 0 THEN
        REPEAT j := 1 TO HIINDEX(result_bag) BY 1;
          results := results + result_bag[j];
        END_REPEAT;
      END_IF;
    END_REPEAT;
  END_IF;
  RETURN(results);

END_FUNCTION; -- 10303-43: representation_schema

FUNCTION valid_calendar_date(
             date: calendar_date
    ): LOGICAL;
  CASE date.month_component OF
    1 :         RETURN((1 <= date.day_component) AND (date.day_component
          <= 31));
    2 :         BEGIN
```

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```
        IF leap_year(date.year_component) THEN
          RETURN((1 <= date.day_component) AND (date.day_component <= 29));
        ELSE
          RETURN((1 <= date.day_component) AND (date.day_component <= 28));
        END_IF;
      END;
    3 :         RETURN((1 <= date.day_component) AND (date.day_component
          <= 31));
    4 :         RETURN((1 <= date.day_component) AND (date.day_component
          <= 30));
    5 :         RETURN((1 <= date.day_component) AND (date.day_component
          <= 31));
    6 :         RETURN((1 <= date.day_component) AND (date.day_component
          <= 30));
    7 :         RETURN((1 <= date.day_component) AND (date.day_component
          <= 31));
    8 :         RETURN((1 <= date.day_component) AND (date.day_component
          <= 31));
    9 :         RETURN((1 <= date.day_component) AND (date.day_component
          <= 30));
    10  :         RETURN((1 <= date.day_component) AND (date.
          day_component <= 31));
    11  :         RETURN((1 <= date.day_component) AND (date.
          day_component <= 30));
    12  :         RETURN((1 <= date.day_component) AND (date.
          day_component <= 31));
    END_CASE;
  RETURN(FALSE);

END_FUNCTION; -- 10303-41: date_time_schema

FUNCTION valid_measure_value(
             m: measure_value
    ): BOOLEAN;
  IF 'REAL' IN TYPEOF(m) THEN
    RETURN(m > 0);
  ELSE
    IF 'INTEGER' IN TYPEOF(m) THEN
      RETURN(m > 0);
    ELSE
      RETURN(TRUE);
    END_IF;
  END_IF;

END_FUNCTION; -- 10303-43: representation_schema

FUNCTION valid_time(
             time: local_time
    ): BOOLEAN;
  IF EXISTS(time.second_component) THEN
    RETURN(EXISTS(time.minute_component));
  ELSE
    RETURN(TRUE);
  END_IF;
```

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```
END_FUNCTION; -- 10303-41: date_time_schema

FUNCTION valid_units(
             m: measure_with_unit
    ): BOOLEAN;
  IF 'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE' IN TYPEOF(m.value_component)
       THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(1,0,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.TIME_MEASURE' IN TYPEOF(m.value_component)
       THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,1,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE' IN TYPEOF(m.
      value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.SOLID_ANGLE_MEASURE' IN TYPEOF(m.
      value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE' IN TYPEOF(m.value_component)
       THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.POSITIVE_LENGTH_MEASURE' IN TYPEOF(m.
      value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(1,0,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'INTEGRATED_CNC_SCHEMA.POSITIVE_PLANE_ANGLE_MEASURE' IN TYPEOF(m.
      value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
```

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```
  END_IF;
  RETURN(TRUE);

END_FUNCTION; -- 10303-41: measure_schema

FUNCTION vector_difference(
             arg1, arg2: vector_or_direction
    ): vector;

  LOCAL
    ndim   : INTEGER;
    mag2   : REAL;
    mag1   : REAL;
    mag    : REAL;
    res    : direction;
    vec1   : direction;
    vec2   : direction;
    result : vector;
  END_LOCAL;
  IF (NOT EXISTS(arg1)) OR (NOT EXISTS(arg2)) OR (arg1.dim <> arg2.dim)
       THEN
    RETURN(?);
  ELSE
    BEGIN
      IF 'INTEGRATED_CNC_SCHEMA.VECTOR' IN TYPEOF(arg1) THEN
        mag1 := arg1.magnitude;
        vec1 := arg1.orientation;
      ELSE
        mag1 := 1;
        vec1 := arg1;
      END_IF;
      IF 'INTEGRATED_CNC_SCHEMA.VECTOR' IN TYPEOF(arg2) THEN
        mag2 := arg2.magnitude;
        vec2 := arg2.orientation;
      ELSE
        mag2 := 1;
        vec2 := arg2;
      END_IF;
      vec1 := normalise(vec1);
      vec2 := normalise(vec2);
      ndim := SIZEOF(vec1.direction_ratios);
      mag := 0;
      res := dummy_gri || direction(vec1.direction_ratios);
      REPEAT i := 1 TO ndim BY 1;
        res.direction_ratios[i] := (mag1 * vec1.direction_ratios[i]) + (
            mag2 * vec2.direction_ratios[i]);
        mag := mag + (res.direction_ratios[i] * res.direction_ratios[i]);
      END_REPEAT;
      IF mag > 0 THEN
        result := dummy_gri || vector(res,SQRT(mag));
      ELSE
        result := dummy_gri || vector(vec1,0);
      END_IF;
    END;
```

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```
  END_IF;
  RETURN(result);

END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION verify_angle_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property(cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT']));
END_FUNCTION;

FUNCTION verify_ball_endmill_edge_dimensions (
        rep:            machining_tool_dimension_representation
        ): BOOLEAN;

    LOCAL
      diameter : length_measure;
      dia_items : SET OF REPRESENTATION_ITEM :=
        QUERY (it <* rep.items | (it.name = 'diameter'));
    END_LOCAL;

    diameter := dia_items[1].value_component;

    RETURN
         ((0 = SIZEOF (QUERY ( it <* rep.items |
           (it.name = 'edge center horizontal') AND NOT
           (it.value_component = 0))))
          AND
          (0 = SIZEOF (QUERY ( it <* rep.items |
           (it.name = 'edge center vertical') AND NOT
           (it.value_component = diameter/2))))
          AND
          (0 = SIZEOF (QUERY ( it <* rep.items |
           (it.name = 'edge radius') AND NOT
           (it.value_component = diameter/2))))
          );
END_FUNCTION;

FUNCTION verify_descriptive_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property(cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']));
END_FUNCTION;

FUNCTION verify_enumeration_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING;
```

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```
        prop_values:    SET OF STRING
        ): BOOLEAN;

    -- Each action property has at least one representation that contains
    -- a descriptive rep item, and that descriptive rep item has a value
    -- drawn from the prop_values set.

    -- there are no properties that do not have matching representations
    RETURN (0 = SIZEOF (QUERY (prop <* get_action_property (cad, prop_name) |

        NOT (
        -- there is at least one rep with matching rep items
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |

           -- property representation has at least one matching rep item
           (0 < SIZEOF (QUERY (it <* prep.representation.items |
               (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
                (it.description IN prop_values))
           )))
        )))
    ))));
END_FUNCTION;

FUNCTION verify_length_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property (cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']));
END_FUNCTION;

FUNCTION verify_optional_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (1 >= SIZEOF (get_action_property (cad, prop_name)));
END_FUNCTION;

FUNCTION verify_optional_in_process_geometry (
        mpe:            machining_process_executable
        ): BOOLEAN;

    RETURN
      ((verify_optional_action_property (mpe, 'as-is shape')) AND
       (verify_optional_action_property (mpe, 'to-be shape')) AND
       (verify_optional_action_property (mpe, 'removal shape')) AND

        -- All properties need advanced brep shape reps
       (0 = SIZEOF (QUERY (prop <*
```

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```
         USEDIN (mpe, 'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY.DEFINITION') |
         ((prop.name IN ['as-is shape', 'to-be shape', 'removal shape']) AND
          (0 = SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
             'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
             ('INTEGRATED_CNC_SCHEMA.ADVANCED_BREP_SHAPE_REPRESENTATION'
               IN TYPEOF (prep.representation))))))
          )))
      );
END_FUNCTION;

FUNCTION verify_optional_relating_amr (
        am:             action_method;
        rel_name:       STRING
        ): BOOLEAN;

    RETURN (1 >= SIZEOF (QUERY (amr <* get_relating_amr (am) |
                 amr.name = rel_name)));
END_FUNCTION;

FUNCTION verify_parameter_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    -- All properties have matching representations.  The reason we test
    -- for "nothing matching the negation" rather than "something matching
    -- the positive" is so that we return true if there are no properties.
    --
    RETURN (0 = SIZEOF (QUERY (prop <* get_action_property (cad, prop_name) |

        -- property has no matching representations
        NOT (

        -- there is at least one rep with matching rep items
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |

           -- property representation has at least one matching rep item
           (0 < SIZEOF (QUERY (it <* prep.representation.items |
               (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
                ('INTEGRATED_CNC_SCHEMA.PARAMETER_VALUE'
                  IN TYPEOF(it.value_component)))
           )))
        )))
    ))));
END_FUNCTION;

FUNCTION verify_ratio_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property (cad, prop_name,
```

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```
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT']));
END_FUNCTION;

FUNCTION verify_related_type_for_amr (
        am:             action_method;
        rel_name:       STRING;
        types:          SET OF STRING
        ): BOOLEAN;

    RETURN  (0 = SIZEOF (QUERY (amr <* get_relating_amr (am) |
            (amr.name = rel_name) AND NOT
            (SIZEOF(types * TYPEOF(amr.related_method)) = SIZEOF(types))
        )));
END_FUNCTION;

FUNCTION verify_rep_item_for_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING;
        prop_types:     SET OF STRING
        ): BOOLEAN;

    -- All properties have matching representations.  The reason we test
    -- for "nothing matching the negation" rather than "something matching
    -- the positive" is so that we return true if there are no properties.
    --
    RETURN (0 = SIZEOF (QUERY (prop <* get_action_property (cad, prop_name) |

        -- property has no matching representations
        NOT (

        -- there is at least one rep with matching rep items
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'ACTION_PROPERTY_REPRESENTATION.PROPERTY') |

           -- property representation has at least one matching rep item
           (0 < SIZEOF (QUERY (it <* prep.representation.items |
               (SIZEOF(prop_types * TYPEOF(it)) = SIZEOF(prop_types))))
           )))
        ))
    )));
END_FUNCTION;

FUNCTION verify_required_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (1 = SIZEOF (get_action_property (cad, prop_name)));
END_FUNCTION;

FUNCTION verify_required_relating_amr (
        am:             action_method;
        rel_name:       STRING
```

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```
        ): BOOLEAN;

    RETURN (1 = SIZEOF (QUERY (amr <* get_relating_amr (am) |
                amr.name = rel_name)));
END_FUNCTION;

FUNCTION verify_time_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): BOOLEAN;

    RETURN (verify_rep_item_for_action_property(cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.TIME_MEASURE_WITH_UNIT']));
END_FUNCTION;

END_SCHEMA; -- integrated_cnc_schema
```

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# Annex B
(normative)

# AIM short names

Table B.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 B.1 — AIM short names of entities

| Entity names | Short names |
|---|---|
| ACTION | ACTION |
| ACTION_METHOD | ACTMTH |
| ACTION_METHOD_RELATIONSHIP | ACMTRL |
| ACTION_PROPERTY | ACTPRP |
| ACTION_PROPERTY_REPRESENTATION | ACPRRP |
| ACTION_RESOURCE | ACTRSR |
| ACTION_RESOURCE_RELATIONSHIP | ACRSRL |
| ACTION_RESOURCE_REQUIREMENT | ACRSRQ |
| ACTION_RESOURCE_TYPE | ACRSTY |
| ADDRESS | ADDRSS |
| ADVANCED_BREP_SHAPE_REPRESENTATION | ABSR |
| ADVANCED_FACE | ADVFC |
| AND_EXPRESSION | ANDEXP |
| ANGULAR_LOCATION | ANGLCT |
| ANGULAR_SIZE | ANGSZ |
| ANGULARITY_TOLERANCE | ANGTLR |
| APEX | APEX |
| APPLICATION_CONTEXT | APPCNT |
| APPLICATION_CONTEXT_ELEMENT | APCNEL |
| APPLICATION_PROTOCOL_DEFINITION | APPRDF |
| APPLIED_APPROVAL_ASSIGNMENT | APAPAS |
| APPLIED_AREA | APPAR |
| APPLIED_DATE_AND_TIME_ASSIGNMENT | ADATA |
| APPLIED_DOCUMENT_REFERENCE | APDCRF |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| APPLIED_DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT | ADUCA |
| APPLIED_EFFECTIVITY_ASSIGNMENT | APEFAS |
| APPLIED_GROUP_ASSIGNMENT | APGRAS |
| APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT | APAOA |
| APPLIED_SECURITY_CLASSIFICATION_ASSIGNMENT | ASCA |
| APPROVAL | APPRVL |
| APPROVAL_ASSIGNMENT | APPASS |
| APPROVAL_DATE_TIME | APDTTM |
| APPROVAL_PERSON_ORGANIZATION | APPROR |
| APPROVAL_ROLE | APPRL |
| APPROVAL_STATUS | APPSTT |
| ASSEMBLY_COMPONENT_USAGE | ASCMUS |
| AXIS1_PLACEMENT | AX1PLC |
| AXIS2_PLACEMENT_2D | A2PL2D |
| AXIS2_PLACEMENT_3D | A2PL3D |
| B_SPLINE_CURVE | BSPCR |
| B_SPLINE_CURVE_WITH_KNOTS | BSCWK |
| B_SPLINE_SURFACE | BSPSR |
| B_SPLINE_SURFACE_WITH_KNOTS | BSSWK |
| BACK_BORING_OPERATION | BCBROP |
| BEZIER_CURVE | BZRCRV |
| BEZIER_SURFACE | BZRSRF |
| BINARY_BOOLEAN_EXPRESSION | BNBLEX |
| BINARY_GENERIC_EXPRESSION | BNGNEX |
| BINARY_NUMERIC_EXPRESSION | BNNMEX |
| BLOCK | BLOCK |
| BLOCK_SHAPE_REPRESENTATION | BLSHRP |
| BOOLEAN_EXPRESSION | BLNEXP |
| BORING_OPERATION | BRNOPR |
| BOSS | BOSS |
| BOSS_TOP | BSSTP |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| BOTTOM_AND_SIDE_MILLING_OPERATION | BASMO |
| BOUNDARY_CURVE | BNDCR |
| BOUNDED_CURVE | BNDCRV |
| BOUNDED_PCURVE | BNDPCR |
| BOUNDED_SURFACE | BNDSRF |
| BOUNDED_SURFACE_CURVE | BNSRCR |
| BREP_WITH_VOIDS | BRWTVD |
| CALENDAR_DATE | CLNDT |
| CARTESIAN_POINT | CRTPNT |
| CARTESIAN_TRANSFORMATION_OPERATOR | CRTROP |
| CARTESIAN_TRANSFORMATION_OPERATOR_3D | CTO3 |
| CENTRE_OF_SYMMETRY | CNOFSY |
| CHAMFER | CHMFR |
| CHAMFER_OFFSET | CHMOFF |
| CHARACTERIZED_OBJECT | CHROBJ |
| CIRCLE | CIRCLE |
| CIRCULAR_CLOSED_PROFILE | CRCLPR |
| CIRCULAR_PATTERN | CRCPTT |
| CIRCULAR_RUNOUT_TOLERANCE | CRRNTL |
| CLASSIFICATION_ROLE | CLSRL |
| CLOSED_PATH_PROFILE | CLPTPR |
| CLOSED_SHELL | CLSSHL |
| COAXIALITY_TOLERANCE | CXLTLR |
| COMMON_DATUM | CMMDTM |
| COMPARISON_EQUAL | CMPEQL |
| COMPARISON_EXPRESSION | CMPEXP |
| COMPARISON_GREATER | CMPGRT |
| COMPARISON_GREATER_EQUAL | CMGREQ |
| COMPARISON_LESS | CMPLSS |
| COMPARISON_LESS_EQUAL | CMLSEQ |
| COMPARISON_NOT_EQUAL | CMNTEQ |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| COMPOSITE_CURVE | CMPCRV |
| COMPOSITE_CURVE_ON_SURFACE | CCOS |
| COMPOSITE_CURVE_SEGMENT | CMCRSG |
| COMPOSITE_HOLE | CMPHL |
| COMPOSITE_SHAPE_ASPECT | CMSHAS |
| COMPOUND_FEATURE | CMPFTR |
| COMPOUND_REPRESENTATION_ITEM | CMRPIT |
| CONCENTRICITY_TOLERANCE | CNCTLR |
| CONCURRENT_ACTION_METHOD | CNACMT |
| CONIC | CONIC |
| CONICAL_SURFACE | CNCSRF |
| CONNECTED_FACE_SET | CNFCST |
| CONTEXT_DEPENDENT_SHAPE_REPRESENTATION | CDSR |
| CONTEXT_DEPENDENT_UNIT | CNDPUN |
| CONVERSION_BASED_UNIT | CNBSUN |
| COORDINATED_UNIVERSAL_TIME_OFFSET | CUTO |
| CURVE | CURVE |
| CURVE_BOUNDED_SURFACE | CRBNSR |
| CURVE_REPLICA | CRVRPL |
| CYLINDRICAL_SHAPE_REPRESENTATION | CYSHRP |
| CYLINDRICAL_SURFACE | CYLSRF |
| CYLINDRICITY_TOLERANCE | CYLTLR |
| DATA_ENVIRONMENT | DTENV |
| DATE | DATE |
| DATE_AND_TIME | DTANTM |
| DATE_AND_TIME_ASSIGNMENT | DATA |
| DATE_TIME_ROLE | DTTMRL |
| DATED_EFFECTIVITY | DTDEFF |
| DATUM | DATUM |
| DATUM_FEATURE | DTMFTR |
| DATUM_REFERENCE | DTMRFR |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| DATUM_TARGET | DTMTRG |
| DEFINITIONAL_REPRESENTATION | DFNRPR |
| DEGENERATE_PCURVE | DGNPCR |
| DEGENERATE_TOROIDAL_SURFACE | DGTRSR |
| DERIVED_SHAPE_ASPECT | DRSHAS |
| DERIVED_UNIT | DRVUNT |
| DERIVED_UNIT_ELEMENT | DRUNEL |
| DESCRIPTION_ATTRIBUTE | DSCATT |
| DESCRIPTIVE_REPRESENTATION_ITEM | DSRPIT |
| DIMENSION_RELATED_TOLERANCE_ZONE_ELEMENT | DRTZE |
| DIMENSIONAL_CHARACTERISTIC_REPRESENTATION | DMCHRP |
| DIMENSIONAL_EXPONENTS | DMNEXP |
| DIMENSIONAL_LOCATION | DMNLCT |
| DIMENSIONAL_LOCATION_WITH_PATH | DLWP |
| DIMENSIONAL_SIZE | DMNSZ |
| DIMENSIONAL_SIZE_WITH_PATH | DSWP |
| DIRECTION | DRCTN |
| DIRECTION_SHAPE_REPRESENTATION | DRSHRP |
| DOCUMENT | DCMNT |
| DOCUMENT_FILE | DCMFL |
| DOCUMENT_REFERENCE | DCMRFR |
| DOCUMENT_REPRESENTATION_TYPE | DCRPTY |
| DOCUMENT_TYPE | DCMTYP |
| DOCUMENT_USAGE_CONSTRAINT | DCUSCN |
| DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT | DUCA |
| DOCUMENT_USAGE_ROLE | DCUSRL |
| DRILLING_OPERATION | DRLOPR |
| DRILLING_TYPE_OPERATION | DRTYOP |
| DRILLING_TYPE_STRATEGY | DRTYST |
| EDGE | EDGE |
| EDGE_CURVE | EDGCRV |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| EDGE_LOOP | EDGLP |
| EDGE_ROUND | EDGRND |
| EFFECTIVITY | EFFCTV |
| EFFECTIVITY_ASSIGNMENT | EFFASS |
| ELEMENTARY_SURFACE | ELMSRF |
| ELLIPSE | ELLPS |
| ENVIRONMENT | ENVRNM |
| EVALUATED_DEGENERATE_PCURVE | EVDGPC |
| EXPANDED_UNCERTAINTY | EXPUNC |
| EXPRESSION | EXPRSS |
| EXPRESSION_REPRESENTATION_ITEM | EXRPIT |
| EXTENSION | EXTNSN |
| EXTERNAL_SOURCE | EXTSRC |
| EXTERNALLY_DEFINED_FEATURE_DEFINITION | EDFD |
| EXTERNALLY_DEFINED_ITEM | EXDFIT |
| FACE | FACE |
| FACE_BOUND | FCBND |
| FACE_OUTER_BOUND | FCOTBN |
| FACE_SHAPE_REPRESENTATION | FCSHRP |
| FACE_SURFACE | FCSRF |
| FEATURE_COMPONENT_DEFINITION | FTCMDF |
| FEATURE_COMPONENT_RELATIONSHIP | FTCMRL |
| FEATURE_DEFINITION | FTRDFN |
| FEATURE_PATTERN | FTRPTT |
| FILLET | FILLET |
| FLAT_FACE | FLTFC |
| FLATNESS_TOLERANCE | FLTTLR |
| FOUNDED_ITEM | FNDITM |
| FREEFORM_MILLING_OPERATION | FRMLOP |
| FREEFORM_MILLING_STRATEGY | FRMLST |
| FREEFORM_MILLING_TOLERANCE_REPRESENTATION | FMTR |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| FUNCTIONALLY_DEFINED_TRANSFORMATION | FNDFTR |
| GENERIC_EXPRESSION | GNREXP |
| GENERIC_LITERAL | GNRLTR |
| GENERIC_VARIABLE | GNRVRB |
| GEOMETRIC_ALIGNMENT | GMTALG |
| GEOMETRIC_INTERSECTION | GMTINT |
| GEOMETRIC_REPRESENTATION_CONTEXT | GMRPCN |
| GEOMETRIC_REPRESENTATION_ITEM | GMRPIT |
| GEOMETRIC_SET | GMTST |
| GEOMETRIC_TOLERANCE | GMTTLR |
| GEOMETRIC_TOLERANCE_RELATIONSHIP | GMTLRL |
| GEOMETRIC_TOLERANCE_WITH_DATUM_REFERENCE | GTWDR |
| GEOMETRIC_TOLERANCE_WITH_DEFINED_UNIT | GTWDU |
| GEOMETRICALLY_BOUNDED_SURFACE_SHAPE_REPRESENTATIO N | GBSSR |
| GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT | GC |
| GLOBAL_UNIT_ASSIGNED_CONTEXT | GUAC |
| GROUP | GROUP |
| GROUP_ASSIGNMENT | GRPASS |
| GROUP_RELATIONSHIP | GRPRLT |
| HOLE_BOTTOM | HLBTT |
| HYPERBOLA | HYPRBL |
| ID_ATTRIBUTE | IDATT |
| INSTANCED_FEATURE | INSFTR |
| INT_LITERAL | INTLTR |
| INT_NUMERIC_VARIABLE | INNMVR |
| INTERSECTION_CURVE | INTCRV |
| ITEM_DEFINED_TRANSFORMATION | ITDFTR |
| LENGTH_MEASURE_WITH_UNIT | LMWU |
| LENGTH_UNIT | LNGUNT |
| LIMITS_AND_FITS | LMANFT |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| LINE | LINE |
| LINE_PROFILE_TOLERANCE | LNP0 |
| LINEAR_PROFILE | LNRPRF |
| LITERAL_NUMBER | LTRNMB |
| LOCAL_TIME | LCLTM |
| LOCATION_SHAPE_REPRESENTATION | LCSHRP |
| LOOP | LOOP |
| LOT_EFFECTIVITY | LTEFF |
| MACHINING_ADAPTIVE_CONTROL_STRATEGY | MACS |
| MACHINING_APPROACH_RETRACT_STRATEGY | MARS |
| MACHINING_CUTTING_COMPONENT | MCCTCM |
| MACHINING_FEATURE_PROCESS | MCFTPR |
| MACHINING_FUNCTIONS | MCHFNC |
| MACHINING_NC_FUNCTION | MCNCFN |
| MACHINING_OFFSET_VECTOR_REPRESENTATION | MOVR |
| MACHINING_OPERATION | MCHOPR |
| MACHINING_OPERATOR_INSTRUCTION | MCOPIN |
| MACHINING_PROCESS_EXECUTABLE | MCPREX |
| MACHINING_PROCESS_MODEL | MCPRMD |
| MACHINING_RAPID_MOVEMENT | MCRPMV |
| MACHINING_STRATEGY | MCHSTR |
| MACHINING_TECHNOLOGY | MCHTCH |
| MACHINING_TOOL | MCHTL |
| MACHINING_TOOL_BODY_REPRESENTATION | MTBR |
| MACHINING_TOOL_DIMENSION_REPRESENTATION | MTDR |
| MACHINING_TOOL_DIRECTION_REPRESENTATION | MTD0 |
| MACHINING_TOOLPATH | MCHTLP |
| MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION | MTSPR |
| MACHINING_TOUCH_PROBING | MCTCPR |
| MACHINING_WORKINGSTEP | MCHWRK |
| MACHINING_WORKPLAN | MCH0 |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| MAKE_FROM_USAGE_OPTION | MFUO |
| MANIFOLD_SOLID_BREP | MNSLBR |
| MANIFOLD_SURFACE_SHAPE_REPRESENTATION | MSSR |
| MAPPED_ITEM | MPPITM |
| MARKING | MRKNG |
| MATERIAL_DESIGNATION | MTRDSG |
| MATERIAL_DESIGNATION_CHARACTERIZATION | MTDSCH |
| MATERIAL_PROPERTY | MTRPRP |
| MATERIAL_PROPERTY_REPRESENTATION | MTPRRP |
| MEASURE_QUALIFICATION | MSRQLF |
| MEASURE_REPRESENTATION_ITEM | MSRPIT |
| MEASURE_WITH_UNIT | MSWTUN |
| MILLING_TYPE_OPERATION | MLTYOP |
| MILLING_TYPE_STRATEGY | MLTYST |
| MODIFIED_GEOMETRIC_TOLERANCE | MDGMTL |
| MODIFIED_PATTERN | MDFPTT |
| MULTIPLE_ARITY_BOOLEAN_EXPRESSION | MABE |
| MULTIPLE_ARITY_GENERIC_EXPRESSION | MAGE |
| MULTIPLE_ARITY_NUMERIC_EXPRESSION | MANE |
| NAME_ATTRIBUTE | NMATT |
| NAMED_UNIT | NMDUNT |
| NEXT_ASSEMBLY_USAGE_OCCURRENCE | NAUO |
| NGON_CLOSED_PROFILE | NGCLPR |
| NGON_SHAPE_REPRESENTATION | NGSHRP |
| NOT_EXPRESSION | NTEXP |
| NUMERIC_EXPRESSION | NMREXP |
| NUMERIC_VARIABLE | NMRVRB |
| OBJECT_ROLE | OBJRL |
| OFFSET_CURVE_3D | OFCR3D |
| OFFSET_SURFACE | OFFSRF |
| OPEN_PATH_PROFILE | OPPTPR |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| OPEN_SHELL | OPNSHL |
| OR_EXPRESSION | OREXP |
| ORDINAL_DATE | ORDDT |
| ORGANIZATION | ORGNZT |
| ORGANIZATIONAL_ADDRESS | ORGADD |
| ORIENTED_CLOSED_SHELL | ORCLSH |
| ORIENTED_EDGE | ORNEDG |
| ORIENTED_FACE | ORNFC |
| ORIENTED_OPEN_SHELL | OROPSH |
| ORIENTED_PATH | ORNPTH |
| OUTER_BOUNDARY_CURVE | OTBNCR |
| OUTER_ROUND | OTRRND |
| OUTSIDE_PROFILE | OTSPRF |
| PARABOLA | PRBL |
| PARALLEL_OFFSET | PRLOFF |
| PARALLELISM_TOLERANCE | PRLTLR |
| PARAMETRIC_REPRESENTATION_CONTEXT | PRRPCN |
| PARTIAL_CIRCULAR_PROFILE | PRCRPR |
| PATH | PATH |
| PATH_FEATURE_COMPONENT | PTFTCM |
| PATH_SHAPE_REPRESENTATION | PTSHRP |
| PATTERN_OFFSET_MEMBERSHIP | PTOFMM |
| PATTERN_OMIT_MEMBERSHIP | PTOMMM |
| PCURVE | PCURVE |
| PERPENDICULAR_TO | PRPT |
| PERPENDICULARITY_TOLERANCE | PRPTLR |
| PERSON | PERSON |
| PERSON_AND_ORGANIZATION | PRANOR |
| PERSON_AND_ORGANIZATION_ASSIGNMENT | PAOA |
| PERSON_AND_ORGANIZATION_ROLE | PAOR |
| PERSONAL_ADDRESS | PRSADD |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| PLACED_DATUM_TARGET_FEATURE | PDT0 |
| PLACEMENT | PLCMNT |
| PLANAR_SHAPE_REPRESENTATION | PLSHRP |
| PLANE | PLANE |
| PLANE_ANGLE_MEASURE_WITH_UNIT | PAMWU |
| PLANE_ANGLE_UNIT | PLANUN |
| PLANE_MILLING_OPERATION | PLMLOP |
| PLUS_MINUS_TOLERANCE | PLMNTL |
| POCKET | POCKET |
| POCKET_BOTTOM | PCKBTT |
| POINT | POINT |
| POINT_ON_CURVE | PNONCR |
| POINT_ON_SURFACE | PNONSR |
| POLYLINE | PLYLN |
| POSITION_TOLERANCE | PSTTLR |
| PRECISION_QUALIFIER | PRCQLF |
| PROCESS_PRODUCT_ASSOCIATION | PRPRAS |
| PROCESS_PROPERTY_ASSOCIATION | PRPRS |
| PRODUCT | PRDCT |
| PRODUCT_CATEGORY | PRDCTG |
| PRODUCT_CATEGORY_RELATIONSHIP | PRCTRL |
| PRODUCT_CONTEXT | PRDCNT |
| PRODUCT_DEFINITION | PRDDFN |
| PRODUCT_DEFINITION_CONTEXT | PRDFCN |
| PRODUCT_DEFINITION_FORMATION | PRDFFR |
| PRODUCT_DEFINITION_PROCESS | PRDFPR |
| PRODUCT_DEFINITION_RELATIONSHIP | PRDFRL |
| PRODUCT_DEFINITION_SHAPE | PRDFSH |
| PRODUCT_DEFINITION_USAGE | PRDFUS |
| PRODUCT_DEFINITION_WITH_ASSOCIATED_DOCUMENTS | PDWAD |
| PRODUCT_RELATED_PRODUCT_CATEGORY | PRPC |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| PROFILE_FLOOR | PRFFLR |
| PROJECTED_ZONE_DEFINITION | PRZNDF |
| PROPERTY_DEFINITION | PRPDFN |
| PROPERTY_DEFINITION_REPRESENTATION | PRDFRP |
| PROPERTY_PROCESS | PRPPRC |
| PROTRUSION | PRTRSN |
| QUALIFIED_REPRESENTATION_ITEM | QLRPIT |
| QUALITATIVE_UNCERTAINTY | QLTUNC |
| QUASI_UNIFORM_CURVE | QSUNCR |
| QUASI_UNIFORM_SURFACE | QSUNSR |
| RATIO_MEASURE_WITH_UNIT | RMWU |
| RATIO_UNIT | RTUNT |
| RATIONAL_B_SPLINE_CURVE | RBSC |
| RATIONAL_B_SPLINE_SURFACE | RBSS |
| REAL_LITERAL | RLLTR |
| REAL_NUMERIC_VARIABLE | RLNMVR |
| RECTANGULAR_CLOSED_PROFILE | RCCLPR |
| RECTANGULAR_COMPOSITE_SURFACE | RCCMSR |
| RECTANGULAR_PATTERN | RCTPTT |
| RECTANGULAR_TRIMMED_SURFACE | RCTRSR |
| REFERENCED_MODIFIED_DATUM | RFMDDT |
| REMOVAL_VOLUME | RMVVLM |
| REPARAMETRISED_COMPOSITE_CURVE_SEGMENT | RCCS |
| REPLICATE_FEATURE | RPLFTR |
| REPRESENTATION | RPRSNT |
| REPRESENTATION_CONTEXT | RPRCNT |
| REPRESENTATION_ITEM | RPRITM |
| REPRESENTATION_ITEM_RELATIONSHIP | RPITRL |
| REPRESENTATION_MAP | RPRMP |
| REPRESENTATION_RELATIONSHIP | RPRRLT |
| REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION | RRWT |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| REQUIREMENT_FOR_ACTION_RESOURCE | RFAR |
| RESOURCE_PROPERTY | RSRPRP |
| RESOURCE_PROPERTY_REPRESENTATION | RSPRRP |
| RESOURCE_REQUIREMENT_TYPE | RSRQTY |
| REVOLVED_PROFILE | RVLPRF |
| RIB_TOP | RBTP |
| RIB_TOP_FLOOR | RBTPFL |
| RIGHT_CIRCULAR_CYLINDER | RGCRCY |
| ROLE_ASSOCIATION | RLASS |
| ROUND_HOLE | RNDHL |
| ROUNDED_END | RNDEND |
| ROUNDED_U_PROFILE | RNUPR |
| ROUNDNESS_TOLERANCE | RNDTLR |
| RUNOUT_ZONE_DEFINITION | RNZNDF |
| RUNOUT_ZONE_ORIENTATION | RNZNOR |
| RUNOUT_ZONE_ORIENTATION_REFERENCE_DIRECTION | RZORD |
| SEAM_CURVE | SMCRV |
| SECURITY_CLASSIFICATION | SCRCLS |
| SECURITY_CLASSIFICATION_ASSIGNMENT | SCCLAS |
| SECURITY_CLASSIFICATION_LEVEL | SCCLLV |
| SEQUENTIAL_METHOD | SQNMTH |
| SERIAL_ACTION_METHOD | SRACMT |
| SERIAL_NUMBERED_EFFECTIVITY | SRNMEF |
| SHAPE_ASPECT | SHPASP |
| SHAPE_ASPECT_DERIVING_RELATIONSHIP | SADR |
| SHAPE_ASPECT_RELATIONSHIP | SHASRL |
| SHAPE_DEFINING_RELATIONSHIP | SHDFRL |
| SHAPE_DEFINITION_REPRESENTATION | SHDFRP |
| SHAPE_DIMENSION_REPRESENTATION | SHDMRP |
| SHAPE_REPRESENTATION | SHPRPR |
| SHAPE_REPRESENTATION_RELATIONSHIP | SHRPRL |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| SHAPE_REPRESENTATION_WITH_PARAMETERS | SRWP |
| SHELL_BASED_SURFACE_MODEL | SBSM |
| SI_UNIT | SUNT |
| SIDE_MILLING_OPERATION | SDMLOP |
| SIMPLE_GENERIC_EXPRESSION | SMGNEX |
| SIMPLE_NUMERIC_EXPRESSION | SMNMEX |
| SLOT | SLOT |
| SLOT_END | SLTEND |
| SOLID_ANGLE_MEASURE_WITH_UNIT | SAMWU |
| SOLID_ANGLE_UNIT | SLANUN |
| SOLID_MODEL | SLDMDL |
| SPHERICAL_CAP | SPHCP |
| SPHERICAL_SURFACE | SPHSRF |
| SQUARE_U_PROFILE | SQUPR |
| STANDARD_UNCERTAINTY | STNUNC |
| STEP | STEP |
| STRAIGHTNESS_TOLERANCE | STRTLR |
| SURFACE | SRFC |
| SURFACE_CURVE | SRFCRV |
| SURFACE_OF_LINEAR_EXTRUSION | SL |
| SURFACE_OF_REVOLUTION | SROFRV |
| SURFACE_PATCH | SRFPTC |
| SURFACE_PROFILE_TOLERANCE | SRPRTL |
| SURFACE_REPLICA | SRFRPL |
| SURFACE_TEXTURE_REPRESENTATION | SRTXRP |
| SWEPT_SURFACE | SWPSRF |
| SYMMETRIC_SHAPE_ASPECT | SYSHAS |
| SYMMETRY_TOLERANCE | SYMTLR |
| TANGENT | TNGNT |
| TAPER | TAPER |
| TAPPING_OPERATION | TPPOPR |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| TEE_PROFILE | TPRF |
| THREAD | THREAD |
| TIME_INTERVAL | TMINT |
| TIME_INTERVAL_BASED_EFFECTIVITY | TIBE |
| TIME_MEASURE_WITH_UNIT | TMWU |
| TIME_UNIT | TMUNT |
| TOLERANCE_VALUE | TLRVL |
| TOLERANCE_ZONE | TLRZN |
| TOLERANCE_ZONE_DEFINITION | TLZNDF |
| TOLERANCE_ZONE_FORM | TLZNFR |
| TOPOLOGICAL_REPRESENTATION_ITEM | TPRPIT |
| TOROIDAL_SURFACE | TRDSRF |
| TOTAL_RUNOUT_TOLERANCE | TTRNTL |
| TRANSITION_FEATURE | TRNFTR |
| TRIMMED_CURVE | TRMCRV |
| TURNED_KNURL | TRNKNR |
| TYPE_QUALIFIER | TYPQLF |
| UNARY_BOOLEAN_EXPRESSION | UNBLEX |
| UNARY_GENERIC_EXPRESSION | UNGNEX |
| UNARY_NUMERIC_EXPRESSION | UNNMEX |
| UNCERTAINTY_MEASURE_WITH_UNIT | UMWU |
| UNCERTAINTY_QUALIFIER | UNCQLF |
| UNIFORM_CURVE | UNFCRV |
| UNIFORM_SURFACE | UNFSRF |
| VALUE_RANGE | VLRNG |
| VARIABLE | VRBL |
| VARIABLE_SEMANTICS | VRBSMN |
| VECTOR | VECTOR |
| VEE_PROFILE | VPRF |
| VERTEX | VERTEX |
| VERTEX_LOOP | VRTLP |

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## Table B.1 — AIM short names of entities (continued)

| Entity names | Short names |
|---|---|
| VERTEX_POINT | VRTPNT |
| WEEK_OF_YEAR_AND_DAY_DATE | WOYADD |
| XOR_EXPRESSION | XREXP |

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# Annex C
(normative)

## Implementation method-specific requirements

The implementation method defines what types of exchange behaviour are required with respect to this part of ISO 10303. Conformance to this part of ISO 10303 shall be realized in an exchange structure.

The file format shall be encoded according to the syntax and EXPRESS language mapping defined in ISO 10303-21 and in the AIM defined in annex A of this part of ISO 10303. The header of the exchange structure shall identify use of this part of ISO 10303 by the schema name ‘integrated_cnc_schema’.

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# Annex D
(normative)

## Protocol Implementation Conformance Statement (PICS) proforma

This clause lists the optional elements of this part of ISO 10303. An implementation may choose to support any combination of these optional elements. However, certain combinations of options are likely to be implemented together. These combinations are called conformance classes and are described in the subclauses of this annex.

This annex is in the form of a questionnaire. This questionnaire is intended to be filled out by the implementor and may be used in preparation for conformance testing by a testing laboratory. The completed PICS proforma is referred to as a PICS.

[ TO BE COMPLETED ]

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# Annex E
(normative)

# Information object registration

## E.1 Document identification

In order to provide for unambiguous identification of an information object in an open system, the object identifier

{ iso standard 10303 part(238) version(1) }

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.

## E.2 Schema identification

In order to provide for unambiguous identification of the schema specifications given in this application protocol integrated_cnc_schema in an open information system, the object identifiers are assigned as follows:

{ iso standard 10303 part(238) version(1) object(1) integrated-cnc-schema(1) }

is assigned to the integrated_cnc_schema expanded schema (see annex A). The meaning of this value is defined in ISO/IEC 8824-1, and is described in ISO 10303-1.

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# Annex F
(informative)

# Application activity model

The application activity model (AAM) is provided as an aid to understanding the scope and information requirements defined in this application protocol. The application activity model is given in the overview and fundamental principles set forth in ISO 14649-1.

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# Annex G
(informative)

# Application reference model

This annex provides the application reference model for this part of ISO 10303. The application reference model is a graphical representation of the structure and constraints of the application objects specified in ISO 14649-10, ISO 14649-11, and ISO 14649-111. The graphical form of the application reference model is presented in EXPRESS-G. The application reference model is independent from any implementation method. This is set forth in Annex D of ISO 14649-10, Annex D of ISO 14649-11, and Annex C of ISO 14649-111.

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# Annex H
(informative)

# AIM EXPRESS-G

The diagrams in this annex correspond to the AIM EXPRESS expanded listing given in annex A. The diagrams use the EXPRESS-G graphical notation for the EXPRESS language. EXPRESS-G is defined in annex D of ISO 10303-11.

[ TO BE COMPLETED ]

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# Annex J
(informative)

# AIM EXPRESS listing

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

— EXPRESS:

http://www.mel.nist.gov/step/parts/part238/
http://www.steptools.com/sc4/archive/APs/10303-238-lf.exp

— Short names:

http://www.steptools.com/cgi-bin/getnames.cgi?schema=INTEGRATED_CNC_SCHEMA

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

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

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# DOCUMENT CHANGE LOG

This log lists the changes between versions of this document, most recent first.

**Version 2.8 (2002-02-24)**

Huge update. Added all local rules for the AIM subtypes and global rules for the things that could not be described with local rules. Added descriptions of all of the new AIM entities, rules, functions in Section 5.2 (240+ pages!), the longform in Annex A (220+ pages!), and shortnames in Annex B. Types that originally appeared in AP-224 or AP-214 have been flagged with a note.

Changed the mapping path for material to property parameter. The previous version had material designation characterization refering to material_property rather than material_property_representation. Fixed some mappings that had related/relating instead of related_method/relating_method as attributes od action method relationships.

The mapping for general outside profile said that the shape aspect referring to outside_profile was named 'outside boundary', but it really should be 'boundary occurrance' to be consistant with the rest of the outside profile mappings and the shape profile mappings. I have corrected this in AP-238, but it was transcribed from AP-224, so it should be corrected there too.

Added a new required description string of "milling" for machining_technology when used to represent a milling_technology ARM (which is the only type of technology currently defined by 14649). This was needed to make sure we could distinguish between the expected turning, edm and other types of technology settings. The "milling" description string is also required for machining_functions/ARM milling_machine_functions for the same reasons.

Changed the name of the action property for the through_pressure attribute of milling machine functions from "through pressure" to "through spindle pressure", which should be clearer and more symmetric with the on/off property.

Thread_drilling and tapping are now mapped to the same AIM object and distinguished by a description string. Since they were both internal thread forming operations, the distinction between them was just not large enough to have two different AIM objects.

**Version 2.7 (2001-09-26)**

Updated the listing of application objects in Clause 4 to reflect the latest documents.

Updated the mappings for the executable UOF to the latest ARM definitions. The ARM definitions for the boolean expressions have changed to be much more in line with the PLIB definitions. The way we do it in the AIM remains the same, but the mappings look a little different because the ARM structures have changed. Added a new representation subtype for offset vector and an action resource subtype for machining_cutting_component. Completed the mapping of cutting component. Added a new action method subtype for operator instructions found in the setup.

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In the Part 11 ARM, the 2.5D milling strategies have changed a bit, which required changing the mappings for stepover direction from a direction to a descriptive rep item. Some NC functions have moved from Part 10 to Part 11, so they have moved around in the UOFs as well.

In the ARM defs for the 2.5D milling operations, the finishing allowance attributes have moved, so they are now documented in different places. Also, they are no longer described as "finishing allowance". Now they are just "allowance" for sides and bottoms, so we have dropped "finishing" from the action property names in the mapping. Some attributes on the drilling ARM defs also moved, so the properties for dwell time and feed on retract moved from the drilling strategy to the drilling operation, and overcut length was added to the more general milling machining operation type.

Each operation still has a machining strategy, which can be found in the AIM via an action method relationship named "machining strategy". But in the ARM, instead of describing the attribute once in the supertype, they now spread it out as a separate attribute in each subtype. Although the relationship is described in a different place, the AIM data does not change.

**Version 2.6 (2001-09-18)**

Added the mappings for all of the features and harmonized them with the AP-224e2 mappings. Added the surface texture mappings and harmonized with AP-214. Also added the value_range rep item type from AP-214 which makes it possible to represent values as ranges, which will be helpful when describing tool requirements.

**Version 2.5 (2001-09-05)**

Clarified the meaning of the rawpiece and bounding box attributes in a workpiece. Just remember that 1) the rawpiece is a separate product, and 2) the bounding box is the shape of the rawpiece product. The bounding box is the AP-224 "base shape" ARM notion, and the mappings now allow call out the AP-224 parameterized shape reps for the block and cylinder stock. (block_shape_representation and cylindrical_shape_representation)

Refined the way machining workingsteps relate to a feature. Added machining_feature_process subtype to link them. Previously this was a workplan, but that isn’t right because workplan has different semantics. Changed the relationship between them from a sequential_method to a more general AMR named "final feature". There will be another relationship for "in-process feature". Shortened the action.name from "feature machining operation" to just "machining".

Clarified the mapping for project so that it uses a product category to distinguish it from other workpiece products in the file. Changed the action.name from "main workplan" to just "machining" in order to match the property_process used with features. Also added the PDM attributes to project

Changed the mapping of Setup to be more similar to that of Project. This allows us to use the standard assembly method for relating each workpiece and its transforms. It is not technically an assembly, so we do not use NAUOs, only PDRs and then do the transforms with context dependant shape reps. The action method subtype previously used "machining_setup" has been eliminated. I think that the machining workpiece position subtype will also be eliminated, but I’m not quite there yet.

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Clarified mapping for milling cutting tool. The action resource should refer to a action resource type with the value of "milling cutting tool". We need this to be able distinguish the milling tools from the other types of tools.

Changed the mapping for toleranced length measure. There are two ways to handle qualifications in Part 45. The measure_qualification is an auxiliary object that is associated with a measure with unit, while qualified representation item is a separate thing that is probably AND/OR combined with any rep item. Since the measure qualification is specifically intended for use with measures, we will use that. Previously, we had used qualified rep item. There is still a question over the use of limits and fits in the ARM model. This sort of thing is usually only in a dimensional callout, which we don't really have in this case.

**Version 2.4 (dated 2001-07-25)**

Added subtypes for the approach/retract and milling strategies. The subtypes for the plunge strategies have changed slightly, from a general "machining strategy" action method subtype to the more specific "machining approach retract strategy" subtype. All of the strategies and their attributes are present, which means that Part 11 is now completely mapped. Also corrected the mapping for the operation.its_tool_direction attribute.

**Version 2.3 (dated 2001-07-16)**

Completing mappings for the attributes of the Part 111 milling tool definitions.

**Version 2.2 (dated 2001-07-12)**

Completing mappings for the attributes of the Part 11 machining_operation subtypes.

**Version 2.1 (dated 2001-07-05)**

Milling process UOF mappings updated with new subtypes for all of the operations. The mapping to specific machining_operation subtypes is documented, including the correct entries for the description attributes. The mappings for all of the attributes are not yet complete though.

**Version 2.0 (dated 2001-06-27)**

Updated to resolve issues raised at Funchal about the handling of material, complex properties with multiple rep items, and control flow with PLIB expressions. Distributed with draft longform schema.

**Version 1.0 (dated 2001-02-12)**

First public distribution of the revised document, prior to the Funchal ISO meeting. All major Part 10 concepts mapped and subtypes available.

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