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ISO/IS 10303-238

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

ABSTRACT: This document specifies an application interpreted model (AIM) based on the application reference model for machining defined by ISO 14649-10, 11, 12, 111 and 121, augmented with ISO 10303 product geometry, geometric dimensioning and tolerancing, and product data management information.

KEYWORDS: data exchange, computerized numerical controler (CNC), machine tool, machining, milling, turning, GD&T, STEP-NC.

COMMENTS TO READER:

For review post-Tolouse SC4. Everything is complete and ready for publication, except that the AIM EXPRESS-G diagrams in the back still need a little work. This document has been reviewed using the internal review checklist (see X), the project leader checklist (see X), and the convener checklist (see X), and is ready for publication.

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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 2.

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

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

ISO 10303-238 was prepared by Technical Committee ISO TC184/SC4, *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 following URL:

`http://www.tc184-sc4.org/titles/STEP_Titles.htm`

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 numerical controlled machining and associated processes, including the scope and information requirements defined by the ISO 14649 data model for numerical controllers, augmented with product geometry, geometric dimensioning and tolerancing, and product data management information.

ISO 14649 defines a richer model for information transfer between CAD/CAM systems and computerized numerical control (CNC) machines than that of the older ISO 6983 “G and M code” language. The ISO 6983 standard[2] describes the path of the tool center point with respect to machine axes. ISO 14649 describes machining processes with respect to a part, including part geometry, manufacturing features, sequencing of operations, associated process parameters, and tool requirements.

This AP specifies the integrated resources necessary to describe the information requirements identified by ISO 14649 in a manner consistent with the part shape, feature, geometric dimension and tolerance information created by design and process-planning activities and represented by APs 203 [4], 214 [5], 224 [6], and 240 [7]. Users of this standard should understand the basic principles and concepts of numerical controlled machining and associated processes and should understand and have access to ISO 14649, particularly parts 1, 10, 11, 12, 111, and 121. A discussion and data planning model is given in ISO 14649-1.

This application protocol defines the context, scope, and information requirements for numerical controlled machining and associated processes 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.

Warning:

This International Standard provides a specification intended to be implemented in software. Incompatibilities may result in machine-to-machine communication in the case of software developed on the basis of translations of this International Standard into languages other than the official ISO languages. It is accordingly strongly recommended that any implementations be developed only on the basis of the texts in the official ISO langauages.

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 use of the integrated resources necessary for the scope and information requirements for manufacturing using numerical controlled machining and associated processes, including the scope and information requirements defined by the ISO 14649 data model for computerized numerical controllers.

NOTE 1 The application activity model in Annex F provides a graphical representation of the processes and information flows that are the basis for the definition of the scope of this part of ISO 10303.

NOTE 2 This part of ISO 10303 is a member of the "STEP Manufacturing Suite" of ISO 10303 application protocols, which cover a wide range of information associated with the manufacture of a product, such as the input to process planning (ISO 10303-224), the output from macro-process planning (ISO 10303-240), numerically-controlled machining (this part of ISO 10303), casting (ISO 10303-223), forging (ISO 10303-229) and the output from dimensional inspection (ISO 10303-219). While each application protocol has unique scope elements, other elements, such as manufacturing feature and manufacturing tolerance descriptions, are common to many of these application protocols.

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

— mechanical parts for manufacturing;

— manufacturing process descriptions, including manufacturing operations, sequences of operations, and associated information as defined in ISO 14649;

NOTE 3 The ISO 14649 documents available at the time of publication cover milling, drilling, and turning processes (ISO 14649-11 and 12). Future editions of this part of ISO 10303 may include additional numerically-controlled processes if additional ISO 14649 descriptions become available.

— the AS-IS and TO-BE shapes of a mechanical part;

— manufacturing features of a part;

— manufacturing tolerance requirements of a part;

— tool requirements for machining operations;

— tool paths for machining operations;

— manufacture of mechanical products using manufacturing processes defined in ISO 14649;

— manufacturing product discipline view.

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

— composite material parts;

— description of manufacturing activities not related to automatic execution by a computerized numerical controller;

NOTE 4 This includes activities such as factory capacity planning and scheduling.

— a catalog of machines available on a factory floor;

— a catalog of tools available in a machine tool magazine;

— design features of a part;

— manufacturing preplanning activities;

— product discipline views other than manufacturing.

2 Normative references

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

ISO 286-1:1988, *ISO system of limits and fits — Part 1: Bases of tolerances, deviations and fits*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

ISO 1101:1983, *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location, and run out — Generalities, definitions, symbols, indications on drawings*

ISO 2806:1994, *Industrial automation systems — Numerical control of machines — Vocabulary*

ISO 5459:1981, *Technical drawings — Geometric tolerancing — Datums and datum-systems for geometric tolerances*

ISO/IEC 8824-1:2002, *Information technology — Abstract Syntax Notation One (ASN.1) — Specification of basic notation*

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

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

ISO 10303-21:2002, *Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of the exchange structure*

ISO 10303-41:2005, *Industrial automation systems and integration — Product data and exchange — Part 41: Integrated generic resources: Fundamentals of product description and support*

ISO 10303-42:2003, *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*

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 10303-501:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 501: Application interpreted construct: Edge-based wireframe*

ISO 10303-502:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 502: Application interpreted construct: Shell-based wireframe*

ISO 10303-507:2001, *Industrial automation systems and integration — Product data representation and exchange — Part 507: Application interpreted construct: Geometrically bounded surface*

ISO 10303-508:2001, *Industrial automation systems and integration — Product data representation and exchange — Part 508: Application interpreted construct: Non-manifold surface*

ISO 10303-509:2001, *Industrial automation systems and integration — Product data representation and exchange — Part 509: Application interpreted construct: Manifold surface*

ISO 10303-510:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 510: Application interpreted construct: Geometrically bounded wireframe*

ISO 10303-511:2001, *Industrial automation systems and integration — Product data representation and exchange — Part 511: Application interpreted construct: Topologically bounded surface*

ISO 10303-512:1999, *Industrial automation systems and integration — Product data representation and exchange — Part 512: Application interpreted construct: Faceted boundary representation*

ISO 10303-514:1999, *Industrial automation systems and integration — Product data representation and exchange — Part 514: Application interpreted construct: Advanced boundary representation*

ISO 10303-519:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 519: Application interpreted construct: Geometric tolerances*

ISO 10303-522:2006, *Industrial automation systems and integration — Product data representation and exchange — Part 522: Application interpreted construct: Machining features*

ISO 13584-20:1998, *Industrial automation systems and integration — Parts library — Part 20: Logical resource: Logical model of expressions*

ISO 14649-1:2003, *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 1: Overview and fundamental principles*

ISO 14649-10:2004, *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 10: General process data*

ISO 14649-11:2004, *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 11: Process data for milling*

ISO 14649-12:2005, *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 12: Process data for turning*

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

ISO 14649-121:2005, *Industrial automation systems — Physical device control — Data model for computerized numerical controllers — Part 121: Tools for turning machines*

3 Terms and definitions

3.1 Terms defined in ISO 1101

For the purpose of this part of ISO 10303, the following terms defined in ISO 1101 apply.

— dimension;

— tolerance.

1.To be published.

3.2 Terms defined in ISO 2806

For the purpose of this part of ISO 10303, the following terms defined in ISO 2806 apply.

— computerized numerical control (CNC);

— numerical control (NC);

— tool path.

3.3 Terms defined in ISO 5459

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

— datum.

3.4 Terms defined in ISO 10303-1

For the purpose of this part of ISO 10303, the following terms defined in ISO 10303-1 apply.

— application;

— application activity model (AAM);

— application interpreted model (AIM);

— application object;

— application protocol (AP);

— application reference model (ARM);

— conformance testing;

— implementation method;

— integrated resource;

— protocol implementation conformance statement (PICS);

— product;

— product data;

— unit of functionality (UoF).

3.5 Terms defined in ISO 10303-11

For the purpose of this part of ISO 10303, the following terms defined in ISO 10303-11 apply.

— complex entity instance;

— simple entity instance.

3.6 Terms defined in ISO 14649-1

For the purpose of this part of ISO 10303, the following terms defined in ISO 14649-1 apply.

— executable;

— machining operation;

— NC function;

— program structure;

— project;

— workingstep;

— workplan.

3.7 Terms defined in ISO 14649-10

For the purpose of this part of ISO 10303, the following terms defined in ISO 14649-10 apply.

— freeform machining.

3.8 Terms defined in ISO 14649-11

For the purpose of this part of ISO 10303, the following terms defined in ISO 14649-11 apply.

— finishing;

— roughing.

4 Information requirements

This clause specifies the information required for manufacturing using numerical controlled machining and associated processes, including information requirements defined by the ISO 14649 data model 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.

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.

4.1 Units of functionality

This subclause specifies the units of functionality for the computerized numerical controllers application protocol. This part of ISO 10303 specifies the following units of functionality:

— measure;

— project;

— workpiece;

— manufacturing feature;

— executable;

— toolpath;

— process data for milling;

— cutting tools for milling;

— manufacturing feature for turning;

— process data for turning;

— cutting tools for turning;

— geometric dimensioning and tolerancing;

— library reference;

— management.

The units of functionality and a description of the functions that each UoF supports are given below. The application objects included in the UoFs are defined in either 4.2 or ISO 14649 parts 10, 11, 12, 111, or 121, as indicated below.

4.1.1 measure

The measure UoF specifies the representation of physical quantities by its value and its unit, along with the representation of allowable variation in that quantity.

The following application objects are used by the measure UoF. These application objects are defined by clause 4.2 of ISO 14649-10 but are extended by this part of ISO 10303 with additional information requirements beyond those specified by ISO 14649-10:

NOTE As defined in ISO 14649-10, these measurements do not explicitly specify a unit. Instead, a default unit is defined for each quantity (mm for length, degrees for angles, etc). In addition, only length parameters could be qualified with a tolerance. This part of ISO 10303 extends these definitions to allow units to be explicitly specified, allows tolerances for any of the measure types, and adds a maximum/minimum Limit_qualifier to the types of qualifications available. The measure types below are all redefined to be a subtype of either Value_with_unit or Value_with_tolerance.

— Length_measure;

— Limits_and_fits;

— Plane_angle_measure;

— Plus_minus_value;

— Pressure_measure;

— Rot_speed_measure;

— Speed_measure;

— Time_measure;

— Toleranced_length_measure.

In addition, the following application objects are used by the measure UoF, and are defined by this part of ISO 10303:

— Area_measure;

— Limit_qualifier;

— Mass_measure;

— Value_range;

— Value_with_tolerance;

— Value_with_unit;

— Volume_measure.

4.1.2 project

The project UoF specifies where to begin interpretation of a machining program, as well as additional management information about the machining program.

The following application objects are used by the project UoF, and are defined by clause 4.3 of ISO 14649-10:

— Project;

— Person_and_address.

NOTE The definition of project in ISO 14649-10 references the “approval” integrated resource entity from ISO 10303-41. This reference does not completely define the information requirements for approvals, so the Approval application object and other associated objects have been defined in the management UoF.

4.1.3 workpiece

The workpiece UoF specifies the mechanical product that is to be produced by a machining program. This description may include material, surface condition, features, and the AS-IS and TO-BE shape of the product.

The following application objects are used by the workpiece UoF, and are defined by clause 4.4 of ISO 14649-10.

— Descriptive_parameter;

— Manufacturing_feature;

— Material;

— Numeric_parameter;

— Property_parameter;

— Workpiece.

This part of ISO 10303 extends the following application objects with additional information requirements beyond those specified by clause 4.4 of ISO 14649-10.

— Manufacturing_feature;

— Workpiece.

In addition, the following application objects are used by the workpiece UoF, and are defined by this part of ISO 10303:

— General_property;

— Hardness;

— Material_property;

— Part_property;

— Process_property;

— Surface_property;

— Workpiece_assembly_component.

4.1.4 manufacturing feature

The manufacturing feature UoF specifies the information necessary to identify shapes of interest on a mechanical product. These shapes represent volumes of material that are removed by machining operations or which result from a series of machining operations. This UoF also specifies the information necessary to describe a feature using a 2D profile swept along a path, as well as information describing the top, bottom, and other boundaries of a feature.

The following application objects are used by the manufacturing feature UoF, and are defined by clause 4.5 of ISO 14649-10.

— 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;

— 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;
- 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;

— 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.

This part of ISO 10303 extends the following application objects with additional information requirements beyond those specified by clause 4.5 of ISO 14649-10.

— Boss;

— Chamfer;

— Edge_round;

— General_closed_profile;

— General_path;

— General_profile;

— Machining_feature;

— Planar_face;

— Pocket;

— Round_hole;

— Rounded_u_profile;

— Square_u_profile;

— Transition_feature;

— Vee_profile.

4.1.5 executable

The executable UoF specifies the information necessary to describe control flow of a machining program as well as the non-machining actions that may be performed by a numerical control. This includes sequential, parallel, and conditional control flow, as well as the logical expressions and variable elements necessary to describe the conditions for conditional control flow. This UoF also specifies the information necessary to describe how a mechanical product, products, or multiple copies thereof are positioned and orientated relative to any machine tool on which a machining program is to be executed.

The following application objects are used by the executable UoF, and are defined by clause 4.6 of ISO 14649-10.

— 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;

— Display_message;

— Executable;

— If_statement;

— In_process_geometry;

— Machining_tool;

— Machining_workingstep;

— Multiple_arity_boolean_expression;

— NC_constant;

— NC_function;

- NC_variable;
- Non_sequential;
- Not_expression;
- Offset_vector;
- Optional_stop;
- Or_expression;
- Parallel;
- Program_stop;
- Program_structure;
- Rapid_movement;
- Return_home;
- Selective;
- Set_mark;
- Setup;
- Setup_instruction;
- Tool_length_probing;
- Tool_probing;
- Tool_radius_probing;
- Touch_probe;
- Touch_probing;
- Unary_boolean_expression;
- Wait_for_mark;
- While_statement;
- Workingstep;
- Workpiece_complete_probing;

— Workpiece_probing;

— Workpiece_setup;

— Workplan;

— Xor_expression.

This part of ISO 10303 extends the following application objects with additional information requirements beyond those specified by clause 4.6 of ISO 14649-10.

— In_process_geometry;

— Machining_workingstep;

— Workplan.

In addition, the following application objects are used by the executable UoF, and are defined by this part of ISO 10303:

— Extended_NC_function;

— Machine_axis_travel;

— Machine_parameters;

— Tool_usage.

4.1.6 operation

The operation UoF specifies the information necessary to describe the technology-independent aspects of machining actions that may be performed by a numerical control.

NOTE This UoF only describes the basic aspects common to all machining actions. The technology-specific aspects of machining actions such as milling, drilling, turning, and knurling are described by the process data for milling UoF (see 4.1.8) and process data for turning UoF (see 4.1.11).

The following application objects are used by the operation UoF, and are defined by clause 4.7 of ISO 14649-10.

— Machine_functions;

— Machining_operation;

— Operation;

— Technology;

— Three_axes;

— Tool_direction;

— Toolpath_list;

— Two_axes.

4.1.7 toolpath

The toolpath UoF specifies the information necessary to describe the motion of a cutting tool as either a precalculated movement trajectory or as a set of motion parameters that can be converted to an exact movement by a numerical control. This includes the information necessary to describe movement trajectories relative to the tip of the cutting tool, the contact point of the cutting tool, or an axis of a machine, as well as to describe the path and rate of movement using splines and other curves.

The following application objects are used by the toolpath UoF, and are defined by clause 4.8 of ISO 14649-10.

— 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.

This part of ISO 10303 extends the following application objects with additional information requirements beyond those specified by clause 4.8 of ISO 14649-10.

— Cutter_contact_trajectory;

— Cutter_location_trajectory;

— Toolpath;

— Toolpath_speed.

4.1.8 process data for milling

The process data for milling UoF specifies the information necessary to describe the milling and drilling-specific aspects of machining actions that may be performed by a numerical control. This includes the information necessary to describe strategies and process parameters for milling and drilling.

The following application objects are used by the process data for milling UoF, and are defined by clause 4 of ISO 14649-11.

— 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;

— Center_milling;

— Contour_bidirectional;

— Contour_parallel;

— Contour_spiral;

— Counter_sinking;

— Drilling;

— Drilling_operation;

— Drilling_type_operation;

— Drilling_type_strategy;

— Exchange_pallet;

— Explicit_strategy;

— Five_axes_const_tilt_yaw;

— Five_axes_var_tilt_yaw;

— Freeform_operation;

— Freeform_strategy;

— Index_pallet;

— Index_table;

— Leading_line_strategy;

— 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;

— 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.

This part of ISO 10303 extends the following application objects with additional information requirements beyond those specified by clause 4 of ISO 14649-11.

— Milling_machine_functions.

In addition, the following application objects are used by the process data for milling UoF, and are defined by this part of ISO 10303:

— Freeform_finish_milling;

— Freeform_rough_milling;

— Machine_axis_constraint.

4.1.9 cutting tools for milling

The cutting tools for milling UoF specifies the information necessary to describe the milling and drilling-specific tool requirements for machining actions.

The following application objects are used by the cutting tools for milling UoF, and are defined by clause 4 of ISO 14649-111.

— Ballnose_endmill;

— Bullnose_endmill;

— Combined_drill_and_reamer;

— Combined_drill_and_tap;

— Counterbore;

— Countersink;

— Cutting_component;

— Dovetail_mill;

— Drilling_cutting_tool;

— Endmill;

— Facemill;

— Milling_cutting_tool;

— Milling_machine_cutting_tool;

— Profiled_end_mill;

— Reaming_cutting_tool;

— Rotating_boring_cutting_tool;

— Shouldermill;

— Side_mill;

— Spade_drill;

— Spotdrill;

— Step_drill;

— T_slot_mill;

— Tapered_drill;

— Tapered_reamer;

— Tapping_cutting_tool;

— Thread_mill;

— Twist_drill.

In addition, the following application objects are used by the cutting tools for milling UoF, and are defined by this part of ISO 10303:

— User_defined_milling_tool.

4.1.10 turning feature

The turning feature UoF specifies the information necessary to identify shapes of interest on a mechanical product. These shapes represent volumes of material that arecommonly removed by turning operations or which result from a series of turning operations.

NOTE Turning features may also result from milling, drilling, or other operations, but are described using parameters that are particularly relevant to turning operations.

The following application objects are used by the turning feature UoF, and are defined by clause 4.2 of ISO 14649-12.

— Diagonal_knurl;

— Diamond_knurl;

— General_revolution;

— Groove;

— Knurl;

— Outer_diameter;

— Outer_diameter_to_shoulder;

— Outer_round;

— Revolved_feature;

— Revolved_flat;

— Revolved_round;

— Straight_knurl;

— Tool_knurl;

— Turning_feature.

4.1.11 process data for turning

The process data for turning UoF specifies the information necessary to describe the turning-specific aspects of machining actions that may be performed by a numerical control. This includes the information necessary to describe strategies and process parameters for turning.

The following application objects are used by the process data for turning UoF, and are defined by clauses 4.3 and 4.4 of ISO 14649-12.

— Bidirectional_turning;

— Const_cutting_speed;

— Const_spindle_speed;

— Contour_turning;

— Contouring;

— Contouring_finish;

— Contouring_rough;

— Cutting_in;

— Explicit_turning_strategy;

- Facing;
- Facing_finish;
- Facing_rough;
- Grooving;
- Grooving_finish;
- Grooving_rough;
- Grooving_strategy;
- Knurling;
- Multistep_grooving_strategy;
- Thread_strategy;
- Threading;
- Threading_finish;
- Threading_rough;
- Turning_machine_functions;
- Turning_machining_operation;
- Turning_machining_strategy;
- Turning_technology;
- Turning_workingstep;
- Unidirectional_turning.

4.1.12 cutting tools for turning

The cutting tools for turning UoF specifies the information necessary to describe the turning-specific tool requirements for machining actions.

The following application objects are used by the cutting tools for turning UoF, and are defined by clause 4 of ISO 14649-121.

- Chamfered_corner;
- Corner_transition;

— Cutting_edge_properties;

— General_turning_tool;

— Grooving_tool;

— Knurling_tool;

— Profiled_corner;

— Rounded_corner;

— Turning_machine_cutting_tool;

— Turning_threading_tool;

— User_defined_turning_tool.

4.1.13 geometric dimensioning and tolerancing

The geometric dimensioning and tolerancing UoF specifies the information necessary to describe geometric dimensions, as well as the allowable variation in those dimensions for the purpose of manufacturing. In addition, this UoF specifies the information necessary to describe geometric tolerances with a datum reference, such as parallelism or perpendicularity, and geometric tolerances without a datum reference, such as straightness or flatness. This includes the information necessary to describe single datum references, common datum references, datum targets, and tolerance zones.

The following application objects are used by the geometric dimensioning and tolerancing UoF:

NOTE The following application objects have been harmonized with the information requirements for geometric dimensions and tolerances defined by ISO 10303-1050 and ISO 10303-1051, which themselves are the result of harmonization efforts between ISO 10303-224 and ISO 10303-214. The application objects dealing with the numerical value of the tolerances (nominal, plus/minus, range, etc.) are addressed in the measure UoF.

— Angular_location_dimension;

— Angular_size_dimension;

— Angularity_tolerance;

— Circular_runout_tolerance;

— Coaxiality_tolerance;

— Common_datum;

— Concentricity_tolerance;

— Curved_distance_dimension;

— Curved_size_dimension;

— Cylindricity_tolerance;

— Datum;

— Datum_defined_by_derived_shape;

— Datum_defined_by_feature;

— Datum_defined_by_targets;

— Datum_reference;

— Datum_target;

— Diameter_size_dimension;

— Externally_defined_size_dimension;

— Flatness_tolerance;

— Geometric_dimension;

— Geometric_tolerance;

— Geometric_tolerance_relationship;

— Height_size_dimension;

— Length_size_dimension;

— Line_profile_tolerance;

— Linear_distance_dimension;

— Location_dimension;

— Measurement_path;

— Parallelism_tolerance;

— Perpendicularity_tolerance;

— Placed_target;

— Position_tolerance;

— Projection;

— Radial_size_dimension;

— Roundness_tolerance;

— Single_datum;

— Size_dimension;

— Straightness_tolerance;

— Surface_profile_tolerance;

— Symmetry_tolerance;

— Target_area;

— Target_circle;

— Target_point;

— Target_rectangle;

— Target_straight_line;

— Thickness_size_dimension;

— Tolerance_condition;

— Tolerance_zone;

— Tolerance_zone_definition;

— Total_runout_tolerance;

— Width_size_dimension.

4.1.14 library reference

The library reference UoF provides the capability and mechanisms by which references can be made to information in external libraries.

The following application objects are used by the library reference UoF:

NOTE The following four Approval application objects have been harmonized with the information requirements for approvals defined by ISO 10303-1012.

— BSU;

— Class_BSU;

— Externally_defined_representation;

— Library_part_assignment;

— Library_property_value;

— Property_BSU;

— Supplier_BSU.

4.1.15 management

The management UoF specifies the information necessary to describe the management aspects of a mechanical product or machining program. This includes the information necessary to describe the approval process, security classifications, persons and dates.

The following application objects are used by the management UoF:

NOTE The following four Approval application objects have been harmonized with the information requirements for approvals defined by ISO 10303-1012.

— Approval;

— Approval_relationship;

— Approval_status;

— Approving_person_organization;

— Assigned_date;

— Assigned_organization;

— Assigned_person;

— Assigned_time;

— Last_modified_timestamp;

NOTE The following two Security_classification application objects have been harmonized with the information requirements for security classifications defined by ISO 10303-1015.

— Security_classification;

— Security_classification_assignment.

4.2 Application objects

This subclause specifies the application objects for the computerized numerical controllers application protocol. Each application object is an atomic element that embodies a unique application concept and contains attributes specifying the data elements of the object. The application objects and their definitions are given below.

NOTE For application objects defined by ISO 14649, a normative reference to the originating document is provided, as well as an informative note containing the ISO 14649 EXPRESS description. Full definitions are provided for all objects not defined in the ISO 14649 documents as well as extensions to the application objects defined in the ISO 14649 documents.

4.2.1 Adaptive_control

The Adaptive_control application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Adaptive_control is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY adaptive_control;
END_ENTITY;
```

4.2.2 Air_strategy

The Air_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Air_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY air_strategy
ABSTRACT SUPERTYPE OF (ONEOF (ap_retract_angle, ap_retract_tangent))
SUBTYPE OF (approach_retract_strategy);
END_ENTITY;
```

4.2.3 Along_path

The Along_path application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Along_path is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY along_path
  SUBTYPE OF (approach_retract_strategy);
  path: toolpath_list;
END_ENTITY;
```

4.2.4 And_expression

The And_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for And_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY and_expression
  SUBTYPE OF (multiple_arity_boolean_expression);
END_ENTITY;
```

4.2.5 Angle_taper

The Angle_taper application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Angle_taper is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY angle_taper;
  angle: plane_angle_measure;
END_ENTITY;
```

4.2.6 Angular_location_dimension

An Angular_location_dimension is a type of Location_dimension (see 4.2.187) that defines the allowable variation in the angle between two elements of the shape of a part.

NOTE This definition has been harmonized with the Angular_location_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Angular_dimension_tolerance definition in ISO 10303-224. Figure 1 illustrates an Angular_location_dimension. Figure 2 illustrates the difference between an Angular_location_dimension and an Angular_size_dimension (see 4.2.7).

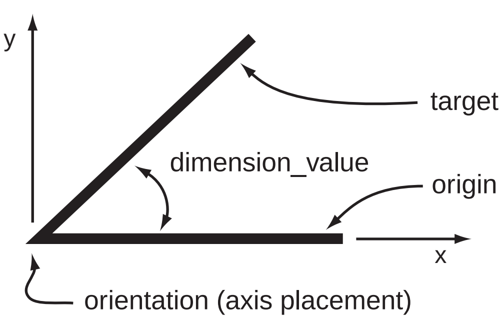

Figure 1 — Angular_location_dimension

The data associated with an Angular_location_dimension are the following:

— orientation.

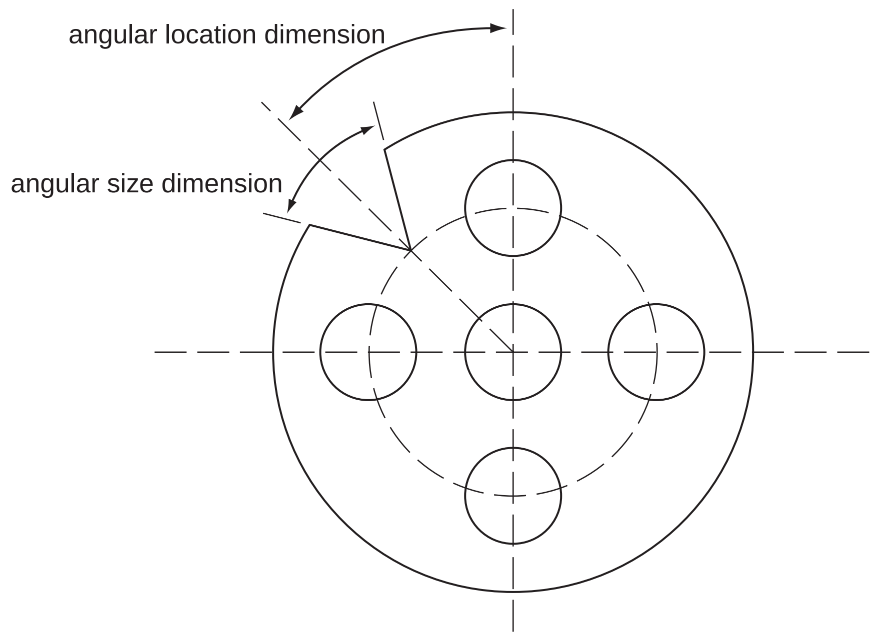

Figure 2 — Angular_location_dimension versus Angular_size_dimension

4.2.6.1 orientation

The orientation specifies an axis placement establishing the direction of positive measure of the Angular_location_dimension. The angle extends in the XY plane from the X axis towards Y, about the origin.

4.2.7 Angular_size_dimension

An Angular_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in the angular size of an element of the shape of a part.

NOTE This definition has been harmonized with the Angular_size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Angular_size_dimension_tolerance definition in ISO 10303-224. Figure 3 illustrates the parameter combinations of an Angular_size_dimension.

The data associated with an Angular_size_dimension are the following:

— full;

— major_angle.

4.2.7.1 full

The full attribute specifies whether the Angular_size_dimension refers to the full angle or the half angle representing the size of the shape element.

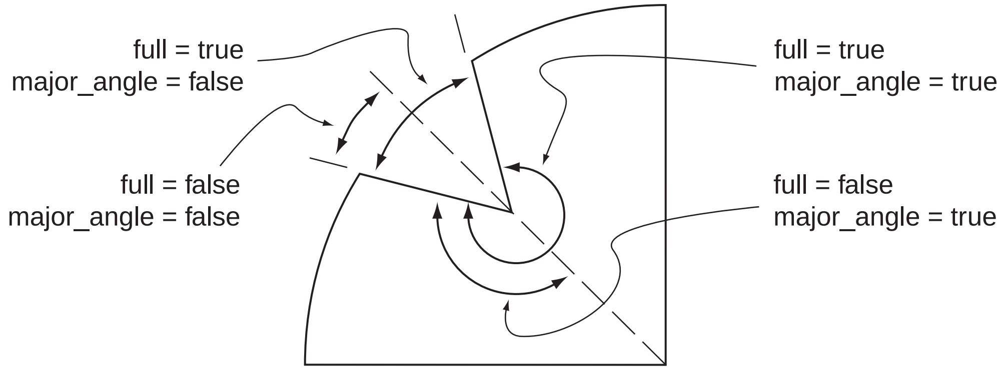

Figure 3 — Angular_size_dimension

4.2.7.2 major_angle

The major_angle specifies which of the two possible angles shall be considered. A value of ‘true’ specifies the angle to be the larger of the two angles formed by the angular element.

4.2.8 Angularity_tolerance

An Angularity_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a constraint on the location of a surface, of a centre plane, of an edge, or of an axis that lies theoretically at a specified angle (other than 90 degrees) from a datum plane or from a datum axis. An Angularity_tolerance specifies one of the following:

NOTE This definition has been harmonized with the Angularity_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.9 of ISO 1101. Figure 4 illustrates an Angularity_tolerance for a plane surface.

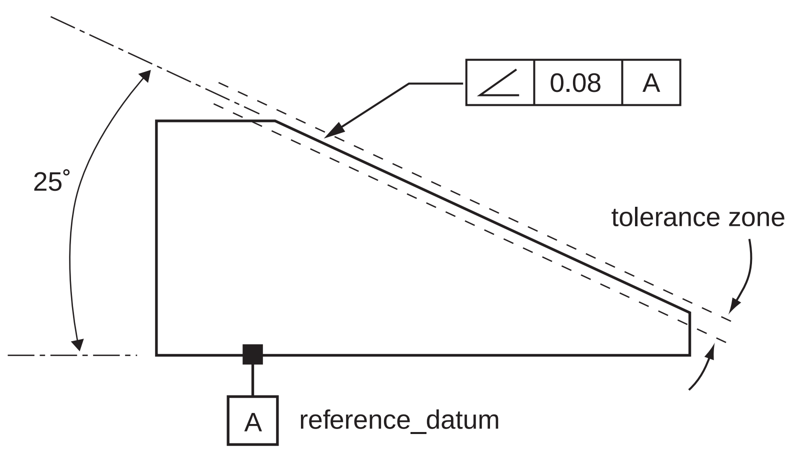

Figure 4 — Angularity_tolerance

— a tolerance zone defined by two parallel planes at the specified basic angle from a datum plane or axis within which the considered element must lie;

— a tolerance zone defined by a cylinder at the specified basic angle from a datum plane or axis within which the considered element must lie.

The data associated with an Angularity_tolerance are the following:

— reference_datum.

4.2.8.1 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.1 for the application assertion.

4.2.9 Ap_lift_path_angle

The Ap_lift_path_angle application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Ap_lift_path_angle is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY ap_lift_path_angle
  SUBTYPE OF (approach_lift_path);
  angle:                      plane_angle_measure;
  benddist:                   length_measure;
END_ENTITY;
```

4.2.10 Ap_lift_path_tangent

The Ap_lift_path_tangent application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Ap_lift_path_tangent is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY ap_lift_path_tangent
  SUBTYPE OF (approach_lift_path);
  radius:                     length_measure;
END_ENTITY;
```

4.2.11 Ap_retract_angle

The Ap_retract_angle application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Ap_retract_angle is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY ap_retract_angle
  SUBTYPE OF (air_strategy);
  angle:         plane_angle_measure;
```



```
    travel_length: length_measure;
  END_ENTITY;
```

4.2.12 Ap_retract_tangent

The Ap_retract_tangent application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Ap_retract_tangent is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
  ENTITY ap_retract_tangent
    SUBTYPE OF (air_strategy);
    radius: length_measure;
  END_ENTITY;
```

4.2.13 Approach_lift_path

The Approach_lift_path application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Approach_lift_path is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
  ENTITY approach_lift_path
    ABSTRACT SUPERTYPE OF (ONEOF (ap_lift_path_angle, ap_lift_path_tangent))
    SUBTYPE OF (parameterised_path);
    fix_point:                  cartesian_point;
    fix_point_dir:              OPTIONAL direction;
  END_ENTITY;
```

4.2.14 Approach_retract_strategy

The Approach_retract_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Approach_retract_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
  ENTITY approach_retract_strategy
    ABSTRACT SUPERTYPE OF (ONEOF (plunge_strategy, air_strategy, along_path));
    tool_orientation: OPTIONAL direction;
  END_ENTITY;
```

4.2.15 Approval

An Approval is a formal confirmation of the quality of some activity or product data.

NOTE This definition has been harmonized with the Approval definition in ISO 10303-1012.

The data associated with an Approval are the following:

— actual_date;

— planned_date;

— purpose;

— status.

4.2.15.1 actual_date

The actual_date specifies the point in time when the Approval actually became valid. The actual_date need not be specified for a particular Approval.

4.2.15.2 planned_date

The planned_date specifies the point in time when the Approval is or was supposed to be performed. The planned_date need not be specified for a particular Approval.

4.2.15.3 purpose

The purpose specifies the text that completes the information provided within the status attribute, specifying the reason or goal of the Approval.

EXAMPLE 'released for production' or 'preliminary design completed' are approval purposes.

4.2.15.4 status

The status specifies the Approval_status that provides a user interpretable designation of the level of approval. See 4.3.2 for the application assertion.

4.2.16 Approval_relationship

An Approval_relationship is a typed association between two instances of Approval.

NOTE This definition has been harmonized with the Approval_relationship definition in ISO 10303-1012.

The data associated with an Approval_relationship are the following:

— description;

— related_approval;

— relating_approval;

— relation_type.

4.2.16.1 description

The description specifies the text that provides further information about the Approval_relationship. The description need not be specified for a particular Approval_relationship.

4.2.16.2 related_approval

The related_approval specifies one of the Approval objects that is a part of the relationship. If one element of the relationship is dependent of the other, this attribute shall be the dependent one. See 4.3.3 for the application assertion.

4.2.16.3 relating_approval

The relating_approval specifies one of the Approval objects that is a part of the relationship. See 4.3.4 for the application assertion.

4.2.16.4 relation_type

The relation_type specifies the text that specifies the meaning of the relationship. Where applicable, the following values shall be used:

— decomposition: The Approval_relationship defines a relationship where the related Approval is one of the components into which the relating Approval is broken down with no implication of ‘sequence’ or ‘dependency’;

— dependency: The Approval_relationship defines a relationship where the issuing of the related Approval is dependent on the issuing of the relating Approval;

— precedence: the Approval_relationship defines a relationship where the related Approval has higher priority than the relating Approval;

— sequence: The Approval_relationship defines a relationship where the relating Approval shall be completed before the related Approval is given.

NOTE The value ‘dependency’ does not imply the semantics of the values ‘decomposition’ or ‘sequence’.

EXAMPLE 1 The Approval of an assembly may be dependent on the Approval of all of the constituents of the assembly.

EXAMPLE 2 In parallel approval processes of two assemblies, assignment of an Approval on one of the assemblies may depend on an Approval assigned to the second assembly.

4.2.17 Approval_status

An Approval_status is a particular rank of approval.

NOTE This definition has been harmonized with the Approval_status definition in ISO 10303-1012.

The data associated with an Approval_status are the following:

— status_name.

4.2.17.1 status_name

The status_name specifies the text by which the Approval_status is designated.

EXAMPLE 'approved' and 'disapproved' are examples of Approval_status.

4.2.18 Approving_person_organization

An Approving_person_organization is an association between an Approval and the organization or person and organization that has granted this approval.

NOTE This definition has been harmonized with the Approving_person_organization definition in ISO 10303-1012.

The data associated with an Approving_person_organization are the following:

— approval_date;

— authorized_approval;

— person_organization;

— role.

4.2.18.1 approval_date

The approval_date specifies the point in time when the Approval has been given. The approval_date need not be specified for a particular Approving_person_organization.

4.2.18.2 authorized_approval

The authorized_approval specifies the Approval that has been given by the considered person or the organization. See 4.3.5 for the application assertion.

4.2.18.3 person_organization

The person_organization specifies the organization or person and organization that has granted the approval.

4.2.18.4 role

The role specifies the text that indicates the role of the considered person or organization with respect to the approval. The role need not be specified for a particular Approving_person_organization. By default, the person or organization shall only be considered as an approver without any specific role.

EXAMPLE 'quality insurance auditor', 'production cost examiner' are examples of values of role of persons or organizations with respect to approvals assigned to product data.

4.2.19 Area_measure

An Area_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes an area.

4.2.20 Assigned_date

An Assigned_date is an association between a role and a date.

NOTE This definition is based on the equivalent assignment definition in ISO 10303-1014.

The data associated with an Assigned_date are the following:

— date_value;

— role.

4.2.20.1 date_value

The date_value specifies the date that is assigned.

4.2.20.2 role

The role specifies the text that indicates the role of the considered date.

EXAMPLE 'creation date', and 'release date' are example role values of dates assigned to product data.

4.2.21 Assigned_organization

An Assigned_organization is an association between a role and an organization.

NOTE This definition is based on the equivalent assignment definition in ISO 10303-1013.

The data associated with an Assigned_organization are the following:

— organization_value;

— role.

4.2.21.1 organization_value

The organization_value specifies the organization that is assigned.

4.2.21.2 role

The role specifies the text that indicates the role of the considered organization.

EXAMPLE 'creator', and 'part supplier' are example role values of organizations assigned to product data.

4.2.22 Assigned_person

An Assigned_person is an association between a role and a person and organization.

NOTE This definition is based on the equivalent assignment definition in ISO 10303-1013.

The data associated with an Assigned_person are the following:

- person_and_organization_value;
- role.

4.2.22.1 person_and_organization_value

The person_and_organization_value specifies the person and organization that is assigned.

4.2.22.2 role

The role specifies the text that indicates the role of the considered person and organization.

EXAMPLE 'design owner', 'creator', and 'part supplier' are example role values of persons assigned to product data.

4.2.23 Assigned_time

An Assigned_time is an association between a role and a date and time.

NOTE This definition is based on the equivalent assignment definition in ISO 10303-1014.

The data associated with an Assigned_time are the following:

- date_and_time_value;
- role.

4.2.23.1 date_and_time_value

The date_and_time_value specifies the date and time that is assigned.

4.2.23.2 role

The role specifies the text that indicates the role of the considered date and time.

EXAMPLE 'creation date', and 'release date' are example role values of date and times assigned to product data.

4.2.24 Assignment

The Assignment application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Assignment is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY assignment
  SUBTYPE OF (program_structure);
  its_lvalue:                 nc_variable;
  its_rvalue:                 rvalue;
END_ENTITY;

TYPE rvalue = SELECT(nc_constant, nc_variable);
END_TYPE;
```

4.2.25 Axis_trajectory

The Axis_trajectory application object is defined by clause 4.8 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with an Axis_trajectory are the following:

— all of the data defined by ISO 14649-10, as modified below for the commands attribute.

NOTE The ISO 14649 EXPRESS description for Axis_trajectory is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY axis_trajectory(* m0 *)
  SUBTYPE OF (trajectory);
  axis_list:                  LIST [1:?] OF identifier;
  commands:                   LIST [1:?] OF bounded_curve;
WHERE
  WR1: SIZEOF(QUERY(cmd <* commands |
    cmd\geometric_representation_item.dim <> 1)) = 0;
END_ENTITY;
```

4.2.25.1 commands

The commands parameter is as defined by ISO 14649-10, but this part of ISO 10303 adds the requirement that the parameterisation of each bounded_curve shall be the same. See 5.2.1.6.1 for additional discussion on curve parameterization.

4.2.26 Back_boring

The Back_boring application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Back_boring is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY back_boring
  SUBTYPE OF (drilling_type_operation);
WHERE
  WR1:  EXISTS(SELF.its_machine_functions.oriented_spindle_stop);
END_ENTITY;
```

4.2.27 Ballnose_endmill

The Ballnose_endmill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Ballnose_endmill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY ballnose_endmill
  SUBTYPE OF (endmill);
  WHERE
  WR1: NOT EXISTS(SELF.edge_radius)
       OR (EXISTS(SELF.edge_radius) AND
           EXISTS(SELF.effective_cutting_diameter) AND
          (SELF.edge_radius = SELF.effective_cutting_diameter/2));
END_ENTITY;
```

4.2.28 Bidirectional

The Bidirectional application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Bidirectional is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY bidirectional
  SUBTYPE OF (two5D_milling_strategy);
  feed_direction:        OPTIONAL direction;
  stepover_direction:    OPTIONAL left_or_right;
  its_stroke_connection_strategy: OPTIONAL stroke_connection_strategy;
END_ENTITY;

TYPE left_or_right = ENUMERATION OF (left, right);
END_TYPE;

TYPE stroke_connection_strategy = ENUMERATION OF
```



```
   (straghtline, lift_shift_plunge, degouge, loop_back);
END_TYPE;
```

4.2.29 Bidirectional_contour

The Bidirectional_contour application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Bidirectional_contour is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY bidirectional_contour
  SUBTYPE OF (two5D_milling_strategy);
  feed_direction:        OPTIONAL direction;
  stepover_direction:       OPTIONAL left_or_right;
  rotation_direction:     OPTIONAL rot_direction;
  spiral_cutmode:         OPTIONAL cutmode_type;
END_ENTITY;

TYPE rot_direction = ENUMERATION OF (cw,ccw);
END_TYPE;
```

4.2.30 Bidirectional_turning

The Bidirectional_turning application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Bidirectional_turning is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY bidirectional_turning
  SUBTYPE OF (turning_machining_strategy);
  feed_direction : OPTIONAL direction;
  stepover_direction : OPTIONAL direction;
  stepover_feed : OPTIONAL feed_select;
END_ENTITY;
```

4.2.31 Binary_boolean_expression

The Binary_boolean_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Binary_boolean_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY binary_boolean_expression
  ABSTRACT SUPERTYPE OF(xor_expression)
  SUBTYPE OF (boolean_expression);
  operand1: boolean_expression;
  operand2: boolean_expression;
END_ENTITY;
```

4.2.32 Blind_bottom_condition

The Blind_bottom_condition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Blind_bottom_condition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY blind_bottom_condition
  ABSTRACT SUPERTYPE OF (ONEOF(flat_hole_bottom, flat_with_radius_hole_bottom,
        spherical_hole_bottom, conical_hole_bottom))
  SUBTYPE OF (hole_bottom_condition);
END_ENTITY;
```

4.2.33 Boolean_expression

The Boolean_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Boolean_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY boolean_expression
  ABSTRACT SUPERTYPE OF(ONEOF(unary_boolean_expression, binary_boolean_expression,
      multiple_arity_boolean_expression, comparison_expression));
END_ENTITY;
```

4.2.34 Boring

The Boring application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Boring is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY boring
  SUBTYPE OF (boring_operation);
END_ENTITY;
```

4.2.35 Boring_operation

The Boring_operation application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Boring_operation is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY boring_operation
  ABSTRACT SUPERTYPE OF (ONEOF(boring, reaming))
  SUBTYPE OF (drilling_type_operation);
  spindle_stop_at_bottom:         BOOLEAN;
  depth_of_testcut:               OPTIONAL length_measure;
  waiting_position:               OPTIONAL cartesian_point;
END_ENTITY;
```

4.2.36 Boss

The Boss application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements to the Boss application object.

The data associated with a Boss are the following:

— all of the data defined by ISO 14649-10;

— boss_height.

NOTE The ISO 14649 EXPRESS description for Boss, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY boss
  SUBTYPE OF(machining_feature);
  its_boundary:         closed_profile;
  slope:                OPTIONAL plane_angle_measure;
  boss_height:          linear_path;    -- ADDED BY 10303-238
END_ENTITY;
```

4.2.36.1 boss_height

The boss_height specifies a Linear_path along which the its_boundary profile is swept to define the volume of the Boss. The placement and orientation of the course_of_travel shall be the same as the Boss feature. See 4.3.6 for the application assertion.

NOTE The length of the path is the height of the boss.

4.2.37 Bottom_and_side_finish_milling

The Bottom_and_side_finish_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Bottom_and_side_finish_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY bottom_and_side_finish_milling
  SUBTYPE OF (bottom_and_side_milling);
END_ENTITY;
```

4.2.38 Bottom_and_side_milling

The Bottom_and_side_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Bottom_and_side_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY bottom_and_side_milling
  ABSTRACT SUPERTYPE OF (ONEOF(bottom_and_side_rough_milling,
      bottom_and_side_finish_milling))
  SUBTYPE OF (two5D_milling_operation);
  axial_cutting_depth:    OPTIONAL length_measure;
  radial_cutting_depth:   OPTIONAL length_measure;
  allowance_side:         OPTIONAL length_measure;
  allowance_bottom:       OPTIONAL length_measure;
END_ENTITY;
```


4.2.39 Bottom_and_side_rough_milling

The Bottom_and_side_rough_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Bottom_and_side_rough_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY bottom_and_side_rough_milling
  SUBTYPE OF (bottom_and_side_milling);
WHERE
  WR1: EXISTS(SELF.allowance_side) AND (SELF.allowance_side>=0.0);
  WR2: EXISTS(SELF.allowance_bottom) AND (SELF.allowance_bottom>=0.0);
END_ENTITY;
```

4.2.40 BSU

A BSU is the identification of a piece of information, that can be a supplier, a class or a property, by specifying a code and a version. Each BSU is either a Supplier_BSU (see 4.2.328), a Class_BSU (see 4.2.55), or a Property_BSU (see 4.2.271).

NOTE 1 BSU is an acronym for basic semantical unit.

NOTE 2 This definition has been harmonized with the BSU definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a BSU are the following:

— code.

4.2.40.1 code

The code specifies the designation of the identification of the information piece.

4.2.41 Bullnose_endmill

The Bullnose_endmill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Bullnose_endmill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY bullnose_endmill
  SUBTYPE OF (endmill);
  WHERE
  WR1:  EXISTS(SELF.edge_radius) AND
        EXISTS(SELF.effective_cutting_diameter) AND
        (SELF.edge_radius < SELF.effective_cutting_diameter/2);
END_ENTITY;
```

4.2.42 Catalogue_thread

The Catalogue_thread application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Catalogue_thread is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY catalogue_thread
  SUBTYPE OF (thread);
  documentation:         specification;
END_ENTITY;
```

4.2.43 Center_drilling

The Center_drilling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Center_drilling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY center_drilling
  SUBTYPE OF (drilling_operation);
END_ENTITY;
```

4.2.44 Center_milling

The Center_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Center_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY center_milling
  SUBTYPE OF (two5D_milling_strategy);
END_ENTITY;
```

4.2.45 Chamfer

The Chamfer application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements. See 5.2.1.3.7 for additional discussion on these information requirements.

NOTE 1 As originally defined by ISO 14649-10, a Chamfer can only describe a transition between two features. For harmonization with ISO 10303-224 and other ISO 10303 parts, the following properties have been added so a Chamfer may alternately describe a transition between two sets of faces on the boundary representation of the workpiece.

The data associated with a Chamfer are the following:

— all of the data defined by ISO 14649-10;

— chamfer_face;

— first_face_shape;

— second_face_shape.

NOTE 2 The ISO 14649 EXPRESS description for Chamfer, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY chamfer
  SUBTYPE OF (transition_feature);
  angle_to_plane:       plane_angle_measure;
  first_offset_amount:  toleranced_length_measure;
  chamfer_face:         OPTIONAL SET [1:?] OF face; -- ADDED BY 10303-238
  first_face_shape:     OPTIONAL SET [1:?] OF face; -- ADDED BY 10303-238
  second_face_shape:    OPTIONAL SET [1:?] OF face; -- ADDED BY 10303-238
END_ENTITY;
```

4.2.45.1 chamfer_face

The chamfer_face specifies the flat transition surface located between the first_face_shape and the second_face_shape surfaces. This is a set of one or more faces on the boundary representation of the workpiece. The chamfer_face need not be specified for a particular Chamfer.

4.2.45.2 first_face_shape

The first_face_shape specifies specifies one of two surfaces that the Chamfer feature will create a transition between. This is a set of one or more faces on the boundary representation of the workpiece. The first_face_shape need not be specified for a particular Chamfer.

4.2.45.3 second_face_shape

The second_face_shape specifies the other surface that the Chamfer feature will create a transition between. This is a set of one or more faces on the boundary representation of the workpiece. The second_face_shape need not be specified for a particular Chamfer.

4.2.46 Chamfered_corner

The Chamfered_corner application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Chamfered_corner is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
ENTITY chamfered_corner;
  corner_chamfer_angle:         plane_angle_measure;
  corner_chamfer_length:        OPTIONAL length_measure;
  corner_chamfer_width:         OPTIONAL length_measure;
END_ENTITY;
```

4.2.47 Channel

The Channel application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Channel is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY channel;
  its_id: identifier;
END_ENTITY;
```

4.2.48 Circular_closed_profile

The Circular_closed_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Circular_closed_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY circular_closed_profile
  SUBTYPE OF(closed_profile);
  diameter:              toleranced_length_measure;
END_ENTITY;
```

4.2.49 Circular_closed_shape_profile

The Circular_closed_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Circular_closed_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY circular_closed_shape_profile
  SUBTYPE OF (shape_profile);
  closed_boundary :      circular_closed_profile;
END_ENTITY;
```

4.2.50 Circular_offset

The Circular_offset application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Circular_offset is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY circular_offset;
  angular_offset:             plane_angle_measure;
  index:                      INTEGER;
END_ENTITY;
```

4.2.51 Circular_omit

The Circular_omit application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Circular_omit is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY circular_omit;
  index:                      INTEGER;
END_ENTITY;
```

4.2.52 Circular_path

The Circular_path application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Circular_path is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY circular_path
  ABSTRACT SUPERTYPE OF(ONEOF(complete_circular_path, partial_circular_path))
  SUBTYPE OF(travel_path);
  radius:                toleranced_length_measure;
END_ENTITY;
```

4.2.53 Circular_pattern

The Circular_pattern application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Circular_pattern is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY circular_pattern
  SUBTYPE OF(replicate_feature);
  angle_increment:            plane_angle_measure;
  number_of_feature:          INTEGER;
  relocated_base_feature:     SET[0:?] OF circular_offset;
  missing_base_feature:       SET[0:?] OF circular_omit;
  base_feature_diameter:      OPTIONAL toleranced_length_measure;
  base_feature_rotation:      plane_angle_measure;
END_ENTITY;
```

4.2.54 Circular_runout_tolerance

A Circular_runout_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a constraint on the circularity of curves pertaining to a surface described by the rotation of a part about an axis. The tolerance is applied independently at any circular measuring position as the part is rotated 360 degrees.

NOTE 1 This definition has been harmonized with the Circular_runout_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.13 of ISO 1101.

NOTE 2 Where applied to surfaces constructed around a datum axis, Circular_runout_tolerance may be used to control the cumulative variations of circularity and coaxiality. Where applied to surfaces constructed at right angles to the datum axis, Circular_runout_tolerance controls circular elements of a plane surface. Figure 5 illustrates a Circular_runout_tolerance.

The data associated with a Circular_runout_tolerance are the following:

— angle;

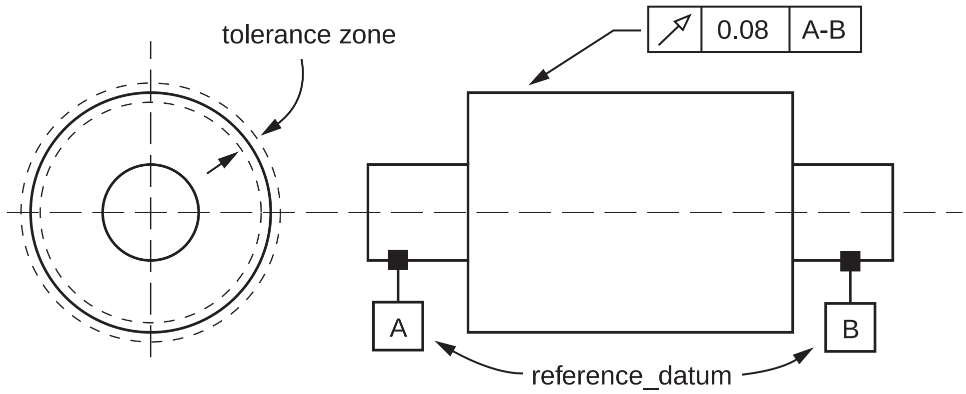

Figure 5 — Circular_runout_tolerance

— reference_datum.

4.2.54.1 angle

The angle specifies the direction in which the runout tolerance is controlled. The angle need not be specified for a particular Circular_runout_tolerance. If the angle is specified, the runout tolerance applies in this angle which is fixed with respect to the datum axis. If the angle is not specified, the runout tolerance applies normal to the surface generated by the rotation.

4.2.54.2 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.7 for the application assertion.

4.2.55 Class_BSU

A Class_BSU is a type of BSU (see 4.2.40) that identifies a class in a parts library.

NOTE 1 The combination of supplier identification, code, and version of a class shall be unique.

NOTE 2 This definition has been harmonized with the Class_BSU definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Class_BSU are the following:

— defined_by;

— version.

4.2.55.1 defined_by

The defined_by specifies Supplier_BSU object which describes the library supplier who defines the library class. See 4.3.8 for the application assertion.

4.2.55.2 version

The version specifies the designation of the version of the information piece.

4.2.56 Closed_pocket

The Closed_pocket application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Closed_pocket is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY closed_pocket
  SUBTYPE OF (pocket);
  feature_boundary:           closed_profile;
END_ENTITY;
```

4.2.57 Closed_profile

The Closed_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Closed_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY closed_profile
  ABSTRACT SUPERTYPE OF
  (ONEOF (rectangular_closed_profile, circular_closed_profile,
          ngon_profile, general_closed_profile))
  SUBTYPE OF(profile);
END_ENTITY;
```

4.2.58 Coaxiality_tolerance

A Coaxiality_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a constraint where the tolerance zone is limited by a cylinder, the diameter of which is the tolerance value. The cylinder axis is defined by the datums that are referenced.

NOTE This definition has been harmonized with the Coaxiality_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. Figure 6 illustrates a Coaxiality_tolerance.

The data associated with a Coaxiality_tolerance are the following:

— reference_datum.

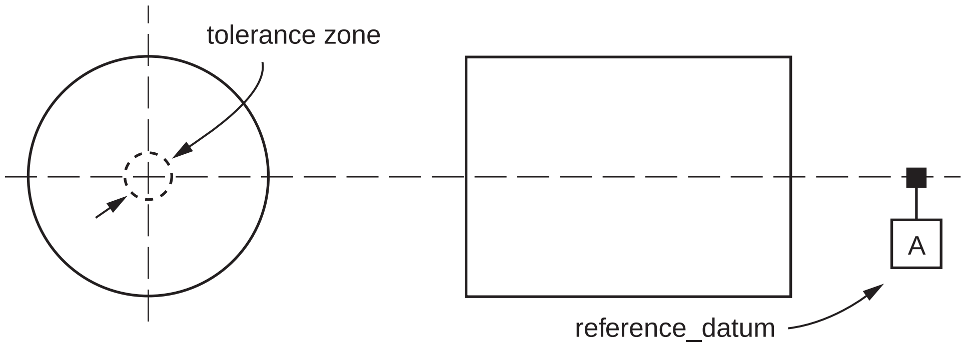

Figure 6 — Coaxiality_tolerance

4.2.58.1 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.9 for the application assertion.

4.2.59 Combined_drill_and_reamer

The Combined_drill_and_reamer application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Combined_drill_and_reamer is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY combined_drill_and_reamer
  SUBTYPE OF (reaming_cutting_tool);
  drill_length: length_measure;
END_ENTITY;
```

4.2.60 Combined_drill_and_tap

The Combined_drill_and_tap application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Combined_drill_and_tap is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY combined_drill_and_tap
  SUBTYPE OF (tapping_cutting_tool);
  drill_length: OPTIONAL length_measure;
END_ENTITY;
```

4.2.61 Common_datum

A Common_datum is a type of Datum (see 4.2.100) defined by a set of two Single_datum objects of equal importance which are used to establish a single datum plane or axis.

NOTE This definition has been harmonized with the Common_datum definition in ISO 10303-1051, and the Compound_datum definition in ISO 10303-214 and ISO 10303-224.

The data associated with a Common_datum are the following:

— made_up_by.

4.2.61.1 made_up_by

The made_up_by specifies the set of Single_datum objects that form the Common_datum. See 4.3.10 for the application assertion.

4.2.62 Comparison_equal

The Comparison_equal application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Comparison_equal is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY comparison_equal
  SUBTYPE OF (comparison_expression);
END_ENTITY;
```

4.2.63 Comparison_expression

The Comparison_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Comparison_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY comparison_expression
  ABSTRACT SUPERTYPE OF(ONEOF(comparison_equal, comparison_not_equal,
     comparison_greater, comparison_greater_equal, comparison_less,
     comparison_less_equal))
  SUBTYPE OF (boolean_expression);
  operand1:                  nc_variable;
  operand2:                  rvalue;
END_ENTITY;
```

4.2.64 Comparison_greater

The Comparison_greater application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Comparison_greater is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY comparison_greater
  SUBTYPE OF (comparison_expression);
END_ENTITY;
```


4.2.65 Comparison_greater_equal

The Comparison_greater_equal application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Comparison_greater_equal is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY comparison_greater_equal
  SUBTYPE OF (comparison_expression);
END_ENTITY;
```

4.2.66 Comparison_less

The Comparison_less application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Comparison_less is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY comparison_less
  SUBTYPE OF (comparison_expression);
END_ENTITY;
```

4.2.67 Comparison_less_equal

The Comparison_less_equal application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Comparison_less_equal is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY comparison_less_equal
  SUBTYPE OF (comparison_expression);
END_ENTITY;
```

4.2.68 Comparison_not_equal

The Comparison_not_equal application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Comparison_not_equal is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY comparison_not_equal
  SUBTYPE OF (comparison_expression);
END_ENTITY;
```

4.2.69 Complete_circular_path

The Complete_circular_path application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Complete_circular_path is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY complete_circular_path
  SUBTYPE OF(circular_path);
END_ENTITY;
```

4.2.70 Compound_feature

The Compound_feature application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements to the Compound_feature application object.

NOTE 1 The name and description properties have been added for harmonization with ISO 10303-224 and other ISO 10303 parts.

The data associated with a Compound_feature are the following:

— all of the data defined by ISO 14649-10;

— feature_description;

— feature_name.

NOTE 2 The ISO 14649 EXPRESS description for Compound_feature, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY compound_feature
  SUPERTYPE OF (ONEOF(counterbore_hole, countersunk_hole))
  SUBTYPE OF (two5D_manufacturing_feature);
  elements: SET [2:?] OF compound_feature_select;
  feature_description: OPTIONAL text; -- ADDED BY 10303-238
  feature_name:        label;         -- ADDED BY 10303-238
  WHERE
  WR1: SIZEOF(QUERY(e <* elements |
     SIZEOF(e\manufacturing_feature.its_operations) <> 0)) = 0;
END_ENTITY;

TYPE compound_feature_select = SELECT(machining_feature, transition_feature);
END_TYPE;
```

4.2.70.1 feature_description

The feature_description specifies text that provides further information about the Compound_feature. The feature_description need not be specified for a particular Compound_feature.

4.2.70.2 feature_name

The feature_name specifies a name for the Compound_feature. The feature_name need not be unique.

NOTE This is separate from the its_id property. In the integrated representation, its_id is the shape_aspect name and feature_name is the characterized_object name.

4.2.71 Concentricity_tolerance

A Concentricity_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a constraint defining one of the following two conditions:

— a condition where the axes of all cross-sectional elements of a surface of revolution perpendicular to the axis of a datum feature are common to this axis. In this case, it implies a cylindrical tolerance zone whose axis coincides with the datum axis and within which all cross-sectional axes of the feature being controlled must lie;

— a condition where the centre point of one sphere is common to the centre point of another sphere. In this case, it implies a spherical tolerance zone within which the centre point of the first sphere must lie. .

NOTE This definition has been harmonized with the Concentricity_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.11 of ISO 1101. Figure 7 illustrates a Concentricity_tolerance.

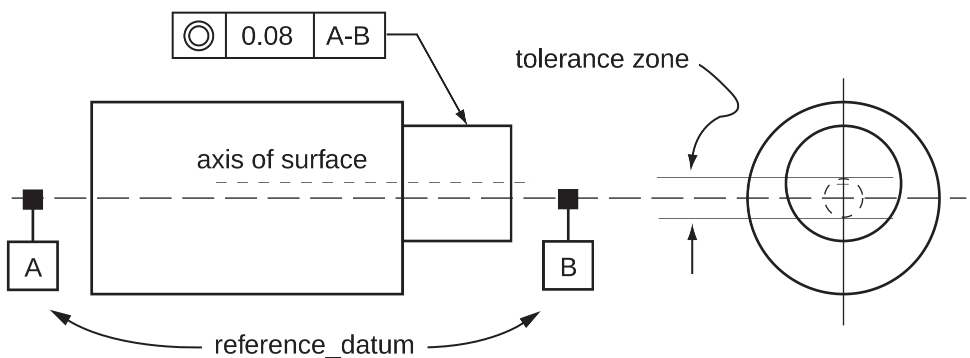

Figure 7 — Concentricity_tolerance

The data associated with a Concentricity_tolerance are the following:

— reference_datum.

4.2.71.1 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.11 for the application assertion.

4.2.72 Conical_hole_bottom

The Conical_hole_bottom application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Conical_hole_bottom is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.


```
ENTITY conical_hole_bottom
  SUBTYPE OF (blind_bottom_condition);
  tip_angle:      plane_angle_measure;
  tip_radius:     OPTIONAL toleranced_length_measure;
END_ENTITY;
```

4.2.73 Connect_direct

The Connect_direct application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Connect_direct is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY connect_direct
  SUBTYPE OF (connector);
END_ENTITY;
```

4.2.74 Connect_secplane

The Connect_secplane application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Connect_secplane is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY connect_secplane
  SUBTYPE OF (connector);
  up_dir  : OPTIONAL direction;
  down_dir: OPTIONAL direction;
END_ENTITY;
```

4.2.75 Connector

The Connector application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Connector is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY connector
  ABSTRACT SUPERTYPE OF (ONEOF(connect_secplane, connect_direct))
  SUBTYPE OF (parameterised_path);
END_ENTITY;
```

4.2.76 Const_cutting_speed

The Const_cutting_speed application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Const_cutting_speed is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY const_cutting_speed;
  speed : speed_measure;
  max_speed : OPTIONAL rot_speed_measure;
```



```
END_ENTITY;
```

4.2.77 Const_spindle_speed

The Const_spindle_speed application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Const_spindle_speed is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY const_spindle_speed;
  rot_speed : rot_speed_measure;
END_ENTITY;
```

4.2.78 Contour_bidirectional

The Contour_bidirectional application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Contour_bidirectional is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY contour_bidirectional
  SUBTYPE OF (two5D_milling_strategy);
  feed_direction:       OPTIONAL direction;
  stepover_direction:   OPTIONAL left_or_right;
  rotation_direction:   OPTIONAL rot_direction;
  spiral_cutmode:       OPTIONAL cutmode_type;
END_ENTITY;
```

4.2.79 Contour_parallel

The Contour_parallel application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Contour_parallel is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY contour_parallel
  SUBTYPE OF (two5D_milling_strategy);
  rotation_direction:   OPTIONAL rot_direction;
  cutmode:              OPTIONAL cutmode_type;
END_ENTITY;
```

4.2.80 Contour_spiral

The Contour_spiral application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Contour_spiral is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY contour_spiral
  SUBTYPE OF (two5D_milling_strategy);
  rotation_direction:     OPTIONAL rot_direction;
  cutmode:                OPTIONAL cutmode_type;
```

```
END_ENTITY;
```

4.2.81 Contour_turning

The Contour_turning application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Contour_turning is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY contour_turning
  SUBTYPE OF (turning_machining_strategy);
  feed_direction:          OPTIONAL direction;
  back_path_direction:     OPTIONAL direction;
  lift_direction:          OPTIONAL direction;
  stepover_direction:      OPTIONAL direction;
  lift_height:             OPTIONAL length_measure;
  lift_feed:               OPTIONAL feed_select;
  stepover_feed:           OPTIONAL feed_select;
  variable_stepover_feed:  OPTIONAL positive_ratio_measure;
END_ENTITY;
```

4.2.82 Contouring

The Contouring application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Contouring is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY contouring
  ABSTRACT SUPERTYPE OF (ONEOF(contouring_rough, contouring_finish))
  SUBTYPE OF (turning_machining_operation);
  allowance : OPTIONAL length_measure;
END_ENTITY;
```

4.2.83 Contouring_finish

The Contouring_finish application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Contouring_finish is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY contouring_finish
  SUBTYPE OF (contouring);
END_ENTITY;
```

4.2.84 Contouring_rough

The Contouring_rough application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Contouring_rough is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.


```
ENTITY contouring_rough
  SUBTYPE OF (contouring);
WHERE
  WR1: EXISTS(SELF.allowance) AND (SELF.allowance >= 0.0);
END_ENTITY;
```

4.2.85 Corner_transition

The Corner_transition application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Corner_transition is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
ENTITY corner_transition;
  corner_identity:      INTEGER;
  transition:           corner_transition_select;
END_ENTITY;

TYPE corner_transition_select = SELECT (
    chamfered_corner, rounded_corner, profiled_corner);
END_TYPE;
```

4.2.86 Counter_sinking

The Counter_sinking application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Counter_sinking is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY counter_sinking
  SUBTYPE OF (drilling_operation);
END_ENTITY;
```

4.2.87 Counterbore

The Counterbore application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Counterbore is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY counterbore
  SUBTYPE OF (drilling_cutting_tool);
END_ENTITY;
```

4.2.88 Counterbore_hole

The Counterbore_hole application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Counterbore_hole is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY counterbore_hole
```



```
  SUBTYPE OF (compound_feature);
WHERE
WR1: SIZEOF(elements) =2;
WR2: (SIZEOF(QUERY ( it <* SELF.elements |
     (('ROUND_HOLE' IN TYPEOF(it))) )) = 2);
WR3: SELF.elements[1].diameter.theoretical_size <>
     SELF.elements[2].diameter.theoretical_size;
END_ENTITY;
```

4.2.89 Countersink

The Countersink application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Countersink is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY countersink
  SUBTYPE OF (drilling_cutting_tool);
  minimum_cutting_diameter: OPTIONAL length_measure;
  maximum_usable_length:    length_measure;
END_ENTITY;
```

4.2.90 Countersunk_hole

The Countersunk_hole application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Countersunk_hole is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY countersunk_hole
  SUBTYPE OF (compound_feature);
WHERE
WR1: SIZEOF(elements) =2;
WR2: (SIZEOF(QUERY ( it <* SELF.elements |
     (('ROUND_HOLE' IN TYPEOF(it))) )) = 2);
WR3: SELF.elements[1].diameter.theoretical_size <>
     SELF.elements[2].diameter.theoretical_size;
WR4: NOT EXISTS(SELF.elements[1].change_in_diameter) AND
     EXISTS(SELF.elements[2].change_in_diameter);
END_ENTITY;
```

4.2.91 Curve_with_normal_vector

The Curve_with_normal_vector application object is defined by clause 4.8 of ISO 14649-10. See 5.2.1.6.1 for additional discussion on the curve parameterization requirements defined by ISO 14649 on the basiccurve and surface_normal data associated with a Curve_with_normal_vector.

NOTE The ISO 14649 EXPRESS description for Curve_with_normal_vector is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY curve_with_normal_vector;
  basiccurve:              bounded_curve;
  surface_normal:          bounded_curve;
END_ENTITY;
```


4.2.92 Curved_distance_dimension

A Curved_distance_dimension is a type of Location_dimension (see 4.2.187) that defines the arc length along a curve between two elements of the shape of a part.

NOTE This definition has been harmonized with the Curved_distance_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Distance_along_curve_tolerance definition in ISO 10303-224. Figure 8 illustrates a Curved_distance_dimension.

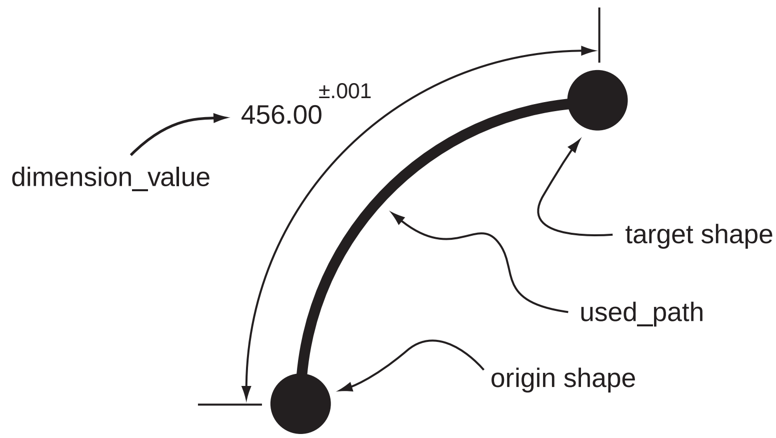

Figure 8 — Curved_distance_dimension

The data associated with a Curved_distance_dimension are the following:

— used_path.

4.2.92.1 used_path

The used_path specifies a Measurement_path along which the Curved_distance_dimension is measured. See 4.3.12 for the application assertion.

4.2.93 Curved_size_dimension

A Curved_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in the length of a curve shape element, as measured along the entire path of the curve.

NOTE This definition has been harmonized with the Curved_size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Curved_dimension_tolerance definition in ISO 10303-224. Figure 9 illustrates a Curved_size_dimension.

4.2.94 Cutter_contact_trajectory

The Cutter_contact_trajectory application object is defined by clause 4.8 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

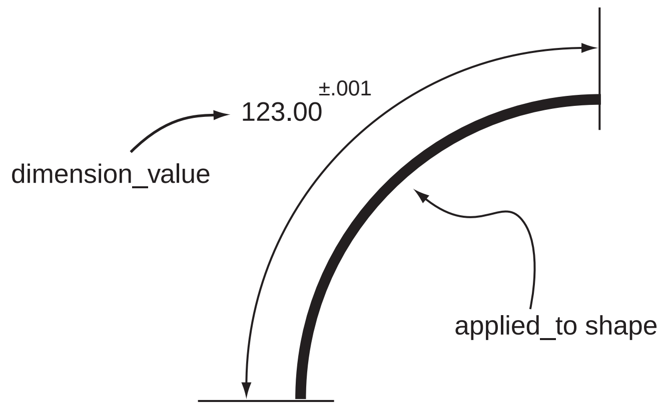

Figure 9 — Curved_size_dimension

The data associated with a Cutter_contact_trajectory are the following:

— all of the data defined by ISO 14649-10, as modified below for the its_toolaxis attributes;

— path_maximum_deviation;

— tool_axis_maximum_deviation.

See 5.2.1.6.1 for additional discussion on the curve parameterization requirements defined by ISO 14649 on the basiccurve and its_toolaxis data associated with a Cutter_contact_trajectory.

NOTE The ISO 14649 EXPRESS description for Cutter_contact_trajectory, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY cutter_contact_trajectory
  SUBTYPE OF (trajectory);
  basiccurve:                  curve_with_surface_normal;
  its_toolaxis:                OPTIONAL bounded_curve;
  its_contact_type:            OPTIONAL contact_type;
  path_maximum_deviation:      OPTIONAL length_measure;     -- ADDED BY 10303-238
  tool_axis_maximum_deviation: OPTIONAL plane_angle_measure;-- ADDED BY 10303-238
END_ENTITY;

TYPE curve_with_surface_normal = SELECT (bounded_pcurve, curve_with_normal_vector);
END_TYPE;

TYPE contact_type = ENUMERATION OF (side, front);
END_TYPE;
```

4.2.94.1 its_toolaxis

The its_toolaxis parameter is defined by ISO 14649-10 to contain tilt and yaw angles, but this part of ISO 10303 modifies this requirement so that its_toolaxis shall contain the IJK components of the tool axis vector, as is defined by the Cutter_location_trajectory its_toolaxis parameter.

4.2.94.2 path_maximum_deviation

The path_maximum_deviation specifies a linear distance. If this distance is specified, the NC control shall not allow the physical motion of the cutter contact point during execution of the toolpath to exceed this distance from the basiccurve specified by the toolpath. The path_maximum_deviation need not be specified for a particular Cutter_contact_trajectory.

4.2.94.3 tool_axis_maximum_deviation

The tool_axis_maximum_deviation specifies a plane angle. If this angle is specified, the NC control shall not allow the physical orientation of the tool axis during execution of the toolpath to exceed this angular distance from the its_toolaxis direction. The tool_axis_maximum_deviation need not be specified for a particular Cutter_contact_trajectory.

NOTE Figure 10 illustrates the range of deviations described by the tool_direction_maximum_deviation and path_maximim_deviation parameters. It is expected than an NC controller will adjust linearization tolerances (for 5-axis operation, as with the APT-CL LINTOL concept) as well as feed and acceleration rates to remain within the allowed deviations.

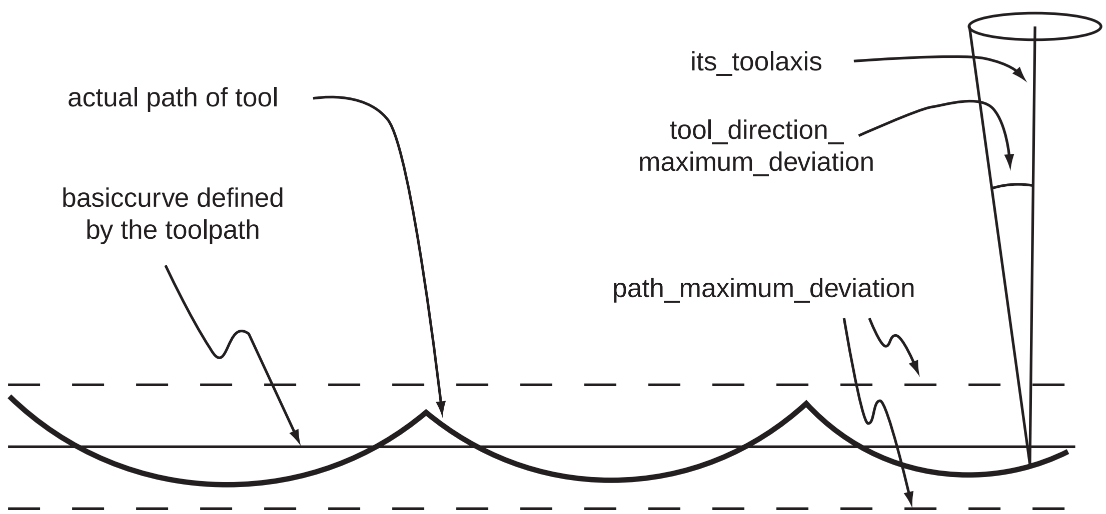

Figure 10 — Toolpath deviation parameters

4.2.95 Cutter_location_trajectory

The Cutter_location_trajectory application object is defined by clause 4.8 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Cutter_location_trajectory are the following:

— all of the data defined by ISO 14649-10, as modified below for the surface_normal attribute;

— path_maximum_deviation;

— tool_axis_maximum_deviation.

See 5.2.1.6.1 for additional discussion on the curve parameterization requirements defined by ISO 14649 on the basiccurve, its_toolaxis, and surface_normal data associated with a Cutter_location_trajectory.

NOTE The ISO 14649 EXPRESS description for Cutter_location_trajectory, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY cutter_location_trajectory
  SUBTYPE OF (trajectory);
  basiccurve:                  bounded_curve;
  its_toolaxis:                OPTIONAL bounded_curve;
  surface_normal:              OPTIONAL bounded_curve;
  path_maximum_deviation:      OPTIONAL length_measure;     -- ADDED BY 10303-238
  tool_axis_maximum_deviation: OPTIONAL plane_angle_measure;-- ADDED BY 10303-238
END_ENTITY;
```

4.2.95.1 surface_normal

The surface_normal parameter is defined by ISO 14649-10 remains unchanged, but this part of ISO 10303 clarifies the contents of this parameter so that surface_normal shall contain the IJK components of the surface normal vector.

4.2.95.2 path_maximum_deviation

The path_maximum_deviation specifies a linear distance. If this distance is specified, the NC control shall not allow the physical motion of the cutter center point during execution of the toolpath to exceed this distance from the basiccurve specified by the toolpath. The path_maximum_deviation need not be specified for a particular Cutter_location_trajectory.

4.2.95.3 tool_axis_maximum_deviation

The tool_axis_maximum_deviation specifies a plane angle. If this angle is specified, the NC control shall not allow the physical orientation of the tool axis during execution of the toolpath to exceed this angular distance from the its_toolaxis direction. The tool_axis_maximum_deviation need not be specified for a particular Cutter_location_trajectory.

NOTE Figure 10 illustrates the range of deviations described by the tool_direction_maximum_deviation and path_maximim_deviation parameters.

4.2.96 Cutting_component

The Cutting_component application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Cutting_component is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY cutting_component;
  tool_functional_length: length_measure;
```



```
    its_material:           OPTIONAL material;
    expected_tool_life:     OPTIONAL time_measure;
    its_technology:         OPTIONAL technology;
  END_ENTITY;
```

4.2.97 Cutting_edge_properties

The Cutting_edge_properties application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Cutting_edge_properties is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
  ENTITY cutting_edge_properties;
    its_material:                 OPTIONAL material;
    expected_tool_life:           OPTIONAL time_measure;
    its_technology:               OPTIONAL technology;
    cutting_edge_length:          OPTIONAL length_measure;
    tool_cutting_edge_angle:      OPTIONAL plane_angle_measure;
    tool_cutting_edge_angle_type: OPTIONAL STRING;
    tool_included_angle:          OPTIONAL plane_angle_measure;
    corner_transitions:           LIST [0:?] OF corner_transition;
    maximum_side_cutting_depth:   OPTIONAL length_measure;
    maximum_end_cutting_depth:    OPTIONAL length_measure;
  END_ENTITY;
```

4.2.98 Cutting_in

The Cutting_in application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Cutting_in is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
  ENTITY cutting_in
    SUBTYPE OF (grooving);
  WHERE
    WR1: NOT(EXISTS(SELF.allowance));
  END_ENTITY;
```

4.2.99 Cylindricity_tolerance

A Cylindricity_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a constraint on the amount a surface may deviate from being nominally cylindrical. The tolerance zone is limited by two coaxial cylinders, with a difference in radii of the tolerance value.

NOTE This definition has been harmonized with the Cylindricity_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. The definition is derived from paragraph 14.4 of ISO 1101. Figure 11 illustrates a Cylindricity_tolerance.

4.2.100 Datum

A Datum is a theoretically exact point, straight line, or plane used as a reference for locating and orienting tolerance zones.

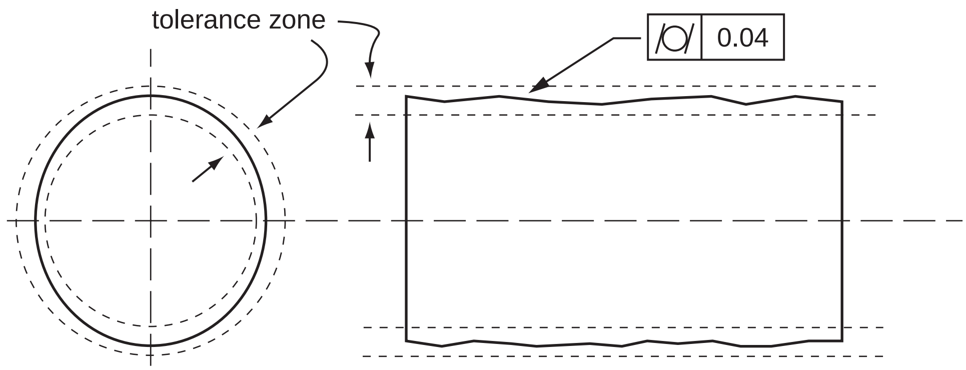

Figure 11 — Cylindricity_tolerance

NOTE The concept of datum for tolerancing is defined in ISO 5459.

4.2.101 Datum_defined_by_derived_shape

A Datum_defined_by_derived_shape is type of both Single_datum (see 4.2.312) and Derived_geometry (see 4.2.107) that is established by a shape element that is derived from an existing aspect of the shape of a part.

NOTE The different types of derived shape elements are described by the Derived_geometry type. The mapping specification in 5.1, represents this type as a complex instance of datum and derived_shape_aspect or a subtype.

4.2.102 Datum_defined_by_feature

A Datum_defined_by_feature is type of Single_datum (see 4.2.312) that is established by an existing aspect of the shape of a part.

The data associated with a Datum_defined_by_feature are the following:

— defined_by.

4.2.102.1 defined_by

The defined_by specifies the shape element that represents the Datum_defined_by_feature. There shall be exactly one shape element that appears as defined_by for a Datum_defined_by_feature.

4.2.103 Datum_defined_by_targets

A Datum_defined_by_targets is type of Single_datum (see 4.2.312) that is established by a set of Datum_target objects used to define a datum reference frame for a part.

NOTE Datums are established from a set of datum targets when the use of an entire feature would introduce excessive variations or lack of repeatability in measurements.

The data associated with a Datum_defined_by_targets are the following:

— defined_by.

— rule_description;

4.2.103.1 defined_by

The defined_by specifies the set of Datum_target objects that form the Datum_defined_by_targets. See 4.3.13 for the application assertion.

4.2.103.2 rule_description

The rule_description specifies the type of datum that is formed by the Datum_defined_by_targets. The rule_description need not be specified for a particular Datum_defined_by_targets.

EXAMPLE The rule_description ‘V-block’ indicates that two Datum_target objects on a cylindrical element are supposed to form the areas of contact in a V-shaped fixture.

4.2.104 Datum_reference

A Datum_reference specifies the usage of a datum within the context of a geometric tolerance.

The data associated with a Datum_reference are the following:

— precedence;

— referenced_datum.

4.2.104.1 precedence

The precedence specifies the position of the referenced_datum in a sequence of Datum objects when used to locate or orient a tolerance zone.

4.2.104.2 referenced_datum

The referenced_datum specifies the Datum to which the Datum_reference applies. See 4.3.14 for the application assertion.

4.2.105 Datum_target

A Datum_target is the identification of a portion of a feature, that is used in the construction of a Datum when it is not desired to use an entire feature nor a substantial region. A Datum_target is a component of a Datum_defined_by_targets.

EXAMPLE A cylindrical part is stabilized for measurement by resting it in a V block, thereby establishing a Datum consisting of two instances of Datum_target, which are straight lines.

The data associated with a Datum_target are the following:

— identifier.

4.2.105.1 identifier

The identifier specifies a unique identification for the Datum_target within a Datum_defined_by_-targets.

4.2.106 Defined_thread

The Defined_thread application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Defined_thread is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY defined_thread
  SUBTYPE OF (thread);
  pitch_diameter:        length_measure;
  minor_diameter:        OPTIONAL length_measure;
  crest:                 OPTIONAL length_measure;
END_ENTITY;
```

4.2.107 Derived_geometry

A Derived_geometry defines a shape element that is derived from an existing aspect of the shape of a part for tolerancing purposes.

The data associated with a Derived_geometry are the following:

— derived_from;

— role.

4.2.107.1 derived_from

The derived_from specifies the set of one or more shape elements from which the geometric element is derived.

4.2.107.2 role

The role specifies the function of the Derived_geometry. Where applicable the following values shall be used:

— apex: the derived geometry is an apex of a cone;

— centre of symmetry: the derived geometry is the center of a symmetrical feature;

— extension: the derived geometry is the spatial extension of a feature;

— geometric alignment: the derived geometry is a geometric alignment of two features;

— geometric intersection: the derived geometry is a geometric intersection of two features;

— parallel offset: the derived geometry is a parallel offset to a feature;

— perpendicular to: the derived geometry is a perpendicular to a feature;

— tangent: the derived geometry is a tangent to a feature.

4.2.108 Descriptive_parameter

The Descriptive_parameter application object is defined by clause 4.4 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Descriptive_parameter is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY descriptive_parameter
  SUBTYPE OF (property_parameter);
  descriptive_string:            text;
END_ENTITY;
```

4.2.109 Diagonal_knurl

The Diagonal_knurl application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Diagonal_knurl is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY diagonal_knurl
  SUBTYPE OF (knurl);
  helix_angle : plane_angle_measure;
END_ENTITY;
```

4.2.110 Diameter_size_dimension

A Diameter_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in the diameter of a circular, cylindrical, or spherical shape element.

NOTE This definition has been harmonized with the Diameter_size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Diameter_dimension_tolerance definition in ISO 10303-224. Figure 12 illustrates a Diameter_size_dimension.

4.2.111 Diameter_taper

The Diameter_taper application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Diameter_taper is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

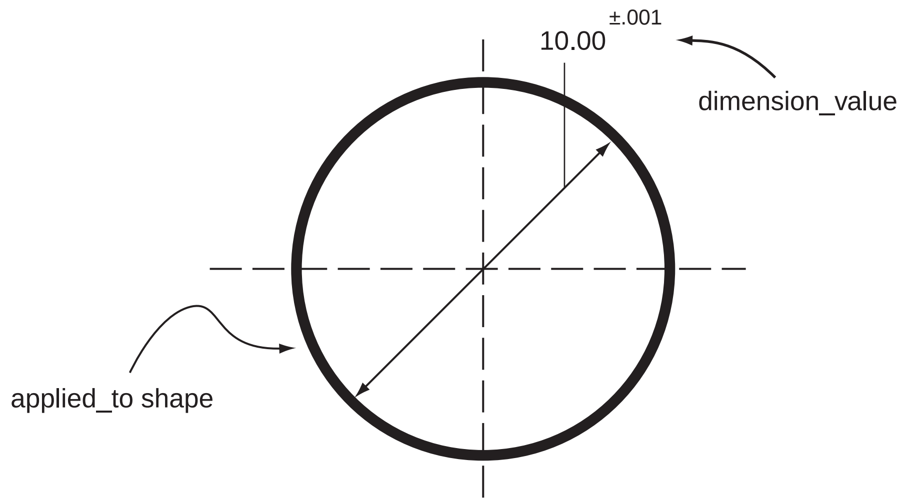

Figure 12 — Diameter_size_dimension

```
ENTITY diameter_taper;
  final_diameter: toleranced_length_measure;
END_ENTITY;
```

4.2.112 Diamond_knurl

The Diamond_knurl application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Diamond_knurl is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY diamond_knurl
  SUBTYPE OF (knurl);
  helix1_angle: plane_angle_measure;
  helix2_angle: OPTIONAL plane_angle_measure;
END_ENTITY;
```

4.2.113 Display_message

The Display_message application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Display_message is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY display_message
  SUBTYPE OF (nc_function);
  its_text:                   text;
END_ENTITY;
```

4.2.114 Dovetail_mill

The Dovetail_mill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Dovetail_mill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY dovetail_mill
  SUBTYPE OF (milling_cutting_tool);
  included_angle: plane_angle_measure;
END_ENTITY;
```

4.2.115 Drilling

The Drilling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Drilling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY drilling
  SUBTYPE OF (drilling_operation);
END_ENTITY;
```

4.2.116 Drilling_cutting_tool

The Drilling_cutting_tool application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Drilling_cutting_tool is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY drilling_cutting_tool
  SUPERTYPE OF (ONEOF(counterbore, countersink, spade_drill, spotdrill,
     step_drill, twist_drill))
  SUBTYPE OF (milling_machine_cutting_tool);
  point_angle: plane_angle_measure;
END_ENTITY;
```

4.2.117 Drilling_operation

The Drilling_operation application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Drilling_operation is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY drilling_operation
  ABSTRACT SUPERTYPE OF (ONEOF(drilling, center_drilling, counter_sinking,
    multistep_drilling))
  SUBTYPE OF (drilling_type_operation);
END_ENTITY;
```

4.2.118 Drilling_type_operation

The Drilling_type_operation application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Drilling_type_operation is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY drilling_type_operation
  ABSTRACT SUPERTYPE OF (ONEOF(drilling_operation, boring_operation, back_boring,
      tapping, thread_drilling))
  SUBTYPE OF (milling_machining_operation);
  cutting_depth:              OPTIONAL length_measure;
  previous_diameter:          OPTIONAL length_measure;
  dwell_time_bottom:          OPTIONAL time_measure;
  feed_on_retract:            OPTIONAL positive_ratio_measure;
  its_machining_strategy:     OPTIONAL drilling_type_strategy;
END_ENTITY;
```

4.2.119 Drilling_type_strategy

The Drilling_type_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Drilling_type_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY drilling_type_strategy;
  reduced_cut_at_start:       OPTIONAL positive_ratio_measure;
  reduced_feed_at_start:      OPTIONAL positive_ratio_measure;
  depth_of_start:             OPTIONAL length_measure;
  reduced_cut_at_end:         OPTIONAL positive_ratio_measure;
  reduced_feed_at_end:        OPTIONAL positive_ratio_measure;
  depth_of_end:               OPTIONAL length_measure;
WHERE
  WR1: EXISTS(depth_of_start) OR
       NOT (EXISTS(reduced_cut_at_start) OR EXISTS(reduced_feed_at_start));
  WR2: EXISTS(depth_of_end) OR
       NOT (EXISTS(reduced_cut_at_end) OR EXISTS(reduced_feed_at_end));
END_ENTITY;
```

4.2.120 Edge_round

The Edge_round application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements. See 5.2.1.3.7 for additional discussion on these information requirements.

NOTE 1 As defined by ISO 14649-10, an Edge_round can only describe a transition between two features. For harmonization with ISO 10303-224 and other ISO 10303 parts, the following properties have been added so an Edge_round may alternately describe a transition between two sets of faces on the boundary representation of the workpiece.

The data associated with an Edge_round are the following:

— all of the data defined by ISO 14649-10;

— edge_round_face;

— first_face_shape;

— second_face_shape.

NOTE 2 The ISO 14649 EXPRESS description for Edge_round, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY edge_round
  SUBTYPE OF (transition_feature);
  radius:               toleranced_length_measure;
  first_offset_amount:  OPTIONAL toleranced_length_measure;
  second_offset_amount: OPTIONAL toleranced_length_measure;
  edge_round_face:      OPTIONAL SET [1:?] OF face; -- ADDED BY 10303-238
  first_face_shape:     OPTIONAL SET [1:?] OF face; -- ADDED BY 10303-238
  second_face_shape:    OPTIONAL SET [1:?] OF face; -- ADDED BY 10303-238
END_ENTITY;
```

4.2.120.1 edge_round_face

The edge_round_face specifies the circular transition surface located between the first_face_shape and the second_face_shape surfaces. This is a set of one or more faces on the boundary representation of the workpiece. The edge_round_face need not be specified for a particular Edge_round.

4.2.120.2 first_face_shape

The first_face_shape specifies one of two surfaces the Edge_round feature will transition between. This is a set of one or more faces on the boundary representation of the workpiece. The first_face_-shape need not be specified for a particular Edge_round.

4.2.120.3 second_face_shape

The second_face_shape specifies the other surface the Edge_round feature will transition between. This is a set of one or more faces on the boundary representation of the workpiece. The second_face_-shape need not be specified for a particular Edge_round.

4.2.121 Endmill

The Endmill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Endmill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY endmill
  SUPERTYPE OF (ONEOF(ballnose_endmill, bullnose_endmill, profiled_end_mill))
  SUBTYPE OF (milling_cutting_tool);
  tool_cutting_edge_angle: plane_angle_measure;
END_ENTITY;
```

4.2.122 Exchange_pallet

The Exchange_pallet application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Exchange_pallet is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY exchange_pallet
  SUBTYPE OF (nc_function);
END_ENTITY;
```

4.2.123 Executable

The Executable application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Executable is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY executable
  ABSTRACT SUPERTYPE OF (ONEOF( workingstep, nc_function, program_structure));
  its_id: identifier;
END_ENTITY;
```

4.2.124 Explicit_strategy

The Explicit_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Explicit_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY explicit_strategy
  SUBTYPE OF (two5D_milling_strategy);
END_ENTITY;
```

4.2.125 Explicit_turning_strategy

The Explicit_turning_strategy application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Explicit_turning_strategy is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY explicit_turning_strategy
  SUBTYPE OF (turning_machining_strategy);
END_ENTITY;
```

4.2.126 Extended_NC_function

An Extended_NC_function is a type of NC_function which specifies a manufacturing or handling operation which does not involve the interpolation of axes and for which no other more specific type of NC_function exists. This shall not be used if equivalent machine behavior can be achieved using other capabilities of this part of ISO 10303.

The data associated with an Extended_NC_function are the following:

— description.

4.2.126.1 description

The description specifies a string value which identifies the function.

4.2.127 Externally_defined_representation

An Externally_defined_representation is used to identify a piece of product data whose definition is provided within an external specification or document.

NOTE This definition has been harmonized with the Externally_defined_representation definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Externally_defined_representation are the following:

— identified_by;

— location;

— placement.

4.2.127.1 identified_by

The identified_by specifies the Library_part_assignment object which describes the part being referenced, that is contained in an external library. See 4.3.15 for the application assertion.

4.2.127.2 location

The location specifies the orientation of the external product data within the geometric domain of the product data of this part of ISO 10303. A location need not be specified for a particular Externally_defined_representation.

4.2.127.3 placement

The placement specifies the positioning of the external product data within the geometric domain of the product data of this part of ISO 10303. A placement need not be specified for a particular Externally_defined_representation.

4.2.128 Externally_defined_size_dimension

An Externally_defined_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in a size dimension whose definition is provided by an external specification.

NOTE This definition has been harmonized with the Externally_defined_size_dimension definitions in ISO 10303-1050, ISO 10303-214, and ISO 10303-224.

The data associated with an Externally_defined_size_dimension are the following:

— defining_document;

— name;

— used_path.

4.2.128.1 defining_document

The defining_document specifies a document that contains information about the type of dimension.

4.2.128.2 name

The name specifies the label by which the Externally_defined_size_dimension is known.

4.2.128.3 used_path

The used_path specifies a Measurement_path along which the Externally_defined_size_dimension is measured. The used_path need not be specified for a particular Externally_defined_size_dimension. See 4.3.16 for the application assertion.

4.2.129 Facemill

The Facemill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Facemill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY facemill
  SUBTYPE OF (milling_cutting_tool);
  tool_cutting_edge_angle: plane_angle_measure;
END_ENTITY;
```

4.2.130 Facing

The Facing application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Facing is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY facing
  ABSTRACT SUPERTYPE OF (ONEOF(facing_rough, facing_finish))
  SUBTYPE OF (turning_machining_operation);
  allowance: OPTIONAL length_measure;
END_ENTITY;
```


4.2.131 Facing_finish

The Facing_finish application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Facing_finish is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY facing_finish
  SUBTYPE OF (facing);
END_ENTITY;
```

4.2.132 Facing_rough

The Facing_rough application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Facing_rough is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY facing_rough
  SUBTYPE OF (facing);
WHERE
  WR1: EXISTS(SELF.allowance) AND (SELF.allowance >= 0.0);
END_ENTITY;
```

4.2.133 Feedstop

The Feedstop application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Feedstop is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY feedstop
  SUBTYPE OF (toolpath);
  dwell:                      time_measure;
END_ENTITY;
```

4.2.134 Five_axes_const_tilt_yaw

The Five_axes_const_tilt_yaw application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Five_axes_const_tilt_yaw is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY five_axes_const_tilt_yaw
  SUBTYPE OF (tool_direction_for_milling);
  tilt_angle : plane_angle_measure;
  yaw_angle  : plane_angle_measure;
END_ENTITY;
```


4.2.135 Five_axes_var_tilt_yaw

The Five_axes_var_tilt_yaw application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Five_axes_var_tilt_yaw is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY five_axes_var_tilt_yaw
  SUBTYPE OF (tool_direction_for_milling);
END_ENTITY;
```

4.2.136 Flat_hole_bottom

The Flat_hole_bottom application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Flat_hole_bottom is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY flat_hole_bottom
  SUBTYPE OF (blind_bottom_condition);
END_ENTITY;
```

4.2.137 Flat_slot_end_type

The Flat_slot_end_type application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Flat_slot_end_type is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY flat_slot_end_type
  SUBTYPE OF (slot_end_type);
  corner_radius1:           toleranced_length_measure;
  corner_radius2:           toleranced_length_measure;
END_ENTITY;
```

4.2.138 Flat_with_radius_hole_bottom

The Flat_with_radius_hole_bottom application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Flat_with_radius_hole_bottom is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY flat_with_radius_hole_bottom
  SUBTYPE OF (blind_bottom_condition);
  corner_radius: toleranced_length_measure;
END_ENTITY;
```


4.2.139 Flatness_tolerance

A Flatness_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a constraint on the amount a surface is allowed to deviate from being flat. All points of the actual surface shall lie between two parallel planes that are a distance apart equal to the specified tolerance.

NOTE This definition has been harmonized with the Flatness_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. The definition is derived from paragraph 14.2 of ISO 1101. Figure 13 illustrates a Flatness_tolerance.

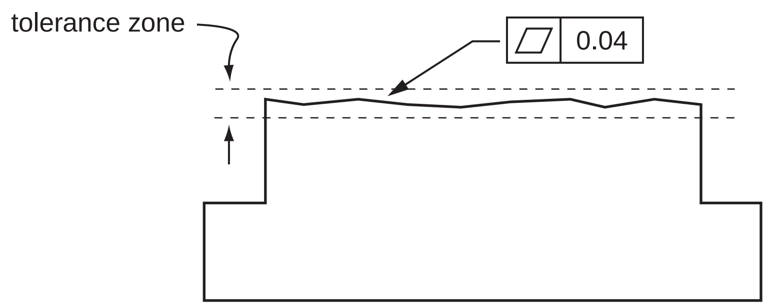

Figure 13 — Flatness_tolerance

4.2.140 Freeform_finish_milling

A Freeform_finish_milling is a type of Freeform_operation that specifies a finishing operation.

NOTE When specifying a freeform milling operation, particularly with an associated toolpath, the Freeform_rough_milling and Freeform_finish_milling subtypes can be used to indicate whether the operation is used for roughing or finishing. Some CNC controls can provide important efficiency gains when provided with this information.

4.2.141 Freeform_operation

The Freeform_operation application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Freeform_operation is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY freeform_operation
  SUBTYPE OF (milling_type_operation);
  its_machining_strategy: OPTIONAL freeform_strategy;
END_ENTITY;
```

4.2.142 Freeform_rough_milling

A Freeform_rough_milling is a type of Freeform_operation that specifies a roughing operation.

4.2.143 Freeform_strategy

The Freeform_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Freeform_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY freeform_strategy
  ABSTRACT SUPERTYPE OF (ONEOF(uv_strategy, plane_cc_strategy, plane_cl_strategy,
     leading_line_strategy));
  pathmode:               pathmode_type;
  cutmode:                cutmode_type;
  its_milling_tolerances: tolerances;
  stepover:               OPTIONAL length_measure;
END_ENTITY;

TYPE pathmode_type = ENUMERATION OF (forward, zigzag);
END_TYPE;

TYPE cutmode_type = ENUMERATION OF (climb, conventional);
END_TYPE;
```

4.2.144 General_closed_profile

The General_closed_profile application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a General_closed_profile are the following:

— all of the data defined by ISO 14649-10, as modified below for the closed_profile_shape attribute.

NOTE The ISO 14649 EXPRESS description for General_closed_profile, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY general_closed_profile
  SUBTYPE OF(closed_profile);
  closed_profile_shape:  path_shape_item; -- RELAXED BY 10303-238
END_ENTITY;

TYPE path_shape_item = SELECT (bounded_curve, edge_curve, path);
END_TYPE;
```

4.2.144.1 closed_profile_shape

The closed_profile_shape parameter is defined by ISO 14649-10 to be of type bounded_curve, but this part of ISO 10303 relaxes this requirement so that closed_profile_shape may also be of type edge_-curve or path.

NOTE This relaxation harmonizes the General_closed_profile definition in ISO 14649-10 with the definitions in ISO 10303-224 and other ISO 10303 parts that permit the use of bounded_curve, edge_curve, or path to describe profile shape. These additional types allow profiles to be described using edge and path elements which may already be present in the advanced brep shape of a workpiece.

4.2.145 General_outside_profile

The General_outside_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for General_outside_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY general_outside_profile
  SUBTYPE OF (profile_feature);
  feature_boundary:       profile;
END_ENTITY;
```

4.2.146 General_path

The General_path application object defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a General_path are the following:

— all of the data defined by ISO 14649-10, as modified below for the swept_path attribute.

NOTE The ISO 14649 EXPRESS description for General_path, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY general_path
  SUBTYPE OF(travel_path);
  (* see general_closed_profile for description of path_shape_item *)
  swept_path:            path_shape_item; -- RELAXED BY 10303-238
END_ENTITY;
```

4.2.146.1 swept_path

The swept_path parameter is defined by ISO 14649-10 to be of type bounded_curve, but this part of ISO 10303 relaxes this requirement so that swept_path may also be of type edge_curve or path.

NOTE This relaxation harmonizes the General_path definition in ISO 14649-10 with the definitions in ISO 10303-224 and other ISO 10303 parts that permit the use of bounded_curve, edge_curve, or path to describe travel path shape. These additional types allow travel paths to be described using edge and path elements which may already be present in the advanced brep shape of a workpiece.

4.2.147 General_pattern

The General_pattern application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for General_pattern is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY general_pattern
  SUBTYPE OF(replicate_feature);
  replicate_locations:  LIST [2:?] OF axis2_placement_3d;
```



```
END_ENTITY;
```

4.2.148 General_pocket_bottom_condition

The General_pocket_bottom_condition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for General_pocket_bottom_condition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY general_pocket_bottom_condition
  SUBTYPE OF (pocket_bottom_condition);
  shape:                      region;
WHERE
  WR1: SIZEOF(shape\manufacturing_feature.its_operations) = 0;
END_ENTITY;
```

4.2.149 General_profile

The General_profile application object defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a General_profile are the following:

— all of the data defined by ISO 14649-10, as modified below for the its_profile attribute.

NOTE The ISO 14649 EXPRESS description for General_profile, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY general_profile
  SUBTYPE OF (open_profile);
  (* see general_closed_profile for description of path_shape_item *)
  its_profile:          path_shape_item; -- RELAXED BY 10303-238
END_ENTITY;
```

4.2.149.1 its_profile

The its_profile parameter is defined by ISO 14649-10 to be of type bounded_curve, but this part of ISO 10303 relaxes this requirement so that its_profile may also be of type edge_curve or path.

NOTE This relaxation harmonizes the General_profile definition in ISO 14649-10 with the definitions in ISO 10303-224 and other ISO 10303 parts that permit the use of bounded_curve, edge_curve, or path to describe profile shape. These additional types allow profiles to be described using edge and path elements which may already be present in the advanced brep shape of a workpiece.

4.2.150 General_profile_floor

The General_profile_floor application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for General_profile_floor is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.


```
ENTITY general_profile_floor
  SUBTYPE OF (profile_floor);
  floor :           face;
END_ENTITY;
```

4.2.151 General_property

A General_property is a characteristic associated with the physical structure or integrity of an element of a part. Each General_property is either a Material_property (see 4.2.201), a Part_property (see 4.2.232), a Process_property (see 4.2.261), or a Surface_property (see 4.2.330).

NOTE This definition is based on the Property definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a General_property are the following:

— description;

— owner;

— specifications;

— related_properties.

4.2.151.1 description

The description specifies a word or group of words by which a property is commonly referred.

4.2.151.2 owner

The owner specifies the Workpiece object or shape element to which the General_property applies. See 4.3.19 for the application assertion.

4.2.151.3 specifications

The specifications specifies the set of Specification objects that have additional information about the General_property. The specifications need not be specified for a particular General_property. See 4.3.18 for the application assertion.

4.2.151.4 related_properties

The related_properties specifies the set of General_property objects that are associated with a General_property. The related_properties need not be specified for a particular General_property. See 4.3.17 for the application assertion.

4.2.152 General_revolution

The General_revolution application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for General_revolution is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY general_revolution
  SUBTYPE OF (revolved_feature);
  outer_edge_profile : general_profile;
END_ENTITY;
```

4.2.153 General_shape_profile

The General_shape_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for General_shape_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY general_shape_profile
  SUBTYPE OF (shape_profile);
  profile_boundary :     profile;
END_ENTITY;
```

4.2.154 General_turning_tool

The General_turning_tool application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for General_turning_tool is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
ENTITY general_turning_tool
  SUBTYPE OF (turning_machine_cutting_tool);
END_ENTITY;
```

4.2.155 Geometric_dimension

A Geometric_dimension is the specification of size of an element of a shape, or a displacement of one shape element relative to another shape element.

NOTE This definition has been harmonized with the Geometric_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Dimensional_tolerance definition in ISO 10303-224.

The data associated with a Geometric_dimension are the following:

— dimension_value;

— id;

— notes.

4.2.155.1 dimension_value

The dimension_value specifies a Value_with_tolerance or Value_range which describes the size of the element or of the distance between the two elements, as well as the total amount by which that value is permitted to vary. See 4.3.20 and 4.3.21 for the application assertion.

4.2.155.2 id

The id specifies the string identifier of the Geometric_dimension.

4.2.155.3 notes

The notes specifies a set of one or more string values that provide additional information about the Geometric_dimension. The notes field need not be specified for a particular Geometric_dimension. Where applicable the following values shall be used:

— auxiliary: the dimension is for information purposes only. The dimension_value shall be a single numerical value without limitation;

— theoretical: the dimension is theoretically exact. The dimension_value shall be a single numerical value without limitation;

Any other string value shall indicate a qualifying note.

4.2.156 Geometric_tolerance

A Geometric_tolerance is a specification of the allowable deviation of shape characteristics as defined in ISO 1101.

NOTE This definition has been harmonized with the Geometric_tolerance definitions in ISO 10303-1050, ISO 10303-214, and ISO 10303-224.

The data associated with a Geometric_tolerance are the following:

— applied_to;

— modification;

— name;

— qualifying_note;

— segment_size;

— significant_digits;

— tolerance_value.

4.2.156.1 applied_to

The applied_to specifies the shape element to which the Geometric_tolerance applies.

4.2.156.2 modification

The modification specifies the Tolerance_condition that is associated with the Geometric_tolerance. The modification need not be specified for a particular Geometric_tolerance. See 4.3.22 for the application assertion.

4.2.156.3 name

The name specifies the word or group of words by which the Geometric_tolerance is referred to. The name need not be specified for a particular Geometric_tolerance.

4.2.156.4 qualifying_note

The qualifying_note specifies text that provides additional information about the Geometric_tolerance. The qualifying_note need not be specified for a particular Geometric_tolerance.

EXAMPLE ‘not concave’ and ‘boundary’ are examples of a qualifying note.

4.2.156.5 segment_size

The segment_size specifies a length of a segment that constrains how the tolerance applies. All along any segment of this size, taken on the toleranced element, the toleranced element shall conform to the tolerance. The segment_size need not be specified for a particular Geometric_tolerance.

4.2.156.6 significant_digits

The significant_digits specify the number of decimal digits indicating the accuracy of the tolerance value. The significant_digits need not be specified for a particular Geometric_tolerance.

4.2.156.7 tolerance_value

The tolerance_value specifies the value of the width of the tolerance zone. The meaning of this value will depend on the standard used for the interpretation of the geometric tolerance.

4.2.157 Geometric_tolerance_relationship

A Geometric_tolerance_relationship specifies a relationship between two instances of Geometric_tolerance.

NOTE This definition has been harmonized with the Geometric_tolerance_relationship definitions in ISO 10303-1050 and ISO 10303-214, as well as the Geometric_tolerance_precedence_relationship definition in ISO 10303-224.

The data associated with a Geometric_tolerance_relationship are the following:

— relating;

— related;

— relation_type.

4.2.157.1 relating

The relating specifies one of the instances of Geometric_tolerance that is a part of the relationship. See 4.3.23 for the application assertion.

NOTE The semantics of this attribute are defined by the attribute relation_type.

4.2.157.2 related

The related specifies one of the instances of Geometric_tolerance that is a part of the relationship. See 4.3.24 for the application assertion.

NOTE The semantics of this attribute are defined by the attribute relation_type.

4.2.157.3 relation_type

The relation_type specifies the meaning of the relationship. Where applicable, the following values shall be used:

— precedence: the relating Geometric_tolerance is of higher priority than the related;

— simultaneity: the relating and the related Geometric_tolerance shall be met simultaneously, that is, in the same actual datum reference frame.

4.2.158 Groove

The Groove application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Groove is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY groove
  SUBTYPE OF (revolved_feature);
  sweep : open_profile;
END_ENTITY;
```

4.2.159 Grooving

The Grooving application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Grooving is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY grooving
  ABSTRACT SUPERTYPE OF (ONEOF(grooving_rough, grooving_finish, cutting_in))
  SUBTYPE OF (turning_machining_operation);
  dwell:     OPTIONAL dwell_select;
  allowance: OPTIONAL length_measure;
END_ENTITY;
```

4.2.160 Grooving_finish

The Grooving_finish application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Grooving_finish is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY grooving_finish
  SUBTYPE OF (grooving);
END_ENTITY;
```

4.2.161 Grooving_rough

The Grooving_rough application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Grooving_rough is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY grooving_rough
  SUBTYPE OF (grooving);
WHERE
  WR1: EXISTS(SELF.allowance) AND (SELF.allowance >= 0.0);
END_ENTITY;
```

4.2.162 Grooving_strategy

The Grooving_strategy application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Grooving_strategy is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY grooving_strategy
  SUPERTYPE OF (multistep_grooving_strategy)
  SUBTYPE OF (turning_machining_strategy);
  grooving_direction:  OPTIONAL direction;
  travel_distance:     OPTIONAL length_measure;
END_ENTITY;
```

4.2.163 Grooving_tool

The Grooving_tool application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Grooving_tool is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
ENTITY grooving_tool
  SUBTYPE OF (turning_machine_cutting_tool);
  cutting_width:                     length_measure;
  maximum_grooving_depth:            length_measure;
  corner_radius:                     OPTIONAL length_measure;
  maximum_axial_grooving_diameter: OPTIONAL length_measure;
  minimum_axial_grooving_diameter: OPTIONAL length_measure;
END_ENTITY;
```

4.2.164 Hardness

A Hardness is the resistance of a material to deformation by external forces.

NOTE This definition has been harmonized with the Hardness definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Hardness are the following:

— high_value;

— low_value;

— nominal;

— scale.

4.2.164.1 high_value

The high_value specifies the highest allowed value of hardness for a specific material type. The high_value need not be specified for a particular Hardness.

4.2.164.2 low_value

The low_value specifies the lowest allowed value of hardness for a specific material type. The low_value need not be specified for a particular Hardness.

4.2.164.3 nominal

The nominal specifies the nominal value of hardness for a specific material type.

4.2.164.4 scale

The scale specifies the method for measuring hardness values. Where applicable, the following values shall be used:

— brinell: The Hardness is measured according to the Brinell method;

— rockwell: The Hardness is measured according to the Rockwell method;

— vickers: The Hardness is measured according to the Vickers method.

4.2.165 Height_size_dimension

A Height_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in the height of an element of the product shape.

NOTE This definition has been harmonized with the Height_size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Height_dimension definition in ISO 10303-224.

The data associated with a Height_size_dimension are the following:

— used_path.

4.2.165.1 used_path

The used_path specifies a Measurement_path along which the Height_size_dimension is measured. The used_path need not be specified for a particular Height_size_dimension. See 4.3.25 for the application assertion.

4.2.166 Hole_bottom_condition

The Hole_bottom_condition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Hole_bottom_condition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY hole_bottom_condition
  ABSTRACT SUPERTYPE OF (ONEOF (blind_bottom_condition, through_bottom_condition));
END_ENTITY;
```

4.2.167 If_statement

The If_statement application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for If_statement is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY if_statement
  SUBTYPE OF (program_structure);
  condition:                boolean_expression;
  true_branch:              executable;
  false_branch:             OPTIONAL executable;
END_ENTITY;
```


4.2.168 In_process_geometry

The In_process_geometry application object is defined by clause 4.4 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

NOTE 1 This modifications below allow the use of shape representation types supported by other APs. In particular, the integrated representation allows the use of shapes described by AIC 501 (edge-based wireframe), AIC 502 (shell-based wireframe), AIC 507 (geometrically-bounded surfaces), AIC 508 (non-manifold surfaces), AIC 509 (manifold surfaces), AIC 510 (geometrically-bounded wireframe), and AIC 512 (faceted brep), as well as the original AIC 514 (advanced brep) descriptions.

The data associated with a In_process_geometry are the following:

— all of the data defined by ISO 14649-10, as modified below for the as_is, to_be and removal attributes;

NOTE 2 The ISO 14649 EXPRESS description for In_process_geometry, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY in_process_geometry;
  as_is:   OPTIONAL shape_representation;   -- RELAXED BY 10303-238
  to_be:   OPTIONAL shape_representation;   -- RELAXED BY 10303-238
  removal: OPTIONAL shape_representation;   -- RELAXED BY 10303-238
WHERE
  WR1: EXISTS (as_is) OR EXISTS (to_be) OR EXISTS (removal);
END_ENTITY;
```

4.2.168.1 as_is

The as_is parameter is defined by ISO 14649-10 to be of type advanced_brep_shape_representation, but this part of ISO 10303 relaxes this requirement so that as_is shall be of the more general type shape_representation.

4.2.168.2 removal

The removal parameter is defined by ISO 14649-10 to be of type advanced_brep_shape_representation, but this part of ISO 10303 relaxes this requirement so that removal shall be of the more general type shape_representation.

4.2.168.3 to_be

The to_be parameter is defined by ISO 14649-10 to be of type advanced_brep_shape_representation, but this part of ISO 10303 relaxes this requirement so that to_be shall be of the more general type shape_representation.

4.2.169 Index_pallet

The Index_pallet application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Index_pallet is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY index_pallet
  SUBTYPE OF (nc_function);
  its_index:             INTEGER;
END_ENTITY;
```

4.2.170 Index_table

The Index_table application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Index_table is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY index_table
  SUBTYPE OF (nc_function);
  its_index:             INTEGER;
END_ENTITY;
```

4.2.171 Knurl

The Knurl application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Knurl is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY knurl
  ABSTRACT SUPERTYPE OF (ONEOF(straight_knurl, diagonal_knurl,
       diamond_knurl, tool_knurl))
  SUBTYPE OF (turning_feature);
  base_feature:         turning_feature;
  partial_profile:      OPTIONAL partial_area_definition;
  tooth_depth:          OPTIONAL toleranced_length_measure;
  diametral_pitch:      OPTIONAL toleranced_length_measure;
  root_fillet:          OPTIONAL toleranced_length_measure;
  number_of_teeth:      OPTIONAL INTEGER;
  major_diameter:       OPTIONAL toleranced_length_measure;
  nominal_diameter:     OPTIONAL toleranced_length_measure;
END_ENTITY;
```

4.2.172 Knurling

The Knurling application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Knurling is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY knurling
  SUBTYPE OF (turning_machining_operation);
END_ENTITY;
```


4.2.173 Knurling_tool

The Knurling_tool application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Knurling_tool is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
ENTITY knurling_tool
  SUBTYPE OF (turning_machine_cutting_tool);
  knurl_pattern:  knurl_pattern_type;
  cutting_length: OPTIONAL length_measure;
  angle:          OPTIONAL plane_angle_measure;
  pitch:          OPTIONAL length_measure;
END_ENTITY;

TYPE knurl_pattern_type = ENUMERATION OF (straight, diagonal, diamond);
END_TYPE;
```

4.2.174 Last_modified_timestamp

A Last_modified_timestamp is an association between one or more projects, workpieces, executables, operations, or toolpaths and the point in time of their most recent modification or creation.

The data associated with a Last_modified_timestamp are the following:

— date_and_time_value;

— items.

4.2.174.1 date_and_time_value

The date_and_time_value specifies the point in time when the items were most recently modified or created.

4.2.174.2 items

The items specifies the set of projects, workpieces, executables, operations, or toolpaths to which the date_and_time_value applies. The items set shall contain at least one object. See 4.3.26, 4.3.27, 4.3.28, 4.3.29, and 4.3.30 for the application assertions.

4.2.175 Leading_line_strategy

The Leading_line_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Leading_line_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY leading_line_strategy
  SUBTYPE OF (freeform_strategy);
  its_line : bounded_curve;
```



```
END_ENTITY;
```

4.2.176 Length_measure

A Length_measure is a type of Value_with_unit (see 4.2.404) in which the value_component describes a length.

NOTE As defined in ISO 14649-10, Length_measure does not explicitly specify a unit. Instead, a default unit of millimeters is defined for all lengths. This part of ISO 10303 extends Length_measure to explicitly specify units using the “unit” attribute inherited from Value_with_unit.

4.2.177 Length_size_dimension

A Length_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in the length of an element of the product shape.

NOTE This definition has been harmonized with the Length_size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Length_dimension definition in ISO 10303-224.

The data associated with a Length_size_dimension are the following:

— used_path.

4.2.177.1 used_path

The used_path specifies a Measurement_path along which the Length_size_dimension is measured. The used_path need not be specified for a particular Length_size_dimension. See 4.3.31 for the application assertion.

4.2.178 Library_part_assignment

A Library_part_assignment is the means to reference information about a class within a parts library dictionary.

NOTE This definition has been harmonized with the Library_part_assignment definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Library_part_assignment are the following:

— definitional_class_bsu;

— definitional_property_value_pairs.

4.2.178.1 definitional_class_bsu

The definitional_class_bsu specifies the Class_BSU object which identifies the component within a parts library as defined by ISO 13584. See 4.3.32 for the application assertion.

4.2.178.2 definitional_property_value_pairs

The definitional_property_value_pairs specifies the set of Library_property_value objects which specify the property basic semantical units and values defining the properties of the class. The definitional_property_value_pairs need not be specified for a particular Library_part_assignment. See 4.3.33 for the application assertion.

4.2.179 Library_property_value

A Library_property_value is a value for a property as specified in the property basic semantical unit.

NOTE This definition has been harmonized with the Property_value definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Library_property_value are the following:

— value_property_bsu;

— value_amount.

4.2.179.1 value_property_bsu

The value_property_bsu specifies the Property_BSU object that defines the basic semantical unit. See 4.3.34 for the application assertion.

4.2.179.2 value_amount

The value_amount specifies the value that is defined as a boolean, integer, number, logical, string, or real.

4.2.180 Limit_qualifier

A Limit_qualifier specifies a limiting characteristic that is associated with a Value_with_tolerance.

NOTE When used with a Value_with_tolerance, this is equivalent to the Value_limit application object in ISO 10303-1106 and ISO 10303-214, as well as the Tolerance_limit application object in ISO 10303-224.

4.2.180.1 qualifier

The qualifier identifies a limiting characteristic. One of the following values shall be used:

— maximum: the physical quantity may assume any vaue less than or equal to the value specified by the value_component of the referencing Value_with_tolerance;

— minimum: the the physical quantity may assume any vaue greater than or equal to the value specified by the value_component of the referencing Value_with_tolerance;

4.2.181 Limits_and_fits

A Limits_and_fits is a tolerance specified by reference to the limits-and-fits system standardized by ISO 286. Limits and fits is a system for assigning tolerances associated with the assembly of mating product features.

NOTE This definition has been harmonized with the Limits_and_fits definitions in ISO 14649-10, ISO 10303-1050, ISO 10303-214, and ISO 10303-224. Limits and fits assigns a tolerance to a feature of size by classification rather than by giving an explicit value. A tolerance classification is composed of a fundamental deviation or "position letter" and a tolerance grade. These are used to calculate the size of the tolerance zone and its location relative to the basic or nominal size of the feature according to the tables and formulas found in ISO 286.

The data associated with a Limits_and_fits are the following:

— deviation;

— grade;

— its_fitting_type.

4.2.181.1 deviation

The deviation specifies the fundamental deviation or “position letter” of the ISO 286-1 limits-and-fits tolerance classification.

NOTE The characters ‘A’ to ‘ZC’ for holes or ‘a’ to ‘zc’ for shafts may be used for deviation.

4.2.181.2 grade

The grade specifies the quality or the accuracy grade of a tolerance.

NOTE The grade is one of the 18 international standard tolerance grades defined in ISO 286-1, such as ‘IT07’.

4.2.181.3 its_fitting_type

The its_fitting_type specifies the kind of fitting to which the tolerance applies. The its_fitting_type need not be specified for a particular Limits_and_fits. Normally the tolerance applies to an external or internal feature of the workpiece. Where applicable, the following values shall be used:

— hole: the tolerance applies to an internal feature of the workpiece;

— shaft: the tolerance applies to an external feature of the workpiece.

NOTE Whether the tolerance applies to an interior or exterior feature can be determined from the position letter of the fundamental deviation, therefore fitting_type need not be specified.

4.2.182 Line_profile_tolerance

A Line_profile_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a uniform boundary along the true profile within which the elements of the surface must lie. The tolerance zone established by a Line_profile_tolerance is two dimensional.

NOTE This definition has been harmonized with the Line_profile_tolerance definitions in ISO 10303-1051 and ISO 10303-214, and the Linear_profile_tolerance definition in ISO 10303-224. This definition is derived from paragraph 14.5 of ISO 1101. Figure 14 illustrates a Line_profile_tolerance.

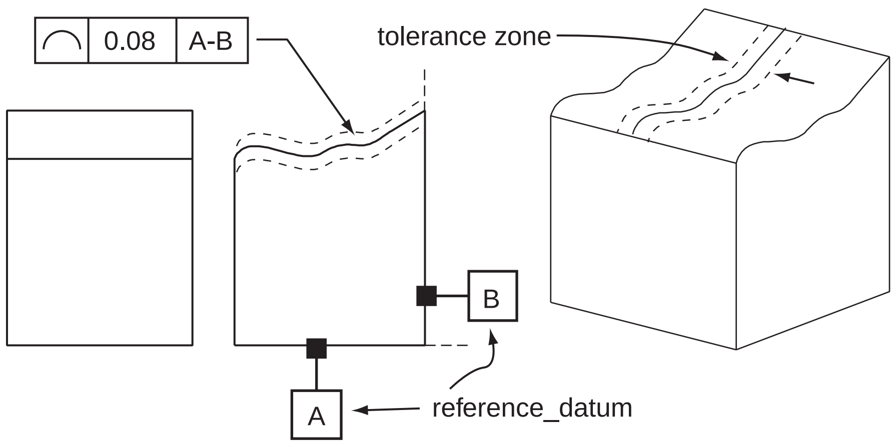

Figure 14 — Line_profile_tolerance

The data associated with a Line_profile_tolerance are the following:

— affected_plane;

— reference_datum.

4.2.182.1 affected_plane

The affected_plane specifies an axis placement, the X-Y plane of which establishes the plane in which the tolerance applies. The affected_plane need not be specified for a particular Line_profile_tolerance.

4.2.182.2 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.35 for the application assertion.

4.2.183 Linear_distance_dimension

A Linear_distance_dimension is a type of Location_dimension (see 4.2.187) that defines the allowable variation in the distance along a straight line between two elements of the shape of a part.

NOTE This definition has been harmonized with the Linear_distance_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Location_dimension_tolerance definition in ISO 10303-224. Figure 15 illustrates a Linear_distance_dimension.

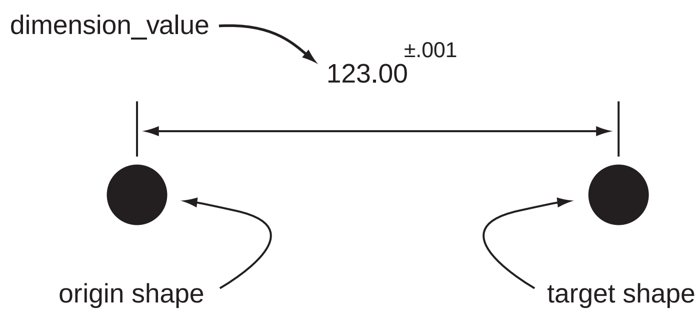

Figure 15 — Linear_distance_dimension

The data associated with a Linear_distance_dimension are the following:

— orientation.

4.2.183.1 orientation

The orientation specifies an axis placement giving a point and a direction along which the Linear_distance_dimension is measured. The direction is given by the X axis of the axis placement. The orientation need not be specified for a particular Linear_distance_dimension.

4.2.184 Linear_path

The Linear_path application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Linear_path is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY linear_path
  SUBTYPE OF(travel_path);
  distance:             toleranced_length_measure;
  its_direction:        direction;
END_ENTITY;
```

4.2.185 Linear_profile

The Linear_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Linear_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY linear_profile
  SUBTYPE OF (open_profile);
  profile_length:       numeric_parameter;
```



```
END_ENTITY;
```

4.2.186 Load_tool

The Load_tool application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Load_tool is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY load_tool
  SUBTYPE OF (nc_function);
  its_tool:             machining_tool;
END_ENTITY;
```

4.2.187 Location_dimension

A Location_dimension is a type of Geometric_dimension (see 4.2.155) that specifies the distance or angle that an origin shape element is displaced from a termination shape element.

NOTE This definition has been harmonized with the Location_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Location_tolerance definition in ISO 10303-224.

The data associated with a Location_dimension are the following:

— description;

— directed;

— origin;

— target.

4.2.187.1 description

The description specifies text that provides further information about the Location_dimension. The description need not be specified for a particular Location_dimension.

4.2.187.2 directed

The directed specifies whether or not the direction is important for measuring a Location_dimension. If the value is 'true' the Location_dimension is measured from origin to target. A value of 'false' indicates that the direction for measuring the Location_dimension is inconsequential. The directed need not be specified for a particular Location_dimension.

4.2.187.3 origin

The origin specifies the shape element that defines the starting position for the Location_dimension.

4.2.187.4 target

The target specifies the shape element that defines the ending position for the Location_dimension.

4.2.188 Loop_slot_end_type

The Loop_slot_end_type application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Loop_slot_end_type is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY loop_slot_end_type
  SUBTYPE OF (slot_end_type);
END_ENTITY;
```

4.2.189 Machine_axis_constraint

A Machine_axis_constraint identifies the range of motion that a machine axis may traverse.

NOTE This information is machine dependent and should not be used. In order to execute an operation or toolpath, an NC controller must convert curves in space into specific axis motions. In some machine geometries, there may not be a unique solution. The machine_axis_constraint mechanism allows additional guidance to be provided to the controller by restricting the motion of one or more axes to be considered as part of the solution.

EXAMPLE When a rotary C table is mounted on a rotary B table, there may be two combinations of C and B angles that give the same tool axis direction. Also, when drilling on a machine with redundant (not necessarily parallel) linear axes, such as a machine with a movable quill (W axis), either the W or other axes could be used to advance the drill.

The data associated with a Machine_axis_constraint are the following:

— axis_identifier;

— axis_range.

4.2.189.1 axis_identifier

The axis_identifier is a string value describing the name of the axis.

EXAMPLE The strings “x”, “y”, “z”, “a”, and “b” are common axis names.

4.2.189.2 axis_range

The axis_range specifies exactly one Value_range containing upper and lower measure values permitted for that axis.

4.2.190 Machine_axis_travel

A Machine_axis_travel identifies the distance that a machine axis may traverse.

The data associated with a Machine_axis_travel are the following:

— axis_identifier;

— travel_distance.

4.2.190.1 axis_identifier

The axis_identifier is a string value describing the name of the axis.

EXAMPLE The strings “x”, “y”, “z”, “a”, and “b” are common axis names.

4.2.190.2 travel_distance

The travel_distance specifies a measure value that describes the distance that the identified axis can traverse.

NOTE A length measure value can be used to describe the traversal of linear axes, while a plane angle measure value can be used to describe the traversal of tilt tables and other angular axes.

4.2.191 Machine_functions

The Machine_functions application object is defined by clause 4.7 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Machine_functions is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY machine_functions
  ABSTRACT SUPERTYPE;
END_ENTITY;
```

4.2.192 Machine_parameters

A Machine_parameters identifies the characteristics of a machine tool.

The data associated with a Machine_parameters are the following:

— axis travel;

— feedrate;

— number_of_control_axis;

— number_of_simultaneous_axis;

— positioning_accuracy;

— spindle_power;

— spindle_speed;

— table_indexing;

— table_length;

— table_width;

— work_volume_height;

— work_volume_length;

— work_volume_width.

4.2.192.1 axis_travel

The axis_travel specifies zero or more Machine_axis_travel objects which describe the distance that the machine tool can move its cutting tool along specified axes. The axis_travel need not be specified for a particular Machine_parameters and the axis_travel shall not be specified if work_volume_length, work_volume_width, or work_volume_height is specified. See 4.3.36 for the application assertion.

4.2.192.2 feedrate

The feedrate specifies the linear velocity at which a machine tool can move its cutting tool. The feedrate need not be specified for a particular Machine_parameters.

4.2.192.3 number_of_control_axis

The number_of_control_axis specifies number of machine tool axes that can be controlled by a numerical controller. The number_of_control_axis need not be specified for a particular Machine_parameters.

4.2.192.4 number_of_simultaneous_axis

The number_of_simultaneous_axis specifies number of machine tool axes that can be controlled simultaneously by a numerical controller. The number_of_simultaneous_axis need not be specified for a particular Machine_parameters.

4.2.192.5 positioning_accuracy

The positioning_accuracy specifies positioning accuracy of the machine tool axes considering displacement error and repeatability error. The positioning_accuracy need not be specified for a particular Machine_parameters.

4.2.192.6 spindle_power

The spindle_power specifies the power which a machine tool apply to turn its spindle. The spindle_power need not be specified for a particular Machine_parameters.

4.2.192.7 spindle_speed

The spindle_speed specifies the rotational velocity at which a machine tool can move its spindle. The spindle_speed need not be specified for a particular Machine_parameters.

4.2.192.8 table_indexing

The table_indexing specifies whether the machine tool table shall be capable of indexing. The table_indexing need not be specified for a particular Machine_parameters.

4.2.192.9 table_length

The table_length specifies length of the machine tool work table. The table_length need not be specified for a particular Machine_parameters.

4.2.192.10 table_width

The table_width specifies length of the machine tool work table. The table_width need not be specified for a particular Machine_parameters.

4.2.192.11 work_volume_height

The work_volume_height specifies height of the volume in which the machine tool can move its cutting tool. The volume is aligned so that the height component lies along the Z axis of the machine. The work_volume_height need not be specified for a particular Machine_parameters and the work_volume_height shall not be specified if axis_travel is specified.

4.2.192.12 work_volume_length

The work_volume_length specifies length of the volume in which the machine tool can move its cutting tool. The volume is aligned so that the length component lies along the X axis of the machine. The work_volume_length need not be specified for a particular Machine_parameters and the work_volume_length shall not be specified if axis_travel is specified.

4.2.192.13 work_volume_width

The work_volume_width specifies width of the volume in which the machine tool can move its cutting tool. The volume is aligned so that the width component lies along the Y axis of the machine. The work_volume_width need not be specified for a particular Machine_parameters and the work_volume_width shall not be specified if axis_travel is specified.

4.2.193 Machined_surface

The Machined_surface application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Machined_surface is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY machined_surface;
  its_machining_feature: machining_feature;
  surface_element:       bottom_or_side;
END_ENTITY;

TYPE bottom_or_side = ENUMERATION OF (bottom, side, bottom_and_side);
END_TYPE;
```

4.2.194 Machining_feature

The Machining_feature application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Machining_feature are the following:

— all of the data defined by ISO 14649-10, as modified below for the depth attribute.

NOTE The ISO 14649 EXPRESS description for Machining_feature, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY machining_feature
  ABSTRACT SUPERTYPE OF (ONEOF(planar_face, pocket, slot, step, round_hole,
      toolpath_feature, profile_feature, boss, spherical_cap, rounded_end, thread))
  SUBTYPE OF (two5D_manufacturing_feature);
  depth: OPTIONAL elementary_surface; -- RELAXED BY 10303-238
END_ENTITY;
```

4.2.194.1 depth

The depth elementary surface is required by ISO 14649-10, but this part of ISO 10303 relaxes this requirement so that the depth need not be specified for a particular Machining_feature.

NOTE As described in 5.2.1.2.1.1, the depth of a feature is defined by the the profile and path elements of the implicit feature definition. Within the AIM, the elementary surface called out as depth by ISO 10303-10 is represented by a parameter called “maximum feature depth,” which is an optional parameter in the ISO 10303-224 and ISO 10303-214 models.

4.2.195 Machining_operation

The Machining_operation application object is defined by clause 4.7 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Machining_operation is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.


```
ENTITY machining_operation
  ABSTRACT SUPERTYPE
  SUBTYPE OF (operation);
  its_id:                 identifier;
  retract_plane:          OPTIONAL length_measure;
  start_point:            OPTIONAL cartesian_point;
  its_tool:               machining_tool;
  its_technology:         technology;
  its_machine_functions:  machine_functions;
END_ENTITY;
```

4.2.196 Machining_tool

The Machining_tool application object is defined by clause 4.6 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Machining_tool are the following:

— all of the data defined by ISO 14649-10;

— its_usage.

NOTE The ISO 14649 EXPRESS description for Machining_tool, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY machining_tool
  ABSTRACT SUPERTYPE;
  its_id:     label;
  its_usage:  OPTIONAL tool_usage;   -- ADDED BY 10303-238
END_ENTITY;
```

4.2.196.1 its_usage

The its_usage specifies a Tool_usage object that describes the tool selected to satisfy the tool requirements set forth by the Machining_tool. The its_usage need not be specified for a particular Machining_tool. See 4.3.36 for the application assertion.

4.2.197 Machining_workingstep

The Machining_workingstep application object is defined by clause 4.6 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Machining_workingstep are the following:

— all of the data defined by ISO 14649-10;

— final_features;

— toolpath_placement.

NOTE The ISO 14649 EXPRESS description for Machining_workingstep, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.


```
ENTITY machining_workingstep
  SUBTYPE OF (workingstep);
  its_feature:        manufacturing_feature;
  its_operation:      machining_operation;
  its_effect:         OPTIONAL in_process_geometry;
  final_features:     OPTIONAL SET [0:?] OF Manufacturing_feature; -- ADDED BY 10303-238
  toolpath_orientation: OPTIONAL axis2_placement_3d;              -- ADDED BY 10303-238
END_ENTITY;
```

4.2.197.1 final_features

The final_features specifies a set of zero or more Manufacturing_feature objects visible on the final form of the workpiece that the workingstep contributes to. If the machining_workingstep its_feature is a process-specific feature consumed by further activities in a process, final_features may be used for traceability to features on the final form of the workpiece. The final_features need not be specified for a particular Machining_workingstep. See 4.3.38 for the application assertion. See 5.2.1.2.3 for additional discussion on the use of this attribute.

NOTE Consider the flow of data through the design and manufacture of a part. The features on the final part are usually the input to process planning, and may be described by an ISO 10303-224 data set. The output of macro process-planning may be described as an ISO 10303-240 data set and will include these features but may identify additional intermediate features related to a particular process. This part of ISO 10303 describes the micro process-plan and is concerned with the features associated with a particular process, but having the ability to associate a process step with the ultimate feature on the final part allows us to preserve information flowing down from the larger process-plan. This will be of benefit to related downstream tasks, such as inspection, which could use the tracability to pinpoint critical areas of interest in the micro and macro process-plans.

EXAMPLE A workingstep drills a hole which is later used as the entry point for a pocketing operation. The hole is consumed by pocketing operation and not visible on the final form of the workpiece. The final_features of the drilling workingstep may reference the pocket to indicate participation in the creation of that feature.

4.2.197.2 toolpath_orientation

The toolpath_orientation specifies the placement of the set of toolpaths given by the its_operation its_toolpath parameter. The toolpath_orientation need not be specified for a particular Machining_workingstep. If the toolpath_orientation is not specified, the toolpaths shall assume an origin of (0,0,0) and axis directions X=(1,0,0) Y=(0,1,0) and Z=(0,0,1).

NOTE To reuse the toolpaths of an operation in a different location, ISO 14649 uses the origin from different features associated with the operation through a workingstep. This technique is not practical in this part of ISO 10303 because of feature harmonization constraints, since features may come from from design and planning with origins that were convenient for the designer.

4.2.198 Manufacturing_feature

This part of ISO 10303 adds the following information requirements to the Manufacturing_feature application object defined by clause 4.4 of ISO 14649-10

NOTE 1 The feature definitions from ISO 14649-10 only support an implicit definition of feature shape, using parameters such as width and height. For harmonization with ISO 10303-224 and other ISO 10303 parts, the following property has been added so that Manufacturing_feature may also describe the feature shape explicitly, using geometry and topology elements, such as faces on the boundary representation of the workpiece.

The data associated with a Manufacturing_feature are the following:

— all of the data defined by ISO 14649-10;

— explicit_representation.

NOTE 2 The ISO 14649 EXPRESS description for Manufacturing_feature, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY manufacturing_feature
  ABSTRACT SUPERTYPE OF (ONEOF(region, two5D_manufacturing_feature,
     transition_feature));
  its_id:             identifier;
  its_workpiece:      workpiece;
  its_operations:     SET [0:?] OF machining_operation;
  explicit_representation: OPTIONAL SET [1:?] OF face; -- ADDED BY 10303-238
END_ENTITY;
```

4.2.198.1 explicit_representation

The explicit_representation specifies the shape of the feature using geometric face elements. This is a set of one or more faces on the boundary representation of the workpiece. The explicit_representation need not be specified for a particular Manufacturing_feature. See 5.2.1.2.2 for additional discussion on the use of this attribute.

4.2.199 Mass_measure

An Mass_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes a mass quantity.

4.2.200 Material

The Material application object is defined by clause 4.4 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Material is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY material;
  standard_identifier:       label;
  material_identifier:       label;
  material_property:         SET [0:?] OF property_parameter;
END_ENTITY;
```


4.2.201 Material_property

A Material_property is a type of General_property (see 4.2.151) that describes the properties of the material used to produce a Workpiece.

NOTE This definition has been harmonized with the Material_property definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Material_property are the following:

— material_characteristics;

— material_hardness.

4.2.201.1 material_characteristics

The material_characteristics specifies the set of Property_parameter objects that describe the Material_property. The material_characteristics need not be specified for a particular Material_property. See 4.3.40 for the application assertion.

4.2.201.2 material_hardness

The material_hardness specifies the set of Hardness objects that describe hardness properties. The material_hardness need not be specified for a particular Material_property. See 4.3.39 for the application assertion.

4.2.202 Measurement_path

A Measurement_path is a path, direction, or domain of applicability for a dimension or tolerance. The path is represented by a Curve.

NOTE This definition has been harmonized with the Measurement_path definition in ISO 10303-1031.

The data associated with a Measurement_path are the following:

— defined_by;

— defined_in.

4.2.202.1 defined_by

The defined_by attribute specifies the curve along which the measurement takes place.

4.2.202.2 defined_in

The defined_in attribute specifies the geometric context in which the measurement path is evaluated.

4.2.203 Milling_cutting_tool

The Milling_cutting_tool application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Milling_cutting_tool is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY milling_cutting_tool
  ABSTRACT SUPERTYPE OF (ONEOF(dovetail_mill, endmill, facemill, shouldermill,
  side_mill, t_slot_mill, thread_mill))
  SUBTYPE OF (milling_machine_cutting_tool);
  number_of_effective_teeth:    OPTIONAL INTEGER;
  edge_radius:                  OPTIONAL length_measure;
END_ENTITY;
```

4.2.204 Milling_machine_cutting_tool

The Milling_machine_cutting_tool application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Milling_machine_cutting_tool is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY milling_machine_cutting_tool
  ABSTRACT SUPERTYPE OF ( ONEOF(milling_cutting_tool, drilling_cutting_tool,
  tapping_cutting_tool, rotating_boring_cutting_tool, reaming_cutting_tool))
  SUBTYPE OF (machining_tool);
  its_cutting_edges:            SET [1:?] OF cutting_component;
  overall_assembly_length:      length_measure;
  effective_cutting_diameter:   length_measure;
  maximum_depth_of_cut:         length_measure;
  hand_of_cut:                  OPTIONAL hand_of_cut_type;
  coolant_through_tool:         OPTIONAL BOOLEAN;
END_ENTITY;

TYPE hand_of_cut_type = ENUMERATION OF(left, neutral, right);
END_TYPE;
```

4.2.205 Milling_machine_functions

The Milling_machine_functions application object is defined by clause 4 of ISO 14649-11. This part of ISO 10303 adds the following information requirements.

The data associated with a Milling_machine_functions are the following:

— all of the data defined by ISO 14649-11;

— axis_constraints.

NOTE The ISO 14649 EXPRESS description for Milling_machine_functions, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-11 for the original definition and explanation of usage.

```
ENTITY milling_machine_functions
  SUBTYPE OF (machine_functions);
```



```
  coolant:              BOOLEAN;
  coolant_pressure:     OPTIONAL pressure_measure;
  mist:                 OPTIONAL BOOLEAN;
  through_spindle_coolant: BOOLEAN;
  through_pressure:     OPTIONAL pressure_measure;
  axis_clamping:        LIST [0:?] OF identifier;
  chip_removal:         BOOLEAN;
  oriented_spindle_stop: OPTIONAL direction;
  its_process_model:    OPTIONAL process_model_list;
  other_functions:      SET [0:?] OF property_parameter;
  axis_constraints: OPTIONAL SET [0:?] OF machine_axis_constraint;-- ADDED BY 10303-238
END_ENTITY;
```

4.2.205.1 axis_constraints

The axis_constraints specifies zero or more Machine_axis_constraint that shall be used by the NC control when computing axis motion. See 4.3.41 for the application assertion.

NOTE This information is machine dependent and should not be used.

4.2.206 Milling_machining_operation

The Milling_machining_operation application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Milling_machining_operation is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY milling_machining_operation
  ABSTRACT SUPERTYPE OF (ONEOF(milling_type_operation, drilling_type_operation))
  SUBTYPE OF (machining_operation);
  overcut_length: OPTIONAL length_measure;
WHERE
  WR1: (EXISTS(SELF.its_technology.feedrate_per_tooth) AND
        EXISTS(SELF.its_tool.number_of_effective_teeth)) OR
        (NOT(EXISTS(SELF.its_technology.feedrate_per_tooth)));
END_ENTITY;
```

4.2.207 Milling_technology

The Milling_technology application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Milling_technology is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY milling_technology
  SUBTYPE OF (technology);
  cutspeed:                      OPTIONAL speed_measure;
  spindle:                       OPTIONAL rot_speed_measure;
  feedrate_per_tooth:            OPTIONAL length_measure;
  synchronize_spindle_with_feed: BOOLEAN;
  inhibit_feedrate_override:     BOOLEAN;
  inhibit_spindle_override:      BOOLEAN;
  its_adaptive_control:          OPTIONAL adaptive_control;
WHERE
  WR1: (EXISTS(cutspeed) AND NOT EXISTS(spindle))
```



```
    OR (EXISTS(spindle) AND NOT EXISTS(cutspeed))
    OR (EXISTS(its_adaptive_control));
  WR2: (EXISTS(SELF.feedrate) AND NOT EXISTS(feedrate_per_tooth))
    OR (EXISTS(feedrate_per_tooth) AND NOT EXISTS(SELF.feedrate))
    OR (EXISTS(its_adaptive_control));
END_ENTITY;
```

4.2.208 Milling_type_operation

The Milling_type_operation application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Milling_type_operation is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY milling_type_operation
  ABSTRACT SUPERTYPE OF (ONEOF(freeform_operation, two5D_milling_operation))
  SUBTYPE OF (milling_machining_operation);
  approach:         OPTIONAL approach_retract_strategy;
  retract:          OPTIONAL approach_retract_strategy;
END_ENTITY;
```

4.2.209 Multiple_arity_boolean_expression

The Multiple_arity_boolean_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Multiple_arity_boolean_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY multiple_arity_boolean_expression
  ABSTRACT SUPERTYPE OF(ONEOF(and_expression, or_expression))
  SUBTYPE OF (boolean_expression);
  operands: LIST [2:?] OF boolean_expression;
END_ENTITY;
```

4.2.210 Multistep_drilling

The Multistep_drilling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Multistep_drilling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY multistep_drilling
  SUBTYPE OF (drilling_operation);
  retract_distance:       length_measure;
  first_depth:            length_measure;
  depth_of_step:          length_measure;
  dwell_time_step:        OPTIONAL time_measure;
END_ENTITY;
```

4.2.211 Multistep_grooving_strategy

The Multistep_grooving_strategy application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Multistep_grooving_strategy is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY multistep_grooving_strategy
  SUBTYPE OF (grooving_strategy);
  retract_distance: length_measure;
END_ENTITY;
```

4.2.212 NC_constant

The NC_constant application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for NC_constant is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY nc_constant;
  its_name:  LABEL;
  its_value: OPTIONAL NUMBER;
END_ENTITY;
```

4.2.213 NC_function

The NC_function application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for NC_function is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY nc_function
  ABSTRACT SUPERTYPE SUBTYPE OF (executable);
END_ENTITY;
```

4.2.214 NC_variable

The NC_variable application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for NC_variable is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY nc_variable;
  its_name:      LABEL;
  initial_value: OPTIONAL NUMBER;
END_ENTITY;
```

4.2.215 Ngon_profile

The Ngon_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Ngon_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.


```
ENTITY ngon_profile
  SUBTYPE OF(closed_profile);
  diameter:              toleranced_length_measure;
  number_of_sides:       INTEGER;
  circumscribed_or_across_flats: BOOLEAN;
END_ENTITY;
```

4.2.216 Non_sequential

The Non_sequential application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Non_sequential is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY non_sequential
  SUBTYPE OF (program_structure);
  its_elements:   SET[2:?] OF executable;
END_ENTITY;
```

4.2.217 Not_expression

The Not_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Not_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY not_expression
  SUBTYPE OF (unary_boolean_expression);
END_ENTITY;
```

4.2.218 Numeric_parameter

The Numeric_parameter application object is defined by clause 4.4 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Numeric_parameter is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY numeric_parameter
  SUBTYPE OF (Property_parameter);
  its_parameter_value:  parameter_value;
  its_parameter_unit:   label;
END_ENTITY;
```

4.2.219 Offset_vector

The Offset_vector application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Offset_vector is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY offset_vector;
  translate: LIST [3:3] OF nc_variable;
```



```
    rotate:    OPTIONAL LIST [3:3] OF nc_variable;
  WHERE
    WR1: (SIZEOF(QUERY(i <* translate | NOT EXISTS(i.initial_value))) = 0)
       AND (NOT EXISTS(rotate) OR (SIZEOF(QUERY(i <* rotate |
            NOT EXISTS(i.initial_value))) = 0));
  END_ENTITY;
```

4.2.220 Open_pocket

The Open_pocket application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Open_pocket is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
  ENTITY open_pocket
    SUBTYPE OF (pocket);
    open_boundary:  open_profile;
    wall_boundary:  OPTIONAL open_profile;
  END_ENTITY;
```

4.2.221 Open_profile

The Open_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Open_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
  ENTITY open_profile
    ABSTRACT SUPERTYPE OF (ONEOF (linear_profile, square_u_profile, rounded_u_profile,
        tee_profile, vee_profile, partial_circular_profile, general_profile))
    SUBTYPE OF(profile);
  END_ENTITY;
```

4.2.222 Open_slot_end_type

The Open_slot_end_type application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Open_slot_end_type is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
  ENTITY open_slot_end_type
    SUBTYPE OF (slot_end_type);
  END_ENTITY;
```

4.2.223 Operation

The Operation application object is defined by clause 4.7 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Operation is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
  ENTITY operation
```



```
  ABSTRACT SUPERTYPE OF (ONEOF (machining_operation, rapid_movement, touch_probing));
  its_toolpath:               OPTIONAL toolpath_list;
  its_tool_direction:         OPTIONAL tool_direction;
END_ENTITY;
```

4.2.224 Optional_stop

The Optional_stop application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Optional_stop is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY optional_stop
  SUBTYPE OF (nc_function);
END_ENTITY;
```

4.2.225 Or_expression

The Or_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Or_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY or_expression
  SUBTYPE OF (multiple_arity_boolean_expression);
END_ENTITY;
```

4.2.226 Outer_diameter

The Outer_diameter application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Outer_diameter is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY outer_diameter
  SUBTYPE OF (outer_round);
  diameter_at_placement: toleranced_length_measure;
  feature_length:        toleranced_length_measure;
  reduced_size:          OPTIONAL taper_select;
END_ENTITY;
```

4.2.227 Outer_diameter_to_shoulder

The Outer_diameter_to_shoulder application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Outer_diameter_to_shoulder is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY outer_diameter_to_shoulder
  SUBTYPE OF (outer_round);
  diameter_at_placement: toleranced_length_measure;
  v_shape_boundary:      vee_profile;
```

```
END_ENTITY;
```

4.2.228 Outer_round

The Outer_round application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Outer_round is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY outer_round
  ABSTRACT SUPERTYPE OF (ONEOF (outer_diameter, outer_diameter_to_shoulder))
  SUBTYPE OF (turning_feature);
END_ENTITY;
```

4.2.229 Parallel

The Parallel application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Parallel is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY parallel
  SUBTYPE OF (program_structure);
  branches:   SET [2:?] OF executable;
END_ENTITY;
```

4.2.230 Parallelism_tolerance

A Parallelism_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a surface or a curve shall be parallel to a reference datum, with an allowed amount of deviation. This reference datum is either a datum plane or a datum axis. A Parallelism_tolerance specifies one of the following:

— a tolerance zone limited by two planes or two lines (if the attribute ‘affected_plane’ is specified) parallel to a datum plane, or axis, within which the line elements of the surface or the axis of the considered feature must lie;

— a cylindrical tolerance zone whose axis is parallel to a datum axis within which the axis of the considered feature must lie.

NOTE This definition has been harmonized with the Parallelism_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.7 of ISO 1101. Figure 16 illustrates a Parallelism_tolerance.

The data associated with a Parallelism_tolerance are the following:

— affected_plane;

— reference_datum.

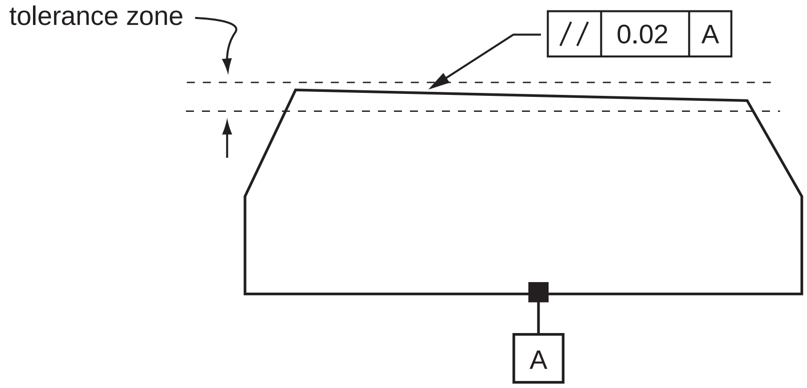

Figure 16 — Parallelism_tolerance

4.2.230.1 affected_plane

The affected_plane specifies an axis placement, the X-Y plane of which establishes the plane in which the tolerance applies. The affected_plane need not be specified for a particular Parallelism_tolerance.

4.2.230.2 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.42 for the application assertion.

4.2.231 Parameterised_path

The Parameterised_path application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Parameterised_path is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY parameterised_path
  ABSTRACT SUPERTYPE OF (ONEOF (approach_lift_path, connector))
  SUBTYPE OF (toolpath);
END_ENTITY;
```

4.2.232 Part_property

A Part_property is a type of General_property (see 4.2.151) that describes a specific characteristic about the form, fit, or function of a Workpiece.

NOTE This definition has been harmonized with the Part_property definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Part_property are the following:

— part_characteristics.

4.2.232.1 part_characteristics

The part_characteristics specifies the set of Property_parameter objects that describe the Part_property. The part_characteristics need not be specified for a particular Part_property. See 4.3.43 for the application assertion.

4.2.233 Partial_area_definition

The Partial_area_definition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Partial_area_definition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY partial_area_definition;
  effective_length:     length_measure;
  placement:            axis2_placement_3D;
  maximum_length:       OPTIONAL length_measure;
END_ENTITY;
```

4.2.234 Partial_circular_path

The Partial_circular_path application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Partial_circular_path is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY partial_circular_path
  SUBTYPE OF(circular_path);
  sweep_angle:  plane_angle_measure;
END_ENTITY;
```

4.2.235 Partial_circular_profile

The Partial_circular_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Partial_circular_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY partial_circular_profile
  SUBTYPE OF (open_profile);
  radius:       toleranced_length_measure;
  sweep_angle:  plane_angle_measure;
END_ENTITY;
```

4.2.236 Partial_circular_shape_profile

The Partial_circular_shape_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Partial_circular_shape_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.


```
ENTITY partial_circular_shape_profile
  SUBTYPE OF (shape_profile);
  open_boundary :        partial_circular_profile;
END_ENTITY;
```

4.2.237 Perpendicularity_tolerance

A Perpendicularity_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies that a surface or a curve shall be perpendicular to a reference datum with an allowed amount of deviation. The reference datum is either a datum plane or a datum axis. A Perpendicularity_tolerance specifies one of the following:

— a tolerance zone limited by two parallel planes perpendicular to a datum plane, or axis, within which the surface or median plane of the considered feature must lie;

— a tolerance zone limited by two parallel planes perpendicular to a datum axis, within which the axis of the considered feature must lie;

— a cylindrical tolerance zone (if the attribute ‘affected_plane’ is not specified), perpendicular to a datum plane, within which the axis of the considered feature must lie;

— a tolerance zone defined by two parallel lines perpendicular to a datum plane, or axis, within which an element of the surface must lie.

NOTE This definition has been harmonized with the Perpendicularity_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.8 of ISO 1101. Figure 17 illustrates a Perpendicularity_tolerance.

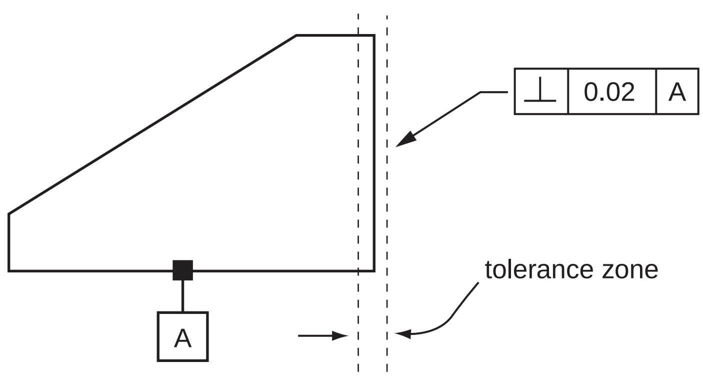

Figure 17 — Perpendicularity_tolerance

The data associated with a Perpendicularity_tolerance are the following:

— affected_plane;

— reference_datum.

4.2.237.1 affected_plane

The affected_plane specifies an axis placement, the X-Y plane of which establishes the plane in which the tolerance applies. The affected_plane need not be specified for a particular Perpendicularity_-tolerance.

4.2.237.2 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.44 for the application assertion.

4.2.238 Person_and_address

The Person_and_address application object is defined by clause 4.3 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Person_and_address is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY person_and_address;
  its_person:   person;
  its_address:  OPTIONAL address;
END_ENTITY;
```

4.2.239 Placed_target

A Placed_target is a type of Datum_target (see 4.2.105) that is described implicitly by parameters.

The data associated with a Placed_target are the following:

— defined_in;

— parameter_reference;

4.2.239.1 defined_in

The defined_in specifies the cartesian coordinate space in which the location and orientation that serves as parameter_reference are defined.

NOTE A Placed_target is not defined in its own local and independent coordinate space but in the coordinate space of the shape that provides the datum.

4.2.239.2 parameter_reference

The placement specifies location and orientation that the parameters or the Placed_target refer to.

4.2.240 Planar_face

The Planar_face application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

NOTE 1 The following properties have been added for harmonization with ISO 10303-224 and other ISO 10303 parts. Figure 18 illustrates the parameters associated with a Planar_face. Refer to 5.2.1.3.1 for additional discussion on the location of the feature origin and other aspects of the Planar_face application object.

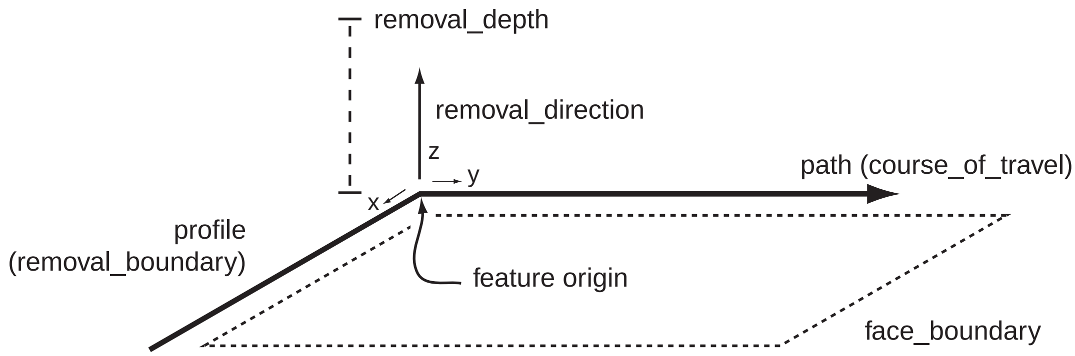

Figure 18 — Planar_face parameters

The data associated with a Planar_face are the following:

— all of the data defined by ISO 14649-10;

— removal_depth;

— removal_direction.

NOTE 2 The ISO 14649 EXPRESS description for Planar_face, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY planar_face
  SUBTYPE OF (machining_feature);
  course_of_travel:     linear_path;
  removal_boundary:     linear_profile;
  face_boundary:        OPTIONAL closed_profile;
  its_boss:             SET [0:?] OF boss;
  removal_depth:        length_measure; -- ADDED BY 10303-238
  removal_direction:    direction;      -- ADDED BY 10303-238
END_ENTITY;
```

4.2.240.1 removal_depth

The removal_depth specifies the distance, measured along the removal direction, of material removal from the Planar_face feature.

4.2.240.2 removal_direction

The removal_direction specifies the direction of material removal from the Planar_face feature.

4.2.241 Planar_pocket_bottom_condition

The Planar_pocket_bottom_condition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Planar_pocket_bottom_condition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY planar_pocket_bottom_condition
  SUBTYPE OF (pocket_bottom_condition);
END_ENTITY;
```

4.2.242 Planar_profile_floor

The Planar_profile_floor application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Planar_profile_floor is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY planar_profile_floor
  SUBTYPE OF (profile_floor);
  floor:        plane;
END_ENTITY;
```

4.2.243 Plane_angle_measure

A Plane_angle_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes a plane angle.

NOTE As defined in ISO 14649-10, Plane_angle_measure does not explicitly specify a unit. Instead, a default unit of degrees is defined for all plane angles. This part of ISO 10303 extends Plane_angle_measure to explicitly specify units using the “unit” attribute inherited from Value_with_unit. In addition, this measure may now be qualified with a tolerance using the “limitation” attribute inherited from Value_with_tolerance.

4.2.244 Plane_cc_strategy

The Plane_cc_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plane_cc_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plane_cc_strategy
  SUBTYPE OF (freeform_strategy);
  its_plane_normal: direction;
END_ENTITY;
```


4.2.245 Plane_cl_strategy

The Plane_cl_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plane_cl_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plane_cl_strategy
  SUBTYPE OF (freeform_strategy);
  its_plane_normal: direction;
END_ENTITY;
```

4.2.246 Plane_finish_milling

The Plane_finish_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plane_finish_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plane_finish_milling
  SUBTYPE OF (plane_milling);
END_ENTITY;
```

4.2.247 Plane_milling

The Plane_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plane_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plane_milling
  ABSTRACT SUPERTYPE OF (ONEOF(plane_rough_milling, plane_finish_milling))
  SUBTYPE OF (two5D_milling_operation);
  axial_cutting_depth:  OPTIONAL length_measure;
  allowance_bottom:     OPTIONAL length_measure;
END_ENTITY;
```

4.2.248 Plane_rough_milling

The Plane_rough_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plane_rough_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plane_rough_milling
  SUBTYPE OF (plane_milling);
WHERE
  WR1: EXISTS(SELF.allowance_bottom) AND (SELF.allowance_bottom>=0.0);
END_ENTITY;
```

4.2.249 Plunge_helix

The Plunge_helix application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plunge_helix is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plunge_helix
  SUBTYPE OF (plunge_strategy);
  radius:       length_measure;
  angle:        plane_angle_measure;
END_ENTITY;
```

4.2.250 Plunge_ramp

The Plunge_ramp application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plunge_ramp is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plunge_ramp
  SUBTYPE OF (plunge_strategy);
  angle:        plane_angle_measure;
END_ENTITY;
```

4.2.251 Plunge_strategy

The Plunge_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plunge_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plunge_strategy
  ABSTRACT SUPERTYPE OF (ONEOF (plunge_toolaxis, plunge_ramp,
     plunge_helix, plunge_zigzag))
  SUBTYPE OF (approach_retract_strategy);
END_ENTITY;
```

4.2.252 Plunge_toolaxis

The Plunge_toolaxis application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plunge_toolaxis is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plunge_toolaxis
  SUBTYPE OF (plunge_strategy);
END_ENTITY;
```

4.2.253 Plunge_zigzag

The Plunge_zigzag application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Plunge_zigzag is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY plunge_zigzag
  SUBTYPE OF (plunge_strategy);
  angle:        plane_angle_measure;
  width:        length_measure;
END_ENTITY;
```

4.2.254 Plus_minus_value

A Plus_minus_value is the specification of a tolerance by offsets which are each added to the value_component of a Value_with_tolerance, to create the two limits of the allowable range.

NOTE This definition has been harmonized with the Plus_minus_value definitions in ISO 10303-1050, ISO 10303-214, and ISO 10303-224. A definition for Plus_minus_value appears in ISO 14649-10, but only applies to length measures. This part of ISO 10303 extends the definition given by ISO 14649-10 to apply to any type of physical quantity given by a Value_with_tolerance. For harmonization, the significant_digits data which appears in ISO 14649-10 is associated with the Value_with_tolerance application object.

The data associated with a Plus_minus_value are the following:

— lower_limit;

— upper_limit.

4.2.254.1 lower_limit

The lower_limit specifies the lower offset measure, which when added to the value_component of a Value_with_tolerance gives the lowest allowable value for the physical quantity.

4.2.254.2 upper_limit

The upper_limit specifies the upper offset measure, which when added to the value_component of a Value_with_tolerance gives the highest allowable value for the physical quantity.

4.2.255 Pocket

The Pocket application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

NOTE 1 The following properties have been added for harmonization with ISO 10303-224 and other ISO 10303 parts. Figure 19 illustrates the parameters of a Pocket with the bottom condition located at the common origin of the feature, profile, and path (indicated by a value of FALSE for bottom_at_path_end). Figure 20 illustrates a Pocket with the bottom condition located at the end of the course_of_travel path (indicated by a value of TRUE for bottom_at_path_end). Refer to 5.2.1.3.3 for additional discussion on the location of the feature origin and other aspects of the Pocket application object.

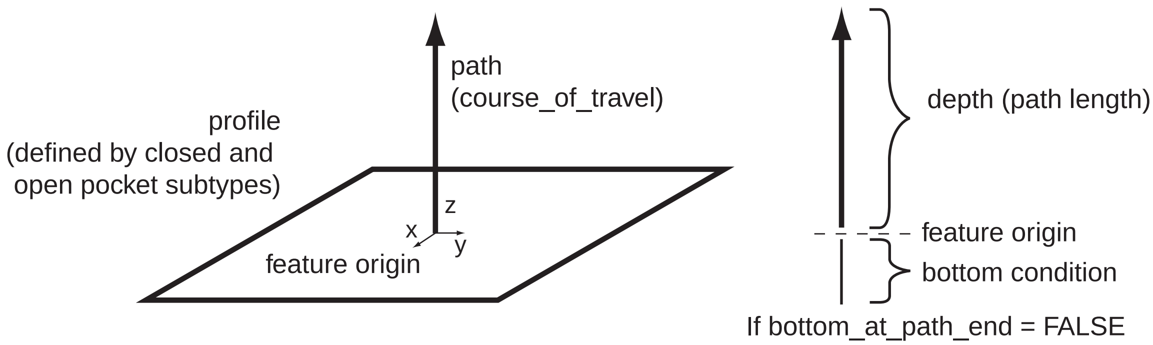

Figure 19 — Pocket (bottom at path origin)

The data associated with a Pocket are the following:

— all of the data defined by ISO 14649-10;

— bottom_at_path_end;

— course_of_travel;

— top_fillet_radius.

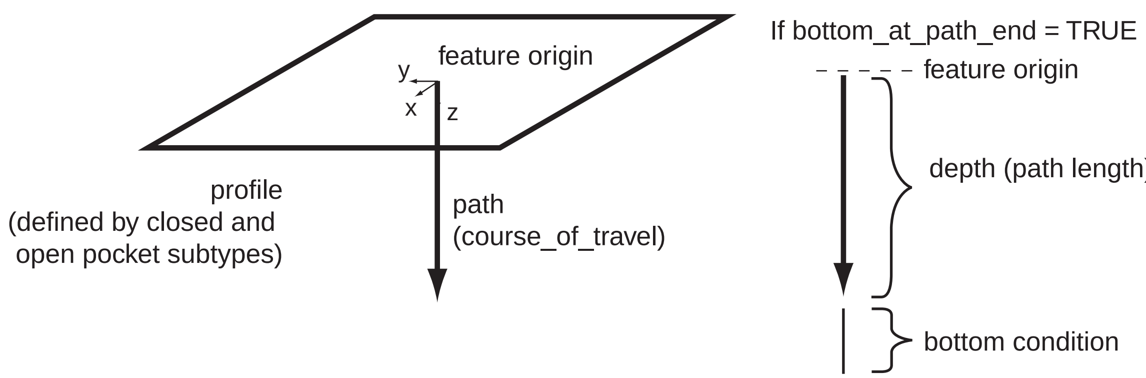

Figure 20 — Pocket (bottom at path end)

NOTE 2 The ISO 14649 EXPRESS description for Pocket, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY pocket
  ABSTRACT SUPERTYPE OF (ONEOF(closed_pocket, open_pocket))
  SUBTYPE OF (machining_feature);
  its_boss:             SET [0:?] OF boss;
  slope:                OPTIONAL plane_angle_measure;
```



```
  bottom_condition:     pocket_bottom_condition;
  planar_radius:        OPTIONAL toleranced_length_measure;
  orthogonal_radius:    OPTIONAL toleranced_length_measure;
  bottom_at_path_end:   BOOLEAN;                           -- ADDED BY 10303-238
  course_of_travel:     linear_path;                       -- ADDED BY 10303-238
  top_fillet_radius:    OPTIONAL toleranced_length_measure; -- ADDED BY 10303-238
END_ENTITY;
```

4.2.255.1 bottom_at_path_end

The bottom_at_path_end specifies the location of the bottom_condition. The bottom_at_path_end shall have a value of TRUE if the bottom_condition is positioned at the end of the the course_of_travel path, and a value of FALSE if it is at the origin of course_of_travel path.

NOTE In ISO 10303-224, this parameter is known as start_or_end and is located on the Pocket_-bottom_condition application object. However, in the integrated representation, this value is represented by the feature component relationship that ties a pocket bottom to a particular pocket. This parameter has been moved to Pocket to allow different values for different pockets which may share the same pocket bottom instance.

4.2.255.2 course_of_travel

The course_of_travel specifies a Linear_path along which the profile defined by a pocket subtype (feature_boundary for Closed_pocket, open_boundary for Open_pocket) is swept to define the volume of the Pocket. The placement and orientation of the course_of_travel shall be the same as the Pocket feature. See 4.3.45 for the application assertion.

NOTE The length of the path is the depth of the pocket.

4.2.255.3 top_fillet_radius

The top_fillet_radius specifies the radius of a radius shape blend between the Pocket and the surrounding Workpiece surface at the top of the Pocket. The top_fillet_radius need not be specified for a particular Pocket.

NOTE In ISO 10303-224, this parameter is known as base_radius, however, to avoid confusion with the orthoganal and planar radius parameters, the name top_fillet_radius is used.

4.2.256 Pocket_bottom_condition

The Pocket_bottom_condition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Pocket_bottom_condition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY pocket_bottom_condition
  ABSTRACT SUPERTYPE OF (ONEOF (through_pocket_bottom_condition,
    planar_pocket_bottom_condition, radiused_pocket_bottom_condition,
    general_pocket_bottom_condition));
END_ENTITY;
```

4.2.257 Position_tolerance

A Position_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies the allowable variation in the position of a shape element. It can be interpreted either as defining a positional boundary within which the entire element is permitted to lie, or as defining a tolerance zone within which the centre, axis, or centre plane of the considered element is permitted to lie.

NOTE This definition has been harmonized with the Position_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.10 of ISO 1101. The concept of position tolerances is defined in ISO 5458 [3]. Figure 21 illustrates a Position_tolerance.

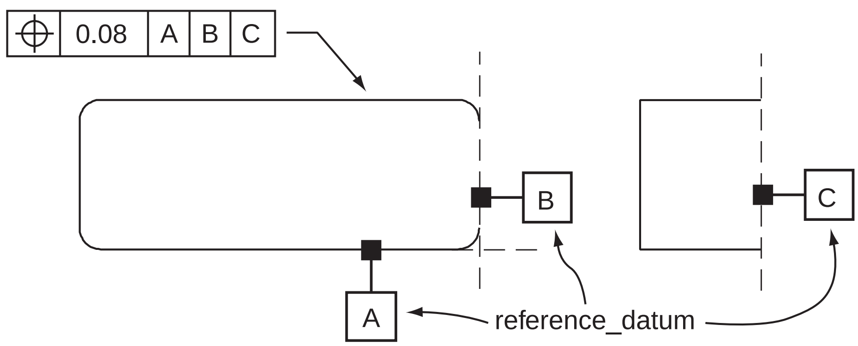

Figure 21 — Position_tolerance

The data associated with a Position_tolerance are the following:

— affected_plane;

— reference_datum.

4.2.257.1 affected_plane

The affected_plane specifies an axis placement, the X-Y plane of which establishes the plane in which the tolerance applies. The affected_plane need not be specified for a particular Position_tolerance.

4.2.257.2 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.46 for the application assertion.

NOTE When a Position_tolerance is the feature relating Position_tolerance of a composite tolerance, it need not have a datum reference frame.

4.2.258 Pressure_measure

A Pressure_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes a pressure.

NOTE As defined in ISO 14649-10, Pressure_measure does not explicitly specify a unit. Instead, a default unit of Pascals is defined for all pressures. This part of ISO 10303 extends Pressure_measure to allow units to be explicitly specified using the “unit” attribute inherited from Value_with_unit. In addition, this measure may now qualified with a tolerance using the “limitation” attribute inherited from Value_with_tolerance.

4.2.259 Process_model

The Process_model application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Process_model is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY process_model;
  ini_data_file:  label;
  its_type:       label;
END_ENTITY;
```

4.2.260 Process_model_list

The Process_model_list application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Process_model_list is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY process_model_list;
  its_list: LIST [1:?] OF process_model;
END_ENTITY;
```

4.2.261 Process_property

A Process_property is a type of General_property (see 4.2.151) that describes a specific characteristic about a process involved in the manufacture of a Workpiece.

NOTE This definition has been harmonized with the Process_property definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Process_property are the following:

— process_characteristics;

— process_name.

4.2.261.1 process_characteristics

The process_characteristics specifies the set of Property_parameter objects that describe the Process_property. The process_characteristics need not be specified for a particular Process_property. See 4.3.47 for the application assertion.

4.2.261.2 process_name

The process_name specifies a word or group of words by which a Process_property is commonly referred.

4.2.262 Profile

The Profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY profile
  ABSTRACT SUPERTYPE OF(ONEOF(closed_profile, open_profile));
  placement:    OPTIONAL axis2_placement_3d;
END_ENTITY;
```

4.2.263 Profile_feature

The Profile_feature application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Profile_feature is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY profile_feature
  ABSTRACT SUPERTYPE OF(ONEOF(general_outside_profile, shape_profile))
  SUBTYPE OF (machining_feature);
  profile_swept_shape : linear_path;
END_ENTITY;
```

4.2.264 Profile_floor

The Profile_floor application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Profile_floor is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY profile_floor
  ABSTRACT SUPERTYPE OF(ONEOF(general_profile_floor, planar_profile_floor));
  floor_radius:         OPTIONAL numeric_parameter;
  start_or_end:         BOOLEAN;
END_ENTITY;
```

4.2.265 Profiled_corner

The Profiled_corner application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Profiled_corner is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.


```
ENTITY profiled_corner;
  transition_profile:   open_profile;
END_ENTITY;
```

4.2.266 Profiled_end_mill

The Profiled_end_mill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Profiled_end_mill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY profiled_end_mill
  SUBTYPE OF (endmill);
END_ENTITY;
```

4.2.267 Program_stop

The Program_stop application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Program_stop is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY program_stop
  SUBTYPE OF (nc_function);
END_ENTITY;
```

4.2.268 Program_structure

The Program_structure application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Program_structure is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY program_structure
  ABSTRACT SUPERTYPE OF (ONEOF(workplan, parallel, non_sequential, selective,
     if_statement, while_statement, assignment))
  SUBTYPE OF (executable);
END_ENTITY;
```

4.2.269 Project

The Project application object is defined by clause 4.3 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Project is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY project;
  its_id:          identifier;
  main_workplan:   workplan;
  its_workpieces:  SET [0:?] OF workpiece;
  its_owner:       OPTIONAL person_and_address;
  its_release:     OPTIONAL date_and_time;
```



```
    its_status:      OPTIONAL approval;
  END_ENTITY;
```

4.2.270 Projection

A Projection is a type of Tolerance_zone_definition (see 4.2.361) where a Tolerance_zone is projected from an element of a part. The projection is external to the part and made from one of the ends of the element for a specified length.

NOTE The concept of projected tolerance zones is defined in ISO 10578.

The data associated with a Projection are the following:

— projection_end;

— projection_length.

4.2.270.1 projection_end

The projection_end specifies the shape element from which the tolerance zone is projected.

4.2.270.2 projection_length

The projection_length specifies the distance from the projection_end where the Geometric_tolerance shall be measured.

4.2.271 Property_BSU

A Property_BSU is a type of BSU (see 4.2.40) that identifies a property basic semantical unit of a class in a parts library.

NOTE This definition has been harmonized with the Property_BSU definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Property_BSU are the following:

— name_scope;

— version.

4.2.271.1 name_scope

The name_scope specifies Class_BSU object which describes the class the property belongs to. See 4.3.48 for the application assertion.

4.2.271.2 version

The version specifies the designation of the version of the information piece.

4.2.272 Property_parameter

The Property_parameter application object is defined by clause 4.4 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Property_parameter is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY property_parameter
  SUPERTYPE OF (ONEOF (descriptive_parameter,numeric_parameter));
  parameter_name:       label;
END_ENTITY;
```

4.2.273 Radial_size_dimension

An Radial_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in the radius of a circular, cylindrical, or spherical shape element.

NOTE This definition has been harmonized with the Radial_size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Radial_dimension_tolerance definition in ISO 10303-224. Figure 26 illustrates a Radial_size_dimension.

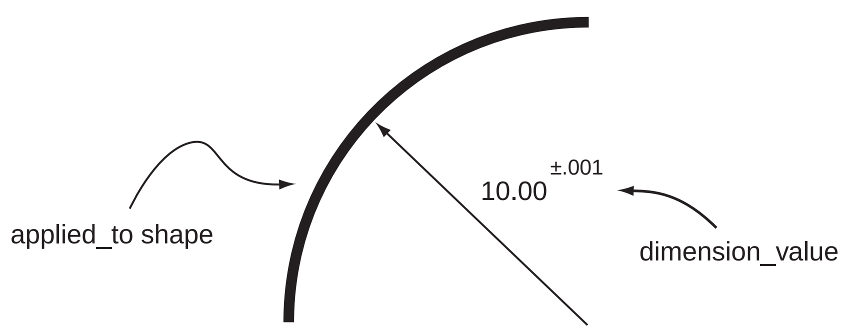

Figure 22 — Radial_size_dimension

The data associated with a Radial_size_dimension are the following:

— radius_type.

4.2.273.1 radius_type

The radius_type specifies the form of the tolerance zone. One of the following values shall be used. The radius_type need not be specified for a particular Radial_size_dimension. If omitted, a value of 'adjoining' shall be assumed.

— centred: the tolerance zone is the shape in between two annular radial segments with their centres at the prescribed centre point. The radial tolerance permits steps in the tolerance zones with respect to its adjoining surface;

NOTE 1 A centred radial tolerance is typically applied to radial surfaces, such as filleted surfaces, that are located by centre point. It is drawn with a centre and the radial leader passes through the centre.

— adjoining: the tolerance zone is a crescent moon shape bounded by a minimum radius arc and a maximum radius arc, in which each arc shall be tangent to the adjacent surfaces.

NOTE 2 An adjoining radial tolerance typically applied to radial surfaces, such as filleted surfaces, that are located by adjoining surfaces. It is drawn without a centre and the radial leader just points to the radial surface.

4.2.274 Radiused_pocket_bottom_condition

The Radiused_pocket_bottom_condition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Radiused_pocket_bottom_condition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY radiused_pocket_bottom_condition
  SUBTYPE OF (pocket_bottom_condition);
  floor_radius_center:  cartesian_point;
  floor_radius:         toleranced_length_measure;
END_ENTITY;
```

4.2.275 Radiused_slot_end_type

The Radiused_slot_end_type application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Radiused_slot_end_type is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY radiused_slot_end_type
  SUBTYPE OF (slot_end_type);
END_ENTITY;
```

4.2.276 Rapid_movement

The Rapid_movement application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Rapid_movement is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY rapid_movement
  SUPERTYPE OF (return_home)
  SUBTYPE OF (workingstep, operation);
END_ENTITY;
```


4.2.277 Reaming

The Reaming application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Reaming is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY reaming
  SUBTYPE OF (boring_operation);
END_ENTITY;
```

4.2.278 Reaming_cutting_tool

The Reaming_cutting_tool application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Reaming_cutting_tool is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY reaming_cutting_tool
  SUPERTYPE OF (ONEOF (tapered_reamer, combined_drill_and_reamer))
  SUBTYPE OF (milling_machine_cutting_tool);
  taper_length: length_measure;
END_ENTITY;
```

4.2.279 Rectangular_closed_profile

The Rectangular_closed_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Rectangular_closed_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY rectangular_closed_profile
  SUBTYPE OF(closed_profile);
  profile_width:        toleranced_length_measure;
  profile_length:       toleranced_length_measure;
END_ENTITY;
```

4.2.280 Rectangular_closed_shape_profile

The Rectangular_closed_shape_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Rectangular_closed_shape_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY rectangular_closed_shape_profile
  SUBTYPE OF (shape_profile);
  closed_boundary:      rectangular_closed_profile;
END_ENTITY;
```

4.2.281 Rectangular_offset

The Rectangular_offset application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Rectangular_offset is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY rectangular_offset;
  offset_direction:   direction;
  offset_distance:    length_measure;
  row_index:          INTEGER;
  column_index:       INTEGER;
END_ENTITY;
```

4.2.282 Rectangular_omit

The Rectangular_omit application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Rectangular_omit is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY rectangular_omit;
  row_index:          INTEGER;
  column_index:       INTEGER;
END_ENTITY;
```

4.2.283 Rectangular_open_shape_profile

The Rectangular_open_shape_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Rectangular_open_shape_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY rectangular_open_shape_profile
  SUBTYPE OF (shape_profile);
  open_boundary:        square_u_profile;
END_ENTITY;
```

4.2.284 Rectangular_pattern

The Rectangular_pattern application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Rectangular_pattern is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY rectangular_pattern
  SUBTYPE OF(replicate_feature);
  spacing:                tolerancced_length_measure;
  its_direction:          direction;
  number_of_rows:         OPTIONAL INTEGER;
  number_of_columns:      INTEGER;
  row_spacing:            OPTIONAL toleranced_length_measure;
```



```
  row_layout_direction:    OPTIONAL direction;
  relocated_base_feature:  SET[0:?] OF rectangular_offset;
  missing_base_feature:    SET[0:?] OF rectangular_omit;
WHERE
 WR1: ((SELF.number_of_rows > 1 )
      AND EXISTS(SELF.row_spacing)
      AND EXISTS(SELF.row_layout_direction));
END_ENTITY;
```

4.2.285 Region

The Region application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Region is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY region
  ABSTRACT SUPERTYPE OF (ONEOF (region_surface_list, region_projection,
     topological_region))
  SUBTYPE OF (manufacturing_feature);
  feature_placement: OPTIONAL axis2_placement_3d;
END_ENTITY;
```

4.2.286 Region_projection

The Region_projection application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Region_projection is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY region_projection
  SUBTYPE OF (region);
  proj_curve:   bounded_curve;
  proj_dir:     direction;
  depth:        toleranced_length_measure;
END_ENTITY;
```

4.2.287 Region_surface_list

The Region_surface_list application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Region_surface_list is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY region_surface_list
  SUBTYPE OF (region);
  surface_list:         LIST [1:?] OF bounded_surface;
END_ENTITY;
```

4.2.288 Replicate_feature

The Replicate_feature application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Replicate_feature is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY replicate_feature
  ABSTRACT SUPERTYPE OF (ONEOF(rectangular_pattern, circular_pattern, general_pattern))
  SUBTYPE OF (two5D_manufacturing_feature);
  replicate_base_feature:     two5D_manufacturing_feature;
END_ENTITY;
```

4.2.289 Return_home

The Return_home application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Return_home is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY return_home
  SUBTYPE OF (rapid_movement);
END_ENTITY;
```

4.2.290 Revolved_feature

The Revolved_feature application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Revolved_feature is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY revolved_feature
  ABSTRACT SUPERTYPE OF (ONEOF (revolved_round, revolved_flat, groove,
     general_revolution))
  SUBTYPE OF (turning_feature);
  material_side:        OPTIONAL direction;
  radius:               length_measure;
END_ENTITY;
```

4.2.291 Revolved_flat

The Revolved_flat application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Revolved_flat is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY revolved_flat
  SUBTYPE OF (revolved_feature);
  flat_edge_shape:      linear_profile;
END_ENTITY;
```

4.2.292 Revolved_round

The Revolved_round application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Revolved_round is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY revolved_round
  SUBTYPE OF (revolved_feature);
  rounded_edge_shape:   partial_circular_profile;
END_ENTITY;
```

4.2.293 Rot_speed_measure

A Rot_speed_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes a rotational speed.

NOTE As defined in ISO 14649-10, Rot_speed_measure does not explicitly specify a unit. Instead, a default unit of revolutions per second is defined for all rotational speeds. This part of ISO 10303 extends Rot_speed_measure to allow units to be explicitly specified using the “unit” attribute inherited from Value_with_unit. In addition, this measure may now qualified with a tolerance using the “limitation” attribute inherited from Value_with_tolerance.

4.2.294 Rotating_boring_cutting_tool

The Rotating_boring_cutting_tool application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Rotating_boring_cutting_tool is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY rotating_boring_cutting_tool
  SUBTYPE OF (milling_machine_cutting_tool);
  retract_movement_forbidden: BOOLEAN;
END_ENTITY;
```

4.2.295 Round_hole

The Round_hole application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

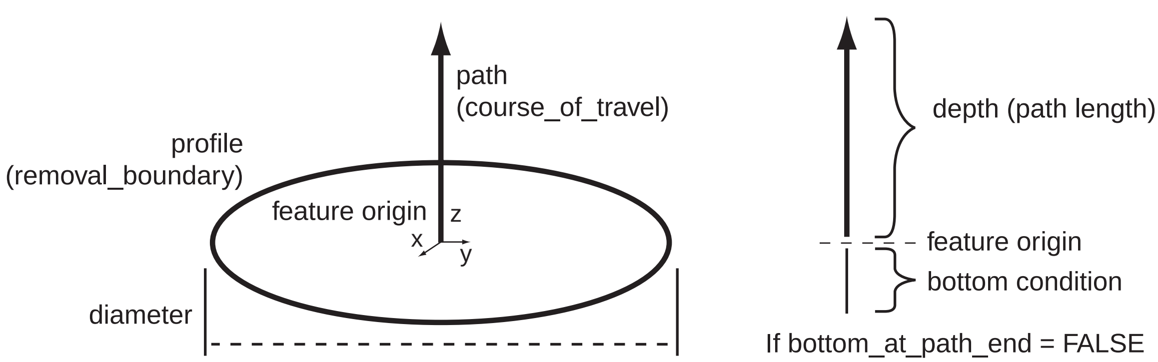

Figure 23 — Round_hole (bottom at path origin)

NOTE 1 The following properties have been added for harmonization with ISO 10303-224 and other ISO 10303 parts. Figure 23 illustrates the parameters of a Round_hole with the bottom condition located at the common origin of the feature, profile, and path (indicated by a value of FALSE for bottom_at_path_end). Figure 24 illustrates a Round_hole with the bottom condition located at the end of the course_of_travel path (indicated by a value of TRUE for bottom_at_path_end). Refer to 5.2.1.3.2 for additional discussion on the location of the feature origin and other aspects of the Round_hole application object.

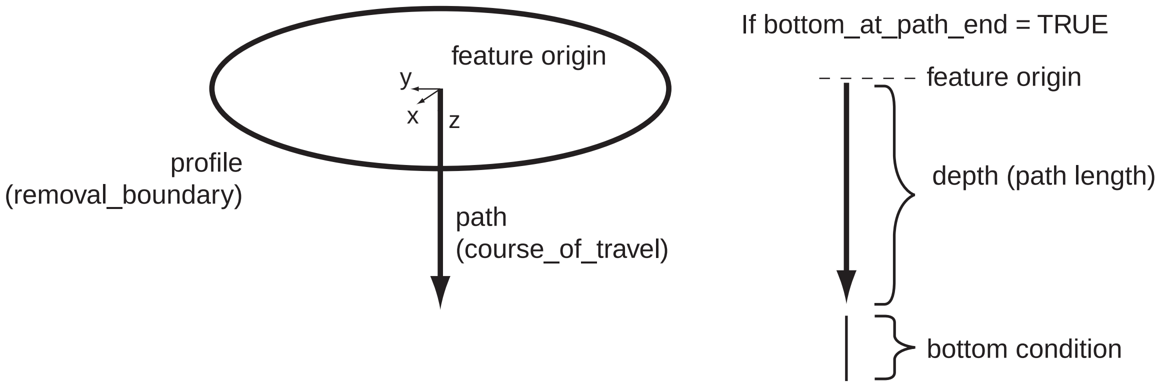

Figure 24 — Round_hole (bottom at path end)

The data associated with a Round_hole are the following:

— all of the data defined by ISO 14649-10;

— bottom_at_path_end;

— course_of_travel.

NOTE 2 The ISO 14649 EXPRESS description for Round_hole, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY round_hole
  SUBTYPE OF (machining_feature);
  diameter:             toleranced_length_measure;
  change_in_diameter:   OPTIONAL taper_select;
  bottom_condition:     hole_bottom_condition;
  bottom_at_path_end:   OPTIONAL BOOLEAN;  -- ADDED BY 10303-238
  course_of_travel:     linear_path;       -- ADDED BY 10303-238

WHERE
  WR1:  EXISTS (bottom_at_path_end) OR
        NOT ('BLIND_BOTTOM_CONDITION' IN TYPEOF(bottom_condition));
END_ENTITY;

TYPE taper_select = SELECT (diameter_taper, angle_taper);
END_TYPE;
```


4.2.295.1 bottom_at_path_end

The bottom_at_path_end specifies the location of the bottom_condition. The bottom_at_path_end shall have a value of TRUE if the bottom_condition is positioned at the end of the the course_of_travel path, and a value of FALSE if it is at the origin of course_of_travel path. This attribute shall only be specified if the hole bottom is of type Blind_bottom_condition.

NOTE In ISO 10303-224, this parameter is known as start_or_end and is located on the Blind_-bottom_condition application object. However, in the integrated representation, this value is represented by the feature component relationship that ties a hole bottom to a particular hole. This parameter has been moved to Round_hole to allow different values for different holes which may share the same hole bottom instance.

4.2.295.2 course_of_travel

The course_of_travel specifies a Linear_path along which the removal_boundary profile is swept to define the volume of the Round_hole. The placement and orientation of the course_of_travel shall be the same as the Round_hole feature. See 4.3.49 for the application assertion.

NOTE The length of the path is the depth of the hole.

4.2.296 Rounded_corner

The Rounded_corner application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Rounded_corner is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
ENTITY rounded_corner;
  corner_radius:        length_measure;
END_ENTITY;
```

4.2.297 Rounded_end

The Rounded_end application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Rounded_end is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY rounded_end
  SUBTYPE OF (machining_feature);
  course_of_travel:          linear_path;
  partial_circular_boundary: partial_circular_profile;
END_ENTITY;
```

4.2.298 Rounded_u_profile

The Rounded_u_profile application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Rounded_u_profile are the following:

— all of the data defined by ISO 14649-10;

— depth.

NOTE The ISO 14649 EXPRESS description for Rounded_u_profile, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY rounded_u_profile
  SUBTYPE OF (open_profile);
  width:        toleranced_length_measure;
  depth:        toleranced_length_measure;      -- ADDED BY 10303-238
END_ENTITY;
```

4.2.298.1 depth

The depth specifies the distance from the midpoint of the arc, along the radius of the arc, to the top of the profile.

NOTE Figure 25 illustrates the parameters associated with a Rounded_u_profile.

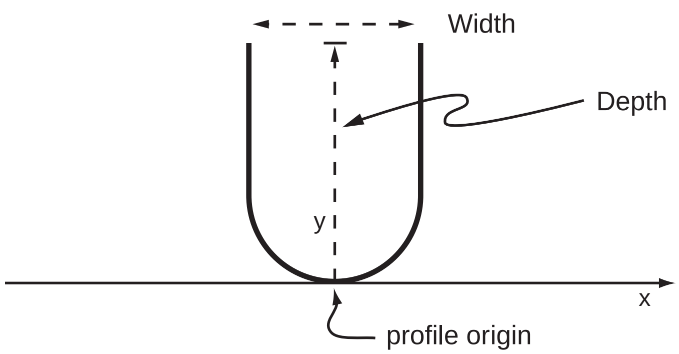

Figure 25 — Rounded_u_profile parameters

4.2.299 Roundness_tolerance

A Roundness_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a tolerance zone bounded by two concentric circles within which each circular element of a surface must lie. For a sphere, a circular element is all points of the surface intersected by any plane passing through a common center. For other surfaces, a circular element is all points of the surface intersected by any plane perpendicular to an axis. The Roundness_tolerance condition applies independently at any plane.

NOTE This definition has been harmonized with the Roundness_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. Figure 26 illustrates a Roundness_tolerance.

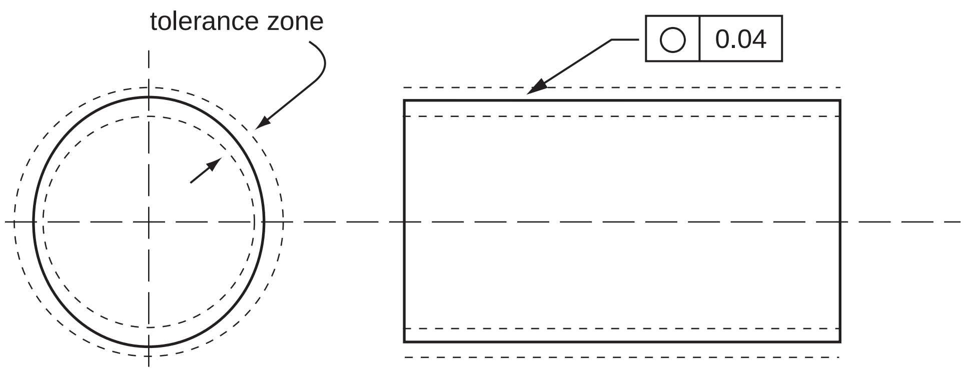

Figure 26 — Roundness_tolerance

4.2.300 Security_classification

A Security_classification is a level of confidentiality that can be applied to protect activity or product data against unauthorized usage.

NOTE This definition has been harmonized with the Security_classification definition in ISO 10303-1015.

The data associated with a Security_classification are the following:

— classification_level;

— description.

4.2.300.1 classification_level

The classification_level is text that specifies the required degree of security.

EXAMPLE 'confidential' is an example of classification_level that may be applied.

4.2.300.2 description

The description is text that provides further information about the Security_classification. The description need not be specified for a particular Security_classification.

4.2.301 Security_classification_assignment

A Security_classification_assignment is an association of a Security_classification with activity or product data.

NOTE This definition has been harmonized with the Security_classification_assignment definition in ISO 10303-1015.

The data associated with a Security_classification_assignment are the following:

— classification;

— items.

4.2.301.1 classification

The classification specifies the Security_classification assigned to activity or product data. See 4.3.53 for the application assertion.

4.2.301.2 items

The items specifies the set of projects, workpieces, executables, operations, or toolpaths to which the Security_classification applies. The items set shall contain at least one object. See 4.3.50, 4.3.51, 4.3.52, 4.3.54, and 4.3.55 for the application assertions.

4.2.302 Selective

The Selective application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Selective is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY selective
  SUBTYPE OF (program_structure);
  its_elements:   SET[2:?] OF executable;
END_ENTITY;
```

4.2.303 Set_mark

The Set_mark application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Set_mark is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY set_mark
  SUBTYPE OF (nc_function);
END_ENTITY;
```

4.2.304 Setup

The Setup application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Setup is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY setup;
  its_id:               identifier;
```



```
  its_origin:           OPTIONAL axis2_placement_3d;
  its_secplane:         elementary_surface;
  its_workpiece_setup:  LIST [0:?] OF workpiece_setup;
END_ENTITY;
```

4.2.305 Setup_instruction

The Setup_instruction application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Setup_instruction is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY setup_instruction;
  description:       OPTIONAL text;
  external_document: OPTIONAL identifier;
WHERE
  WR1: EXISTS (description) OR EXISTS (external_document);
END_ENTITY;
```

4.2.306 Shape_profile

The Shape_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Shape_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY shape_profile
  ABSTRACT SUPERTYPE OF(ONEOF(general_shape_profile,partial_circular_shape_profile,
    circular_closed_shape_profile,rectangular_open_shape_profile,
    rectangular_closed_shape_profile))
  SUBTYPE OF (profile_feature);
  floor_condition:      profile_select;
  removal_direction:    direction;
END_ENTITY;

TYPE profile_select = SELECT (through_profile_floor, profile_floor);
END_TYPE;
```

4.2.307 Shouldermill

The Shouldermill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Shouldermill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY shouldermill
  SUBTYPE OF (milling_cutting_tool);
END_ENTITY;
```

4.2.308 Side_finish_milling

The Side_finish_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Side_finish_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY side_finish_milling
  SUBTYPE OF (side_milling);
END_ENTITY;
```

4.2.309 Side_mill

The Side_mill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Side_mill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY side_mill
  SUBTYPE OF (milling_cutting_tool);
  cutter_width: length_measure;
END_ENTITY;
```

4.2.310 Side_milling

The Side_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Side_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY side_milling
  ABSTRACT SUPERTYPE OF (ONEOF(side_rough_milling, side_finish_milling))
  SUBTYPE OF (two5D_milling_operation);
  axial_cutting_depth:    OPTIONAL length_measure;
  radial_cutting_depth:   OPTIONAL length_measure;
  allowance_side:         OPTIONAL length_measure;
END_ENTITY;
```

4.2.311 Side_rough_milling

The Side_rough_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Side_rough_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY side_rough_milling
  SUBTYPE OF (side_milling);
WHERE
  WR1: EXISTS(SELF.allowance_side) AND (SELF.allowance_side>=0.0);
END_ENTITY;
```

4.2.312 Single_datum

A Single_datum is a type of Datum (see 4.2.100) that specifies a point, line, axis, or plane used as a reference for locating and orienting tolerance zones.

The data associated with a Single_datum are the following:

— datum_name;

— modification.

4.2.312.1 datum_name

The datum_name specifies the word or group of words by which the Single_datum is referred to.

EXAMPLE Typical names of Single_datum objects are ‘A’, ‘B’, or ‘C’.

4.2.312.2 modification

The modification specifies a Tolerance_condition that is associated with the application of the Single_datum. The modification need not be specified for a particular Single_datum. See 4.3.56 for the application assertion.

EXAMPLE Material conditions such as LMC or MMC are typical conditions.

4.2.313 Size_dimension

A Size_dimension is a type of Geometric_dimension (see 4.2.155) that specifies the size of an individual element of the shape of a part.

NOTE 1 This definition has been harmonized with the Size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Size_tolerance definition in ISO 10303-224.

NOTE 2 Size_dimension as defined in this part of ISO 10303 describe an intrinsic length or angle characteristic of part shape. This includes characteristics of what are traditionally called “features-of-size,” but they are not limited to that usage alone. For example, the radial_size_dimension and curved_size_dimension application objects describe characteristics which may not be applied to features-of-size.

The data associated with a Size_dimension are the following:

— applied_to;

— envelope_principle.

4.2.313.1 applied_to

The applied_to specifies the shape element to which the Size_dimension applies.

4.2.313.2 envelope_principle

The envelope_principle specifies whether or not the envelope principle applies to this size dimension. A value of 'true' indicates that the envelope principle applies. The envelope_principle need not be specified for a particular Size_dimension.

When the envelope principle applies, the envelope of the perfect shape corresponding to the maximum material shall not be larger than the specified dimension and tolerance. The envelope principle specifies that size and form tolerances are not additive.

NOTE The Envelope principle is defined in ISO 1101. It is equivalent to ASME Y14.5 rule 1. It may have counterparts in other standards.

4.2.314 Slot

The Slot application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Slot is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY slot
  SUBTYPE OF (machining_feature);
  course_of_travel:     travel_path;
  swept_shape:          open_profile;
  end_conditions:       LIST[0:2] OF slot_end_type;
WHERE
  WR1: (( SIZEOF(QUERY (it <* SELF.end_conditions |
        ('LOOP_SLOT_END_TYPE' IN TYPEOF(it)) )) = 1) AND
        (SIZEOF(end_conditions) = 1) ) OR
        (SIZEOF(end_conditions) <> 1);
END_ENTITY;
```

4.2.315 Slot_end_type

The Slot_end_type application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Slot_end_type is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY slot_end_type
  ABSTRACT SUPERTYPE OF (ONEOF (woodruff_slot_end_type, radiused_slot_end_type,
     flat_slot_end_type, loop_slot_end_type, open_slot_end_type));
END_ENTITY;
```

4.2.316 Spade_drill

The Spade_drill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Spade_drill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.


```
ENTITY spade_drill
  SUBTYPE OF (drilling_cutting_tool);
END_ENTITY;
```

4.2.317 Specification

The Specification application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Specification is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY specification;
  constraint:                SET [0:?] OF specification_usage_constraint;
  specification_id:          text;
  specification_description: OPTIONAL text;
  specification_class:       OPTIONAL text;
END_ENTITY;
```

4.2.318 Specification_usage_constraint

The Specification_usage_constraint application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Specification_usage_constraint is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY specification_usage_constraint;
  element:               text;
  class_id:              text;
END_ENTITY;
```

4.2.319 Speed_measure

A Speed_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes a linear speed.

NOTE As defined in ISO 14649-10, Speed_measure does not explicitly specify a unit. Instead, a default unit of meters per second is defined for all linear speeds. This part of ISO 10303 extends Speed_measure to allow units to be explicitly specified using the “unit” attribute inherited from Value_with_unit. In addition, this measure may now qualified with a tolerance using the “limitation” attribute inherited from Value_with_tolerance.

4.2.320 Spherical_cap

The Spherical_cap application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Spherical_cap is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY spherical_cap
  SUBTYPE OF (machining_feature);
  internal_angle:        numeric_parameter;
  radius:                numeric_parameter;
```



```
END_ENTITY;
```

4.2.321 Spherical_hole_bottom

The Spherical_hole_bottom application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Spherical_hole_bottom is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY spherical_hole_bottom
  SUBTYPE OF (blind_bottom_condition);
  radius: toleranced_length_measure;
END_ENTITY;
```

4.2.322 Spotdrill

The Spotdrill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Spotdrill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY spotdrill
  SUBTYPE OF (drilling_cutting_tool);
END_ENTITY;
```

4.2.323 Square_u_profile

The Square_u_profile application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Square_u_profile are the following:

— all of the data defined by ISO 14649-10;

— depth.

NOTE The ISO 14649 EXPRESS description for Square_u_profile, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY square_u_profile
  SUBTYPE OF (open_profile);
  width:                toleranced_length_measure;
  first_radius:         toleranced_length_measure;
  first_angle:          plane_angle_measure;
  second_radius:        toleranced_length_measure;
  second_angle:         plane_angle_measure;
  depth:                toleranced_length_measure;      -- ADDED BY 10303-238
END_ENTITY;
```


4.2.323.1 depth

The depth specifies the distance from the center of the base line, measured perpendicular to the base line, to the top of the profile.

NOTE Figure 27 illustrates the parameters associated with a Square_u_profile.

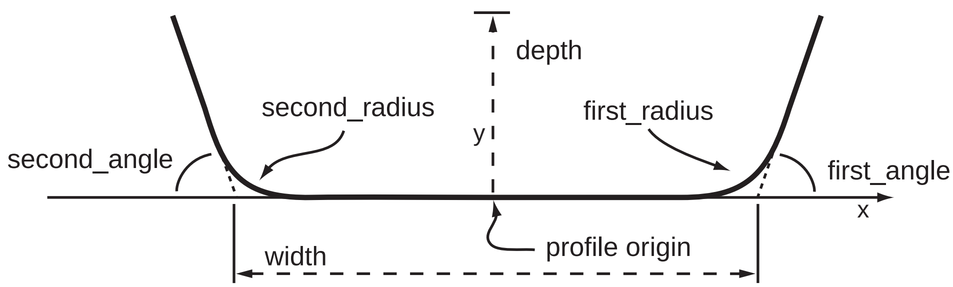

Figure 27 — Square_u_profile parameters

4.2.324 Step

The Step application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Step is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY step
  SUBTYPE OF (machining_feature);
  open_boundary:        linear_path;
  wall_boundary:        OPTIONAL vee_profile;
  its_boss:             SET[0:?] OF boss;
END_ENTITY;
```

4.2.325 Step_drill

The Step_drill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Step_drill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY step_drill
  SUBTYPE OF (drilling_cutting_tool);
  diameters:    LIST [1:?] of length_measure;
  step_length:  LIST [1:?] of length_measure;
END_ENTITY;
```

4.2.326 Straight_knurl

The Straight_knurl application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Straight_knurl is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY straight_knurl
  SUBTYPE OF (knurl);
END_ENTITY;
```

4.2.327 Straightness_tolerance

A Straightness_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies the allowable variation that a curve or any curve on a surface may have from being a straight line. It defines a tolerance zone within which the curve must lie.

NOTE This definition has been harmonized with the Straightness_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.1 of ISO 1101. Figure 28 illustrates a Straightness_tolerance.

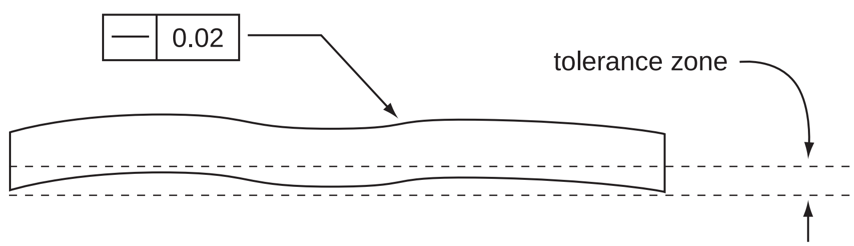

Figure 28 — Straightness_tolerance

The data associated with a Straightness_tolerance are the following:

— affected_plane.

4.2.327.1 affected_plane

The affected_plane specifies an axis placement, the X-Y plane of which establishes the plane in which the tolerance applies. The affected_plane need not be specified for a particular Straightness_tolerance.

4.2.328 Supplier_BSU

A Supplier_BSU is a type of BSU (see 4.2.40) that identifies the supplier of a parts library.

NOTE This definition has been harmonized with the Supplier_BSU definitions in ISO 10303-224 and ISO 10303-240.

4.2.329 Surface_profile_tolerance

A Surface_profile_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a uniform boundary along an ideal profile within which the elements of a surface must lie.

The tolerance zone established by a Surface_profile_tolerance is three dimensional, extending along the length and the width of the considered feature as a whole respectively along each segment of a defined size if the segment_size attribute is specified. If the tolerance is to be unequally disposed about the theoretically exact feature, a Tolerance_zone having only one boundary element is associated to the instance of Surface_profile_tolerance.

NOTE This definition has been harmonized with the Surface_profile_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.6 of ISO 1101. Figure 29 illustrates a Surface_profile_tolerance.

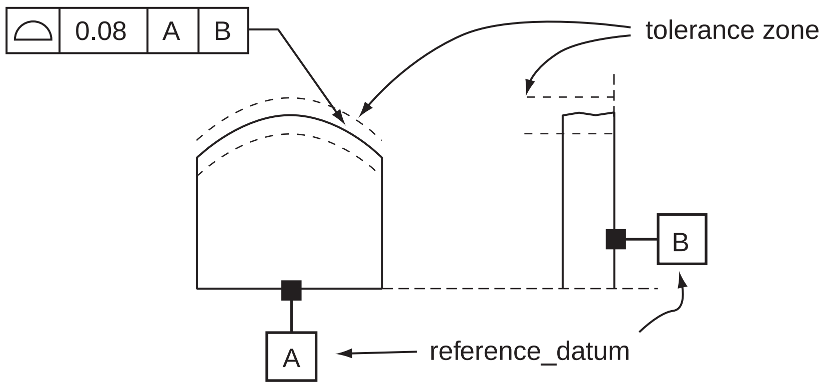

Figure 29 — Surface_profile_tolerance

The data associated with a Surface_profile_tolerance are the following:

— reference_datum.

4.2.329.1 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.57 for the application assertion.

4.2.330 Surface_property

A Surface_property is a type of General_property (see 4.2.151) that describes a specific characteristic about a surface condition of a Workpiece.

NOTE This definition has been harmonized with the Surface_property definitions in ISO 10303-224 and ISO 10303-240.

The data associated with a Surface_property are the following:

— is_surface_finish.

— surface_characteristics;

4.2.330.1 is_surface_finish

The is_surface_finish indicates whether or not the Surface_property is a surface finish.

4.2.330.2 surface_characteristics

The surface_characteristics specifies the set of Property_parameter objects that describe the Surface_property. The surface_characteristics need not be specified for a particular Surface_property. See 4.3.58 for the application assertion.

4.2.331 Surface_texture_parameter

The Surface_texture_parameter application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Surface_texture_parameter is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY surface_texture_parameter;
  its_value:           parameter_value;
  parameter_name:      label;
  measuring_method:    identifier;
  parameter_index:     OPTIONAL identifier;
  applied_surfaces:    SET [1:?] OF machined_surface;
END_ENTITY;
```

4.2.332 Symmetry_tolerance

A Symmetry_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a constraint on the amount of deviation a toleranced element may have from being symmetrical to a datum. Any edge or (median) plane of the part must lie in a tolerance zone limited by two parallel lines or planes, symmetrically located with respect to a datum.

NOTE This definition has been harmonized with the Symmetry_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.12 of ISO 1101. Figure 30 illustrates a Symmetry_tolerance.

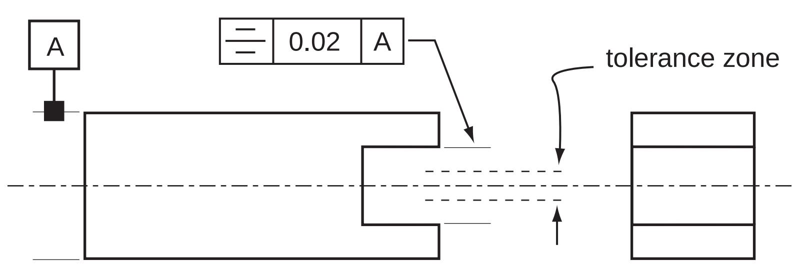

Figure 30 — Symmetry_tolerance

The data associated with a Symmetry_tolerance are the following:

— affected_plane;

— reference_datum.

4.2.332.1 affected_plane

The affected_plane specifies an axis placement, the X-Y plane of which establishes the plane in which the tolerance applies. The affected_plane need not be specified for a particular Symmetry_tolerance.

4.2.332.2 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.59 for the application assertion.

4.2.333 T_slot_mill

The T_slot_mill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for T_slot_mill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY t_slot_mill
  SUBTYPE OF (milling_cutting_tool);
  cutting_width: length_measure;
END_ENTITY;
```

4.2.334 Tapered_drill

The Tapered_drill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Tapered_drill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY tapered_drill
  SUBTYPE OF (twist_drill);
  taper_angle: plane_angle_measure;
END_ENTITY;
```

4.2.335 Tapered_reamer

The Tapered_reamer application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Tapered_reamer is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY tapered_reamer
  SUBTYPE OF (reaming_cutting_tool);
  taper_angle: plane_angle_measure;
END_ENTITY;
```


4.2.336 Tapping

The Tapping application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Tapping is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY tapping
  SUBTYPE OF (drilling_type_operation);
  compensation_chuck:   BOOLEAN;
END_ENTITY;
```

4.2.337 Tapping_cutting_tool

The Tapping_cutting_tool application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Tapping_cutting_tool is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY tapping_cutting_tool
  SUPERTYPE OF (combined_drill_and_tap)
  SUBTYPE OF (milling_machine_cutting_tool);
  thread_form_type:     STRING;
  thread_size:          length_measure;
  thread_pitch:         REAL;
  taper_thread_count:   REAL;
END_ENTITY;
```

4.2.338 Target_area

A Target_area is a type of Datum_target (see 4.2.105) that specifies an area bounded by a closed shape element. The shape of the Target_area is described explicitly by a set of curves with reference to the part coordinate system.

NOTE This definition has been harmonized with the Target_area definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224.

4.2.339 Target_circle

A Target_circle is a type of Placed_target (see 4.2.239) that specifies a Datum_target that is defined by an implicit circle. The location of the parameter_reference is the center of the circle, and the orientation of the Target_circle is the X-Y plane of the parameter_reference.

The data associated with a Target_circle are the following:

— diameter.

4.2.339.1 diameter

The diameter specifies the diameter of the Target_circle.

4.2.340 Target_point

A Target_circle is a type of Placed_target (see 4.2.239) that specifies a Datum_target that is defined by a single implicit point. The position of the Target_point is defined by the parameter_reference.

NOTE This definition has been harmonized with the Target_circle definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224.

4.2.341 Target_rectangle

A Target_rectangle is a type of Placed_target (see 4.2.239) that specifies a Datum_target that is defined by an implicit rectangle. The location of the parameter_reference is the center of the rectangle, and the orientation of the Target_rectangle is the X-Y plane with half the length of the rectangle in positive and half the length in negative direction along the X-axis and with half the width of the rectangle in positive and half the width in negative direction along the Y-axis.

NOTE This definition has been harmonized with the Target_rectangle definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224.

The data associated with a Target_rectangle are the following:

— target_length;

— target_width.

4.2.341.1 target_length

The target_length specifies the length of the Target_rectangle.

4.2.341.2 target_width

The target_width specifies the width of the Target_rectangle.

4.2.342 Target_straight_line

A Target_straight_line is a type of Placed_target (see 4.2.239) that specifies a Datum_target that is defined by a straight line. The first end point of the line is specified by the location of the parameter_reference. The second end point is located on the z-axis of the parameter_reference at the specified distance.

NOTE This definition has been harmonized with the Target_straight_line definition in ISO 10303-1051 as well as the Target_line definitions in ISO 10303-214 and ISO 10303-224.

The data associated with a Target_straight_line are the following:

— target_length.

4.2.342.1 target_length

The target_length specifies the length of the Target_straight_line.

4.2.343 Technology

The Technology application object is defined by clause 4.7 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Technology is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY technology
  ABSTRACT SUPERTYPE;
  feedrate:             OPTIONAL speed_measure;
  feedrate_reference:   tool_reference_point;
END_ENTITY;

TYPE tool_reference_point = ENUMERATION OF (tcp, ccp);
END_TYPE;
```

4.2.344 Tee_profile

The Tee_profile application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Tee_profile is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY tee_profile
  SUBTYPE OF (open_profile);
  first_angle:          plane_angle_measure;
  second_angle:         plane_angle_measure;
  cross_bar_width:      toleranced_length_measure;
  cross_bar_depth:      toleranced_length_measure;
  radius:               toleranced_length_measure;
  width:                toleranced_length_measure;
  first_offset:         toleranced_length_measure;
  second_offset:        toleranced_length_measure;
END_ENTITY;
```

4.2.345 Thickness_size_dimension

A Thickness_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in the thickness of an element of the product shape.

NOTE This definition has been harmonized with the Thickness_size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Thickness_tolerance definition in ISO 10303-224. Figure 31 illustrates a Thickness_size_dimension.

EXAMPLE A Thickness_size_dimension might be used to describe the remaining thickness below a blind hole or the thickness of a coating layer.

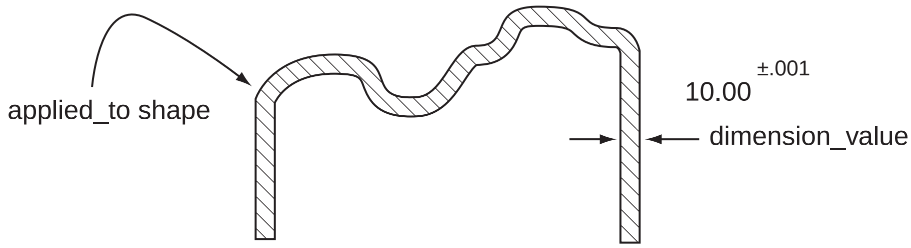

Figure 31 — Thickness_size_dimension

The data associated with a Thickness_size_dimension are the following:

— used_path.

4.2.345.1 used_path

The used_path specifies a Measurement_path along which the Thickness_size_dimension is measured. The used_path need not be specified for a particular Thickness_size_dimension. See 4.3.60 for the application assertion.

4.2.346 Thread

The Thread application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Thread is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY thread
  ABSTRACT SUPERTYPE OF(ONEOF(catalogue_thread, defined_thread))
  SUBTYPE OF(machining_feature);
  partial_profile:       partial_area_definition;
  applied_shape:         SET[1:?] OF machining_feature;
  inner_or_outer_thread: BOOLEAN;
  qualifier:             OPTIONAL descriptive_parameter;
  fit_class:             descriptive_parameter;
  form:                  descriptive_parameter;
  major_diameter:        length_measure;
  number_of_threads:     numeric_parameter;
  thread_hand:           descriptive_parameter;
WHERE
  WR1: ('ROUND_HOLE' IN TYPEOF(applied_shape)) OR
       ('CIRCULAR_CLOSED_SHAPE_PROFILE' IN TYPEOF(applied_shape)) OR
       ('BOSS' IN TYPEOF(applied_shape));
END_ENTITY;
```

4.2.347 Thread_drilling

The Thread_drilling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Thread_drilling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY thread_drilling
  SUBTYPE OF (drilling_type_operation);
  helical_movement_on_forward:    BOOLEAN;
END_ENTITY;
```

4.2.348 Thread_mill

The Thread_mill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Thread_mill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY thread_mill
  SUBTYPE OF (milling_cutting_tool);
  thread_form_type:     STRING;
  thread_size:          length_measure;
  thread_pitch:         REAL;
END_ENTITY;
```

4.2.349 Thread_strategy

The Thread_strategy application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Thread_strategy is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY thread_strategy
  SUBTYPE OF (turning_machining_strategy);
  cut_in_amount_function: thread_cut_depth_type;
  threading_direction: threading_direction_type;
  path_return_angle: OPTIONAL plane_angle_measure;
  lift_height: OPTIONAL length_measure;
END_ENTITY;

TYPE thread_cut_depth_type = ENUMERATION OF (
   constant_depth, variable_depth, constant_removal_amount);
END_TYPE;

TYPE threading_direction_type = ENUMERATION OF (
    left, right, center, left_zigzag, right_zigzag);
END_TYPE;
```

4.2.350 Threading

The Threading application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Threading is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY threading
  ABSTRACT SUPERTYPE OF (ONEOF(threading_rough, threading_finish))
```



```
    SUBTYPE OF (turning_machining_operation);
    allowance:    OPTIONAL length_measure;
  END_ENTITY;
```

4.2.351 Threading_finish

The Threading_finish application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Threading_finish is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
  ENTITY threading_finish
    SUBTYPE OF (threading);
  END_ENTITY;
```

4.2.352 Threading_rough

The Threading_rough application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Threading_rough is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
  ENTITY threading_rough
    SUBTYPE OF (threading);
  WHERE
    WR1: EXISTS(SELF.allowance) AND (SELF.allowance >= 0.0);
  END_ENTITY;
```

4.2.353 Three_axes

The Three_axes application object is defined by clause 4.7 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Three_axes is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
  ENTITY three_axes
    SUBTYPE OF (tool_direction);
  END_ENTITY;
```

4.2.354 Three_axes_tilted_tool

The Three_axes_tilted_tool application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Three_axes_tilted_tool is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
  ENTITY three_axes_tilted_tool
    SUBTYPE OF (tool_direction_for_milling);
    its_tool_direction:   direction;
  END_ENTITY;
```

4.2.355 Through_bottom_condition

The Through_bottom_condition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Through_bottom_condition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY through_bottom_condition
  SUBTYPE OF (hole_bottom_condition);
END_ENTITY;
```

4.2.356 Through_pocket_bottom_condition

The Through_pocket_bottom_condition application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Through_pocket_bottom_condition is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY through_pocket_bottom_condition
  SUBTYPE OF (pocket_bottom_condition);
END_ENTITY;
```

4.2.357 Through_profile_floor

The Through_profile_floor application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Through_profile_floor is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY through_profile_floor;
END_ENTITY;
```

4.2.358 Time_measure

A Time_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes a time duration.

NOTE As defined in ISO 14649-10, Time_measure does not explicitly specify a unit. Instead, a default unit of seconds is defined for all time durations. This part of ISO 10303 extends Time_measure to allow units to be explicitly specified using the “unit” attribute inherited from Value_with_unit. In addition, this measure may now qualified with a tolerance using the “limitation” attribute inherited from Value_with_tolerance.

4.2.359 Tolerance_condition

A Tolerance_condition specifies the material condition of a feature of size, which is its actual size with respect to its size tolerance.

NOTE The use of material conditions is defined in ISO 2692 [1].

4.2.359.1 condition

The condition specifies the kind of Tolerance_condition.

EXAMPLE Maximum material condition (MMC) and least material condition (LMC) are examples of conditions.

4.2.360 Tolerance_zone

A Tolerance_zone is the zone wherein all points of the toleranced element shall fall.

EXAMPLE Figure 32 illustrates a Tolerance_zone of a Straightness_tolerance with tolerance_value ‘0.1’ specified for a line.

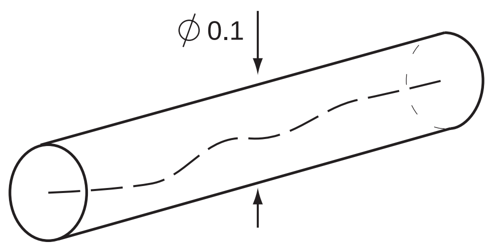

Figure 32 — Tolerance_zone

The data associated with a Tolerance_zone are the following:

— form_type;

— zone_for.

4.2.360.1 form_type

The form_type specifies the shape of the Tolerance_zone.

EXAMPLE 1 ‘cylindrical’, ‘parallelepiped’, or ‘spherical’ are examples of form_type.

EXAMPLE 2 A Surface_profile_tolerance has a tolerance zone that is based on the profile of the feature. The form_type is ‘profile’.

4.2.360.2 zone_for

The zone_for specifies the set of Geometric_tolerance objects for which the Tolerance_zone defines the zone. See 4.3.61 for the application assertion.

4.2.361 Tolerance_zone_definition

A Tolerance_zone_definition is the specification of the boundaries of a Tolerance_zone. Each Tolerance_zone_definition may be a Projection.

The data associated with a Tolerance_zone_definition are the following:

— defining;

— first_element;

— second_element.

4.2.361.1 defining

The defining specifies the Tolerance_zone that is specified by the Tolerance_zone_definition. See 4.3.62 for the application assertion.

4.2.361.2 first_element

The first_element specifies the shape element that represents the first or, in the case of a cylindrical tolerance zone, the only boundary of the Tolerance_zone_definition.

4.2.361.3 second_element

The second_element specifies the shape element that represents the second bounding element. The second_element need not be specified for a particular Tolerance_zone_definition.

4.2.362 Toleranced_length_measure

A Toleranced_length_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes a length.

NOTE As defined in ISO 14649-10, Toleranced_length_measure does not explicitly specify a unit. Instead, a default unit of millimeters is defined for all lengths. This part of ISO 10303 extends Toleranced_length_measure to allow units to be explicitly specified using the “unit” attribute inherited from Value_with_unit. In addition, the “theoretical_size” attribute defined by ISO 14649-10 is now the “value_component” attribute inherited from Value_with_unit, and the “implicit_tolerance” attribute is now “limitation” inherited from Value_with_tolerance.

4.2.363 Tolerances

The Tolerances application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Tolerances is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.


```
ENTITY tolerances;
  chordal_tolerance:    length_measure;
  scallop_height:       length_measure;
END_ENTITY;
```

4.2.364 Tool_direction

The Tool_direction application object is defined by clause 4.7 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Tool_direction is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY tool_direction
  ABSTRACT SUPERTYPE OF (ONEOF (two_axes, three_axes));
END_ENTITY;
```

4.2.365 Tool_direction_for_milling

The Tool_direction_for_milling application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Tool_direction_for_milling is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY tool_direction_for_milling
  ABSTRACT SUPERTYPE OF (ONEOF(three_axes_tilted_tool, five_axes_var_tilt_yaw,
     five_axes_const_tilt_yaw))
  SUBTYPE OF (tool_direction);
END_ENTITY;
```

4.2.366 Tool_knurl

The Tool_knurl application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Tool_knurl is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY tool_knurl
  SUBTYPE OF (knurl);
END_ENTITY;
```

4.2.367 Tool_length_probing

The Tool_length_probing application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Tool_length_probing is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY tool_length_probing
  SUBTYPE OF (tool_probing);
END_ENTITY;
```

4.2.368 Tool_probing

The Tool_probing application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Tool_probing is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY tool_probing
  ABSTRACT SUPERTYPE OF (ONEOF (tool_length_probing, tool_radius_probing))
  SUBTYPE OF (touch_probing);
  offset:       cartesian_point;
  max_wear:     length_measure;
  its_tool:     machining_tool;
END_ENTITY;
```

4.2.369 Tool_radius_probing

The Tool_radius_probing application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Tool_radius_probing is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY tool_radius_probing
  SUBTYPE OF (tool_probing);
END_ENTITY;
```

4.2.370 Tool_usage

A Tool_usage specifies a physical cutting tool that satisfies tool requirements such as those set forth by an instance of Machining_tool.

NOTE As one goes from higher level process descriptions (features and strategies) to lower level descriptions (explicit toolpaths), the tool requirements associated with an operation may become increasingly specific. At some point, it may become desirable to call out a specific tool that should be used to satisfy the requirements.

The data associated with a Tool_usage are the following:

— its_carousel;

— its_id;

— its_library_reference;

— its_position;

— its_product.

4.2.370.1 its_carousel

The its_carousel specifies a machine tool turret, magazine, or carousel. The its_carousel need not be specified for a particular Tool_usage.

4.2.370.2 its_id

The its_id specifies a word or group of words which identify the Tool_usage.

4.2.370.3 its_library_reference

The its_library_reference specifies an Externally_defined_representation object that identifies the tool whose associated product information is provided within an external specification or document. The its_library_reference need not be specified for a particular Tool_usage. See 4.3.64 for the application assertion.

EXAMPLE ISO 13399 [8] is one such external specification which describes various data about cutting tools and cutting tool assemblies, including reference dictionaries that describe tool properties.

4.2.370.4 its_position

The its_position specifies a location within a machine tool turret, magazine, or carousel. The its_position need not be specified for a particular Tool_usage.

4.2.370.5 its_product

The its_product specifies a Workpiece object that describes the physical shape and associated product information of the tool. The its_product need not be specified for a particular Tool_usage. See 4.3.63 for the application assertion.

4.2.371 Toolpath

The Toolpath application object is defined by clause 4.8 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Toolpath are the following:

— all of the data defined by ISO 14649-10;

— its_id.

NOTE The ISO 14649 EXPRESS description for Toolpath, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY toolpath
  ABSTRACT SUPERTYPE OF (ONEOF(feedstop, trajectory, parameterised_path));
  its_priority:                BOOLEAN;
  its_type:                    toolpath_type;
```



```
  its_speed:                    OPTIONAL toolpath_speedprofile;
  its_technology:               OPTIONAL technology;
  its_machine_functions:        OPTIONAL machine_functions;
  its_id:                       identifier;  -- ADDED BY 10303-238
END_ENTITY;

TYPE toolpath_type = ENUMERATION OF (
   approach, lift, connect, non_contact, contact, trajectory_path);
END_TYPE;

TYPE toolpath_speedprofile = SELECT (
   toolpath_speed, positive_ratio_measure, speed_name);
END_TYPE;

TYPE speed_name = ENUMERATION OF(RAPID);
END_TYPE;
```

4.2.371.1 its_id

The its_id specifies the string identifier of the Toolpath. The its_id need not be specified for a particular Toolpath.

4.2.372 Toolpath_feature

The Toolpath_feature application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Toolpath_feature is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY toolpath_feature
  SUBTYPE OF (machining_feature);
END_ENTITY;
```

4.2.373 Toolpath_list

The Toolpath_list application object is defined by clause 4.7 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Toolpath_list is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY toolpath_list;
  its_list: LIST [1:?] OF toolpath;
END_ENTITY;
```

4.2.374 Toolpath_speed

The Toolpath_speed application object is defined by clause 4.8 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Toolpath_speed are the following:

— all of the data defined by ISO 14649-10, as modified below for the speed attribute.

NOTE The ISO 14649 EXPRESS description for Toolpath_speed, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY toolpath_speed;
  speed:        bounded_curve; -- RELAXED BY 10303-238
WHERE
  WR1: speed\geometric_representation_item.dim = 1;
END_ENTITY;
```

4.2.374.1 speed

The speed parameter is defined by ISO 14649-10 to be of type b_spline_curve, but this part of ISO 10303 relaxes this requirement so that the speed shall be of the more general type bounded_curve. All constraints on the parameterisation of the curve defined by ISO 14649-10 shall remain in effect. See 5.2.1.6.1 for additional discussion on the curve parameterization requirements.

NOTE This relaxation allows the use of simpler polyline speed curves already present in sources such as existing APT/CL data without forcing reparameterisation of the data into a more complicated B-spline curve. Because the parameterisation contstraints remain in effect, the speed curve for a polyline basiccurve would be a polyline with the same distribution of points.

4.2.375 Topological_region

The Topological_region application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Topological_region is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY topological_region
  SUBTYPE OF (region, open_shell);
WHERE
  WR1: SIZEOF(QUERY(it <* SELF.cfs_faces | NOT('ADVANCED_FACE' IN TYPEOF(it)))) = 0;
END_ENTITY;
```

4.2.376 Total_runout_tolerance

A Total_runout_tolerance is a type of Geometric_tolerance (see 4.2.156) that specifies a constraint on a cylindrical surface with respect to a datum axis the part is rotated about. The tolerance is applied simultaneously to all positions as the part is rotated 360 degrees.

NOTE 1 Where applied to surfaces constructed around a datum axis, Total_runout_tolerance is used to control cumulative variations of circularity, straightness, coaxiality, angularity, taper, and profile of a surface.

NOTE 2 Where applied to surfaces constructed at right angles to a datum axis, Total_runout_tolerance controls cumulative variations or perpendicularity and flatness.

NOTE 3 This definition has been harmonized with the Total_runout_tolerance definitions in ISO 10303-1051, ISO 10303-214, and ISO 10303-224. This definition is derived from paragraph 14.13 of ISO 1101. Figure 33 illustrates a Total_runout_tolerance.

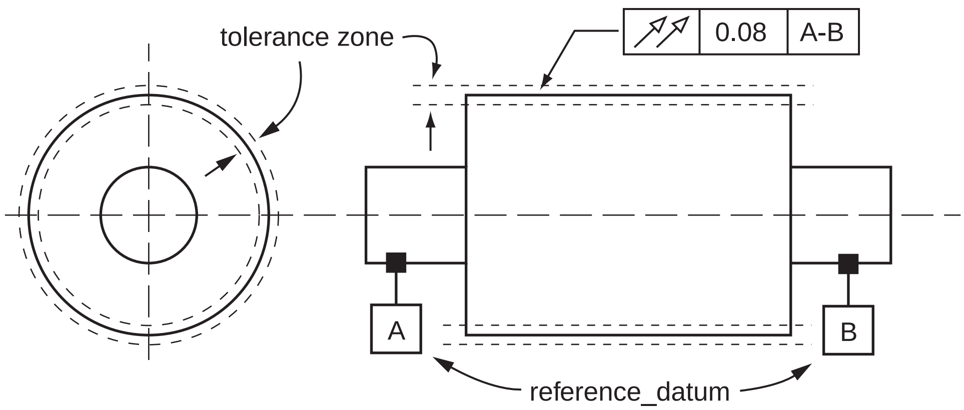

Figure 33 — Total_runout_tolerance

The data associated with a Total_runout_tolerance are the following:

— angle;

— reference_datum.

4.2.376.1 angle

The angle specifies the direction in which the runout tolerance is controlled. The angle need not be specified for a particular Total_runout_tolerance. If the angle is specified the runout tolerance applies for this angle. If not specified the runout tolerance applies normal to the shape element surface.

4.2.376.2 reference_datum

The reference_datum specifies the set of Datum_reference objects that define the reference frame for the geometric tolerance. See 4.3.65 for the application assertion.

4.2.377 Touch_probe

The Touch_probe application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Touch_probe is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY touch_probe;
  its_id: identifier;
END_ENTITY;
```

4.2.378 Touch_probing

The Touch_probing application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Touch_probing is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY touch_probing
  ABSTRACT SUPERTYPE OF (ONEOF (workpiece_probing, workpiece_complete_probing,
     tool_probing))
  SUBTYPE OF (workingstep, operation);
  measured_offset: nc_variable;
END_ENTITY;
```

4.2.379 Trajectory

The Trajectory application object is defined by clause 4.8 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Trajectory is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY trajectory
  ABSTRACT SUPERTYPE OF (ONEOF(cutter_location_trajectory, cutter_contact_trajectory,
     axis_trajectory))
  SUBTYPE OF (toolpath);
  its_direction:     OPTIONAL BOOLEAN;
END_ENTITY;
```

4.2.380 Transition_feature

The Transition_feature application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

NOTE 1 As described in 5.2.1.3.7, edge round and chamfer transition features may relate either two features or two sets of faces on the workpiece shape. At least one method must be used, and both may be used if desired. In ISO 14649-10, first_feature and second_feature are defined as required attributes, so this clause relaxes the original definition to allow them to be omitted if the other method is used. The Chamfer (See 4.2.45) and Edge_round (See 4.2.120) application objects describe the information requirements for the faces. In the AIM, the chamfer_requires_faces_or_features (See 5.2.4.4) and edge_round_requires_faces_or_features (See 5.2.4.8) global rules enforce the use of at least one of the methods.

The data associated with a Transition_feature are the following:

— all of the data defined by ISO 14649-10, as modified below for the first_feature and second_feature attributes.

NOTE 2 The ISO 14649 EXPRESS description for Transition_feature, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY transition_feature
  ABSTRACT SUPERTYPE OF (ONEOF(chamfer, edge_round))
  SUBTYPE OF (manufacturing_feature);
  first_feature:        OPTIONAL machining_feature; -- RELAXED BY 10303-238
  second_feature:       OPTIONAL machining_feature; -- RELAXED BY 10303-238
END_ENTITY;
```


4.2.380.1 first_feature

The first_feature machining_feature is required by ISO 14649-10, but this part of ISO 10303 relaxes this requirement so that the first_feature need not be specified for a particular Transition_feature.

4.2.380.2 second_feature

The second_feature machining_feature is required by ISO 14649-10, but this part of ISO 10303 relaxes this requirement so that the second_feature need not be specified for a particular Transition_feature.

4.2.381 Travel_path

The Travel_path application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Travel_path is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY travel_path
  ABSTRACT SUPERTYPE OF(ONEOF(general_path, linear_path, circular_path));
  placement:    OPTIONAL axis2_placement_3d;
END_ENTITY;
```

4.2.382 Turning_feature

The Turning_feature application object is defined by clause 4.2 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Turning_feature is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY turning_feature
  ABSTRACT SUPERTYPE OF (ONEOF(outer_round, revolved_feature, knurl))
  SUBTYPE OF (two5D_manufacturing_feature);
END_ENTITY;
```

4.2.383 Turning_machine_cutting_tool

The Turning_machine_cutting_tool application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Turning_machine_cutting_tool is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
ENTITY turning_machine_cutting_tool
SUBTYPE OF (machining_tool);
  functional_length:              length_measure;
  f_dimension:                    length_measure;
  minimum_cutting_diameter:       OPTIONAL length_measure;
  a_dimension_on_f:               OPTIONAL length_measure;
  a_dimension_on_lf:              OPTIONAL length_measure;
  cutting_edge:                   cutting_edge_properties;
  hand_of_tool:                   OPTIONAL hand_of_tool_type;
END_ENTITY;
```



```
TYPE hand_of_tool_type = ENUMERATION OF (left,right,neutral);
END_TYPE;
```

4.2.384 Turning_machine_functions

The Turning_machine_functions application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Turning_machine_functions is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY turning_machine_functions
  SUBTYPE OF (machine_functions);
  coolant:              BOOLEAN;
  coolant_type:         OPTIONAL coolant_select;
  coolant_pressure:     OPTIONAL pressure_measure;
  axis_clamping:        LIST [0:?] OF identifier;
  chip_removal:         OPTIONAL BOOLEAN;
  oriented_spindle_stop: OPTIONAL direction;
  its_process_model:    OPTIONAL process_model_list;
  other_functions:      SET [0:?] OF property_parameter;
  tail_stock:           OPTIONAL BOOLEAN;
  steady_rest:          OPTIONAL BOOLEAN;
  follow_rest:          OPTIONAL BOOLEAN;
END_ENTITY;

TYPE coolant_select = ENUMERATION OF (flood, mist, through_tool);
END_TYPE;
```

4.2.385 Turning_machining_operation

The Turning_machining_operation application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Turning_machining_operation is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY turning_machining_operation
  ABSTRACT SUPERTYPE OF (ONEOF(facing, grooving, contouring, threading, knurling))
  SUBTYPE OF (machining_operation);
  approach:                     OPTIONAL approach_retract_strategy;
  retract:                      OPTIONAL approach_retract_strategy;
  its_machining_strategy:       OPTIONAL turning_machining_strategy;
END_ENTITY;
```

4.2.386 Turning_machining_strategy

The Turning_machining_strategy application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Turning_machining_strategy is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY turning_machining_strategy
  ABSTRACT SUPERTYPE OF (ONEOF (unidirectional_turning, bidirectional_turning,
     thread_strategy, contour_turning, grooving_strategy, explicit_turning_strategy));
  overcut_length:               OPTIONAL length_measure;
```

```
    allow_multiple_passes:        OPTIONAL BOOLEAN;
    cutting_depth:                LIST[0:?] OF length_measure;
    variable_feedrate:            OPTIONAL positive_ratio_measure;
  END_ENTITY;
```

4.2.387 Turning_technology

The Turning_technology application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Turning_technology is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
  ENTITY turning_technology
    SUBTYPE OF (technology);
    spindle_speed:                speed_select;
    feed_per_revolution:      OPTIONAL feed_per_rev_type;
    sync_spindle_and_z_feed:      BOOLEAN;
    inhibit_feedrate_override:    BOOLEAN;
    inhibit_spindle_override:     BOOLEAN;
    its_adaptive_control:         OPTIONAL adaptive_control;
  WHERE
    WR1: (EXISTS(SELF.feedrate) AND
          NOT EXISTS(SELF.feed_per_revolution)) OR
          (NOT EXISTS(SELF.feedrate) AND EXISTS(SELF.feed_per_revolution));
  END_ENTITY;

  TYPE speed_select = SELECT (const_spindle_speed, const_cutting_speed);
  END_TYPE;
```

4.2.388 Turning_threading_tool

The Turning_threading_tool application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for Turning_threading_tool is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
  ENTITY turning_threading_tool
  SUBTYPE OF (turning_machine_cutting_tool);
    threading_pitch:      length_measure;
    thread_hand:          thread_hand_type;
    its_thread_type:      thread_type;
    thread_profile:       thread_profile_type;
    thread_form_type:     STRING;
  END_ENTITY;

  TYPE thread_hand_type = ENUMERATION OF (left, right);
  END_TYPE;

  TYPE thread_type = ENUMERATION OF (internal, external);
  END_TYPE;

  TYPE thread_profile_type = ENUMERATION OF (full_profile, partial_profile);
  END_TYPE;
```

4.2.389 Turning_workingstep

The Turning_workingstep application object is defined by clause 4.3 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Turning_workingstep is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY turning_workingstep
  SUBTYPE OF (workingstep);
  its_features:         LIST [2:?] OF manufacturing_feature;
  its_operation:        turning_machining_operation;
  its_effect:           OPTIONAL in_process_geometry;
END_ENTITY;
```

4.2.390 Twist_drill

The Twist_drill application object is defined by clause 4 of ISO 14649-111.

NOTE The ISO 14649 EXPRESS description for Twist_drill is shown below. Refer to ISO 14649-111 for the complete definition and explanation of usage.

```
ENTITY twist_drill
  SUPERTYPE OF (tapered_drill)
  SUBTYPE OF (drilling_cutting_tool);
END_ENTITY;
```

4.2.391 Two5d_manufacturing_feature

The Two5d_manufacturing_feature application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Two5d_manufacturing_feature is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY two5D_manufacturing_feature
  ABSTRACT SUPERTYPE OF (ONEOF(machining_feature, replicate_feature, compound_feature))
  SUBTYPE OF (manufacturing_feature);
  feature_placement:        axis2_placement_3d;
END_ENTITY;
```

4.2.392 Two5d_milling_operation

The Two5d_milling_operation application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Two5d_milling_operation is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY two5D_milling_operation
  ABSTRACT SUPERTYPE OF (ONEOF(plane_milling, side_milling, bottom_and_side_milling))
  SUBTYPE OF (milling_type_operation);
  its_machining_strategy: OPTIONAL two5D_milling_strategy;
END_ENTITY;
```

4.2.393 Two5d_milling_strategy

The Two5d_milling_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Two5d_milling_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY two5D_milling_strategy
  ABSTRACT SUPERTYPE OF (ONEOF (unidirectional, bidirectional, contour_parallel,
    bidirectional_contour, contour_bidirectional, contour_spiral, center_milling,
    explicit_strategy));
  overlap:                OPTIONAL positive_ratio_measure;
  allow_multiple_passes:  OPTIONAL BOOLEAN;
END_ENTITY;
```

4.2.394 Two_axes

The Two_axes application object is defined by clause 4.7 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Two_axes is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY two_axes
  SUBTYPE OF (tool_direction);
END_ENTITY;
```

4.2.395 Unary_boolean_expression

The Unary_boolean_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Unary_boolean_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY unary_boolean_expression
  ABSTRACT SUPERTYPE OF(not_expression)
  SUBTYPE OF (boolean_expression);
  operand: boolean_expression;
END_ENTITY;
```

4.2.396 Unidirectional

The Unidirectional application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Unidirectional is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY unidirectional
  SUBTYPE OF (two5D_milling_strategy);
  feed_direction:       OPTIONAL direction;
  cutmode:              OPTIONAL cutmode_type;
END_ENTITY;
```


4.2.397 Unidirectional_turning

The Unidirectional_turning application object is defined by clause 4.4 of ISO 14649-12.

NOTE The ISO 14649 EXPRESS description for Unidirectional_turning is shown below. Refer to ISO 14649-12 for the complete definition and explanation of usage.

```
ENTITY unidirectional_turning
  SUBTYPE OF (turning_machining_strategy);
  feed_direction:       OPTIONAL direction;
  back_path_direction:  OPTIONAL direction;
  lift_direction:       OPTIONAL direction;
  stepover_direction:   OPTIONAL direction;
  lift_height:          OPTIONAL length_measure;
  lift_feed:            OPTIONAL feed_select;
  stepover_feed:        OPTIONAL feed_select;
END_ENTITY;
```

4.2.398 Unload_tool

The Unload_tool application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Unload_tool is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY unload_tool
  SUBTYPE OF (nc_function);
  its_tool:     OPTIONAL machining_tool;
END_ENTITY;
```

4.2.399 User_defined_milling_tool

A User_defined_milling_tool is a type of Milling_machine_cutting_tool whose characteristics are either not known or lie outside of the set of milling tools described by ISO 10303-111.

NOTE ISO 10303-121 provides the User_defined_turning_tool definition for equivalent use in turning applications.

The data associated with a User_defined_milling_tool are the following:

— identifier.

4.2.399.1 identifer

The identifer specifies a word or group of words which identify the tool.

4.2.400 User_defined_turning_tool

The User_defined_turning_tool application object is defined by clause 4 of ISO 14649-121.

NOTE The ISO 14649 EXPRESS description for User_defined_turning_tool is shown below. Refer to ISO 14649-121 for the complete definition and explanation of usage.

```
ENTITY user_defined_turning_tool
  SUBTYPE OF (turning_machine_cutting_tool);
  identifier: label;
END_ENTITY;
```

4.2.401 Uv_strategy

The Uv_strategy application object is defined by clause 4 of ISO 14649-11.

NOTE The ISO 14649 EXPRESS description for Uv_strategy is shown below. Refer to ISO 14649-11 for the complete definition and explanation of usage.

```
ENTITY uv_strategy
  SUBTYPE OF (freeform_strategy);
  forward_direction:      direction;
  sideward_direction:     direction;
END_ENTITY;
```

4.2.402 Value_range

A Value_range is a pair of numerical values representing the range in which the value shall lie.

The data associated with a Value_range are the following:

— lower_range;

— significant_digits;

— upper_range.

4.2.402.1 lower_range

The lower_range specifies the lowest allowable value for a physical quantity.

4.2.402.2 significant_digits

The significant_digits specify the number of decimal digits indicating the accuracy of the lower limit and upper limit values. The significant_digits need not be specified for a particular Value_range.

4.2.402.3 upper_range

The upper_range specifies the highest allowable value for a physical quantity.

4.2.403 Value_with_tolerance

A Value_with_tolerance is a type of Value_with_unit (see 4.2.404) that qualifies the nominal value specified by Value_with_unit to specify the allowable variation of a physical quantity.

NOTE This application object is mapped to integrated definitions that have been harmonized across ISO 10303-1050, ISO 10303-214, and ISO 10303-224. The structure of the application object differs somewhat, due to the need in this part of ISO 10303 to combine both harmonized GD&T definitions as well as ISO 14649 concepts.

The data associated with a Value_with_tolerance are the following:

— limitation;

— significant_digits.

4.2.403.1 limitation

The limitation specifies the tolerance range, by either Limit_qualifier, Limits_and_fits, or Plus_minus_value for the physical quantity. The limitation need not be specified for a particular Value_with_tolerance. See 4.3.66, 4.3.67, and 4.3.68 for the application assertions.

4.2.403.2 significant_digits

The significant_digits specifies the number of decimal digits indicating the accuracy of the physical quantity. The significant_digits need not be specified for a particular Value_with_tolerance.

4.2.404 Value_with_unit

A Value_with_unit is the specification of a physical quantity by its value and its unit.

NOTE This definition has been harmonized with the Value_with_unit definitions in ISO 10303-1054.

The data associated with a Value_with_unit are the following:

— unit;

— value_component.

4.2.404.1 unit

The unit specifies the unit with which the physical quantity is expressed.

4.2.404.2 value_component

The value_component specifies the numeric value of the quantity.

4.2.405 Vee_profile

The Vee_profile application object is defined by clause 4.5 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Vee_profile are the following:

— all of the data defined by ISO 14649-10;

— first_side_length;

— second_side_length.

NOTE The ISO 14649 EXPRESS description for Vee_profile, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY vee_profile
  SUBTYPE OF (open_profile);
  profile_radius:      toleranced_length_measure;
  profile_angle:       plane_angle_measure;
  tilt_angle:          plane_angle_measure;
  first_side_length:   toleranced_length_measure;      -- ADDED BY 10303-238
  second_side_length:  toleranced_length_measure;      -- ADDED BY 10303-238
END_ENTITY;
```

4.2.405.1 first_side_length

The first_side_length indicates the distance, as measured from the profile origin, along the side of the vee located by the tilt_angle parameter.

4.2.405.2 second_side_length

The second_side_length indicates the distance, as measured from the profile origin, along the side of the vee located by the sum of the tilt_angle and profile_angle.

NOTE Figure 34 illustrates the parameters associated with a Vee_profile. The tilt_angle is shown as the angle between the first side and the X axis as originally defined by ISO 10303-224. The ISO 14649-10 definition does not clearly specify which side this angle is measured from.

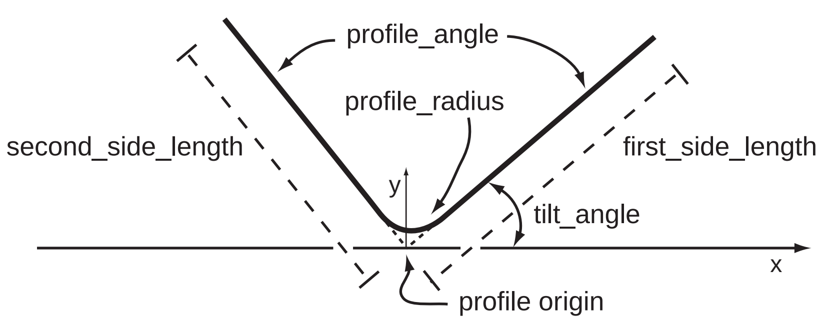

Figure 34 — Vee_profile parameters

4.2.406 Volume_measure

An Volume_measure is a type of Value_with_tolerance (see 4.2.403) in which the value_component describes a volume quantity.

4.2.407 Wait_for_mark

The Wait_for_mark application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Wait_for_mark is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY wait_for_mark
  SUBTYPE OF (nc_function);
  its_channel:  channel;
END_ENTITY;
```

4.2.408 While_statement

The While_statement application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for While_statement is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY while_statement
  SUBTYPE OF (program_structure);
  condition: boolean_expression;
  body:      executable;
END_ENTITY;
```

4.2.409 Width_size_dimension

A Width_size_dimension is a type of Size_dimension (see 4.2.313) that defines the allowable variation in the width of an element of the product shape.

NOTE This definition has been harmonized with the Width_size_dimension definitions in ISO 10303-1050 and ISO 10303-214, as well as the Width_dimension definition in ISO 10303-224.

The data associated with a Width_size_dimension are the following:

— used_path.

4.2.409.1 used_path

The used_path specifies a Measurement_path along which the Width_size_dimension is measured. The used_path need not be specified for a particular Width_size_dimension. See 4.3.69 for the application assertion.

4.2.410 Woodruff_slot_end_type

The Woodruff_slot_end_type application object is defined by clause 4.5 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Woodruff_slot_end_type is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY woodruff_slot_end_type
  SUBTYPE OF (slot_end_type);
  radius:               toleranced_length_measure;
END_ENTITY;
```

4.2.411 Workingstep

The Workingstep application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Workingstep is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY workingstep
  ABSTRACT SUPERTYPE OF (ONEOF (machining_workingstep, rapid_movement, touch_probing))
  SUBTYPE OF (executable);
  its_secplane:         elementary_surface;
END_ENTITY;
```

4.2.412 Workpiece

The Workpiece application object is defined by clause 4.4 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Workpiece are the following:

— all of the data defined by ISO 14649-10, as modified below for the its_geometry and its_bounding_geometry attributes;

— its_approvals;

— its_categories;

— its_components;

— its_datestamps;

— its_orgs;

— its_people;

— its_related_geometry;

— its_timestamps;

— product_approvals;

— product_datestamps;

— product_orgs;

— product_people;

— product_timestamps;

— revision_approvals;

— revision_datestamps;

— revision_id;

— revision_orgs;

— revision_people;

— revision_timestamps.

NOTE The ISO 14649 EXPRESS description for Workpiece, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY workpiece;
  its_id:                identifier;
  its_material:          OPTIONAL material;
  global_tolerance:      OPTIONAL length_measure;
  its_rawpiece:          OPTIONAL workpiece;
  its_geometry:          OPTIONAL shape_representation;  -- RELAXED BY 10303-238
  its_bounding_geometry: OPTIONAL bounding_geometry_select;
  clamping_positions:    SET [0:?] OF cartesian_point;

  -- ADDED BY 10303-238, fields for PDM information
  its_approvals:          SET [0:?] OF approval;
  its_categories:         SET [0:?] OF STRING;
  its_components:         SET [0:?] OF workpiece_assembly_component;
  its_datestamps:         SET [0:?] OF assigned_date;
  its_orgs:               SET [0:?] OF assigned_organization;
  its_people:             SET [0:?] OF assigned_person;
  its_related_geometry:   SET [0:?] OF shape_representation;
  its_timestamps:         SET [0:?] OF assigned_time;

  product_approvals:      SET [0:?] OF approval;
  product_datestamps:     SET [0:?] OF assigned_date;
  product_orgs:           SET [0:?] OF assigned_organization;
  product_people:         SET [0:?] OF assigned_person;
  product_timestamps:     SET [0:?] OF assigned_time;

 revision_approvals:     SET [0:?] OF approval;
  revision_datestamps:    SET [0:?] OF assigned_date;
  revision_id:            OPTIONAL identifier;
  revision_orgs:          SET [0:?] OF assigned_organization;
  revision_people:        SET [0:?] OF assigned_person;
  revision_timestamps:    SET [0:?] OF assigned_time;
```



```
END_ENTITY;

TYPE bounding_geometry_select = SELECT (
  block, right_circular_cylinder,
  advanced_brep_shape_representation,
  edge_based_wireframe_shape_representation,    -- ADDED BY 10303-238
  faceted_brep_shape_representation,            -- ADDED BY 10303-238
  geometrically_bounded_surface_shape_representation, -- ADDED BY 10303-238
  geometrically_bounded_wireframe_shape_representation, -- ADDED BY 10303-238
  manifold_surface_shape_representation,                -- ADDED BY 10303-238
  non_manifold_surface_shape_representation,    -- ADDED BY 10303-238
  shell_based_wireframe_shape_representation    -- ADDED BY 10303-238
);
END_TYPE;
```

4.2.412.1 its_geometry

The its_geometry parameter is defined by ISO 14649-10 to be of type advanced_brep_shape_representation, but this part of ISO 10303 relaxes this requirement so that its_geometry shall be of the more general type shape_representation.

NOTE This relaxation allows the use of shape representation types supported by other APs. In particular, the integrated representation allows the use of shapes described by AIC 501 (edge-based wireframe), AIC 502 (shell-based wireframe), AIC 507 (geometrically-bounded surfaces), AIC 508 (non-manifold surfaces), AIC 509 (manifold surfaces), AIC 510 (geometrically-bounded wireframe), and AIC 512 (faceted brep), as well as the original AIC 514 (advanced brep) descriptions.

4.2.412.2 its_bounding_geometry

The its_bounding_geometry parameter is defined by ISO 14649-10 to be of type block, right_circular_cylinder, or advanced_brep_shape_representation, but this part of ISO 10303 relaxes this requirement so that its_bounding_geometry may also be of type edge_based_wireframe_shape_-representation, faceted_brep_shape_representation, geometrically_bounded_surface_shape_representation, geometrically_bounded_wireframe_shape_representation, manifold_surface_shape_representation, non_manifold_surface_shape_representation, or shell_based_wireframe_shape_representation

.NOTE This relaxation allows the use of shape representation types supported by other APs. In particular, the integrated representation allows the use of shapes described by AIC 501 (edge-based wireframe), AIC 502 (shell-based wireframe), AIC 507 (geometrically-bounded surfaces), AIC 508 (non-manifold surfaces), AIC 509 (manifold surfaces), AIC 510 (geometrically-bounded wireframe), and AIC 512 (faceted brep), as well as the original AIC 514 (advanced brep) descriptions.

4.2.412.3 its_approvals

The its_approvals specifies the set of Approval objects that define the approval status of the manufacturing description of the revision given by the revision_id of the Workpiece. The its_approvals need not be specified for a particular Workpiece. See 4.3.70 for the application assertion.

4.2.412.4 its_categories

The its_categories specifies the set of names that identify categories that apply to the Workpiece. The its_categories need not be specified for a particular Workpiece. Where applicable, the following values shall be used:

— fixture: the Workpiece object describes the geometry and associated product information of a machining fixture used in the production of other machined parts;

— fixtured workpiece: the Workpiece object describes the geometry and associated product information of an assembly containing one or more fixtures and the final state of a machined part;

— rawpiece: the Workpiece object describes the initial state of a machined part;

— tool: the Workpiece object describes the geometry and associated product information of a machining tool;

NOTE A Workpiece object categorized as a tool may be present to describe a specific tool chosen to fullfill the tool requirements called out by a Machining_tool application object

— workpiece: the Workpiece object describes the final state of a machined part.

4.2.412.5 its_components

The its_components specifies the set of Workpiece_assembly_component objects that define the components of a Workpiece. The its_components need not be specified for a particular Workpiece. See 4.3.85 for the application assertion.

4.2.412.6 its_datestamps

The its_datestamps specifies the set of Assigned_date objects that define dates and associated roles that apply to the manufacturing description of the revision given by the revision_id of the Workpiece. The its_datestamps need not be specified for a particular Workpiece. See 4.3.73 for the application assertion.

4.2.412.7 its_orgs

The its_orgs specifies the set of Assigned_organization objects that define organizations and associated roles that apply to the manufacturing description of the revision given by the revision_id of the Workpiece. The its_orgs need not be specified for a particular Workpiece. See 4.3.76 for the application assertion.

4.2.412.8 its_people

The its_people specifies the set of Assigned_person objects that define people and associated roles that apply to the manufacturing description of the revision given by the revision_id of the Workpiece. The its_people need not be specified for a particular Workpiece. See 4.3.79 for the application assertion.

4.2.412.9 its_related_geometry

The its_related_geometry specifies the set of zero or more shape representations associated with the its_geometry shape representation to form the entire shape of the workpiece.

NOTE This parameter has been added for harmonization with ISO 10303-203 and ISO 10303-214 shape description of a part composed of shape constructs of multiple types of shape_representation. The most common usage is to specify the advanced brep shape of a workpiece as its_related_geometry while the its_geometry simply contains an axis2_placement_3d.

4.2.412.10 its_timestamps

The its_timestamps specifies the set of Assigned_time objects that define dates with times and associated roles that apply to the manufacturing description of the revision given by the revision_id of the Workpiece. The its_timestamps need not be specified for a particular Workpiece. See 4.3.82 for the application assertion.

4.2.412.11 product_approvals

The product_approvals specifies the set of Approval objects that define approval status across all revisions of the Workpiece. The product_approvals need not be specified for a particular Workpiece. See 4.3.71 for the application assertion.

4.2.412.12 product_datestamps

The product_datestamps specifies the set of Assigned_date objects that define dates and associated roles that apply across all revisions of the Workpiece. The product_datestamps need not be specified for a particular Workpiece. See 4.3.74 for the application assertion.

4.2.412.13 product_orgs

The product_orgs specifies the set of Assigned_organization objects that define organizations and associated roles that apply across all revisions of the Workpiece. The product_orgs need not be specified for a particular Workpiece. See 4.3.77 for the application assertion.

4.2.412.14 product_people

The product_people specifies the set of Assigned_person objects that define people and associated roles that apply across all revisions of the Workpiece. The product_people need not be specified for a particular Workpiece. See 4.3.80 for the application assertion.

4.2.412.15 product_timestamps

The product_timestamps specifies the set of Assigned_time objects that define dates with times and associated roles that apply across all revisions of the Workpiece. The product_timestamps need not be specified for a particular Workpiece. See 4.3.83 for the application assertion.

4.2.412.16 revision_approvals

The revision_approvals specifies the set of Approval objects that define the approval status of the revision given by the revision_id of the Workpiece. The revision_approvals need not be specified for a particular Workpiece. See 4.3.72 for the application assertion.

4.2.412.17 revision_datestamps

The revision_datestamps specifies the set of Assigned_date objects that define dates and associated roles that apply to the revision given by the revision_id of the Workpiece. The revision_datestamps need not be specified for a particular Workpiece. See 4.3.75 for the application assertion.

4.2.412.18 revision_id

The revision_id identifies the revision of the Workpiece. The revision_id need not be specified for a particular Workpiece.

4.2.412.19 revision_orgs

The revision_orgs specifies the set of Assigned_organization objects that define organizations and associated roles that apply to the revision given by the revision_id of the Workpiece. The revision_orgs need not be specified for a particular Workpiece. See 4.3.78 for the application assertion.

4.2.412.20 revision_people

The revision_people specifies the set of Assigned_person objects that define people and associated roles that apply to the revision given by the revision_id of the Workpiece. The revision_people need not be specified for a particular Workpiece. See 4.3.81 for the application assertion.

4.2.412.21 revision_timestamps

The revision_timestamps specifies the set of Assigned_time objects that define dates with times and associated roles that apply to the revision given by the revision_id of the Workpiece. The revision_timestamps need not be specified for a particular Workpiece. See 4.3.84 for the application assertion.

4.2.413 Workpiece_assembly_component

A Workpiece_assembly_component specifies the usage of a Workpiece as a component in an assembly, along with the geometric placement of the Workpiece within the assembly.

The data associated with a Workpiece_assembly_component are the following:

— component;

— originating_orientation;

— resulting_orientation;

— reference_designator.

4.2.413.1 component

The component specifies the release date of the Workpiece_assembly_component. See 4.3.86 for the application assertion.

4.2.413.2 originating_orientation

The originating_orientation specifies the placement of the component prior to being positioned in an assembly.

4.2.413.3 resulting_orientation

The resulting_orientation specifies the placement of the component within an assembly.

4.2.413.4 reference_designator

The reference_designator specifies a distinctive code that identifies the usage of the component in an assembly. The reference_designator need not be specified for a particular Workpiece_assembly_-component.

4.2.414 Workpiece_complete_probing

The Workpiece_complete_probing application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Workpiece_complete_probing is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY workpiece_complete_probing
  SUBTYPE OF (touch_probing);
  its_workpiece:        workpiece;
  probing_distance:     toleranced_length_measure;
  its_probe:            touch_probe;
  computed_offset:      offset_vector;
END_ENTITY;
```

4.2.415 Workpiece_probing

The Workpiece_probing application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Workpiece_probing is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY workpiece_probing
  SUBTYPE OF (touch_probing);
  start_position:       axis2_placement_3d;
  its_workpiece:        workpiece;
  its_direction:        direction;
  expected_value:       toleranced_length_measure;
```



```
  its_probe:            touch_probe;
END_ENTITY;
```

4.2.416 Workpiece_setup

The Workpiece_setup application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Workpiece_setup is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY workpiece_setup;
  its_workpiece:        workpiece;
  its_origin:           axis2_placement_3d;
  its_offset:           OPTIONAL offset_vector;
  its_restricted_area:  OPTIONAL restricted_area_select;
  its_instructions:     LIST [0:?] OF setup_instruction;
END_ENTITY;

TYPE restricted_area_select = SELECT (bounded_surface, bounding_geometry_select);
END_TYPE;
```

4.2.417 Workplan

The Workplan application object is defined by clause 4.6 of ISO 14649-10. This part of ISO 10303 adds the following information requirements.

The data associated with a Workplan are the following:

— all of the data defined by ISO 14649-10;

— its_minimum_machine_params.

NOTE The ISO 14649 EXPRESS description for Workplan, as adapted by this part of ISO 10303, is shown below. Refer to ISO 14649-10 for the original definition and explanation of usage.

```
ENTITY workplan
  SUBTYPE OF (program_structure);
  its_elements:                 LIST[0:?] OF executable;
  its_channel:                  OPTIONAL channel;
  its_setup:                    OPTIONAL setup;
  its_effect:                   OPTIONAL in_process_geometry;
  its_minimum_machine_params:   OPTIONAL machine_parameters; -- ADDED BY 10303-238
WHERE
   WR1: SIZEOF(QUERY(it <* its_elements | it = SELF)) = 0;
END_ENTITY;
```

4.2.417.1 its_minimum_machine_params

The its_minimum_machine_params specifies a Machine_parameters object which describe the minimum machine tool characteristics required to execute the workplan. The its_minimum_machine_-params need not be specified for a particular Workplan. See 4.3.87 for the application assertion.

4.2.418 Xor_expression

The Xor_expression application object is defined by clause 4.6 of ISO 14649-10.

NOTE The ISO 14649 EXPRESS description for Xor_expression is shown below. Refer to ISO 14649-10 for the complete definition and explanation of usage.

```
ENTITY xor_expression
  SUBTYPE OF (binary_boolean_expression);
END_ENTITY;
```

4.3 Application assertions

This subclause specifies the application assertions for the computerized numerical controllers application protocol. Application assertions specify the relationships between application objects, the cardinality of the relationships, and the rules required for the integrity and validity of the application objects and UoFs. The application assertions and their definitions are given below.

NOTE The application assertions specified below pertain only to the application objects defined by this part of ISO 10303. All assertions governing the relationships between application objects defined in ISO 14649 are specified in ISO 14649.

4.3.1 Angularity_tolerance to Datum_reference

Each Angularity_tolerance refers to one or two Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Angularity_tolerance objects.

4.3.2 Approval to Approval_status

Each Approval has exactly one Approval_status as status. Each Approval_status is the status of one or more Approval.

4.3.3 Approval_relationship to Approval (as related_approval)

Each Approval_relationship has exactly one Approval as related_approval. Each Approval is the related_approval of zero or more Approval_relationship.

4.3.4 Approval_relationship to Approval (as relating_approval)

Each Approval_relationship has exactly one Approval as relating_approval. Each Approval is the relating_approval of zero or more Approval_relationship.

4.3.5 Approving_person_organization to Approval

Each Approving_person_organization has exactly one Approval as authorized_approval. Each Approval is the authorized_approval of one or more Approving_person_organization.

4.3.6 Boss to Linear_path

Each Boss has exactly one Linear_path as boss_height. Each Linear_path is the boss_height of zero or more Boss.

4.3.7 Circular_runout_tolerance to Datum_reference

Each Circular_runout_tolerance refers to one or two Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Circular_runout_tolerance objects.

4.3.8 Class_BSU to Supplier_BSU

Each Class_BSU refers to exactly one Supplier_BSU object as defined_by. Each Supplier_BSU acts as defined_by for zero or more Class_BSU objects.

4.3.9 Coaxiality_tolerance to Datum_reference

Each Coaxiality_tolerance refers to one or two Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Coaxiality_tolerance objects.

4.3.10 Common_datum to Single_datum

Each Common_datum refers to two or more Single_datum objects as made_up_by. Each Single_datum is related to zero or more Common_datum objects.

4.3.11 Concentricity_tolerance to Datum_reference

Each Concentricity_tolerance refers to one or two Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Concentricity_tolerance objects.

4.3.12 Curved_distance_dimension to Measurement_path

Each Curved_distance_dimension has exactly one Measurement_path as used_path. Each Measurement_path is the used_path of zero or more Curved_distance_dimension.

4.3.13 Datum_defined_by_targets to Datum_target

Each Datum_defined_by_targets refers to one or more Datum_target objects as defined_by. Each Datum_target acts as target for zero or more Datum_defined_by_targets objects.

4.3.14 Datum_reference to Datum

Each Datum_reference refers to exactly one Datum object as referenced_datum. Each Datum acts as referenced_datum for zero or more Datum_reference objects.

4.3.15 Externally_defined_representation to Library_part_assignment

Each Externally_defined_representation refers to exactly one Library_part_assignment object as identified_by. Each Library_part_assignment acts as identified_by for zero or more Externally_-defined_representation objects.

4.3.16 Externally_defined_size_dimension to Measurement_path

Each Externally_defined_size_dimension has at most one Measurement_path as used_path. Each Measurement_path is the used_path of zero or more Externally_defined_size_dimension.

4.3.17 General_property to General_property

Each General_property refers to zero or more General_property objects as related_properties. Each General_property is the related_properties of one or more General_property objects.

4.3.18 General_property to Specification

Each General_property refers to zero or more Specification objects as specifications. Each Specification is the specifications of zero or more General_property objects.

4.3.19 General_property to Workpiece

Each General_property has zero or one Workpiece as owner. Each Workpiece is the owner of zero or more General_property objects.

4.3.20 Geometric_dimension to Value_range

Each Geometric_dimension has at most one Value_range as dimension_value. Each Value_range is the dimension_value of zero or more Geometric_dimension.

4.3.21 Geometric_dimension to Value_with_tolerance

Each Geometric_dimension has at most one Value_with_tolerance as dimension_value. Each Value_with_tolerance is the dimension_value of zero or more Geometric_dimension.

4.3.22 Geometric_tolerance to Tolerance_condition

Each Geometric_tolerance has at most one Tolerance_condition as modification. Each Tolerance_condition is the dimension_value of zero or more Geometric_tolerance.

4.3.23 Geometric_tolerance_relationship to Geometric_tolerance (as relating)

Each Geometric_tolerance_relationship has exactly one Geometric_tolerance as relating. Each Geometric_tolerance is the relating of zero or more Geometric_tolerance_relationship.

4.3.24 Geometric_tolerance_relationship to Geometric_tolerance (as related)

Each Geometric_tolerance_relationship has exactly one Geometric_tolerance as related. Each Geometric_tolerance is the related of zero or more Geometric_tolerance_relationship.

4.3.25 Height_size_dimension to Measurement_path

Each Height_size_dimension has at most one Measurement_path as used_path. Each Measurement_path is the used_path of zero or more Height_size_dimension.

4.3.26 Last_modified_timestamp to Executable

Each Last_modified_timestamp has zero or more Executable as items. Each Executable is the items of at most one Last_modified_timestamp.

4.3.27 Last_modified_timestamp to Operation

Each Last_modified_timestamp has zero or more Operation as items. Each Operation is the items of at most one Last_modified_timestamp.

4.3.28 Last_modified_timestamp to Project

Each Last_modified_timestamp has zero or more Project as items. Each Project is the items of at most one Last_modified_timestamp.

4.3.29 Last_modified_timestamp to Toolpath

Each Last_modified_timestamp has zero or more Toolpath as items. Each Toolpath is the items of at most one Last_modified_timestamp.

4.3.30 Last_modified_timestamp to Workpiece

Each Last_modified_timestamp has zero or more Workpiece as items. Each Workpiece is the items of at most one Last_modified_timestamp.

4.3.31 Length_size_dimension to Measurement_path

Each Length_size_dimension has at most one Measurement_path as used_path. Each Measurement_path is the used_path of zero or more Length_size_dimension.

4.3.32 Library_part_assignment to Class_BSU

Each Library_part_assignment refers to exactly one Class_BSU object as definitional_class_bsu. Each Class_BSU acts as value_property_bsu for zero or more Library_part_assignment objects.

4.3.33 Library_part_assignment to Library_property_value

Each Library_part_assignment refers to zero or more Library_property_value object as definitional_-property_value_pairs. Each Library_property_value acts as definitional_property_value_pairs for zero or more Library_part_assignment objects.

4.3.34 Library_property_value to Property_BSU

Each Library_property_value refers to exactly one Property_BSU object as value_property_bsu. Each Property_BSU acts as value_property_bsu for zero or more Library_property_value objects.

4.3.35 Line_profile_tolerance to Datum_reference

Each Line_profile_tolerance refers to zero, one, two, or three Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Line_profile_tolerance objects.

4.3.36 Machine_parameters to Machine_axis_travel

Each Machine_parameters refers to zero or more Machine_axis_travel objects as axis_travel. Each Machine_axis_travel acts as axis_travel for one or more Machine_parameters objects.

4.3.37 Machining_tool to Tool_usage

Each Machining_tool refers to zero or one Tool_usage objects as its_usage. Each Tool_usage acts as its_usage for zero or more Machining_tool objects.

4.3.38 Machining_workingstep to Manufacturing_feature (as final_features)

Each Machining_workingstep has zero or more Manufacturing_feature as final_features. Each Manufacturing_feature is the final_features of zero or more Machining_workingstep.

4.3.39 Material_property to Hardness

Each Material_property refers to zero or more Hardness objects as material_hardness. Each Hardness is the material_hardness of one or more Material_property objects.

4.3.40 Material_property to Property_parameter

Each Material_property refers to zero or more Property_parameter objects as material_characteristics. Each Property_parameter is the material_characteristics of zero or more Material_property objects.

4.3.41 Milling_machine_functions to Machine_axis_constraint

Each Milling_machine_functions has zero or more Machine_axis_constraint as axis_constraints. Each Machine_axis_constraint is the axis_constraints of at least one Milling_machine_functions.

4.3.42 Parallelism_tolerance to Datum_reference

Each Parallelism_tolerance refers to one or two Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Parallelism_tolerance objects.

4.3.43 Part_property to Property_parameter

Each Part_property refers to zero or more Property_parameter objects as part_characteristics. Each Property_parameter is the part_characteristics of zero or more Part_property objects.

4.3.44 Perpendicularity_tolerance to Datum_reference

Each Perpendicularity_tolerance refers to one, two, or three Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Perpendicularity_tolerance objects.

4.3.45 Pocket to Linear_path

Each Pocket has exactly one Linear_path as course_of_travel. Each Linear_path is the course_of_-travel of zero or more Pocket.

4.3.46 Position_tolerance to Datum_reference

Each Position_tolerance refers to zero, one, two, or three Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Position_tolerance objects.

4.3.47 Process_property to Property_parameter

Each Process_property refers to zero or more Property_parameter objects as process_characteristics. Each Property_parameter is the process_characteristics of zero or more Process_property objects.

4.3.48 Property_BSU to Class_BSU

Each Property_BSU refers to exactly one Class_BSU object as name_scope. Each Class_BSU acts as name_scope for zero or more Property_BSU objects.

4.3.49 Round_hole to Linear_path

Each Round_hole has exactly one Linear_path as course_of_travel. Each Linear_path is the course_-of_travel of zero or more Round_hole.

4.3.50 Security_classification_assignment to Executable

Each Security_classification_assignment has zero or more Executable as items. Each Executable is the items of at most one Security_classification_assignment.

4.3.51 Security_classification_assignment to Operation

Each Security_classification_assignment has zero or more Operation as items. Each Operation is the items of at most one Security_classification_assignment.

4.3.52 Security_classification_assignment to Project

Each Security_classification_assignment has zero or more Project as items. Each Project is the items of at most one Security_classification_assignment.

4.3.53 Security_classification_assignment to Security_classification

Each Security_classification_assignment has exactly one Security_classification as classification. Each Security_classification is the classification of one or more Security_classification_assignment.

4.3.54 Security_classification_assignment to Toolpath

Each Security_classification_assignment has zero or more Toolpath as items. Each Toolpath is the items of at most one Security_classification_assignment.

4.3.55 Security_classification_assignment to Workpiece

Each Security_classification_assignment has zero or more Workpiece as items. Each Workpiece is the items of at most one Security_classification_assignment.

4.3.56 Single_datum to Tolerance_condition

Each Single_datum refers to zero or one Tolerance_condition as modification. Each Tolerance_condition acts as modification for zero or more Single_datum objects.

4.3.57 Surface_profile_tolerance to Datum_reference

Each Surface_profile_tolerance refers to zero, one, two, or three Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Surface_profile_tolerance objects.

4.3.58 Surface_property to Property_parameter

Each Surface_property refers to zero or more Property_parameter objects as surface_characteristics. Each Property_parameter is the surface_characteristics of zero or more Surface_property objects.

4.3.59 Symmetry_tolerance to Datum_reference

Each Symmetry_tolerance refers to one, two, or three Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Symmetry_tolerance objects.

4.3.60 Thickness_size_dimension to Measurement_path

Each Thickness_size_dimension has at most one Measurement_path as used_path. Each Measurement_path is the used_path of zero or more Thickness_size_dimension.

4.3.61 Tolerance_zone to Geometric_tolerance

Each Tolerance_zone has one or more Geometric_tolerance objects as zone_for. Each Geometric_tolerance is related to zero or more Tolerance_zone objects.

4.3.62 Tolerance_zone_definition to Tolerance_zone

Each Tolerance_zone_definition has exactly one Tolerance_zone as defining. Each Tolerance_zone is related to zero or more Tolerance_zone_definition objects.

4.3.63 Tool_usage to Workpiece

Each Tool_usage refers to zero or one Workpiece objects as its_product. Each Workpiece acts as its_product for zero or more Tool_usage objects.

4.3.64 Tool_usage to Externally_defined_representation

Each Tool_usage refers to zero or one Externally_defined_representation objects as its_library_reference. Each Externally_defined_representation acts as its_library_reference for zero or more Tool_usage objects.

4.3.65 Total_runout_tolerance to Datum_reference

Each Total_runout_tolerance refers to one or two Datum_reference objects as reference_datum. Each Datum_reference acts as reference_datum for zero or more Total_runout_tolerance objects.

4.3.66 Value_with_tolerance to Limit_qualifier

Each Value_with_tolerance has at most one Limit_qualifier as limitation. Each Limit_qualifier is the limitation of zero or more Value_with_tolerance.

4.3.67 Value_with_tolerance to Limits_and_fits

Each Value_with_tolerance has at most one Limits_and_fits as limitation. Each Limits_and_fits is the limitation of zero or more Value_with_tolerance.

4.3.68 Value_with_tolerance to Plus_minus_value

Each Value_with_tolerance has at most one Plus_minus_value as limitation. Each Plus_minus_value is the limitation of zero or more Value_with_tolerance.

4.3.69 Width_size_dimension to Measurement_path

Each Width_size_dimension has at most one Measurement_path as used_path. Each Measurement_path is the used_path of zero or more Width_size_dimension.

4.3.70 Workpiece to Approval (as its_approvals)

Each Workpiece has zero or more Approval objects as its_approvals. Each Approval is the its_approvals of zero or more Workpiece.

4.3.71 Workpiece to Approval (as product_approvals)

Each Workpiece has zero or more Approval objects as product_approvals. Each Approval is the product_approvals of zero or more Workpiece.

4.3.72 Workpiece to Approval (as revision_approvals)

Each Workpiece has zero or more Approval objects as revision_approvals. Each Approval is the revision_approvals of zero or more Workpiece.

4.3.73 Workpiece to Assigned_date (as its_datestamps)

Each Workpiece has zero or more Assigned_date objects as its_datestamps. Each Assigned_date is the its_datestamps of zero or more Workpiece.

4.3.74 Workpiece to Assigned_date (as product_datestamps)

Each Workpiece has zero or more Assigned_date objects as product_datestamps. Each Assigned_date is the product_datestamps of zero or more Workpiece.

4.3.75 Workpiece to Assigned_date (as revision_datestamps)

Each Workpiece has zero or more Assigned_date objects as revision_datestamps. Each Assigned_date is the revision_datestamps of zero or more Workpiece.

4.3.76 Workpiece to Assigned_organization (as its_orgs)

Each Workpiece has zero or more Assigned_organization objects as its_orgs. Each Assigned_organization is the its_orgs of zero or more Workpiece.

4.3.77 Workpiece to Assigned_organization (as product_orgs)

Each Workpiece has zero or more Assigned_organization objects as product_orgs. Each Assigned_-organization is the product_orgs of zero or more Workpiece.

4.3.78 Workpiece to Assigned_organization (as revision_orgs)

Each Workpiece has zero or more Assigned_organization objects as revision_orgs. Each Assigned_-organization is the revision_orgs of zero or more Workpiece.

4.3.79 Workpiece to Assigned_person (as its_people)

Each Workpiece has zero or more Assigned_person objects as its_people. Each Assigned_person is the its_people of zero or more Workpiece.

4.3.80 Workpiece to Assigned_person (as product_people)

Each Workpiece has zero or more Assigned_person objects as product_people. Each Assigned_person is the product_people of zero or more Workpiece.

4.3.81 Workpiece to Assigned_person (as revision_people)

Each Workpiece has zero or more Assigned_person objects as revision_people. Each Assigned_person is the revision_people of zero or more Workpiece.

4.3.82 Workpiece to Assigned_time (as its_timestamps)

Each Workpiece has zero or more Assigned_time objects as its_timestamps. Each Assigned_time is the its_timestamps of zero or more Workpiece.

4.3.83 Workpiece to Assigned_time (as product_timestamps)

Each Workpiece has zero or more Assigned_time objects as product_timestamps. Each Assigned_time is the product_timestamps of zero or more Workpiece.

4.3.84 Workpiece to Assigned_time (as revision_timestamps)

Each Workpiece has zero or more Assigned_time objects as revision_timestamps. Each Assigned_time is the revision_timestamps of zero or more Workpiece.

4.3.85 Workpiece to Workpiece_assembly_component

Each Workpiece has zero or more Workpiece_assembly_component objects as its_components. Each Workpiece_assembly_component is the its_components of exactly one Workpiece.

4.3.86 Workpiece_assembly_component to Workpiece

Each Workpiece_assembly_component has exactly one Workpiece as component. Each Workpiece is the component of zero or more Workpiece_assembly_component.

4.3.87 Workplan to Machine_parameters

Each Workplan refers to zero or one Machine_parameters object as its_minimum_machine_params. Each Machine_parameters acts as its_minimum_machine_params for zero or more Workplan objects.

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.

NOTE It is customary to present mapping tables in alphabetical order by UoF name, however this part of ISO 10303 presents the mapping table in the same order as they appear in clause 4.1. This ordering matches the ordering of clauses in the ISO 14649 parts and is intended to simplify reference between these documents."

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;

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.

n) *: used in conjunction with braces to indicate that any number of relationship entity data types may be assembled in a relationship tree structure

Table 1 — Mapping table for measure UoF

Application element	AIM element	Source	Rules	Reference path
AREA_MEASURE	measure_representation_item	10303-45		measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = area_measure area_measure }
LENGTH_MEASURE	[length_measure_with_unit] [measure_representation_item]	10303-41 10303-45		length_measure_with_unit <= measure_with_unit => { measure_with_unit.value_component -> measure_value measure_value = length_measure length_measure } measure_representation_item <= representation_item
LIMITS_AND_FITS #1: if used as the limitation of a value_with_tolerance that is the dimension_value of a geometric_dimension #2: if otherwise See NOTE 1	#1: (limits_and_fits) #2: (qualified_representation_item)	10303-47 10303-45		

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
deviation	#1: (limits_and_fits.form_variance) #2: (qualitative_uncertainty. uncertainty_value)	10303-47 10303-45		#1: (limits_and_fits limits_and_fits.form_variance) #2: (qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = uncertainty_qualifier { uncertainty_qualifier.measure_name = ‘form variance’ } uncertainty_qualifier => qualitative_uncertainty qualitative_uncertainty.uncertainty_value)
grade	#1: (limits_and_fits.grade) #2: (qualitative_uncertainty. uncertainty_value)	10303-47 10303-45		#1: (limits_and_fits limits_and_fits.grade) #2: (qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = uncertainty_qualifier { uncertainty_qualifier.measure_name = ‘grade’ } uncertainty_qualifier => qualitative_uncertainty qualitative_uncertainty.uncertainty_value)
its_fitting_type	#1: (limits_and_fits.zone_variance) #2: (qualitative_uncertainty. uncertainty_value)	10303-47 10303-45		#1: (limits_and_fits limits_and_fits.grade) #2: (qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = uncertainty_qualifier { uncertainty_qualifier.measure_name = ‘zone variance’ } uncertainty_qualifier => qualitative_uncertainty qualitative_uncertainty.uncertainty_value)

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LIMIT_QUALIFIER	qualified_representation_item	10303-45		
qualifier	type_qualifier.name	10303-45		qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier = type_qualifier type_qualifier { (type_qualifier.name = 'maximum') (type_qualifier.name = 'minimum') }
MASS_MEASURE	[mass_measure_with_unit] [measure_representation_item]	10303-41 10303-45		mass_measure_with_unit <= measure_with_unit => { measure_with_unit.value_component -> measure_value measure_value = mass_measure mass_measure } measure_representation_item <= representation_item
PLANE_ANGLE_MEASURE	[plane_angle_measure_with_unit] [measure_representation_item]	10303-41 10303-45		plane_angle_measure_with_unit <= measure_with_unit => { measure_with_unit.value_component -> measure_value measure_value = plane_angle_measure plane_angle_measure } measure_representation_item <= representation_item
PLUS_MINUS_VALUE #1: if used as the limitation of a value_with_tolerance that is the dimension_value of a geometric_dimension #2: if otherwise See NOTE 1	#1: (tolerance_value) #2: (qualified_representation_item)	10303-47 10303-45		

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
lower_limit	#1: (measure_with_unit) #2: (standard_uncertainty. uncertainty_value)	10303-41 10303-45		#1: (tolerance_value tolerance_value.lower_bound -> measure_with_unit) #2: (qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = uncertainty_qualifier { uncertainty_qualifier.measure_name = ‘lower limit’ } uncertainty_qualifier => standard_uncertainty standard_uncertainty.uncertainty_value)
upper_limit	#1: (measure_with_unit) #2: (standard_uncertainty. uncertainty_value)	10303-41 10303-45		#1: (tolerance_value tolerance_value.upper_bound -> measure_with_unit) #2: (qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = uncertainty_qualifier { uncertainty_qualifier.measure_name = ‘upper limit’ } uncertainty_qualifier => standard_uncertainty standard_uncertainty.uncertainty_value)
PRESSURE_MEASURE	measure_representation_item	10303-45		measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ROT_SPEED_MEASURE	measure_representation_item	10303-45		measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }
SPEED_MEASURE	measure_representation_item	10303-45		measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }
TIME_MEASURE	[time_measure_with_unit] [measure_representation_item]	10303-41 10303-45		time_measure_with_unit <= measure_with_unit => { measure_with_unit.value_component -> measure_value measure_value = time_measure time_measure } measure_representation_item <= representation_item
TOLERANCED_LENGTH_MEASURE	[length_measure_with_unit] [measure_representation_item]	10303-41 10303-45		length_measure_with_unit <= measure_with_unit => { measure_with_unit.value_component -> measure_value measure_value = length_measure length_measure } measure_representation_item <= representation_item

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
VALUE_RANGE #1: if used as the dimension_value of a geometric_dimension #2: if otherwise See NOTE 2	#1:(shape_dimension_representation) #2:(value_range)	10303-47 10303-238		
value_range to value_with_unit (as lower_range)	PATH			#1: (shape_dimension_representation <= shape_representation<= representation representation.items[i] -> { representation_item.name = 'lower range'} representation_item => measure_representation_item) #2: (value_range <= compound_representation_item compound_representation_item.item_element -> set_representation_item set_representation_item[i] -> { representation_item.name = 'lower limit' } representation_item => measure_representation_item)

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
significant_digits	precision_qualifier.precision_value	10303-45		#1: (shape_dimension_representation <= shape_representation <= representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit <- measure_qualification.qualified_measure measure_qualification measure_qualification.qualifiers[i] -> value_qualifier = precision_qualifier precision_qualifier precision_qualifier.precision_value) #2: (value_range <= compound_representation_item <= representation_item => qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = precision_qualifier precision_qualifier precision_qualifier.precision_value)

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
value_range to value_with_unit (as upper_range)	PATH			#1: (shape_dimension_representation <= shape_representation<= representation representation.items[i] -> { representation_item.name = 'upper range'} representation_item => measure_representation_item) #2: (value_range <= compound_representation_item compound_representation_item.item_element -> set_representation_item set_representation_item[i] -> { representation_item.name = 'upper limit' } representation_item => measure_representation_item)
VALUE_WITH_TOLERANCE #1: if significant_digits is specified, or if limitation is specified and either the limitation is limit_qualifier or the value_with_tolerance is not the dimension_value of a geometric_dimension #2: if otherwise See NOTE 1	#1: [measure_representation_item] [qualified_representation_item] #2: measure_representation_item			#1: (measure_representation_item <= representation_item => qualified_representation_item) #2: (measure_representation_item <= representation_item)

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
value_with_tolerance to plus_minus_value, limits_and_fits, or limit_qualifier (as limitation) #1: if value_with_tolerance is the dimension_value of a geometric_dimension and limitation is plus_minus_value or limits_and_fits #2: if otherwise See NOTE 1	PATH			#1 (measure_representation_item <= representation_item <- representation.items[i] representation => shape_representation => shape_dimension_representation <- dimensional_characteristic_representation.representation dimensional_characteristic_representation dimensional_characteristic_representation.dimension -> dimensional_characteristic (dimensional_characteristic = dimensional_size dimensional_size <-) (dimensional_characteristic = dimensional_location dimensional_location <-) plus_minus_tolerance.toleranced_dimension plus_minus_tolerance plus_minus_tolerance.range -> tolerance_method_definition (tolerance_method_definition = tolerance_value tolerance_value) (tolerance_method_definition = limits_and_fits limits_and_fits)) #2: (measure_representation_item <= representation_item => qualified_representation_item)
significant_digits	precision_qualifier.precision_value	10303-45		measure_representation_item <= representation_item => qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = precision_qualifier precision_qualifier precision_qualifier.precision_value

Table 1 — Mapping table for measure UoF (continued)

Application element	AIM element	Source	Rules	Reference path
VALUE_WITH_UNIT	measure_representation_item	10303-45		measure_representation_item <= measure_with_unit
unit	unit	10303-41	5, 6	measure_representation_item <= measure_with_unit measure_with_unit.unit_component -> unit
value_component	measure_value	10303-41		measure_with_unit measure_with_unit.value_component -> measure_value
VOLUME_MEASURE	measure_representation_item	10303-45		measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = volume_measure volume_measure }

Table 2 — Mapping table for project UoF

Application element	AIM element	Source	Rules	Reference path
PERSON_AND_ADDRESS	person	10303-41		
its_person	IDENTICAL MAPPING	10303-41		
its_address	personal_address	10303-41		person <- personal_address.people[i] personal_address
PROJECT	product_definition_formation	10303-41		product_definition_formation { product_definition_formation.of_product -> product => machining_project }
its_id	product.id	10303-41		product_definition_formation product_definition_formation.of_product -> product product.id
project to workplan (as main_workplan)	PATH			product_definition_formation <- product_definition.formation product_definition characterized_product_definition = product_definition characterized_product_definition <- process_product_association.defined_product process_product_association process_product_association.process -> product_definition_process <= action { action.name = ‘machining’ } action.chosen_method -> action_method => machining_process_executable => machining_workplan

Table 2 — Mapping table for project UoF (continued)

Application element	AIM element	Source	Rules	Reference path
project to workpiece (as its_workpieces)	PATH			product_definition_formation <- product_definition.formation product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship { product_definition_relationship => machining_project_workpiece_relationship } product_definition_relationship.related_product_definition -> product_definition
project to person_and_address (as its_owner)	PATH			product_definition_formation person_and_organization_item = product_definition_formation person_and_organization_item <- applied_person_and_organization_assignment.items[i] applied_person_and_organization_assignment <= person_and_organization_assignment { person_and_organization_assignment.role -> person_and_organization_role person_and_organization_role.name = ‘owner’ } person_and_organization_assignment.- assigned_person_and_organization -> person_and_organization person_and_organization.the_person -> person
its_release	date_and_time	10303-41		product_definition_formation date_and_time_item = product_definition_formation date_and_time_item <- applied_date_and_time_assignment.items[i] applied_date_and_time_assignment <= date_and_time_assignment { date_and_time_assignment.role -> date_time_role date_time_role.name = ‘release date’ } date_and_time_assignment.assigned_date_and_time -> date_and_time

Table 2 — Mapping table for project UoF (continued)

Application element	AIM element	Source	Rules	Reference path
project to approval (as its_status)	PATH			product_definition_formation approval_item = product_definition_formation approval_item <- applied_approval_assignment.items[i] applied_approval_assignment <= approval_assignment approval_assignment.assigned_approval -> approval

Table 3 — Mapping table for workpiece UoF

Application element	AIM element	Source	Rules	Reference path
DESCRIPTIVE_PARAMETER	descriptive_representation_item	10303-45		
descriptive_string	descriptive_representation_item.- description	10303-45		
GENERAL_PROPERTY	property_definition	10303-41		
description	property_definition.description	10303-41		
general_property to workpiece or shape_aspect (as owner) #1: if owner is a workpiece #2: if owner is a shape_aspect	PATH			property_definition property_definition.definition -> characterized_definition #1: (characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition product_definition) #2: (characterized_definition = shape_definition shape_definition shape_definition = shape_aspect shape_aspect)
general_property to general_property (as related_properties)	PATH			property_definition <- property_definition_relationship.relating_property_definition property_definition_relationship property_definition_relationship.related_property_definition -> property_definition
general_property to specification (as specifications)	PATH			property_definition document_reference_item = property_definition document_reference_item <- applied_document_reference.items[i] applied_document_reference <= document_reference document_reference.assigned_document -> document

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
HARDNESS	material_property_representation	10303-45		material_property_representation {material_property_representation.dependent_environment-> data_environment data_environment.name = 'hardness' }
high_value	measure_with_unit	10303-41		material_property_representation <= property_definition_representation property_definition_representation.used_representation-> representation representation.items[i] -> { representation_item=> qualified_representation_item qualified_representation_item.qualifiers[i]-> value_qualifier=type_qualifier type_qualifier type_qualifier.name='high value'} { representation_item.name = 'high value'} representation_item => measure_representation_item <= measure_with_unit
low_value	measure_with_unit	10303-41		material_property_representation <= property_definition_representation property_definition_representation.used_representation-> representation representation.items[i] -> { representation_item=> qualified_representation_item qualified_representation_item.qualifiers[i]-> value_qualifier=type_qualifier type_qualifier type_qualifier.name='low value'} { representation_item.name = 'low value'} representation_item => measure_representation_item <= measure_with_unit

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
nominal	measure_with_unit	10303-41		material_property_representation <= property_definition_representation property_definition_representation.used_representation-> representation representation.items[i] -> { representation_item=> qualified_representation_item qualified_representation_item.qualifiers[i]-> value_qualifier=type_qualifier type_qualifier type_qualifier.name='nominal'} { representation_item.name = 'nominal'} representation_item => measure_representation_item <= measure_with_unit
scale	data_environment.description	10303-45		material_property_representation material_property_representation.dependent_environment-> data_environment { (data_environment.description = 'brinell') (data_environment.description = 'rockwell') (data_environment.description = 'vickers') (data_environment.description) } data_environment.description
MANUFACTURING_FEATURE	shape_aspect	10303-41		
its_id	shape_aspect.name See NOTE 3			

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
manufacturing_feature to workpiece (as its_workpiece)	PATH			shape_aspect shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition product_definition

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
manufacturing_feature to machining_operation (as its_operations) See NOTE 4. This attribute and the resulting path is redundant.	PATH		8	shape_aspect shape_definition = shape_aspect shape_definition property_or_shape_select = shape_definition property_or_shape_select <- process_property_association.property_or_shape process_property_association process_property_association.process -> property_process <= action { action.name = ‘machining’ } action.chosen_method -> { action_method => machining_feature_process } action_method <- action_method_relationship.related_method action_method_relationship { action_method_relationship => machining_feature_relationship } action_method_relationship.relating_method -> { action_method => machining_workingstep } action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_operation_relationship } action_method_relationship.related_method -> action_method => machining_operation

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
explicit_representation #1: preferred #2: alternate, compatible with observed AP 224 usage See NOTE 5	face	10303-42		shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition represented_definition = property_definition represented_definition <- property_definition_representation.definition property_definition_representation #1: { property_definition_representation => shape_definition_representation } property_definition_representation.used_representation -> #1: ({ representation.name = 'explicit feature shape' } { representation => shape_representation } representation) #2: (representation) representation.items[i] -> representation_item => face
MATERIAL	material_designation	10303-45		
standard_identifier	document.id	10303-41		material_designation document_reference_item = material_designation document_reference_item <- applied_document_reference.items[i] applied_document_reference <= document_reference document_reference.assigned_document -> document document.id
material_identifier:	material_designation.name	10303-45		

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
material to property_parameter (as material_property)	PATH			material_designation <- material_designation_characterization.designation material_designation_characterization material_designation_characterization.property -> characterized_material_property characterized_material_property=material_property_representation material_property_representation <= property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> representation_item
MATERIAL_PROPERTY	material_property	10303-45		material_property <= property_definition
material_property to property_parameter (as material_characteristics)	PATH			material_property <= property_definition represented_definition = property_definition represented_definition <- property_definition_representation.definition { property_definition_representation=> material_property_representation } property_definition_representation.used_representation -> representation representation.items[i] -> representation_item
material_property to hardness (as material_hardness)	PATH			material_property <= property_definition represented_definition = property_definition represented_definition <- property_definition_representation.definition property_definition_representation=> material_property_representation
NUMERIC_PARAMETER	measure_representation_item	10303-45		

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_parameter_value	measure_value	10303-41		measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value
its_parameter_unit	unit	10303-41	5, 6	measure_representation_item <= measure_with_unit measure_with_unit.unit_component -> unit
PART_PROPERTY	property_definition	10303-41		property_definition {property_definition.name = 'part property'}
part_property to property_parameter (as part_characteristics)	PATH			property_definition property_definition = represented_definition represented_definition<- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> representation_item
PROPERTY_PARAMETER	representation_item	10303-43		
parameter_name	representation_item.name	10303-43		
PROCESS_PROPERTY	property_definition	10303-41		property_definition {property_definition.name = 'process property'}

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
process_property to property_parameter (as process_characteristics)	PATH			property_definition represented_definition = property_definition represented_definition<- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> representation_item
process_name	representation.name	10303-43		property_definition property_definition = represented_definition represented_definition<- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.name
SURFACE_PROPERTY	property_definition	10303-41		property_definition {property_definition.name = 'surface property'}
is_surface_finish #1 if value is true #2 if value is false	property_definition.description			property_definition property_definition.description #1: (property_definition.description = 'surface finish') #2: (property_definition.description)
surface_property to property_parameter (as surface_characteristics)				property_definition property_definition = represented_definition represented_definition<- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> representation_item

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
WORKPIECE	product_definition	10303-41		
its_id	product.id	10303-41		product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product product.id
workpiece to material (as its_material)	PATH			product_definition <- product_definition_relationship.relating_product_definition {product_definition_relationship => product_definition_usage => make_from_usage_option} product_definition_relationship product_definition_relationship.related_product_definition -> product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- material_designation.definitions[i] material_designation

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
global_tolerance	length_measure_with_unit	10303-41		product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition { property_definition.name = ‘global tolerance’ } property_definition represented_definition = property_definition represented_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation => shape_representation representation.items[i]-> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
workpiece to workpiece (as its_rawpiece)	PATH			product_definition <- product_definition_relationship.relating_product_definition {product_definition_relationship => product_definition_usage => make_from_usage_option} product_definition_relationship.related_product_definition -> product_definition

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_geometry	shape_representation	10303-41		product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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 => (advanced_brep_shape_representation) (edge_based_wireframe_shape_representation) (faceted_brep_shape_representation) (geometrically_bounded_surface_shape_representation) (geometrically_bounded_wireframe_shape_representation) (manifold_surface_shape_representation) (non_manifold_surface_shape_representation) (shell_based_wireframe_shape_representation) }

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_bounding_geometry #1: if bounding geometry is a block #2: if bounding geometry is a right_circular_cylinder #3: if bounding geometry is any other shape representation See NOTE 6	#1: block_shape_representation #2: cylindrical_shape_representation #3: (advanced_brep_-shape_representation) (edge_based_wireframe_-shape_representation) (faceted_brep_shape_representation) (geometrically_bounded_surface_-shape_representation) (geometrically_bounded_wireframe_shape_representation) (manifold_surface_-shape_representation) (non_manifold_surface_-shape_representation) (shell_based_wireframe_-shape_representation)	10303-238 10303-238 10303-514 10303-501 10303-512 10303-507 10303-510 10303-509 10303-508 10303-502		product_definition <- product_definition_relationship.relating_product_definition {product_definition_relationship => product_definition_usage => make_from_usage_option} product_definition_relationship product_definition_relationship.related_product_definition -> product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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 => #1: (shape_representation_with_parameters => block_shape_representation) #2: (shape_representation_with_parameters => cylindrical_shape_representation) #3: (advanced_brep_shape_representation) (edge_based_wireframe_shape_representation) (faceted_brep_shape_representation) (geometrically_bounded_surface_shape_representation) (geometrically_bounded_wireframe_shape_representation) (manifold_surface_shape_representation) (non_manifold_surface_shape_representation) (shell_based_wireframe_shape_representation)

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
clamping_positions	cartesian_point	10303-42		product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition { property_definition.name = ‘clamping position’ } property_definition represented_definition = property_definition represented_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation => shape_representation representation.items[i]-> representation_item => geometric_representation_item => point => cartesian_point
workpiece to approval (as its_approvals)	PATH			product_definition approval_item = product_definition approval_item <- applied_approval_assignment.items[i] applied_approval_assignment <= approval_assignment approval_assignment.assigned_approval -> approval

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_categories	product_category.name	10303-41		product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product <- product_related_product_category.products[i] product_related_product_category => product_category { (product_category.name = 'fixture') (product_category.name = 'fixtured workpiece') (product_category.name = 'rawpiece') (product_category.name = 'tool') (product_category.name = 'workpiece') (product_category.name) } product_category.name
workpiece to workpiece_assembly_component (as its_components)	PATH			product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship => product_definition_usage => assembly_component_usage => next_assembly_usage_occurrence
workpiece to assigned_date (as its_datestamps)	PATH			product_definition date_item = product_definition date_item <- applied_date_assignment.items[i] applied_date_assignment
workpiece to assigned_organization (as its_orgs)	PATH			product_definition organization_item = product_definition organization_item <- applied_organization_assignment.items[i] applied_organization_assignment

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
workpiece to assigned_person (as its_people)	PATH			product_definition person_and_organization_item = product_definition person_and_organization_item <- applied_person_and_organization_assignment.items[i] applied_person_and_organization_assignment
its_related_geometry	shape_representation	10303-41		product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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 } representation <- representation_relationship.rep_1 { representation_relationship => shape_representation_relationship } representation_relationship representation_relationship.rep_2 -> representation => shape_representation

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
workpiece to assigned_time (as its_timestamps)	PATH			product_definition date_and_time_item = product_definition date_and_time_item <- applied_date_and_time_assignment.items[i] applied_date_and_time_assignment
workpiece to approval (as product_approvals)	PATH			product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product approval_item = product approval_item <- applied_approval_assignment.items[i] applied_approval_assignment <= approval_assignment approval_assignment.assigned_approval -> approval
workpiece to assigned_date (as product_datestamps)	PATH			product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product date_item = product date_item <- applied_date_assignment.items[i] applied_date_assignment

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
workpiece to assigned_organization (as product_orgs)	PATH			product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product organization_item = product organization_item <- applied_organization_assignment.items[i] applied_organization_assignment
workpiece to assigned_person (as product_people)	PATH			product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product person_and_organization_item = product person_and_organization_item <- applied_person_and_organization_assignment.items[i] applied_person_and_organization_assignment
workpiece to assigned_time (as product_timestamps)	PATH			product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product date_and_time_item = product date_and_time_item <- applied_date_and_time_assignment.items[i] applied_date_and_time_assignment

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
workpiece to approval (as revision_approvals)	PATH			product_definition product_definition.formation -> product_definition_formation approval_item = product_definition_formation approval_item <- applied_approval_assignment.items[i] applied_approval_assignment <= approval_assignment approval_assignment.assigned_approval -> approval
workpiece to assigned_date (as revision_datestamps)	PATH			product_definition product_definition.formation -> product_definition_formation date_item = product_definition_formation date_item <- applied_date_assignment.items[i] applied_date_assignment
revision_id	product_definition_formation.id	10303-41		product_definition product_definition.formation -> product_definition_formation product_definition_formation.id See NOTE 7
workpiece to assigned_organization (as revision_orgs)	PATH			product_definition product_definition.formation -> product_definition_formation organization_item = product_definition_formation organization_item <- applied_organization_assignment.items[i] applied_organization_assignment

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
workpiece to assigned_person (as revision_people)	PATH			product_definition product_definition.formation -> product_definition_formation person_and_organization_item = product_definition_formation person_and_organization_item <- applied_person_and_organization_assignment.items[i] applied_person_and_organization_assignment
workpiece to assigned_time (as revision_timestamps)	PATH			product_definition product_definition.formation -> product_definition_formation date_and_time_item = product_definition_formation date_and_time_item <- applied_date_and_time_assignment.items[i] applied_date_and_time_assignment
WORKPIECE_ASSEMBLY_- COMPONENT	next_assembly_usage_occurrence	10303-44		
component	PATH			next_assembly_usage_occurrence<= assembly_component_usage<= product_definition_usage<= product_definition_relationship product_definition_relationship.related_product_definition-> product_definition

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
originating_orientation #1: if component is placed using mapped_item #2: if component is placed using context_dependent_shape_representation See NOTE 8	axis2_placement_3d	10303-42		next_assembly_usage_occurrence<= product_definition_relationship characterized_product_definition = product_definition_relationship characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition #1:(property_definition {property_definition => product_definition_shape} represented_definition = property_definition represented_definition <- property_definition_representation.definition property_definition_representation {property_definition_representation => shape_definition_representation} property_definition_representation.used_representation -> {representation => shape_representation} representation representation.items[i]-> mapped_item mapped_item.mapping_source-> representation_map representation_map.mapping_origin->) #2: (property_definition => product_definition_shape <- context_dependent_shape_representation.- represented_product_relation context_dependent_shape_representation context_dependent_shape_representation.representation_relation -> [shape_representation_relationship] [representation_relationship_with_transformation] representation_relationship_with_transformation.- transformation_operator -> transformation transformation = item_defined_transformation item_defined_transformation item_defined_transformation.transform_item_1 ->) representation_item=> axis2_placement_3d

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
resulting_orientation #1: if component is placed using mapped_item #2: if component is placed using context_dependent_shape_representation See NOTE 8	axis2_placement_3d	10303-42		next_assembly_usage_occurrence<= product_definition_relationship characterized_product_definition = product_definition_relationship characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition #1:(property_definition {property_definition => product_definition_shape} represented_definition = property_definition represented_definition <- property_definition_representation.definition property_definition_representation {property_definition_representation => shape_definition_representation} property_definition_representation.used_representation -> {representation => shape_representation} representation representation.items[i]-> mapped_item mapped_item.mapping_target->) #2: (property_definition => product_definition_shape <- context_dependent_shape_representation.- represented_product_relation context_dependent_shape_representation context_dependent_shape_representation.representation_relation -> [shape_representation_relationship] [representation_relationship_with_transformation] representation_relationship_with_transformation.- transformation_operator -> transformation transformation = item_defined_transformation item_defined_transformation item_defined_transformation.transform_item_2 ->) representation_item=> axis2_placement_3d

Table 3 — Mapping table for workpiece UoF (continued)

Application element	AIM element	Source	Rules	Reference path
reference_designator	assembly_component_usage.\ reference_designator	10303-44		next_assembly_usage_occurrence<= assembly_component_usage assembly_component_usage.reference_designator

Table 4 — Mapping table for manufacturing features UoF

Application element	AIM element	Source	Rules	Reference path
ANGLE_TAPER	taper	10303-522		taper <= shape_aspect {shape_aspect.description = ‘angle taper’} { shape_aspect.of_shape-> product_definition_shape <= property_definition property_definition.definition-> characterized_definition characterized_definition = characterized_object characterized_object => feature_component_definition}
angle	plane_angle_measure_with_unit	10303-41		taper <= 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.name = ‘taper angle’} representation_item => measure_representation_item <= measure_with_unit => 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	10303-522		hole_bottom <= shape_aspect {(shape_aspect.description = ‘conical’) (shape_aspect.description = ‘flat’) (shape_aspect.description = ‘flat with radius’) (shape_aspect.description = ‘flat with taper’) (shape_aspect.description = ‘spherical’)} {shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => feature_component_definition}
BOSS	boss	10303-522		boss <= {feature_definition => instanced_feature} feature_definition <= characterized_object {(characterized_object.description = ‘circular’) (characterized_object.description = ‘complex’) (characterized_object.description = ‘rectangular’)}

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

Application element	AIM element	Source	Rules	Reference path
boss to closed_profile (as its_boundary)	PATH			boss <= feature_definition <= characterized_object #1: { (characterized_object.description = 'circular') #2: (characterized_object.description = 'complex') #3: (characterized_object.description = 'rectangular')} characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape #1: { (shape_aspect.description = 'circular profile occurrence') #2: (shape_aspect.description = 'enclosed profile occurrence') #3: (shape_aspect.description = 'rectangular profile occurrence')} shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship => shape_defining_relationship } { shape_aspect_relationship.description = 'profile usage' } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => #1: (circular_closed_profile) #2: (closed_path_profile) #2: (ngon_closed_profile) #3: (rectangular_closed_profile)

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

Application element	AIM element	Source	Rules	Reference path
slope	plane_angle_measure_with_unit	10303-41		boss <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘change in boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘taper usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = ‘angle taper’} shape_aspect => taper NOTE See mapping for ANGLE_TAPER.angle for path from here to plane angle measure

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

Application element	AIM element	Source	Rules	Reference path
boss to linear_profile (as boss_height)	PATH			boss <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect.description = 'boss height occurrence' } shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship => shape_defining_relationship } { shape_aspect_relationship.name = 'boss height' } { shape_aspect_relationship.description = \\ 'path feature component usage' } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect.description = 'linear' } shape_aspect => path_feature_component

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

Application element	AIM element	Source	Rules	Reference path
CATALOGUE_THREAD	externally_defined_feature_-definition	10303-522		externally_defined_feature_definition <= [externally_defined_item {externally_defined_item.item_id-> source_item source_item = 'external thread'} {externally_defined_item.source-> external_source external_source.source_id-> source_item source_item = 'external feature specification'}] [{feature_definition => instanced_feature} feature_definition <= characterized_object {characterized_object.description = 'thread'}]

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

Application element	AIM element	Source	Rules	Reference path
catalogue_thread to specification (as documentation) #1: (if specification has zero constrants) #2: (if specification has one or more constrants)	PATH			#1: (externally_defined_feature_definition document_reference_item = externally_defined_feature_definition document_reference_item <- applied_document_reference.items[i] applied_document_reference <= document_reference document_reference.assigned_document -> document) #2:(externally_defined_feature_definition document_reference_item = externally_defined_feature_definition document_reference_item <- applied_document_usage_constraint_assignment.items[i] applied_document_usage_constraint_assignment <= document_usage_constraint_assignment document_usage_constraint_assignment.- assigned_document_usage -> document_usage_constraint document_usage_constraint.source-> document) {document <- document_representation_type.represented_document document_representation_type} {document => document_file <= characterized_object}
CHAMFER	chamfer	10303-522		chamfer <= transition_feature <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
angle_to_plane	plane_angle_measure_with_unit	10303-41		chamfer <= transition_feature <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> { shape_aspect.description = ‘second offset’ } { shape_aspect => chamfer_offset } 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.name = ‘offset angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
first_offset_amount	length_measure_with_unit	10303-41		chamfer <= transition_feature <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> { shape_aspect.description = ‘first offset’ } { shape_aspect => chamfer_offset } 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.name = ‘offset amount’} 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
chamfer_face	face	10303-42	3	chamfer <= transition_feature <= 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=> face_shape_representation } representation {representation.name = ‘chamfer face’} representation.items[i] -> representation_item => topological_representation_item => face

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

Application element	AIM element	Source	Rules	Reference path
first_face_shape	face	10303-42	3	chamfer <= transition_feature <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> { shape_aspect.description = ‘first offset’ } { shape_aspect => chamfer_offset } 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 property_definition_representation.used_representation -> { representation => shape_representation=> face_shape_representation } representation {representation.name = ‘first face shape’} representation.items[i] -> representation_item => topological_representation_item => face

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

Application element	AIM element	Source	Rules	Reference path
second_face_shape	face	10303-42	3	chamfer <= transition_feature <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> { shape_aspect.description = ‘second offset’ } { shape_aspect => chamfer_offset } 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 property_definition_representation.used_representation -> { representation => shape_representation=> face_shape_representation } representation {representation.name = ‘second face shape’} representation.items[i] -> representation_item => topological_representation_item => face
CIRCULAR_CLOSED_PROFILE	circular_closed_profile	10303-522		circular_closed_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
diameter	length_measure_with_unit	10303-41		circular_closed_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.name = ‘diameter’} 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_- PROFILE	outside_profile	10303-522		outside_profile <= {feature_definition => instanced_feature} 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 = 'closed circular boundary occurrence'}
circular_closed_shape_profile to circular_closed_profile (as closed_boundary)	PATH			outside_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = 'closed circular boundary occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = 'profile usage'} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => circular_closed_profile

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

Application element	AIM element	Source	Rules	Reference path
CIRCULAR_OFFSET	shape_aspect	10303-41		[shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship => feature_component_relationship => pattern_offset_membership] [shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship.relating_shape_aspect-> shape_aspect => modified_pattern]
angular_offset	plane_angle_measure_with_unit	10303-41		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.name = ‘offset’ } representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		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.name = ‘offset index’} representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure

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

Application element	AIM element	Source	Rules	Reference path
CIRCULAR_OMIT	shape_aspect	10303-41		[shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship => feature_component_relationship => pattern_omit_membership] [shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship.relating_shape_aspect-> shape_aspect => modified_pattern]

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

Application element	AIM element	Source	Rules	Reference path
index	count_measure	10303-41		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.name = 'omit index'} representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure
CIRCULAR_PATH	path_feature_component	10303-522		path_feature_component <= shape_aspect { (shape_aspect.description = 'partial circular') (shape_aspect.description = 'complete circular') }

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

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		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.name = ‘radius’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
CIRCULAR_PATTERN	circular_pattern	10303-522		circular_pattern <= replicate_feature <= {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
angle_increment	plane_angle_measure_with_unit	10303-41		circular_pattern <= replicate_feature <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘angular spacing’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
number_of_feature	count_measure	10303-41		circular_pattern <= replicate_feature <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘number of features’} representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure

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

Application element	AIM element	Source	Rules	Reference path
circular_pattern to circular_offset (as relocated_base_feature)	PATH			circular_pattern <= replicate_feature <= 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_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship => pattern_offset_membership} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect] [shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘base pattern’} shape_aspect_relationship.relating_shape_aspect-> shape_aspect <- {shape_aspect => modified_pattern} shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘modified pattern’} shape_aspect_relationship.related_shape_aspect-> shape_aspect]

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

Application element	AIM element	Source	Rules	Reference path
circular_pattern to circular_omit (as missing_base_feature)	PATH			circular_pattern <= replicate_feature <= 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_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship => pattern_omit_membership} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect] [shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘base pattern’} shape_aspect_relationship.relating_shape_aspect-> shape_aspect <- {shape_aspect => modified_pattern} shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘modified pattern’} shape_aspect_relationship.related_shape_aspect-> shape_aspect]

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

Application element	AIM element	Source	Rules	Reference path
base_feature_diameter	length_measure_with_unit	10303-41		circular_pattern <= replicate_feature <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘diameter’} 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
base_feature_rotation	plane_angle_measure_with_unit	10303-41		circular_pattern <= replicate_feature <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘base feature rotation’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
CLOSED_POCKET	pocket	10303-522		pocket <= {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
closed_pocket to closed_profile (as feature_boundary) #1: preferred #2: alternate, compatible with AP 224 rectangular_closed_pocket usage See NOTE 9	PATH			pocket <= feature_definition <= characterized_object #2: { characterized_object.description = 'closed rectangular' } characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape #1: {shape_aspect.description = 'boundary occurrence'} #2: {shape_aspect.description = 'rectangular profile occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = 'profile usage'} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> #1: {shape_aspect.description = 'boundary'} shape_aspect => #1: (circular_closed_profile) #1: (closed_path_profile) #1: (ngon_closed_profile) #1,#2: (rectangular_closed_profile)
CLOSED_PROFILE	(circular_closed_profile) (closed_path_profile) (ngon_closed_profile) (rectangular_closed_profile)	10303-522 10303-522 10303-522 10303-522		(circular_closed_profile <=) (closed_path_profile <=) (ngon_closed_profile <=) (rectangular_closed_profile <=) shape_aspect
COMPLETE_CIRCULAR_PATH	path_feature_component	10303-522		path_feature_component <= shape_aspect { shape_aspect.description = 'complete circular' }

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

Application element	AIM element	Source	Rules	Reference path
COMPOUND_FEATURE	compound_feature	10303-522		compound_feature <= {feature_definition => instanced_feature} 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.name = ‘compound feature in solid’ }
compound_feature to compound_feature_select (as elements) #1: as machining_feature #2: as transition_feature	PATH			compound_feature <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship=> feature_component_relationship} shape_aspect_relationship.related_shape_aspect-> shape_aspect => #1: (instanced_feature) #2: (transition_feature)

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

Application element	AIM element	Source	Rules	Reference path
feature_description	characterized_object.description	10303-41		compound_feature <= feature_definition <= characterized_object characterized_object.description
feature_name	characterized_object.name	10303-41		compound_feature <= feature_definition <= characterized_object characterized_object.name
CONICAL_HOLE_BOTTOM	hole_bottom	10303-522		hole_bottom <= shape_aspect { shape_aspect.description = ‘conical’ }

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

Application element	AIM element	Source	Rules	Reference path
tip_angle	plane_angle_measure_with_unit	10303-41		hole_bottom <= 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.name = ‘tip angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
tip_radius	length_measure_with_unit	10303-41		hole_bottom <= 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.name = ‘tip 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
COUNTERBORE_HOLE	composite_hole	10303-522		composite_hole <= compound_feature <= { feature_definition => instanced_feature} feature_definition <= characterized_object { characterized_object.description = 'counterbore' } { characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship.name = 'large hole' } shape_aspect_relationship=> feature_component_relationship} { characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship.name = 'small hole' } shape_aspect_relationship=> feature_component_relationship}

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

Application element	AIM element	Source	Rules	Reference path
COUNTERSUNK_HOLE	composite_hole	10303-522		composite_hole <= compound_feature <= { feature_definition => instanced_feature} feature_definition <= characterized_object { characterized_object.description = 'countersunk' } { characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship.name = 'tapered hole' } shape_aspect_relationship=> feature_component_relationship} { characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship.name = 'constant diameter hole' } shape_aspect_relationship=> feature_component_relationship}

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

Application element	AIM element	Source	Rules	Reference path
DEFINED_THREAD	thread	10303-522		thread <= {feature_definition => instanced_feature} feature_definition <= characterized_object
pitch_diameter	length_measure_with_unit	10303-41		thread <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘pitch diameter’} 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
minor_diameter	length_measure_with_unit	10303-41		thread <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘minor diameter’} 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
crest	length_measure_with_unit	10303-41		thread <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘crest’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
DIAMETER_TAPER	taper	10303-522		taper <= shape_aspect { shape_aspect.description = ‘diameter taper’} { shape_aspect.of_shape-> product_definition_shape <= property_definition property_definition.definition-> characterized_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
final_diameter	length_measure_with_unit	10303-41		taper <= 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.name = ‘final diameter’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
EDGE_ROUND	edge_round	10303-522		edge_round <= transition_feature <= shape_aspect {shape_aspect.description = ‘constant radius’}

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

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		edge_round <= transition_feature <= 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.name = ‘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
first_offset_amount	length_measure_with_unit	10303-41		edge_round <= transition_feature <= 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.name = ‘first offset’} 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
second_offset_amount	length_measure_with_unit	10303-41		edge_round <= transition_feature <= 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.name = ‘second offset’} 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
edge_round_face	face	10303-42	7	edge_round <= transition_feature <= 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=> face_shape_representation } representation { representation.name = ‘edge round face’ } representation.items[i] -> representation_item => topological_representation_item => face

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

Application element	AIM element	Source	Rules	Reference path
first_face_shape	face	10303-42	7	edge_round <= transition_feature <= 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 property_definition_representation.used_representation -> { representation => shape_representation=> face_shape_representation } representation { representation.name = ‘first face shape’ } representation.items[i] -> representation_item => topological_representation_item => face

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

Application element	AIM element	Source	Rules	Reference path
second_face_shape	face	10303-42	7	edge_round <= transition_feature <= 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 property_definition_representation.used_representation -> { representation => shape_representation=> face_shape_representation } representation { representation.name = ‘second face shape’ } representation.items[i] -> representation_item => topological_representation_item => face
FLAT_HOLE_BOTTOM	hole_bottom	10303-522		hole_bottom <= shape_aspect { shape_aspect.description = ‘flat’ }
FLAT_SLOT_END_TYPE	slot_end	10303-522		slot_end <= shape_aspect { shape_aspect.description = ‘flat’ }

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

Application element	AIM element	Source	Rules	Reference path
corner_radius1	length_measure_with_unit	10303-41		slot_end <= 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_with_parameters} representation representation.items[i] -> {representation_item.name = ‘first 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
corner_radius2	length_measure_with_unit	10303-41		slot_end <= 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_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	10303-522		hole_bottom <= shape_aspect { shape_aspect.description = ‘flat with radius’ }

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

Application element	AIM element	Source	Rules	Reference path
corner_radius	length_measure_with_unit	10303-41		hole_bottom <= 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.name = 'corner radius'} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
GENERAL_CLOSED_PROFILE	closed_path_profile	10303-522		closed_path_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
closed_profile_shape #1: if a bounded_curve #2: if an edge_curve #3: if a path	#1: (bounded_curve) #2: (edge_curve) #3:(path)	10303-42 10303-42 10303-42		closed_path_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 property_definition_representation.used_representation -> { representation => shape_representation=> path_shape_representation } representation representation.items[i] -> representation_item => #1: (geometric_representation_item => curve => bounded_curve) #2: (geometric_representation_item => edge_curve) #3:(topological_representation_item => path)

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

Application element	AIM element	Source	Rules	Reference path
GENERAL_OUTSIDE_PROFILE	outside_profile	10303-522		outside_profile <= { feature_definition => instanced_feature } 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 = ‘outside boundary’}

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

Application element	AIM element	Source	Rules	Reference path
general_outside_profile to profile (as feature_boundary)	PATH			outside_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = ‘profile usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = ‘outside boundary’} shape_aspect => (circular_closed_profile) (closed_path_profile) (ngon_closed_profile) (rectangular_closed_profile) (linear_profile) (open_path_profile) (partial_circular_profile) (rounded_u_profile) (square_u_profile) (tee_profile) (vee_profile)
GENERAL_PATH	path_feature_component	10303-522		path_feature_component <= shape_aspect { shape_aspect.description = ‘complex’ }

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

Application element	AIM element	Source	Rules	Reference path
swept_path #1: if a bounded_curve #2: if an edge_curve #3: if a path	#1: (bounded_curve) #2: (edge_curve) #3:(path)	10303-42 10303-42 10303-42		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 property_definition_representation.used_representation -> {representation.name = 'sweep path'} { representation => shape_representation=> path_shape_representation } representation representation.items[i] -> representation_item => #1: (geometric_representation_item => curve => bounded_curve) #2: (geometric_representation_item => edge_curve) #3:(topological_representation_item => path)
GENERAL_PATTERN	feature_pattern	10303-522		feature_pattern <= replicate_feature <= {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
replicate_locations	axis2_placement_3d	10303-42		feature_pattern <= replicate_feature <= feature_definition<= characterized_object characterized_definition = characterized_object characterized_definition<- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘base feature placement’} representation_item => geometric_representation_item => placement => axis2_placement_3d
GENERAL_POCKET_BOTTOM_- CONDITION	pocket_bottom	10303-522		pocket_bottom <= shape_aspect { 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 (as shape)	PATH			pocket_bottom <= 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 property_definition_representation.used_representation -> {representation.name = ‘floor face’} representation => shape_representation=> face_shape_representation See NOTE 10
GENERAL_PROFILE	open_path_profile	10303-522		open_path_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
its_profile #1: if a bounded_curve #2: if an edge_curve #3: if a path	#1: (bounded_curve) #2: (edge_curve) #3:(path)	10303-42 10303-42 10303-42		open_path_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 property_definition_representation.used_representation -> { representation => shape_representation=> path_shape_representation } representation representation.items[i] -> representation_item => #1: (geometric_representation_item => curve => bounded_curve) #2: (geometric_representation_item => edge_curve) #3:(topological_representation_item => path)
GENERAL_PROFILE_FLOOR	profile_floor	10303-522		profile_floor <= shape_aspect { shape_aspect.description = ‘complex’ }

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

Application element	AIM element	Source	Rules	Reference path
floor	face	10303-42		profile_floor <= 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 property_definition_representation.used_representation -> { representation => shape_representation=> face_shape_representation } representation {representation.name = ‘floor’} representation.items[i] -> representation_item => topological_representation_item => face
GENERAL_SHAPE_PROFILE	outside_profile	10303-522		outside_profile <= {feature_definition => instanced_feature} 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 = ‘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 (as profile_boundary)	PATH			outside_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = 'complex boundary occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship } { shape_aspect_relationship.description = 'profile usage'} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = 'boundary'} shape_aspect => (circular_closed_profile) (closed_path_profile) (ngon_closed_profile) (rectangular_closed_profile) (open_path_profile) (partial_circular_profile) (rounded_u_profile) (square_u_profile) (tee_profile) (vee_profile)
HOLE_BOTTOM_CONDITION	hole_bottom	10303-522		hole_bottom <= shape_aspect
LINEAR_PATH	path_feature_component	10303-522		path_feature_component <= shape_aspect { shape_aspect.description = 'linear' }

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

Application element	AIM element	Source	Rules	Reference path
distance	length_measure_with_unit	10303-41		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.name = ‘distance’} 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
its_direction	direction	10303-42		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 property_definition_representation.used_representation -> representation { representation => shape_representation=> direction_shape_representation } representation.items[i] -> representation_item => geometric_representation_item => direction
LINEAR_PROFILE	linear_profile	10303-522		linear_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
profile_length	length_measure_with_unit	10303-41		linear_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.name = 'profile length'} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
LOOP_SLOT_END_TYPE	slot_end	10303-522		slot_end <= shape_aspect { shape_aspect.description = 'loop' }
MACHINED_SURFACE	property_definition	10303-41		property_definition property_definition.name { (property_definition.name = 'bottom surface condition') (property_definition.name = 'bottom and side surface condition') (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 property_definition.definition -> characterized_definition characterized_definition = shape_definition shape_definition shape_definition = shape_aspect shape_aspect => instanced_feature
surface_element	property_definition.name	10303-41		property_definition property_definition.name { (property_definition.name = ‘bottom surface condition’) (property_definition.name = ‘bottom and side surface condition’) (property_definition.name = ‘side surface condition’) }
MACHINING_FEATURE	instanced_feature	10303-522		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
depth NOTE This is an optional attribute. See 5.2.1.2.1.1 and 4.2.194 for the procedure to determine the depth of features.	elementary_surface	10303-42		instanced_feature <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition { property_definition => product_definition_shape } property_definition <- property_definition_representation.definition { property_definition_representation => shape_definition_representation } property_definition_representation property_definition_representation .used_representation-> { representation => shape_representation } {representation.name = ‘maximum feature limit’ } representation representation.items[i] -> representation_item => elementary_surface
NGON_PROFILE	ngon_closed_profile	10303-522		ngon_closed_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
diameter	length_measure_with_unit	10303-41		ngon_closed_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.name = ‘circumscribed diameter’) (representation_item.name = ‘diameter across flats’) } 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
number_of_sides	count_measure	10303-41		ngon_closed_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.name = ‘number of sides’} representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure 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') (representation_item.name = 'diameter across flats')	10303-41 10303-41		ngon_closed_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 = 'circumscribed diameter') (representation_item.name = 'diameter across flats') }
OPEN_POCKET	pocket	10303-522		pocket <= {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
open_pocket to open_profile (as open_boundary) #1: preferred #2: alternate, compatible with AP 224 rectangular_open_pocket usage See NOTE 9	PATH			pocket <= feature_definition <= characterized_object #2: { characterized_object.description = ‘open rectangular’ } characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape #1: {shape_aspect.description = ‘boundary occurrence’} #2: {shape_aspect.description = ‘open boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = ‘profile usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> #1: {shape_aspect.description = 'boundary’} shape_aspect => #1: (open_path_profile) #1: (partial_circular_profile) #1: (rounded_u_profile) #1, #2: (square_u_profile) #1: (tee_profile) #1: (vee_profile)

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

Application element	AIM element	Source	Rules	Reference path
open_pocket to open_profile (as wall_boundary)	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.description = ‘wall boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = ‘wall boundary usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = ‘wall boundary’} shape_aspect => (open_path_profile) (partial_circular_profile) (rounded_u_profile) (square_u_profile) (tee_profile) (vee_profile)
OPEN_PROFILE	(linear_profile) (open_path_profile) (partial_circular_profile) (rounded_u_profile) (square_u_profile) (tee_profile) (vee_profile)	10303-522 10303-522 10303-522 10303-522 10303-522 10303-522 10303-522		(linear_profile <=) (open_path_profile <=) (partial_circular_profile <=) (rounded_u_profile <=) (square_u_profile <=) (tee_profile <=) (vee_profile <=) shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
OPEN_SLOT_END_TYPE	slot_end	10303-522		slot_end <= shape_aspect { shape_aspect.description = ‘open’ }
PARTIAL_AREA_DEFINITION	applied_area	10303-522		applied_area <= shape_aspect {shape_aspect shape_aspect.of_shape-> product_definition_shape}
effective_length	length_measure_with_unit	10303-41		applied_area <= 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.name = ‘effective length’} 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
placement	axis2_placement_3d	10303-42		applied_area <= 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.name = ‘orientation’} representation_item => geometric_representation_item => placement => axis2_placement_3d

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

Application element	AIM element	Source	Rules	Reference path
maximum_length	length_measure_with_unit	10303-41		applied_area <= 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.name = ‘maximum length’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
PARTIAL_CIRCULAR_PATH	path_feature_component	10303-522		path_feature_component <= shape_aspect { shape_aspect.description = ‘partial circular’ }

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

Application element	AIM element	Source	Rules	Reference path
sweep_angle	plane_angle_measure_with_unit	10303-41		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.name = ‘sweep angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
PARTIAL_CIRCULAR_PROFILE	partial_circular_profile	10303-522		partial_circular_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		partial_circular_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.name = ‘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
sweep_angle	plane_angle_measure_with_unit	10303-41		partial_circular_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.name = ‘sweep angle’} representation_item => measure_representation_item <= measure_with_unit => 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_-PROFILE	outside_profile	10303-522		outside_profile <= {feature_definition => instanced_feature} 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 = ‘partial circular boundary occurrence’}
partial_circular_shape_profile to partial_circular_profile (as open_boundary)	PATH			outside_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘partial circular boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = ‘profile usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => partial_circular_profile

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

Application element	AIM element	Source	Rules	Reference path
PLANAR_FACE	flat_face	10303-522		flat_face <= {feature_definition => instanced_feature} feature_definition <= characterized_object
planar_face to linear_path (as course_of_travel)	PATH			flat_face <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = 'course of travel occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.name = 'course of travel'} {shape_aspect_relationship.description = \ 'path feature component usage'} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = 'linear'} shape_aspect => 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 (as removal_boundary)	PATH			flat_face <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘removal boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.name = ‘removal boundary’} {shape_aspect_relationship.description = ‘profile usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => linear_profile

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

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

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

Application element	AIM element	Source	Rules	Reference path
planar_face to boss (as its_boss)	PATH			flat_face <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship.description = ‘uncut volume’} {shape_aspect_relationship=> feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect => instanced_feature <= feature_definition => boss

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

Application element	AIM element	Source	Rules	Reference path
removal_depth	length_measure_with_unit	10303-41		flat_face <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘removal depth’} 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
removal_direction	direction	10303-42		flat_face <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- {property_definition => product_definition_shape} property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation { representation.name = ‘removal direction’ } { representation => shape_representation=> direction_shape_representation } representation.items[i] -> representation_item => geometric_representation_item => direction
PLANAR_POCKET_BOTTOM_- CONDITION	pocket_bottom	10303-522		pocket_bottom <= shape_aspect { shape_aspect.description = ‘planar’ }
PLANAR_PROFILE_FLOOR	profile_floor	10303-522		profile_floor <= shape_aspect { shape_aspect.description = ‘planar’ }

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

Application element	AIM element	Source	Rules	Reference path
floor	plane	10303-42		profile_floor <= 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 property_definition_representation.used_representation -> { representation => shape_representation=> planar_shape_representation } representation {representation.name = ‘floor’} representation.items[i] -> representation_item => geometric_representation_item => surface => elementary_surface => plane
POCKET	pocket	10303-522		pocket <= {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
pocket to boss (as its_boss)	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 => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship.description = 'uncut volume'} {shape_aspect_relationship=> feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect => instanced_feature <= feature_definition => boss

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

Application element	AIM element	Source	Rules	Reference path
pocket to angle_taper (as slope)	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.description = ‘change in boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘taper usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = ‘angle taper’} shape_aspect => 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.description = ‘bottom condition occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘pocket bottom usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => pocket_bottom

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

Application element	AIM element	Source	Rules	Reference path
planar_radius NOTE The mapping path for this property passes through the pocket bottom condition for harmonization with AP 224 and AP 214.	length_measure_with_unit	10303-41		pocket <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship => feature_component_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect => pocket_bottom } 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_with_parameters} representation representation.items[i] -> {representation_item.name = ‘radius’} representation_item => measure_representation_item <= length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
orthogonal_radius	length_measure_with_unit	10303-41		pocket <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘orthogonal fillet 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
bottom_at_path_end See NOTE 11, preferred mapping #1: if value is true #2: if value is false	shape_aspect_relationship.name	10303-41		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.description = ‘bottom condition occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.name { #1: (shape_aspect_relationship.name = ‘pocket depth end’) #2: (shape_aspect_relationship.name = ‘pocket depth start’) }

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

Application element	AIM element	Source	Rules	Reference path
bottom_at_path_end See NOTE 11, alternate mapping based on observed AP 224 usage #1: if value is true #2: if value is false	descriptive_representation_item.-description	10303-45		pocket <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {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.relating_shape_aspect -> shape_aspect {shape_aspect => pocket_bottom} shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation_with_parameters} representation representation.items[i] -> {representation_item.name = ‘pocket bottom orientation’} representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = \\ ‘pocket depth end’) #2: (descriptive_representation_item.description = \\ ‘pocket depth start’) }

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

Application element	AIM element	Source	Rules	Reference path
pocket to linear_path (as course_of_travel)	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.description = 'pocket depth occurrence' } shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship => shape_defining_relationship } { shape_aspect_relationship.name = 'pocket depth' } { shape_aspect_relationship.description = \\ 'path feature component usage' } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect.description = 'linear' } shape_aspect => path_feature_component

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

Application element	AIM element	Source	Rules	Reference path
top_fillet_radius	length_measure_with_unit	10303-41		pocket <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘fillet radius’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
POCKET_BOTTOM_CONDITION	pocket_bottom	10303-522		pocket_bottom <= shape_aspect { shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_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	(circular_closed_profile) (closed_path_profile) (ngon_closed_profile) (rectangular_closed_profile) (linear_profile) (open_path_profile) (partial_circular_profile) (rounded_u_profile) (square_u_profile) (tee_profile) (vee_profile)	10303-522 10303-522 10303-522 10303-522 10303-522 10303-522 10303-522 10303-522 10303-522 10303-522 10303-522		(circular_closed_profile <=) (closed_path_profile <=) (ngon_closed_profile <=) (rectangular_closed_profile <=) (linear_profile <=) (open_path_profile <=) (partial_circular_profile <=) (rounded_u_profile <=) (square_u_profile <=) (tee_profile <=) (vee_profile <=) shape_aspect {shape_aspect shape_aspect.of_shape-> product_definition_shape <= property_definition property_definition.definition-> characterized_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
placement	axis2_placement_3d	10303-42		(circular_closed_profile <=) (closed_path_profile <=) (ngon_closed_profile <=) (rectangular_closed_profile <=) (linear_profile <=) (open_path_profile <=) (partial_circular_profile <=) (rounded_u_profile <=) (square_u_profile <=) (tee_profile <=) (vee_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.name = ‘orientation’} representation_item => geometric_representation_item => placement => axis2_placement_3d

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

Application element	AIM element	Source	Rules	Reference path
PROFILE_FEATURE	outside_profile	10303-522		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 (as profile_swept_shape) #1: if profile_feature is a general_outside_profile #2: if profile_feature is general_shape_profile #3: if profile_feature is a partial_circular_shape_profile #4: if profile_feature is a circular_closed_shape_profile #5: if profile_feature is a rectangular_open_shape_profile #6: if profile_feature is a rectangular_closed_shape_profile See NOTE 12	PATH			outside_profile<= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { #1: (shape_aspect.description = ‘outside boundary’) #2: (shape_aspect.description = ‘complex boundary occurrence’) #3: (shape_aspect.description = \\ ‘partial circular boundary occurrence’) #4: (shape_aspect.description = \\ ‘closed circular boundary occurrence’) #5: (shape_aspect.description = \\ ‘open rectangular boundary occurrence’) #6: (shape_aspect.description = \\ ‘closed rectangular boundary occurrence’)} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.name = ‘profile swept shape’} {shape_aspect_relationship.description = \\ ‘path feature component usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect.description = ‘linear’ } shape_aspect => path_feature_component

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

Application element	AIM element	Source	Rules	Reference path
PROFILE_FLOOR	profile_floor	10303-522		profile_floor <= shape_aspect {shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => feature_component_definition}
floor_radius	length_measure_with_unit	10303-41		profile_floor <= 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.name = ‘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
start_or_end #1: if value is true #2: if value is false	descriptive_representation_- item.description	10303-45		profile_floor <= 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.name = ‘shape profile floor orientation’} representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = \\ ‘shape profile end’) #2: (descriptive_representation_item.description = \\ ‘shape profile start’) }
RADIUSED_POCKET_BOTTOM_- CONDITION	pocket_bottom	10303-522		pocket_bottom <= shape_aspect { shape_aspect.description = ‘radiused’ }

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

Application element	AIM element	Source	Rules	Reference path
floor_radius	length_measure_with_unit	10303-41		pocket_bottom <= 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_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
floor_radius_center	cartesian_point	10303-42		pocket_bottom <= 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 {representation.name = ‘pocket bottom radius location’} { representation => shape_representation=> location_shape_representation } representation.items[i] -> representation_item => geometric_representation_item => point => cartesian_point
RADIUSED_SLOT_END_TYPE	slot_end	10303-522		slot_end <= shape_aspect { shape_aspect.description = ‘radiused’ }
RECTANGULAR_CLOSED_PROFILE	rectangular_closed_profile	10303-522		rectangular_closed_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
profile_width	length_measure_with_unit	10303-41		rectangular_closed_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.name = ‘width’} 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
profile_length	length_measure_with_unit	10303-41		rectangular_closed_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.name = ‘length’} 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_SHAPE_- PROFILE	outside_profile	10303-522		outside_profile <= {feature_definition => instanced_feature} 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 = \ 'closed rectangular boundary occurrence'}
rectangular_closed_shape_profile to rectangular_closed_profile (as closed_boundary)	PATH			outside_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = \ 'closed rectangular boundary occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = 'profile usage'} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => rectangular_closed_profile

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

Application element	AIM element	Source	Rules	Reference path
RECTANGULAR_OFFSET	shape_aspect	10303-41		[shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship => feature_component_relationship => pattern_offset_membership] [shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship.relating_shape_aspect-> shape_aspect => modified_pattern]
offset_direction	direction	10303-42		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 property_definition_representation.used_representation -> representation {representation.name = ‘offset direction’} { representation => shape_representation=> direction_shape_representation } representation.items[i] -> representation_item => geometric_representation_item => direction

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

Application element	AIM element	Source	Rules	Reference path
offset_distance	length_measure_with_unit	10303-41		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.name = ‘offset distance’} 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
row_index	count_measure	10303-41		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.name = ‘row index’} representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure

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

Application element	AIM element	Source	Rules	Reference path
column_index	count_measure	10303-41		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.name = ‘column index’} representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure

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

Application element	AIM element	Source	Rules	Reference path
RECTANGULAR_OMIT	shape_aspect	10303-41		[shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship => feature_component_relationship => pattern_omit_membership] [shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship.relating_shape_aspect-> shape_aspect => modified_pattern]

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

Application element	AIM element	Source	Rules	Reference path
row_index	count_measure	10303-41		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.name = ‘row index’} representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure

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

Application element	AIM element	Source	Rules	Reference path
column_index	count_measure	10303-41		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.name = ‘column index’} representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure

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

Application element	AIM element	Source	Rules	Reference path
RECTANGULAR_OPEN_SHAPE_- PROFILE	outside_profile	10303-522		outside_profile <= {feature_definition => instanced_feature} 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 = \ ‘open rectangular boundary occurrence’}
rectangular_open_shape_profile to square_u_profile (as open_boundary)	PATH			outside_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = \ ‘open rectangular boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = ‘profile usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => square_u_profile

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

Application element	AIM element	Source	Rules	Reference path
RECTANGULAR_PATTERN	rectangular_pattern	10303-522		rectangular_pattern <= replicate_feature <= {feature_definition => instanced_feature} feature_definition<= characterized_object
spacing	length_measure_with_unit	10303-41		rectangular_pattern <= replicate_feature <= feature_definition<= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘column spacing’} 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
its_direction	direction	10303-42		rectangular_pattern <= replicate_feature <= feature_definition<= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- {property_definition => product_definition_shape} property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation.name = ‘column layout direction’} { representation => shape_representation=> direction_shape_representation } representation.items[i] -> representation_item => geometric_representation_item => direction

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

Application element	AIM element	Source	Rules	Reference path
number_of_rows	count_measure	10303-41		rectangular_pattern <= replicate_feature <= feature_definition<= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘number of rows’} representation_item => measure_representation_item {measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure}

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

Application element	AIM element	Source	Rules	Reference path
number_of_columns	count_measure	10303-41		rectangular_pattern <= replicate_feature <= feature_definition<= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘number of columns’} representation_item => measure_representation_item {measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure}

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

Application element	AIM element	Source	Rules	Reference path
row_spacing	length_measure_with_unit	10303-41		rectangular_pattern <= replicate_feature <= feature_definition<= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘row spacing’} 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
row_layout_direction	direction	10303-42		rectangular_pattern <= replicate_feature <= feature_definition<= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition {property_definition => product_definition_shape } property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation.name = ‘row layout direction’} { representation => shape_representation=> direction_shape_representation } representation.items[i] -> representation_item => geometric_representation_item => direction

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

Application element	AIM element	Source	Rules	Reference path
rectangular_pattern to rectangular_offset (as relocated_base_feature)	PATH			rectangular_pattern <= replicate_feature <= 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_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship => pattern_offset_membership} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect] [shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘base pattern’} shape_aspect_relationship.relating_shape_aspect-> shape_aspect <- {shape_aspect => modified_pattern} shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘modified pattern’} shape_aspect_relationship.related_shape_aspect-> shape_aspect]

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

Application element	AIM element	Source	Rules	Reference path
rectangular_pattern to rectangular_omit (as missing_base_feature)	PATH			rectangular_pattern <= replicate_feature <= 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_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship => pattern_omit_membership} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect] [shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘base pattern’} shape_aspect_relationship.relating_shape_aspect-> shape_aspect <- {shape_aspect => modified_pattern} shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘modified pattern’} shape_aspect_relationship.related_shape_aspect-> shape_aspect]

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

Application element	AIM element	Source	Rules	Reference path
REGION	removal_volume	10303-522		removal_volume <= {feature_definition => instanced_feature} feature_definition <= characterized_object
feature_placement	axis2_placement_3d	10303-42		removal_volume <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘orientation’} representation_item => geometric_representation_item => placement => axis2_placement_3d

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

Application element	AIM element	Source	Rules	Reference path
REGION_PROJECTION	shape_representation	10303-41		shape_representation <= representation <- property_definition_representation.used_representation property_definition_representation { property_definition_representation => shape_definition_representation } property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = shape_definition shape_definition shape_definition = shape_aspect { shape_aspect.description = ‘volume shape’} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship => shape_defining_relationship } { shape_aspect_relationship.description = ‘volume shape usage’ } shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect { shape_aspect.description = ‘shape volume occurrence’ } shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => removal_volume

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

Application element	AIM element	Source	Rules	Reference path
proj_curve	surface_of_linear_extrusion.- swept_curve	10303-42		shape_representation <= representation representation.items[i] -> representation_item=> geometric_representation_item=> surface=> swept_surface {swept_surface => surface_of_linear_extrusion} swept_surface.swept_curve
proj_dir	vector.orientation	10303-42		shape_representation <= representation representation.items[i] -> representation_item=> surface_of_linear_extrusion surface_of_linear_extrusion.extrusion_axis -> vector vector.orientation
depth	vector.magnitude	10303-42		shape_representation <= representation representation.items[i] -> representation_item=> surface_of_linear_extrusion surface_of_linear_extrusion.extrusion_axis -> vector vector.magnitude

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

Application element	AIM element	Source	Rules	Reference path
REGION_SURFACE_LIST	geometric_set	10303-507		geometric_set <= representation_item <- representation.items[i] {representation => geometrically_bounded_surface_shape_representation } representation <- property_definition_representation.used_representation property_definition_representation { property_definition_representation => shape_definition_representation } property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = shape_definition shape_definition shape_definition = shape_aspect { shape_aspect.description = ‘volume shape’} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship => shape_defining_relationship } { shape_aspect_relationship.description = ‘volume shape usage’ } shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect { shape_aspect.description = ‘shape volume occurrence’ } shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => 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	10303-42		geometric_set geometric_set.elements[i] -> geometric_set_select geometric_set_select = surface surface => bounded_surface
REPLICATE_FEATURE	replicate_feature			replicate_feature <= {feature_definition <= instanced_feature} feature_definition<= characterized_object
replicate_feature to two5D_manufacturing_feature (as replicate_base_feature)	PATH			replicate_feature <= feature_definition => instanced_feature <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship.name = ‘pattern basis’} {shape_aspect_relationship => feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect => instanced_feature
ROUND_HOLE	round_hole	10303-522		round_hole <= {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
diameter	length_measure_with_unit	10303-41		round_hole <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = 'diameter occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.name = 'diameter'} {shape_aspect_relationship.description = 'profile usage'} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => circular_closed_profile NOTE See mapping for CIRCULAR_CLOSED_PROFILE.-diameter for the 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 (as change_in_diameter) #1: as angle_taper #2: as diameter_taper	PATH			round_hole <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = 'change in diameter occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = 'taper usage'} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { #1: (shape_aspect.description = 'angle taper') #2: (shape_aspect.description = 'diameter taper') } shape_aspect => taper

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 <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘bottom condition occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘hole bottom usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {(shape_aspect.description = ‘conical’) (shape_aspect.description = ‘flat’) (shape_aspect.description = ‘flat with radius’) (shape_aspect.description = ‘flat with taper’) (shape_aspect.description = ‘spherical’) (shape_aspect.description = ‘through’)} shape_aspect => hole_bottom

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

Application element	AIM element	Source	Rules	Reference path
bottom_at_path_end See NOTE 11, preferred mapping #1: if value is true #2: if value is false	shape_aspect_relationship.name	10303-41		round_hole <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {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.name { #1: (shape_aspect_relationship.name = ‘hole depth end’) #2: (shape_aspect_relationship.name = ‘hole depth start’) }

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

Application element	AIM element	Source	Rules	Reference path
bottom_at_path_end See NOTE 11, alternate mapping based on observed AP 224 usage #1: if value is true #2: if value is false	descriptive_representation_item.-description	10303-45		round_hole <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {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.relating_shape_aspect -> shape_aspect {shape_aspect => hole_bottom} shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation_with_parameters} representation representation.items[i] -> {representation_item.name = ‘blind bottom orientation’} representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = \ ‘hole depth end’ #2: (descriptive_representation_item.description = \ ‘hole depth start’}

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

Application element	AIM element	Source	Rules	Reference path
round_hole to linear_path (as course_of_travel)	PATH			round_hole <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = 'hole depth occurrence'} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.name = 'hole depth'} {shape_aspect_relationship.description = \ 'path feature component usage'} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = 'linear'} shape_aspect => path_feature_component
ROUNDED_END	rounded_end	10303-522		rounded_end <= {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
rounded_end to linear_path (as course_of_travel)	PATH			rounded_end <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘course of travel occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = \\ ‘path feature component usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = ‘linear’} shape_aspect => path_feature_component

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 <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘partial circular boundary occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = ‘profile usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => partial_circular_profile
ROUNDED_U_PROFILE	rounded_u_profile	10303-522		rounded_u_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
width	length_measure_with_unit	10303-41		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.name = ‘width’} 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
depth	length_measure_with_unit	10303-41		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.name = ‘depth’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
SHAPE_PROFILE	outside_profile	10303-522		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
shape_profile to profile_select (as floor_condition) #1: as profile_floor #2: as through_profile_floor	PATH			outside_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {(shape_aspect.description = ‘complex boundary occurrence’) (shape_aspect.description = ‘partial circular boundary occurrence’) (shape_aspect.description = ‘closed circular boundary occurrence’) (shape_aspect.description = \\ ‘open rectangular boundary occurrence’) (shape_aspect.description = \\ ‘closed rectangular boundary occurrence’)} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘profile floor usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { #1: (shape_aspect.description = ‘planar’) #1: (shape_aspect.description = ‘complex’) #2: (shape_aspect.description = ‘through’) } shape_aspect => profile_floor

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

Application element	AIM element	Source	Rules	Reference path
removal_direction	direction	10303-42		outside_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- {property_definition => product_definition_shape <- shape_aspect.of_shape shape_aspect (shape_aspect.description = ‘complex boundary occurrence’) (shape_aspect.description = ‘partial circular boundary occurrence’) (shape_aspect.description = ‘closed circular boundary occurrence’) (shape_aspect.description = \ ‘open rectangular boundary occurrence’) (shape_aspect.description = \ ‘closed rectangular boundary occurrence’) } property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation.name = ‘removal direction’} { representation => shape_representation=> direction_shape_representation } representation.items[i] -> representation_item => geometric_representation_item => direction
SLOT	slot	10303-522		slot <= {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
slot to travel_path (as course_of_travel)	PATH			slot <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘course of travel occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.name = ‘course of travel’} {shape_aspect_relationship.description = \\ ‘path feature component usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => path_feature_component

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

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

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

Application element	AIM element	Source	Rules	Reference path
slot to slot_end_type (as end_conditions)	PATH			slot <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘end condition occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => feature_component_relationship} {shape_aspect_relationship.description = ‘slot end usage’} {(shape_aspect_relationship.name = ‘course of travel start’) (shape_aspect_relationship.name = ‘course of travel end’)} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => slot_end
SLOT_END_TYPE	slot_end	10303-522		slot_end <= shape_aspect {shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => feature_component_definition}
SPECIFICATION	document	10303-41		

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	10303-41		
specification_description	document.description	10303-41		
specification_class	document_with_class.class	10303-41		document=> document_with_class
SPECIFICATION_USAGE_-CONSTRAINT	document_usage_constraint	10303-41		
element	document_usage_constraint.-subject_element	10303-41		
class_id	document_usage_constraint.-subject_element_value	10303-41		
SPHERICAL_CAP	spherical_cap	10303-522		spherical_cap <= {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
internal_angle	plane_angle_measure_with_unit	10303-41		spherical_cap <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘internal angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		spherical_cap <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘radius’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
SPHERICAL_HOLE_BOTTOM	hole_bottom	10303-522		hole_bottom <= shape_aspect { shape_aspect.description = ‘spherical’ }

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

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		hole_bottom <= 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.name = ‘radius’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
SQUARE_U_PROFILE	square_u_profile	10303-522		square_u_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
width	length_measure_with_unit	10303-41		square_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.name = ‘width’} 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
first_radius	length_measure_with_unit	10303-41		square_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.name = ‘first 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
first_angle	plane_angle_measure_with_unit	10303-41		square_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.name = ‘first angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
second_radius	length_measure_with_unit	10303-41		square_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.name = ‘second 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
second_angle	plane_angle_measure_with_unit	10303-41		square_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.name = ‘second angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
depth	length_measure_with_unit	10303-41		square_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.name = ‘depth’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
STEP	step	10303-522		step <= {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
step to linear_path (as open_boundary)	PATH			step <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect.description = ‘course of travel occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship => shape_defining_relationship} {shape_aspect_relationship.description = \ ‘path feature component usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> {shape_aspect.description = ‘linear’} shape_aspect => path_feature_component

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

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

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

Application element	AIM element	Source	Rules	Reference path
step to boss (as its_boss)	PATH			step <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship.description = 'uncut volume'} {shape_aspect_relationship=> feature_component_relationship} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect => instanced_feature <= feature_definition => boss
SURFACE_TEXTURE_PARAMETER	surface_texture_representation	10303-238		surface_texture_representation <= representation
surface_texture_parameter to parameter_value (as its_value)	measure_representation_item	10303-45		surface_texture_representation <= representation representation.items[i] -> representation_item => measure_representation_item

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

Application element	AIM element	Source	Rules	Reference path
parameter_name	representation_item.name	10303-43		surface_texture_representation <= representation representation.items[i] -> { representation_item => measure_representation_item } representation_item representation_item.name
measuring_method	descriptive_representation_item.- description	10303-45		surface_texture_representation <= representation representation.items[i] -> representation_item => {representation_item.name = 'measuring method'} descriptive_representation_item descriptive_representation_item.description {(descriptive_representation_item.description) (descriptive_representation_item.description = 'ISO 4287') (descriptive_representation_item.description = 'ISO 12085') (descriptive_representation_item.description = 'ISO 13565')}
parameter_index	representation_item.name	10303-43		surface_texture_representation <= representation representation.items[i] -> { representation_item => measure_representation_item } representation_item representation_item.name See NOTE 13
surface_texture_parameter to machined_surface (as applied_surfaces)	PATH			surface_texture_representation <= representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition

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

Application element	AIM element	Source	Rules	Reference path
TEE_PROFILE	tee_profile	10303-522		tee_profile <= shape_aspect
first_angle	plane_angle_measure_with_unit	10303-41		tee_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.name = ‘first angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
second_angle	plane_angle_measure_with_unit	10303-41		tee_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.name = ‘second angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
cross_bar_width	length_measure_with_unit	10303-41		tee_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.name = ‘cross bar width’} 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
cross_bar_depth	length_measure_with_unit	10303-41		tee_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.name = ‘cross bar depth’} 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
radius	length_measure_with_unit	10303-41		tee_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.name = ‘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
width	length_measure_with_unit	10303-41		tee_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.name = ‘width’} 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
first_offset	length_measure_with_unit	10303-41		tee_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.name = ‘first offset’} 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
second_offset	length_measure_with_unit	10303-41		tee_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.name = ‘second offset’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
THREAD	(thread) (externally_defined_feature_- definition)	10303-522 10303-522		(thread <= {feature_definition => instanced_feature} feature_definition <= characterized_object) (externally_defined_feature_definition <= [externally_defined_item] [{feature_definition => instanced_feature} feature_definition <= characterized_object {characterized_object.description = ‘thread’}])

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

Application element	AIM element	Source	Rules	Reference path
thread to partial_area_definition (as partial_profile)	PATH			(thread <=) (externally_defined_feature_definition <=) 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_relationship.related_shape_aspect {shape_aspect_relationship.description = ‘applied area usage’} {shape_aspect_relationship => shape_defining_relationship} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => applied_area

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

Application element	AIM element	Source	Rules	Reference path
thread to machining_feature (as applied_shape)	PATH			(thread <=) (externally_defined_feature_definition <=) 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_relationship.related_shape_aspect { shape_aspect_relationship.description = ‘applied shape’ } { shape_aspect_relationship => shape_defining_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => instanced_feature

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

Application element	AIM element	Source	Rules	Reference path
inner_or_outer_thread	descriptive_representation_- item.description	10303-45		(thread <=) (externally_defined_feature_definition <=) feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘thread side’} representation_item => descriptive_representation_item descriptive_representation_item.description {(descriptive_representation_item.description = ‘internal’) (descriptive_representation_item.description = ‘external’)}

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

Application element	AIM element	Source	Rules	Reference path
qualifier	descriptive_representation_item	10303-45		(thread <=) (externally_defined_feature_definition <=) feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘qualifier’} representation_item => 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	10303-45		(thread <=) (externally_defined_feature_definition <=) feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘fit class’} representation_item => descriptive_representation_item

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

Application element	AIM element	Source	Rules	Reference path
form	descriptive_representation_item	10303-45		(thread <=) (externally_defined_feature_definition <=) feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘form’} representation_item => descriptive_representation_item

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

Application element	AIM element	Source	Rules	Reference path
major_diameter	length_measure_with_unit	10303-41		(thread <=) (externally_defined_feature_definition <=) feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘major diameter’} 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
number_of_threads	ratio_measure_with_unit			(thread <=) (externally_defined_feature_definition <=) feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘number of threads’} representation_item => measure_representation_item <= measure_with_unit => 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_- item.description	10303-45		(thread <=) (externally_defined_feature_definition <=) feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘hand’ } representation_item => descriptive_representation_item descriptive_representation_item.description {(descriptive_representation_item.description = ‘left’) (descriptive_representation_item.description = ‘right’)}

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

Application element	AIM element	Source	Rules	Reference path
THROUGH_BOTTOM_CONDITION	hole_bottom	10303-522		hole_bottom <= shape_aspect { shape_aspect.description = 'through' } {shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => feature_component_definition}
THROUGH_POCKET_BOTTOM_-CONDITION	pocket_bottom	10303-522		pocket_bottom <= shape_aspect { shape_aspect.description = 'through' }
THROUGH_PROFILE_FLOOR	profile_floor	10303-522		profile_floor <= shape_aspect {shape_aspect.description = 'through'} {shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => feature_component_definition}
TOOLPATH_FEATURE	instanced_feature	10303-522		instanced_feature <= feature_definition <= characterized_object { 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	10303-42		open_shell <- shell_based_surface_model.sbsm_boundary[1] shell_based_surface_model <= representation_item <- representation.items[i] {representation => manifold_surface_shape_representation } representation <- property_definition_representation.used_representation property_definition_representation { property_definition_representation => shape_definition_representation } property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = shape_definition shape_definition = shape_aspect { shape_aspect.description = ‘volume shape’} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship => shape_defining_relationship } { shape_aspect_relationship.description = ‘volume shape usage’ } shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect { shape_aspect.description = ‘shape volume occurrence’ } shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_object => removal_volume

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

Application element	AIM element	Source	Rules	Reference path
TRANSITION_FEATURE	transistion_feature	10303-522		transition_feature <= shape_aspect
transition_feature to machining_feature (as first_feature)	PATH		3, 7	transition_feature <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship.name = 'first feature' } {shape_aspect_relationship=> feature_component_relationship} shape_aspect_relationship.related_shape_aspect-> shape_aspect => (instanced_feature) (transition_feature)

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		3, 7	transition_feature <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape {shape_aspect => composite_shape_aspect} shape_aspect <- shape_aspect_relationship.relating_shape_aspect { shape_aspect_relationship.name = ‘second feature’ } {shape_aspect_relationship=> feature_component_relationship} shape_aspect_relationship.related_shape_aspect-> shape_aspect => (instanced_feature) (transition_feature)
TRAVEL_PATH	path_feature_component	10303-522		path_feature_component <= shape_aspect {shape_aspect shape_aspect.of_shape-> product_definition_shape <= property_definition property_definition.definition-> characterized_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
placement	axis2_placement_3d	10303-42		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.name = ‘orientation’} representation_item => geometric_representation_item => placement => axis2_placement_3d
TWO5D_MANUFACTURING_- FEATURE	instanced_feature	10303-522		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
feature_placement	axis2_placement_3d	10303-42		instanced_feature <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘orientation’} representation_item => geometric_representation_item => placement => axis2_placement_3d See NOTE 14
VEE_PROFILE	vee_profile	10303-522		vee_profile <= shape_aspect

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

Application element	AIM element	Source	Rules	Reference path
profile_radius	length_measure_with_unit	10303-41		vee_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.name = ‘profile 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
profile_angle	plane_angle_measure_with_unit	10303-41		vee_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.name = ‘profile angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
tilt_angle	plane_angle_measure_with_unit	10303-41		vee_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.name = ‘tilt angle’} representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
first_side_length	length_measure_with_unit	10303-41		vee_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.name = ‘first side length’} 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
second_side_length	length_measure_with_unit	10303-41		vee_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.name = ‘second side length’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
WOODRUFF_SLOT_END_TYPE	slot_end	10303-522		slot_end <= shape_aspect { shape_aspect.description = ‘woodruff’ }

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

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		slot_end <= 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_with_parameters} representation representation.items[i] -> {representation_item.name = ‘radius’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 5 — Mapping table for executable UoF

Application element	AIM element	Source	Rules	Reference path
AND_EXPRESSION	and_expression	13584-20		and_expression <= multiple_arity_boolean_expression <= [boolean_expression <= expression <=] [multiple_arity_generic_expression <=] generic_expression
ASSIGNMENT	machining_process_executable	10303-238		machining_process_executable <= action_method { action_method.description = ‘assignment’ }
assignment to nc_variable (as its_lvalue)	PATH			machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘lvalue’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => expression_representation_item

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
assignment to rvalue (as its_rvalue)	PATH			machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'rvalue' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => expression_representation_item
BINARY_BOOLEAN_EXPRESSION	binary_boolean_expression	13584-20		binary_boolean_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression
binary_boolean_expression to boolean_expression (as operand1)	PATH			binary_boolean_expression <= binary_generic_expression binary_generic_expression.operands[1] -> generic_expression => expression => boolean_expression
binary_boolean_expression to boolean_expression (as operand2)	PATH			binary_boolean_expression <= binary_generic_expression binary_generic_expression.operands[2] -> generic_expression => expression => boolean_expression

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
BOOLEAN_EXPRESSION	boolean_expression	13584-20		boolean_expression <= expression <= generic_expression
CHANNEL	representation	10303-43		representation { representation.name = 'channel' }
its_id	descriptive_representation_item.-description	10303-45		representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description
COMPARISON_EQUAL	comparison_equal	13584-20		comparison_equal <= comparison_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression
COMPARISON_EXPRESSION	comparison_expression	13584-20		comparison_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression
comparison_expression to nc_variable (as operand1)	PATH			comparison_expression <= binary_generic_expression binary_generic_expression.operands[1] -> generic_expression => expression => numeric_expression => simple_numeric_expression => 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	13584-20		comparison_greater <= comparison_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression
COMPARISON_GREATER_EQUAL	comparison_greater_equal	13584-20		comparison_greater_equal <= comparison_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression
COMPARISON_LESS	comparison_less	13584-20		comparison_less <= comparison_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression
COMPARISON_LESS_EQUAL	comparison_less_equal	13584-20		comparison_less_equal <= comparison_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
COMPARISON_NOT_EQUAL	comparison_not_equal	13584-20		comparison_not_equal <= comparison_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression
DISPLAY_MESSAGE	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘display message’ }
its_text	descriptive_representation_item.- description	10303-45		machining_nc_function <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘message text’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description
EXECUTABLE	machining_process_executable	10303-238		machining_process_executable <= action_method
its_id	action_method.name	10303-41		machining_process_executable <= action_method action_method.name

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
EXTENDED_NC_FUNCTION	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘extended function’ }
description	descriptive_representation_item.- description	10303-45		machining_nc_function <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘description’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description
IF_STATEMENT	machining_process_executable	10303-238		machining_process_executable <= action_method { action_method.description = ‘if statement’ }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
if_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
if_statement to executable (as true_branch)	PATH			machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_process_body_relationship => machining_process_branch_relationship } { action_method_relationship.name = ‘true branch’ } action_method_relationship.related_method -> action_method => machining_process_executable

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
if_statement to executable (as false_branch)	PATH			machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_process_body_relationship => machining_process_branch_relationship } { action_method_relationship.name = ‘false branch’ } action_method_relationship.related_method -> action_method => machining_process_executable
IN_PROCESS_GEOMETRY	<action_property>	10303-49		< action_property { action_property.name = ‘as-is shape’ } >
	<action_property>	10303-49		< action_property { action_property.name = ‘to-be shape’ } >
	<action_property>	10303-49		< action_property { action_property.name = ‘removal shape’ } >

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
as_is	shape_representation	10303-41		action_property <- { action_property.name = ‘as-is shape’ } action_property_representation.property action_property_representation action_property_representation.representation -> representation => shape_representation { shape_representation => (advanced_brep_shape_representation) (edge_based_wireframe_shape_representation) (faceted_brep_shape_representation) (geometrically_bounded_surface_shape_representation) (geometrically_bounded_wireframe_shape_representation) (manifold_surface_shape_representation) (non_manifold_surface_shape_representation) (shell_based_wireframe_shape_representation) }
to_be	shape_representation	10303-41		action_property <- { action_property.name = ‘to-be shape’ } action_property_representation.property action_property_representation action_property_representation.representation -> representation => shape_representation { shape_representation => (advanced_brep_shape_representation) (edge_based_wireframe_shape_representation) (faceted_brep_shape_representation) (geometrically_bounded_surface_shape_representation) (geometrically_bounded_wireframe_shape_representation) (manifold_surface_shape_representation) (non_manifold_surface_shape_representation) (shell_based_wireframe_shape_representation) }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
removal	shape_representation	10303-41		action_property <- { action_property.name = ‘removal shape’ } action_property_representation.property action_property_representation action_property_representation.representation -> representation => shape_representation { shape_representation => (advanced_brep_shape_representation) (edge_based_wireframe_shape_representation) (faceted_brep_shape_representation) (geometrically_bounded_surface_shape_representation) (geometrically_bounded_wireframe_shape_representation) (manifold_surface_shape_representation) (non_manifold_surface_shape_representation) (shell_based_wireframe_shape_representation) }
MACHINE_AXIS_TRAVEL	measure_with_unit	10303-41		measure_with_unit => measure_representation_item <= representation_item { representation_item <- representation.items[i] representation <- resource_property_representation.representation resource_property_representation resource_property_representation.property -> resource_property resource_property.name = ‘axis travel’ }
axis_identifier	representation_item.name	10303-41		measure_with_unit measure_representation_item <= representation_item representation_item.name
travel_distance	measure_with_unit	10303-41		IDENTICAL MAPPING

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
MACHINE_PARAMETERS	machining_execution_resource	10303-238		machining_execution_resource <= action_resource
machine_parameters to machine_axis_travel (as axis_travel)	PATH			machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘axis travel’ } 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 => length_measure_with_unit

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
feedrate	measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘feedrate’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘feed speed’ } representation.items[i] -> { representation_item.name = ‘feed speed’ } representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
number_of_control_axis	count_measure	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘number of control axis’ } 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 => measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
number_of_simultaneous_axis	count_measure	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘number of simultaneous axis’ } 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 => measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure
positioning_accuracy	length_measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘positioning accuracy’ } 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 => length_measure_with_unit

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
spindle_power	measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘spindle power’ } 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 { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
spindle_speed	measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'spindle' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_spindle_speed_representation } representation { representation.name = 'spindle speed' } representation.items[i] -> { representation_item.name = 'rotational speed' } representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
table_indexing	descriptive_representation_item.- description	10303-45		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘table indexing’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘required’) (descriptive_representation_item.description = ‘not required’) }
table_length	length_measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘table length’ } 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 => length_measure_with_unit

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
table_width	length_measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'table width' } 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 => length_measure_with_unit
work_volume_height	length_measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'work volume height' } 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 => length_measure_with_unit

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
work_volume_length	length_measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'work volume length' } 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 => length_measure_with_unit
work_volume_width	length_measure_with_unit	10303-41		machining_execution_resource <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'work volume width' } 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 => length_measure_with_unit
MACHINING_TOOL	machining_tool	10303-238		machining_tool <= action_resource

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_id	action_resource.name	10303-41		machining_tool <= action_resource action_resource.name
machining_tool to tool_usage (as its_usage)	PATH			machining_tool <= action_resource <- requirement_for_action_resource.resources[i] requirement_for_action_resource <= action_resource_requirement action_resource_requirement.operations[1] -> characterized_action_definition characterized_action_definition=action_method action_method => machining_tool_usage
MACHINING_WORKINGSTEP	machining_workingstep	10303-238		machining_workingstep <= machining_process_executable <= action_method { action_method.description = ‘machining’ }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
machining_workingstep to manufacturing_feature (as its_feature)	PATH		8	machining_workingstep <= machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_feature_relationship } action_method_relationship.related_method -> { action_method => machining_process_executable => machining_feature_process } action_method <- action.chosen_method { action.name = ‘machining’ } action => property_process <- process_property_association.process process_property_association process_property_association.property_or_shape -> property_or_shape_select property_or_shape_select = shape_definition shape_definition shape_definition = shape_aspect shape_aspect

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
machining_workingstep to manufacturing_feature (as final_features)	PATH		8	machining_workingstep <= machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_final_feature_relationship } action_method_relationship.related_method -> { action_method => machining_process_executable => machining_feature_process } action_method <- action.chosen_method { action.name = ‘machining’ } action => property_process <- process_property_association.process process_property_association process_property_association.property_or_shape -> property_or_shape_select property_or_shape_select = shape_definition shape_definition shape_definition = shape_aspect shape_aspect
machining_workingstep to machining_operation (as its_operation)	PATH			machining_workingstep <= machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_operation_relationship } action_method_relationship.related_method -> action_method => machining_operation

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
machining_workingstep to in_process_geometry (as its_effect)	PATH			machining_workingstep <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition < action_property { action_property.name = ‘as-is shape’ } > < action_property { action_property.name = ‘to-be shape’ } > < action_property { action_property.name = ‘removal shape’ } >
toolpath_orientation	axis2_placement_3d	10303-42		machining_workingstep <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘toolpath orientation’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => placement => axis2_placement_3d
MULTIPLE_ARITY_BOOLEAN_- EXPRESSION	multiple_arity_boolean_expression	13584-20		multiple_arity_boolean_expression <= [boolean_expression <= expression <=] [multiple_arity_generic_expression <=] generic_expression

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
multiple_arity_boolean_expression to boolean_expression (as operands)	PATH			multiple_arity_boolean_expression <= multiple_arity_generic_expression multiple_arity_generic_expression.operands[i] -> generic_expression => expression => boolean_expression
NC_CONSTANT	[literal_number] [expression_representation_item]	13584-20 10303-238		expression_representation_item <= generic_expression => expression => numeric_expression => simple_numeric_expression => literal_number => (int_literal) (real_literal)
its_name	representation_item.name	10303-41		expression_representation_item <= representation_item representation_item.name
its_value	literal_number.the_value	13584-20		
NC_FUNCTION	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method
NC_VARIABLE	[numeric_variable] [expression_representation_item]	13584-20 10303-238	9	expression_representation_item <= generic_expression => expression => numeric_expression => simple_numeric_expression => numeric_variable => (int_numeric_variable) (real_numeric_variable)

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_name	representation_item.name	10303-41		expression_representation_item <= representation_item representation_item.name
initial_value See NOTE 15	literal_number.the_value	13584-20	9	expression_representation_item <= representation_item <- representation_item_relationship.relating_representation_item { representation_item_relationship.description = ‘initial value’ } representation_item_relationship representation_item_relationship.related_representation_item -> representation_item => expression_representation_item <= generic_expression => literal_number { literal_number => (int_literal) (real_literal) } literal_number.the_value
NON_SEQUENTIAL	machining_process_executable	10303-238		machining_process_executable <= action_method { action_method.description = ‘non-sequential’ }
non_sequential to executable (as its_elements)	PATH			machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_process_body_relationship } action_method_relationship.related_method -> action_method => machining_process_executable

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
NOT_EXPRESSION	not_expression	13584-20		not_expression <= unary_boolean_expression <= [boolean_expression <= expression <=] [unary_generic_expression <=] generic_expression
OFFSET_VECTOR	machining_offset_vector_-representation	10303-43		machining_offset_vector_representation <= representation
offset_vector to nc_variable (as translate)	PATH			machining_offset_vector_representation <= representation representation.items[i] -> { representation_item.name = ‘translate’ } representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = list_representation_item list_representation_item[i] -> representation_item => expression_representation_item
offset_vector to nc_variable (as rotate)	PATH			machining_offset_vector_representation <= representation representation.items[i] -> { representation_item.name = ‘rotate’ } representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = list_representation_item list_representation_item[i] -> representation_item => expression_representation_item

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
OPTIONAL_STOP	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘optional stop’ }
OR_EXPRESSION	or_expression	13584-20		or_expression <= multiple_arity_boolean_expression <= [boolean_expression <= expression <=] [multiple_arity_generic_expression <=] generic_expression
PARALLEL	machining_process_executable	10303-238		machining_process_executable <= action_method { action_method.description = ‘parallel’ }
parallel to executable (as branches)	PATH			machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => [machining_process_body_relationship =>] [concurrent_action_method =>] machining_process_concurrent_relationship } action_method_relationship.related_method -> action_method => machining_process_executable
PROGRAM_STOP	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘program stop’ }
PROGRAM_STRUCTURE	machining_process_executable	10303-238		machining_process_executable <= action_method

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
RAPID_MOVEMENT	machining_rapid_movement	10303-238		machining_rapid_movement <= [machining_operation <=] [machining_process_executable <=] action_method
RETURN_HOME	machining_rapid_movement	10303-238		machining_rapid_movement <= [machining_operation <=] [machining_process_executable <=] action_method { action_method.description = ‘return home’ }
SELECTIVE	machining_process_executable	10303-238		machining_process_executable <= action_method { action_method.description = ‘selective’ }
selective to executable (as its_elements)	PATH			machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_process_body_relationship => machining_process_branch_relationship } action_method_relationship.related_method -> action_method => machining_process_executable
SET_MARK	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘set mark’ }
SETUP	product_definition_formation	10303-41		product_definition_formation { product_definition_formation.of_product -> product => machining_setup }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_id	product.id	10303-41		product_definition_formation product_definition_formation.of_product -> product product.id
its_origin	axis2_placement_3d	10303-42		product_definition_formation <- product_definition.formation product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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 representation.items[i] -> {representation_item.name = ‘orientation’} representation_item => geometric_representation_item => placement => axis2_placement_3d

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
setup to elementary_surface (as its_secplane)	elementary_surface	10303-42		product_definition_formation <- product_definition.formation product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition { property_definition.name = 'security plane' } property_definition represented_definition = property_definition represented_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> representation_item => geometric_representation_item => surface => elementary_surface
setup to workpiece_setup (as its_workpiece_setup)	PATH			product_definition_formation <- product_definition.formation product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship => machining_setup_workpiece_relationship
SETUP_INSTRUCTION	machining_operator_instruction	10303-238		machining_operator_instruction <= action_method_with_associated_documents <= action_method

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
description	action_method.description	10303-41		machining_operator_instruction <= action_method_with_associated_documents <= action_method action_method.description
external_document	document.id	10303-41		machining_operator_instruction <= action_method_with_associated_documents action_method_with_associated_documents.documents[i] -> document document.id
TOOL_LENGTH_PROBING	machining_touch_probing	10303-238		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method { action_method.description = ‘tool length probing’ }
TOOL_PROBING	machining_touch_probing	10303-238		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method { (action_method.description = ‘tool length probing’) (action_method.description = ‘tool radius probing’) }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
offset	cartesian_point	10303-42		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘offset’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => point => cartesian_point

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
max_wear	positive_length_measure	10303-41		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘maximum wear’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit measure_with_unit.value_component -> measure_value measure_value = positive_length_measure positive_length_measure
tool_probing to machining_tool (as its_tool)	PATH			machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method supported_item = action_method supported_item <- action_resource.usage[i] action_resource => machining_tool

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
TOOL_RADIUS_PROBING	machining_touch_probing	10303-238		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method { action_method.description = ‘tool radius probing’ }
TOOL_USAGE	machining_tool_usage	10303-238		machining_tool_usage <= action_method
its_carousel	descriptive_representation_item.- description	10303-45		machining_tool_usage <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘tool carousel’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description
its_id	action_method.name	10303-41		machining_tool_usage <= action_method action_method.name

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
tool_usage to externally_defined_representation (as its_library_reference)	PATH			machining_tool_usage <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'library reference' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation => externally_defined_representation_with_parameters
its_position	descriptive_representation_item.-description	10303-45		machining_tool_usage <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'tool position' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
tool_usage to workpiece (as its_product)	PATH			machining_tool_usage <= action_method <- action.chosen_method { action.name = 'tool usage' } action => product_definition_process <- process_product_association.process process_product_association process_product_association.defined_product -> characterized_product_definition characterized_product_definition = product_definition product_definition
TOUCH_PROBE	representation	10303-43		representation { representation.name = 'touch probe' }
its_id	descriptive_representation_item.- description	10303-45		representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description
TOUCH_PROBING	machining_touch_probing	10303-238		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
touch_probing to nc_variable (as measured_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 = ‘measured offset’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => expression_representation_item
UNARY_BOOLEAN_EXPRESSION	unary_boolean_expression	13584-20		unary_boolean_expression <= [boolean_expression <= expression <=] [unary_generic_expression <=] generic_expression
unary_boolean_expression to boolean_expression (as operand)	PATH			unary_boolean_expression <= unary_generic_expression unary_generic_expression.operand -> generic_expression => expression => boolean_expression
WAIT_FOR_MARK	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘wait for mark’ }

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
wait_for_mark to channel (as its_channel)	PATH			machining_nc_function <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'channel' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation
WHILE_STATEMENT	machining_process_executable	10303-238		machining_process_executable <= action_method { action_method.description = 'while statement' }
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

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
while_statement to executable (as body)	PATH			machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_process_body_relationship } action_method_relationship.related_method -> action_method => machining_process_executable
WORKINGSTEP #1: if workingstep is a machining_workingstep or turning_workingstep #2: if workingstep is a rapid_movement #3: if workingstep is a touch_probing	#1: (machining_workingstep) #2: (machining_rapid_movement) #3: (machining_touch_probing)	10303-238 10303-238 10303-238		#1: (machining_workingstep <=) #2: (machining_rapid_movement <=) #3: (machining_touch_probing <=) machining_process_executable <= action_method

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_secplane #1: if workingstep is a machining_workingstep or turning_workingstep #2: if workingstep is a rapid_movement #3: if workingstep is a touch_probing	elementary_surface	10303-42		#1: (machining_workingstep <=) #2: (machining_rapid_movement <=) #3: (machining_touch_probing <=) machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘security plane’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => surface => elementary_surface
WORKPIECE_COMPLETE_PROBING	machining_touch_probing	10303-238		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method { 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 <= [machining_operation <=] [machining_process_executable <=] action_method <- action.chosen_method { action.name = ‘workpiece complete probing’ } action => product_definition_process <- process_product_association.process process_product_association process_product_association.defined_product -> characterized_product_definition characterized_product_definition = product_definition product_definition
probing_distance	length_measure_with_unit	10303-41		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘probing distance’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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	10303-238		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	10303-42		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'start position' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => placement => axis2_placement_3d
workpiece_probing to workpiece (as its_workpiece)	PATH			machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method <- action.chosen_method { action.name = 'workpiece probing' } action => product_definition_process <- process_product_association.process process_product_association process_product_association.defined_product -> characterized_product_definition characterized_product_definition = product_definition product_definition

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_direction	direction	10303-42		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
expected_value	length_measure_with_unit	10303-41		machining_touch_probing <= [machining_operation <=] [machining_process_executable <=] action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘expected value’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
workpiece_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_SETUP	product_definition_relationship	10303-41		machining_setup_workpiece_relationship <= product_definition_relationship
workpiece_setup to workpiece (as its_workpiece)	PATH			machining_setup_workpiece_relationship <= product_definition_relationship product_definition_relationship.related_product_definition -> product_definition

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_origin	axis2_placement_3d	10303-42		machining_setup_workpiece_relationship <= product_definition_relationship characterized_product_definition = product_definition_relationship characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition => product_definition_shape <- context_dependent_shape_representation.- represented_product_relation context_dependent_shape_representation context_dependent_shape_representation.- representation_relation -> [shape_representation_relationship] [representation_relationship_with_transformation] representation_relationship_with_transformation.- transformation_operator -> transformation transformation = item_defined_transformation item_defined_transformation item_defined_transformation.transform_item_2 -> representation_item => axis2_placement_3d See NOTE 16

Table 5 — Mapping table for executable UoF (continued)

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

Table 5 — Mapping table for executable UoF (continued)

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

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			machining_setup_workpiece_relationship <= product_definition_relationship characterized_product_definition = product_definition_relationship characterized_product_definition <- process_product_association.defined_product process_product_association process_product_association.process -> product_definition_process <= action { action.name = ‘setup instructions’ } action.chosen_method -> { action_method => machining_process_executable } { action_method.description = ‘setup instructions’ } action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => serial_action_method => sequential_method => machining_operator_instruction_relationship } action_method_relationship.related_method -> action_method => machining_operator_instruction See NOTE 17
WORKPLAN	machining_workplan	10303-238		machining_workplan <= machining_process_executable <= action_method

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
workplan to executable (as its_elements)	PATH			machining_workplan <= machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => [machining_process_body_relationship =>] [serial_action_method => sequential_method =>] machining_process_sequence_relationship } action_method_relationship.related_method -> action_method => machining_process_executable See NOTE 17
workplan to channel (as its_channel)	PATH			machining_workplan <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘channel’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
workplan to setup (as its_setup)	PATH			machining_workplan <= machining_process_executable <= action_method <- action.chosen_method { action.name = ‘setup’ } action => product_definition_process <- process_product_association.process process_product_association process_product_association.defined_product -> characterized_product_definition characterized_product_definition = product_definition product_definition product_definition.formation -> product_definition_formation
workplan to in_process_geometry (as its_effect)	PATH			machining_workplan <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition action_property
workplan to machine_parameters (as its_minimum_machine_params)	PATH			machining_workplan <= machining_process_executable <= action_method supported_item = action_method supported_item <- action_resource.usage[i] action_resource => machining_execution_resource

Table 5 — Mapping table for executable UoF (continued)

Application element	AIM element	Source	Rules	Reference path
XOR_EXPRESSION	xor_expression	13584-20		xor_expression <= binary_boolean_expression <= [boolean_expression <= expression <=] [binary_generic_expression <=] generic_expression

Table 6 — Mapping table for operation UoF

Application element	AIM element	Source	Rules	Reference path
MACHINE_FUNCTIONS	machining_functions	10303-238		machining_functions <= action_method
MACHINING_OPERATION	machining_operation	10303-238		machining_operation <= action_method
its_id	action_method.name	10303-49		machining_operation <= action_method action_method.name
retract_plane	length_measure_with_unit	10303-41		machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘retract plane’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 6 — Mapping table for operation UoF (continued)

Application element	AIM element	Source	Rules	Reference path
start_point	cartesian_point	10303-42		machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'cut start point' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => point => cartesian_point
machining_operation to machining_tool (as its_tool)	PATH			machining_operation <= action_method supported_item = action_method supported_item <- action_resource.usage[i] action_resource => machining_tool
machining_operation to technology (as its_technology)	PATH			machining_operation <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_technology_relationship } action_method_relationship.related_method -> action_method => machining_technology

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 => machining_functions_relationship } action_method_relationship.related_method -> action_method => machining_functions
OPERATION	machining_operation	10303-238		machining_operation <= action_method
operation to toolpath (as its_toolpath) See NOTE 18	PATH			machining_operation <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => serial_action_method => sequential_method => machining_toolpath_sequence_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 (as its_tool_direction)	PATH			machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘tool direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation => machining_tool_direction_representation
TECHNOLOGY	machining_technology	10303-238		machining_technology <= action_method

Table 6 — Mapping table for operation UoF (continued)

Application element	AIM element	Source	Rules	Reference path
feedrate	measure_with_unit	10303-41		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘feed speed’ } representation.items[i] -> { representation_item.name = ‘feed speed’ } representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

Table 6 — Mapping table for operation UoF (continued)

Application element	AIM element	Source	Rules	Reference path
feedrate_reference #1: if value is tool center point (mapping may also be omitted if value is tool center point) #2: if value is cutter contact point	descriptive_representation_item	10303-45		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feedrate reference’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = \ ‘tool center point’) #2: (descriptive_representation_item.description = \ ‘cutter contact point’)}
THREE_AXES	machining_tool_direction_- representation	10303-238		machining_tool_direction_representation <= representation {representation.name = ‘three axes’ }
TOOL_DIRECTION	machining_tool_direction_- representation	10303-238		machining_tool_direction_representation <= representation
TOOLPATH_LIST	NOT MAPPED See NOTE 18			
TWO_AXES	machining_tool_direction_- representation	10303-238		machining_tool_direction_representation <= representation {representation.name = ‘two axes’ }

Table 7 — Mapping table for toolpath UoF

Application element	AIM element	Source	Rules	Reference path
AP_LIFT_PATH_ANGLE	machining_toolpath	10303-238		machining_toolpath <= action_method { action_method.description = ‘approach lift path angle’ }
angle	plane_angle_measure_with_unit	10303-41		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘angle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
benddist	length_measure_with_unit	10303-41		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘bend distance’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
AP_LIFT_PATH_TANGENT	machining_toolpath	10303-238		machining_toolpath <= action_method { action_method.description = ‘approach lift path tangent’ }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘radius’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
APPROACH_LIFT_PATH	machining_toolpath	10303-238		machining_toolpath <= action_method { (action_method.description = ‘approach lift path angle’) (action_method.description = ‘approach lift path tangent’) }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
fix_point	cartesian_point	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘fix point’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => point => cartesian_point
fix_point_dir	direction	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘fix point direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
AXIS_TRAJECTORY	machining_toolpath	10303-238		machining_toolpath <= action_method { action_method.description = ‘axis trajectory’ }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
axis_list See NOTE 19	representation_item.name	10303-43		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘axis commands’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> { representation_item => geometric_representation_item => curve => bounded_curve } representation_item representation_item.name
commands See NOTE 19	bounded_curve	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘axis commands’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => curve => bounded_curve

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CONNECT_DIRECT	machining_toolpath	10303-238		machining_toolpath <= action_method { action_method.description = ‘connect direct’ }
CONNECT_SECPLANE	machining_toolpath	10303-238		machining_toolpath <= action_method { action_method.description = ‘connect security plane’ }
up_dir	direction	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘up direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
down_dir	direction	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘down direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
CONNECTOR	machining_toolpath	10303-238		machining_toolpath <= action_method { (action_method.description = ‘connect direct’) (action_method.description = ‘connect security plane’) }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CURVE_WITH_NORMAL_VECTOR	[bounded_curve] [bounded_curve]	10303-42 10303-42		[bounded_curve <= representation_item <- representation.items[i] representation <- action_property_representation.representation action_property_representation action_property_representation.property -> action_property { action_property.name = ‘basic curve’ }] [bounded_curve <= representation_item <- representation.items[i] representation <- action_property_representation.representation action_property_representation action_property_representation.property -> action_property { action_property.name = ‘surface normal’ }]
basiccurve	bounded_curve	10303-42		bounded_curve <= representation_item <- representation.items[i] representation <- action_property_representation.representation action_property_representation action_property_representation.property -> action_property { action_property.name = ‘basic curve’ }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
surface_normal	bounded_curve	10303-42		bounded_curve <= representation_item <- representation.items[i] representation <- action_property_representation.representation action_property_representation action_property_representation.property -> action_property { action_property.name = ‘surface normal’ }
CUTTER_CONTACT_TRAJECTORY	machining_toolpath	10303-238		machining_toolpath <= action_method { action_method.description = ‘cutter contact trajectory’ }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
basiccurve #1: if the basiccurve is a bounded_pcurve #2: if the basiccurve is a curve_with_normal_vector	#1: (bounded_pcurve) #2: ([bounded_curve] [bounded_curve])	10303-42 10303-42 10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- #1: (action_property.definition { action_property.name = 'basic curve' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => bounded_curve => bounded_pcurve) #2: ([action_property.definition { action_property.name = 'basic curve' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => bounded_curve] [action_property.definition { action_property.name = 'surface normal' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => bounded_curve])

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_toolaxis	bounded_curve	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘tool axis’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => curve => bounded_curve
its_contact_type	descriptive_representation_item	10303-45		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘contact type’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘side’) (descriptive_representation_item.description = ‘front’) }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
path_maximum_deviation	length_measure_with_unit	10303-41		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘path maximum deviation’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
tool_axis_maximum_deviation	plane_angle_measure_with_unit	10303-41		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘tool axis maximum deviation’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CUTTER_LOCATION_TRAJECTORY	machining_toolpath	10303-238		machining_toolpath <= action_method { action_method.description = ‘cutter location trajectory’ }
basiccurve	bounded_curve	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘basic curve’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => curve => bounded_curve

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_toolaxis	bounded_curve	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'tool axis' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => curve => bounded_curve
surface_normal	bounded_curve	10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'surface normal' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => curve => bounded_curve

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
path_maximum_deviation	length_measure_with_unit	10303-41		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘path maximum deviation’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
tool_axis_maximum_deviation	plane_angle_measure_with_unit	10303-41		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘tool axis maximum deviation’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FEEDSTOP	machining_toolpath	10303-238		machining_toolpath <= action_method { action_method.description = 'feedstop' }
dwell	time_measure_with_unit	10303-41		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'dwell' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_dwell_time_representation } representation { representation.name = 'dwell time' } representation.items[i] -> { representation_item.name = 'dwell time' } representation_item => measure_representation_item <= measure_with_unit => time_measure_with_unit
PARAMETERISED_PATH	machining_toolpath	10303-238		machining_toolpath <= action_method { (action_method.description = 'approach lift path angle') (action_method.description = 'approach lift path tangent') (action_method.description = 'connect direct') (action_method.description = 'connect security plane') }
TOOLPATH	machining_toolpath	10303-238		machining_toolpath <= action_method

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_priority #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item	10303-45		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘priority’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = ‘required’) #2: (descriptive_representation_item.description = ‘suggested’) }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_type #1: if value is approach #2: if value is lift #3: if value is connect #4: if value is non-contact #5: if value is contact #6: if value is trajectory path (mapping may also be omitted if value is trajectory path)				machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘trajectory type’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = ‘approach’) #2: (descriptive_representation_item.description = ‘lift’) #3: (descriptive_representation_item.description = ‘connect’) #4: (descriptive_representation_item.description = ‘non-contact’) #5: (descriptive_representation_item.description = ‘contact’) #6: (descriptive_representation_item.description = \ ‘trajectory path’) }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_speed	(descriptive_representation_item) (ratio_measure_with_unit) (bounded_curve)	10303-45 10303-41 10303-42		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘speed profile’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_toolpath_speed_profile_representation } representation representation.items[i] -> (representation_item => descriptive_representation_item descriptive_representation_item.description { descriptive_representation_item.description = ‘rapid’ }) (representation_item => measure_representation_item <= measure_with_unit => ratio_measure_with_unit) (representation_item => geometric_representation_item => curve => bounded_curve)

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
toolpath to technology (as its_technology)	PATH			machining_toolpath <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_technology_relationship } action_method_relationship.related_method -> action_method => machining_technology
toolpath to machine_functions (as its_machine_functions)	PATH			machining_toolpath <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_functions_relationship } action_method_relationship.related_method -> action_method => machining_functions
its_id	action_method.name	10303-49		machining_toolpath <= action_method action_method.name
TOOLPATH_SPEED	bounded_curve	10303-42		bounded_curve { bounded_curve <- representation.items[i] representation => machining_toolpath_speed_profile_representation }
speed	IDENTICAL MAPPING			
TRAJECTORY	machining_toolpath	10303-238		machining_toolpath <= action_method { (action_method.description = ‘axis trajectory’) (action_method.description = ‘cutter contact trajectory’) (action_method.description = ‘cutter location trajectory’) }

Table 7 — Mapping table for toolpath UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_direction #1: if value is true (mapping may also be omitted if value is true) #2: if value is false	descriptive_representation_item	10303-45		machining_toolpath <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'direction' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \ 'beginning to end') #2: (descriptive_representation_item.description = \ 'end to beginning') }

Table 8 — Mapping table for process data for milling UoF

Application element	AIM element	Source	Rules	Reference path
ADAPTIVE_CONTROL	machining_technology	10303-238		machining_technology <= action_method { action_method.description = ‘adaptive control’ }
AIR_STRATEGY	machining_approach_retract_strategy	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { (action_method.description = ‘approach retract angle’) (action_method.description = ‘approach retract tangent’) }
ALONG_PATH	machining_approach_retract_strategy	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { action_method.description = ‘along path’ }
along_path to toolpath (as path) See NOTE 18	PATH			machining_approach_retract_strategy <= machining_strategy <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_toolpath_sequence_relationship } action_method_relationship.related_method -> action_method => machining_toolpath
AP_RETRACT_ANGLE	machining_approach_retract_strategy	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { 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	10303-41		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘travel angle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
travel_length	length_measure_with_unit	10303-41		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘travel length’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { action_method.description = ‘approach retract tangent’ }
radius	length_measure_with_unit	10303-41		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘travel radius’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
APPROACH_RETRACT_STRATEGY	machining_approach_retract_strategy	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method

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

Application element	AIM element	Source	Rules	Reference path
tool_orientation	direction	10303-42		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'tool orientation' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
BACK_BORING	back_boring_operation	10303-238		back_boring_operation <= drilling_type_operation <= machining_operation <= action_method
BIDIRECTIONAL	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { action_method.description = 'bidirectional' }

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

Application element	AIM element	Source	Rules	Reference path
feed_direction	direction	10303-42		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feed direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
stepover_direction	descriptive_representation_item.- description	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘left’) (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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘connection strategy’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘straight line’) (descriptive_representation_item.description = ‘lift shift plunge’) (descriptive_representation_item.description = ‘degouge’) (descriptive_representation_item.description = ‘loop back’) }
BIDIRECTIONAL_CONTOUR	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘bidirectional contour’ }

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

Application element	AIM element	Source	Rules	Reference path
feed_direction	direction	10303-42		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feed direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
stepover_direction	descriptive_representation_item.- description	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘left’) (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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘rotation direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = \ ‘clockwise’) (descriptive_representation_item.description = \ ‘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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘spiral cutmode’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘climb’) (descriptive_representation_item.description = ‘conventional’) }
BORING	boring_operation	10303-238		boring_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = ‘boring’ }
BORING_OPERATION	boring_operation	10303-238		boring_operation <= drilling_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
spindle_stop_at_bottom #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		boring_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘spindle stop’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \ ‘spindle stop at bottom’) #2: (descriptive_representation_item.description = \ ‘spindle nonstop’) }

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	10303-41		boring_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘testcut depth’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
waiting_position	cartesian_point	10303-42		boring_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'waiting position' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => point => cartesian_point
BOTTOM_AND_SIDE_FINISH_-MILLING	bottom_and_side_milling_operation	10303-238		bottom_and_side_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = 'finishing' }
BOTTOM_AND_SIDE_MILLING	bottom_and_side_milling_operation	10303-238		bottom_and_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	10303-41		bottom_and_side_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘axial cutting depth’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		bottom_and_side_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘radial cutting depth’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		bottom_and_side_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘allowance side’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		bottom_and_side_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'allowance bottom' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
BOTTOM_AND_SIDE_ROUGH_- MILLING	bottom_and_side_milling_operation	10303-238		bottom_and_side_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = 'roughing' }
CENTER_DRILLING	drilling_operation	10303-238		drilling_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = 'center drilling' }
CENTER_MILLING	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { action_method.description = 'center milling' }

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

Application element	AIM element	Source	Rules	Reference path
CONTOUR_BIDIRECTIONAL	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘contour bidirectional’ }
feed_direction	direction	10303-42		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feed direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘left’) (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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘rotation direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = \ ‘clockwise’) (descriptive_representation_item.description = \ ‘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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘spiral cutmode’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘climb’) (descriptive_representation_item.description = ‘conventional’) }
CONTOUR_PARALLEL	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘contour parallel’ }

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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘rotation direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = \\ ‘clockwise’) (descriptive_representation_item.description = \\ ‘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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘cutmode’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘climb’) (descriptive_representation_item.description = ‘conventional’) }
CONTOUR_SPIRAL	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘contour spiral’ }

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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘rotation direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = \ ‘clockwise’) (descriptive_representation_item.description = \ ‘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	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘cutmode’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘climb’) (descriptive_representation_item.description = ‘conventional’) }
COUNTER_SINKING	drilling_operation	10303-238		drilling_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = ‘counter sinking’ }
DRILLING	drilling_operation	10303-238		drilling_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = ‘drilling’ }
DRILLING_OPERATION	drilling_operation	10303-238		drilling_operation <= drilling_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
DRILLING_TYPE_OPERATION	drilling_type_operation	10303-238		drilling_type_operation <= machining_operation <= action_method
cutting_depth	length_measure_with_unit	10303-41		drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'cutting depth' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘previous diameter’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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_bottom	time_measure_with_unit	10303-41		drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘dwell time bottom’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_dwell_time_representation } representation { representation.name = ‘dwell time’ } representation.items[i] -> { representation_item.name = ‘dwell time’ } representation_item => measure_representation_item <= measure_with_unit => time_measure_with_unit

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	10303-41		drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feedrate on retract’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘relative speed’ } representation.items[i] -> { representation_item.name = ‘relative speed’ } representation_item => measure_representation_item <= measure_with_unit => ratio_measure_with_unit
drilling_type_operation to drilling_type_strategy (as its_machining_strategy)	PATH			drilling_type_operation <= machining_operation <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_strategy_relationship } { action_method_relationship.name = ‘machining’ } action_method_relationship.related_method -> action_method => machining_strategy => drilling_type_strategy

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

Application element	AIM element	Source	Rules	Reference path
DRILLING_TYPE_STRATEGY	drilling_type_strategy	10303-238		drilling_type_strategy <= machining_strategy <= action_method
reduced_cut_at_start	ratio_measure_with_unit	10303-41		drilling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘reduced cut at start’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_spindle_speed_representation } representation { representation.name = ‘relative speed’ } representation.items[i] -> { representation_item.name = ‘relative speed’ } representation_item => measure_representation_item <= measure_with_unit => ratio_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
reduced_feed_at_start	ratio_measure_with_unit	10303-41		drilling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘reduced feedrate at start’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘relative speed’ } representation.items[i] -> { representation_item.name = ‘relative speed’ } representation_item => measure_representation_item <= measure_with_unit => ratio_measure_with_unit

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	10303-41		drilling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘depth of start’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
reduced_cut_at_end	ratio_measure_with_unit	10303-41		drilling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘reduced cut at end’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_spindle_speed_representation } representation { representation.name = ‘relative speed’ } representation.items[i] -> { representation_item.name = ‘relative speed’ } representation_item => measure_representation_item <= measure_with_unit => ratio_measure_with_unit

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	10303-41		drilling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘reduced feedrate at end’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘relative speed’ } representation.items[i] -> { representation_item.name = ‘relative speed’ } representation_item => measure_representation_item <= measure_with_unit => ratio_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
depth_of_end	length_measure_with_unit	10303-41		drilling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘depth of end’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
EXCHANGE_PALLET	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘exchange pallet’ }
EXPLICIT_STRATEGY	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘explicit’ }
FIVE_AXES_CONST_TILT_YAW	machining_tool_direction_representa tion	10303-238		machining_tool_direction_representation <= representation {representation.name = ‘five axes const tilt yaw’ }

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

Application element	AIM element	Source	Rules	Reference path
tilt_angle	plane_angle_measure_with_unit	10303-41		machining_tool_direction_representation <= representation representation.items[i] -> { representation_item.name = 'tool direction tilt angle' } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
yaw_angle	plane_angle_measure_with_unit	10303-41		machining_tool_direction_representation <= representation representation.items[i] -> { representation_item.name = 'tool direction yaw angle' } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
FIVE_AXES_VAR_TILT_YAW	machining_tool_direction_- representation	10303-238		machining_tool_direction_representation <= representation {representation.name = 'five axes var tilt yaw' }
FREEFORM_FINISH_MILLING	freeform_milling_operation	10303-238		freeform_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = 'finishing' }
FREEFORM_OPERATION	freeform_milling_operation	10303-238		freeform_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
freeform_operation to freeform_strategy (as its_machining_strategy)	PATH			freeform_milling_operation <= milling_type_operation <= machining_operation <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_strategy_relationship } { action_method_relationship.name = ‘machining’ } action_method_relationship.related_method -> action_method => machining_strategy => milling_type_strategy => freeform_milling_strategy
FREEFORM_ROUGH_MILLING	freeform_milling_operation	10303-238		freeform_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = ‘roughing’ }
FREEFORM_STRATEGY	freeform_milling_strategy	10303-238		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method

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

Application element	AIM element	Source	Rules	Reference path
pathmode	descriptive_representation_item.- description	10303-45		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘pathmode’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘forward’) (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	10303-45		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘cutmode’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘climb’) (descriptive_representation_item.description = ‘conventional’) }
freeform_strategy to tolerances (as its_milling_tolerances)	PATH			freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘milling tolerances’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation => freeform_milling_tolerance_representation

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

Application element	AIM element	Source	Rules	Reference path
stepover	length_measure_with_unit	10303-41		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover length’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
INDEX_PALLET	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { 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	count_measure	10303-41		machining_nc_function <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘pallet index’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure
INDEX_TABLE	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = ‘index table’ }

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

Application element	AIM element	Source	Rules	Reference path
its_index	count_measure	10303-41		machining_nc_function <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘table index’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure
LEADING_LINE_STRATEGY	freeform_milling_strategy	10303-238		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method { 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	10303-42		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'leading line' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => curve => bounded_curve
LOAD_TOOL	machining_nc_function	10303-238		machining_nc_function <= machining_process_executable <= action_method { action_method.description = 'load tool' }
load_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

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

Application element	AIM element	Source	Rules	Reference path
MACHINE_AXIS_CONSTRAINT	value_range	10303-238		value_range <= compound_representation_item <= representation_item { representation_item <- representation.items[i] representation <- action_property_representation.representation action_property_representation action_property_representation.property -> action_property action_property.name = ‘axis constraint’ }
axis_identifier	representation_item.name	10303-41		value_range <= compound_representation_item <= representation_item representation_item.name
machine_axis_constraint to value_range (as axis_range)	PATH			IDENTICAL MAPPING
MILLING_MACHINE_FUNCTIONS	machining_functions	10303-238		machining_functions <= action_method { action_method.description = ‘milling’ }

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

Application element	AIM element	Source	Rules	Reference path
coolant #1: if value is true #2: if value is false	descriptive_representation_item.- description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘coolant’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = ‘coolant on’) #2: (descriptive_representation_item.description = ‘coolant off’) }

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

Application element	AIM element	Source	Rules	Reference path
coolant_pressure	measure_with_unit	10303-41		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘coolant pressure’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

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

Application element	AIM element	Source	Rules	Reference path
mist #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'mist' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = 'mist on') #2: (descriptive_representation_item.description = 'mist off') }

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

Application element	AIM element	Source	Rules	Reference path
through_spindle_coolant #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.- description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘through spindle coolant’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \ ‘through spindle coolant on’) #2: (descriptive_representation_item.description = \ ‘through spindle coolant off’) }

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

Application element	AIM element	Source	Rules	Reference path
through_pressure	measure_with_unit	10303-41		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘through spindle pressure’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

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	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘axis clamping’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = list_representation_item list_representation_item[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description

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

Application element	AIM element	Source	Rules	Reference path
chip_removal #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘chip removal’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \\ ‘chip removal on’) #2: (descriptive_representation_item.description = \\ ‘chip removal off’) }
oriented_spindle_stop	direction	10303-42		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘oriented spindle stop’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

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

Application element	AIM element	Source	Rules	Reference path
milling_machine_functions to process_model (as its_process_model) See NOTE 20	PATH			machining_functions <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => serial_action_method => sequential_method => machining_process_model_relationship } action_method_relationship.related_method -> action_method => machining_process_model
milling_machine_functions to property_parameter (as other_functions)	PATH			machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘other functions’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = set_representation_item set_representation_item[i] -> representation_item

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

Application element	AIM element	Source	Rules	Reference path
axis_constraints	value_range	10303-238		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'axis constraint' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => compound_representation_item => value_range
MILLING_MACHINING_OPERATION	machining_operation	10303-238		machining_operation <= { machining_operation => (milling_type_operation) (drilling_type_operation) } action_method

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	10303-41		machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘overcut length’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
MILLING_TECHNOLOGY	machining_technology	10303-238		machining_technology <= action_method { action_method.description = ‘milling’ }

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

Application element	AIM element	Source	Rules	Reference path
cutspeed	measure_with_unit	10303-41		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘spindle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_spindle_speed_representation } representation { representation.name = ‘cutting speed’ } representation.items[i] -> { representation_item.name = ‘surface speed’ } representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

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

Application element	AIM element	Source	Rules	Reference path
spindle	measure_with_unit	10303-41		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘spindle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_spindle_speed_representation } representation { representation.name = ‘spindle speed’ } representation.items[i] -> { representation_item.name = ‘rotational speed’ } representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }

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

Application element	AIM element	Source	Rules	Reference path
feedrate_per_tooth	length_measure_with_unit	10303-41		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘feed per tooth’ } representation.items[i] -> { representation_item.name = ‘feed per tooth’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
synchronize_spindle_with_feed #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.- description	10303-45		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘synchronize spindle with feed’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = \ ‘synchronized’) #2: (descriptive_representation_item.description = \ ‘not synchronized’) }

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

Application element	AIM element	Source	Rules	Reference path
inhibit_feedrate_override #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.- description	10303-45		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘inhibit feedrate override’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \\ ‘override not allowed’) #2: (descriptive_representation_item.description = \\ ‘override allowed’) }

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

Application element	AIM element	Source	Rules	Reference path
inhibit_spindle_override #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘inhibit spindle override’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \\ ‘override not allowed’) #2: (descriptive_representation_item.description = \\ ‘override allowed’) }
milling_technology to adaptive_control (as its_adaptive_control)	PATH			machining_technology <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_adaptive_control_relationship } action_method_relationship.related_method -> action_method => machining_technology
MILLING_TYPE_OPERATION	milling_type_operation	10303-238		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
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 => machining_strategy_relationship } { action_method_relationship.name = ‘approach’ } 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 => machining_strategy_relationship } { action_method_relationship.name = ‘retract’ } action_method_relationship.related_method -> action_method => machining_strategy => machining_approach_retract_strategy
MULTISTEP_DRILLING	drilling_operation	10303-238		drilling_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = ‘multistep drilling’ }

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	10303-41		drilling_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘retract distance’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		drilling_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘first depth’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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	10303-41		drilling_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘depth of step’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		drilling_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘dwell time step’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_dwell_time_representation } representation { representation.name = ‘dwell time’ } representation.items[i] -> { representation_item.name = ‘dwell time’ } representation_item => measure_representation_item <= measure_with_unit => time_measure_with_unit
PLANE_CC_STRATEGY	freeform_milling_strategy	10303-238		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘plane cutter contact’ }

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

Application element	AIM element	Source	Rules	Reference path
its_plane_normal	direction	10303-42		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘plane normal’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
PLANE_CL_STRATEGY	freeform_milling_strategy	10303-238		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method { 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	10303-42		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘plane normal’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
PLANE_FINISH_MILLING	plane_milling_operation	10303-238		plane_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = ‘finishing’ }
PLANE_MILLING	plane_milling_operation	10303-238		plane_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	10303-41		plane_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘axial cutting depth’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		plane_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘allowance bottom’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
PLANE_ROUGH_MILLING	plane_milling_operation	10303-238		plane_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = ‘roughing’ }
PLUNGE_HELIX	machining_approach_retract_strategy	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { action_method.description = ‘plunge helix’ }

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

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘plunge radius’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
angle	plane_angle_measure_with_unit	10303-41		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘plunge angle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { action_method.description = ‘plunge ramp’ }
angle	plane_angle_measure_with_unit	10303-41		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘plunge angle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
PLUNGE_STRATEGY	machining_approach_retract_strategy	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { (action_method.description = ‘plunge helix’) (action_method.description = ‘plunge ramp’) (action_method.description = ‘plunge toolaxis’) (action_method.description = ‘plunge zigzag’) }
PLUNGE_TOOLAXIS	machining_approach_retract_strategy	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { action_method.description = ‘plunge toolaxis’ }

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	10303-238		machining_approach_retract_strategy <= machining_strategy <= action_method { action_method.description = ‘plunge zigzag’ }
angle	plane_angle_measure_with_unit	10303-41		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘plunge angle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		machining_approach_retract_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'plunge width' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
PROCESS_MODEL	machining_process_model	10303-238		machining_process_model <= action_method
ini_data_file	descriptive_representation_item	10303-45		machining_process_model <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'initialization data' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description

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

Application element	AIM element	Source	Rules	Reference path
its_type	action_method.description	10303-49		machining_process_model <= action_method action_method.description
PROCESS_MODEL_LIST	NOT MAPPED See NOTE 20			
REAMING	boring_operation	10303-238		boring_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = ‘reaming’ }
SIDE_FINISH_MILLING	side_milling_operation	10303-238		side_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = ‘finishing’ }
SIDE_MILLING	side_milling_operation	10303-238		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	10303-41		side_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘axial cutting depth’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		side_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘radial cutting depth’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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	10303-41		side_milling_operation <= milling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'allowance side' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
SIDE_ROUGH_MILLING	side_milling_operation	10303-238		side_milling_operation <= milling_type_operation <= machining_operation <= action_method { action_method.description = 'roughing' }
TAPPING	tapping_operation	10303-238		tapping_operation <= drilling_type_operation <= machining_operation <= action_method { action_method.description = 'tapping' }

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

Application element	AIM element	Source	Rules	Reference path
compensation_chuck #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		tapping_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘compensation chuck’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \\ ‘compensation chuck used’) #2: (descriptive_representation_item.description = \\ ‘compensation chuck not used’) }
THREAD_DRILLING	tapping_operation	10303-238		tapping_operation <= drilling_type_operation <= machining_operation <= action_method { 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 #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.- description	10303-45		tapping_operation <= drilling_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘helical movement on forward’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \ ‘helical movement on forward’) #2: (descriptive_representation_item.description = \ ‘no helical movement on forward’) }
THREE_AXES_TILTED_TOOL	machining_tool_direction_- representation	10303-238		machining_tool_direction_representation <= representation {representation.name = ‘three axes tilted tool’ }
its_tool_direction	direction	10303-42		machining_tool_direction_representation <= representation representation.items[i] -> { representation_item.name = ‘tool direction orientation’ } representation_item => geometric_representation_item => direction
TOLERANCES	freeform_milling_tolerance_- representation	10303-238		freeform_milling_tolerance_representation <= representation

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

Application element	AIM element	Source	Rules	Reference path
chordal_tolerance	length_measure_with_unit	10303-41		freeform_milling_tolerance_representation <= representation representation.items[i] -> { representation_item.name = ‘chordal tolerance’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
scallop_height	length_measure_with_unit	10303-41		freeform_milling_tolerance_representation <= representation representation.items[i] -> { representation_item.name = ‘scallop height’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
TOOL_DIRECTION_FOR_MILLING	machining_tool_direction_- representation	10303-238		machining_tool_direction_representation <= representation
TWO5D_MILLING_OPERATION	milling_type_operation	10303-238		milling_type_operation <= machining_operation <= action_method
two5d_milling_operation to two5d_milling_strategy (as its_machining_strategy)	PATH			milling_type_operation <= machining_operation <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_strategy_relationship } { action_method_relationship.name = ‘machining’ } action_method_relationship.related_method -> action_method => machining_strategy => milling_type_strategy

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

Application element	AIM element	Source	Rules	Reference path
TWO5D_MILLING_STRATEGY	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { (action_method.description = ‘bidirectional’) (action_method.description = ‘bidirectional contour’) (action_method.description = ‘center milling’) (action_method.description = ‘contour bidirectional’) (action_method.description = ‘contour parallel’) (action_method.description = ‘contour spiral’) (action_method.description = ‘explicit’) (action_method.description = ‘unidirectional’) }
overlap	ratio_measure_with_unit	10303-41		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘overlap ratio’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => 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 #1: if value is true (mapping may also be omitted if value is true) #2: if value is false	descriptive_representation_item.-description	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘multiple passes’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \\ ‘multiple passes allowed’) #2: (descriptive_representation_item.description = \\ ‘multiple passes not allowed’) }
UNIDIRECTIONAL	milling_type_strategy	10303-238		milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘unidirectional’ }

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

Application element	AIM element	Source	Rules	Reference path
feed_direction	direction	10303-42		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'feed direction' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
cutmode	descriptive_representation_item.- description	10303-45		milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'cutmode' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = 'climb') (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	10303-238		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	10303-238		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method { action_method.description = ‘uv’ }

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

Application element	AIM element	Source	Rules	Reference path
forward_direction	direction	10303-42		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘forward direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
sideward_direction	direction	10303-42		freeform_milling_strategy <= milling_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘sideward direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

Table 9 — Mapping table for cutting tools for milling UoF

Application element	AIM element	Source	Rules	Reference path
BALLNOSE_ENDMILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘ballnose endmill’ }
BULLNOSE_ENDMILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘bullnose endmill’ }
COMBINED_DRILL_AND_REAMER	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘combined drill and reamer’ }
drill_length	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘drill length’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
COMBINED_DRILL_AND_TAP	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘combined drill and tap’ }

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

Application element	AIM element	Source	Rules	Reference path
drill_length	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'drill length' } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
COUNTERBORE	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = 'counterbore' }
COUNTERSINK	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = 'countersink' }

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

Application element	AIM element	Source	Rules	Reference path
minimum_cutting_diameter	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘minimum cutting diameter’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
maximum_usable_length	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘maximum usable length’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
CUTTING_COMPONENT	machining_cutting_component	10303-238		machining_cutting_component <= [action_resource] [characterized_object] { action_resource.kind -> action_resource_type action_resource_type.name = ‘milling cutting edge’ }

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

Application element	AIM element	Source	Rules	Reference path
tool_functional_length	length_measure_with_unit	10303-41		machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘functional length’ } 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 => length_measure_with_unit
cutting_component to material (as its_material)	PATH			machining_cutting_component <= characterized_object characterized_definition = characterized_object characterized_definition <- material_designation.definitions[i] material_designation

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

Application element	AIM element	Source	Rules	Reference path
expected_tool_life	time_measure_with_unit	10303-41		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
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
DOVETAIL_MILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘dovetail mill’ }

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

Application element	AIM element	Source	Rules	Reference path
included_angle	plane_angle_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'included angle' } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
DRILLING_CUTTING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { (action_resource.description = 'drill') (action_resource.description = 'counterbore') (action_resource.description = 'countersink') (action_resource.description = 'spade drill') (action_resource.description = 'spot drill') (action_resource.description = 'step drill') (action_resource.description = 'tapered drill') (action_resource.description = 'twist drill') }

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

Application element	AIM element	Source	Rules	Reference path
point_angle	plane_angle_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘point angle’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
ENDMILL	machining_tool	10303-238		machining_tool <= action_resource { (action_resource.description = ‘endmill’) (action_resource.description = ‘ballnose endmill’) (action_resource.description = ‘bullnose endmill’) (action_resource.description = ‘profiled endmill’) }

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

Application element	AIM element	Source	Rules	Reference path
tool_cutting_edge_angle	plane_angle_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'tool cutting edge angle' } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
FACEMILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = 'facemill' }

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

Application element	AIM element	Source	Rules	Reference path
tool_cutting_edge_angle	plane_angle_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘tool cutting edge angle’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
MILLING_CUTTING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { (action_resource.description = ‘ballnose endmill’) (action_resource.description = ‘bullnose endmill’) (action_resource.description = ‘dovetail mill’) (action_resource.description = ‘endmill’) (action_resource.description = ‘facemill’) (action_resource.description = ‘profiled endmill’) (action_resource.description = ‘shoulder mill’) (action_resource.description = ‘tee slot mill’) (action_resource.description = ‘thread mill’) (action_resource.description = ‘side mill’) }

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

Application element	AIM element	Source	Rules	Reference path
number_of_effective_teeth	count_measure	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘number of effective teeth’ } representation_item => measure_representation_item <= measure_with_unit => measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure

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

Application element	AIM element	Source	Rules	Reference path
edge_radius	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘edge radius’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
MILLING_MACHINE_CUTTING_- TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.kind -> action_resource_type action_resource_type.name = ‘milling cutting tool’ }
milling_machine_cutting_tool to cutting_component (as its_cutting_edges)	PATH			machining_tool <= action_resource <- action_resource_relationship.relating_resource action_resource_relationship action_resource_relationship.related_resource -> action_resource => machining_cutting_component

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

Application element	AIM element	Source	Rules	Reference path
overall_assembly_length	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'overall assembly length' } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
effective_cutting_diameter	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘effective cutting diameter’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
maximum_depth_of_cut	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘maximum depth of cut’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
hand_of_cut	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { 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’) }

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	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘coolant through tool’ } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘supported’) (descriptive_representation_item.description = ‘not supported’) }
PROFILED_END_MILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘profiled endmill’ }
REAMING_CUTTING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { (action_resource.description = ‘reamer’) (action_resource.description = ‘combined drill and reamer’) (action_resource.description = ‘tapered reamer’) }

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

Application element	AIM element	Source	Rules	Reference path
taper_length	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘taper length’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
ROTATING_BORING_CUTTING_- TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘boring tool’ }

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

Application element	AIM element	Source	Rules	Reference path
retract_movement_forbidden	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘retract movement’ } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘permitted’) (descriptive_representation_item.description = ‘forbidden’) }
SHOULDERMILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘shoulder mill’ }
SIDE_MILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘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	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘cutter width’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
SPADE_DRILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘spade drill’ }
SPOTDRILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘spot drill’ }
STEP_DRILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘step drill’ }

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

Application element	AIM element	Source	Rules	Reference path
diameters	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘step diameters’ } representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = list_representation_item list_representation_item[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
step_length	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘step lengths’ } representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = list_representation_item list_representation_item[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
T_SLOT_MILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘tee slot mill’ }

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

Application element	AIM element	Source	Rules	Reference path
cutting_width	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘cutting width’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
TAPERED_DRILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘tapered drill’ }

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	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘taper angle’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
TAPERED_REAMER	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘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	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'taper angle' } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
TAPPING_CUTTING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { (action_resource.description = 'tapping tool') (action_resource.description = 'combined drill and tap') }

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

Application element	AIM element	Source	Rules	Reference path
thread_form_type	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread form type’ } representation_item => descriptive_representation_item descriptive_representation_item.description

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

Application element	AIM element	Source	Rules	Reference path
thread_size	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread size’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
thread_pitch	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread pitch’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
taper_thread_count	count_measure	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'taper thread count' } representation_item => measure_representation_item <= measure_with_unit => measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure
THREAD_MILL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = 'thread mill' }

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

Application element	AIM element	Source	Rules	Reference path
thread_form_type	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread form type’ } representation_item => descriptive_representation_item descriptive_representation_item.description

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

Application element	AIM element	Source	Rules	Reference path
thread_size	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread size’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

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

Application element	AIM element	Source	Rules	Reference path
thread_pitch	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'thread pitch' } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
TWIST_DRILL	machining_tool	10303-238		machining_tool <= action_resource { (action_resource.description = 'twist drill') (action_resource.description = 'tapered drill') }
USER_DEFINED_MILLING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = 'user defined milling tool' }

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

Application element	AIM element	Source	Rules	Reference path
identifier	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘tool identifier’ } representation_item => descriptive_representation_item descriptive_representation_item.description

Table 10 — Mapping table for turning features UoF

Application element	AIM element	Source	Rules	Reference path
DIAGONAL_KNURL	turned_knurl	10303-522		turned_knurl <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘diagonal’ }
helix_angle	plane_angle_measure_with_unit	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘helix angle’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
DIAMOND_KNURL	turned_knurl	10303-522		turned_knurl <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = 'diamond' }
helix1_angle	plane_angle_measure_with_unit	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = 'helix angle' } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
helix2_angle	plane_angle_measure_with_unit	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘helix second angle’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
GENERAL_REVOLUTION	revolved_profile	10303-522		revolved_profile <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘open profile’ }

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
general_revolution to general_profile (as outer_edge_profile)	PATH			revolved_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect.description = ‘outer edge shape occurrence’ } shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship.description = ‘profile usage’ } { shape_aspect_relationship => shape_defining_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect.description = ‘outer edge shape’ } shape_aspect => open_path_profile
GROOVE	revolved_profile	10303-522		revolved_profile <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘groove’ }

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
groove to open_profile (as sweep)	PATH			revolved_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect.description = 'sweep occurrence' } shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship.description = 'profile usage' } { shape_aspect_relationship => shape_defining_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect.description = 'sweep' } shape_aspect => (open_path_profile) (partial_circular_profile) (rounded_u_profile) (square_u_profile) (tee_profile) (vee_profile)
KNURL	turned_knurl	10303-522		turned_knurl <= { feature_definition => instanced_feature } feature_definition <= characterized_object

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
knurl to turning_feature (as base_feature)	PATH			turned_knurl <= 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_relationship.related_shape_aspect { shape_aspect_relationship.description = ‘applied shape’ } { shape_aspect_relationship => shape_defining_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => instanced_feature <= feature_definition => (outer_round) (revolved_profile) (turned_knurl)

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
knurl to partial_area_definition (as partial_profile)	PATH			turned_knurl <= 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_relationship.related_shape_aspect { shape_aspect_relationship.description = ‘applied area usage’ } { shape_aspect_relationship => shape_defining_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => applied_area

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
tooth_depth	length_measure_with_unit	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘tooth depth’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
diametral_pitch	plane_angle_measure_with_unit	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘diametral pitch’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
root_fillet	length_measure_with_unit	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘root fillet’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
number_of_teeth	count_measure	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.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

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
major_diameter	length_measure_with_unit	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘major diameter’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
nominal_diameter	length_measure_with_unit	10303-41		turned_knurl <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘nominal diameter’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
OUTER_DIAMETER	outer_round	10303-522		outer_round <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘outer diameter’ }

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
diameter_at_placement	length_measure_with_unit	10303-41		outer_round <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘diameter’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
feature_length	length_measure_with_unit	10303-41		outer_round <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘length’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outer_diameter to taper_select (as reduced_size) #1: as angle_taper #2: as diameter_taper	PATH			outer_round <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect.description = ‘reduced size occurrence’ } shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship => feature_component_relationship } { shape_aspect_relationship.name = ‘reduced size’ } { shape_aspect_relationship.description = ‘taper usage’ } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { #1: (shape_aspect.description = ‘angle taper’) #2: (shape_aspect.description = ‘diameter taper’) } shape_aspect => taper
OUTER_DIAMETER_TO_SHOULDER	outer_round	10303-522		outer_round <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘outer diameter to shoulder’ }

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
diameter_at_placement	length_measure_with_unit	10303-41		outer_round <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘diameter’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outer_diameter_to_shoulder to vee_profile (as v_shape_boundary)	PATH			outer_round <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect.description = 'v-shape boundary occurrence' } shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship.description = 'profile usage' } { shape_aspect_relationship => shape_defining_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect.description = 'v-shape' } shape_aspect => vee_profile
OUTER_ROUND	outer_round	10303-522		outer_round <= { feature_definition => instanced_feature } feature_definition <= characterized_object
REVOLVED_FEATURE	revolved_profile	10303-522		revolved_profile <= { feature_definition => instanced_feature } feature_definition <= characterized_object

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
material_side	direction	10303-42		revolved_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> { representation.name = ‘removal direction’ } representation { representation => shape_representation => direction_shape_representation } representation.items[i] -> representation_item => geometric_representation_item => direction

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
radius	length_measure_with_unit	10303-41		revolved_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition { property_definition => product_definition_shape } 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.name = ‘radius’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
REVOLVED_FLAT	revolved_profile	10303-522		revolved_profile <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘flat’ }

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
revolved_flat to linear_profile (as flat_edge_shape)	PATH			revolved_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect.description = ‘flat edge shape occurrence’ } shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship.description = ‘profile usage’ } { shape_aspect_relationship => shape_defining_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect.description = ‘flat edge shape’ } shape_aspect => linear_profile
REVOLVED_ROUND	revolved_profile	10303-522		revolved_profile <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘round’ }

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
revolved_round to partial_circular_profile (as rounded_edge_shape)	PATH			revolved_profile <= feature_definition <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape { shape_aspect.description = ‘rounded edge shape occurrence’ } shape_aspect <- shape_aspect_relationship.related_shape_aspect { shape_aspect_relationship.description = ‘profile usage’ } { shape_aspect_relationship => shape_defining_relationship } shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> { shape_aspect.description = ‘rounded edge shape’ } shape_aspect => partial_circular_profile
STRAIGHT_KNURL	turned_knurl	10303-522		turned_knurl <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘straight’ }
TOOL_KNURL	turned_knurl	10303-522		turned_knurl <= { feature_definition => instanced_feature } feature_definition <= characterized_object { characterized_object.description = ‘tool’ }

Table 10 — Mapping table for turning features UoF (continued)

Application element	AIM element	Source	Rules	Reference path
TURNING_FEATURE	(outer_round) (revolved_profile) (turned_knurl)	10303-522 10303-522 10303-522		(outer_round <=) (revolved_profile <=) (turned_knurl <=) { feature_definition => instanced_feature } feature_definition <= characterized_object

Table 11 — Mapping table for process data for turning UoF

Application element	AIM element	Source	Rules	Reference path
BIDIRECTIONAL_TURNING	turning_type_strategy	10303-238		turning_type_strategy <= machining_strategy <= action_method { action_method.description = ‘bidirectional’ }
feed_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feed direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stepover_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
stepover_feed	machining_feed_speed_-representation	10303-238		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { (representation.name = ‘feed speed’) (representation.name = ‘feed per revolution’) } representation => machining_feed_speed_representation
CONST_CUTTING_SPEED	machining_spindle_speed_-representation	10303-238		machining_spindle_speed_representation <= representation {representation.name = ‘cutting speed’ }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
speed	measure_with_unit	10303-41		machining_spindle_speed_representation <= representation representation.items[i] -> { representation_item.name = ‘surface speed’ } representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }
max_speed	measure_with_unit	10303-41		machining_spindle_speed_representation <= representation representation.items[i] -> { representation_item.name = ‘maximum rotational speed’ } representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }
CONST_SPINDLE_SPEED	machining_spindle_speed_- representation	10303-238		machining_spindle_speed_representation <= representation {representation.name = ‘spindle speed’ }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
rot_speed	measure_with_unit	10303-41		machining_spindle_speed_representation <= representation representation.items[i] -> { representation_item.name = 'rotational speed' } representation_item => measure_representation_item <= measure_with_unit { measure_with_unit.value_component -> measure_value measure_value = numeric_measure numeric_measure }
CONTOUR_TURNING	turning_type_strategy	10303-238		turning_type_strategy <= machining_strategy <= action_method { action_method.description = 'contour' }
feed_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'feed direction' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
back_path_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘back path direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
lift_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘lift direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stepover_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
lift_height	length_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘lift height’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
lift_feed	machining_feed_speed_- representation	10303-238		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘lift feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { (representation.name = ‘feed speed’) (representation.name = ‘feed per revolution’) } representation => machining_feed_speed_representation
stepover_feed	machining_feed_speed_- representation	10303-238		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { (representation.name = ‘feed speed’) (representation.name = ‘feed per revolution’) } representation => machining_feed_speed_representation

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
variable_stepover_feed	ratio_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘variable stepover feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘relative speed’ } representation.items[i] -> { representation_item.name = ‘relative speed’ } representation_item => measure_representation_item <= measure_with_unit => ratio_measure_with_unit
CONTOURING	contouring_turning_operation	10303-238		contouring_turning_operation <= turning_type_operation <= machining_operation <= action_method

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
allowance	length_measure_with_unit	10303-41		contouring_turning_operation <= turning_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'allowance' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
CONTOURING_FINISH	contouring_turning_operation	10303-238		contouring_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = 'finishing' }
CONTOURING_ROUGH	contouring_turning_operation	10303-238		contouring_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = 'roughing' }
CUTTING_IN	grooving_turning_operation	10303-238		grooving_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = 'cutting in' }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
EXPLICIT_TURNING_STRATEGY	turning_type_strategy	10303-238		turning_type_strategy <= machining_strategy <= action_method { action_method.description = ‘explicit’ }
FACING	facing_turning_operation	10303-238		facing_turning_operation <= turning_type_operation <= machining_operation <= action_method
allowance	length_measure_with_unit	10303-41		facing_turning_operation <= turning_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘allowance’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
FACING_FINISH	facing_turning_operation	10303-238		facing_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = ‘finishing’ }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FACING_ROUGH	facing_turning_operation	10303-238		facing_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = ‘roughing’ }
GROOVING	grooving_turning_operation	10303-238		grooving_turning_operation <= turning_type_operation <= machining_operation <= action_method
dwell	machining_dwell_time_- representation	10303-238		grooving_turning_operation <= turning_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘dwell’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { (representation.name = ‘dwell time’) (representation.name = ‘dwell revolution’) } representation => machining_dwell_time_representation

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
allowance	length_measure_with_unit	10303-41		grooving_turning_operation <= turning_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘allowance’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
GROOVING_FINISH	grooving_turning_operation	10303-238		grooving_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = ‘finishing’ }
GROOVING_ROUGH	grooving_turning_operation	10303-238		grooving_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = ‘roughing’ }
GROOVING_STRATEGY	turning_type_strategy	10303-238		turning_type_strategy <= machining_strategy <= action_method { (action_method.description = ‘grooving’) (action_method.description = ‘multistep grooving’) }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
grooving_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘grooving direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
travel_distance	length_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘travel distance’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
KNURLING	knurling_turning_operation	10303-238		knurling_turning_operation <= turning_type_operation <= machining_operation <= action_method
MULTISTEP_GROOVING_STRATEGY	turning_type_strategy	10303-238		turning_type_strategy <= machining_strategy <= action_method { action_method.description = 'multistep grooving' }
retract_distance	length_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'retract distance' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
THREAD_STRATEGY	turning_type_strategy	10303-238		turning_type_strategy <= machining_strategy <= action_method { action_method.description = 'thread' }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
cut_in_amount_function	descriptive_representation_item.- description	10303-45		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'cut in amount' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = 'constant depth') (descriptive_representation_item.description = 'variable depth') (descriptive_representation_item.description = \ 'constant removal amount') }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
threading_direction	descriptive_representation_item.- description	10303-45		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘threading direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘left’) (descriptive_representation_item.description = ‘right’) (descriptive_representation_item.description = ‘center’) (descriptive_representation_item.description = ‘left zigzag’) (descriptive_representation_item.description = ‘right zigzag’) }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
path_return_angle	plane_angle_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘path return angle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
lift_height	length_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘lift height’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
THREADING	threading_turning_operation	10303-238		threading_turning_operation <= turning_type_operation <= machining_operation <= action_method
allowance	length_measure_with_unit	10303-41		threading_turning_operation <= turning_type_operation <= machining_operation <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'allowance' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
THREADING_FINISH	threading_turning_operation	10303-238		threading_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = 'finishing' }
THREADING_ROUGH	threading_turning_operation	10303-238		threading_turning_operation <= turning_type_operation <= machining_operation <= action_method { action_method.description = 'roughing' }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
TURNING_MACHINE_FUNCTIONS	machining_functions	10303-238		machining_functions <= action_method { action_method.description = ‘turning’ }
coolant #1: if value is true #2: if value is false	descriptive_representation_item.- description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘coolant’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = ‘coolant on’) #2: (descriptive_representation_item.description = ‘coolant off’) }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
coolant_type	descriptive_representation_item.- description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘coolant type’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘flood’) (descriptive_representation_item.description = ‘mist’) (descriptive_representation_item.description = ‘through tool’) }
coolant_pressure	measure_with_unit	10303-41		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘coolant pressure’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
axis_clamping	descriptive_representation_item.- description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘axis clamping’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = list_representation_item list_representation_item[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
chip_removal #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.- description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘chip removal’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description {#1: (descriptive_representation_item.description = \\ ‘chip removal on’) #2: (descriptive_representation_item.description = \\ ‘chip removal off’) }
oriented_spindle_stop	direction	10303-42		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘oriented spindle stop’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
turning_machine_functions to process_model (as its_process_model) See NOTE 20	PATH			machining_functions <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => serial_action_method => sequential_method => machining_process_model_relationship } action_method_relationship.related_method -> action_method => machining_process_model
turning_machine_functions to property_parameter (as other_functions)	PATH			machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = 'other functions' } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = set_representation_item set_representation_item[i] -> representation_item

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
tail_stock #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘tail stock’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \ ‘tail stock used’) #2: (descriptive_representation_item.description = \ ‘tail stock not used’) }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
steady_rest #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘steady rest’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \ ‘steady rest used’) #2: (descriptive_representation_item.description = \ ‘steady rest not used’) }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
follow_rest #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		machining_functions <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘follow rest’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \\ ‘follow rest used’) #2: (descriptive_representation_item.description = \\ ‘follow rest not used’) }
TURNING_MACHINING_OPERATION	turning_type_operation	10303-238		turning_type_operation <= machining_operation <= action_method
turning_type_operation to approach_retract_strategy (as approach)	PATH			turning_type_operation <= machining_operation <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_strategy_relationship } { action_method_relationship.name = ‘approach’ } action_method_relationship.related_method -> action_method => machining_strategy => machining_approach_retract_strategy

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
turning_type_operation to approach_retract_strategy (as retract)	PATH			turning_type_operation <= machining_operation <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_strategy_relationship } { action_method_relationship.name = ‘retract’ } action_method_relationship.related_method -> action_method => machining_strategy => machining_approach_retract_strategy
turning_type_operation to turning_machining_strategy (as its_machining_strategy)	PATH			turning_type_operation <= machining_operation <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_strategy_relationship } { action_method_relationship.name = ‘machining’ } action_method_relationship.related_method -> action_method => machining_strategy => turning_type_strategy
TURNING_MACHINING_STRATEGY	turning_type_strategy	10303-238		turning_type_strategy <= machining_strategy <= action_method

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
overcut_length	length_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘overcut length’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
allow_multiple_passes #1: if value is true (mapping may also be omitted if value is true) #2: if value is false	descriptive_representation_item.-description	10303-45		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘multiple passes’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \\ ‘multiple passes allowed’) #2: (descriptive_representation_item.description = \\ ‘multiple passes not allowed’) }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
cutting_depth	length_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘cutting depth’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => compound_representation_item compound_representation_item.item_element -> compound_item_definition compound_item_definition = list_representation_item list_representation_item[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
variable_feedrate	ratio_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘variable feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘relative speed’ } representation.items[i] -> { representation_item.name = ‘relative speed’ } representation_item => measure_representation_item <= measure_with_unit => ratio_measure_with_unit
TURNING_TECHNOLOGY	machining_technology	10303-238		machining_technology <= action_method { action_method.description = ‘turning’ }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
spindle_speed	PATH			machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘spindle’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { (representation.name = ‘spindle speed’) (representation.name = ‘cutting speed’) } representation => machining_spindle_speed_representation
feed_per_revolution	measure_with_unit	10303-41		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { representation => machining_feed_speed_representation } representation { representation.name = ‘feed per revolution’ } representation.items[i] -> { representation_item.name = ‘feed per revolution’ } representation_item => measure_representation_item <= measure_with_unit

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
sync_spindle_and_z_feed #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘synchronize spindle with z feed’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \\ ‘synchronized’) #2: (descriptive_representation_item.description = \\ ‘not synchronized’) }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inhibit_feedrate_override #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.-description	10303-45		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘inhibit feedrate override’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \ ‘override not allowed’) #2: (descriptive_representation_item.description = \ ‘override allowed’) }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inhibit_spindle_override #1: if value is true #2: if value is false (mapping may also be omitted if value is false)	descriptive_representation_item.- description	10303-45		machining_technology <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘inhibit spindle override’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description { #1: (descriptive_representation_item.description = \ ‘override not allowed’) #2: (descriptive_representation_item.description = \ ‘override allowed’) }
turning_technology to adaptive_control (as its_adaptive_control)	PATH			machining_technology <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_adaptive_control_relationship } action_method_relationship.related_method -> action_method => machining_technology
TURNING_WORKINGSTEP	machining_workingstep	10303-238		machining_workingstep <= machining_process_executable <= action_method { action_method.description = ‘turning’ }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
turning_workingstep to manufacturing_feature (as its_features)	PATH			machining_workingstep <= machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_feature_relationship => machining_feature_sequence_relationship } action_method_relationship.related_method -> { action_method => machining_process_executable => machining_feature_process } action_method <- action.chosen_method { action.name = ‘machining’ } action => property_process <- process_property_association.process process_property_association process_property_association.property_or_shape -> property_or_shape_select property_or_shape_select = shape_definition shape_definition shape_definition = shape_aspect shape_aspect See NOTE 17

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
turning_workingstep to turning_machining_operation (as its_operation)	PATH			machining_workingstep <= machining_process_executable <= action_method <- action_method_relationship.relating_method action_method_relationship { action_method_relationship => machining_operation_relationship } action_method_relationship.related_method -> action_method => machining_operation => turning_type_operation
turning_workingstep to in_process_geometry (as its_effect)	PATH			machining_workingstep <= machining_process_executable <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition action_property
UNIDIRECTIONAL_TURNING	turning_type_strategy	10303-238		turning_type_strategy <= machining_strategy <= action_method { action_method.description = ‘unidirectional’ }

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
feed_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘feed direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
back_path_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘back path direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
lift_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘lift direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction
stepover_direction	direction	10303-42		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover direction’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => geometric_representation_item => direction

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
lift_height	length_measure_with_unit	10303-41		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘lift height’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> representation representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
lift_feed	machining_feed_speed_- representation	10303-238		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘lift feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { (representation.name = ‘feed speed’) (representation.name = ‘feed per revolution’) } representation => machining_feed_speed_representation

Table 11 — Mapping table for process data for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stepover_feed	machining_feed_speed_- representation	10303-238		turning_type_strategy <= machining_strategy <= action_method characterized_action_definition = action_method characterized_action_definition <- action_property.definition { action_property.name = ‘stepover feedrate’ } action_property <- action_property_representation.property action_property_representation action_property_representation.representation -> { (representation.name = ‘feed speed’) (representation.name = ‘feed per revolution’) } representation => machining_feed_speed_representation

Table 12 — Mapping table for cutting tools for turning UoF

Application element	AIM element	Source	Rules	Reference path
CHAMFERED_CORNER	machining_cutting_corner_-representation	10303-238		machining_cutting_corner_representation <= representation { representation.name = 'chamfered corner' }
corner_chamfer_angle	plane_angle_measure_with_unit	10303-41		machining_cutting_corner_representation <= representation representation.items[i] -> { representation_item.name = 'chamfer angle' } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit
corner_chamfer_length	length_measure_with_unit	10303-41		machining_cutting_corner_representation <= representation representation.items[i] -> { representation_item.name = 'chamfer length' } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
corner_chamfer_width	length_measure_with_unit	10303-41		machining_cutting_corner_representation <= representation representation.items[i] -> { representation_item.name = 'chamfer width' } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
CORNER_TRANSITION	machining_cutting_corner_-representation	10303-238		machining_cutting_corner_representation <= representation

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
corner_identity	count_measure	10303-41		machining_cutting_corner_representation <= representation representation.items[i] -> { representation_item.name = 'corner identity' } representation_item => measure_representation_item <= measure_with_unit => measure_with_unit.value_component -> measure_value measure_value = count_measure count_measure
corner_transition to chamfered_corner, rounded_corner, or profiled_corner (as transition)	IDENTICAL MAPPING			
CUTTING_EDGE_PROPERTIES	machining_cutting_component	10303-238		machining_cutting_component <= [action_resource] [characterized_object] { action_resource.kind -> action_resource_type action_resource_type.name = 'turning cutting edge' }
cutting_edge_properties to material (as its_material)	PATH			machining_cutting_component <= characterized_object characterized_definition = characterized_object characterized_definition <- material_designation.definitions[i] material_designation

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
expected_tool_life	time_measure_with_unit	10303-41		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
cutting_edge_properties 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

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
cutting_edge_length	length_measure_with_unit	10303-41		machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘cutting edge length’ } 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 => length_measure_with_unit
tool_cutting_edge_angle	plane_angle_measure_with_unit	10303-41		machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘cutting edge angle’ } 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 => plane_angle_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
cutting_edge_properties to corner_transition (as corner_transitions)	PATH			machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'corner transitions' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> representation => machining_cutting_corner_representation See NOTE 21
tool_included_angle	plane_angle_measure_with_unit	10303-41		machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool included angle' } 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 => plane_angle_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
maximum_side_cutting_depth	length_measure_with_unit	10303-41		machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘maximum side cutting depth’ } 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 => length_measure_with_unit
maximum_end_cutting_depth	length_measure_with_unit	10303-41		machining_cutting_component <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘maximum end cutting depth’ } 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 => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
GENERAL_TURNING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘general turning tool’ }
GROOVING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘grooving tool’ }
cutting_width	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘cutting width’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
maximum_grooving_depth	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘maximum grooving depth’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
corner_radius	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘corner radius’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
maximum_axial_grooving_diameter	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> {representation_item.name = ‘maximum axial grooving diameter’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
minimum_axial_grooving_diameter	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> {representation_item.name = ‘minimum axial grooving diameter’} representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
KNURLING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘knurling tool’ }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
knurl_pattern	descriptive_representation_item.-description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘knurl pattern’ } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘straight’) (descriptive_representation_item.description = ‘diagonal’) (descriptive_representation_item.description = ‘diamond’) }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
cutting_length	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘cutting length’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
angle	plane_angle_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘cutting angle’ } representation_item => measure_representation_item <= measure_with_unit => plane_angle_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
pitch	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘cutting pitch’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
PROFILED_CORNER	machining_cutting_corner_- representation	10303-238		machining_cutting_corner_representation <= representation { representation.name = ‘profiled corner’ }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
profiled_corner to open_profile (as transition_profile)	PATH			machining_cutting_corner_representation <= representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> represented_definition represented_definition = shape_aspect shape_aspect (linear_profile) (open_path_profile) (partial_circular_profile) (rounded_u_profile) (square_u_profile) (tee_profile) (vee_profile)
ROUNDED_CORNER	machining_cutting_corner_- representation	10303-238		machining_cutting_corner_representation <= representation { representation.name = ‘rounded corner’ }
corner_radius	length_measure_with_unit	10303-41		machining_cutting_corner_representation <= representation representation.items[i] -> { representation_item.name = ‘radius’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
TURNING_MACHINE_CUTTING_- TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.kind -> action_resource_type action_resource_type.name = ‘turning cutting tool’ }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
functional_length	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'functional length' } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
f_dimension	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘f dimension’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
minimum_cutting_diameter	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘minimum cutting diameter’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
a_dimension_on_f	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘a dimension on f’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
a_dimension_on_lf	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘a dimension on lf’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit
turning_machine_cutting_tool to cutting_edge_properties (as cutting_edge)	PATH			machining_tool <= action_resource <- action_resource_relationship.relating_resource action_resource_relationship action_resource_relationship.related_resource -> action_resource => machining_cutting_component

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hand_of_tool	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { 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’) }
TURNING_THREADING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘turning threading tool’ }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
threading_pitch	length_measure_with_unit	10303-41		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread pitch’ } representation_item => measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thread_hand	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread hand’ } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘left’) (descriptive_representation_item.description = ‘right’) }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
its_thread_type	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = 'tool body' } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = 'thread type' } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = 'internal') (descriptive_representation_item.description = 'external') }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thread_profile	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread profile’ } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘full’) (descriptive_representation_item.description = ‘partial’) }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thread_form_type	descriptive_representation_item.-description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘thread form type’ } representation_item => descriptive_representation_item descriptive_representation_item.description
USER_DEFINED_TURNING_TOOL	machining_tool	10303-238		machining_tool <= action_resource { action_resource.description = ‘user defined turning tool’ }

Table 12 — Mapping table for cutting tools for turning UoF (continued)

Application element	AIM element	Source	Rules	Reference path
identifier	descriptive_representation_item.- description	10303-45		machining_tool <= action_resource characterized_resource_definition = action_resource characterized_resource_definition <- resource_property.resource { resource_property.name = ‘tool body’ } resource_property <- resource_property_representation.property resource_property_representation resource_property_representation.representation -> { representation => machining_tool_body_representation } representation representation.items[i] -> { representation_item.name = ‘tool identifier’ } representation_item => descriptive_representation_item descriptive_representation_item.description

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF

Application element	AIM element	Source	Rules	Reference path
ANGULAR_LOCATION_DIMENSION #1: If the directed attribute is 'false' #2: If the directed attribute is 'true'	#1:(angular_location) #2:([angular_location] [directed_dimensional_location])	10303-47 10303-47 10303-238		angular_location <= #2: { dimensional_location => directed_dimensional_location } dimensional_location <= shape_aspect_relationship
orientation	placement	10303-42		angular_location <= dimensional_location <= shape_aspect_relationship shape_definition = shape_aspect_relationship shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> { representation_item.name = ‘orientation’ } representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)
ANGULAR_SIZE_DIMENSION	angular_size	10303-47		

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
full	descriptive_representation_item.- description	10303-45		angular_size <= dimensional_size dimensional_characteristic = dimensional_size dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation representation.items[i] -> { representation_item.name = ‘angle type’ } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘full angle’) (descriptive_representation_item.description = ‘half angle’) }
major_angle	angular_size.angle_selection	10303-47		
ANGULARITY_TOLERANCE	angularity_tolerance	10303-519		angularity_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance
angularity_tolerance to datum_reference (as reference_datum)	PATH			angularity_tolerance <= geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
CIRCULAR_RUNOUT_TOLERANCE	circular_runout_tolerance	10303-519		circular_runout_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
angle	measure_with_unit	10303-41		circular_runout_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance <- tolerance_zone.defining_tolerance[i] tolerance_zone <- tolerance_zone_definition.zone tolerance_zone_definition => runout_zone_definition runout_zone_definition.orientation -> runout_zone_orientation runout_zone_orientation.angle -> measure_with_unit
circular_runout_tolerance to datum_reference (as reference_datum)	PATH			circular_runout_tolerance <= geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
COAXIALITY_TOLERANCE	coaxiality_tolerance	10303-519		coaxiality_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance
coaxiality_tolerance to datum_reference (as reference_datum)	PATH			coaxiality_tolerance <= geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
COMMON_DATUM	common_datum	10303-519		
common_datum to single_datum (as made_up_by)	PATH			common_datum <= datum <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect => datum

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CONCENTRICITY_TOLERANCE	concentricity_tolerance	10303-519		concentricity_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance
concentricity_tolerance to datum_reference (as reference_datum)	PATH			concentricity_tolerance <= geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
CURVED_DISTANCE_DIMENSION #1: If the directed attribute is 'false' #2: If the directed attribute is 'true'	#1:(dimensional_location_with_path) #2:([dimensional_location_with_path] [directed_dimensional_location])	10303-47 10303-47 10303-238		dimensional_location_with_path <= dimensional_location <= #2: { dimensional_location => directed_dimensional_location } shape_aspect_relationship { shape_aspect_relationship.name = ‘curved distance’ }
curved_distance_dimension to measurement_path (as used_path)	PATH			dimensional_location_with_path dimensional_location_with_path.path -> shape_aspect shape_definition = shape_aspect characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation
CURVED_SIZE_DIMENSION	dimensional_size	10303-47		dimensional_size { dimensional_size.name = ‘curve length’ }
CYLINDRICITY_TOLERANCE	cylindricity_tolerance	10303-519		cylindricity_tolerance <= geometric_tolerance
DATUM	datum	10303-47		

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
DATUM_DEFINED_BY_DERIVED_- SHAPE	[datum] [derived_shape_aspect]	10303-47 10303-47		datum <= shape_aspect => derived_shape_aspect
DATUM_DEFINED_BY_FEATURE	datum	10303-47		
defined_by	datum_feature	10303-47		datum <= shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => datum_feature See NOTE 22
DATUM_DEFINED_BY_TARGETS	datum	10303-47		
datum_defined_by_targets to datum_target (as defined_by)	PATH			datum <= shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => datum_target
rule_description	shape_aspect.description	10303-41		datum <= shape_aspect shape_aspect.description
DATUM_REFERENCE	datum_reference	10303-47		
precedence	datum_reference.precedence	10303-47		datum_reference datum_reference.precedence
datum_reference to datum (as referenced_datum)	PATH			datum_reference datum_reference.referenced_datum -> datum

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
DATUM_TARGET	datum_target	10303-47		
id	datum_target.target_id	10303-47		datum_target datum_target.target_id
DERIVED_GEOMETRY	derived_shape_aspect	10303-47		
derived_from	shape_aspect	10303-41		derived_shape_aspect <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship { shape_aspect_relationship => shape_aspect_deriving_relationship} shape_aspect_relationship.related_shape_aspect -> shape_aspect
role #1: if role is ‘apex’ #2: if role is ‘centre of symmetry’ #3: if role is ‘extension’ #4: if role is ‘geometric alignment’ #5: if role is ‘geometric intersection’ #6: if role is ‘parallel offset’ #7: if role is ‘perpendicular to’ #8: if role is ‘tangent’ #9: if otherwise	#1: (apex) #2: (centre_of_symmetry) #3: (extension) #4: (geometric_alignment) #5: (geometric_intersection) #6: (parallel_offset) #7: (perpendicular_to) #8: (tangent) #9: (shape_aspect.description)	10303-47 10303-47 10303-47 10303-47 10303-47 10303-47 10303-47 10303-47 10303-41		#1: (derived_shape_aspect => apex) #2: (derived_shape_aspect => centre_of_symmetry) #3: (derived_shape_aspect => extension) #4: (derived_shape_aspect => geometric_alignment) #5: (derived_shape_aspect => geometric_intersection) #6: (derived_shape_aspect => parallel_offset) #7: (derived_shape_aspect => perpendicular_to) #8: (derived_shape_aspect => tangent) #9: (derived_shape_aspect <= shape_aspect shape_aspect.description)

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
DIAMETER_SIZE_DIMENSION	dimensional_size	10303-47		dimensional_size { dimensional_size.name = ‘diameter’ }
EXTERNALLY_DEFINED_SIZE_- DIMENSION #1: If no measurement_path is specified #2: If a measurement_path is specified	#1: (externally_defined_- dimension_definition) #2: ([externally_defined_- dimension_definition] [dimensional_size_with_path])	10303-238 10303-238 10303-47		externally_defined_dimension_definition <= #2: { externally_defined_dimension_definition <= dimensional_size => dimensional_size_with_path } externally_defined_item { externally_defined_item.item_id -> source_item source_item = 'external size dimension'} { externally_defined_item.source -> external_source external_source.source_id-> source_item source_item = 'external size dimension specification' }
defining_document	document	10303-41		externally_defined_dimension_definition document_reference_item = \\ externally_defined_dimension_definition document_reference_item <- applied_document_reference.items[i] applied_document_reference <= document_reference document_reference.assigned_document -> document { document.description = ‘external size dimension specification’ }
name	dimensional_size.name	10303-47		externally_defined_dimension_definition <= dimensional_size dimensional_size.name

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
externally_defined_size_dimension to measurement_path (as used_path)	PATH			dimensional_size_with_path dimensional_size_with_path.path -> shape_aspect shape_definition = shape_aspect characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation
FLATNESS_TOLERANCE	flatness_tolerance	10303-519		flatness_tolerance <= geometric_tolerance
GEOMETRIC_DIMENSION #1: if a location_dimension #2: if a size_dimension	#1:(dimensional_location) #2:(dimensional_size)	10303-47 10303-47		
geometric_dimension to value_with_tolerance or value_range (as dimension_value) #1: if to a value_range #2: if to a value_with_tolerance	PATH			(dimensional_location dimensional_characteristic = dimensional_location) (dimensional_size dimensional_characteristic = dimensional_size) dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> #1: (shape_dimension_representation) #2: (shape_dimension_representation <= shape_representation <= representation representation.items[i] -> representation_item => measure_representation_item)

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
id #1: if a location_dimension #2: if a size_dimension	#1:(shape_aspect_relationship.name) #2:(identification_assignment.- assigned_id)	10303-41 10303-41		#1: (dimensional_location <= shape_aspect_relationship shape_aspect_relationship.name) #2: (dimensional_size identification_item = dimensional_size identification_item <- applied_identification_assignment.items[i] applied_identification_assignment <= identification_assignment { identification_assignment.role -> identification_role identification_role.name = ‘size id’ } identification_assignment.assigned_id)
notes	descriptive_representation_item.- description	10303-45		(dimensional_location dimensional_characteristic = dimensional_location) (dimensional_size dimensional_characteristic = dimensional_size) dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation representation.items[i] -> representation_item { representation_item.name = ‘dimensional note’ } representation_item => descriptive_representation_item { (descriptive_representation_item.description = ‘auxiliary’) (descriptive_representation_item.description = ‘theoretical’) (descriptive_representation_item.description) }
GEOMETRIC_TOLERANCE	geometric_tolerance	10303-47		

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
applied_to	shape_aspect	10303-41		geometric_tolerance geometric_tolerance.toleranced_shape_aspect -> shape_aspect
geometric_tolerance to tolerance_condition (as modification)	PATH			geometric_tolerance => modified_geometric_tolerance modified_geometric_tolerance.modifier
name	geometric_tolerance.name	10303-47		
qualifying_note	geometric_tolerance.description	10303-47		
segment_size	length_measure_with_unit	10303-41		geometric_tolerance => geometric_tolerance_with_defined_unit geometric_tolerance_with_defined_unit.unit_size -> measure_with_unit => length_measure_with_unit
significant_digits	precision_qualifier.precision_value	10303-45		geometric_tolerance geometric_tolerance.magnitude -> measure_with_unit <- measure_qualification.qualified_measure measure_qualification measure_qualification.qualifiers[i] -> value_qualifier value_qualifier = precision_qualifier precision_qualifier precision_qualifier.precision_value
tolerance_value	measure_with_unit	10303-41		geometric_tolerance geometric_tolerance.magnitude -> measure_with_unit => length_measure_with_unit
GEOMETRIC_TOLERANCE_-RELATIONSHIP	geometric_tolerance_relationship	10303-47		

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
geometric_tolerance_relationship to geometric_tolerance (as relating)	PATH			geometric_tolerance_relationship geometric_tolerance_relationship.relating_geometric_tolerance -> geometric_tolerance
geometric_tolerance_relationship to geometric_tolerance (as related)	PATH			geometric_tolerance_relationship geometric_tolerance_relationship.related_geometric_tolerance -> geometric_tolerance
relation_type	geometric_tolerance_relationship.-name	10303-47		
HEIGHT_SIZE_DIMENSION #1: If no measurement_path is specified #2: If a measurement_path is specified	#1: (dimensional_size) #2: (dimensional_size_with_path)	10303-47 10303-47		dimensional_size #2: { dimensional_size => dimensional_size_with_path } { dimensional_size.name = 'height' }
height_size_dimension to measurement_path (as used_path)	PATH			dimensional_size_with_path dimensional_size_with_path.path -> shape_aspect shape_definition = shape_aspect characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation
LENGTH_SIZE_DIMENSION	#1: (dimensional_size) #2: (dimensional_size_with_path)	10303-47 10303-47		dimensional_size #2: { dimensional_size => dimensional_size_with_path } { dimensional_size.name = 'length' }

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
length_size_dimension to measurement_path (as used_path)	PATH			dimensional_size_with_path dimensional_size_with_path.path -> shape_aspect shape_definition = shape_aspect characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation
LINE_PROFILE_TOLERANCE	line_profile_tolerance	10303-519		line_profile_tolerance <= geometric_tolerance

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
affected_plane	placement	10303-42		line_profile_tolerance <= geometric_tolerance <- tolerance_zone.defining_tolerance[i] tolerance_zone <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect { shape_aspect.description = ‘affected plane’ } shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> { representation_item.name = ‘affected plane’ } representation_item => geometric_representation_item => placement
line_profile_tolerance to datum_reference (as reference_datum)	PATH			line_profile_tolerance <= geometric_tolerance => geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
LINEAR_DISTANCE_DIMENSION #1: If the directed attribute is 'false' #2: If the directed attribute is 'true'	#1:(dimensional_location) #2:(directed_dimensional_location)	10303-47 10303-238		dimensional_location <= #2: { dimensional_location => directed_dimensional_location } shape_aspect_relationship { shape_aspect_relationship.name = ‘linear distance’ }

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
orientation	placement	10303-42		dimensional_location <= shape_aspect_relationship shape_definition = shape_aspect_relationship shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> { representation_item.name = ‘orientation’ } representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)
LOCATION_DIMENSION #1: If the directed attribute is 'false' #2: If the directed attribute is 'true'	#1:(dimensional_location) #2:(directed_dimensional_location)	10303-47 10303-238		dimensional_location #2: { dimensional_location => directed_dimensional_location }
description	shape_aspect_relationship.- description	10303-41		dimensional_location <= shape_aspect_relationship shape_aspect_relationship.description
directed	IDENTICAL MAPPING			
origin	shape_aspect	10303-41		dimensional_location <= shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
target	shape_aspect	10303-41		dimensional_location <= shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect
MEASUREMENT_PATH	representation	10303-43		representation { representation.name = ‘measuring direction’ }
defined_by	curve	10303-42		representation representation.items[i] -> representation_item => geometric_representation_item => curve => { (pcurve) (surface_curve) }
defined_in	geometric_representation_context	10303-42		representation representation.context_of_items -> representation_context => geometric_representation_context
PARALLELISM_TOLERANCE	parallelism_tolerance	10303-519		parallelism_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
affected_plane	placement	10303-42		parallelism_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance <- tolerance_zone.defining_tolerance[i] tolerance_zone <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect { shape_aspect.description = 'affected plane' } shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> { representation_item.name = 'affected plane' } representation_item => geometric_representation_item => placement
parallelism_tolerance to datum_reference (as reference_datum)	PATH			parallelism_tolerance <= geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
PERPENDICULARITY_TOLERANCE	perpendicularity_tolerance	10303-519		perpendicularity_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
affected_plane	placement	10303-42		perpendicularity_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance <- tolerance_zone.defining_tolerance[i] tolerance_zone <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect { shape_aspect.description = ‘affected plane’ } shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> { representation_item.name = ‘affected plane’ } representation_item => geometric_representation_item => placement
perpendicularity_tolerance to datum_reference (as reference_datum)	PATH			perpendicularity_tolerance <= geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
PLACED_TARGET	placed_datum_target_feature	10303-238		placed_datum_target_feature <= datum_target

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
defined_in	geometric_representation_context	10303-42		placed_datum_target_feature <= datum_target <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition 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.context_of_items -> representation_context => geometric_representation_context

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
parameter_reference	placement	10303-42		placed_datum_target_feature <= datum_target <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition 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 => { representation_item.name = ‘orientation’ } geometric_representation_item => placement
POSITION_TOLERANCE	position_tolerance	10303-519		position_tolerance <= geometric_tolerance

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
affected_plane	placement	10303-42		position_tolerance <= geometric_tolerance <- tolerance_zone.defining_tolerance[i] tolerance_zone <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect { shape_aspect.description = ‘affected plane’ } shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> { representation_item.name = ‘affected plane’ } representation_item => geometric_representation_item => placement
position_tolerance to datum_reference (as reference_datum)	PATH			position_tolerance <= geometric_tolerance => geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
PROJECTION	projected_zone_definition	10303-47		projected_zone_definition <= tolerance_zone_definition

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
projection_end	shape_aspect	10303-41		projected_zone_definition projected_zone_definition.projection_end -> shape_aspect
projection_length	measure_with_unit	10303-41		projected_zone_definition projected_zone_definition.projected_length -> measure_with_unit
RADIAL_SIZE_DIMENSION	dimensional_size	10303-47		dimensional_size { dimensional_size.name = ‘radius’ }
radius_type	descriptive_representation_item.- description	10303-45		dimensional_size dimensional_characteristic = dimensional_size dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation representation.items[i] -> { representation_item.name = ‘radius type’ } representation_item => descriptive_representation_item descriptive_representation_item.description { (descriptive_representation_item.description = ‘centred’) (descriptive_representation_item.description = ‘adjoining’) }
ROUNDNESS_TOLERANCE	roundness_tolerance	10303-519		roundness_tolerance <= geometric_tolerance
SINGLE_DATUM	datum	10303-47		
datum_name	datum.identification	10303-47		

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
single_datum to tolerance_condition (as modification)	referenced_modified_datum.modifier	10303-47		datum <- datum_reference.referenced_datum datum_reference datum_reference => referenced_modified_datum referenced_modified_datum.modifier
SIZE_DIMENSION	dimensional_size	10303-47		
applied_to	shape_aspect	10303-41		dimensional_size dimensional_size.applies_to -> shape_aspect
envelope_principle #1: if envelope_principle is true #2: if envelope_principle is false	representation.name	10303-43		dimensional_size dimensional_characteristic = dimensional_size dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation representation.name #1: ({ representation.name = 'envelope tolerance' } #2: { representation.name = '' })
STRAIGHTNESS_TOLERANCE	straightness_tolerance	10303-519		straightness_tolerance <= geometric_tolerance

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
affected_plane	placement	10303-42		straightness_tolerance <= geometric_tolerance <- tolerance_zone.defining_tolerance[i] tolerance_zone <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect { shape_aspect.description = ‘affected plane’ } shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> { representation_item.name = ‘affected plane’ } representation_item => geometric_representation_item => placement
SURFACE_PROFILE_TOLERANCE	surface_profile_tolerance	10303-519		surface_profile_tolerance <= geometric_tolerance
surface_profile_tolerance to datum_reference (as reference_datum)	PATH			surface_profile_tolerance <= geometric_tolerance => geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SYMMETRY_TOLERANCE	symmetry_tolerance	10303-519		symmetry_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance
affected_plane	placement	10303-42		symmetry_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance <- tolerance_zone.defining_tolerance[i] tolerance_zone <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect-> shape_aspect { shape_aspect.description = ‘affected plane’ } shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> { representation_item.name = ‘affected plane’ } representation_item => geometric_representation_item => placement
symmetry_tolerance to datum_reference (as reference_datum)	PATH			symmetry_tolerance <= geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference
TARGET_AREA	datum_target	10303-47		

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
TARGET_CIRCLE	placed_datum_target_feature	10303-238		placed_datum_target_feature <= datum_target <= shape_aspect { shape_aspect.description = ‘circle’ }
diameter	length_measure_with_unit	10303-41		placed_datum_target_feature <= datum_target <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition 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 => { representation_item.name = ‘target diameter’ } measure_representation_item <= measure_with_unit => length_measure_with_unit
TARGET_POINT	placed_datum_target_feature	10303-238		placed_datum_target_feature <= datum_target <= shape_aspect { shape_aspect.description = ‘point’ }

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
TARGET_RECTANGLE	placed_datum_target_feature	10303-238		placed_datum_target_feature <= datum_target <= shape_aspect { shape_aspect.description = ‘rectangle’ }
target_length	length_measure_with_unit	10303-41		placed_datum_target_feature <= datum_target <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition 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 => { representation_item.name = ‘target length’ } measure_representation_item <= measure_with_unit => length_measure_with_unit

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
target_width	length_measure_with_unit	10303-41		placed_datum_target_feature <= datum_target <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition 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 => { representation_item.name = ‘target width’ } measure_representation_item <= measure_with_unit => length_measure_with_unit
TARGET_STRAIGHT_LINE	placed_datum_target_feature	10303-238		placed_datum_target_feature <= datum_target <= shape_aspect { shape_aspect.description = ‘line’ }

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
target_length	length_measure_with_unit	10303-41		placed_datum_target_feature <= datum_target <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition 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 => { representation_item.name = ‘target length’ } measure_representation_item <= measure_with_unit => length_measure_with_unit
THICKNESS_SIZE_DIMENSION	#1: (dimensional_size) #2: (dimensional_size_with_path)	10303-47 10303-47		dimensional_size #2: { dimensional_size => dimensional_size_with_path } { dimensional_size.name = ‘thickness size’ }

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness_size_dimension to measurement_path (as used_path)	PATH			dimensional_size_with_path dimensional_size_with_path.path -> shape_aspect shape_definition = shape_aspect characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation
TOLERANCE_CONDITION #1: If the tolerance_condition is referenced by a geometric_tolerance. #2: If the tolerance_condition is referenced by a single_datum.	#1: (modified_geometric_tolerance.-modifier) #2: (referenced_modified_datum.-modifier)	10303-47 10303-47		
condition	limit_condition	10303-47		#1: (modified_geometric_tolerance.modifier ->) #2: (referenced_modified_datum.modifier ->) limit_condition
TOLERANCE_ZONE	tolerance_zone	10303-47		
form_type	tolerance_zone_form.name	10303-47		tolerance_zone tolerance_zone.form -> tolerance_zone_form tolerance_zone_form.name
tolerance_zone to geometric_tolerance (as zone_for)	PATH			tolerance_zone tolerance_zone.defining_tolerance[i] -> geometric_tolerance
TOLERANCE_ZONE_DEFINITION	tolerance_zone_definition	10303-47		

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
tolerance_zone_definition to tolerance_zone (as defining)	PATH			tolerance_zone_definition tolerance_zone_definition.zone -> tolerance_zone
first_element	shape_aspect	10303-41		tolerance_zone_definition tolerance_zone_definition.boundaries[i] -> shape_aspect
second_element	shape_aspect	10303-41		tolerance_zone_definition tolerance_zone_definition.boundaries[i] -> shape_aspect
TOTAL_RUNOUT_TOLERANCE	total_runout_tolerance	10303-519		total_runout_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance
angle	measure_with_unit	10303-41		total_runout_tolerance <= geometric_tolerance_with_datum_reference <= geometric_tolerance <- tolerance_zone.defining_tolerance[i] tolerance_zone <- tolerance_zone_definition.zone tolerance_zone_definition => runout_zone_definition runout_zone_definition.orientation -> runout_zone_orientation runout_zone_orientation.angle -> measure_with_unit
total_runout_tolerance to datum_reference (as reference_datum)	PATH			total_runout_tolerance <= geometric_tolerance_with_datum_reference geometric_tolerance_with_datum_reference.datum_system[i] -> datum_reference

Table 13 — Mapping table for geometric dimensioning and tolerancing UoF (continued)

Application element	AIM element	Source	Rules	Reference path
WIDTH_SIZE_DIMENSION	#1: (dimensional_size) #2: (dimensional_size_with_path)	10303-47 10303-47		dimensional_size #2: { dimensional_size => dimensional_size_with_path } { dimensional_size.name = 'width' }
width_size_dimension to measurement_path (as used_path)	PATH			dimensional_size_with_path dimensional_size_with_path.path -> shape_aspect shape_definition = shape_aspect characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation

Table 14 — Mapping table for library reference UoF

Application element	AIM element	Source	Rules	Reference path
BSU #1: if BSU is a Class_BSU #2: if BSU is a Property_BSU #3: if BSU is a Supplier_BSU	#1: (externally_defined_class) #2: (externally_defined_- general_property) #3: (organization)	10303-238 10303-238 10303-41		#1: (externally_defined_class <= externally_defined_item) #2: (externally_defined_general_property <= externally_defined_item) #3: (organization)
code #1: if BSU is a Class_BSU #2: if BSU is a Property_BSU #3: if BSU is a Supplier_BSU	#1,2: (externally_defined_item.- item_id) #3: (organization.id)	10303-41 10303-41		#1: (externally_defined_class <= externally_defined_item externally_defined_item.item_id) #2: (externally_defined_general_property <= externally_defined_item externally_defined_item.item_id) #3: (organization.id)
CLASS_BSU	externally_defined_class	10303-238		[externally_defined_class <= class <= group] [externally_defined_class <= externally_defined_item {externally_defined_item.source -> external_source => known_source <= pre_defined_item pre_defined_item.name = ‘ISO 13584 library’}]

Table 14 — Mapping table for library reference UoF (continued)

Application element	AIM element	Source	Rules	Reference path
class_bsu to supplier_bsu (as defined_by)	PATH			externally_defined_class <= externally_defined_item externally_defined_item.source -> external_source => known_source organization_item = known_source organization_item <- applied_organization_assignment.items[i] applied_organization_assignment <= organization_assignment {organization_assignment.role -> organization_role organization_role.name = ‘library supplier’} organization_assignment.assigned_organization -> organization
version	identification_assignment.-assigned_id	10303-41		externally_defined_class external_identification_item = externally_defined_class external_identification_item <- applied_external_identification_assignment.items[i] applied_external_identification_assignment <= external_identification_assignment<= identification_assignment {identification_assignment.role -> identification_role identification_role.name = ‘class version’} identification_assignment.assigned_id
EXTERNALLY_DEFINED_-REPRESENTATION	externally_defined_representation_-with_parameters	10303-238		externally_defined_representation_with_parameters <= representation

Table 14 — Mapping table for library reference UoF (continued)

Application element	AIM element	Source	Rules	Reference path
externally_defined_representation to library_part_assignment (as identified_by)	PATH			externally_defined_representation_with_parameters classification_item = \ externally_defined_representation_with_parameters classification_item <- applied_classification_assignment.items[i] applied_classification_assignment
location	placement.location	10303-42		externally_defined_representation_with _parameters<= representation representation.items[i]-> representation_item=> geometric_representation_item=> placement placement.location
placement	placement	10303-42		externally_defined_representation_with _parameters<= representation representation.items[i]-> representation_item=> geometric_representation_item=> placement
LIBRARY_PART_ASSIGNMENT	applied_classification_assignment	10303-238		applied_classification_assignment <= classification_assignment
library_part_assignment to class_bsu (as definitional_class_bsu)	PATH			applied_classification_assignment <= classification_assignment {classification_assignment.role -> classification_role classification_role.name = 'definitional class membership'} classification_assignment.assigned_class -> group => {group.name = 'library identifier'} class => externally_defined_class

Table 14 — Mapping table for library reference UoF (continued)

Application element	AIM element	Source	Rules	Reference path
library_part_assignment to library_property_value (as definitional_property_value_pairs)	PATH			applied_classification_assignment <= classification_assignment {classification_assignment.role -> classification_role classification_role.name = 'definitional class membership'} classification_assignment.assigned_class -> group => {group.name = 'library identifier'} class => externally_defined_class <= externally_defined_item <- externally_defined_item_relationship.related_item {externally_defined_item_relationship.name = ‘name scope’} externally_defined_item_relationship externally_defined_item_relationship.relating_item-> externally_defined_item => externally_defined_general_property <= general_property <- general_property_association.base_definition general_property_association {general_property_association.name = 'definitional'} general_property_association.derived_definition-> property_definition property_definition = represented_definition represented_definition<- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation-> representation {representation.name = 'property value'}
LIBRARY_PROPERTY_VALUE	representation	10303-43		representation {representation.name = ‘property value’}

Table 14 — Mapping table for library reference UoF (continued)

Application element	AIM element	Source	Rules	Reference path
library_property_value to property_bsu (as value_property_bsu)	PATH			representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> represented_definition = general_property general_property => externally_defined_general_property

Table 14 — Mapping table for library reference UoF (continued)

Application element	AIM element	Source	Rules	Reference path
value_amount #1: if boolean value #2: if integer value #3: if logical value #4: if number value #5: if real value #6: if string value	#1,#3,#6: (descriptive_-representation_item) #2,#4,#5: (value_-representation_item)	10303-45 10303-43		representation representation.items[i] -> representation_item => #1: (descriptive_representation_item {(descriptive_representation_item.description = 'TRUE') (descriptive_representation_item.description = 'FALSE')}) #2: (value_representation_item value_representation_item.value_component {value_representation_item.value_component-> measure_value measure_value=count_measure}) #3: (descriptive_representation_item {(descriptive_representation_item.description = 'TRUE') (descriptive_representation_item.description = 'FALSE') (descriptive_representation_item.description = 'UNKNOWN')}) #4: (value_representation_item value_representation_item.value_component {value_representation_item.value_component-> measure_value measure_value=count_measure}) #5: (value_representation_item value_representation_item.value_component {value_representation_item.value_component-> measure_value measure_value=length_measure}) #6: (descriptive_representation_item descriptive_representation_item.description)

Table 14 — Mapping table for library reference UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PROPERTY_BSU	externally_defined_general_property	10303-238		[externally_defined_general_property <= general_property] [externally_defined_general_property <= externally_defined_item {externally_defined_item.source -> external_source => known_source <= pre_defined_item pre_defined_item.name = 'ISO 13584 library'}]
property_bsu to class_bsu (as name_scope)	PATH			externally_defined_general_property <= externally_defined_item <- externally_defined_item_relationship.relating_item externally_defined_item_relationship {externally_defined_item_relationship.name = ‘name scope’} externally_defined_item_relationship.related_item -> externally_defined_item => externally_defined_class
version	identification_assignment.- assigned_id	10303-41		externally_defined_general_property external_identification_item = \ externally_defined_general_property external_identification_item <- applied_external_identification_assignment.items[i] applied_external_identification_assignment <= external_identification_assignment<= identification_assignment {identification_assignment.role-> identification_role identification_role.name = ‘property_version’} identification_assignment.assigned_id

Table 14 — Mapping table for library reference UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SUPPLIER_BSU	organization	10303-41		externally_defined_class <= externally_defined_item externally_defined_item.source -> external_source => known_source organization_item = known_source organization_item <- applied_organization_assignment.items[i] applied_organization_assignment <= organization_assignment {organization_assignment.role -> organization_role organization_role.name = ‘library supplier’} organization_assignment organization_assignment.assigned_organization -> organization

Table 15 — Mapping table for management UoF

Application element	AIM element	Source	Rules	Reference path
APPROVAL	approval	10303-41	1, 2	
actual_date	(date_and_time) (date)	10303-41 10303-41		approval <- approval_date_time.dated_approval approval_date_time {approval_date_time.role -> object_role object_role.name = ‘actual’} approval_date_time.date_time -> date_time_select (date_time_select = date_and_time date_and_time) (date_time_select = date date)
planned_date	(date_and_time) (date)	10303-41 10303-41		approval <- approval_date_time.dated_approval approval_date_time {approval_date_time.role -> object_role object_role.name = ‘planned’} approval_date_time.date_time -> date_time_select (date_time_select = date_and_time date_and_time) (date_time_select = date date)
purpose	approval.level	10303-41		
approval to approval_status (as status)	PATH			approval approval.status -> approval_status
APPROVAL_RELATIONSHIP	approval_relationship	10303-41		

Table 15 — Mapping table for management UoF (continued)

Application element	AIM element	Source	Rules	Reference path
description	approval_relationship.description	10303-41		
approval_relationship to approval (as related_approval)	PATH			approval_relationship approval_relationship.related_approval -> approval
approval_relationship to approval (as relating_approval)	PATH			approval_relationship approval_relationship.relating_approval -> approval
relation_type	approval_relationship.name	10303-41		
APPROVAL_STATUS	approval_status	10303-41	4	
status_name	approval_status.name	10303-41		
APPROVING_PERSON_-ORGANIZATION	approval_person_organization	10303-41		
approval_date	date_and_time	10303-41		approval_person_organization date_and_time_item = approval_person_organization date_and_time_item <- applied_date_and_time_assignment.items[i] applied_date_and_time_assignment <= date_and_time_assignment {date_and_time_assignment.role -> date_time_role date_time_role.name = ‘sign off’} date_and_time_assignment.assigned_date_and_time -> date_and_time
approving_person_organization to approval (as authorized_approval)	PATH			approval_person_organization approval_person_organization.authorized_approval -> approval

Table 15 — Mapping table for management UoF (continued)

Application element	AIM element	Source	Rules	Reference path
person_organization	(organization) (person_and_organization)	10303-41 10303-41		approval_person_organization approval_person_organization.person_organization -> person_organization_select (person_organization_select = organization organization) (person_organization_select = person_and_organization person_and_organization)
role	approval_role.role	10303-41		approval_person_organization approval_person_organization.role -> approval_role approval_role.role
ASSIGNED_DATE	applied_date_assignment	10303-238		
date_value	date	10303-41		applied_date_assignment <= date_assignment date_assignment.assigned_date -> date
role	date_role.name	10303-41		applied_date_assignment <= date_assignment date_assignment.role -> date_role date_role.name
ASSIGNED_ORGANIZATION	applied_organization_assignment	10303-238		
organization_value	organization	10303-41		applied_organization_assignment <= organization_assignment organization_assignment.assigned_organization -> organization

Table 15 — Mapping table for management UoF (continued)

Application element	AIM element	Source	Rules	Reference path
role	organization_role.name	10303-41		applied_organization_assignment <= organization_assignment organization_assignment.role -> organization_role organization_role.name
ASSIGNED_PERSON	applied_person_and_organization_- assignment	10303-238		
person_and_organization_value	person_and_organization	10303-41		applied_person_and_organization_assignment <= person_and_organization_assignment person_and_organization_assignment.assigned_person_- and_organization -> person_and_organization
role	person_and_organization_role.name	10303-41		applied_person_and_organization_assignment <= person_and_organization_assignment person_and_organization_assignment.role -> person_and_organization_role person_and_organization_role.name
ASSIGNED_TIME	applied_date_and_time_assignment	10303-238		
date_and_time_value	date_and_time	10303-41		applied_date_and_time_assignment <= date_and_time_assignment date_and_time_assignment.assigned_date_and_time -> date_and_time
role	date_time_role.name	10303-41		applied_date_and_time_assignment <= date_and_time_assignment date_and_time_assignment.role -> date_time_role date_time_role.name

Table 15 — Mapping table for management UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LAST_MODIFIED_TIMESTAMP	applied_date_and_time_assignment	10303-238		applied_date_and_time_assignment <= date_and_time_assignment.role -> date_time_role { date_time_role.name = 'last modified' }
date_and_time_value	date_and_time	10303-41		applied_date_and_time_assignment <= date_and_time_assignment date_and_time_assignment.assigned_date_and_time -> date_and_time
last_modified_timestamp to executable, toolpath, operation, workpiece, or project (as items)	PATH			applied_date_and_time_assignment applied_date_and_time_assignment.items[i]-> date_and_time_item (date_and_time_item = machining_process_executable machining_process_executable) (date_and_time_item = machining_toolpath machining_toolpath) (date_and_time_item = machining_operation machining_operation) (date_and_time_item = product_definition product_definition) (date_and_time_item = product_definition_formation product_definition_formation { product_definition_formation.of_product -> product => machining_project })
SECURITY_CLASSIFICATION	security_classification	10303-41		
classification_level	security_classification_level.name	10303-41		security_classification security_classification.security_level -> security_classification_level security_classification_level.name
description	security_classification.purpose	10303-41		

Table 15 — Mapping table for management UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SECURITY_CLASSIFICATION_- ASSIGNMENT	applied_security_classification_- assignment	10303-238		
security_classification_assignment to security_classification (as classification)	PATH			applied_security_classification_assignment <= security_classification_assignment security_classification_assignment.assigned_security_- classification -> security_classification
security_classification_assignment to executable, toolpath, operation, workpiece, or project (as items)	PATH			applied_security_classification_assignment applied_security_classification_assignment.items[i]-> security_classification_item (security_classification_item = machining_process_executable machining_process_executable) (security_classification_item = machining_toolpath machining_toolpath) (security_classification_item = machining_operation machining_operation) (security_classification_item = product_definition product_definition) (security_classification_item = product_definition_formation product_definition_formation { product_definition_formation.of_product -> product => machining_project })

The following rules are referenced in the preceding tables:

1) approval_requires_approval_person_organization
2) approval_requires_assignment
3) chamfer_requires_faces_or_features
4) dependent_instantiable_approval_status
5) dependent_instantiable_derived_unit
6) dependent_instantiable_named_unit
7) edge_round_requires_faces_or_features
8) feature_optional_machining_property_process
9) nc_variable_compatible_initial_value

The following notes are referenced in the preceding tables:

1) As part of the harmonization of GD&T definitions across AP 224, AP 214, and ISO 10303-1050, the mapping for plus/minus and limits and fits qualifications differ when they appear in a dimension tolerance versus other uses. As a result, these particular mappings are a bit convoluted. A complex instance of measure_representation_item and qualified_representation_item is normally used and the plus/minus, limits and fits, limit qualification, or significant digits are mapped as elements of the “qualifiers” attribute of qualified_representation_item. However, when a plus/minus or limits and fits qualifications appear in a dimension tolerance, they are mapped to the Part 47 plus_minus_tolerance type and a reference path links this to the measure_representation_item.

2) As part of the GD&T harmonization described in the note above, the mapping of value ranges differ when they appear in a dimension tolerance versus other uses. A range is normally mapped as a subtype of compound_representation_item containing measure_representation_items for the upper and lower bounds. However, in a dimension tolerance, the upper and lower bounds appear separately as items in a shape_dimension_representation.

3) AP 214 has both name and description for features while AP 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 it is mapped to name.

4) The its_operation attribute is redundant It combines the relationships established between manufacturing_feature and machining/turning_workingstep and the relationship between these workingstep types and machining_operation. The mapping path listed for this attribute simply concatenates the paths established for the other relationships.

5) AP 224 does not define a mapping for explicit_representation, but the usage observed in existing implementations corresponds to the alternate case given in this part of ISO 10303. This alternate is provided to allow the use of instance data that may have originated from an AP 224 process, but the preferred reference path should be used for any new instance data. See 5.2.1.2.2 for additional discussion on explicit feature geometry.

6) For bounding geometry that is either a block or cylinder, ISO 14649-10 references block and right_circular_cylinder. For harmonization with AP 224 and AP 214 these two cases have been mapped to the shape_representation subtypes block_shape_representation and cylindrical_shape_representation instead. Aside from these two cases, the mapping for its_bounding_geometry is simply the the its_geometry parameter of the its_rawpiece.

7) The product_definition_formation_with_specified_source subtype of product_definition_formation is present in the integrated representation to simplify the use of workpiece descriptions that may have originated from an AP 203 process. This use of this subtype is not recommended in the general case.

8) Assembly information is likely to originate in upstream applications using AP 203 or AP 214, which permit assembly components to be placed using mapped_item or item_defined_transformation. The originating_orientation and resulting_orientation mappings allow either technique to be used for compatibility with existing APs and data sets. When using item_defined_transformation, some APs have not clearly stated which attribute refers to the component and which refers to the enclosing assembly, which has led to confusion. Here transform_item_1 refers to the original workpiece placement and transform_item_2 refers to the placement within the assembly. Additional discussion on the handling of shape in assemblies can be found in 5.2.1.6 of ISO 10303-214.

9) AP 224 defines special pocket subtypes for open and closed pockets with rectangular profiles. Within AP 224, pockets with rectangular profiles can be represented as a general pocket ARM object or as the rectangular specialization. Within this part of ISO 10303, no specialization exists, but the mappings have an alternate case to cover the AP 224 usage. This allows the use of pocket feature data that may have originated from an AP 224 process.

10) The pocket bottom condition has been mapped to a face surface representation rather than a region feature for harmonization with AP 224 and AP 214.

11) The preferred mapping table entry for Pocket and Round_hole bottom_at_path_end matches the reference path given in the AP 224 specification and should be used for any new instance data. The alternate mapping table entry matches a non-conforming usage observed in existing AP 224 implementations and is provided to allow the use of instance data that may have originated from such a process.

12) The name of this attribute is confusing. This is the path along which the profile is swept, not a profile itself. The various ARM subtypes of Profile_feature specify the profiles that is swept. The usage of these attributes are described in 5.2.1.3.4.

13) 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.

14) Although the feature_placement is represented as axis2_placement3d in both ISO 14649-10 and this part of ISO 10303, the numeric value of the placement will change due to the use of different reference points for measuring location in the ISO 14649 and ISO 10303 standards. See clause 5.2.1 for a complete description of the differences and instructions for converting between them.

15) Although the initial_value for Nc_variable is defined as a Number by ISO 14649, the mapping has been constructed as if it were actually of type Nc_constant, so as to avoid introducing a different way of handling essentially the same concept.

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

17) This ARM attribute is defined as a list. The mapping path shown in the table shows how to relate the elements of the list. Ordering is handled by the sequence_position attribute on the relationship, which is inherited from the sequential_method supertype. This attribute holds a number indicating the position within the list. For exemple, the fifth item in the list would have sequence_position=5.

18) The Toolpath_list application object is not mapped. Instead, the mapping goes directly to the tool-path objects. Ordering is handled by the sequence_position attribute on the relationship as described in NOTE 17.

19) The ARM models Axis_trajectory as two parallel lists, where axis_list[1] contains the axis name corresponding to the curve in command[1]. Then, axis_list[2] contains the axis name for command[2] and so on. In the AIM, parallel lists are not used. Instead, the representation.items set contains one bounded curve for each axis to be moved by the trajectory and the axis name is kept in the representation_item.name attribute of each curve.

20) The process_model_list application object is not mapped. Instead, the mapping goes directly to the process model objects. Ordering is handled by the sequence_position attribute on the relationship as described in NOTE 17.

21) The ARM attribute corner_transitions is defined as a list, but list ordering is not encoded by the mapping. If ordering is desired, the corner transitions shall be ordered by corner_identity.

22) If a manufacturing feature is used to establish a Datum_defined_by_feature, the datum_feature type must be added to the complex instance of shape_aspect subtypes used to represent the manufacturing features. A planar face manufacturing feature is normally mapped to a complex instance of instanced_feature and flat_face. If it is used as a datum, a complex instance of instanced_feature, flat_face, and datum_feature must be appear.

5.2 AIM EXPRESS short listing

This clause specifies the EXPRESS schema that uses elements from the integrated resources and the AICs and contains the types, entity specializations, rules, and functions that are specific to this part of ISO 10303. This clause also specifies modifications to the text for constructs that are imported from the integrated resources and the AICs. The definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes that are not imported into the AIM. Requirements stated in the integrated resources that refer to select list items and subtypes apply exclusively to those items that are imported into the AIM.

```
*)
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_edge_based_wireframe                                 -- 10303-501
    (edge_based_wireframe_shape_representation);

USE FROM aic_faceted_brep                                         -- 10303-512
    (faceted_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_geometrically_bounded_wireframe                      -- 10303-510
```



```
    (geometrically_bounded_wireframe_shape_representation);

USE FROM aic_machining_feature                                   -- 10303-522
    (applied_area,
     boss,
     boss_top,
     chamfer,
     chamfer_offset,
     circular_closed_profile,
     circular_pattern,
     closed_path_profile,
     composite_hole,
     compound_feature,
     direction_shape_representation,
     edge_round,
     externally_defined_feature_definition,
     face_shape_representation,
     feature_component_definition,
     feature_component_relationship,
     feature_definition,
     feature_pattern,
     fillet,
     flat_face,
     gear,
     hole_bottom,
     instanced_feature,
     linear_profile,
     location_shape_representation,
     marking,
     modified_pattern,
     ngon_closed_profile,
     open_path_profile,
     outer_round,
     outside_profile,
     partial_circular_profile,
     path_feature_component,
     path_shape_representation,
     pattern_offset_membership,
     pattern_omit_membership,
     planar_shape_representation,
     pocket,
     pocket_bottom,
     profile_floor,
     protrusion,
     rectangular_closed_profile,
     rectangular_pattern,
     removal_volume,
     replicate_feature,
     revolved_profile,
     rib_top,
     rib_top_floor,
     round_hole,
     rounded_end,
     rounded_u_profile,
```



```
     shape_defining_relationship,
     shape_representation_with_parameters,
     slot,
     slot_end,
     spherical_cap,
     square_u_profile,
     step,
     taper,
     tee_profile,
     thread,
     thread_runout,
     transition_feature,
     turned_knurl,
     vee_profile);

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

USE FROM aic_non_manifold_surface                             -- 10303-508
    (non_manifold_surface_shape_representation);

USE FROM aic_shell_based_wireframe                            -- 10303-502
    (shell_based_wireframe_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,
     approval_relationship,
     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,
     document_usage_constraint,
     document_with_class);

USE FROM external_reference_schema                            -- 10303-41
```



```
    (externally_defined_item,
     externally_defined_item_relationship,
     pre_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,
     geometric_representation_context);

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

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,
     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_assignment,
     classification_role,
     date_and_time_assignment,
     date_assignment,
     document_reference,
```

```
     document_usage_constraint_assignment,
     external_identification_assignment,
     identification_assignment,
     identification_role,
     organization_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
    (area_measure,
     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,
     mass_measure,
     mass_measure_with_unit,
     mass_unit,
     measure_with_unit,
     named_unit,
     numeric_measure,
     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,
     time_measure_with_unit,
     time_unit,
     volume_measure);

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

```
USE FROM person_organization_schema                              -- 10303-41
    (organization,
     organization_role,
     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,
     characterized_action_definition,
     characterized_resource_definition,
     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_formation_with_specified_source,
     product_definition_relationship,
     product_definition_with_associated_documents,
     product_related_product_category);

USE FROM product_property_definition_schema                      -- 10303-41
    (characterized_object,
     general_property,
     general_property_association,
     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
```



```
    (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,
     mapped_item,
     representation,
     representation_item,
     representation_item_relationship,
     representation_relationship,
     representation_relationship_with_transformation,
     set_representation_item,
     value_representation_item);

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

USE FROM shape_aspect_definition_schema                        -- 10303-47
    (apex,
     centre_of_symmetry,
     datum,
     datum_feature,
     datum_reference,
     datum_target,
     derived_shape_aspect,
     extension,
     geometric_alignment,
     geometric_intersection,
     parallel_offset,
     perpendicular_to,
     referenced_modified_datum,
     tangent);

USE FROM shape_dimension_schema                                -- 10303-47
    (angular_location,
     angular_size,
     dimensional_characteristic_representation,
     dimensional_location,
```



```
     dimensional_location_with_path,
     dimensional_size,
     dimensional_size_with_path,
     shape_dimension_representation);

USE FROM shape_tolerance_schema                                  -- 10303-47
    (limits_and_fits,
     modified_geometric_tolerance,
     plus_minus_tolerance,
     projected_zone_definition,
     runout_zone_definition,
     tolerance_value,
     tolerance_zone,
     tolerance_zone_definition,
     tolerance_zone_form);
(*
```

5.2.1 Fundamental concepts and assumptions

5.2.1.1 Introduction

The ISO 10303 application protocols describe various aspects of a product throughout the lifecycle from design to analysis to manufacturing and beyond. By mapping the information requirements to a common set of integrated resources these application protocols describe shared concepts in a consistent manner.

ISO 10303-238 is designed for representation and exchange of data for manufacture using numerically controlled machines. It begins with the information requirements set forth by the ISO 14649 data model for computerized numerical controllers and describes how to represent those within the larger view of product data defined by the combined set of ISO 10303 application protocols.

Where the ISO 14649 standards describe requirements not already handled by other APs, this integration process is straightforward. However, there are several areas where the ISO 14649 standards redefine concepts that have already been addressed by existing application protocols.

The first is the definition of manufacturing features. Requirements for manufacturing features are documented in AP 224 and AP 214, and the integrated resources used to describe them are documented in AIC 522. During development of the ISO 14649 standards, efforts were made to align ISO 14649 feature definitions with those already existing in ISO 10303. Progress was made, but a number of differences remain. See 5.2.1.2 for discussion of the general feature concepts and 5.2.1.3 for an explanation of how differences are handled for specific feature types within this part of ISO 10303.

The second is the use of units of measurement. The ISO 14649 standards constrain the usage of units to simplify their model. Within the context of ISO 10303 application protocols, this constraint is inappropriate because of the general unit handling mechanism of the ISO 10303 integrated resources. See 5.2.1.4 for discussion of measurement concepts in more detail.

In addition, there are several places where the ISO 14649 standards directly reference ISO 10303 integrated resources without giving any context as to how they should be used. To cover these situations, additional definitions have been added to Clause 4 to provide guidance. The ISO 10303 integrated representation also requires additional context descriptions for some types of information See 5.2.1.5 for discussion of these context descriptions.

Finally, there are information requirements which were not considered by ISO 14649 for the isolated case of input to a CNC control, but which must be considered by this part of ISO 10303 for integrating across the lifecycle such as geometric dimensions and tolerances. Additional definitions have been added to Clause 4 to handle these.

5.2.1.2 Manufacturing feature concepts

5.2.1.2.1 Implicit shape by profile and travel path

In the ISO 10303 integrated representation, the shape of many manufacturing feature types can be described as a profile swept along a travel path. This implicit description of feature shape is controlled by characteristic parameters of the Profile (See 4.2.262) and Travel_path (See 4.2.381) subtypes.

EXAMPLE 1 The profile and path representation of several feature types is shown in Figure 35.   The shape of the features are controlled by such characteristic parameters as the length of the sweep path, the diameter of the swept circular profile, the length and width of the swept rectangular profile, etc.

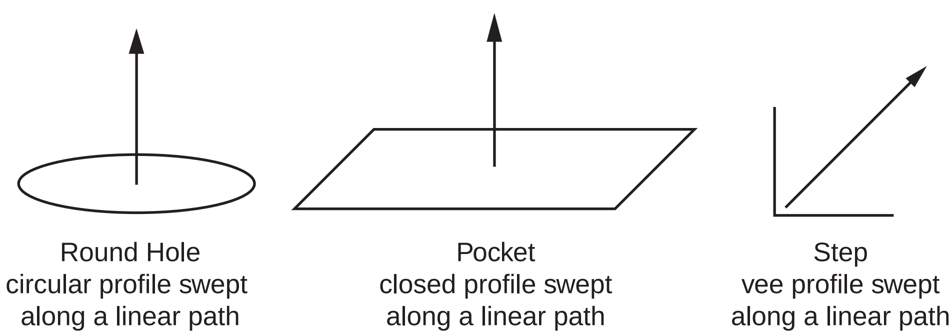

Figure 35 — Profile and path definition of features

Most of the machining_feature types defined by ISO 14649-10 use the same profile and path information requirements as the ISO 10303 integrated representation. However, in some, the authors of ISO 14649-10 chose to merge profile parameters into the feature definition, change orientations, or change conventions for reference points.

Several common cases are discussed below. See 5.2.1.3 for a systematic review of the profile and path conventions for feature types in the integrated representation, and an explanation of how to convert to the conventions used by ISO 14649.

EXAMPLE 2 The ISO 14649-10 definition of a round hole has a diameter measure. In the AIM mappings, we tie this to the diameter measure of a circular profile. The profile and path representation is still used at the AIM level for harmonization, even when the concepts are only tangentially represented in the ARM.

5.2.1.2.1.1 Feature placement and depth

Each feature has a placement parameter that describes the location and orientation of the feature in space. The origin of the feature is the reference point for the placement. In the integrated representation, placement is conveyed as an instance of axis2_placement3d. A Cartesian point gives the location in space of the feature origin, and a pair of direction vectors gives the orientation of the Z and X axes of the feature.

To describe feature depth, the ISO 10303 integrated representation uses a parameter of the profile or path. This varies by feature type but is often the length of the sweep path. The origin of the feature is at the start of the sweep path, with the Z axis of the feature aligned along the path. This means that the feature origin is at the bottom of the feature with Z either pointed up and out of the material (pocket, round hole, outside profile), or along the material (slot, step, planar face).

The authors of ISO 14649 chose a different method and instead encode depth as a surface representing the deepest part of the feature. As part of this, ISO 14649 defines the origin of the feature at the top of the feature, so that depth can be computed geometrically as the distance between the feature placement and the depth surface.

Consequently, a feature may have different values for placement location, and possibly orientation, in the ISO 10303 integrated representation and the ISO 14649 representation.

EXAMPLE Consider Figure 36 and assume a round hole 2 units deep, with the bottom center of the hole located at (0, 0, 0). In the ISO 10303 representation, the placement location of the hole is (0, 0, 0) and the length of the sweep path is 2 units. In the ISO 14649 representation, the placement location of the hole would be (0, 0, +2) and the feature would point to an instance of elementary_surface defining a plane at z=0;

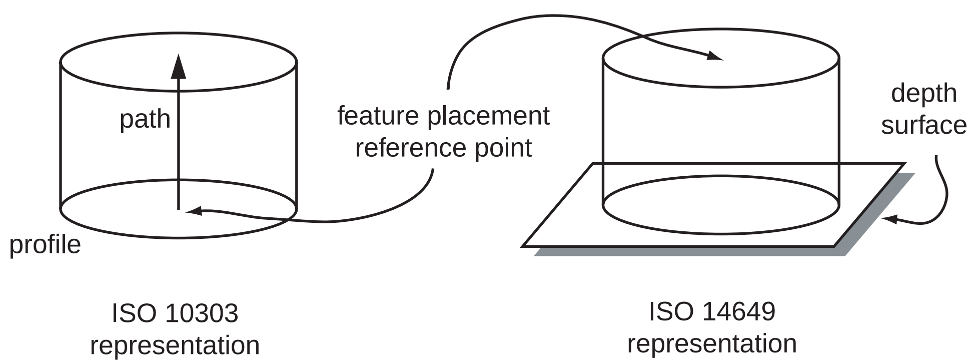

Figure 36 — Feature placement differences

ISO 14649 requires a depth surface for all machining_feature types, even where profile and path information is available. Within this part of ISO 10303, this constraint is relaxed since depth is already available from the profile and path parameters. The depth surface is represented by a parameter called "maximum feature depth," which is also an optional parameter in the AP 224 and AP 214 models.

NOTE Why were the reference points for features done this way? Before it is machined, the top of a feature often corresponds to a tangible location on the stock where a machinist could measure or make a mark. The bottom of the feature is usually buried within the stock.

The ISO 10303 standards originally defined features on the final form of the part as input to process planning. However, the features on the final part may not exactly match the features as machined. Consider a flat surface with a hole drilled in it. If the hole is drilled before the face is machined, the top of the hole will be higher than if it is drilled after the face is machined. The location in space of the bottom of the hole remains the same regardless of the sequence of operations.

Since planning activity may explore different operation sequences, describing the location from a reference point at the bottom of the feature allows the numeric value of the location to remain constant, even if the volume of the feature changes during process planning. Subsequent ISO 10303 standards continue to use this convention for compatibility.

ISO 14649 chose to use the top to more closely match the conventions used by machinists. Application software built around AP 238 may find it useful to present location information to a human using the ISO 14649 conventions, while still using the ISO 10303 convention for data exchange.

5.2.1.2.1.2 Orientation of profiles

The placement of a feature is described by an axis2_placement_3d, which contains a pair of direction vectors that give the orientation of the Z and X axes of the feature. From these, the orientation of the Y axis is computed by vector cross product, and the orientation of the other feature aspects are determined by conventions established in the feature definitions.

In the ISO 10303 integrated representation, profiles are defined to exist in the XY plane. Most features sweep the profile in the Z direction (the one exception is planar face, which uses a linear profile defined to lie along the X axis and is swept along the Y axis). The origin of a feature, its profile, and its path are all at the same point in space. Within the AIM instance data, it is recommended that the "placement" parameters of all three share the same axis2_placement_3d instance.

In ISO 14649, profiles are also defined in the XY plane, but sometimes interpreted as lying in the XZ plane because of the way feature orientation is defined. In the ISO 14649 representation, the origin of the profile, path, and feature may lie at different points. See 5.2.1.3 for a listing of specific differences for each feature type.

EXAMPLE Figure 37 shows a slot made up of a rounded u profile. In the ISO 10303 representation, the feature placement gives the origin of both the sweep path and the profile, with the profile in the XY plane and the sweep along the Z axis.

In the ISO 14649 representation, the feature placement location defines the top center of the slot, with the profile assumed to lie in the XZ plane, and swept along the Y axis. To find the origin of the profile, one must offset by the depth of the profile. Because of the change in axes, the direction of sweep is reversed, which means that the placement is also at the other end of the slot from the ISO 10303 representation.

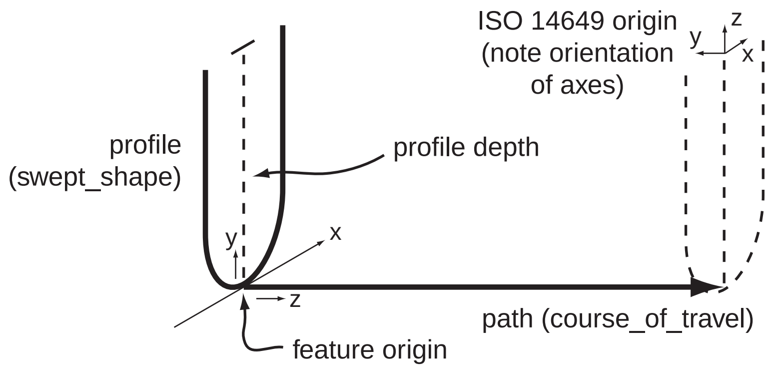

Figure 37 — Feature placement differences

5.2.1.2.2 Explicit shape by geometry

In the ISO 10303 integrated representation, feature shape can be described implicitly using a collection of characteristic parameters like depth, width, etc. This is done using the profile and path representation discussed in previous sections. It is also possible to describe feature shape using an explicit representation based on faces from a boundary representation.

ISO 14649 only supports implicit representation of feature shape. For harmonization, an explicit_representation parameter has been added to Manufacturing_feature (See 4.2.198) support the explicit representation approach.

Within the AIM instance data, an explicit shape description appears as face instances in the items set of a shape_representation. The characteristic parameters for the implicit shape description appear as measure_representation_item instances in the items set of a shape_representation_with_parameters. The characteristic parameters for profile and path instances are handled in the same way.

Both of these representations are associated with the feature through shape_definition_representation instances which refer to a property_definition. The property_definition refers to the shape_aspect instances representing the feature. Features that inherit from characterized_object (all except for transition features) use the product_definition_shape subtype instead. Local rules permit only one product_definition_shape instance per feature, so the instance is shared by both implicit and explicit representations, as well as the reference paths for any profile and path instances.

EXAMPLE 1 Figure 38 shows an instance diagram for a feature containing implicit and explicit representations. The instances describing the profile and path are not shown, but each is a shape_aspect subtype similar to the feature instance. The parameters describing each is held by a shape_representation_with_parameters instance and related to the profile or path using the same pattern of shape_definition_representation and product_definition_shape instances as shown below.

An alternate mapping path is given for the explicit_representation parameter that does not use the shape_representation or shape_definition_representation subtypes. This alternate should only be used for reading instance data that may have originated from an AP 224 process. The preferred mapping should be used for any new instance data. Examples 2 and 3 illustrate both mappings.

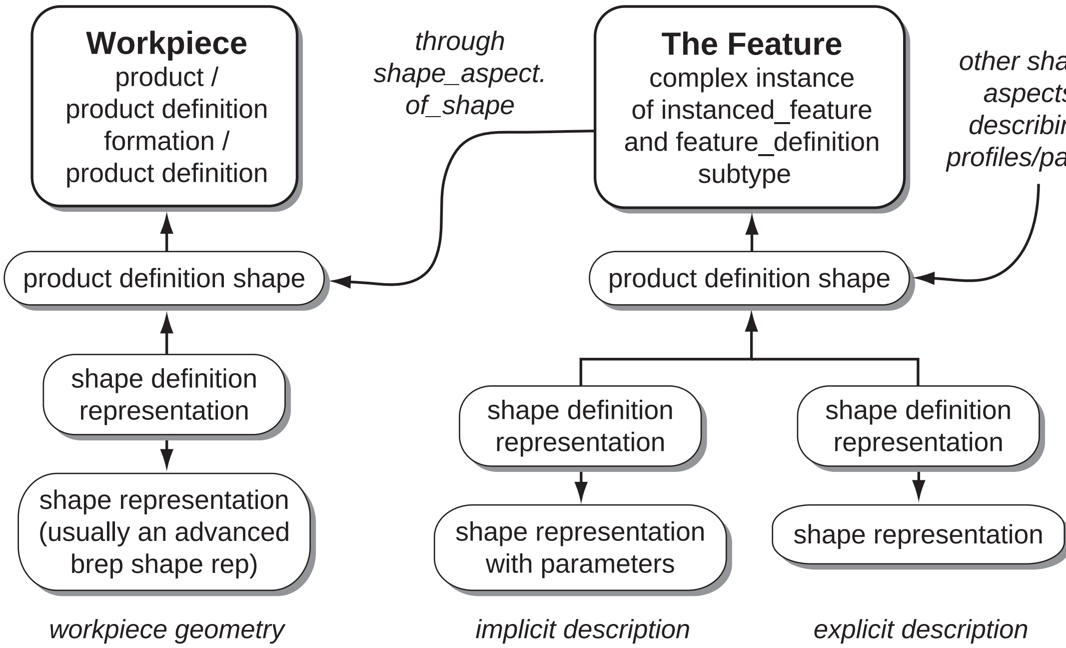

Figure 38 — AIM Instances for implicit and explicit feature shape

EXAMPLE 2 The preferred explicit_representation encoding. In the exchange file fragment below, #10 describes a round hole feature on a workpiece (#100, not shown). The explicit shape description is given by the advanced_face instances (#50, #60, #70) in a shape_representation (#40) with a name of "explicit feature shape", and is related to the feature through a shape_definition_representation (#30) and product_definition_shape (#20).

```
#10=(
  CHARACTERIZED_OBJECT('',$)
  FEATURE_DEFINITION()
  INSTANCED_FEATURE()
  ROUND_HOLE()
  SHAPE_ASPECT('',$,#100,.T.)
);

#20=PRODUCT_DEFINITION_SHAPE('','',#10);
#30=SHAPE_DEFINITION_REPRESENTATION(#20,#40);
#40=SHAPE_REPRESENTATION('explicit feature shape',(#50,#60,#70),#200);
#50=ADVANCED_FACE( ... );
#60=ADVANCED_FACE( ... );
#70=ADVANCED_FACE( ... );

#100= [ ... to workpiece ... ]
#200= [ ... to geometric context ... ]
```

EXAMPLE 3 The alternate explicit_representation encoding. The exchange file fragment below describes the same feature as the previous example, but the advanced_face instances are in an instance of the representation base type (#40) with no name, and is related to the feature through a property_definition_representation (#30) and property_definition (#20) with no name. Since other feature properties may have representations containing faces, there may be some ambiguity.


```
#10=(
  CHARACTERIZED_OBJECT('',$)
  FEATURE_DEFINITION()
  INSTANCED_FEATURE()
  ROUND_HOLE()
  SHAPE_ASPECT('',$,#100,.T.)
);

#20=PROPERTY_DEFINITION('',$,#10);
#30=PROPERTY_DEFINITION_REPRESENTATION(#20,#40);
#40=REPRESENTATION('',(#50,#60,#70),#200);
#50=ADVANCED_FACE( ... );
#60=ADVANCED_FACE( ... );
#70=ADVANCED_FACE( ... );

#100=PRODUCT_DEFINITION_SHAPE('','',#210);
#110=PRODUCT_DEFINITION( ... workpiece product definition ... );
#200= [ ... geometric context omitted ... ]
```

5.2.1.2.3 Features describing process or final form

A machining workplan is composed of machining workingsteps, each of which refers to a feature that defines a volume of space acted upon by that workingstep. This volume of space is empty of material when the operation is finished, subject to any finishing allowance or overcut modifiers in the associated operation parameters. Furthermore, the workingstep shall not remove any material outside of the feature volume.

NOTE The volume defined by the feature may not be the exact removal volume since some of the material may have already been removed by previous workingsteps. Consider roughing and finishing of a pocket. Both workingsteps would refer to the pocket. The roughing step removes the entire volume except for a finishing allowance, while the finishing step removes only a thin shell.

These features are tightly tied to the machining process defined by the workplan. If a manufacturing engineer creates an alternate workplan to make the same workpiece, the new workplan may use a completely different set of features.

EXAMPLE 1 Figure 39 shows a stairway-shaped workpiece and two different machining processes to produce that workpiece. The example on the right shows a depth-first machining workplan while the example on the left shows a breadth-first machining workplan. Both workplans produce the same result, but each calls out very different features.

AP 224 and other parts of ISO 10303 identify features on the final form of the workpiece that are not necessarily tied to a specific sequence of machining processes. These features are used as input to the process planning activity. The output of macro process-planning may be described as an AP 240 data set that will include these features but may identify additional intermediate features related to a particular process. This part of ISO 10303 describes the micro process-plan and is concerned with the features associated with a particular process, but it is desirable to link the features on the final form with the set of workingsteps that contribute to their manufacture. This associativity through the entire design to manufacturing path is useful for related downstream tasks, such as inspection, which could use the tracability to pinpoint critical areas of interest in the micro and macro process-plans.

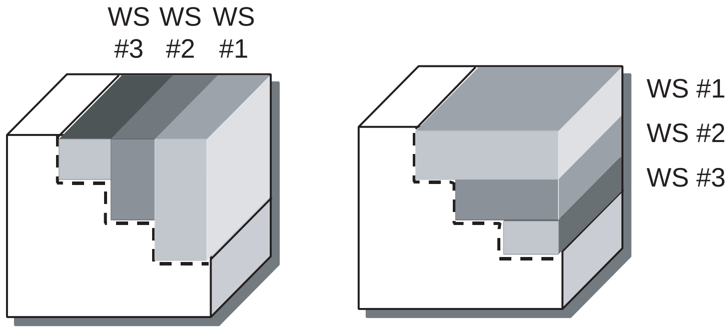

Figure 39 — Alternate machining processes and features

EXAMPLE 2 Figure 40 shows a workpiece whose final form contains a step and an open slot. The input to the process planner was an open slot and step, and for whatever reason, he decided to machine the slot first and the step second. The workplan contains two workingsteps, the first of which refers to a closed slot and the second of which refers to the step.

With the first workingstep, ISO 14649 is only concerned with the closed slot, and there is no way to trace back to the open slot feature on the final part. In the second workingstep, of course, the process and final form feature are the same thing.

A similar situation arises for "consumed" features such as entry holes, which are drilled to provide a starting point for an endmill to facilitate later machining operations. The entry hole feature never appears on the final workpiece because it is machined away by subsequent operations.

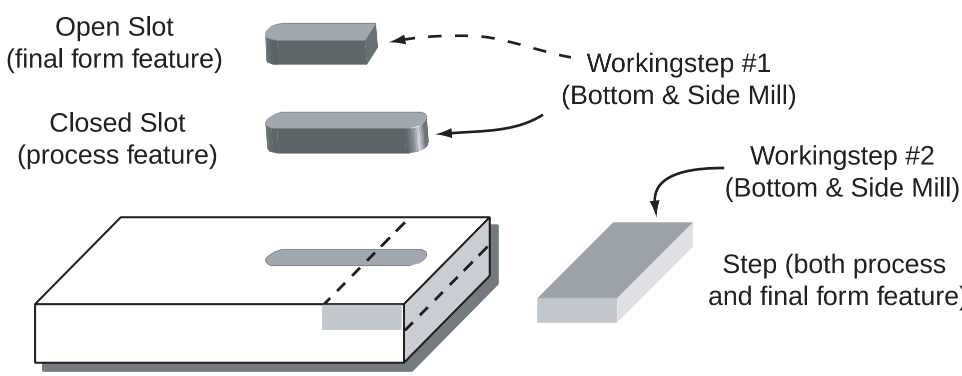

Figure 40 — Example of process and final form features

ISO 14649 links the machining_workingstep application object to the feature that defines its removal volume through the its_feature attribute. In this part of ISO 10303, an optional attribute called final_features has been added to machining_workingstep to support traceability back to the features used as input to the process planning activity.

If used, this attribute contains a set of one or more features visible on the final form of the workpiece that the process planner was targeting when he or she added the machining_workingstep to the machining workplan.

5.2.1.3 Manufacturing feature details by type

5.2.1.3.1 Planar face

In the ISO 10303 integrated representation, a planar face is represented by a linear profile swept along a linear path to form the plane that results after material has been removed. The origin of the feature lies on the plane. The depth of material removed is given by the removal_depth length parameter associated with the feature. Figure 41 illustrates the planar face parameters.

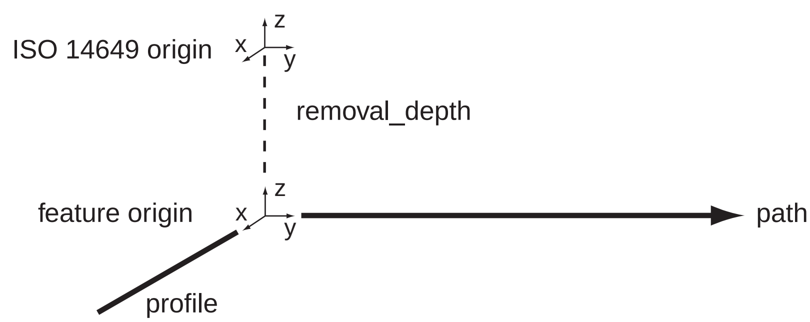

Figure 41 — Planar face origin and parameters

Two direction vectors are associated with the planar face. One is part of the linear path and defines the direction that the profile is swept sweeps along the path direction. This shall be aligned along the Y axis of the feature placement. The other direction vector is the removal_direction, which defines the surface normal of the plane. This shall be aligned with the Z axis of the feature placement. The profile is defined to extend along the X axis of the feature placement.

In ISO 14649, the placement of the feature is defined to lie at the top of the material to be removed. One must then geometrically evaluate the distance between this placement and the depth surface to determine the depth of material.

This part of ISO 10303 adds the removal_depth and removal_direction attributes to the planar_face application object. These attributes are present for harmonization with the other ISO 10303 parts and also simplify conversion between the two conventions.

To convert to the ISO 14649 representation, move the placement along the direction given by the removal_direction by the distance given by the removal_depth attribute.

5.2.1.3.2 Round hole

In the ISO 10303 integrated representation, a round hole is represented by a circular closed profile swept along a linear path. The diameter of the profile is the diameter of the circle and the length of the travel path is the depth of the hole. The Round_hole (See 4.2.295) bottom_at_path_end parameter determines whether the placement is at the bottom of the hole with the Z axis pointing up out of the material or at the top of the hole with the Z axis pointing down into the material. Figure 42 illustrates the handling of round hole placement.

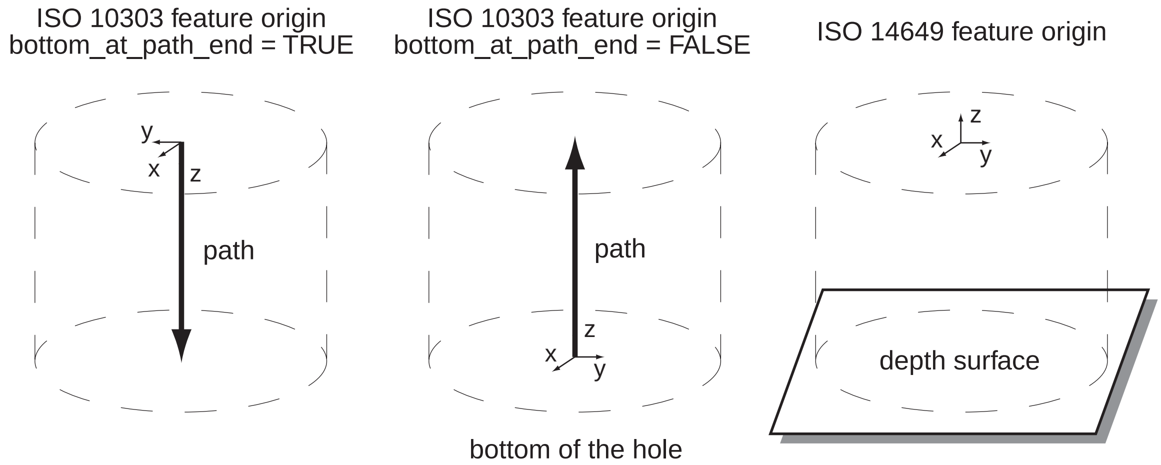

Figure 42 — Round hole origin

A direction vector is part of the linear path and defines the direction that the profile is swept. This shall be aligned along the Z axis of the feature placement. The profile lies in the XY plane of the feature placement with the feature placement at the center of the profile.

In ISO 14649, a hole does not use profile or path definitions. Instead, the diameter is an attribute of the Round_hole definition. To convey depth, the feature placement is assumed to be at the top of the hole with Z pointed away from the material. To determine the depth of the hole, one must geometrically evaluate the distance in the negative Z direction between this placement and the depth surface.

This part of ISO 10303 adds the course_of_travel attribute to the Round_hole application object. This attribute represents the travel path for harmonization with the other ISO 10303 parts and simplifies conversion between the two conventions.

To convert to the ISO 14649 representation, construct the depth surface if it is not present and adjust the feature placement. For a placement is at the top of the hole (bottom_at_path_end is TRUE), rotate the feature placement about the X axis so that Z => Y and Y => -Z. For a placement is at the bottom of the hole (bottom_at_path_end is FALSE), move the placement in the Z direction by the length of the course_of_travel path.

5.2.1.3.3 Pocket

In the ISO 10303 integrated representation, a pocket is represented by a profile swept along a linear path. Material is removed on the inside of the profile, and the length of the travel path is the depth of the pocket. The Pocket (See 4.2.255) bottom_at_path_end parameter determines whether the placement is at the bottom of the pocket with the Z axis pointing up out of the material or at the top of the pocket with the Z axis pointing down into the material. Figure 43 illustrates the handling of pocket placement.

A direction vector is part of the linear path and defines the direction that the profile is swept. This shall be aligned along the Z axis of the feature placement. The profile lies in the XY plane of the feature placement with the profile origin aligned with feature placement.

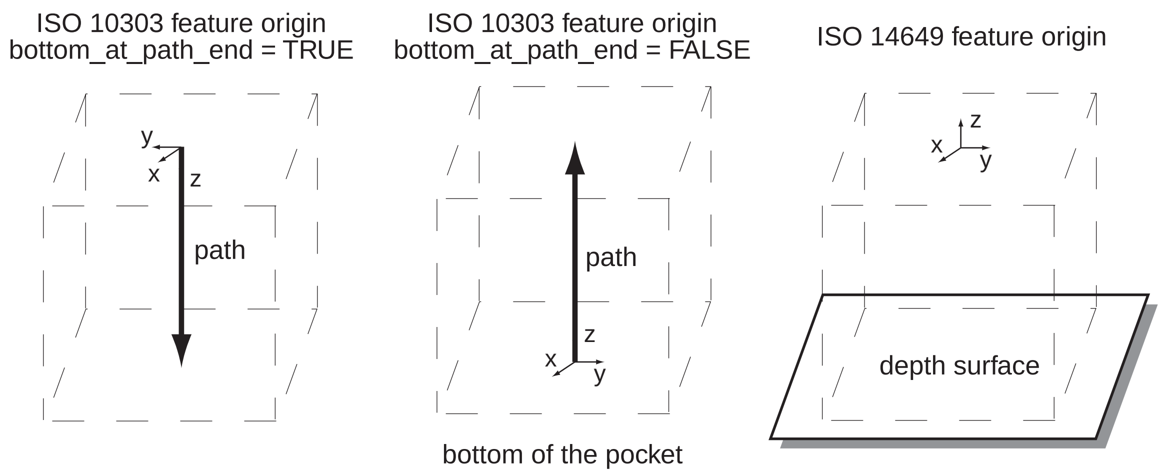

Figure 43 — Pocket origin

In ISO 14649, the pocket definitions have a profile but not a path attribute. In order to convey depth, the placement of the feature is assumed to be at the top of the feature with Z pointed away from the material. To determine the depth of the pocket, one must geometrically evaluate the distance in the negative Z direction between this placement and the depth surface.

This part of ISO 10303 adds the course_of_travel attribute to the Pocket application object. This attribute represents the travel path for harmonization with the other ISO 10303 parts and simplifies conversion between the two conventions.

To convert to the ISO 14649 representation, construct the depth surface if it is not present and adjust the feature placement. For a placement is at the top of the pocket (bottom_at_path_end is TRUE), rotate the feature placement about the X axis so that Z => Y and Y => -Z. For a placement is at the bottom of the pocket (bottom_at_path_end is FALSE), move the placement in the Z direction by the length of the course_of_travel path.

5.2.1.3.4 General outside and shape profile features

In the ISO 10303 integrated representation, a Profile_feature (General_outside_profile (See 4.2.145) or Shape_profile (See 4.2.306)) is represented by a profile swept along a linear path. Material is removed on the outside of the swept profile. The length of the travel path is the depth of the profile_feature.

For a general outside profile, the feature placement is at the bottom with the Z axis pointing up out of the material. Figure 44 illustrates the parameters associated with all Profile_features as well as the placement of a general outside profile.

Shape profiles have an additional floor condition that determines the feature placement. For shape profiles, the Profile_floor (See 4.2.264) start_or_end parameter determines whether the feature placement is at the bottom of the profile with the Z axis pointing up out of the material (start_or_end is FALSE), or at the top of the profile with the Z axis pointing down into the material (start_or_end is TRUE). Figure 45 illustrates the placement of a shape profile.

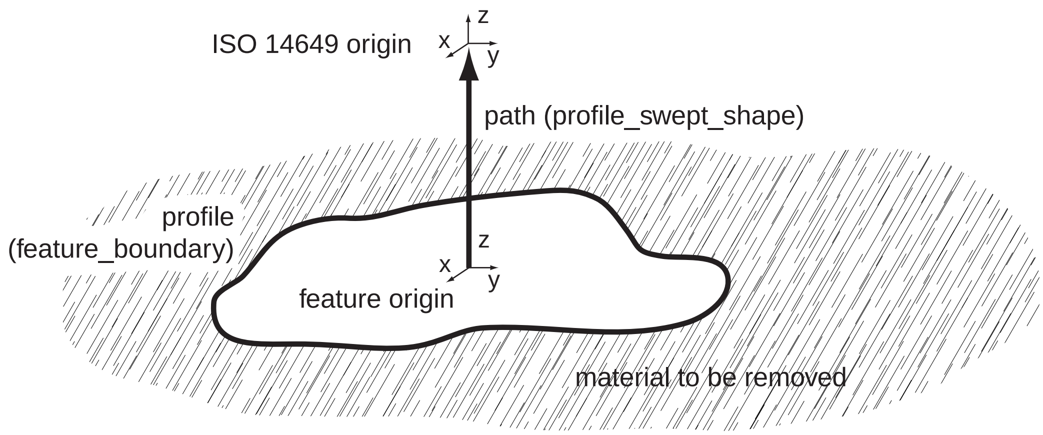

Figure 44 — General Outside profile origin

A direction vector is part of the linear path and defines the direction that the profile is swept. This shall be aligned along the Z axis of the feature placement. The swept profile lies in the XY plane of the feature placement with the origin of the swept profile aligned with feature placement.

In ISO 14649, the feature definitions have a profile and path, but use a different convention for placement. The placement of the feature is assumed to be at the top of the feature with Z pointed away from the material. To determine the depth of the Profile_feature, one must geometrically evaluate the distance in the negative Z direction between this placement and the depth surface. However, the depth is also present in the length of the travel path, given by the profile_swept_shape attribute.

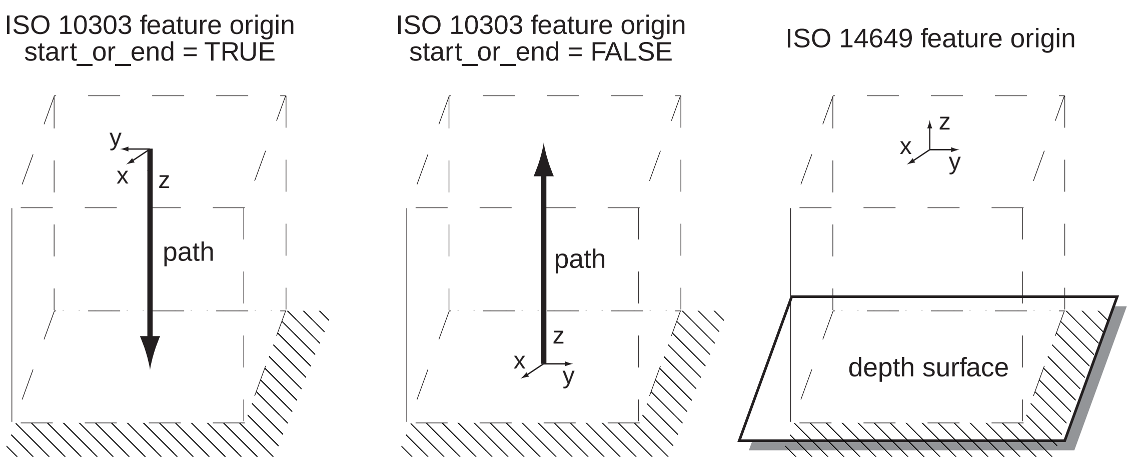

Figure 45 — Shape profile origin

To convert a General_outside_profile to the ISO 14649 representation, construct the depth surface if it is not present and move the placement in the Z direction by the length of the profile_swept_shape path.

To convert a Shape_profile to the ISO 14649 representation, construct the depth surface if it is not present and adjust the feature placement. For a placement is at the top of the Shape_profile (start_or_end is TRUE), rotate the feature placement about the X axis so that Z => Y and Y => -Z. For a placement is at the bottom of the Shape_profile (start_or_end is FALSE), move the placement in the Z direction by the length of the profile_swept_shape path.

5.2.1.3.5 Slot

In the ISO 10303 integrated representation, a slot feature is represented by an open profile swept along a travel path. Material is removed on the inside of the swept profile. The depth of the open profile gives the depth of the slot feature. The feature placement is at the bottom of the feature with the Z axis pointing along the travel path. Figure 46 illustrates the slot parameters.

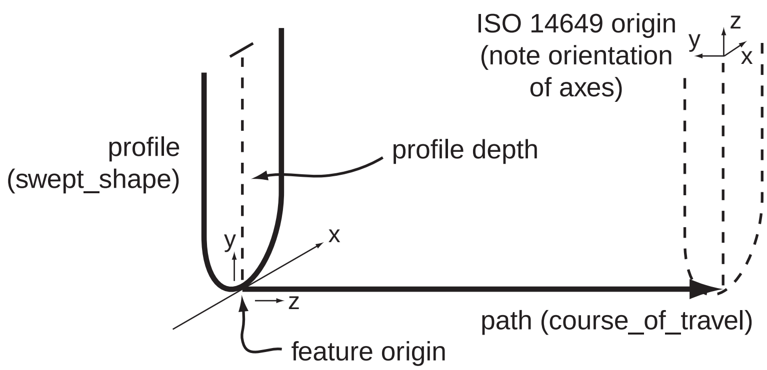

Figure 46 — Slot origin and orientation

A direction vector is part of the travel path and defines the direction that the profile is swept. This shall be aligned along the Z axis of the feature placement. The profile lies in the XY plane of the feature placement with the profile origin aligned with feature placement at the bottom of the slot feature.

In ISO 14649, the slot definition has a profile and path, but uses a different convention for the location and orientation of the feature placement. The placement is defined at the top of the material with the Z axis pointing up and the travel path is defined to extend along the Y axis. To determine the depth of the slot, one must geometrically evaluate the distance in the negative Z direction between this placement and the depth surface.

This part of ISO 10303 adds depth attributes to the Square_u_profile and Rounded_u_profile application objects. These attributes represent the depth of the profiles for harmonization with the other ISO 10303 parts and to simplify conversion between the two conventions. The depths of other open profile types can be computed from existing parameters.

To convert to the ISO 14649 representation, rotate the feature placement about the X axis so that Z => Y and Y => -Z. Then move the placement along the length of the course_of_travel and depth of the swept profile.

Change the direction on the course_of_travel path so that it points along the new Y axis rather than the Z axis. The origin of the open profile is defined at the bottom of the profile, so it can no longer share the placement of the feature. Assign it a separate placement offset by the profile depth. Finally, construct the depth surface if it is not present.

5.2.1.3.6 Step

In the ISO 10303 integrated representation, a step feature is represented by a vee profile swept along a linear path. Material is removed on the inside of the vee profile. The length of one arm of the vee profile gives the depth of the step feature. The length of the other arm gives the width of the step feature. The feature placement is at the point of the vee profile with the Z axis pointing along the travel path. Figure 47 illustrates the step parameters.

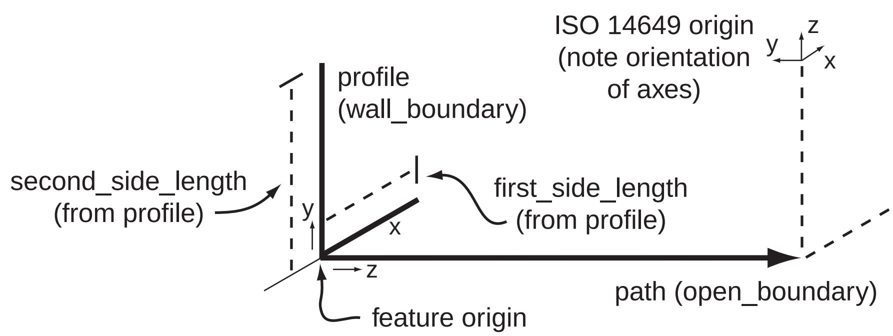

Figure 47 — Step origin and orientation

A direction vector is part of the travel path and defines the direction that the profile is swept. This shall be aligned along the Z axis of the feature placement. The profile lies in the XY plane of the feature placement with the profile origin aligned with feature placement at the point of the vee profile.

In ISO 14649, the step definition has a profile and path, but uses a different convention for the location and orientation of the feature placement. The placement is defined at the top of the material with the Z axis pointing up and the travel path is defined to extend along the Y axis. To determine the depth of the step, one must geometrically evaluate the distance in the negative Z direction between this placement and the depth surface.

This part of ISO 10303 adds the first_side_length and second_side_length attributes to the Vee_profile application object. These attributes represent the length of each arm of the vee for harmonization with the other ISO 10303 parts and to simplify conversion between the two conventions.

To convert to the ISO 14649 representation, rotate the feature placement about the X axis so that Z => Y and Y => -Z. Then move the placement along the length of the course_of_travel and the second_side_length arm of the vee profile.

Change the direction on the course_of_travel path so that it points along the new Y axis rather than the Z axis. The origin of the vee_profile is defined as the point of the vee, so it can no longer share the placement of the feature. Assign it a separate placement offset by the second_side_length. Finally, construct the depth surface if it is not present.

5.2.1.3.7 Transition Features

In the ISO 10303 application protocols, chamfers and edge rounds are defined as a relationship between two sets of geometric elements on the boundary representation of the workpiece. Each transition feature has a first_face_shape and a second_face_shape parameter. Each contains a set of face_surface or oriented_face instances taken from the brep description of the workpiece shape. In addition, several characteristic parameters are associated with each feature type. Chamfers have an offset and face angle, while edge rounds have two offsets and a radius to describe the transition surface.

ISO 14649 calls out the same characteristic parameters, but defines chamfers and edge rounds as a relationship between two features. Each transition feature has a first_feature and a second_feature parameter referring to the features on either side of the transition.

NOTE 1 Why were two approaches used? Historically, the ISO 10303 approach was defined first, but this requires that brep geometry be present in order to describe transition features. From the ISO 14649 perspective, geometry is optional and may be omitted, so it made sense to define transition features as a relationship between two features instead.

This part of ISO 10303 extends the Chamfer and Edge_round application objects to support the use of both approaches. This was done by adding chamfer_face, first_face_shape and second_face_shape attributes to Chamfer and adding edge_round_face, first_face_shape and second_face_shape attributes to Edge_round. These attributes are optional and represent the faces associated with the transition features for harmonization with the other ISO 10303 parts. Figure 48 shows both approaches for transition features.

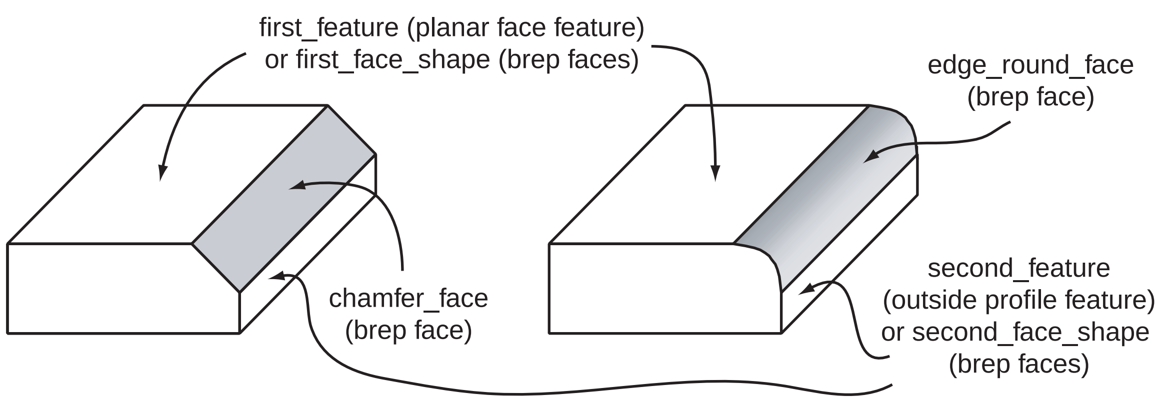

Figure 48 — Transition features relating faces or features

The chamfer_requires_faces_or_features and edge_round_requires_faces_or_features rules have been added to require transition features to use at least one of the approaches.

NOTE 2 The AIC 522 rules originally required chamfers and edge rounds to have associated sets of faces. In order to accommodate either style, these rules were changed from required ("exactly one") to optional ("at most one") in AIC 522 Edition 2. APs that wish to permit only the face style can add a global rule to strengthen these constraints if desired.

As originally mapped in AP 224, Edge_round has three face sets, each mapped to a face_shape_representation. They are attached through the common product_definition_shape instance, but the mapping calls for the edge_round_face to be associated via a shape_definition_representation (and thus is also the feature's explicit representation) while the first and second_face_shapes are called to be associated only by plain property_definition_representation instances.

5.2.1.4 Measurement concepts

5.2.1.4.1 Measurement values and units

In the ISO 10303 integrated representation, measurements such as length, angle, and time are represented as instances of the measure_with_unit type. A subtype is used when one exists for the particular type of measure value. The following sections discuss measure_with_unit subtypes in greater detail.

Within each instance, the value_component attribute holds the numeric value of a measure and the unit_component attribute holds a reference to an instance of named_unit or derived_unit defining the unit of measurement for the value. In this way, each numeric value is accompanied by a unit to provide context. In general, only one instance of each unit is needed, as a single unit instance may be shared by many measure_with_unit instances.

Measurements most often appear in the items set of the representation of an action_property, resource_property, or property_definition. The items set must refer to representation_item instances, so measurements are encoded as a measure_representation_item, which is a subtype of measure_with_unit and representation_item. The measure_with_unit subtypes for specific types of values are still used by creating a complex entity instance with measure_representation_item.

EXAMPLE 1 No value-specific subtype of measure_with_unit exists for count measurements, so a count value is simply encoded as an instance of measure_representation_item. In the exchange file fragment below, #10 is an instance of this type describing a count of 5. The unit for the value is encoded by #20, which is a context_dependent_unit with a name of "count".

```
#10=MEASURE_REPRESENTATION_ITEM('', COUNT_MEASURE(5.),#20);
#20=CONTEXT_DEPENDENT_UNIT(#30,'count');
#30=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);
```

EXAMPLE 2 A length measurement would be encoded as a complex instance of length_measure_with_unit and measure_representation_item. In the exchange file fragment below, #10 is a complex instance of these types describing a value of 22.5mm. The millimetre unit is encoded by #20, which is also a complex instance of length_unit and si_unit. In general, each value-specific subtype of measure_with_unit has a corresponding subtypes of named_unit that is used in a complex instance with either si_unit or conversion_based_unit for units describing those types of values.

```
#40=(
  LENGTH_MEASURE_WITH_UNIT()
  MEASURE_REPRESENTATION_ITEM()
  MEASURE_WITH_UNIT(LENGTH_MEASURE(22.5),#50)
  REPRESENTATION_ITEM('')
);

#50=(
```



```
    LENGTH_UNIT()
    NAMED_UNIT(*)
    SI_UNIT(.MILLI.,.METRE.)
  );
```

In ISO 14649 all basic measures are defined using specific, fixed units (all lengths are expressed in millimeters, all plane angles are expressed in degrees), so units do not appear explicitly in the data sets. ISO 14649 is unable to transmit measurements defined by other units without first numerically converting the values to the specified units.

To convert to the ISO 14649 representation, convert the numeric value of each measure from the unit description provided with the measure to the default unit specified by ISO 14649.

5.2.1.4.2 Tolerance qualifications

In the ISO 10303 integrated representation, qualifications such as plus/minus bounds, significant digits, limits and fits, or maximum/minimum may be applied to measurement values. This is encoded by creating a complex entity instance of qualified_representation_item, measure_representation_item, and, if one exists, a value-specific measure_with_unit subtype. The qualified_representation_item adds a set of value qualifiers to the instance that describe the conditions placed on the value.

EXAMPLE 1 A length measurement with a plus/minus tolerance is encoded as a complex instance of length_measure_with_unit, measure_representation_item, and qualified_representation_item. In the exchange file fragment below, #10 describes a value of 80mm plus or minus 0.1, with 5 significant digits of precision. The upper and lower bounds (#20 and #30) are encoded using standard_uncertainty instances, while the digits of precision (#40) are encoded using a a precision_qualifier.

```
  #10=(
    LENGTH_MEASURE_WITH_UNIT()
    MEASURE_REPRESENTATION_ITEM()
    MEASURE_WITH_UNIT(LENGTH_MEASURE(80.),#50)
    QUALIFIED_REPRESENTATION_ITEM((#20,#30,#40))
    REPRESENTATION_ITEM('')
  );
  #20=STANDARD_UNCERTAINTY('upper limit','',0.1);
  #30=STANDARD_UNCERTAINTY('lower limit','',0.1);
  #40=PRECISION_QUALIFIER(5);

  #50=(
    LENGTH_UNIT()
    NAMED_UNIT(*)
    SI_UNIT(.MILLI.,.METRE.)
  );
```

EXAMPLE 2 A length measurement with a value limitation is encoded in the same way, but a type_qualifier is used to indicate the type of limitation. In the exchange file fragment below, #10 describes a maximum value of 80mm.

```
  #10=(
    LENGTH_MEASURE_WITH_UNIT()
    MEASURE_REPRESENTATION_ITEM()
    MEASURE_WITH_UNIT(LENGTH_MEASURE(80.),#30)
    QUALIFIED_REPRESENTATION_ITEM((#20))
    REPRESENTATION_ITEM('')
```



```
);
#20=TYPE_QUALIFIER('maximum');

#30=(
  LENGTH_UNIT()
  NAMED_UNIT(*)
  SI_UNIT(.MILLI.,.METRE.)
);
```

NOTE The qualified_representation_item encoding is used for all measure types, including lengths and plane angles, with one exception. When a length or plane angle measure is appears as the dimension_value of a Geometric_dimension (See 4.2.155), a plus/minus or limits and fits qualification is encoded differently for harmonization reasons. See the mapping specifications for Plus_minus_value and Limits_and_fits for details.

5.2.1.4.3 Angle (plane) measure

A plane angle measure is encoded using an instance of plane_angle_measure_with_unit. Local rules on this type require that the unit used to describe the measure be a plane_angle_unit, so a complex entity instance with si_unit or a conversion_based_unit is used.

EXAMPLE A plane angle measurement used in a representation would be encoded as a complex instance of plane_angle_measure_with_unit and measure_representation_item. In the exchange file fragment below, #10 describes a value of 90 degrees.

```
#10=(
  MEASURE_REPRESENTATION_ITEM()
  MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(90.),#30)
  PLANE_ANGLE_MEASURE_WITH_UNIT()
  REPRESENTATION_ITEM('')
);
```

The degree unit is encoded by #30, which is a complex instance of plane_angle_unit and conversion_based_unit that defines one degree as PI/180 radians. The name attribute has a value of "degree", which is not required, but is good form. The radian unit is encoded by #20, which is a complex instance of plane_angle_unit and si_unit.

```
#20=(
  NAMED_UNIT(*)
  PLANE_ANGLE_UNIT()
  SI_UNIT($,.RADIAN.)
);

#30=(
  CONVERSION_BASED_UNIT('degree',#50)
  NAMED_UNIT(#40)
  PLANE_ANGLE_UNIT()
);
#40=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);
#50=PLANE_ANGLE_MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(0.01745329252),#20);
```

5.2.1.4.4 Angle (solid) measure

A solid angle measure is encoded using an instance of solid_angle_measure_with_unit. Local rules on this type require that the unit used to describe the measure be a solid_angle_unit, so a complex entity instance with si_unit or a conversion_based_unit is used.

EXAMPLE A solid angle measurement used in a representation would be encoded as a complex instance of solid_angle_measure_with_unit and measure_representation_item. In the exchange file fragment below, #10 describes a value of 0.5 steradian.

```
#10=(
  MEASURE_REPRESENTATION_ITEM()
  MEASURE_WITH_UNIT(SOLID_ANGLE_MEASURE(0.5),#20)
  REPRESENTATION_ITEM('')
  SOLID_ANGLE_MEASURE_WITH_UNIT()
);
```

The steradian unit is encoded by #20, which is a complex instance of solid_angle_unit and si_unit. Conversion-based solid angle units, such as square degrees, are possible but not used in practice.

```
#20=(
  NAMED_UNIT(*)
  SI_UNIT($,.STERADIAN.)
  SOLID_ANGLE_UNIT()
);
```

5.2.1.4.5 Area measure

An area measure is encoded using an instance of measure_with_unit (or measure_representation_item when used in a representation). A derived_unit consisting of a length unit squared is used to describe the measure.

NOTE ISO 10303-41 defines value-specific subtypes area_measure_with_unit and area_unit, but the use of these are deprecated because they are not usable as defined. The unit for an area measure must be described as a derived_unit, but a complex instance of area_unit and derived_unit is not permitted by the EXPRESS definition.

EXAMPLE An area measurement used in a representation would be encoded as a measure_representation_item. In the exchange file fragment below, #10 describes a value of 10 square millimetres.

```
#10=MEASURE_REPRESENTATION_ITEM('',AREA_MEASURE(10.),#20);
```

The square millimetre unit is encoded by #20, which is a derived_unit based on one derived_unit_element which references a millimetre unit (#50) with an exponent of 2. The derived_unit has an associated name_attribute instance with a value of "square millimetre", which is not required, but is good form.

```
#20=DERIVED_UNIT((#30));
#30=DERIVED_UNIT_ELEMENT(#50,2.);
#40=NAME_ATTRIBUTE('square millimetre',#20);
#50=(
  LENGTH_UNIT()
  NAMED_UNIT(*)
  SI_UNIT(.MILLI.,.METRE.)
);
```


5.2.1.4.6 Count measures

A count measure is encoded using an instance of measure_with_unit (or measure_representation_item when used in a representation). A context_dependent_unit with a name of "count" is used to describe the measure.

EXAMPLE A count measurement used in a representation would be encoded as a measure_representation_item. In the exchange file fragment below, #10 describes a count of 5. The count unit is encoded by #20.

```
#10=MEASURE_WITH_UNIT(COUNT_MEASURE(5.),#20);
#20=CONTEXT_DEPENDENT_UNIT(#30,'count');
#30=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);
```

5.2.1.4.7 Length measure

A length measure is encoded using an instance of length_measure_with_unit. Local rules on this type require that the unit used to describe the measure be a length_unit, so a complex entity instance with si_unit or a conversion_based_unit is used.

EXAMPLE A length measurement used in a representation would be encoded as a complex instance of length_measure_with_unit and measure_representation_item. In the exchange file fragment below, #10 describes a value of 12 inches.

```
#10=(
  LENGTH_MEASURE_WITH_UNIT()
  MEASURE_REPRESENTATION_ITEM()
  MEASURE_WITH_UNIT(TIME_MEASURE(12.),#30)
  REPRESENTATION_ITEM('')
);
```

The inch unit is encoded by #30, which is a complex instance of length_unit and conversion_based_unit that defines one inch as 25.4 millimetres. The name attribute has a value of "inch", which is not required, but is good form. The millimetre unit is encoded by #20, which is a complex instance of length_unit and si_unit.

```
#20=(
  LENGTH_UNIT()
  NAMED_UNIT(*)
  SI_UNIT(.MILLI.,.METRE.)
);

#30=(
  CONVERSION_BASED_UNIT('inch',#50)
  LENGTH_UNIT()
  NAMED_UNIT(#40)
);
#40=DIMENSIONAL_EXPONENTS(1.,0.,0.,0.,0.,0.,0.);
#50=LENGTH_MEASURE_WITH_UNIT(LENGTH_MEASURE(25.4),#20);
```


5.2.1.4.8 Mass measure

A mass measure is encoded using an instance of mass_measure_with_unit. Local rules on this type require that the unit used to describe the measure be a mass_unit, so a complex entity instance with si_unit or a conversion_based_unit is used.

EXAMPLE A mass measurement used in a representation would be encoded as a complex instance of mass_measure_with_unit and measure_representation_item. In the exchange file fragment below, #10 describes a mass of 2 kilograms. The kilogram unit is encoded by #20, which is a complex instance of mass_unit and si_unit.

```
#10=(
  MASS_MEASURE_WITH_UNIT()
  MEASURE_REPRESENTATION_ITEM()
  MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(2.),#20)
  REPRESENTATION_ITEM('')
);

#20=(
  MASS_UNIT()
  NAMED_UNIT(*)
  SI_UNIT(.KILO.,.GRAM.)
);
```

5.2.1.4.9 Pressure measure

A pressure measure is encoded using an instance of measure_with_unit (or measure_representation_item when used in a representation). The value_component of the instance is a numeric_measure. A si_unit or a conversion_based_unit is used to describe the measure.

EXAMPLE A pressure measurement used in a representation would be encoded as a measure_representation_item. In the exchange file fragment below, #10 describes a value of 15 kilopascals (kPa) and #20 describes a value of 14 pounds per square inch (psi)

```
#10=MEASURE_REPRESENTATION_ITEM('',NUMERIC_MEASURE(20.),#30);
#20=MEASURE_REPRESENTATION_ITEM('',NUMERIC_MEASURE(14.),#40);
```

The kPa unit is encoded by #30, which is a simple entity instance of si_unit. The psi unit is encoded as a simple entity instance of conversion_based_unit that defines one psi as 6.894757 kilopascals. The name attribute has a value of "pound/square inch", which is not required, but is good form. Note the dimensional exponents in #50 as pressure requires dimensions of mass/(length * time squared).

```
#30=SI_UNIT(*,.KILO.,.PASCAL.);
#40=CONVERSION_BASED_UNIT(#50,'pound/square inch',#60);
#50=DIMENSIONAL_EXPONENTS(-1.,1.,-2.,0.,0.,0.,0.);
#60=MEASURE_WITH_UNIT(NUMERIC_MEASURE(6.894757),#20);
```

5.2.1.4.10 Ratio and percentage measures

A ratio measure is encoded using an instance of ratio_measure_with_unit. Local rules on this type require that the unit used to describe the measure be a ratio_unit. Percentage measures are represented as an instance of ratio_measure_with_unit with a numeric value of 0 representing 0/100 or 0% and a numeric value of 1 representing 100/100 or 100%.

EXAMPLE A ratio measurement used in a representation would be encoded as a complex instance of ratio_measure_with_unit and measure_representation_item. In the exchange file fragment below, #10 describes a value of 25% (0.25). The ratio unit is encoded by #20.

```
#10=(
  MEASURE_REPRESENTATION_ITEM()
  MEASURE_WITH_UNIT(RATIO_MEASURE(0.25),#20)
  RATIO_MEASURE_WITH_UNIT()
  REPRESENTATION_ITEM('')
);

#20=RATIO_UNIT(#30);
#30=DIMENSIONAL_EXPONENTS (0.,0.,0.,0.,0.,0.,0.);
```

5.2.1.4.11 Speed (linear) measure

A linear speed measure is encoded using an instance of measure_with_unit (or measure_representation_item when used in a representation). The value_component of the instance is a numeric_measure. A derived_unit consisting of a length unit per time unit is used to describe the measure.

EXAMPLE A linear speed measurement used in a representation would be encoded as a measure_representation_item. In the exchange file fragment below, #10 describes a value of 10 millimetres per second.

```
#10=MEASURE_REPRESENTATION_ITEM('',NUMERIC_MEASURE(10.),#20);
```

The mm/s unit is encoded by #20, which is a derived_unit based on a derived_unit_element which references a millimetre unit (#60) with an exponent of 1, and a derived_unit_element which references a second unit (#70) with an exponent of -1. The derived_unit has an associated name_attribute instance with a value of "millimetre/second", which is not required, but is good form.

To describe other velocity units, like meter per second or inch per minute, replace the length unit (#60) and the time unit (#70) with the appropriate meter, inch, or minute unit descriptions.

```
#20=DERIVED_UNIT((#30,#40));
#30=DERIVED_UNIT_ELEMENT(#60,1.);
#40=DERIVED_UNIT_ELEMENT(#70,-1.);
#50=NAME_ATTRIBUTE('millimetre/second',#20);

#60=(
  LENGTH_UNIT()
  NAMED_UNIT(*)
  SI_UNIT(.MILLI.,.METRE.)
);

#70=(
  NAMED_UNIT(*)
  SI_UNIT($,.SECOND.)
  TIME_UNIT()
);
```


5.2.1.4.12 Speed (rotational) measure

A rotational speed measure is encoded using an instance of measure_with_unit (or measure_representation_item when used in a representation). The value_component of the instance is a numeric_measure. A derived_unit consisting of an inverse time unit is used to describe the measure.

EXAMPLE A rotational speed measurement used in a representation would be encoded as a measure_representation_item. In the exchange file fragment below, #10 describes a value of 5 revolutions per second.

```
#10=MEASURE_REPRESENTATION_ITEM('',NUMERIC_MEASURE(5.),#20);
```

The revolutions per second (1/s) unit is encoded by #20, which is a derived_unit based on a derived_unit_element which references a second unit (#70) with an exponent of -1. The derived_unit has an associated name_attribute instance with a value of "revolution/second", which is not required, but is good form.

To describe other rotational speed units, like revolutions per minute, replace the time unit (#50) with the appropriate minute unit description.

```
#20=DERIVED_UNIT((#30));
#30=DERIVED_UNIT_ELEMENT(#50,-1.);
#40=NAME_ATTRIBUTE('revolution/second',#20);

#50=(
  NAMED_UNIT(*)
  SI_UNIT($,.SECOND.)
  TIME_UNIT()
);
```

NOTE While the hertz si_unit is mathematically equivalent to the 1/s example above, derived_unit parallels the description of linear speed units and should be used for clarity.

5.2.1.4.13 Time measure

A time measure is encoded using an instance of time_measure_with_unit. Local rules on this type require that the unit used to describe the measure be a time_unit, so a complex entity instance with si_unit or a conversion_based_unit is used.

EXAMPLE A time measurement used in a representation would be encoded as a complex instance of time_measure_with_unit and measure_representation_item. In the exchange file fragment below, #10 describes a value of 5 minutes.

```
#10=(
  MEASURE_REPRESENTATION_ITEM()
  MEASURE_WITH_UNIT(TIME_MEASURE(5.),#30)
  REPRESENTATION_ITEM('')
  TIME_MEASURE_WITH_UNIT()
);
```

The minute unit is encoded by #30, which is a complex instance of time_unit and conversion_based_unit that defines one minute as 60 seconds. The name attribute has a value of "minute", which is not required, but is good form. The second unit is encoded by #20, which is a complex instance of time_unit and si_unit.


```
#20=(
  NAMED_UNIT(*)
  SI_UNIT($,.SECOND.)
  TIME_UNIT()
);

#30=(
  CONVERSION_BASED_UNIT('minute',#50)
  NAMED_UNIT(#40)
  TIME_UNIT()
);
#40=DIMENSIONAL_EXPONENTS(0.,0.,1.,0.,0.,0.,0.);
#50=TIME_MEASURE_WITH_UNIT(TIME_MEASURE(60.),#20);
```

5.2.1.4.14 Volume measure

A volume measure is encoded using an instance of measure_with_unit (or measure_representation_item when used in a representation). A derived_unit consisting of a length unit cubed is used to describe the measure.

NOTE ISO 10303-41 defines value-specific subtypes volume_measure_with_unit and volume_unit, but the use of these are deprecated because they are not usable as defined. The unit for an volume measure must be described as a derived_unit, but a complex instance of volume_unit and derived_unit is not permitted by the EXPRESS definition.

EXAMPLE A volume measurement used in a representation would be encoded as a measure_representation_item. In the exchange file fragment below, #10 describes a value of 20 cubic millimetres.

```
#10=MEASURE_REPRESENTATION_ITEM('',VOLUME_MEASURE(20.),#20);
```

The cubic millimetre unit is encoded by #20, which is a derived_unit based on a derived_unit_element which references a millimetre unit (#50) with an exponent of 3. The derived_unit has an associated name_attribute instance with a value of "cubic millimetre", which is not required, but is good form.

```
#20=DERIVED_UNIT((#30));
#30=DERIVED_UNIT_ELEMENT(#50,3.);
#40=NAME_ATTRIBUTE('cubic millimetre',#20);
#50=(
  LENGTH_UNIT()
  NAMED_UNIT(*)
  SI_UNIT(.MILLI.,.METRE.)
);
```

5.2.1.4.15 Feed, spindle, and dwell property representations

A number of properties on the technology and machining strategy application objects describe feedrate, spindle speed, or dwell time values. Several alternative types of measure value can be used to describe each of these values.

EXAMPLE 1 A feedrate could be described either as a linear speed (length per unit of time), or as a length per tooth of the tool being used.

The ISO 14649 documents use different modeling styles to describe these alternatives. The ISO 10303-11 milling model frequently uses different attributes for each alternative with a local rule forbidding the use of more than one at a time. The ISO 10303-12 turning model frequently uses a SELECT type to model the alternatives.

EXAMPLE 2 In ISO 10303-11, Milling_technology "spindle" and "cutspeed" are separate attributes that use different techniques (constant angular speed versus constant linear speed at the cutting point) to describe the machine tool spindle rotation. A local rule on Milling_technology prevents the use of both. ISO 10303-12 uses one attribute called "spindle_speed" defined as a Speed_select SELECT type that models the same two different ways to describe spindle rotation.

In the integrated representation, all alternative description techniques for a particular kind of value (feed speed, spindle speed, or dwell time) are encoded using a single representation subtype.

These representation subtypes identifies the technique being used by with a particular value of the representation "description" attribute. Within the representation are representation items that give the numeric measure values. The uses and allowable combinations are described by the mapping specifications and local rules on the EXPRESS definition.

5.2.1.4.15.1 Feed speeds

Feed speeds are encoded using machining_feed_speed_representation (See 5.2.3.1.45). This representation subtype handles four different ways of describing a feedrate:

— a linear speed, as used by the Technology "feedrate", and Feed_velocity_type application objects;

— a length per tooth of a tool, as used by the Milling_technology "feedrate_per_tooth" application object;

— a length per spindle revolution, as used by the Turning_technology "feedrate_per_revolution", and Feed_per_rev_type application objects;

— a relative speed, expressed as a multiplier applied to a separate feed speed, as used by the Drilling_type_strategy "reduced_feed_at_start" and "reduced_feed_at_end", Drilling_type_operation "feed_on_retract", Turning_machining_strategy "variable_feedrate", and Contour_turning "variable_stepover_feed" application objects.

5.2.1.4.15.2 Spindle speeds

Spindle speeds are encoded using machining_spindle_speed_representation (See 5.2.3.1.67). This representation subtype handles three different ways of describing a spindle speed:

— a rotational speed, as used by the Milling_technology "spindle", and Const_spindle_speed application objects;

— a linear speed measured at the contact point between tool and surface, as used by the Milling_technology "cutspeed", and Const_cutting_speed application objects;

— a relative speed, expressed as a multiplier applied to a separate spindle speed, as used by the Drilling_type_strategy "reduced_cut_at_start" and "reduced_feed_at_end" application object.

ISO 14649 defines the direction of spindle rotation to be counter-clockwise when described as a positive rotational speed value, and clockwise when described as a negative rotational speed value. However, ISO 14649-11 is silent on the direction of rotation when spindle speed is described as a linear speed value.

In this part of ISO 10303, the same sign convention shall be used for spindle speeds described as either rotational or linear speeds: positive linear speed describes counter-clockwise spindle rotation and negative linear speed describes clockwise spindle rotation. The rotational direction is as observed looking from spindle to workpiece. A zero rotational or linear speed shall indicate a stopped spindle.

NOTE Many cutting tools require clockwise motion so spindle speeds will typically be negative.

5.2.1.4.15.3 Dwell times

Dwell times are encoded using machining_dwell_time_representation (See 5.2.3.1.40). This representation subtype handles two different ways of describing a dwell time:

— a time measure, as used by the Feedstop "dwell", Multistep_drilling "dwell_time_step", Drilling_type_operation "dwell_time_bottom", and the Dwell_time application objects;

— a count of spindle revolutions, as used by the Dwell_revolution application object.

5.2.1.4.16 Boolean and symbolic property representations

A number of application object properties describe boolean or enumeration symbolic values. Each symbolic value is encoded using an instance of descriptive_representation_item. The description field of the instance holds the value.

Since the range of symbolic values is fixed, it is recommended to instantiate this entity exactly once for each unique symbolic value that appears in the data set. Properties that have the same symbolic value can share either the descriptive_representation_item or the enclosing representation.

EXAMPLE In the exchange file fragment below, #10 and #20 describe two Milling_machine_functions application objects, each with chip removal on and coolant on. Within the ARM, chip removal and coolant are both described as boolean parameters. In the integrated representation, thse are represented as symbolic values ‘chip removal on’, ‘chip removal off’, ‘coolant on’, and ‘coolant off’.

Only one descriptive_representation_item instance is needed to describe the ‘chip removal on’ value (#30), and it can be shared by all properties, along with its enclosing representation (#31). The instance describing ‘coolant on’ (#40) and its enclosing representation (#41) is shared as well.

```
#10=MACHINING_FUNCTIONS('functions one','milling','','');
#11=ACTION_PROPERTY('chip removal','',#10);
#12=ACTION_PROPERTY_REPRESENTATION('','',#11,#30);
#13=ACTION_PROPERTY('coolant','',#10);
#14=ACTION_PROPERTY_REPRESENTATION('','',#13,#40);
```



```
#20=MACHINING_FUNCTIONS('functions two','milling','','');
#21=ACTION_PROPERTY('chip removal','',#20);
#22=ACTION_PROPERTY_REPRESENTATION('','',#21,#30);
#23=ACTION_PROPERTY('coolant','',#20);
#24=ACTION_PROPERTY_REPRESENTATION('','',#23,#40);

#30=REPRESENTATION('constant',(#31),#50);
#31=DESCRIPTIVE_REPRESENTATION_ITEM('','chip removal on');

#40=REPRESENTATION('constant',(#41),#50);
#41=DESCRIPTIVE_REPRESENTATION_ITEM('','coolant on');
#50=REPRESENTATION_CONTEXT('','units not necessary');
```

5.2.1.5 Context concepts

5.2.1.5.1 Representation contexts

Context forms an important part of the ISO 10303 integrated representation, particularly with respect to the description of geometric properties. The value of an action_property, resource_property, or property_definition is encoded as a set of representation_items within an instance of a representation. The representation context_of_items attribute refers to a representation_context instance that supplies additional contextual information about the value.

Local rules on the ISO 10303 geometry definitions require that any enclosing representation must refer to a geometric_representation_context to identify the dimensionality (2D, 3D, etc.) of the geometry. The geometry definitions are unitless, so global_unit_assigned_context is also used to specify length, plane angle, and solid angle units. Finally, to enable solid model exchange between systems with dissimilar geometric accuracy, global_uncertainty_assigned_context is often used to document an uncertainty distance below which two points are considered to be the same.

A representation can only refer to a single representation_context instance, so a complex entity instance of the types is normally used.

EXAMPLE 1 In the exchange file fragment below, #10 is a representation containing an axis placement (#20, and #21) describing an origin location at (1.1, 2.2, 3.3). The representation context is given by #30 which indicates that the geometry described is three dimensional, lengths are measured in millimetres, angles in radians, solid angles in steradians, and points within 0.000006mm of each other are to be considered the same.

```
#10=SHAPE_REPRESENTATION('',(#20),#30);
#20=AXIS2_PLACEMENT_3D('orientation',#21,$,$);
#21=CARTESIAN_POINT('',(1.1,2.2,3.3));

#30=(
  GEOMETRIC_REPRESENTATION_CONTEXT(3)
  GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT((#40))
  GLOBAL_UNIT_ASSIGNED_CONTEXT((#50,#60,#70))
  REPRESENTATION_CONTEXT('ID1','3D')
);

#40=UNCERTAINTY_MEASURE_WITH_UNIT(LENGTH_MEASURE(1.E-006),#50,
'DISTANCE_ACCURACY_VALUE',
'Maximum model space distance between geometric entities at asserted connectivities');

#50=( LENGTH_UNIT() NAMED_UNIT(*) SI_UNIT(.MILLI.,.METRE.) );
```



```
#60=( NAMED_UNIT(*) PLANE_ANGLE_UNIT() SI_UNIT($,.RADIAN.) );
#70=( NAMED_UNIT(*) SI_UNIT($,.STERADIAN.) SOLID_ANGLE_UNIT() );
```

A context is still required for a representation containing non-geometric representation_item instances. In this case, an instance of the representation_context base type is sufficent.

In general, only one instance of each type of context is needed, as it may be shared by many representation instances.

EXAMPLE 2 In the exchange file fragment below, #10 is a representation containing a description (#20) and a length measure (#21). The length measure is already completely described by its unit (#40) and neither it nor the description require additional context information. The representation context (#30) satisfies the EXPRESS definition requirement that the representation context_of_items has a value.

```
#10=REPRESENTATION('',(#20,#21),#30);
#20=DESCRIPTIVE_REPRESENTATION_ITEM('','coolant on');
#21=(
  LENGTH_MEASURE_WITH_UNIT()
  MEASURE_REPRESENTATION_ITEM()
  MEASURE_WITH_UNIT(LENGTH_MEASURE(2.),#40)
  REPRESENTATION_ITEM('')
);

#30=REPRESENTATION_CONTEXT('','units not necessary');
#40=( LENGTH_UNIT() NAMED_UNIT(*) SI_UNIT(.MILLI.,.METRE.) );
```

5.2.1.5.2 Product and product_definition contexts

Within this part of ISO 10303, Project (See 4.2.269), Setup (See 4.2.304), and Workpiece (See 4.2.412) are encoded in the integrated representation as products. Like representations, additional context information is also required for these products.

A product is required to have a product_context which identifies engineering discipline's point of view the data is being presented by the application protocol. This in turn refers to an application_context and application_protocol_definition which describes the application protocol used to describe the product, the schema name, and status of the application protocol within the ISO standardization process. It is recommended to instantiate the product_context, application_context, and application_protocol_definition entities exactly once in the data set.

A product_definition is required to have a product_definition_context which identifies the the life cycle stage or maturity of the data being presented and refers to an application context description. It is recommended to instantiate the product_definition_context entity exactly once in the data set.

NOTE A value of "manufacturing" is recommended for both product_context discipline_type and product_definition_context life_cycle_stage.

EXAMPLE In the exchange file fragment below, #10, #20, and #30 are the product structure instances encoding a workpiece with its_id = "1234-K789" and a revision_id = "1.0". The product_context (#40) identified a design discipline, the product_definition_context (#70) identifies a life cycle stage, and instances #50 and #60 identify this part of ISO 10303.


```
#10=PRODUCT('1234-K789','widget','a fictional product',(#40));
#20=PRODUCT_DEFINITION_FORMATION('1.0','first version of our widget',#10);
#30=PRODUCT_DEFINITION('design','example product_definition',#20,#70);

#40=PRODUCT_CONTEXT('CNC Machining',#50,'manufacturing');
#50=APPLICATION_CONTEXT('Application protocol for the exchange of CNC data');
#60=APPLICATION_PROTOCOL_DEFINITION('international standard',
'integrated_cnc_schema',2006,#50);

#70=PRODUCT_DEFINITION_CONTEXT('CNC Machining',#50,'manufacturing');
```

5.2.1.6 Toolpath description concepts

5.2.1.6.1 Matching curve parameterization

The definitions of Cutter_contact_trajectory (See 4.2.94), Cutter_location_trajectory (See 4.2.95), Axis_trajectory (See 4.2.25), and Toolpath_speed (See 4.2.374), require that the curves that describe location (basiccurve), tool axis, surface normal, and feed speed must have the same parameterization.

When the curves are b-splines, the intent of this requirement is that all curves are evaluated at the same U and V values to get the appropriate XYZ or IJK values. When the location curve is described using other types of bounded_curve, such as a polyline, ISO 14649 does not describe how the corresponding tool axis, surface normal, and feed speed values are to be determined for specific location values.

NOTE Since these other types of curve have no explicit UV parameterization to synchronize, the simplest approach is to describe the tool axis, surface normal, or tool speed at the start and end of the curve, and then linearly interpolate between the two values as the tool moves along the basis curve. Polylines and composite curves are segmented, so the direction can be given at each segment.

Except for the cases described below, all supporting curves (tool axis, surface normal, or feed) shall be given as polyline with two points. The first point indicates the supporting value (tool axis, surface normal, or feed) at the start of the location curve, and the second point indicates the supporting value at the end of the location curve.

— given a location curve of type b_spline_curve, each supporting curve shall be either a b_spline_curve that evaluates to the appropriate supporting values (IJK or feed ratio) for a given UV pair, or as a polyline with a start and end point giving the appropriate supporting values;

— given a location curve of type polyline, each supporting curve shall be a polyline with the same number of points;

— given a location curve of type composite_curve, each supporting curve shall be a composite curve with the same number of curve segments. Each segment shall have a parent_curve of type as indicated herein for the parent_curve in the corresponding location curve segment;

— given a location curve of type trimmed_curve, bounded_pcurve, or bounded_surface_curve, each supporting curve shall be of type as indicated herein for the underlying location curve.

EXAMPLE The exchange file fragment below shows a sample Cutter_location_trajectory basiccurve (#10) and its_toolaxis curve (#60). Both curves are polylines with the same number of points. At the locations described by #20 #30, and #40, the tool axis is as described by #70. At the location described by #50, the tool axis is as described by #80. The sharing of instance #70 is not required, but leads to a more space-efficient description than replicating the cartesian point values across three instances would.

```
#10=POLYLINE('basic curve for WS 12 TP 124',(#20,#30,#40,#50));
#20=CARTESIAN_POINT('',(2.9164976,0.4320305,-2.2));
#30=CARTESIAN_POINT('',(2.8524770,0.4960510,-3.2348622));
#40=CARTESIAN_POINT('',(-0.4960510,-2.8524770,-3.2348622));
#50=CARTESIAN_POINT('',(-0.4898882,-2.8586399,-3.1352428));

#60=POLYLINE('tool axis for WS 12 TP 124',(#70,#70,#70,#80));
#70=CARTESIAN_POINT('',(0.0616284,-0.0616284,0.9961947));
#80=CARTESIAN_POINT('',(-0.0616284,-0.0616284,0.9961947));
```

5.2.1.6.2 Toolpath direction vectors

The definitions of Cutter_contact_trajectory (See 4.2.94) and Cutter_location_trajectory (See 4.2.95) specify curves that describe the components of direction vectors for tool axis and surface normal. ISO 14649 does not indicate whether the direction vectors given by these curves shall be normalized (length equal to one).

It is recommended that these direction vectors be normalized.

5.2.1.6.3 Toolpath arcs

When describing a toolpath consisting of a circular arc, the trimmed_curve subtype of bounded_curve is used. The trimmed_curve.basis_curve attribute is an instance of circle, and the trim_1 and trim_2 attributes contain cartesian_points representing the start and end points respectively. The direction of traversal is indicated by comparing the trimmed_curve sense_agreement attribute with the mathematical sense of the underlying circle.

NOTE Given a circle in the XY plane with an axis placement along the positive Z axis, a sense_agreement of true indicates counterclockwise motion (from 0,+X to +Y,0 to 0,-X to -Y,0), while a sense_agreement of false indicates clockwise motion.

EXAMPLE The exchange file fragment below shows a trimmed curve (#10), based on a circle located at (0,0,0) with a radius of 3.5. The arc starts (3.5,0,0) (#50) and traverses a 90 degree arc to (0,3.5,0) (#60).

```
#10=TRIMMED_CURVE('',#20,(#50),(#60),.T.,.CARTESIAN.);
#20=CIRCLE('',#30,3.5);
#30=AXIS2_PLACEMENT_3D('center placement',#40,$,$);
#40=CARTESIAN_POINT('center location',(0.,0.,0.));
#50=CARTESIAN_POINT('start point',(3.5,0.,0.));
#60=CARTESIAN_POINT('end point',(0.,3.5,0.));
```

5.2.1.6.4 Complete circles

When describing a toolpath consisting of a complete circle, the trimmed_curve approach described in the previous section is used, but the trim_1 (start) and trim_2 (end) points shall be the same point in space, and specify where the cutter enters & exits the circle. The start and end may either reference the same cartesian_point instance or two instances with identical XYZ values.

NOTE Use of the same cartesian_point instance is preferred as this avoids numeric comparisons between coordinate values.

EXAMPLE Arcs and complete circles might occur when roughing out a circular pocket. There may be an entry arc, full circle and then exit arc as illustrated in Figure 49.

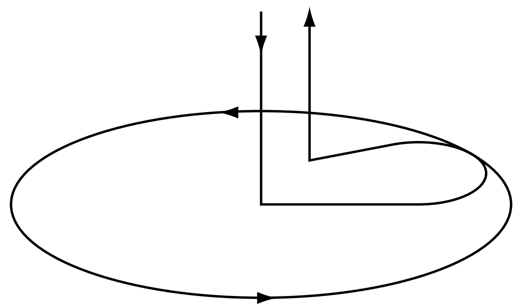

Figure 49 — Toolpath with complete circle

5.2.2 Integrated CNC types

5.2.2.1 Integrated CNC type definitions

5.2.2.1.1 approval_item

An **approval_item** identifies a **product**, **product_definition** or **product_definition_formation** to which an **approval** may be assigned.

EXPRESS specification:

```
*)
TYPE approval_item = SELECT (
        product,
        product_definition,
        product_definition_formation
        );
END_TYPE;
(*
```

5.2.2.1.2 classification_item

An **classification_item** identifies a **externally_defined_representation_with_parameters** to which a **group** may be assigned.

EXPRESS specification:

```
*)
TYPE classification_item = SELECT (
        externally_defined_representation_with_parameters
```



```
        );
END_TYPE;
(*
```

5.2.2.1.3 date_and_time_item

A **date_and_time_item** identifies an **approval_person_organization**, **machining_operation**, **machining_process_executable**, **machining_toolpath**, **product**, **product_definition**, or **product_-definition_formation** to which a referenced **date_and_time** may be assigned.

EXPRESS specification:

```
*)
TYPE date_and_time_item = SELECT (
        approval_person_organization,
        machining_operation,
        machining_process_executable,
        machining_toolpath,
        product,
        product_definition,
        product_definition_formation
        );
END_TYPE;
(*
```

5.2.2.1.4 date_item

A **date_item** identifies a **product**, **product_definition**, or **product_definition_formation** to which a referenced **date** may be assigned.

EXPRESS specification:

```
*)
TYPE date_item = SELECT (
        product,
        product_definition,
        product_definition_formation
        );
END_TYPE;
(*
```

5.2.2.1.5 document_reference_item

A **document_reference_item** identifies an **externally_defined_dimension_definition**, **externally_-defined_feature_definition**, **material_designation**, or **property_definition** to which a referenced **document** may be assigned.

EXPRESS specification:

```
*)
```

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

5.2.2.1.6 external_identification_item

An **external_identification_item** identifies an **externally_defined_class** or **externally_defined_-general_property** to which an **identifier** and referenced **external_source** may be assigned.

EXPRESS specification:

```
*)
TYPE external_identification_item = SELECT (
        externally_defined_class,
        externally_defined_general_property
        );
END_TYPE;
(*
```

5.2.2.1.7 identification_item

An **identification_item** identifies a **dimensional_size** to which an identifier may be assigned by means of an **applied_ identfication_assignment**.

EXPRESS specification:

```
*)
TYPE identification_item = SELECT (
        dimensional_size
        );
END_TYPE;
(*
```

5.2.2.1.8 organization_item

An **organization_item** identifies a **product**, **product_definition**, **product_definition_formation** or **known_source** to which a referenced **organization** may be assigned.

EXPRESS specification:

```
*)
TYPE organization_item = SELECT (
        product,
        product_definition,
        product_definition_formation,
        known_source
```



```
        );
END_TYPE;
(*
```

5.2.2.1.9 person_and_organization_item

A **person_and_organization_item** identifies a **product**, **product_definition**, or **product_-definition_formation** to which a referenced **person_and_organization** may be assigned.

EXPRESS specification:

```
*)
TYPE person_and_organization_item = SELECT (
        product,
        product_definition,
        product_definition_formation
        );
END_TYPE;
(*
```

5.2.2.1.10 security_classification_item

A **security_classification_item** identifies a **machining_operation**, **machining_process_executable**, **machining_toolpath**, **product_definition**, or **product_definition_formation** to which a referenced **security_classification** may be assigned.

EXPRESS specification:

```
*)
TYPE security_classification_item = SELECT (
        machining_operation,
        machining_process_executable,
        machining_toolpath,
        product_definition,
        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_approval_assignment

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

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.

5.2.3.1.2 applied_classification_assignment

An **applied_classification_assignment** specifies those **classification_item** instances to which a referenced **group** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_classification_assignment
  SUBTYPE OF (classification_assignment);
  items: SET[1:?] OF classification_item;
END_ENTITY;
(*
```

Attribute definition:

items: the set of **classification_item** instances to which a referenced **group** 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_date_assignment

An **applied_date_assignment** specifies those **date_item** instances to which a referenced **date** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_date_assignment
  SUBTYPE OF (date_assignment);
  items : SET[1:?] OF date_item;
END_ENTITY;
(*
```

Attribute definition:

items: the set of **date_item** instances to which a referenced **date** is assigned.

5.2.3.1.5 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.

5.2.3.1.6 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.

5.2.3.1.7 applied_external_identification_assignment

An **applied_external_identification_assignment** specifies those **external_identification_item** instances to which an identifier and referenced **external_source** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_external_identification_assignment
  SUBTYPE OF (external_identification_assignment);
  items: SET[1:?] OF external_identification_item;
END_ENTITY;
(*
```

Attribute definition:

items: the set of **external_identification_item** instances to which an identifier and referenced **external_source** are assigned.

5.2.3.1.8 applied_identification_assignment

An **applied_identification_assignment** specifies those **identification_item** instances to which the specified identifier is assigned.

EXPRESS specification:

```
*)
ENTITY applied_identification_assignment
  SUBTYPE OF (identification_assignment);
  items : SET [1:?] OF identification_item;
END_ENTITY;
(*
```

Attribute definition:

items: the set of **identification_item** instances to which a referenced identifier is assigned.

5.2.3.1.9 applied_organization_assignment

An **applied_organization_assignment** specifies those **organization_item** instances to which a referenced **organization** is assigned.

EXPRESS specification:

```
*)
ENTITY applied_organization_assignment
```



```
  SUBTYPE OF (organization_assignment);
  items : SET [1:?] OF organization_item;
END_ENTITY;
(*
```

Attribute definition:

items: the set of **organization_item** instances to which a referenced **organization** is assigned.

5.2.3.1.10 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.

5.2.3.1.11 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.

5.2.3.1.12 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.

EXPRESS specification:

```
*)
ENTITY back_boring_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (0 = SIZEOF (QUERY (amr <* get_relating_amr (SELF) |
           ('INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'
              IN TYPEOF (amr)) AND NOT
           (verify_required_action_property
                (amr.related_method, 'oriented spindle stop')))));
END_ENTITY;
(*
```

Formal propositions:

WR1: All instances of **machining_functions_relationship** in which the **back_boring_operation** is the **relating_method** shall have a **related_method** which 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.

5.2.3.1.13 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([
          '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.

5.2.3.1.14 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_optional_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
        (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 at most 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**.

5.2.3.1.15 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 ['roughing','finishing']);

  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 = 'roughing') OR
        ((verify_required_action_property (SELF, 'allowance side')) AND
         (verify_required_action_property (SELF, 'allowance bottom')));
END_ENTITY;
(*
```

<u>Formal propositions:</u>

WR1: The **description** of the **bottom_and_side_milling_operation** shall be either 'roughing' or 'finishing'.

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 'roughing', 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 class

A **class** is a type of **group** that specifies a type of classification assignment.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-214, ISO 10303-224, and ISO 10303-240

EXPRESS specification:

```
*)
ENTITY class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.17 contouring_turning_operation

A **contouring_turning_operation** is a **turning_type_operation**. See the ARM definitions for Contouring and subtypes in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY contouring_turning_operation
  SUBTYPE OF (turning_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing','finishing']);

  WR2:  (verify_optional_action_property        (SELF, 'allowance')) AND
        (verify_length_measure_action_property  (SELF, 'allowance'));

  WR3:  NOT (SELF.description = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance'));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **description** of the **contouring_turning_operation** shall be either 'roughing' or 'finishing'.

WR2: The **contouring_turning_operation** shall be the **definition** of at most one **action_property** with a **name** of 'allowance', 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: If the **description** of the **contouring_turning_operation** is 'roughing', the **contouring_-turning_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'allowance'.

NOTE This corresponds to local constraints **WR1** on the ARM entity **Contouring_rough** in ISO 14649-12.

5.2.3.1.18 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:

```
*)
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.

5.2.3.1.19 directed_dimensional_location

A **directed_dimensional_location** is a type of **dimensional_location** that identifies the direction to measure the location dimension.

NOTE This definition has been harmonized with the equivalent definitions in ISO 10303-214, ISO 10303-224, and ISO 10303-1050.

EXPRESS specification:

```
*)
ENTITY directed_dimensional_location
  SUBTYPE OF (dimensional_location);
END_ENTITY;
(*
```

5.2.3.1.20 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'
         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'.

5.2.3.1.21 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_rep_type_for_action_property   (SELF, 'dwell time step',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_DWELL_TIME_REPRESENTATION'])) AND
         (verify_rep_name_for_action_property   (SELF, 'dwell time step',
           ['dwell time']))
        );
END_ENTITY;
(*
```

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 be of type **machining_dwell_time_representation** with a **description** of 'dwell time'.

5.2.3.1.22 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_rep_type_for_action_property    (SELF, 'dwell time bottom',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_DWELL_TIME_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property    (SELF, 'dwell time bottom',
```



```
          ['dwell time']));

  WR5:  (verify_optional_action_property        (SELF, 'feedrate on retract'))
AND
        (verify_rep_type_for_action_property    (SELF, 'feedrate on retract',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property    (SELF, 'feedrate on retract',
           ['relative speed']));

  WR6:  ((verify_optional_relating_amr_with_name  (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.DRILLING_TYPE_STRATEGY']))
        );
END_ENTITY;
(*
```

<u>Formal propositions:</u>

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 be of type **machining_dwell_time_representation** with a **description** of 'dwell time'.

WR5: The **drilling_type_operation** shall be the **definition** of at most one **action_property** with a **name** of 'feedrate on retract', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of 'relative speed'.

WR6: The **drilling_type_operation** shall be the **relating_method** of at most one **machining_strategy_relationship** with a **name** of 'machining', in which the **related_method** shall be of type **drilling_type_strategy**.

5.2.3.1.23 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_rep_type_for_action_property(SELF, 'reduced cut at start',
       ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property(SELF, 'reduced cut at start',
           ['relative speed']));

  WR2:  (verify_optional_action_property(SELF, 'reduced feedrate at start')) AND
      (verify_rep_type_for_action_property(SELF, 'reduced feedrate at start',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property(SELF, 'reduced feedrate at start',
           ['relative speed']));

  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_rep_type_for_action_property  (SELF, 'reduced cut at end',
        ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property  (SELF, 'reduced cut at end',
           ['relative speed']));

  WR5:  (verify_optional_action_property  (SELF, 'reduced feedrate at end')) AND
        (verify_rep_type_for_action_property(SELF, 'reduced feedrate at end',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property(SELF, 'reduced feedrate at end',
           ['relative speed']));

  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 feedrate 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 feedrate 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 be of type **machining_spindle_speed_representation** with a **description** of 'relative speed'.

WR2: The **drilling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'reduced feedrate at start', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of 'relative speed'.

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 be of type **machining_spindle_speed_representation** with a **description** of 'relative speed'.

WR5: The **drilling_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'reduced feedrate at end', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of 'relative speed'.

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 feedrate 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 feedrate at end'.

NOTE This corresponds to local constraint **WR2** on ARM entity **Drilling_type_strategy** in ISO 14649-11.

5.2.3.1.24 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 combined with a **measure_with_unit** subtype, such as **length_measure_with_unit**, in the representation of a property.

<u>EXPRESS specification:</u>

```
*)
ENTITY expression_representation_item
```



```
  SUBTYPE OF (representation_item, generic_expression);
END_ENTITY;
(*
```

5.2.3.1.25 externally_defined_class

An **externally_defined_class** is a type of **externally_defined_item** and **class** that represents classification information whose identification and definition is defined externally, i.e., not within this part of ISO 10303.

NOTE This definition has been harmonized with the equivalent definitions in ISO 10303-214, ISO 10303-224, and ISO 10303-240.

EXPRESS specification:

```
*)
ENTITY externally_defined_class
  SUBTYPE OF (externally_defined_item,class);
  WHERE
  WR1: 'INTEGRATED_CNC_SCHEMA.KNOWN_SOURCE' IN TYPEOF(SELF.source);
  WR2: SELF.source.name = 'ISO 13584 library';

  WR3: ( SIZEOF ( QUERY ( aoa <* USEDIN ( SELF.source,
       'INTEGRATED_CNC_SCHEMA.APPLIED_ORGANIZATION_ASSIGNMENT.ITEMS' )|
       (aoa.role.name = 'library supplier')))=1);

  WR4: (SIZEOF ( QUERY ( aoa <* USEDIN ( SELF, 'INTEGRATED_CNC_SCHEMA.'+
       'APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT.ITEMS' )|
       (aoa.role.name = 'class version')))=1);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **externally_defined_class** shall have as **source** an instance of **known_source**.

WR2: The **externally_defined_class** shall have as **source** an instance of **known_source** with a **name** of 'ISO 13584 library'.

WR3: The **externally_defined_class** shall have as **source** attribute an instance that is referenced by the **items** set of exactly one **applied_organization_assignment** that has an **organization_role** with a **name** of 'library supplier'.

WR4: The **externally_defined_class** shall be referenced by the **items** set of exactly one **applied_external_identification_assignment** with an **identification_role** with **name** of 'class version'.

5.2.3.1.26 externally_defined_dimension_definition

An **externally_defined_dimension_definition** is a **dimensional_size** and **externally_defined_item** that represents a type of size dimension that is defined by an external document.

NOTE This definition has been harmonized with the equivalent definitions in ISO 10303-214, ISO 10303-224, and ISO 10303-1050.

EXPRESS specification:

```
*)
ENTITY externally_defined_dimension_definition
     SUBTYPE OF (externally_defined_item, dimensional_size);
WHERE
 WR1: (SELF\externally_defined_item.item_id =
        'external size dimension')  AND
      (SELF\externally_defined_item.source.source_id =
        'external size dimension specification');

 WR2: 1 >= SIZEOF(QUERY ( adr <* USEDIN(SELF,
      'INTEGRATED_CNC_SCHEMA.APPLIED_DOCUMENT_REFERENCE.ITEMS')|
      (adr.assigned_document.description =
      'external size dimension specification')
      ));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **externally_defined_dimension_definition** shall have an **item_id** of 'external size dimension' and shall have as **source** an instance of **external_source** with a **source_id** of 'external size dimension specification'.

WR2: The **externally_defined_dimension_definition** shall appear in the **items** set of at most one **applied_document_reference** in which the **assigned_document** has a **description** of 'external size dimension specification'.

5.2.3.1.27 externally_defined_general_property

An **externally_defined_general_property** is a type of **general_property** and **externally_defined_item** that represents general property definition information which is defined externally, i.e., not within this part of ISO 10303.

NOTE This definition has been harmonized with the equivalent definitions in ISO 10303-214, ISO 10303-224, and ISO 10303-240.

EXPRESS specification:

```
*)
ENTITY externally_defined_general_property
```

```
  SUBTYPE OF (general_property, externally_defined_item);
  WHERE
  WR1: 'INTEGRATED_CNC_SCHEMA.KNOWN_SOURCE' IN TYPEOF(SELF.source);
  WR2: SELF.source.name = 'ISO 13584 library';

  WR3: (SIZEOF (QUERY ( aoa <* USEDIN ( SELF, 'INTEGRATED_CNC_SCHEMA.'+
       'APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT.ITEMS' )|
       (aoa.role.name = 'property version' )))=1);

  WR4: (SIZEOF(QUERY ( ap <* USEDIN(SELF, 'INTEGRATED_CNC_SCHEMA.'+
       'EXTERNALLY_DEFINED_ITEM_RELATIONSHIP.RELATING_ITEM') |
       ((ap.name='name scope') AND
       ('INTEGRATED_CNC_SCHEMA.EXTERNALLY_DEFINED_CLASS' IN
         TYPEOF(ap.related_item)) )))>=1);

END_ENTITY;
(*
```

Formal propositions:

WR1: The **externally_defined_general_property** shall have as **source** an instance of **known_source**.

WR2: The **externally_defined_general_property** shall have as **source** an instance of **known_source** with a **name** of 'ISO 13584 library'.

WR3: The **externally_defined_general_property** shall be referenced by the **items** set of exactly one **applied_external_identification_assignment** with an **identification_role** with **name** of 'property version'.

WR4: The **externally_defined_general_property** shall be referenced as the **relating_item** of at least one **externally_defined_item_relationship** with **name** of 'name scope' and **related_item** of type **externally_defined_class**.

5.2.3.1.28 externally_defined_representation_with_parameters

An **externally_defined_representation_with_parameters** is a type of **representation** that defines placement and orientation for an external reference.

NOTE This definition has been harmonized with the equivalent definitions in ISO 10303-224 and ISO 10303-240.

EXPRESS specification:

```
*)
ENTITY externally_defined_representation_with_parameters
  SUBTYPE OF (representation);
  WHERE
  WR1: (SIZEOF(USEDIN(SELF, 'INTEGRATED_CNC_SCHEMA.'+
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS')) = 1);

  WR2: (SIZEOF (QUERY(adr <* SELF.items|
```



```
        'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(adr))) <=1);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **externally_defined_representation_with_parameters** shall be referenced by the **items** set of exactly one **applied_classification_assignment**.

WR2: The **externally_defined_representation_with_parameters items** set shall contain at most one **placement** instance.

5.2.3.1.29 facing_turning_operation

A **facing_turning_operation** is a **turning_type_operation**. See the ARM definitions for Facing and subtypes in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY facing_turning_operation
  SUBTYPE OF (turning_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing','finishing']);

  WR2:  (verify_optional_action_property        (SELF, 'allowance')) AND
        (verify_length_measure_action_property  (SELF, 'allowance'));

  WR3:  NOT (SELF.description = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance'));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **description** of the **facing_turning_operation** shall be either 'roughing' or 'finishing'.

WR2: The **facing_turning_operation** shall be the **definition** of at most one **action_property** with a **name** of 'allowance', 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: If the **description** of the **facing_turning_operation** is 'cutting in', the **facing_-turning_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'allowance'.

NOTE This corresponds to local constraints **WR1** on the ARM entity **Facing_rough** in ISO 14649-12.

5.2.3.1.30 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_optional_relating_amr_with_name  (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.FREEFORM_MILLING_STRATEGY']))
        );
END_ENTITY;
(*
```

Formal propositions:

WR1: The **freeform_milling_operation** shall be the **relating_method** of at most one **machining_-strategy_relationship** with a **name** of 'machining', in which the **related_method** shall be of type **freeform_milling_strategy**.

5.2.3.1.31 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

         (verify_required_action_property       (SELF, 'cutmode')) AND
         (verify_enumeration_action_property    (SELF, 'cutmode',
           ['climb', 'conventional'])) AND

         (verify_required_action_property    (SELF, 'milling tolerances')) AND
         (verify_rep_type_for_action_property(SELF, 'milling tolerances',
```



```
      ['INTEGRATED_CNC_SCHEMA.FREEFORM_MILLING_TOLERANCE_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;
(*
```

<u>Formal propositions:</u>

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';

— 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**.

5.2.3.1.32 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);
  WHERE
  WR1:   (verify_required_rep_item       (SELF, 'chordal tolerance')) AND
         (verify_length_measure_rep_item (SELF, 'chordal tolerance'));

  WR2:   (verify_required_rep_item       (SELF, 'scallop height')) AND
         (verify_length_measure_rep_item (SELF, 'scallop height'));
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** .

5.2.3.1.33 grooving_turning_operation

A **grooving_turning_operation** is a **turning_type_operation**. See the ARM definitions for Grooving and subtypes in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY grooving_turning_operation
  SUBTYPE OF (turning_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing', 'finishing', 'cutting in']);

  WR2:  (verify_optional_action_property     (SELF, 'dwell')) AND
        (verify_rep_type_for_action_property (SELF, 'dwell',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_DWELL_TIME_REPRESENTATION']));

  WR3:  (verify_optional_action_property        (SELF, 'allowance')) AND
        (verify_length_measure_action_property  (SELF, 'allowance'));

  -- allowance propery required for roughing
  WR4:  NOT (SELF.description = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance'));

  -- allowance propery forbidden for cutting in
  WR5:  NOT (SELF.description = 'cutting in') OR
        (0 = SIZEOF (get_action_property (SELF, 'allowance')));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **description** of the **grooving_turning_operation** shall be either 'roughing', 'finishing' or 'cutting in'.

WR2: The **grooving_turning_operation** shall be the **definition** of at most one **action_property** with a **name** of 'dwell', and the **representation** used to describe the **action_property** shall be of type **turning_dwell_time_representation.**

WR3: The **grooving_turning_operation** shall be the **definition** of at most one **action_property** with a **name** of 'allowance', 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 **grooving_turning_operation** is 'roughing', the **grooving_turning_-operation** shall be the **definition** of exactly one **action_property** with a **name** of 'allowance'.

NOTE This corresponds to local constraints **WR1** on the ARM entity **Grooving_rough** in ISO 14649-12.

WR5: If the **description** of the **grooving_turning_operation** is 'cutting in', the **grooving_turning_-operation** shall be the **definition** of no **action_property** with a **name** of 'allowance'.

NOTE This corresponds to local constraints **WR1** on the ARM entity **Cutting_in** in ISO 14649-12.

5.2.3.1.34 known_source

A **known_source** is a type of **external_source** and of **pre_defined_item** that is a source of information whose name and content are predetermined. It provides a mechanism to refer to an entry in an external library.

NOTE This definition has been harmonized with the equivalent definition in ISO 10303-214, ISO 10303-224, and ISO 10303-240

EXPRESS specification:

```
*)
ENTITY known_source
  SUBTYPE OF (external_source,pre_defined_item);
END_ENTITY;
(*
```

5.2.3.1.35 knurling_turning_operation

A **knurling_turning_operation** is a **turning_type_operation**. See the ARM definitions for Knurling in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY knurling_turning_operation
  SUBTYPE OF (turning_type_operation);
END_ENTITY;
(*
```

5.2.3.1.36 machining_adaptive_control_relationship

A **machining_adaptive_control_relationship** is a type of **action_method_relationship** that represents the use of an Adaptive_control description in some context. See the ARM definitions for the Technology subtypes in ISO 14649-11 and ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_adaptive_control_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY;
(*
```

5.2.3.1.37 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.

<u>EXPRESS specification:</u>

```
*)
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',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION']));

  WR3:  NOT (SELF.description = 'along path') OR
        ((1 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP']))
AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH']))
        );

  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**.

WR3: If the **description** of the **machining_approach_retract_strategy** is 'along path', the **machining_approach_retract_strategy** shall be the **relating_method** of at least one **machining_-toolpath_sequence_relationship**, in which **related_method** 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 **machining_toolpath_sequence_relationship** instances which refer to the same **machining_-approach_retract_strategy** through **relating_method** shall have unique **sequence_position** values.

5.2.3.1.38 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 definitions for Cutting_component in ISO 14649-111 and Cutting_edge_properties in ISO 14649-121 for more information.

EXPRESS specification:

```
*)
ENTITY machining_cutting_component
  SUBTYPE OF (action_resource,characterized_object);
  WHERE
  WR1:  (1 >= SIZEOF (USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.' +
           'MATERIAL_DESIGNATION.DEFINITIONS')));

  WR2:  (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))))
        )));

  WR3:  (verify_optional_resource_property     (SELF, 'expected life')) AND
        (verify_time_measure_resource_property (SELF, 'expected life'));


  WR4:  NOT (SELF.kind.name = 'milling cutting edge') OR
        ((verify_required_resource_property
           (SELF, 'functional length')) AND
         (verify_length_measure_resource_property
           (SELF, 'functional length'))
        );

  WR5:  NOT (SELF.kind.name = 'turning cutting edge') OR
        ((verify_optional_resource_property
           (SELF, 'cutting edge length')) AND
         (verify_length_measure_resource_property
           (SELF, 'cutting edge length')) AND

         (verify_optional_resource_property
           (SELF, 'cutting edge angle')) AND
         (verify_angle_measure_resource_property
           (SELF, 'cutting edge angle')) AND
```



```
          (verify_optional_resource_property
            (SELF, 'cutting edge angle type')) AND
          (verify_rep_item_for_resource_property
            (SELF, 'cutting edge angle type',
            ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'])) AND

          (verify_optional_resource_property
            (SELF, 'tool included angle')) AND
          (verify_angle_measure_resource_property
            (SELF, 'tool included angle')) AND

          (verify_rep_type_for_resource_property
            (SELF, 'corner transitions',
            ['INTEGRATED_CNC_SCHEMA.'+
             'MACHINING_CUTTING_CORNER_REPRESENTATION'])) AND

          (verify_optional_resource_property
            (SELF, 'maximum side cutting depth')) AND
          (verify_length_measure_resource_property
            (SELF, 'maximum side cutting depth')) AND

          (verify_optional_resource_property
            (SELF, 'maximum end cutting depth')) AND
          (verify_length_measure_resource_property
            (SELF, 'maximum end cutting depth'))
         );
END_ENTITY;
(*
```

Formal propositions:

WR1: The **machining_cutting_component** appears in the set of **definitions** of at most one **material_designation**.

WR2: 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 component' and the set of **operations** contains exactly one **machining_technology**

WR3: 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**.

WR4: If the **kind** of the **machining_cutting_component** is an **action_resource_type** with a **name** of 'milling cutting edge', the **machining_cutting_component** shall satisfy the following conditions:

— the **machining_cutting_component** is the **resource** of exactly one **resource_property** with a **name** of 'functional 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**.

WR5: If the **kind** of the **machining_cutting_component** is an **action_resource_type** with a **name** of 'turning cutting edge', the **machining_cutting_component** shall satisfy the following conditions:

— the **machining_cutting_component** is the **resource** of at most one **resource_property** with a **name** of 'cutting edge 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**;

— the **machining_cutting_component** is the **resource** of at most one **resource_property** with a **name** of 'cutting edge angle', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **plane_angle_measure_with_unit**;

— the **machining_cutting_component** is the **resource** of at most one **resource_property** with a **name** of 'cutting edge angle type', and the **representation** used to describe the **resource_-property** shall contain a **representation_item** of type **descriptive_representation_item**;

— the **machining_cutting_component** is the **resource** of at most one **resource_property** with a **name** of 'tool included angle', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **plane_angle_measure_with_unit**;

— the **machining_cutting_component** is the **resource** of zero or more **resource_property** with a **name** of 'corner transitions', and the **representation** used to describe the **resource_property** shall be of type **machining_cutting_corner_representation**;

— the **machining_cutting_component** is the **resource** of at most one **resource_property** with a **name** of 'maximum side cutting depth', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**;

— the **machining_cutting_component** is the **resource** of at most one **resource_property** with a **name** of 'maximum end cutting depth', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

5.2.3.1.39 machining_cutting_corner_representation

A **machining_cutting_corner_representation** is a type of **representation** that represents the corner transitions of a cutting edge of a tool for machining. See the ARM definition for Corner_transition in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_cutting_corner_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  ((verify_required_rep_item       (SELF, 'corner identity')) AND
         (verify_count_measure_rep_item  (SELF, 'corner identity'))
```



```
        );

  WR2:  NOT (SELF.name = 'chamfered corner') OR
        ((verify_required_rep_item       (SELF, 'chamfer angle')) AND
         (verify_angle_measure_rep_item  (SELF, 'chamfer angle')) AND

         (verify_optional_rep_item       (SELF, 'chamfer length')) AND
         (verify_length_measure_rep_item (SELF, 'chamfer length')) AND

         (verify_optional_rep_item       (SELF, 'chamfer width')) AND
         (verify_length_measure_rep_item (SELF, 'chamfer width'))
        );

  WR3:  NOT (SELF.name = 'rounded corner') OR
        ((verify_required_rep_item       (SELF, 'radius')) AND
         (verify_length_measure_rep_item (SELF, 'radius'))
        );

  WR4:  NOT (SELF.name = 'profiled corner') OR
        (1 = SIZEOF (QUERY (prep <* USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.' +
           'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
           (('INTEGRATED_CNC_SCHEMA.LINEAR_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.OPEN_PATH_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.TEE_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.VEE_PROFILE'
                IN TYPEOF(prep.definition)))
        )));
END_ENTITY;
(*
```

<u>Formal propositions:</u>

WR1: The **items** set shall contain exactly one **representation_item** with a **name** of 'corner identity', which shall be of type type **measure_representation_item** with a **value_component** of type **count_measure**.

WR2: If the **name** of the **machining_cutting_corner_representation** is 'chamfered corner', the **items** set shall contain the following items:

— exactly one **representation_item** with a **name** of 'chamfer angle', which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**;

— at most one **representation_item** with a **name** of 'chamfer length', which shall be of type **measure_representation_item** and **length_measure_with_unit**;

— at most one **representation_item** with a **name** of 'chamfer width', which shall be of type **measure_representation_item** and **length_measure_with_unit**.

WR3: If the **name** of the **machining_cutting_corner_representation** is 'rounded corner', the **items** set shall contain exactly one **representation_item** with a **name** of 'radius', which shall be of type **measure_representation_item** and **length_measure_with_unit**;

WR4: If the **name** of the **machining_cutting_corner_representation** is 'profiled corner', the **machining_cutting_corner_representation** shall be the **used_representation** of exactly one **property_definition_representation** in which the **definition** refers to a **shape_aspect** which shall be of type **linear_profile**, **open_path_profile**, **partial_circular_profile**, **rounded_u_profile**, **square_-u_profile**, **tee_profile**, or **vee_profile**.

5.2.3.1.40 machining_dwell_time_representation

A **machining_dwell_time_representation** is a type of **representation** that represents the duration of time that a machine tool perfoms some action. The dwell time is described as one of the following:

:— as a time measure, as described by the ARM definitions for the Feedstop "dwell" attribute in ISO 14649-10, the Multistep_drilling "dwell_time_step" and Drilling_type_operation "dwell_time_-bottom" attributes in ISO 14649-11, and Dwell_time in ISO 14649-12;

— as a count of spindle revolutions, as described by the ARM definitions for Dwell_revolution in ISO 14649-12.

<u>EXPRESS specification:</u>

```
*)
ENTITY machining_dwell_time_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  (SELF.name IN ['dwell time', 'dwell revolution']);

  WR2:  NOT (SELF.name = 'dwell time') OR
        ((verify_required_rep_item       (SELF, 'dwell time')) AND
         (verify_time_measure_rep_item   (SELF, 'dwell time'))
        );

  WR3:  NOT (SELF.name = 'dwell revolution') OR
        ((verify_required_rep_item       (SELF, 'dwell revolution')) AND
         (verify_count_measure_rep_item  (SELF, 'dwell revolution'))
        );
END_ENTITY;
(*
```


Formal propositions:

WR1: The **name** of the **machining_dwell_time_representation** shall be either 'dwell time' or 'dwell revolution'.

WR2: If the **name** of the **machining_dwell_time_representation** is 'dwell time', the **items** set shall contain exactly one **representation_item** with a **name** of 'dwell time', which shall be of type **measure_representation_item** and **time_measure_with_unit**.

WR3: If the **name** of the **machining_dwell_time_representation** is 'dwell revolution', the **items** set shall contain exactly one **representation_item** with a **name** of 'dwell revolution', which shall be of type **measure_representation_item** with a **value_component** of type **count_measure**.

5.2.3.1.41 machining_execution_resource

A **machining_execution_resource** is a type of **action_resource** that represents machine tool capability requirements for machining. See the ARM definition for Machine_parameters in 4.2.192 for more information.

EXPRESS specification:

```
*)
ENTITY machining_execution_resource
  SUBTYPE OF (action_resource);
  WHERE
  WR1:  ((verify_optional_resource_property      (SELF, 'feedrate')) AND
         (verify_rep_type_for_resource_property  (SELF, 'feedrate',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])));

  WR2:  ((verify_optional_resource_property     (SELF, 'spindle')) AND
         (verify_rep_type_for_resource_property (SELF, 'spindle',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])));

  WR3:  ((verify_optional_resource_property     (SELF, 'spindle power')) AND
         (verify_rep_item_for_resource_property (SELF, 'spindle power',
           ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'])));

  WR4:  ((verify_optional_resource_property
           (SELF, 'number of control axis')) AND
         (verify_count_measure_resource_property
           (SELF, 'number of control axis')));

  WR5:  ((verify_optional_resource_property
           (SELF, 'number of simultaneous axis')) AND
         (verify_count_measure_resource_property
           (SELF, 'number of simultaneous axis')));

  WR6:  ((verify_optional_resource_property
           (SELF, 'positioning accuracy')) AND
         (verify_length_measure_resource_property
           (SELF, 'positioning accuracy')));
```



```
  WR7:  ((verify_optional_resource_property    (SELF, 'table indexing')) AND
         (verify_enumeration_resource_property (SELF, 'table indexing',
          ['required', 'not required'])));

  WR8:  ((verify_optional_resource_property
           (SELF, 'table length')) AND
         (verify_length_measure_resource_property
           (SELF, 'table length')) AND

         (verify_optional_resource_property
           (SELF, 'table width')) AND
         (verify_length_measure_resource_property
           (SELF, 'table width')));

  WR9:  ((verify_optional_resource_property (SELF, 'axis travel')) AND
         (0 = SIZEOF (QUERY (prop <* get_resource_property
                (SELF, 'axis travel') | NOT
          ((0 < SIZEOF (QUERY (prep <* USEDIN (prop,
           'INTEGRATED_CNC_SCHEMA.RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
            (1 <= SIZEOF (QUERY ( it <* prep.representation.items |
                  (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                    TYPEOF(it)) = 2))))

                ))))
         ))));

  WR10: ((verify_optional_resource_property
           (SELF, 'work volume length')) AND
         (verify_length_measure_resource_property
           (SELF, 'work volume length')) AND

         (verify_optional_resource_property
           (SELF, 'work volume width')) AND
         (verify_length_measure_resource_property
           (SELF, 'work volume width')) AND

         (verify_optional_resource_property
           (SELF, 'work volume height')) AND
         (verify_length_measure_resource_property
           (SELF, 'work volume height'))
        );

  WR11:  (0 = SIZEOF (get_action_property (SELF, 'axis travel'))) OR
         ((0 = SIZEOF (get_action_property (SELF, 'work volume length'))) AND
          (0 = SIZEOF (get_action_property (SELF, 'work volume width'))) AND
          (0 = SIZEOF (get_action_property (SELF, 'work volume height'))));

END_ENTITY;
(*
```


Formal propositions:

WR1: The **machining_execution_resource** is the **resource** of at most one **resource_property** with a **name** of 'feedrate', and the **representation** used to describe the **resource_property** shall be of type **machining_feed_speed_representation**.

WR2: The **machining_execution_resource** is the **resource** of at most one **resource_property** with a **name** of 'spindle', and the **representation** used to describe the **resource_property** shall be of type **machining_spindle_speed_representation**.

WR3: The **machining_execution_resource** is the **resource** of at most one **resource_property** with a **name** of 'spindle power', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item**.

WR4: The **machining_execution_resource** is the **resource** of at most one **resource_property** with a **name** of 'number of control axis', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** in which the **value_component** is of type **count_measure**.

WR5: The **machining_execution_resource** is the **resource** of at most one **resource_property** with a **name** of 'number of simultaneous axis', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** in which the **value_component** is of type **count_measure**.

WR6: The **machining_execution_resource** is the **resource** of at most one **resource_property** with a **name** of 'positioning accuracy', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_-with_unit**.

WR7: The **machining_execution_resource** is the **resource** of at most one **resource_property** with a **name** of 'table indexing', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'required' or 'not required'.

WR8: The **machining_execution_resource** shall satisfy the following conditions:

— the **machining_execution_resource** shall be the **resource** of at most one **resource_property** with a **name** of 'table 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**;

— the **machining_execution_resource** shall be the **resource** of at most one **resource_property** with a **name** of 'table width', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_-with_unit**.

WR9: The **machining_execution_resource** is the **resource** of at most one **resource_property** with a **name** of 'axis travel', and the **representation** used to describe the **resource_property** shall contain at least one **representation_item** of type **measure_representation_item** and **length_measure_-with_unit**.

WR10: The **machining_execution_resource** shall satisfy the following conditions:

— the **machining_execution_resource** shall be the **resource** of at most one **resource_property** with a **name** of 'work volume 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**;

— the **machining_execution_resource** shall be the **resource** of at most one **resource_property** with a **name** of 'work volume width', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**;

— the **machining_execution_resource** shall be the **resource** of at most one **resource_property** with a **name** of 'work volume height', and the **representation** used to describe the **resource_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

WR11: The **machining_execution_resource** is the **resource** of no **resource_property** with a **name** of 'axis travel', or else the **machining_execution_resource** is the **resource** of no **resource_property** with a **name** of 'work volume length', 'work volume width', or 'work volume height'.

5.2.3.1.42 machining_feature_process

A **machining_feature_process** 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'.

5.2.3.1.43 machining_feature_relationship

A **machining_feature_relationship** is a type of **action_method_relationship** that represents use of a feature as the manufacturing target of a workingstep. See the ARM definitions for Workingstep and Turning_workingstep in ISO 14649-10 and ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_feature_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY;
(*
```

5.2.3.1.44 machining_feature_sequence_relationship

A **machining_feature_sequence_relationship** is a type of **machining_feature_relationship** and **sequential_method** that represents use of a feature as an element of a sequence of manufacturing targets of a workingstep. See the ARM definition for Turning_workingstep in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_feature_sequence_relationship
  SUBTYPE OF (machining_feature_relationship, sequential_method);
END_ENTITY;
(*
```

5.2.3.1.45 machining_feed_speed_representation

A **machining_feed_speed_representation** is a type of **representation** that represents the speed at which a tool is moved through material. The feed speed is described as one of the following:

:— as a linear speed, as described by the ARM definitions for the Technology "feedrate" attribute in ISO 14649-10 and Feed_velocity_type in ISO 14649-12;

— as a length measure, which is the distance moved per tooth of a tool, as described by the ARM definition for the Milling_technology "feedrate_per_tooth" attribute in ISO 14649-11;

— as a length measure, which is the distance moved per spindle revolution, as described by the ARM definitions for Turning_technology "feedrate_per_revolution" and Feed_per_rev_type in ISO 14649-12;

— as relative speed, expressed as a multiplier applied to a separate feed speed, as described by ARM definitions for the Drilling_type_strategy "reduced_feed_at_start", "reduced_feed_at_end", and Drilling_type_operation "feed_on_retract" attributes in ISO 14649-11, as well as definitions for the Turning_machining_strategy "variable_feedrate" and Contour_turning "variable_stepover_-feed" attributes in ISO 14649-12.

EXPRESS specification:

```
*)
ENTITY machining_feed_speed_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  (SELF.name IN ['feed speed', 'feed per revolution',
         'feed per tooth', 'relative speed']);

  WR2:  NOT (SELF.name = 'feed speed') OR
        ((verify_required_rep_item             (SELF, 'feed speed')) AND
         (verify_linear_speed_measure_rep_item (SELF, 'feed speed'))
        );

  WR3:  NOT (SELF.name = 'feed per revolution') OR
        ((verify_required_rep_item       (SELF, 'feed per revolution')) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'feed per revolution') AND NOT (
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)))))
        );

  WR4:  NOT (SELF.name = 'feed per tooth') OR
        ((verify_required_rep_item       (SELF, 'feed per tooth')) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'feed per tooth') AND NOT (
            'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)))))
        );

  WR5:  NOT (SELF.name = 'relative speed') OR
        ((verify_required_rep_item       (SELF, 'relative speed')) AND
         (verify_ratio_measure_rep_item  (SELF, 'relative speed'))
        );
END_ENTITY;
(*
```

Formal propositions:

WR1: The **name** of the **machining_feed_speed_representation** shall be either 'feed speed', 'feed per revolution', 'feed per tooth', or 'relative speed'.

WR2: If the **name** of the **machining_feed_speed_representation** is 'feed speed', the **items** set shall contain exactly one **representation_item** with a **name** of 'feed speed', which shall be of type **measure_representation_item** with a **value_component** of type **numeric_measure**.

WR3: If the **name** of the **machining_feed_speed_representation** is 'feed per revolution', the **items** set shall contain exactly one **representation_item** with a **name** of 'feed per revolution', which shall be of type **measure_representation_item** .

WR4: If the **name** of the **machining_feed_speed_representation** is 'feed per tooth', the **items** set shall contain exactly one **representation_item** with a **name** of 'feed per tooth', which shall be of type **measure_representation_item**.

WR5: If the **name** of the **machining_feed_speed_representation** is 'relative speed', the **items** set shall contain exactly one **representation_item** with a **name** of 'relative speed', which shall be of type **measure_representation_item** and **ratio_measure_with_unit**.

5.2.3.1.46 machining_final_feature_relationship

A **machining_final_feature_relationship** is a type of **action_method_relationship** that represents a feature visible on the final form of the workpiece that a workingstep may not manufacture directly, but in some way contributes to the creation of. See 4.2.197.1 for more information.

EXPRESS specification:

```
*)
ENTITY machining_final_feature_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY;
(*
```

5.2.3.1.47 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, Milling_machine_functions in ISO 14649-11, and Turning_machine_functions in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
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_pressure_measure_action_property
           (SELF, 'coolant pressure')) AND

         (verify_optional_action_property       (SELF, 'mist')) AND
```



```
        (verify_enumeration_action_property    (SELF, 'mist',
          ['mist on', 'mist off'])) AND

        (verify_optional_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_pressure_measure_action_property
          (SELF, 'through spindle pressure')) AND

        -- axis constraints property must contain zero or more ranges
        (0 = SIZEOF (QUERY (prop <* get_action_property
               (SELF, 'axis constraints') | NOT
                ((0 < SIZEOF (QUERY (prep <* USEDIN (prop,
           'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
             (0 <= SIZEOF (QUERY (it <* prep.representation.items |
                ('INTEGRATED_CNC_SCHEMA.VALUE_RANGE' in TYPEOF(it)))))
               )))))))
       );

WR2:  NOT (SELF.description = 'turning') 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 type')) AND
       (verify_enumeration_action_property    (SELF, 'coolant type',
         ['flood', 'mist', 'through tool'])) AND

       (verify_optional_action_property
         (SELF, 'coolant pressure')) AND
       (verify_pressure_measure_action_property
         (SELF, 'coolant pressure')) AND

       (verify_optional_action_property       (SELF, 'tail stock')) AND
       (verify_enumeration_action_property    (SELF, 'tail stock',
         ['tail stock used', 'tail stock not used'])) AND

       (verify_optional_action_property       (SELF, 'steady rest')) AND
       (verify_enumeration_action_property    (SELF, 'steady rest',
         ['steady rest used', 'steady rest not used'])) AND

       (verify_optional_action_property       (SELF, 'follow rest')) AND
       (verify_enumeration_action_property    (SELF, 'follow rest',
         ['follow rest used', 'follow rest not used']))
      );

WR3:  NOT (SELF.description IN ['milling', 'turning']) OR
      ((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_optional_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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_MODEL_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_MODEL'])) 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;
(*
```

<u>Formal propositions:</u>

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** that is of type **measure_representation_item** and have a **value_component** of type **numeric_measure**;

— 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 at most 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** that is of type **measure_representation_item** and have a **value_component** of type **numeric_measure**.

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'axis constraints', and the **representation** used to describe the **action_property** shall contain zero or more **representation_items** that are of type **value_range**.

WR2: If the **description** of the **machining_functions** is 'turning', 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 type', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'flood', 'mist', or 'through tool';

— 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** that is of type **measure_representation_item** and have a **value_component** of type **numeric_measure**;

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'tail stock', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'tail stock used' or 'tail stock not used';

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'steady rest', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'steady rest used' or 'steady rest not used';

— the **machining_functions** shall be the **definition** of at most one **action_property** with a **name** of 'follow rest', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'follow rest used' or 'follow rest not used'.

WR3: If the **description** of the **machining_functions** is either 'milling' or 'turning', the **machining_functions** shall satisfy the following conditions:

— 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 at most 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**;

— the **machining_functions** shall be the **relating_method** of zero or more **machining_process_-model_relationship**, in which **related_method** shall be 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 **machining_process_model_relationship** instances which refer to the same **machining_-functions** through **relating_method** shall have unique **sequence_position** values.

5.2.3.1.48 machining_functions_relationship

A **machining_functions_relationship** is a type of **action_method_relationship** that represents use of a Machine_functions description in some context. See the ARM definitions for Operation, Toolpath and their subtypes in ISO 14649-10, ISO 14649-11 and ISO 14649-12 for more information.

EXPRESS specification:

*)


```
ENTITY machining_functions_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY;
(*
```

5.2.3.1.49 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',
        'legacy function']);

  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_count_measure_action_property  (SELF, 'pallet index')));

  WR5:  NOT (SELF.description = 'index table') OR
        ((verify_required_action_property       (SELF, 'table index')) AND
         (verify_count_measure_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)))));

  WR8:  NOT (SELF.description = 'legacy function') OR
        ((verify_required_action_property       (SELF, 'function text')) AND
         (verify_descriptive_action_property    (SELF, 'function text')));
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', 'index table', 'load tool', 'unload tool', or 'legacy function'.

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 **represen-tation** used to describe the **action_property** shall contain a **representation_item** of type **measure_-representation_item** in which the **value_component** is of type **count_measure**.

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 'table index', and the **represen-tation** used to describe the **action_property** shall contain a **representation_item** of type **measure_-representation_item** in which the **value_component** is of type **count_measure**.

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**.

WR8: If the **description** of the **machining_nc_function** is 'legacy function', the **machining_nc_-function** shall be the **definition** of exactly one **action_property** with a **name** of 'function text', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item**.

5.2.3.1.50 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_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**.

5.2.3.1.51 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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH']))
       );

  WR2:  (verify_optional_action_property     (SELF, 'tool direction')) AND
        (verify_rep_type_for_action_property (SELF, 'tool direction',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_DIRECTION_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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY'])) AND

         (verify_required_relating_amr  (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS']))
        );
END_ENTITY;
(*
```

Formal propositions:

WR1: The **machining_operation** shall be the **relating_method** of zero or more instances of **machining_toolpath_sequence_relationship**, in which the **related_method** shall be 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_method** of exactly one **machining_technology_-relationship**, in which the **related_method** shall be of type **machining_technology**;

— the **machining_operation** shall be the **relating_method** of exactly one **machining_functions_-relationship**, in which the **related_method** shall be of type **machining_functions**.

Informal propositions:

IP1: All **machining_toolpath_sequence_relationship** instances which refer to the same **machining_-operation** through **relating_method** shall have unique **sequence_position** values.

5.2.3.1.52 machining_operation_relationship

A **machining_operation_relationship** is a type of **action_method_relationship** that represents use of an Operation to describe the action performed by a workingstep. See the ARM definitions for Workingstep and Turning_workingstep in ISO 14649-10 and ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_operation_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY;
(*
```

5.2.3.1.53 machining_operator_instruction

A **machining_operator_instruction** is a type of **action_method_with_associated_documents** 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 (action_method_with_associated_documents);
  WHERE
  WR1:  EXISTS (self.description) OR (0 < SIZEOF(self.documents));
END_ENTITY;
(*
```

Formal propositions:

WR1: Either the **description** of the **machining_operator_instruction** shall have a value, or the **documents** attribute shall contain at least one element.

NOTE This corresponds to local constraint **WR1** on the ARM entity **Setup_instruction** in ISO 14649-10.

5.2.3.1.54 machining_operator_instruction_relationship

A **machining_operator_instruction_relationship** is a type of **sequential_method** that represents use of a Setup_instruction as an element of a sequence of instructions in a Workpiece_setup. See the ARM definitions for Workpiece_setup in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_operator_instruction_relationship
  SUBTYPE OF (sequential_method);
END_ENTITY;
(*
```

5.2.3.1.55 machining_process_body_relationship

A **machining_process_body_relationship** is a type of **action_method_relationship** that represents use of an Executable as an element in the control flow described by another Executable. See the ARM definitions for the Executable subtypes in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_process_body_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY;
(*
```

5.2.3.1.56 machining_process_branch_relationship

A **machining_process_branch_relationship** is a type of **machining_process_body_relationship** that represents use of an Executable as an element in the branching control flow described by another Executable. See the ARM definitions for If_statement, Selective, and other Executable subtypes in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_process_branch_relationship
  SUBTYPE OF (machining_process_body_relationship);
END_ENTITY;
(*
```


5.2.3.1.57 machining_process_concurrent_relationship

A **machining_process_branch_relationship** is a type of **machining_process_body_relationship** and **concurrent_action_method** that represents use of an Executable as one of possibly several simultaneous elements in the control flow described by another Executable. See the ARM definitions for Parallel and other Executable subtypes in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_process_concurrent_relationship
  SUBTYPE OF (machining_process_body_relationship, concurrent_action_method);
END_ENTITY;
(*
```

5.2.3.1.58 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_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', 'setup instructions']);

  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_with_name  (SELF, 'true branch',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'])) AND
        (verify_related_type_for_amr_with_name   (SELF, 'true branch',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'],
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE'])) AND

        (verify_optional_relating_amr_with_name  (SELF, 'false branch',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'])) AND
        (verify_related_type_for_amr_with_name   (SELF, 'false branch',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'],
         ['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,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BODY_RELATIONSHIP'])) AND
        (verify_related_type_for_amr   (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BODY_RELATIONSHIP'],
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
       );

  WR5:  NOT (SELF.description = 'parallel') OR
       ((2 <= get_count_of_relating_amr (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_CONCURRENT_RELATIONSHIP']))
       AND
        (verify_related_type_for_amr   (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_CONCURRENT_RELATIONSHIP'],
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
       );

  WR6:  NOT (SELF.description = 'non-sequential') OR
       ((2 <= get_count_of_relating_amr (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BODY_RELATIONSHIP'])) AND
        (verify_related_type_for_amr   (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BODY_RELATIONSHIP'],
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
       );

  WR7:  NOT (SELF.description = 'selective') OR
       ((2 <= get_count_of_relating_amr (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'])) AND
        (verify_related_type_for_amr   (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'],
         ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
       );
```



```
  WR8:  NOT (SELF.description = 'setup instructions') OR
        ((verify_related_type_for_amr   (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATOR_INSTRUCTION_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATOR_INSTRUCTION']))
        );
END_ENTITY;
(*
```

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_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', 'while statement', or 'setup instructions'.

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_method** of exactly one **machining_-process_branch_relationship** with a **name** of 'true branch', in which the **related_method** is of type **machining_process_executable**;

— the **machining_process_executable** shall be the **relating_method** of at most one **machining_-process_branch_relationship** with a **name** of 'false branch', in which the **related_method** 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_method** of exactly one **machining_-process_body_relationship**, in which the **related_method** is of type **machining_-process_executable**.

WR5: If the **description** of the **machining_process_executable** is 'parallel', the **machining_-process_executable** shall be the **relating_method** of at least two instances of **machining_process_-concurrent_relationship**, in which the **related_method** is of type **machining_process_executable**.

WR6: If the **description** of the **machining_process_executable** is 'non-sequential', the **machining_-process_executable** shall be the **relating_method** of at least two instances of **machining_process_-body_relationship**, in which the **related** is of type **machining_process_executable**.

WR7: If the **description** of the **machining_process_executable** is 'selective', the **machining_-process_executable** shall be the **relating_method** of at least two instances of **machining_process_-branch_relationship**, in which the **related_method** is of type **machining_process_executable**.

WR8: If the **description** of the **machining_process_executable** is 'setup instructions', the **machining_process_executable** shall be the **relating_method** of zero or more instances of **machining_operator_instruction_relationship**, in which the **related_method** is of type **machining_operator_instruction**.

Informal propositions:

IP1: The **name** of a **machining_process_executable** shall be unique within the machining process.

5.2.3.1.59 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**.

5.2.3.1.60 machining_process_model_relationship

A **machining_process_model_relationship** is a type of **sequential_method** that represents use of a Process_model as an element of a sequence of models in a Machine_functions description. See the ARM definitions for the Machine_functions subtypes in ISO 14649-11 and ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_process_model_relationship
  SUBTYPE OF (sequential_method);
END_ENTITY;
(*
```

5.2.3.1.61 machining_process_sequence_relationship

A **machining_process_sequence_relationship** is a type of **machining_process_body_relationship** and **sequential_method** that represents use of an Executable as an element of a sequence in the control flow described by another Executable. See the ARM definitions for Workplan and other Executable subtypes in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_process_sequence_relationship
  SUBTYPE OF (machining_process_body_relationship, sequential_method);
END_ENTITY;
(*
```

5.2.3.1.62 machining_project

A **machining_project** is a type of **product** that represents a Project. See the ARM definitions for Project in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_project
          SUBTYPE OF (product);
  WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.' +
          'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | 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'))))
```

```
        )));


  WR2: (0 = SIZEOF (QUERY (pdf <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.' +
          'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | 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'))))
        )));


  WR3: (0 = SIZEOF (QUERY (pdf <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.' +
          'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | NOT

          (0 = SIZEOF (QUERY (pd <* USEDIN (pdf,
           'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION.FORMATION') | NOT

          -- it has one associated workplan.
          (1 = SIZEOF (QUERY (ppa <* USEDIN (pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROCESS_PRODUCT_ASSOCIATION.DEFINED_PRODUCT') |
             (ppa.process.name = 'machining') AND
             ('INTEGRATED_CNC_SCHEMA.MACHINING_WORKPLAN'
               IN TYPEOF (ppa.process.chosen_method)))))
          )))
        )));
END_ENTITY;
(*
```

<u>Formal propositions:</u>

WR1: Each **product_definition_formation** that refers to the **machining_project** as **of_product**, shall itself appear in the **items** set of at most one **applied_person_and_organization_assignment** instance in which **role** refers to a **person_and_organization_role** with a **name** of 'owner'.

WR2: Each **product_definition_formation** that refers to the **machining_project** as **of_product**, shall itself appear in the **items** set of at most one **applied_date_and_time_assignment** instance in which **role** refers to a **date_and_time_role** with a **name** of 'release date'.

WR3: Each **product_definition** that refers to a **product_definition_formation** that refers to the **machining_project** as **of_product**, shall itself appear as the **defined_product** of exactly one **process_product_association** instance in which **process** shall have a **name** of 'machining' and a **chosen_method** of type **machining_workplan**.

5.2.3.1.63 machining_project_workpiece_relationship

A **machining_project_workpiece_relationship** is a type of **product_definition_relationship** that represents use of an Workpiece as an element of a Project. See the ARM definitions for Project in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_project_workpiece_relationship
  SUBTYPE OF (product_definition_relationship);
END_ENTITY;
(*
```

5.2.3.1.64 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'])));
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**.

5.2.3.1.65 machining_setup

A **machining_setup** is a type of **product** that represents a Setup. See the ARM definitions for Setup in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_setup
  SUBTYPE OF (product);
  WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* USEDIN (SELF,
```

```
          'INTEGRATED_CNC_SCHEMA.' +
          'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | NOT

          (0 = SIZEOF (QUERY (pd <* USEDIN (pdf,
           'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION.FORMATION') | NOT

          -- it has one associated security plane.
          (1 = SIZEOF (QUERY (prop <* USEDIN (pd,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
             (prop.name = 'security plane'))))
          )))
        )));

END_ENTITY;
(*
```

Formal propositions:

WR1: Each **product_definition** that refers to a **product_definition_formation** that refers to the **machining_setup** shall be the **definition** of exactly one **property_definition** with a **name** of 'security plane'.

5.2.3.1.66 machining_setup_workpiece_relationship

A **machining_setup_workpiece_relationship** is a type of **product_definition_relationship** that represents use of an Workpiece as an element of a Setup in a Workpiece_setup. See the ARM definitions for Setup and Workpiece_setup in ISO 14649-10 for more information.

EXPRESS specification:

```
*)
ENTITY machining_setup_workpiece_relationship
  SUBTYPE OF (product_definition_relationship);
END_ENTITY;
(*
```

5.2.3.1.67 machining_spindle_speed_representation

A **machining_spindle_speed_representation** is a type of **representation** that represents the speed at which a machine tool spindle rotates. The spindle speed is described as one of the following:

:— as a rotational speed, as described by the ARM definitions for the Milling_technology "spindle" attribute in ISO 14649-11 and Const_spindle_speed in ISO 14649-12;

— as a linear speed measured at the contact point between tool and surface, as described by the ARM definition for Milling_technology "cutspeed" attribute in ISO 14649-11 and Const_cutting_speed in ISO 14649-12;

— as relative speed, expressed as a multiplier applied to a separate spindle speed, as described by the ARM definitions for the Drilling_type_strategy "reduced_cut_at_start" and "reduced_feed_at_-end" attributes in ISO 14649-11.

EXPRESS specification:

```
*)
ENTITY machining_spindle_speed_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  (SELF.name IN ['spindle speed', 'cutting speed', 'relative speed']);

  WR2:  NOT (SELF.name = 'spindle speed') OR
        ((verify_required_rep_item             (SELF, 'rotational speed')) AND
         (verify_rotary_speed_measure_rep_item (SELF, 'rotational speed'))
        );

  WR3:  NOT (SELF.name = 'cutting speed') OR
        ((verify_required_rep_item             (SELF, 'surface speed')) AND
         (verify_linear_speed_measure_rep_item (SELF, 'surface speed')) AND

         (verify_optional_rep_item
           (SELF, 'maximum rotational speed')) AND
         (verify_rotary_speed_measure_rep_item
           (SELF, 'maximum rotational speed'))
        );

  WR4:  NOT (SELF.name = 'relative speed') OR
        ((verify_required_rep_item             (SELF, 'relative speed')) AND
         (verify_ratio_measure_rep_item        (SELF, 'relative speed'))
        );
END_ENTITY;
(*
```

Formal propositions:

WR1: The **name** of the **machining_spindle_speed_representation** shall be either 'spindle speed', 'cutting speed', or 'relative speed'.

WR2: If the **name** of the **machining_spindle_speed_representation** is 'spindle speed', the **items** set shall contain exactly one **representation_item** with a **name** of 'rotational speed', which shall be of type **measure_representation_item** with a **value_component** of type **numeric_measure**.

WR3: If the **name** of the **machining_spindle_speed_representation** is 'cutting speed', the **items** set shall contain the following items:

— exactly one **representation_item** with a **name** of 'surface speed', which shall be type **measure_representation_item** with a **value_component** of type **numeric_measure**;

— at most one **representation_item** with a **name** of 'maximum rotational speed', which shall be type **measure_representation_item** with a **value_component** of type **numeric_measure**.

WR4: If the **name** of the **machining_spindle_speed_representation** is 'relative speed', the **items** set shall contain exactly one **representation_item** with a **name** of 'relative speed', which shall be of type **measure_representation_item** and **ratio_measure_with_unit**.

5.2.3.1.68 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;
(*
```

5.2.3.1.69 machining_strategy_relationship

A **machining_strategy_relationship** is a type of **action_method_relationship** that represents use of a Two5d_milling_strategy, Drilling_type_strategy, Freeform_strategy, Turning_machining_strategy, or Approach_retract_strategy description in some context. See the ARM definitions for the Operation subtypes in ISO 14649-11 and ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_strategy_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY;
(*
```

5.2.3.1.70 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 Milling_technology in ISO 14649-11, and Turning_technology in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_technology
  SUBTYPE OF (action_method);
  WHERE
  WR1:  (verify_optional_action_property      (SELF, 'feedrate')) AND
        (verify_rep_type_for_action_property  (SELF, 'feedrate',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION']));

  WR2:  (verify_optional_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, 'spindle')) AND
         (verify_rep_type_for_action_property (SELF, 'spindle',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])) AND

         (verify_optional_action_property
           (SELF, 'synchronize spindle with feed')) AND
         (verify_enumeration_action_property
           (SELF, 'synchronize spindle with feed',
           ['synchronized', 'not synchronized'])) AND

         (verify_optional_action_property
           (SELF, 'inhibit feedrate override')) AND
         (verify_enumeration_action_property
           (SELF, 'inhibit feedrate override',
           ['override allowed', 'override not allowed'])) AND

         (verify_optional_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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP']))
AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY']))
        );

  WR4:  NOT (SELF.description = 'milling') OR
        ((verify_required_relating_amr (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP'])) OR

         (verify_required_action_property     (SELF, 'spindle') AND
          verify_rep_name_for_action_property (SELF, 'spindle',
           ['spindle speed', 'cutting speed']))
        );

  WR5:  NOT (SELF.description = 'milling') OR
        ((verify_required_relating_amr (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP'])) OR

         (verify_required_action_property     (SELF, 'feedrate') AND
          verify_rep_name_for_action_property (SELF, 'feedrate',
           ['feed speed', 'feed per tooth']))
        );

  WR6:  NOT (SELF.description = 'turning') OR
        ((verify_optional_action_property     (SELF, 'spindle')) AND
         (verify_rep_type_for_action_property (SELF, 'spindle',
```



```
         ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])) AND
         (verify_rep_name_for_action_property (SELF, 'spindle',
           ['spindle speed', 'cutting speed'])) AND

         (verify_rep_name_for_action_property (SELF, 'feedrate',
           ['feed speed', 'feed per revolution'])) AND

         (verify_optional_action_property
           (SELF, 'synchronize spindle with z feed')) AND
         (verify_enumeration_action_property
           (SELF, 'synchronize spindle with z feed',
           ['synchronized', 'not synchronized'])) AND

         (verify_optional_action_property
           (SELF, 'inhibit feedrate override')) AND
         (verify_enumeration_action_property
           (SELF, 'inhibit feedrate override',
           ['override allowed', 'override not allowed'])) AND

         (verify_optional_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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP']))
AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY']))
        );
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 be of type **machining_feed_speed_representation**.

WR2: The **machining_technology** shall be the **definition** of at most 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'.

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 'spindle', and the **representation** used to describe the **action_property** shall be of type **machining_spindle_speed_representation**;

— the **machining_technology** shall be the **definition** of at most 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 at most 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 at most 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_method** of at most one **machining_adaptive_-control_relationship**, in which the **related_method** shall be of type **machining_technology**.

WR4: If the **description** of the **machining_technology** is 'milling', either the **machining_technology** shall be the **relating_method** of exactly one **machining_adaptive_control_relationship**, or else the **machining_technology** shall be the **definition** of exactly one **action_property** with a **name** of 'spindle', and the **representation** used to describe the **action_property** shall have a **description** of either 'spindle speed' or 'cutting speed'.

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

WR5: If the **description** of the **machining_technology** is 'milling', either the **machining_technology** shall be the **relating_method** of exactly one **machining_adaptive_control_relationship**, or else the **machining_technology** shall be the **definition** of exactly one **action_property** with a **name** of 'feedrate', and the **representation** used to describe the **action_property** shall have a **description** of either 'feed speed' or 'feed per tooth'.

NOTE This corresponds to local constraint **WR2** on the ARM entity Milling_technology in ISO 14649-11

WR6: If the **description** of the **machining_technology** is 'turning', 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 'spindle', and the **representation** used to describe the **action_property** shall be of type **machining_spindle_speed_representation** with a **description** of either 'spindle speed' or 'cutting speed';

— if the **machining_technology** is the **definition** of an **action_property** with a **name** of 'feedrate', the **representation** used to describe the **action_property** shall have a **description** of either 'feed speed' or 'feed per revolution';

— the **machining_technology** shall be the **definition** of at most one **action_property** with a **name** of 'synchronize spindle with z 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 at most 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 at most 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_method** of at most one **machining_adaptive_control_relationship**, in which the **related_method** shall be of type **machining_technology**.

5.2.3.1.71 machining_technology_relationship

A **machining_technology_relationship** is a type of **action_method_relationship** that represents use of a Technology description in some context. See the ARM definitions for Operation, Toolpath and their subtypes in ISO 14649-10, ISO 14649-11 and ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_technology_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY;
(*
```

5.2.3.1.72 machining_tool

A **machining_tool** is a type of **action_resource** that represents tool requirements for machining. See the ARM definitions for Machining_tool in ISO 14649-10, Milling_machine_cutting_tool in ISO 14649-111, and Turning_machine_cutting_tool in ISO 14649-121 for more information.

NOTE The action resource concept is used here because this describes required resources (tools) to perform an action method (machining workingstep). Design information about individual tools (not just usage requirements) can be represented using the product and product_definition_formation concepts rather than action_resource. The machining_tool_usage type represents the bridge between these two descriptions.

EXPRESS specification:

```
*)
ENTITY machining_tool
  SUBTYPE OF (action_resource);
  WHERE
  WR1:  NOT (SELF.kind.name = 'milling cutting tool') OR
        ((0 <= SIZEOF (QUERY (arr <* USEDIN (SELF,
```



```
'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE_RELATIONSHIP.RELATING_RESOURCE') |
          (('INTEGRATED_CNC_SCHEMA.MACHINING_CUTTING_COMPONENT'
             IN TYPEOF (arr.related_resource)) AND
           (arr.related_resource.kind.name = 'milling cutting edge') )))) AND

         (verify_optional_tool_body_item
           (SELF, 'overall assembly length')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'overall assembly length')) AND

         (verify_optional_tool_body_item
           (SELF, 'effective cutting diameter')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'effective cutting diameter')) AND

         (verify_optional_tool_body_item
           (SELF, 'maximum depth of cut')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'maximum depth of cut')) AND

         (verify_optional_tool_body_item (SELF, 'hand of cut')) AND
         (verify_enumeration_tool_body_item (SELF, 'hand of cut',
           ['left', 'right', 'neutral'])) AND

         (verify_optional_tool_body_item (SELF, 'coolant through tool')) AND
         (verify_enumeration_tool_body_item (SELF, 'coolant through tool',
           ['supported', 'not supported']))
        );

  WR2:  NOT ((SELF.kind.name = 'milling cutting tool') AND
        (SELF.description IN [ 'counterbore', 'countersink',
         'spade drill', 'spot drill', 'step drill', 'tapered drill',
         'twist drill', 'drill']))
        OR
        ((verify_optional_tool_body_item      (SELF, 'point angle')) AND
         (verify_angle_measure_tool_body_item (SELF, 'point angle'))
        );

  WR3:  NOT ((SELF.kind.name = 'milling cutting tool') AND
        (SELF.description = 'countersink'))
        OR
        ((verify_optional_tool_body_item
           (SELF, 'minimum cutting diameter')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'minimum cutting diameter')) AND

         (verify_required_tool_body_item
           (SELF, 'maximum usable length')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'maximum usable length'))
        );

  WR4:  NOT ((SELF.kind.name = 'milling cutting tool') AND
```



```
       (SELF.description = 'tapered drill'))
       OR
       ((verify_required_tool_body_item      (SELF, 'taper angle')) AND
        (verify_angle_measure_tool_body_item (SELF, 'taper angle'))
       );

  WR5: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'step drill'))
       OR
       ((verify_required_tool_body_item      (SELF, 'step diameters')) AND
        (verify_rep_item_for_tool_body
          (SELF, 'step diameters',
          ['INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'])) AND

        (verify_required_tool_body_item      (SELF, 'step lengths')) AND
        (verify_rep_item_for_tool_body
          (SELF, 'step lengths',
          ['INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM']))
       );

  WR6: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description IN [ 'ballnose endmill', 'bullnose endmill',
        'dovetail mill', 'endmill', 'facemill', 'profiled endmill',
        'shoulder mill', 'tee slot mill', 'thread mill', 'side mill']))
       OR
       ((verify_optional_tool_body_item
          (SELF, 'number of effective teeth')) AND
        (verify_count_measure_tool_body_item
          (SELF, 'number of effective teeth')) AND

        (verify_optional_tool_body_item       (SELF, 'edge radius')) AND
        (verify_length_measure_tool_body_item (SELF, 'edge radius'))
       );

  WR7: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description IN [ 'ballnose endmill', 'bullnose endmill',
        'endmill', 'facemill', 'profiled endmill']))
       OR
       ((verify_optional_tool_body_item
          (SELF, 'tool cutting edge angle')) AND
        (verify_angle_measure_tool_body_item
          (SELF, 'tool cutting edge angle'))
       );

  WR8: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'ballnose endmill'))
       OR verify_ballnose_endmill_dimensions (SELF);

  WR9: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'bullnose endmill'))
       OR verify_bullnose_endmill_dimensions (SELF);

  WR10: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'tee slot mill'))
```



```
      OR
      ((verify_optional_tool_body_item       (SELF, 'cutting width')) AND
       (verify_length_measure_tool_body_item (SELF, 'cutting width'))
      );

WR11: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description = 'dovetail mill'))
      OR
      ((verify_optional_tool_body_item       (SELF, 'included angle')) AND
       (verify_angle_measure_tool_body_item  (SELF, 'included angle'))
      );

WR12: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description = 'side mill'))
      OR
      ((verify_optional_tool_body_item       (SELF, 'cutter width')) AND
       (verify_length_measure_tool_body_item (SELF, 'cutter width'))
      );


WR13: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description IN [ 'thread mill', 'tapping tool',
       'combined drill and tap']))
      OR
      ((verify_required_tool_body_item  (SELF, 'thread form type')) AND
       (verify_rep_item_for_tool_body   (SELF, 'thread form type',
         ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'])) AND

       (verify_required_tool_body_item       (SELF, 'thread size')) AND
       (verify_length_measure_tool_body_item (SELF, 'thread size')) AND

       (verify_required_tool_body_item       (SELF, 'thread pitch')) AND
       (verify_length_measure_tool_body_item (SELF, 'thread pitch'))
      );


WR14: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description IN [ 'tapping tool', 'combined drill and tap']))
      OR
      ((verify_required_tool_body_item
         (SELF, 'taper thread count')) AND
       (verify_count_measure_tool_body_item
         (SELF, 'taper thread count'))
      );

WR15: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description IN [ 'reamer', 'combined drill and reamer',
       'tapered reamer']))
      OR
      ((verify_required_tool_body_item       (SELF, 'taper length')) AND
       (verify_length_measure_tool_body_item (SELF, 'taper length'))
      );

WR16: NOT ((SELF.kind.name = 'milling cutting tool') AND
```

```
       (SELF.description = 'tapered reamer'))
       OR
       ((verify_required_tool_body_item       (SELF, 'taper angle')) AND
        (verify_angle_measure_tool_body_item  (SELF, 'taper angle'))
       );

  WR17: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description IN [ 'combined drill and reamer',
        'combined drill and tap']))
       OR
       ((verify_required_tool_body_item       (SELF, 'drill length')) AND
        (verify_length_measure_tool_body_item (SELF, 'drill length'))
       );

  WR18: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'boring tool'))
       OR
       ((verify_required_tool_body_item    (SELF, 'retract movement')) AND
        (verify_enumeration_tool_body_item (SELF, 'retract movement',
          ['permitted', 'forbidden']))
       );

  WR19: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'user defined milling tool'))
       OR
       ((verify_required_tool_body_item  (SELF, 'tool identifier')) AND
        (verify_rep_item_for_tool_body   (SELF, 'tool identifier',
          ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']))
       );

  WR20: NOT (SELF.kind.name = 'turning cutting tool') OR
       ((verify_required_tool_body_item       (SELF, 'functional length')) AND
        (verify_length_measure_tool_body_item (SELF, 'functional length')) AND

        (verify_required_tool_body_item       (SELF, 'f dimension')) AND
        (verify_length_measure_tool_body_item (SELF, 'f dimension')) AND

        (verify_optional_tool_body_item
          (SELF, 'minimum cutting diameter')) AND
        (verify_length_measure_tool_body_item
          (SELF, 'minimum cutting diameter')) AND

        (verify_optional_tool_body_item
          (SELF, 'a dimension on f')) AND
        (verify_length_measure_tool_body_item
          (SELF, 'a dimension on f')) AND

        (verify_optional_tool_body_item
          (SELF, 'a dimension on lf')) AND
        (verify_length_measure_tool_body_item
          (SELF, 'a dimension on lf')) AND

        (verify_optional_tool_body_item    (SELF, 'hand of cut')) AND
        (verify_enumeration_tool_body_item (SELF, 'hand of cut',
```



```
          ['left', 'right', 'neutral'])) AND

         (0 <= SIZEOF (QUERY (arr <* USEDIN (SELF,

'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE_RELATIONSHIP.RELATING_RESOURCE') |
          (('INTEGRATED_CNC_SCHEMA.MACHINING_CUTTING_COMPONENT'
             IN TYPEOF (arr.related_resource)) AND
           (arr.related_resource.kind.name = 'turning cutting edge') ))))
        );

  WR21: NOT ((SELF.kind.name = 'turning cutting tool') AND
        (SELF.description = 'turning threading tool'))
        OR
        ((verify_required_tool_body_item       (SELF, 'threading pitch')) AND
         (verify_length_measure_tool_body_item (SELF, 'threading pitch')) AND

         (verify_required_tool_body_item       (SELF, 'thread hand')) AND
         (verify_enumeration_tool_body_item    (SELF, 'thread hand',
           ['left', 'right'])) AND

         (verify_required_tool_body_item       (SELF, 'thread type')) AND
         (verify_enumeration_tool_body_item    (SELF, 'thread type',
           ['internal', 'external'])) AND

         (verify_required_tool_body_item       (SELF, 'thread profile')) AND
         (verify_enumeration_tool_body_item    (SELF, 'thread profile',
           ['full', 'partial'])) AND

         (verify_required_tool_body_item  (SELF, 'thread form type')) AND
         (verify_rep_item_for_tool_body   (SELF, 'thread form type',
           ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']))
        );

  WR22: NOT ((SELF.kind.name = 'turning cutting tool') AND
        (SELF.description = 'grooving tool'))
        OR
        ((verify_required_tool_body_item
           (SELF, 'cutting width')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'cutting width')) AND

         (verify_required_tool_body_item
           (SELF, 'maximum grooving depth')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'maximum grooving depth')) AND

         (verify_optional_tool_body_item
           (SELF, 'corner radius')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'corner radius')) AND

         (verify_optional_tool_body_item
           (SELF, 'maximum axial grooving diameter')) AND
         (verify_length_measure_tool_body_item
```

```
          (SELF, 'maximum axial grooving diameter')) AND

         (verify_optional_tool_body_item
           (SELF, 'minimum axial grooving diameter')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'minimum axial grooving diameter'))
        );

  WR23: NOT ((SELF.kind.name = 'turning cutting tool') AND
        (SELF.description = 'knurling tool'))
        OR
        ((verify_required_tool_body_item    (SELF, 'knurl pattern')) AND
         (verify_enumeration_tool_body_item (SELF, 'knurl pattern',
           ['straight', 'diagonal', 'diamond'])) AND

         (verify_optional_tool_body_item       (SELF, 'cutting length')) AND
         (verify_length_measure_tool_body_item (SELF, 'cutting length')) AND

         (verify_optional_tool_body_item       (SELF, 'cutting angle')) AND
         (verify_angle_measure_tool_body_item  (SELF, 'cutting angle')) AND

         (verify_optional_tool_body_item       (SELF, 'cutting pitch')) AND
         (verify_length_measure_tool_body_item (SELF, 'cutting pitch'))
        );

  WR24: NOT ((SELF.kind.name = 'turning cutting tool') AND
        (SELF.description = 'user defined turning tool'))
        OR
        ((verify_required_tool_body_item  (SELF, 'tool identifier')) AND
         (verify_rep_item_for_tool_body   (SELF, 'tool identifier',
           ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']))
        );

  WR25: (1 >= SIZEOF (QUERY (rar <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.REQUIREMENT_FOR_ACTION_RESOURCE.RESOURCES') |
         ((1 = SIZEOF(rar.operations)) AND
          ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_USAGE'
           IN TYPEOF (rar\action_resource_requirement.operations[1])))
        )));
END_ENTITY;
(*
```

Formal propositions:

WR1: 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 **relating** in zero or more **action_resource_relationship** in which the **related** is of type **machining_cutting_component** and the **kind** of the **machining_cutting_-component** is an **action_resource_type** with a **name** of 'milling cutting edge';

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'overall assembly length' which shall be of type **measure_representation_item** and **length_measure_-**

with_unit. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'effective cutting diameter' which shall be of type **measure_representation_item** and **length_measure_-with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'maximum depth of cut' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to 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'. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to 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'. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR2: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'counterbore', 'countersink', 'spade drill', 'spot drill', 'step drill', 'tapered drill', 'twist drill', or 'drill', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'point angle' which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR3: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'countersink', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'minimum cutting diameter' which shall be of type **measure_representation_item** and **length_measure_-with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'maximum usable length' which shall be of type **measure_representation_item** and **length_measure_-with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR4: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'tapered drill', **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'taper angle' which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR5: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'step drill', **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'step diameters' which shall be of type **compound_representation_item**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'step lengths' which shall be of type **compound_representation_item**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR6: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'ballnose endmill', 'bullnose endmill', 'dovetail mill', 'endmill', 'facemill', 'profiled endmill', 'shoulder mill', 'tee slot mill', 'thread mill', or 'side mill', **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'number of effective teeth', which shall be of type which shall be of type **measure_representation_item** with a **value_component** of type **count_measure**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'edge radius' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR7: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'ballnose endmill', 'bullnose endmill', 'endmill', 'facemill', or 'profiled endmill', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'tool cutting edge angle' which shall be of type **measure_representation_item** and **plane_angle_measure_-with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR8: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'ballnose endmill', the conditions tested by the **verify_ballnose_endmill_dimensions** shall be satisfied.

NOTE This corresponds to the local constraint **WR1**on **Ballnose_endmill** in ISO 14649-111

WR9: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'bullnose endmill', the conditions tested by the **verify_bullnose_endmill_dimensions** shall be satisfied.

NOTE This corresponds to the local constraint **WR1**on **Bullnose_endmill** in ISO 14649-111

WR10: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'tee slot mill', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'cutting width' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR11: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'dovetail mill', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to 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**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR12: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'side mill', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'cutter width' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type

machining_tool_body_representation which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR13: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'thread mill', 'tapping tool', or 'combined drill and tap', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'thread form type' which shall be of type **descriptive_representation_item**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'thread size' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'thread pitch' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR14: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'tapping tool' or 'combined drill and tap', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'number of effective teeth', which shall be of type which shall be of type **measure_representation_item** with a **value_component** of type **count_measure**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR15: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'reamer', 'combined drill and reamer', or 'tapered reamer', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'taper length' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR16: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'tapered reamer', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'taper angle' which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR17: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'combined drill and reamer' or 'combined drill and tap', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'drill length' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR18: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'boring tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to 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'. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR19: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'milling cutting tool' and the **description** of the **machining_tool** is 'user defined milling tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'tool identifier', which shall be of type **descriptive_representation_item**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR20: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'turning cutting tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'functional length' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'f dimension' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type

machining_tool_body_representation which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'minimum cutting diameter' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'a dimension on f' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'a dimension on lf' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to 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'. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is the **relating** in zero or more **action_resource_relationship** in which the **related** is of type **machining_cutting_component** and the **kind** of the **machining_cutting_component** is an **action_resource_type** with a **name** of 'turning cutting edge'.

WR21: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'turning cutting tool' and the **description** of the **machining_tool** is 'turning threading tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'thread pitch' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'thread hand' which shall be of type **descriptive_representation_item** with a **description** of 'left' or 'right'. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'thread type' which shall be of type **descriptive_representation_item** with a **description** of 'internal' or 'external'. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'thread profile' which shall be of type **descriptive_representation_item** with a **description** of 'full' or 'partial'. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'thread form type' which shall be of type **descriptive_representation_item**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR22: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'turning cutting tool' and the **description** of the **machining_tool** is 'grooving tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'cutting width' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'maximum grooving depth' which shall be of type **measure_representation_item** and **length_measure_with_unit**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'corner radius' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'maximum axial grooving diameter' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'minimum axial grooving diameter' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR23: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'turning cutting tool' and the **description** of the **machining_tool** is 'knurling tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'knurl pattern' which shall be of type **descriptive_representation_item** with a **description** of 'straight', 'diagonal', or 'diamond'. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'cutting length' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'cutting angle' which shall be of type **measure_representation_item** and **plane_angle_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**;

— the **machining_tool** is related to at most one **representation_item** with a **name** of 'cutting pitch' which shall be of type **measure_representation_item** and **length_measure_with_unit**. If present, the **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR24: If the **kind** of the **machining_tool** is an **action_resource_type** with a **name** of 'turning cutting tool' and the **description** of the **machining_tool** is 'user defined turning tool', the **machining_tool** shall satisfy the following conditions:

— the **machining_tool** is related to exactly one **representation_item** with a **name** of 'tool identifier', which shall be of type **descriptive_representation_item**. The **representation_item** shall appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the **machining_tool**.

WR25: The **machining_tool** shall be a member of the **resources** attribute of at most one **requirement_for_action_resource** which has an **operations** attribute containing a single instance which is of type **machining_tool_usage**.

Informal propositions:

IP1: The **machining_tool name** shall be unique.

5.2.3.1.73 machining_tool_body_representation

A **machining_tool_body_representation** is a type of **representation** that describes the body configuration parameters of a tool for machining.

EXPRESS specification:

```
*)
ENTITY machining_tool_body_representation
  SUBTYPE OF (representation);
END_ENTITY;
(*
```

5.2.3.1.74 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
        ((verify_required_rep_item       (SELF, '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
       ((verify_required_rep_item       (SELF, 'tool direction tilt angle')) AND
        (verify_angle_measure_rep_item  (SELF, 'tool direction tilt angle')) AND

        (verify_required_rep_item       (SELF, 'tool direction yaw angle')) AND
        (verify_angle_measure_rep_item  (SELF, 'tool direction yaw angle'))
        );
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'.

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**.

5.2.3.1.75 machining_tool_usage

A **machining_tool_usage** is a type of **action_method** that represents tool usage to satisfy requirements for machining. See the ARM definition for Tool_usage in 4.2.370 for more information.

EXPRESS specification:

```
*)
ENTITY machining_tool_usage
  SUBTYPE OF (action_method);
  WHERE
  WR1:  ((verify_optional_action_property    (SELF, 'tool position')) AND
         (verify_descriptive_action_property (SELF, 'tool position')));

  WR2:  ((verify_optional_action_property    (SELF, 'tool carousel')) AND
         (verify_descriptive_action_property (SELF, 'tool carousel')));

  WR3:  (1 >= SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'tool usage')))) AND
        (0 = SIZEOF (QUERY (act <*
          USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.ACTION.CHOSEN_METHOD') |
          (act.name = 'tool usage') AND NOT
          ('INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION_PROCESS' IN TYPEOF (act))
        )));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **machining_tool_usage** shall be the **definition** of at most one **action_property** with a **name** of 'tool position', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item**.

WR2: The **machining_tool_usage** shall be the **definition** of at most one **action_property** with a **name** of 'tool carousel', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item**.

WR3: The **machining_tool_usage** shall be the **chosen_method** of at most one **product_definition_-process** with a **name** of 'tool usage'.

5.2.3.1.76 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:  (SELF.description IN ['feedstop', 'axis trajectory',
        'cutter location trajectory', 'cutter contact trajectory',
        'approach lift path angle', 'approach lift path tangent',
        'connect security plane', 'connect direct']);

  WR2:  (verify_optional_action_property        (SELF, 'priority')) AND
        (verify_enumeration_action_property     (SELF, 'priority',
         ['required', 'suggested']));

  WR3:  (verify_optional_action_property        (SELF, 'trajectory type')) AND
        (verify_enumeration_action_property     (SELF, 'trajectory type',
         ['approach', 'lift', 'connect', 'non-contact',
          'contact', 'trajectory path']));

  WR4:  ((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)) )))
         )))
        );

  WR5:  (verify_optional_relating_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY_RELATIONSHIP'])) AND
        (verify_related_type_for_amr    (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY']));

  WR6:  (verify_optional_relating_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'])) AND
        (verify_related_type_for_amr    (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS']));


  WR7:  NOT (SELF.description IN ['axis trajectory',
                'cutter location trajectory',
```



```
                'cutter contact trajectory']) OR
        ((verify_optional_action_property    (SELF, 'direction')) AND
         (verify_enumeration_action_property (SELF, 'direction',
          ['beginning to end', 'end to beginning']))
        );


  WR8:  NOT (SELF.description = 'connect security plane') OR
        ((verify_optional_action_property     (SELF, 'up direction')) AND
         (verify_rep_item_for_action_property (SELF, 'up direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

         (verify_optional_action_property     (SELF, 'down direction')) AND
         (verify_rep_item_for_action_property (SELF, 'down direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION']))
        );

  WR9:  NOT (SELF.description = 'feedstop') OR
        ((verify_required_action_property     (SELF, 'dwell')) AND
         (verify_time_measure_action_property (SELF, 'dwell'))
        );

  WR10: NOT (SELF.description = 'axis trajectory') OR
        ((verify_required_action_property     (SELF, 'axis commands')) AND

         -- axis commands property must contain one or more bounded curves
        (0 = SIZEOF (QUERY (prop <* get_action_property (SELF, 'axis commands')
|
          NOT ((0 < SIZEOF (QUERY (prep <* USEDIN (prop,
               'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY')
|
              (1 <= SIZEOF (QUERY (it <* prep.representation.items |
                 ('INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE' in TYPEOF(it)))))
                )))))))
        );

  WR11: NOT (SELF.description IN ['approach lift path angle',
           'approach lift path tangent']) OR
        ((verify_required_action_property     (SELF, 'fix point')) AND
         (verify_rep_item_for_action_property (SELF, 'fix point',
           ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT'])) AND

        (verify_optional_action_property     (SELF, 'fix point direction')) AND
         (verify_rep_item_for_action_property (SELF, 'fix point direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION']))
        );

  WR12: NOT (SELF.description = 'approach lift path angle') OR
        ((verify_required_action_property      (SELF, 'angle')) AND
         (verify_angle_measure_action_property (SELF, 'angle')) AND

         (verify_required_action_property       (SELF, 'bend distance')) AND
         (verify_length_measure_action_property (SELF, 'bend distance'))
        );
```

```
WR13: NOT (SELF.description = 'approach lift path tangent') OR
      ((verify_required_action_property       (SELF, 'radius')) AND
       (verify_length_measure_action_property (SELF, 'radius'))
      );

WR14: NOT (SELF.description = 'cutter location trajectory') OR
      ((verify_required_action_property     (SELF, 'basic curve')) AND
       (verify_rep_item_for_action_property (SELF, 'basic curve',
         ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

       (verify_optional_action_property     (SELF, 'surface normal')) AND
       (verify_rep_item_for_action_property (SELF, 'surface normal',
         ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

       (verify_optional_action_property     (SELF, 'tool axis')) AND
       (verify_rep_item_for_action_property (SELF, 'tool axis',
         ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

       (verify_optional_action_property
        (SELF, 'path maximum deviation')) AND
       (verify_length_measure_action_property
        (SELF, 'path maximum deviation')) AND

       (verify_optional_action_property
        (SELF, 'tool axis maximum deviation')) AND
       (verify_angle_measure_action_property
        (SELF, 'tool axis maximum deviation'))
      );

WR15: NOT (SELF.description = 'cutter contact trajectory') OR
      ((((verify_required_action_property     (SELF, 'basic curve')) AND
         (verify_rep_item_for_action_property (SELF, 'basic curve',
          ['INTEGRATED_CNC_SCHEMA.BOUNDED_PCURVE'])) )

         OR

        ((verify_required_action_property     (SELF, 'basic curve')) AND
         (verify_rep_item_for_action_property (SELF, 'basic curve',
          ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

         (verify_required_action_property     (SELF, 'surface normal')) AND
         (verify_rep_item_for_action_property (SELF, 'surface normal',
          ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) )
        ) AND

       (verify_optional_action_property     (SELF, 'tool axis')) AND
       (verify_rep_item_for_action_property (SELF, 'tool axis',
         ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

       (verify_optional_action_property     (SELF, 'contact type')) AND
       (verify_enumeration_action_property  (SELF, 'contact type',
         ['side', 'front'])) AND
```



```
         (verify_optional_action_property
          (SELF, 'path maximum deviation')) AND
         (verify_length_measure_action_property
          (SELF, 'path maximum deviation')) AND

         (verify_optional_action_property
          (SELF, 'tool axis maximum deviation')) AND
         (verify_angle_measure_action_property
          (SELF, 'tool axis maximum deviation'))
        );

END_ENTITY;
(*
```

Formal propositions:

WR1: The **description** of the **machining_toolpath** shall be either ''feedstop', 'axis trajectory', 'cutter location trajectory', 'cutter contact trajectory', 'approach lift path angle', 'approach lift path tangent', 'connect security plane', or 'connect direct'.

WR2: The **machining_toolpath** shall be the **definition** of at most 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'.

WR3: The **machining_toolpath** shall be the **definition** of at most 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'.

WR4: 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**.

WR5: The **machining_toolpath** shall be the **relating_method** of at most one **machining_-technology_relationship**, in which the **related_method** shall be of type **machining_technology**.

WR6: The **machining_toolpath** shall be the **relating_method** of at most one **machining_-functions_relationship**, in which the **related_method** shall be of type **machining_functions**.

WR7: If the **description** of the **machining_toolpath** is 'axis trajectory', 'cutter location trajectory', or 'cutter contact trajectory', the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'beginning to end' or 'end to beginning'.

WR8: If the **description** of the **machining_toolpath** is 'connect security plane', the **machining_toolpath** shall satisfy the following conditions:

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'up direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'down direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**.

WR9: If the **description** of the **machining_toolpath** is 'feedstop', the **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of 'dwell', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **time_measure_with_unit**.

WR10: If the **description** of the **machining_toolpath** is 'axis trajectory', the **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of 'axis commands', and the **representation** used to describe the **action_property** shall contain at least one **representation_item** of type **bounded_curve**.

WR11: If the **description** of the **machining_toolpath** is either 'approach lift path angle' or 'approach lift path tangent', the **machining_toolpath** shall satisfy the following conditions:

— the **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of 'fix point', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **cartesian_point**;

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'fix point direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**.

WR12: If the **description** of the **machining_toolpath** is 'approach lift path angle', the **machining_toolpath** shall satisfy the following conditions:

— the **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of '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_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of 'bend 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**.

WR13: If the **description** of the **machining_toolpath** is 'approach lift path tangent', the **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of '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**.

WR14: If the **description** of the **machining_toolpath** is 'cutter location trajectory', the **machining_toolpath** shall satisfy the following conditions:

— the **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of 'basic curve', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **bounded_curve**;

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'surface normal', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **bounded_curve**;

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'tool axis', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **bounded_curve**;

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'path maximum deviation', 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_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'tool axis maximum deviation', 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**.

WR15: If the **description** of the **machining_toolpath** is 'cutter contact trajectory', the **machining_toolpath** shall satisfy the following conditions:

— the **machining_toolpath** shall either be the **definition** of exactly one **action_property** with a **name** of 'basic curve' with an associated **representation** that contains a **bounded_pcurve**, or the **machining_toolpath** shall be the **definition** of exactly one **action_property** with a **name** of 'basic curve' with an associated **representation** that contains a **bounded_curve** and exactly one **action_property** with a **name** of 'surface normal' with an associated **representation** that contains a **bounded_curve**;

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'tool axis', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **bounded_curve**;

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'contact type', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'side' or 'front';

— the **machining_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'path maximum deviation', 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_toolpath** shall be the **definition** of at most one **action_property** with a **name** of 'tool axis maximum deviation', 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**.

5.2.3.1.77 machining_toolpath_sequence_relationship

A **machining_toolpath_sequence_relationship** is a type of **sequential_method** that represents use of a Toolpath as an element of a sequence in an Operation or strategy. See the ARM definitions for Workpiece_setup in ISO 14649-10 and Along_path in ISO 14649-11 for more information.

EXPRESS specification:

```
*)
ENTITY machining_toolpath_sequence_relationship
  SUBTYPE OF (sequential_method);
END_ENTITY;
(*
```

5.2.3.1.78 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);
  WHERE
  WR1:  (1 = SIZEOF (QUERY ( it <* SELF.items |
          ( (('INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE'
              IN TYPEOF(it))) OR

            (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
              IN TYPEOF(it)) AND
             (it.description IN ['rapid']))  OR

            ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT'] *
              TYPEOF(it)) = 2))
           )
        )));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **items** set shall contain exactly one **representation_item** that is either of type **b_spline_curve**, of type **descriptive_representation_item** with a **description** of 'side', or of type **measure_representation_item** and **ratio_measure_with_unit**.

5.2.3.1.79 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 ['tool length probing', 'tool radius probing',
          'workpiece probing', 'workpiece complete probing']);

  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

         (verify_required_action_property       (SELF, 'computed offset')) AND
         (verify_rep_type_for_action_property   (SELF, 'computed offset',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OFFSET_VECTOR_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';

— 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**.

5.2.3.1.80 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 and Turning_workingstep in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY machining_workingstep
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  ((verify_optional_action_property     (SELF, 'security plane')) AND
         (verify_rep_item_for_action_property (SELF, 'security plane',
          ['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE'])));

  WR2:  NOT (SELF.description = 'machining') OR
        ((verify_required_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_RELATIONSHIP'])) AND
         (verify_related_type_for_amr  (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS'])) AND

         (verify_related_type_for_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FINAL_FEATURE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS'])) AND

         (verify_required_relating_amr  (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION']))
        );

  WR3:  NOT (SELF.description = 'turning') OR
        ((2 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_SEQUENCE_RELATIONSHIP']))
AND
         (verify_related_type_for_amr    (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_SEQUENCE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS'])) AND

         (verify_required_relating_amr  (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.TURNING_TYPE_OPERATION']))
        );

  WR4:  NOT (SELF.description IN ['machining', 'turning']) OR
```



```
        (verify_optional_in_process_geometry (SELF));

  WR5:  ((verify_optional_action_property (SELF, 'toolpath orientation')) AND
         (verify_rep_item_for_action_property (SELF, 'toolpath orientation',
          ['INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D'])));

END_ENTITY;
(*
```

Formal propositions:

WR1: The **machining_workingstep** shall be the **definition** of at most 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: If the **description** of the **machining_workingstep** is 'machining', the **machining_workingstep** shall satisfy the following conditions:

— **machining_workingstep** shall be the **relating_method** of exactly one **machining_feature_-relationship**, in which the **related_method** is of type **machining_feature_process**;

— **machining_workingstep** shall be the **relating_method** of zero or more **machining_final_-feature_relationship**, in which the **related_method** is of type **machining_feature_process**;

— **machining_workingstep** shall be the **relating_method** of exactly one **machining_operation_-relationship**, in which the **related_method** is of type **machining_operation**.

WR3: If the **description** of the **machining_workingstep** is 'turning', the **machining_workingstep** shall satisfy the following conditions:

— **machining_workingstep** shall be the **relating_method** of two or more instances of **machining_-feature_sequence_relationship**, in which the **related_method** is of type **machining_feature_-process**;

— **machining_workingstep** shall be the **relating_method** of exactly one **machining_operation_-relationship**, in which the **related_method** is of type **turning_type_operation**.

WR4: If the **description** of the **machining_workingstep** is either 'machining' or 'turning', 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.

WR5: The **machining_workingstep** shall be the **definition** of at most one **action_property** with a **name** of 'toolpath orientation', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **axis2_placement_3d**.

Informal propositions:

IP1: If the **description** of the **machining_workingstep** is 'turning', all **sequential_method** instances with a **name** of 'process feature' which refer to the **machining_workingstep** through the **related** attribute shall have unique **sequence_position** values.

5.2.3.1.81 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 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_SEQUENCE_RELATIONSHIP']))
AND
        (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_SEQUENCE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']));

  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_method** of at least one **machining_process_-sequence_relationship**, in which the **related_method** 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.

Informal propositions:

IP1: All **machining_process_sequence_relationship** instances which refer to the same **machining_-workplan** through the **relating_method** attribute shall have unique **sequence_position** values.

5.2.3.1.82 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_with_name  (SELF, 'approach',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'approach',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR3:  ((verify_optional_relating_amr_with_name  (SELF, 'retract',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'retract',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR4:  ((verify_optional_relating_amr_with_name  (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['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_method** of at most one **machining_-strategy_relationship** with a **name** of 'approach', in which the **related_method** shall be of type **machining_approach_retract_strategy**.

WR3: The **milling_type_operation** shall be the **relating_method** of at most one **machining_-strategy_relationship** with a **name** of 'retract', in which the **related_method** shall be of type **machining_approach_retract_strategy**.

WR4: The **milling_type_operation** shall be the **relating_method** of at most one **machining_-strategy_relationship** with a **name** of 'machining', in which the **related_method** shall be of type **milling_type_strategy**.

5.2.3.1.83 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'])) );

  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;
(*
```

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';

— 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'.

5.2.3.1.84 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.

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'.

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.

5.2.3.1.85 placed_datum_target_feature

A **placed_datum_target_feature** is a type of **datum_target** that represents the implicit definition of a datum target for tolerancing purposes.

NOTE This definition has been harmonized with the equivalent definitions in ISO 10303-214, ISO 10303-224, and ISO 10303-1050.

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.' +
        '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([
         '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
(*
```

<u>Formal propositions:</u>

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**.

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'.

5.2.3.1.86 plane_milling_operation

A **plane_milling_operation** is a type of **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 ['roughing','finishing']);

  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 = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance bottom'));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **description** of the **plane_milling_operation** shall be either 'roughing' or 'finishing'.

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 'roughing', 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.

5.2.3.1.87 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 ['roughing','finishing']);

  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 = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance side'));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **description** of the **side_milling_operation** shall be either 'roughing' or 'finishing'.

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.**

WR5: If the **description** of the **side_milling_operation** is 'roughing', 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.

5.2.3.1.88 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;
(*
```

5.2.3.1.89 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_optional_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_optional_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 at most 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'.

WR2: If the **description** of the **tapping_operation** is 'thread drilling', the **tapping_operation** shall be the **definition** of at most 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'.

5.2.3.1.90 threading_turning_operation

A **threading_turning_operation** is a **turning_type_operation**. See the ARM definitions for Threading and subtypes in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY threading_turning_operation
  SUBTYPE OF (turning_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing','finishing']);

  WR2:  (verify_optional_action_property        (SELF, 'allowance')) AND
        (verify_length_measure_action_property  (SELF, 'allowance'));

  WR3:  NOT (SELF.description = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance'));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **description** of the **threading_turning_operation** shall be either 'roughing' or 'finishing'.

WR2: The **threading_turning_operation** shall be the **definition** of at most one **action_property** with a **name** of 'allowance', 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: If the **description** of the **threading_turning_operation** is 'roughing', the **threading_turning_operation** shall be the **definition** of exactly one **action_property** with a **name** of 'allowance'.

NOTE This corresponds to local constraints **WR1** on the ARM entity **Threading_rough** in ISO 14649-12.

5.2.3.1.91 turning_type_operation

A **turning_type_operation** is a type of **machining_operation** that represents the details of a turning step of a machining process. See the ARM definitions for Turning_machining_operation and subtypes in ISO 14649-12 for more information.

<u>EXPRESS specification:</u>

```
*)
ENTITY turning_type_operation
  SUBTYPE OF (machining_operation);
  WHERE
  WR1:  ((verify_optional_relating_amr_with_name  (SELF, 'approach',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'approach',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR2:  ((verify_optional_relating_amr_with_name  (SELF, 'retract',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'retract',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR3:  ((verify_optional_relating_amr_with_name  (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.TURNING_TYPE_STRATEGY']))
        );

END_ENTITY;
(*
```

<u>Formal propositions:</u>

WR1: The **turning_type_operation** shall be the **relating_method** of at most one **machining_-strategy_relationship** with a **name** of 'approach', and a **related_method** of type **machining_-approach_retract_strategy**.

WR2: The **turning_type_operation** shall be the **relating_method** of at most one **machining_-strategy_relationship** with a **name** of 'retract', and a **related_method** of type **machining_-approach_retract_strategy**.

WR3: The **turning_type_operation** shall be the **relating_method** of at most one **machining_-strategy_relationship** with a **name** of 'machining', and a **related_method** of type **turning_type_-strategy**.

5.2.3.1.92 turning_type_strategy

A **turning_type_strategy** is a type of **machining_strategy** that represents the approach used to determine the motion of the cutting tool during a turning operation. See the ARM definitions for Turning_machining_strategy and subtypes in ISO 14649-12 for more information.

EXPRESS specification:

```
*)
ENTITY turning_type_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  (SELF.description IN ['unidirectional', 'bidirectional',
          'contour', 'thread', 'grooving', 'multistep grooving',
          'explicit']);

  WR2:  ((verify_optional_action_property       (SELF, 'overcut length')) AND
         (verify_length_measure_action_property (SELF, 'overcut length'))
        );

  WR3:  ((verify_optional_action_property       (SELF, 'multiple passes')) AND
         (verify_enumeration_action_property    (SELF, 'multiple passes',
          ['multiple passes allowed', 'multiple passes not allowed']))
        );

  WR4:  ((verify_optional_action_property (SELF, 'cutting depth')) AND
         (0 = SIZEOF (QUERY (prop <*
           get_action_property (SELF, 'cutting depth') | 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 (SIZEOF([
                    'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                    'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                    TYPEOF(ie)) = 2))))
             ))))
           )))
         )))
        );

  WR5:  ((verify_optional_action_property     (SELF, 'variable feedrate')) AND
         (verify_rep_type_for_action_property (SELF, 'variable feedrate',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
         (verify_rep_name_for_action_property (SELF, 'variable feedrate',
           ['relative speed']))
        );

  WR6:  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, 'back path direction')) AND
 (verify_rep_item_for_action_property (SELF, 'back path direction',
   ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

 (verify_optional_action_property     (SELF, 'lift direction')) AND
 (verify_rep_item_for_action_property (SELF, 'lift direction',
   ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

 (verify_optional_action_property     (SELF, 'stepover direction')) AND
 (verify_rep_item_for_action_property (SELF, 'stepover direction',
   ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

 (verify_optional_action_property       (SELF, 'lift height')) AND
 (verify_length_measure_action_property (SELF, 'lift height')) AND

 (verify_optional_action_property     (SELF, 'lift feedrate')) AND
 (verify_rep_type_for_action_property (SELF, 'lift feedrate',
   ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
 (verify_rep_name_for_action_property (SELF, 'lift feedrate',
   ['feed speed', 'feed per revolution'])) AND

 (verify_optional_action_property     (SELF, 'stepover feedrate')) AND
 (verify_rep_type_for_action_property (SELF, 'stepover feedrate',
   ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
 (verify_rep_name_for_action_property (SELF, 'stepover feedrate',
   ['feed speed', 'feed per revolution']))
);

WR7:  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_rep_item_for_action_property (SELF, 'stepover direction',
         ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

       (verify_optional_action_property     (SELF, 'stepover feedrate')) AND
       (verify_rep_type_for_action_property (SELF, 'stepover feedrate',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
       (verify_rep_name_for_action_property (SELF, 'stepover feedrate',
         ['feed speed', 'feed per revolution']))
      );

WR8:  NOT (SELF.description = 'contour') 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, 'back path direction')) AND
       (verify_rep_item_for_action_property (SELF, 'back path direction',
```



```
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

        (verify_optional_action_property     (SELF, 'lift direction')) AND
        (verify_rep_item_for_action_property (SELF, 'lift direction',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

        (verify_optional_action_property     (SELF, 'stepover direction')) AND
        (verify_rep_item_for_action_property (SELF, 'stepover direction',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

        (verify_optional_action_property       (SELF, 'lift height')) AND
        (verify_length_measure_action_property (SELF, 'lift height')) AND

        (verify_optional_action_property     (SELF, 'lift feedrate')) AND
        (verify_rep_type_for_action_property (SELF, 'lift feedrate',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property (SELF, 'lift feedrate',
          ['feed speed', 'feed per revolution'])) AND

        (verify_optional_action_property     (SELF, 'stepover feedrate')) AND
        (verify_rep_type_for_action_property (SELF, 'stepover feedrate',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property (SELF, 'stepover feedrate',
          ['feed speed', 'feed per revolution'])) AND

        (verify_optional_action_property
          (SELF, 'variable stepover feedrate')) AND
        (verify_rep_type_for_action_property
          (SELF, 'variable stepover feedrate',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property
          (SELF, 'variable stepover feedrate', ['relative speed']))
       );

  WR9:  NOT (SELF.description = 'thread') OR
       ((verify_required_action_property     (SELF, 'cut in amount')) AND
        (verify_enumeration_action_property  (SELF, 'cut in amount',
         ['constant depth', 'variable depth', 'constant removal amount'])) AND

       (verify_required_action_property     (SELF, 'threading direction')) AND
        (verify_enumeration_action_property  (SELF, 'threading direction',
          ['left', 'right', 'center', 'left zigzag', 'right zigzag'])) AND

       (verify_optional_action_property       (SELF, 'path return angle')) AND
       (verify_angle_measure_action_property  (SELF, 'path return angle')) AND

        (verify_optional_action_property       (SELF, 'lift height')) AND
        (verify_length_measure_action_property (SELF, 'lift height'))
       );

  WR10: NOT (SELF.description IN ['grooving', 'multistep grooving']) OR
       ((verify_optional_action_property     (SELF, 'grooving direction')) AND
        (verify_rep_item_for_action_property (SELF, 'grooving direction',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND
```



```
         (verify_optional_action_property       (SELF, 'travel distance')) AND
         (verify_length_measure_action_property (SELF, 'travel distance'))
        );

  WR11: NOT (SELF.description = 'multistep grooving') OR
        ((verify_optional_action_property       (SELF, 'retract distance')) AND
         (verify_length_measure_action_property (SELF, 'retract distance'))
        );
END_ENTITY;
(*
```

<u>Formal propositions:</u>

WR1: The **description** of the **turning_type_strategy** shall be either 'unidirectional', 'bidirectional', 'contour', 'thread', 'grooving', 'multistep grooving', or 'explicit'.

WR2: The **turning_type_strategy** 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**.

WR3: The **turning_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'.

WR4: The **turning_type_strategy** 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 exactly one **compound_representation_item**, in which the **item_element** is of type **list_representation_item** and contains only instances of type type **measure_representation_item** and **length_measure_with_unit**.

WR5: The **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'variable feedrate', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of 'relative speed'.

WR6: If the **description** of the **turning_type_strategy** is 'unidirectional', the **turning_type_strategy** shall satisfy the following conditions:

— the **turning_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 **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'back path direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'lift direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **turning_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 **direction**;

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'lift height', 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 **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'lift feedrate', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of either 'feed speed' or 'feed per revolution';

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'stepover feedrate', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of either 'feed speed' or 'feed per revolution'.

WR7: If the **description** of the **turning_type_strategy** is 'bidirectional', the **turning_type_strategy** shall satisfy the following conditions:

— the **turning_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 **turning_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 **direction**;

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'stepover feedrate', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of either 'feed speed' or 'feed per revolution'.

WR8: If the **description** of the **turning_type_strategy** is 'contour', the **turning_type_strategy** shall satisfy the following conditions:

— the **turning_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 **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'back path direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'lift direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **turning_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 **direction**;

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'lift height', 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 **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'lift feedrate', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of either 'feed speed' or 'feed per revolution';

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'stepover feedrate', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of either 'feed speed' or 'feed per revolution';

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'variable stepover feedrate', and the **representation** used to describe the **action_property** shall be of type **machining_feed_speed_representation** with a **description** of 'relative speed'.

WR9: If the **description** of the **turning_type_strategy** is 'thread', the **turning_type_strategy** shall satisfy the following conditions:

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'cut in amount', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **descriptive_representation_item** with a **description** of 'constant depth', 'variable depth', or 'constant removal amount';

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'threading 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', 'right', 'center', 'left zigzag', or 'right zigzag';

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'path return 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 **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'lift height', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **measure_representation_item** and **length_measure_with_unit**.

WR10: If the **description** of the **turning_type_strategy** is either 'grooving' or 'multistep grooving', the **turning_type_strategy** shall satisfy the following conditions:

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'grooving direction', and the **representation** used to describe the **action_property** shall contain a **representation_item** of type **direction**;

— the **turning_type_strategy** shall be the **definition** of at most one **action_property** with a **name** of 'travel 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**.

WR11: If the **description** of the **turning_type_strategy** is 'multistep grooving', the **turning_type_-strategy** shall be the **definition** of at most 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**.

5.2.3.1.93 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 definitions found in ISO 10303-214 and ISO 10303-1106.

EXPRESS specification:

```
*)
ENTITY value_range
  SUBTYPE OF (compound_representation_item);
END_ENTITY;
(*
```

5.2.3.2 Integrated CNC imported entity modifications

5.2.3.2.1 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).

5.2.3.2.2 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).

5.2.3.2.3 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_person_organization (See 5.2.4.2);

— approval_requires_assignment (See 5.2.4.3).

5.2.3.2.4 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.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **approval_assignment** entity:

— approval_requires_assignment (See 5.2.4.3).

5.2.3.2.5 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 5.2.4.2).

5.2.3.2.6 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).

5.2.3.2.7 chamfer

The base definition of the **chamfer** entity is given in ISO 10303-522. 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 **chamfer** entity:

— chamfer_requires_faces_or_features (See 5.2.4.4).

5.2.3.2.8 derived_unit

The base definition of the **derived_unit** 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 **derived_unit** entity:

— dependent_instantiable_derived_unit (See 5.2.4.6).

5.2.3.2.9 edge_round

The base definition of the **edge_round** entity is given in ISO 10303-522. 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 **edge_round** entity:

— edge_round_requires_faces_or_features (See 5.2.4.8).

5.2.3.2.10 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.

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 5.2.4.7).

5.2.3.2.11 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 5.2.4.10).

5.2.3.2.12 process_property_association

The base definition of the **process_property_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_property_association** entity:

— feature_optional_machining_property_process (See 5.2.4.9).

5.2.3.2.13 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 5.2.4.11).

5.2.3.2.14 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.

Associated global rules:

The following global rule defined in this part of ISO 10303 applies to the **product_definition_formation** entity:

— product_requires_version (See 5.2.4.11).

5.2.3.2.15 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 5.2.4.10).

5.2.3.2.16 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.

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).

5.2.3.2.17 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).

5.2.3.2.18 shape_aspect

The base definition of the **shape_aspect** 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 **shape_aspect** entity:

— feature_optional_machining_property_process (See 5.2.4.9).

5.2.4 Integrated CNC rule definitions

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**.

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_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))))
        )));
```

```
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**.

5.2.4.3 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**.

5.2.4.4 chamfer_requires_faces_or_features

The **chamfer_requires_faces_or_features** rule specifies that each instance of **chamfer** shall define the transition between either two features or two sets of faces on the workpiece.

EXPRESS specification:

```
*)
RULE chamfer_requires_faces_or_features FOR (
        chamfer,
        property_definition_representation,
        feature_component_relationship
        );

WHERE
WR1:  (0 = SIZEOF (QUERY (cf <* chamfer | NOT (

  -- chamfer relates two sets of faces in AP 224 style
  ((1 = SIZEOF (QUERY (pdr <* property_definition_representation |
        ((pdr.used_representation.name = 'chamfer face') AND
         (pdr.definition.definition :=: cf) AND
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
           IN TYPEOF (pdr.used_representation)))))) AND

   (1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.relating_shape_aspect :=: cf) AND
         (fcr.related_shape_aspect.description = 'first offset') AND
         ('INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET'
           IN TYPEOF (fcr.related_shape_aspect)) AND
         ((1 = SIZEOF (QUERY (pdr <* property_definition_representation |
               ((pdr.used_representation.name = 'first face shape') AND
                (pdr.definition.definition :=: fcr.related_shape_aspect) AND
                ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
                  IN TYPEOF (pdr.used_representation)))
         )))) )))) AND

   (1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.relating_shape_aspect :=: cf) AND
         (fcr.related_shape_aspect.description = 'second offset') AND
         ('INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET'
           IN TYPEOF (fcr.related_shape_aspect)) AND
         ((1 = SIZEOF (QUERY (pdr <* property_definition_representation |
               ((pdr.used_representation.name = 'second face shape') AND
                (pdr.definition.definition :=: fcr.related_shape_aspect) AND
                ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
                  IN TYPEOF (pdr.used_representation)))
         )))) ))))
  )
  OR
  -- chamfer relates two features in ISO 14649 style
  ((1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.name = 'first feature') AND
         (fcr.relating_shape_aspect.of_shape.definition :=: cf) AND
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
           IN TYPEOF (fcr.relating_shape_aspect)))))) AND

   (1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.name = 'second feature') AND
```



```
          (fcr.relating_shape_aspect.of_shape.definition :=: cf) AND
          ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
            IN TYPEOF (fcr.relating_shape_aspect)))))))
   ))));
END_RULE;
(*
```

Argument definitions:

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

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

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

Formal propositions:

WR1: For each instance of **chamfer**, either:

— the **chamfer** shall be related to exactly one **property_definition_representation** with a **used_representation** of type **face_shape_representation** with a **name** of 'chamfer face';

— the **chamfer** shall be the **relating_shape_aspect** of exactly one **feature_component_relationship** with a **description** of 'first offset' and a **related_shape_aspect** of type **chamfer_offset**. The **chamfer_offset** shall be related to exactly one **property_definition_representation** with a **used_representation** of type **face_shape_representation** with a **name** of 'first face shape';

— the **chamfer** shall be the **relating_shape_aspect** of exactly one **feature_component_relationship** with a **description** of 'second offset' and a **related_shape_aspect** of type **chamfer_offset**. The **chamfer_offset** shall be related to exactly one **property_definition_representation** with a **used_representation** of type **face_shape_representation** with a **name** of 'second face shape'.

or else:

— the **chamfer** shall be the related by the **of_shape** attribute of a **composite_shape_aspect** which is the **relating_shape_aspect** of exactly one **feature_component_relationship** with a **name** of 'first feature';

— the **chamfer** shall be the related by the **of_shape** attribute of a **composite_shape_aspect** which is the **relating_shape_aspect** of exactly one **feature_component_relationship** with a **name** of 'second feature'.

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.

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_derived_unit

The **dependent_instantiable_derived_unit** rule specifies that each instance of **derived_unit** is dependent on its usage to define another entity.

EXPRESS specification:

```
*)
RULE dependent_instantiable_derived_unit FOR (derived_unit);
WHERE
  WR1:  (0 = SIZEOF (QUERY (du <* derived_unit | NOT
           (1 <= SIZEOF (USEDIN (du, '')))
        )));
END_RULE;
(*
```

Argument definitions:

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

Formal propositions:

WR1: For each instance of **derived_unit**, there shall be at least one reference to the **derived_unit** instance from an attribute of another entity.

5.2.4.7 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.

5.2.4.8 edge_round_requires_faces_or_features

The **edge_round_requires_faces_or_features** rule specifies that each instance of **edge_round** shall define the transition between either two features or two sets of faces on the workpiece.

EXPRESS specification:

```
*)
RULE edge_round_requires_faces_or_features FOR (
        edge_round,
        property_definition_representation,
        feature_component_relationship
        );

WHERE
WR1:  (0 = SIZEOF (QUERY (er <* edge_round | NOT (

  -- edge round relates two sets of faces in AP 224 style
  ((1 = SIZEOF (QUERY (pdr <* property_definition_representation |
        ((pdr.used_representation.name = 'edge round face') AND
         (pdr.definition.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
           IN TYPEOF (pdr.used_representation)))))) AND

   (1 = SIZEOF (QUERY (pdr <* property_definition_representation |
        ((pdr.used_representation.name = 'first face shape') AND
         (pdr.definition.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
           IN TYPEOF (pdr.used_representation)))))) AND

   (1 = SIZEOF (QUERY (pdr <* property_definition_representation |
        ((pdr.used_representation.name = 'second face shape') AND
         (pdr.definition.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
           IN TYPEOF (pdr.used_representation))))))
```



```
  )
  OR
  -- edge round relates two features in ISO 14649 style
  ((1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.name = 'first feature') AND
         (fcr.relating_shape_aspect.of_shape.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
           IN TYPEOF (fcr.relating_shape_aspect)))))) AND

   (1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.name = 'second feature') AND
         (fcr.relating_shape_aspect.of_shape.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
           IN TYPEOF (fcr.relating_shape_aspect)))))))
   ))));
END_RULE;
(*
```

<u>Argument definitions:</u>

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

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

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

<u>Formal propositions:</u>

WR1: For each instance of **chamfer**, either:

— the **edge_round** shall be related to exactly one **property_definition_representation** with a **used_representation** of type **face_shape_representation** with a **name** of 'edge round face';

— the **edge_round** shall be related to exactly one **property_definition_representation** with a **used_representation** of type **face_shape_representation** with a **name** of 'first face shape';

— the **edge_round** shall be related to exactly one **property_definition_representation** with a **used_representation** of type **face_shape_representation** with a **name** of 'second face shape'.

or else:

— the **edge_round** shall be the related by the **of_shape** attribute of a **composite_shape_aspect** which is the **relating_shape_aspect** of exactly one **feature_component_relationship** with a **name** of 'first feature';

— the **edge_round** shall be the related by the **of_shape** attribute of a **composite_shape_aspect** which is the **relating_shape_aspect** of exactly one **feature_component_relationship** with a **name** of 'second feature'.

5.2.4.9 feature_optional_machining_property_process

The **feature_optional_machining_process_property** rule specifies that each **feature_definition** or **transition_feature** instance shall be associated with at most one **property_process** having a **name** of 'machining'.

<u>EXPRESS specification:</u>

```
*)
RULE feature_optional_machining_property_process FOR (
        shape_aspect,
        process_property_association
        );
WHERE
WR1:  (0 = SIZEOF (QUERY (sa <* shape_aspect |
        (('INTEGRATED_CNC_SCHEMA.FEATURE_DEFINITION' IN TYPEOF (sa)) OR
         ('INTEGRATED_CNC_SCHEMA.TRANSITION_FEATURE' IN TYPEOF (sa)))
         AND NOT
         (1 >= SIZEOF (QUERY (ppa <* process_property_association |
            ((ppa.property_or_shape :=: sa) AND
             (ppa.process.name = 'machining')))))
        )));
END_RULE;
(*
```

<u>Argument definitions:</u>

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

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

<u>Formal propositions:</u>

WR1: Each **shape_aspect** that is an instance of either **feature_definition** or **transition_feature** shall appear as the **property_or_shape** of at most one **process_property_association** in which the **process** attribute refers to a **property_process** having a **name** of 'machining'.

5.2.4.10 nc_variable_compatible_initial_value

The **nc_variable_compatible_initial_value** rule specifies that each instance of **numeric_variable** that is also an **expression_representation_item** 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**.

<u>EXPRESS specification:</u>

```
*)
RULE nc_variable_compatible_initial_value FOR
  (expression_representation_item,
```



```
   representation_item_relationship);
WHERE
  -- each nc_variable has at most one one initial value
  WR1: (0 = SIZEOF (QUERY (nv <* expression_representation_item |
            ('INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'
              IN TYPEOF (nv)) AND 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
            ('INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'
              IN TYPEOF (rir.relating_representation_item))
            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:

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

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

Formal propositions:

WR1: Each instance of **expression_representation_item** that is also of type **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 **name** is 'initial value' and **relating** is of type **numeric_variable** 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**.

5.2.4.11 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**.

5.2.4.12 restrict_unneeded_feature_usage

The **restrict_unneeded_feature_usage** rule specifies that no instance of **feature_definition** shall be of type **fillet**, **marking**, **protrusion**, or **rib_top**.

NOTE These extra features are present for compatibility with ISO 10303-224, but are restricted until ISO 14649-10 or some other part requires them.

EXPRESS specification:

```
*)
RULE restrict_unneeded_feature_usage FOR (feature_definition);
  WHERE
  WR1:  (0 = SIZEOF (QUERY (fd <* feature_definition |
         ('INTEGRATED_CNC_SCHEMA.FILLET' IN TYPEOF(fd)) OR
         ('INTEGRATED_CNC_SCHEMA.GEAR' IN TYPEOF(fd)) OR
         ('INTEGRATED_CNC_SCHEMA.MARKING' IN TYPEOF(fd)) OR
         ('INTEGRATED_CNC_SCHEMA.PROTRUSION' IN TYPEOF(fd)) OR
         ('INTEGRATED_CNC_SCHEMA.RIB_TOP' IN TYPEOF(fd))
        )));
END_RULE;
(*
```

Argument definitions:

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

Formal propositions:

WR1: Each instance of **feature_definition** shall not be of type **fillet**, **gear**, **marking**, **protrusion**, or **rib_top**.

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 |
               (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 function definitions

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_count_of_relating_amr

The **get_count_of_relating_amr** function returns the number of **action_method_relationship** instances in which the input **action_method** appears as the **relating_method** and the relationship is of all types which appear in the **amr_types** input parameter.

EXPRESS specification:

```
*)
FUNCTION get_count_of_relating_amr (
        am:             action_method;
        amr_types:      SET OF STRING
        ): INTEGER;

    RETURN (SIZEOF (QUERY (amr <* get_relating_amr (am) |
               (SIZEOF(amr_types * TYPEOF(amr)) =
                SIZEOF(amr_types)) )));
END_FUNCTION;
(*
```

Argument definitions:

am: the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

amr_types: the set of desired type names for the **action_method_relationship** instances.

5.2.5.3 get_count_of_relating_amr_with_name

The **get_count_of_relating_amr_with_name** function returns the number of **action_method_relationship** instances in which the input **action_method** appears as the **relating_method**, the relationship is of all types which appear in the **amr_types** input parameter, and the input parameter **amr_name** appears as the **name** of the **action_method_relationship**.

EXPRESS specification:

```
*)
```



```
FUNCTION get_count_of_relating_amr_with_name (
        am:             action_method;
        amr_name:       STRING
        amr_types:      SET OF STRING
        ): INTEGER;

    RETURN (SIZEOF (QUERY (amr <* get_relating_amr (am) |
              ((amr.name = amr_name) AND
               (SIZEOF(amr_types * TYPEOF(amr)) =
                SIZEOF(amr_types))) )));
END_FUNCTION;
(*
```

Argument definitions:

am: the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

amr_name: the string that appears as the **name** of the **action_method_relationship** instances to examine.

amr_types: the set of desired type names for the **action_method_relationship** instances.

5.2.5.4 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.

5.2.5.5 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 <*
        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.

5.2.5.6 get_tool_body_item

The **get_tool_body_item** function returns the set of **representation_item** instances that have a **name** equal to the input parameter **prop_name** and appear in the **items** set of a **representation** of type **machining_tool_body_representation** which describes a **resource_property** with a **name** of 'tool body' and a **resource** which refers to the input **machining_tool**.

EXPRESS specification:

```
*)
FUNCTION get_tool_body_item (
    mt :             machining_tool;
    prop_name :      STRING
    ): SET OF representation_item;

    LOCAL
      props : SET OF resource_property;
      preps : SET OF resource_property_representation;
      items : SET OF representation_item;
    END_LOCAL;

    props := get_resource_property (mt, 'tool body');
    REPEAT i := 1 TO HIINDEX(props);
        preps := preps + USEDIN (props[i], 'INTEGRATED_CNC_SCHEMA.'+
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY');
    END_REPEAT;

    REPEAT i := 1 TO HIINDEX(preps);
        IF ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_BODY_REPRESENTATION'
                IN TYPEOF (preps[i].representation))
        THEN
```



```
            items := items + preps[i].representation.items;
        END_IF;
    END_REPEAT;

    RETURN (bag_to_set (QUERY (it <* items | (it.name = prop_name))));
END_FUNCTION;
(*
```

Argument definitions:

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to return.

prop_name: the string that appears as the **name** of the **representation_item** instances to return.

5.2.5.7 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
        ): LOGICAL;

    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.

5.2.5.8 verify_angle_measure_rep_item

The **verify_angle_measure_rep_item** function returns true if and only if the **items** set of the input **representation** contains a **representation_item** with a **name** equal to the input parameter **prop_name** that is of type **measure_representation_item** and **plane_angle_measure_with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_angle_measure_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))));
END_FUNCTION;
(*
```

Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.9 verify_angle_measure_resource_property

The **verify_angle_measure_resource_property** function evaluates each **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **resource_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_resource_property (
    crd :       characterized_resource_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_resource_property (crd, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

Argument definitions:

crd: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_property** instances to examine.

5.2.5.10 verify_angle_measure_tool_body_item

The **verify_angle_measure_tool_body_item** function examines the **representation_item** instances that have a **name** equal to the input parameter **prop_name** and are associated with the input **machining_tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type **machining_tool_body_representation**. The function returns true if and only if all such **representation_item** instances are of type **measure_representation_item** and **plane_angle_-measure_with_unit**.

<u>EXPRESS specification:</u>

```
*)
FUNCTION verify_angle_measure_tool_body_item (
    mt :        machining_tool;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_tool_body(mt, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

<u>Argument definitions:</u>

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.11 verify_ballnose_endmill_dimensions

The **verify_ballnose_endmill_dimensions** function examines the **representation_item** instances that are associated with the input **machining_tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type **machining_tool_body_representation**. It returns true if and only if the items meet certain value requirements.

<u>EXPRESS specification:</u>

```
*)
FUNCTION verify_ballnose_endmill_dimensions (
    mt :          machining_tool
    ): LOGICAL;

    LOCAL
      rads : SET OF REPRESENTATION_ITEM :=
        get_tool_body_item (mt, 'edge radius');
      dias : SET OF REPRESENTATION_ITEM :=
        get_tool_body_item (mt, 'effective cutting diameter');
    END_LOCAL;
```



```
    RETURN ((0 = SIZEOF(rads)) OR
            ((1 = SIZEOF(rads)) AND
             (1 = SIZEOF(dias)) AND
             (rads[1].value_component = dias[1].value_component/2))
        );
END_FUNCTION;
(*
```

Argument definitions:

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

5.2.5.12 verify_bullnose_endmill_dimensions

The **verify_bullnose_endmill_dimensions** function examines the **representation_item** instances that are associated with the input **machining_tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type **machining_tool_body_representation**. It returns true if and only if the items meet certain value requirements.

EXPRESS specification:

```
*)
FUNCTION verify_bullnose_endmill_dimensions (
    mt :          machining_tool
    ): LOGICAL;

    LOCAL
      rads : SET OF REPRESENTATION_ITEM :=
        get_tool_body_item (mt, 'edge radius');
      dias : SET OF REPRESENTATION_ITEM :=
        get_tool_body_item (mt, 'effective cutting diameter');
    END_LOCAL;

    RETURN  ((1 = SIZEOF(rads)) AND
             (1 = SIZEOF(dias)) AND
             (rads[1].value_component < dias[1].value_component/2)
        );
END_FUNCTION;
(*
```

Argument definitions:

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

5.2.5.13 verify_count_measure_action_property

The **verify_count_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 **count_measure**.

EXPRESS specification:

```
*)
FUNCTION verify_count_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): LOGICAL;

    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.MEASURE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
                ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
                  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_count_measure_rep_item

The **verify_count_measure_rep_item** function returns true if and only if the **items** set of the input **representation** contains a **representation_item** with a **name** equal to the input parameter **prop_name** that is of type **measure_representation_item** and has a **value_component** of type **count_measure**.

EXPRESS specification:

```
*)
FUNCTION verify_count_measure_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT
          (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
```



```
            IN TYPEOF(it)) AND
           ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
            IN TYPEOF(it.value_component))))));
END_FUNCTION;
(*
```

Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.15 verify_count_measure_resource_property

The **verify_count_measure_resource_property** function evaluates each **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **resource_properties** have an associated **representation** in which the **items** set contains a **measure_representation_item** with a **value_component** of type **count_measure**.

EXPRESS specification:

```
*)
FUNCTION verify_count_measure_resource_property (
    crd : characterized_resource_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (prop <* get_resource_property (crd, prop_name) |
        NOT (
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |

           (0 < SIZEOF (QUERY (it <* prep.representation.items |
               (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
                ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
                  IN TYPEOF(it.value_component)))
           )))
        )))
    ))));
END_FUNCTION;
(*
```

Argument definitions:

crd: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_property** instances to examine.

5.2.5.16 verify_count_measure_tool_body_item

The **verify_count_measure_tool_body_item** function examines the **representation_item** instances that have a **name** equal to the input parameter **prop_name** and are associated with the input **machining_tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type **machining_tool_body_representation**. The function returns true if and only if all such **representation_item** instances are of type **measure_representation_item** with a **value_component** of type **count_measure**.

EXPRESS specification:

```
*)
FUNCTION verify_count_measure_tool_body_item (
    mt :          machining_tool;
    prop_name :   STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (it <* get_tool_body_item (mt, prop_name) | NOT
              (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
               ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
                  IN TYPEOF(it.value_component)))
        )));
END_FUNCTION;
(*
```

Argument definitions:

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.17 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
        ): LOGICAL;

    RETURN (verify_rep_item_for_action_property(cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']));
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.

5.2.5.18 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
        ): LOGICAL;

    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.

5.2.5.19 verify_enumeration_resource_property

The **verify_enumeration_resource_property** function evaluates each **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **resource_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_resource_property (
    crd :   characterized_resource_definition;
    prop_name :   STRING;
    prop_values : SET OF STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (prop <* get_resource_property (crd, prop_name) |

        NOT (
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_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:

crd: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_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.

5.2.5.20 verify_enumeration_measure_tool_body_item

The **verify_enumeration_measure_tool_body_item** function examines the **representation_item** instances that have a **name** equal to the input parameter **prop_name** and are associated with the input **machining_tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type **machining_tool_body_representation**. The function returns true if and only if all such

representation_item instances are of type **descriptive_representation_item** with a **description** value that appears in the **prop_values** set of strings.

EXPRESS specification:

```
*)
FUNCTION verify_enumeration_tool_body_item (
    mt :          machining_tool;
    prop_name :   STRING;
    prop_values : SET OF STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (it <* get_tool_body_item (mt, prop_name) | NOT
              (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
               (it.description IN prop_values))
        )));
END_FUNCTION;
(*
```

Argument definitions:

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

prop_values: the set of string values that the **description** attribute of a **descriptive_representation_-item** is to be compared against.

5.2.5.21 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
        ): LOGICAL;

    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.

5.2.5.22 verify_length_measure_rep_item

The **verify_length_measure_rep_item** function returns true if and only if the **items** set of the input **representation** contains a **representation_item** with a **name** equal to the input parameter **prop_name** that is of type **measure_representation_item** and **length_measure_with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_length_measure_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))));
END_FUNCTION;
(*
```

Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.23 verify_length_measure_resource_property

The **verify_length_measure_resource_property** function evaluates each **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **resource_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_resource_property (
        crd:            characterized_resource_definition;
        prop_name:      STRING
        ): LOGICAL;
```

```
    RETURN (verify_rep_item_for_resource_property (crd, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

Argument definitions:

crd: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_property** instances to examine.

5.2.5.24 verify_length_measure_tool_body_item

The **verify_length_measure_tool_body_item** function examines the **representation_item** instances that have a **name** equal to the input parameter **prop_name** and are associated with the input **machining_tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type **machining_tool_body_representation**. The function returns true if and only if all such **representation_item** instances are of type **measure_representation_item** and **length_measure_-with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_length_measure_tool_body_item (
    mt :        machining_tool;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_tool_body(mt, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

Argument definitions:

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.25 verify_linear_speed_measure_rep_item

The **verify_linear_speed_measure_rep_item** function returns true if and only if the **items** set of the input **representation** contains a **representation_item** with a **name** equal to the input parameter **prop_name** that is of type **measure_representation_item** and has a **value_component** of type **numeric_measure**.

EXPRESS specification:

```
*)
FUNCTION verify_linear_speed_measure_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT
          (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
           ('INTEGRATED_CNC_SCHEMA.NUMERIC_MEASURE'
            IN TYPEOF(it.value_component))))));
END_FUNCTION;
(*
```

Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.26 verify_numeric_measure_action_property

The **verify_numeric_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 has a **value_component** of type **numeric_measure**.

EXPRESS specification:

```
*)
FUNCTION verify_numeric_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): LOGICAL;

    -- 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.NUMERIC_MEASURE'
                 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.

5.2.5.27 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
        ): LOGICAL;

    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.

5.2.5.28 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 **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 **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 **shape_representation**.

EXPRESS specification:

```
*)
FUNCTION verify_optional_in_process_geometry (
        mpe:            machining_process_executable
        ): LOGICAL;

    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.SHAPE_REPRESENTATION'
               IN TYPEOF (prep.representation))))))
          )))
      );
END_FUNCTION;
(*
```

Argument definitions:

mpe: the **machining_process_executable** to examine.

5.2.5.29 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 **action_method_relationship** is of all types which appear in the **amr_types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_optional_relating_amr (
```



```
        am:             action_method;
        amr_types:      SET OF STRING
        ): LOGICAL;

    RETURN (1 >= get_count_of_relating_amr (am, amr_types));
END_FUNCTION;
(*
```

Argument definitions:

am: the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

amr_types: the set of desired type names for the **action_method_relationship** instances.

5.2.5.30 verify_optional_relating_amr_with_name

The **verify_optional_relating_amr_with_name** 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**, the **action_method_relationship** is of all types which appear in the **amr_types** input parameter, and the input parameter **amr_name** appears as the **name** of the **action_method_relationship**.

EXPRESS specification:

```
*)
FUNCTION verify_optional_relating_amr_with_name (
        am:             action_method;
        amr_name:       STRING
        amr_types:      SET OF STRING
        ): LOGICAL;

    RETURN (1 >= get_count_of_relating_amr_with_name (
                am, amr_name, amr_types));
END_FUNCTION;
(*
```

Argument definitions:

am: the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

amr_name: the string that appears as the **name** of the **action_method_relationship** instances to examine.

amr_types: the set of desired type names for the **action_method_relationship** instances.

5.2.5.31 verify_optional_rep_item

The **verify_optional_rep_item** function returns true if and only if the **items** set of the input **representation** contains at most one **representation_item** with a **name** equal to the input parameter **prop_name**.

EXPRESS specification:

```
*)
FUNCTION verify_optional_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (1 >= SIZEOF (QUERY ( it <* rep.items |
            (it.name = prop_name))));
END_FUNCTION;
(*
```

Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.32 verify_optional_resource_property

The **verify_optional_resource_property** function returns true if and only if there is at most one **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**.

EXPRESS specification:

```
*)
FUNCTION verify_optional_resource_property (
        crd:            characterized_resource_definition;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (1 >= SIZEOF (get_resource_property (crd, prop_name)));
END_FUNCTION;
(*
```

Argument definitions:

crd: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_property** instances to examine.

5.2.5.33 verify_optional_tool_body_item

The **verify_optional_tool_body_item** function examines the **representation_item** instances that have a **name** equal to the input parameter **prop_name** and are associated with the input **machining_tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type **machining_tool_body_representation**. The function returns true if and only if there is at most one such **representation_item** instance.

<u>EXPRESS specification:</u>

```
*)
FUNCTION verify_optional_tool_body_item (
    mt :        machining_tool;
    prop_name : STRING
    ): LOGICAL;

    RETURN (1 >= SIZEOF (get_tool_body_item (mt, prop_name)));
END_FUNCTION;
(*
```

<u>Argument definitions:</u>

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.34 verify_pressure_measure_action_property

The **verify_pressure_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 has a **value_component** of type **numeric_measure**.

<u>EXPRESS specification:</u>

```
*)
FUNCTION verify_pressure_measure_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (verify_numeric_measure_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.

5.2.5.35 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
        ): LOGICAL;

    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.

5.2.5.36 verify_ratio_measure_rep_item

The **verify_ratio_measure_rep_item** function returns true if and only if the **items** set of the input **representation** contains a **representation_item** with a **name** equal to the input parameter **prop_name** that is of type **measure_representation_item** and **ratio_measure_with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_ratio_measure_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;
```



```
    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))));
END_FUNCTION;
(*
```

Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.37 verify_related_type_for_amr

The **verify_related_type_for_amr** function evaluates the **action_method_relationship** instances in which the input **action_method** appears as **relating_method**, and the relationship is of all types which appear in the **amr_types** input parameter. 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;
        amr_types:      SET OF STRING
        types:          SET OF STRING
        ): LOGICAL;

    RETURN  (0 = SIZEOF (QUERY (amr <* get_relating_amr (am) |
               (SIZEOF(amr_types * TYPEOF(amr)) =
                SIZEOF(amr_types)) 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.

amr_types: the set of desired type names for the **action_method_relationship** instances.

types: the set of desired type names for the **action_method** that appears as the **related_method** of the **action_method_relationship** instances.

5.2.5.38 verify_related_type_for_amr_with_name

The **verify_related_type_for_amr_with_name** function evaluates the **action_method_relationship** instances in which the input **action_method** appears as the **relating_method**, the relationship is of all types which appear in the **amr_types** input parameter, and the **name** is equal to the **amr_name** input parameter . 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_with_name (
        am:             action_method;
        amr_name:       STRING;
        amr_types:      SET OF STRING
        types:          SET OF STRING
        ): LOGICAL;

    RETURN  (0 = SIZEOF (QUERY (amr <* get_relating_amr (am) |
               (amr.name = amr_name) AND
               (SIZEOF(amr_types * TYPEOF(amr)) =
                SIZEOF(amr_types)) 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.

amr_name: the string that appears as the **name** of the **action_method_relationship** instances to examine.

amr_types: the set of desired type names for the **action_method_relationship** instances.

types: the set of desired type names for the **action_method** that appears as the **related_method** of the **action_method_relationship** instances.

5.2.5.39 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 **rep_item_types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_rep_item_for_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING;
        rep_item_types: SET OF STRING
        ): LOGICAL;

    -- 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 (rep_item_types * TYPEOF(it)) =
                SIZEOF (rep_item_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.

rep_item_types: the set of desired **representation_item** type names.

5.2.5.40 verify_rep_item_for_resource_property

The **verify_rep_item_for_resource_property** function evaluates each **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **resource_properties** have an associated **representation** in which the **items** set contains a **representation_item** that is of all types which appear in the **rep_item_types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_rep_item_for_resource_property (
        crd:            characterized_resource_definition;
        prop_name:      STRING;
        rep_item_types: SET OF STRING
        ): LOGICAL;
```



```
    RETURN (0 = SIZEOF (QUERY (prop <* get_resource_property (crd, prop_name) |
        NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                 'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |

            (0 < SIZEOF (QUERY (it <* prep.representation.items |
                 (SIZEOF (rep_item_types * TYPEOF(it)) =
                  SIZEOF (rep_item_types)))))
            )))
        )));
END_FUNCTION;
(*
```

Argument definitions:

cad: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_property** instances to examine.

rep_item_types: the set of desired **representation_item** type names.

5.2.5.41 verify_rep_item_for_tool_body

The **verify_rep_item_for_tool_body** function examines the **representation_item** instances that have a **name** equal to the input parameter **prop_name** and are associated with the input **machining_tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type **machining_tool_body_representation**. The function returns true if and only if all such **representation_item** instances are of all types which appear in the **rep_item_types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_rep_item_for_tool_body (
    mt :             machining_tool;
    prop_name :      STRING;
    rep_item_types : SET OF STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (it <* get_tool_body_item (mt, prop_name) | NOT
               ((SIZEOF (rep_item_types * TYPEOF(it)) =
                 SIZEOF (rep_item_types)))
        )));
END_FUNCTION;
(*
```

Argument definitions:

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

rep_item_types: the set of desired **representation_item** type names.

5.2.5.42 verify_rep_name_for_action_property

The **verify_rep_name_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** with a **name** that appear in the **desc_names** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_rep_name_for_action_property (
        cad:            characterized_action_definition;
        prop_name:      STRING;
        desc_names:     SET OF STRING
        ): LOGICAL;

    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') |
               (prep.representation.name IN desc_names)
                )))
        )));
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.

desc_names: the set of string values to compare against the **name** of each **representation**.

5.2.5.43 verify_rep_type_for_action_property

The **verify_rep_type_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** that is of all types which appear in the **rep_types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_rep_type_for_action_property (
```



```
        cad:            characterized_action_definition;
        prop_name:      STRING;
        rep_types:      SET OF STRING
        ): LOGICAL;

    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') |

               (SIZEOF(rep_types * TYPEOF(prep.representation)) =
                SIZEOF(rep_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.

rep_types: the set of desired **representation** type names.

5.2.5.44 verify_rep_type_for_resource_property

The **verify_rep_type_for_resource_property** function evaluates each **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **resource_properties** have an associated **representation** that is of all types which appear in the **rep_types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_rep_type_for_resource_property (
        crd:            characterized_resource_definition;
        prop_name:      STRING;
        rep_types:      SET OF STRING
        ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (prop <*
            get_resource_property (crd, prop_name) | NOT
            (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.'+
               'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |

               (SIZEOF(rep_types * TYPEOF(prep.representation)) =
                SIZEOF(rep_types))
                )))
        )));
END_FUNCTION;
```

```
(*
```

Argument definitions:

crd: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_property** instances to examine.

rep_types: the set of desired **representation** type names.

5.2.5.45 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
        ): LOGICAL;

    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.

5.2.5.46 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 **action_method_relationship** is of all types which appear in the **amr_types** input parameter.

EXPRESS specification:

```
*)
FUNCTION verify_required_relating_amr (
        am:             action_method;
        amr_types:      SET OF STRING
        ): LOGICAL;
```



```
    RETURN (1 = get_count_of_relating_amr (am, amr_types));
END_FUNCTION;
(*
```

Argument definitions:

am: the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

amr_types: the set of desired type names for the **action_method_relationship** instances.

5.2.5.47 verify_required_relating_amr_with_name

The **verify_required_relating_amr_with_name** 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**, the **action_method_relationship** is of all types which appear in the **amr_types** input parameter, and the input parameter **amr_name** appears as the **name** of the **action_method_relationship**.

EXPRESS specification:

```
*)
FUNCTION verify_required_relating_amr_with_name (
        am:             action_method;
        amr_name:       STRING
        amr_types:      SET OF STRING
        ): LOGICAL;

    RETURN (1 = get_count_of_relating_amr_with_name (
                am, amr_name, amr_types));
END_FUNCTION;
(*
```

Argument definitions:

am: the **action_method** that appears as the **relating_method** of the **action_method_relationship** instances to examine.

amr_name: the string that appears as the **name** of the **action_method_relationship** instances to examine.

amr_types: the set of desired type names for the **action_method_relationship** instances.

5.2.5.48 verify_required_rep_item

The **verify_required_rep_item** function returns true if and only if the **items** set of the input **representation** contains exactly one **representation_item** with a **name** equal to the input parameter **prop_name**.

EXPRESS specification:

```
*)
FUNCTION verify_required_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (1 = SIZEOF (QUERY ( it <* rep.items |
            (it.name = prop_name))));
END_FUNCTION;
(*
```

Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.49 verify_required_resource_property

The **verify_required_resource_property** function returns true if and only if there is exactly one **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**.

EXPRESS specification:

```
*)
FUNCTION verify_required_resource_property (
        crd:            characterized_resource_definition;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (1 = SIZEOF (get_resource_property (crd, prop_name)));
END_FUNCTION;
(*
```

Argument definitions:

crd: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_property** instances to examine.

5.2.5.50 verify_required_tool_body_item

The **verify_required_tool_body_item** function examines the **representation_item** instances that have a **name** equal to the input parameter **prop_name** and are associated with the input **machining_-tool** through a **resource_property** with a **name** of 'tool body' and a **representation** of type

machining_tool_body_representation. The function returns true if and only if there is at most one such **representation_item** instance.

EXPRESS specification:

```
*)
FUNCTION verify_required_tool_body_item (
    mt :        machining_tool;
    prop_name : STRING
    ): LOGICAL;

    RETURN (1 = SIZEOF (get_tool_body_item (mt, prop_name)));
END_FUNCTION;
(*
```

Argument definitions:

mt: the **machining_tool** that is related through a **resource_property** to the **representation_item** instances to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.51 verify_rotary_speed_measure_rep_item

The **verify_rotary_speed_measure_rep_item** function returns true if and only if the **items** set of the input **representation** contains a **representation_item** with a **name** equal to the input parameter **prop_name** that is of type **measure_representation_item** and has a **value_component** of type **numeric_measure**.

EXPRESS specification:

```
*)
FUNCTION verify_rotary_speed_measure_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT
          (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
           ('INTEGRATED_CNC_SCHEMA.NUMERIC_MEASURE'
            IN TYPEOF(it.value_component))))));
END_FUNCTION;
(*
```

Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.52 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
        ): LOGICAL;

    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;
(*
```

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.

5.2.5.53 verify_time_measure_rep_item

The **verify_time_measure_rep_item** function returns true if and only if the **items** set of the input **representation** contains a **representation_item** with a **name** equal to the input parameter **prop_name** that is of type **measure_representation_item** and **ratio_measure_with_unit**.

EXPRESS specification:

```
*)
FUNCTION verify_time_measure_rep_item (
        rep:            representation;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.TIME_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))));
END_FUNCTION;
(*
```


Argument definitions:

rep: the **representation** to examine.

prop_name: the string that appears as the **name** of the **representation_item** instances to examine.

5.2.5.54 verify_time_measure_resource_property

The **verify_time_measure_resource_property** function evaluates each **resource_property** that refers to the input **characterized_resource_definition** and has a **name** equal to the input parameter **prop_name**. The function returns true if and only if all such **resource_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_resource_property (
        crd:            characterized_resource_definition;
        prop_name:      STRING
        ): LOGICAL;

    RETURN (verify_rep_item_for_resource_property (crd, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.TIME_MEASURE_WITH_UNIT']));
END_FUNCTION;
(*
```

Argument definitions:

crd: the **characterized_resource_definition** that appears as the **definition** of the **resource_property** instances to examine.

prop_name: the string that appears as the **name** of the **resource_property** instances to examine.

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

6 Conformance requirements

Conformance to this part of ISO 10303 includes satisfying the requirements stated in this part, the requirements of the implementation method(s) supported, and the relevant requirements of the normative references.

An implementation shall support at least one of the following implementation methods:

— ISO 10303-21.

Requirements with respect to implementation methods-specific requirements are specified in Annex C.

The Protocol Implementation Conformance Statement (PICS) proforma lists the options or the combinations of options that may be included in the implementation. The PICS proforma is provided in Annex D.

This part of ISO 10303 provides for a number of options that may be supported by an implementation. These options have been grouped into the following conformance classes:

— Tool path programming (CC1);

— Closed-loop programming (CC2);

— Feature-based programming (CC3);

— Generative programming (CC4).

These conformance classes are defined so that each class includes all the options specified by the preceeding class. Support for a particular conformance class requires support of all the options specified in that class.

EXAMPLE CC2 contains everything in CC1, plus additional options. CC3 contains everything in CC2, plus additional options. CC4 contains everything in CC3, plus all remaining options.

Conformance to a particular class requires that all AIM elements defined as part of that class be supported. Table 15 defines the classes to which each AIM element belongs. The conformance classes are described in detail by the following sections:

6.1 Conformance Class for tool path programming (CC1)

This conformance class supports the description of machining programs containing a single sequence of operations, each of which is described using the machine-independent path of the tool center point, using a simplified set of curves types, as well as tool requirements, management information about the program, and all technology-specific process parameters.

This conformance class includes all application objects from the measure, operation, project, workpiece, process data for milling, cutting tools for milling, process data for turning, cutting tools for turning, library reference, and management UoFs.

NOTE Since this conformance class requires a toolpath for every operation, any specified strategy is simply for additional information. In the absence of any other useful information, it is recommended that the machining operation be specified as a Freeform_operation with no associated strategies.

This conformance class includes the following application objects and their supertypes from the executable UoF:

— Machining_tool;

— Machining_workingstep;

— NC_function, the subtypes Display_message, NC_legacy_function, Optional_stop, Program_stop, Set_mark, Wait_for_mark, and the supporting object Channel;

— Rapid_movement and the subtype Return_home;

— Setup and the supporting objects Workpiece_setup and Setup_instruction;

— Workplan.

This conformance class includes the following application objects and their supertypes from the toolpath UoF:

— Cutter_location_trajectory;

— Feedstop;

— Toolpath_speed.

In addition, the following apply to use of the application objects in this conformance class:

— the its_toolpath shall be specified for each Operation object;

— the its_feature need not be specified for a particular Machining_workingstep object;

— the its_secplane need not be specified for a particular Machining_workingstep object;

— the dataset shall contain exactly one Workplan object;

— the basiccurve, its_toolaxis, and surface_normal for each Cutter_location_trajectory object shall be described using only polylines, composite or trimmed curves based upon lines or conics;

— no geometric shape information shall be specified for Machining_workingstep its_effect, Manufacturing_feature explicit_representation, Workpiece its_geometry or its_bounding_geometry, Workpiece_setup its_restricted_area, or Workplan its_effect.

6.2 Conformance Class for closed-loop programming (CC2)

This conformance class extends the previous conformance class to support the description of machining programs with the full range of toolpath specifications as well as full shape information for the workpiece, rawpiece and restricted areas on the setup.

This conformance class includes everything specified by CC1, plus all remaining application objects from the toolpath UoF and the Parallel application object from the executable UOF.

In addition, the following apply to use of the application objects in this conformance class:

— the dataset may contain multiple, nested Workplan objects;

— the basiccurve, its_toolaxis, and surface_normal for each Cutter_location_trajectory object may be described by any bounded_curve type;

— geometric shape information may be specified for Machining_workingstep its_effect, Workpiece its_geometry or its_bounding_geometry, Workpiece_setup its_restricted_area, or Workplan its_effect.

6.3 Conformance Class for feature-based programming (CC3)

This conformance class extends the previous conformance class to support the description of machining programs using the full range of executable constructs and manufacturing process features defined by implicit parameters.

This conformance class includes everything specified by CC2, plus all application objects from the manufacturing feature and manufacturing feature for turning UOFs and all remaining application objects from the executable UoF.

In addition, the following apply to use of the application objects in this conformance class:

— the its_toolpath need not be specified for a particular Operation object;

— the its_feature shall be specified for all Machining_workingstep objects;

— the its_secplane shall be specified for all Machining_workingstep objects.

6.4 Conformance Class for generative programming (CC4)

This conformance class extends the previous conformance class to support the description of geometric dimension and tolerance information sufficient to compute optimal speeds and feeds, manufacturing features appearing on the final product shape, and features with linkage to explicit geometry.

This conformance class includes everything specified by CC3, plus all application objects from the geometric dimensioning and tolerancing UOF and all remaining application objects from other UoFs.

In addition, the following apply to use of the application objects in this conformance class:

— the final_features may be specified for any Machining_workingstep object;

— the explicit_representation may be specified for any Manufacturing_feature object.

Table 16 — Conformance class elements

AIM element	Conformance class			
	1	2	3	4
action	X	X	X	X
action_method	X	X	X	X
action_method_relationship	X	X	X	X
action_method_with_associated_documents	X	X	X	X
action_property	X	X	X	X
action_property_representation	X	X	X	X
action_relationship			X	X
action_resource	X	X	X	X
action_resource_relationship	X	X	X	X
action_resource_requirement	X	X	X	X
action_resource_requirement_relationship	X	X	X	X
action_resource_type	X	X	X	X
address	X	X	X	X
advanced_brep_shape_representation		X	X	X
advanced_face		X	X	X
and_expression			X	X
angular_location			X	X
angular_size			X	X
angularity_tolerance			X	X
apex				X
application_context	X	X	X	X
application_context_element	X	X	X	X
application_protocol_definition	X	X	X	X
applied_approval_assignment	X	X	X	X
applied_area			X	X
applied_classification_assignment	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
applied_date_and_time_assignment	X	X	X	X
applied_date_assignment	X	X	X	X
applied_document_reference	X	X	X	X
applied_document_usage_constraint_assignment	X	X	X	X
applied_external_identification_assignment	X	X	X	X
applied_identification_assignment				X
applied_organization_assignment	X	X	X	X
applied_person_and_organization_assignment	X	X	X	X
applied_security_classification_assignment	X	X	X	X
approval	X	X	X	X
approval_assignment	X	X	X	X
approval_date_time	X	X	X	X
approval_person_organization	X	X	X	X
approval_relationship	X	X	X	X
approval_role	X	X	X	X
approval_status	X	X	X	X
assembly_component_usage	X	X	X	X
axis1_placement	X	X	X	X
axis2_placement_2d	X	X	X	X
axis2_placement_3d	X	X	X	X
b_spline_curve		X	X	X
b_spline_curve_with_knots		X	X	X
b_spline_surface		X	X	X
b_spline_surface_with_knots		X	X	X
back_boring_operation	X	X	X	X
bezier_curve		X	X	X
bezier_surface		X	X	X
binary_boolean_expression			X	X
binary_generic_expression			X	X
block		X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
block_shape_representation		X	X	X
boolean_expression			X	X
boring_operation	X	X	X	X
boss			X	X
boss_top			X	X
bottom_and_side_milling_operation	X	X	X	X
boundary_curve		X	X	X
bounded_curve	X	X	X	X
bounded_pcurve		X	X	X
bounded_surface		X	X	X
bounded_surface_curve		X	X	X
brep_with_voids		X	X	X
calendar_date	X	X	X	X
cartesian_point	X	X	X	X
cartesian_transformation_operator	X	X	X	X
cartesian_transformation_operator_3d	X	X	X	X
centre_of_symmetry				X
chamfer			X	X
chamfer_offset			X	X
characterized_object	X	X	X	X
circle	X	X	X	X
circular_closed_profile			X	X
circular_pattern			X	X
circular_runout_tolerance				X
class	X	X	X	X
classification_assignment	X	X	X	X
classification_role	X	X	X	X
closed_path_profile			X	X
closed_shell		X	X	X
coaxiality_tolerance				X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
common_datum				X
comparison_equal			X	X
comparison_expression			X	X
comparison_greater			X	X
comparison_greater_equal			X	X
comparison_less			X	X
comparison_less_equal			X	X
comparison_not_equal			X	X
composite_curve	X	X	X	X
composite_curve_on_surface		X	X	X
composite_curve_segment	X	X	X	X
composite_hole			X	X
composite_shape_aspect			X	X
compound_feature			X	X
compound_representation_item			X	X
concentricity_tolerance				X
concurrent_action_method		X	X	X
conic	X	X	X	X
conical_surface		X	X	X
connected_edge_set		X	X	X
connected_face_set		X	X	X
context_dependent_shape_representation	X	X	X	X
context_dependent_unit	X	X	X	X
contouring_turning_operation	X	X	X	X
conversion_based_unit	X	X	X	X
coordinated_universal_time_offset	X	X	X	X
curve	X	X	X	X
curve_bounded_surface		X	X	X
curve_replica		X	X	X
cylindrical_shape_representation		X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
cylindrical_surface		X	X	X
cylindricity_tolerance				X
data_environment			X	X
date	X	X	X	X
date_and_time	X	X	X	X
date_and_time_assignment	X	X	X	X
date_assignment	X	X	X	X
date_role	X	X	X	X
date_time_role	X	X	X	X
datum				X
datum_feature				X
datum_reference				X
datum_target				X
definitional_representation		X	X	X
degenerate_pcurve		X	X	X
degenerate_toroidal_surface		X	X	X
derived_shape_aspect			X	X
derived_unit	X	X	X	X
derived_unit_element	X	X	X	X
description_attribute	X	X	X	X
descriptive_representation_item	X	X	X	X
dimension_related_tolerance_zone_element				X
dimensional_characteristic_representation				X
dimensional_exponents	X	X	X	X
dimensional_location				X
dimensional_location_with_path				X
dimensional_size				X
dimensional_size_with_path				X
directed_dimensional_location				X
direction	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
direction_shape_representation			X	X
document	X	X	X	X
document_file	X	X	X	X
document_reference	X	X	X	X
document_representation_type	X	X	X	X
document_type	X	X	X	X
document_usage_constraint	X	X	X	X
document_usage_constraint_assignment	X	X	X	X
document_usage_role	X	X	X	X
document_with_class	X	X	X	X
drilling_operation	X	X	X	X
drilling_type_operation	X	X	X	X
drilling_type_strategy	X	X	X	X
edge		X	X	X
edge_based_wireframe_model		X	X	X
edge_based_wireframe_shape_representation		X	X	X
edge_curve		X	X	X
edge_loop		X	X	X
edge_round			X	X
elementary_surface	X	X	X	X
ellipse	X	X	X	X
environment			X	X
evaluated_degenerate_pcurve		X	X	X
expanded_uncertainty			X	X
expression			X	X
expression_representation_item			X	X
extension				X
external_identification_assignment	X	X	X	X
external_source			X	X
externally_defined_class	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
externally_defined_dimension_definition				X
externally_defined_feature_definition			X	X
externally_defined_general_property	X	X	X	X
externally_defined_item			X	X
externally_defined_item_relationship	X	X	X	X
externally_defined_representation_with_parameters	X	X	X	X
face		X	X	X
face_based_surface_model		X	X	X
face_bound		X	X	X
face_outer_bound		X	X	X
face_shape_representation			X	X
face_surface		X	X	X
faceted_brep		X	X	X
faceted_brep_shape_representation		X	X	X
facing_turning_operation	X	X	X	X
feature_component_definition			X	X
feature_component_relationship			X	X
feature_definition			X	X
feature_pattern			X	X
fillet			X	X
flat_face			X	X
flatness_tolerance				X
founded_item	X	X	X	X
freeform_milling_operation	X	X	X	X
freeform_milling_strategy	X	X	X	X
freeform_milling_tolerance_representation	X	X	X	X
functionally_defined_transformation			X	X
gear			X	X
general_property	X	X	X	X
general_property_association	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
generic_expression			X	X
generic_literal			X	X
generic_variable			X	X
geometric_alignment				X
geometric_curve_set		X	X	X
geometric_intersection				X
geometric_representation_context	X	X	X	X
geometric_representation_item	X	X	X	X
geometric_set		X	X	X
geometric_tolerance				X
geometric_tolerance_relationship				X
geometric_tolerance_with_datum_reference				X
geometric_tolerance_with_defined_unit				X
geometrically_bounded_surface_shape_representation		X	X	X
geometrically_bounded_wireframe_shape_representation		X	X	X
global_uncertainty_assigned_context	X	X	X	X
global_unit_assigned_context	X	X	X	X
grooving_turning_operation	X	X	X	X
group	X	X	X	X
hole_bottom			X	X
hyperbola	X	X	X	X
id_attribute	X	X	X	X
identification_assignment				X
identification_role				X
instanced_feature			X	X
int_literal			X	X
int_numeric_variable			X	X
intersection_curve			X	X
item_defined_transformation	X	X	X	X
known_source	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
knurling_turning_operation	X	X	X	X
length_measure_with_unit	X	X	X	X
length_unit	X	X	X	X
limits_and_fits				X
line	X	X	X	X
line_profile_tolerance				X
linear_profile			X	X
literal_number			X	X
local_time	X	X	X	X
location_shape_representation			X	X
loop		X	X	X
machining_adaptive_control_relationship	X	X	X	X
machining_approach_retract_strategy	X	X	X	X
machining_cutting_component	X	X	X	X
machining_cutting_corner_representation	X	X	X	X
machining_dwell_time_representation	X	X	X	X
machining_execution_resource	X	X	X	X
machining_feature_process			X	X
machining_feature_relationship			X	X
machining_feature_sequence_relationship			X	X
machining_feed_speed_representation	X	X	X	X
machining_final_feature_relationship				X
machining_functions	X	X	X	X
machining_functions_relationship	X	X	X	X
machining_nc_function	X	X	X	X
machining_offset_vector_representation			X	X
machining_operation	X	X	X	X
machining_operation_relationship	X	X	X	X
machining_operator_instruction	X	X	X	X
machining_operator_instruction_relationship	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	**2**	**3**	**4**
machining_process_body_relationship	X	X	X	X
machining_process_branch_relationship			X	X
machining_process_concurrent_relationship		X	X	X
machining_process_executable	X	X	X	X
machining_process_model	X	X	X	X
machining_process_model_relationship	X	X	X	X
machining_process_sequence_relationship	X	X	X	X
machining_project	X	X	X	X
machining_project_workpiece_relationship	X	X	X	X
machining_rapid_movement	X	X	X	X
machining_setup	X	X	X	X
machining_setup_workpiece_relationship	X	X	X	X
machining_spindle_speed_representation	X	X	X	X
machining_strategy	X	X	X	X
machining_strategy_relationship	X	X	X	X
machining_technology	X	X	X	X
machining_technology_relationship	X	X	X	X
machining_tool	X	X	X	X
machining_tool_body_representation	X	X	X	X
machining_tool_direction_representation	X	X	X	X
machining_tool_usage	X	X	X	X
machining_toolpath	X	X	X	X
machining_toolpath_sequence_relationship	X	X	X	X
machining_toolpath_speed_profile_representation	X	X	X	X
machining_touch_probing			X	X
machining_workingstep	X	X	X	X
machining_workplan	X	X	X	X
make_from_usage_option	X	X	X	X
manifold_solid_brep		X	X	X
manifold_surface_shape_representation			X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
mapped_item		X	X	X
marking			X	X
mass_measure_with_unit	X	X	X	X
mass_unit	X	X	X	X
material_designation	X	X	X	X
material_designation_characterization	X	X	X	X
material_property	X	X	X	X
material_property_representation	X	X	X	X
measure_qualification			X	X
measure_representation_item	X	X	X	X
measure_with_unit	X	X	X	X
milling_type_operation	X	X	X	X
milling_type_strategy	X	X	X	X
modified_geometric_tolerance				X
modified_pattern			X	X
multiple_arity_boolean_expression			X	X
multiple_arity_generic_expression			X	X
name_attribute	X	X	X	X
named_unit	X	X	X	X
next_assembly_usage_occurrence	X	X	X	X
ngon_closed_profile			X	X
ngon_shape_representation			X	X
non_manifold_surface_shape_representation		X	X	X
not_expression			X	X
numeric_expression			X	X
numeric_variable			X	X
object_role	X	X	X	X
offset_curve_3d		X	X	X
offset_surface		X	X	X
open_path_profile			X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
open_shell		X	X	X
or_expression			X	X
ordinal_date	X	X	X	X
organization	X	X	X	X
organization_assignment	X	X	X	X
organization_role	X	X	X	X
organizational_address	X	X	X	X
oriented_closed_shell		X	X	X
oriented_edge		X	X	X
oriented_face		X	X	X
oriented_open_shell		X	X	X
oriented_path		X	X	X
outer_boundary_curve		X	X	X
outer_round			X	X
outside_profile			X	X
parabola	X	X	X	X
parallel_offset				X
parallelism_tolerance				X
parametric_representation_context		X	X	X
partial_circular_profile			X	X
path		X	X	X
path_feature_component			X	X
path_shape_representation			X	X
pattern_offset_membership			X	X
pattern_omit_membership			X	X
pcurve		X	X	X
perpendicular_to				X
perpendicularity_tolerance				X
person	X	X	X	X
person_and_organization	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	**2**	**3**	**4**
person_and_organization_assignment	X	X	X	X
person_and_organization_role	X	X	X	X
personal_address	X	X	X	X
placed_datum_target_feature				X
placement	X	X	X	X
planar_shape_representation			X	X
plane	X	X	X	X
plane_angle_measure_with_unit	X	X	X	X
plane_angle_unit	X	X	X	X
plane_milling_operation	X	X	X	X
plus_minus_tolerance				X
pocket			X	X
pocket_bottom			X	X
point	X	X	X	X
point_on_curve		X	X	X
point_on_surface		X	X	X
point_replica		X	X	X
poly_loop		X	X	X
polyline	X	X	X	X
position_tolerance				X
pre_defined_item	X	X	X	X
precision_qualifier	X	X	X	X
process_product_association	X	X	X	X
process_property_association			X	X
product	X	X	X	X
product_category			X	X
product_category_relationship			X	X
product_context	X	X	X	X
product_definition	X	X	X	X
product_definition_context	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	**2**	**3**	**4**
product_definition_formation	X	X	X	X
product_definition_formation_with_specified_source	X	X	X	X
product_definition_process	X	X	X	X
product_definition_relationship	X	X	X	X
product_definition_shape		X	X	X
product_definition_usage	X	X	X	X
product_definition_with_associated_documents	X	X	X	X
product_related_product_category			X	X
profile_floor			X	X
projected_zone_definition				X
property_definition	X	X	X	X
property_definition_representation	X	X	X	X
property_process			X	X
protrusion				X
qualified_representation_item	X	X	X	X
qualitative_uncertainty	X	X	X	X
quasi_uniform_curve		X	X	X
quasi_uniform_surface		X	X	X
ratio_measure_with_unit	X	X	X	X
ratio_unit	X	X	X	X
rational_b_spline_curve		X	X	X
rational_b_spline_surface		X	X	X
real_literal			X	X
real_numeric_variable			X	X
rectangular_closed_profile			X	X
rectangular_composite_surface		X	X	X
rectangular_pattern			X	X
rectangular_trimmed_surface		X	X	X
referenced_modified_datum				X
removal_volume			X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
reparametrised_composite_curve_segment		X	X	X
replicate_feature			X	X
representation	X	X	X	X
representation_context	X	X	X	X
representation_item	X	X	X	X
representation_item_relationship	X	X	X	X
representation_map	X	X	X	X
representation_relationship	X	X	X	X
representation_relationship_with_transformation	X	X	X	X
requirement_for_action_resource	X	X	X	X
resource_property	X	X	X	X
resource_property_representation	X	X	X	X
resource_requirement_type	X	X	X	X
revolved_profile			X	X
rib_top			X	X
rib_top_floor			X	X
right_circular_cylinder		X	X	X
role_association	X	X	X	X
round_hole			X	X
rounded_end			X	X
rounded_u_profile			X	X
roundness_tolerance				X
runout_zone_definition				X
runout_zone_orientation				X
runout_zone_orientation_reference_direction				X
seam_curve		X	X	X
security_classification	X	X	X	X
security_classification_assignment	X	X	X	X
security_classification_level	X	X	X	X
sequential_method	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
serial_action_method	X	X	X	X
shape_aspect			X	X
shape_aspect_deriving_relationship			X	X
shape_aspect_relationship			X	X
shape_defining_relationship			X	X
shape_definition_representation		X	X	X
shape_dimension_representation				X
shape_representation		X	X	X
shape_representation_relationship		X	X	X
shape_representation_with_parameters			X	X
shell_based_surface_model		X	X	X
shell_based_wireframe_model		X	X	X
shell_based_wireframe_shape_representation		X	X	X
si_unit	X	X	X	X
side_milling_operation	X	X	X	X
simple_generic_expression			X	X
simple_numeric_expression			X	X
slot			X	X
slot_end			X	X
solid_angle_measure_with_unit	X	X	X	X
solid_angle_unit	X	X	X	X
solid_model		X	X	X
spherical_cap			X	X
spherical_surface		X	X	X
square_u_profile			X	X
standard_uncertainty	X	X	X	X
step			X	X
straightness_tolerance				X
surface		X	X	X
surface_curve		X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
surface_of_linear_extrusion		X	X	X
surface_of_revolution	X	X	X	X
surface_patch		X	X	X
surface_profile_tolerance				X
surface_replica		X	X	X
surface_texture_representation	X	X	X	X
swept_surface		X	X	X
symmetric_shape_aspect				X
symmetry_tolerance				X
tangent				X
taper			X	X
tapping_operation	X	X	X	X
tee_profile			X	X
thread			X	X
thread_runout			X	X
threading_turning_operation	X	X	X	X
time_measure_with_unit	X	X	X	X
time_unit	X	X	X	X
tolerance_value				X
tolerance_zone				X
tolerance_zone_definition				X
tolerance_zone_form				X
topological_representation_item		X	X	X
toroidal_surface		X	X	X
total_runout_tolerance				X
transition_feature			X	X
trimmed_curve	X	X	X	X
turned_knurl			X	X
turning_type_operation	X	X	X	X
turning_type_strategy	X	X	X	X

Table 16 — Conformance class elements (continued)

AIM element	Conformance class			
	1	**2**	**3**	**4**
type_qualifier	X	X	X	X
unary_boolean_expression			X	X
unary_generic_expression			X	X
uncertainty_measure_with_unit			X	X
uncertainty_qualifier			X	X
uniform_curve		X	X	X
uniform_surface		X	X	X
value_range	X	X	X	X
value_representation_item	X	X	X	X
variable			X	X
variable_semantics			X	X
vector	X	X	X	X
vee_profile			X	X
vertex		X	X	X
vertex_loop		X	X	X
vertex_point		X	X	X
vertex_shell		X	X	X
week_of_year_and_day_date	X	X	X	X
wire_shell		X	X	X
xor_expression			X	X

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
  (product,
   product_definition,
   product_definition_formation);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE area_measure = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE axis2_placement = SELECT
  (axis2_placement_2d,
   axis2_placement_3d);
END_TYPE; -- 10303-42: geometry_schema

TYPE b_spline_curve_form = ENUMERATION OF
  (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 characterized_action_definition = SELECT
  (action,
   action_method,
   action_method_relationship,
   action_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,
   action_resource_requirement_relationship);
END_TYPE; -- 10303-49: process_property_schema

TYPE classification_item = SELECT
  (externally_defined_representation_with_parameters);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE compound_item_definition = SELECT
  (list_representation_item,
   set_representation_item);
END_TYPE; -- 10303-43: representation_schema
```

```
TYPE context_dependent_measure = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE count_measure = NUMBER;
END_TYPE; -- 10303-41: measure_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,
   machining_operation,
   machining_process_executable,
   machining_toolpath,
   product,
   product_definition,
   product_definition_formation);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE date_item = SELECT
  (product,
   product_definition,
   product_definition_formation);
END_TYPE; -- 10303-238: integrated_cnc_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
    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_role,
   date_time_role,
   context_dependent_shape_representation,
   external_source,
   organization_role,
   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
  (externally_defined_dimension_definition,
   externally_defined_feature_definition,
   material_designation,
   property_definition);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE external_identification_item = SELECT
  (externally_defined_class,
   externally_defined_general_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 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 identification_item = SELECT
  (dimensional_size);
END_TYPE; -- 10303-238: integrated_cnc_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;
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 mass_measure = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE measure_value = SELECT
  (length_measure,
   mass_measure,
   time_measure,
   plane_angle_measure,
```



```
   solid_angle_measure,
   area_measure,
   volume_measure,
   ratio_measure,
   parameter_value,
   numeric_measure,
   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,
   person_and_organization,
   product_definition,
   property_definition_representation);
END_TYPE; -- 10303-41: basic_attribute_schema

TYPE numeric_measure = NUMBER;
END_TYPE; -- 10303-41: measure_schema

TYPE organization_item = SELECT
  (product,
   product_definition,
   product_definition_formation,
   known_source);
END_TYPE; -- 10303-238: integrated_cnc_schema

TYPE parameter_value = REAL;
END_TYPE; -- 10303-41: measure_schema

TYPE pcurve_or_surface = SELECT
  (pcurve,
   surface);
END_TYPE; -- 10303-42: geometry_schema

TYPE person_and_organization_item = SELECT
  (product,
   product_definition,
   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 > 0.0;
END_TYPE; -- 10303-41: measure_schema

TYPE positive_plane_angle_measure = plane_angle_measure;
  WHERE
    WR1: SELF > 0.0;
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 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

TYPE represented_definition = SELECT
  (general_property,
   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,
   security_classification_assignment);
END_TYPE; -- 10303-41: basic_attribute_schema

TYPE second_in_minute = REAL;
  WHERE
    WR1: (0 <= SELF) AND (SELF <= 60.0);
END_TYPE; -- 10303-41: date_time_schema

TYPE security_classification_item = SELECT
  (machining_operation,
   machining_process_executable,
   machining_toolpath,
   product_definition,
   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,
   shape_aspect_relationship);
END_TYPE; -- 10303-41: product_property_definition_schema

TYPE shell = SELECT
  (vertex_shell,
   wire_shell,
   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,
   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 = ENUMERATION OF
  (made,
   bought,
   not_known);
END_TYPE; -- 10303-41: product_definition_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 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
  (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 volume_measure = REAL;
END_TYPE; -- 10303-41: measure_schema
```

```
TYPE week_in_year_number = INTEGER;
  WHERE
    WR1: (1 <= SELF) AND (SELF <= 53);
END_TYPE; -- 10303-41: date_time_schema

TYPE wireframe_model = SELECT
  (shell_based_wireframe_model,
   edge_based_wireframe_model);
END_TYPE; -- 10303-42: geometric_model_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;
    description     : OPTIONAL text;
    relating_method : action_method;
    related_method  : action_method;
END_ENTITY; -- 10303-41: action_schema

ENTITY action_method_with_associated_documents
  SUBTYPE OF (action_method);
    documents : SET [1:?] OF document;
END_ENTITY; -- 10303-49: method_definition_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_relationship;
    name            : label;
    description     : OPTIONAL text;
    relating_action : action;
    related_action  : action;
END_ENTITY; -- 10303-41: action_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_requirement_relationship;
    name                                 : label;
    description                          : text;
    relating_action_resource_requirement : action_resource_requirement;
    related_action_resource_requirement  : action_resource_requirement;
  WHERE
    WR1: relating_action_resource_requirement :<>:
              related_action_resource_requirement;
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;
    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',
```



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        'INTEGRATED_CNC_SCHEMA.SWEPT_SURFACE' ] * TYPEOF(
        face_geometry)) = 1;
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.associated_geometry| NOT (
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              '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;
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,
             '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 = '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; -- 10303-522: aic_machining_feature

ENTITY applied_classification_assignment
  SUBTYPE OF (classification_assignment);
    items : SET [1:?] OF classification_item;
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_date_assignment
  SUBTYPE OF (date_assignment);
    items : SET [1:?] OF date_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

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



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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_external_identification_assignment
  SUBTYPE OF (external_identification_assignment);
    items : SET [1:?] OF external_identification_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_identification_assignment
  SUBTYPE OF (identification_assignment);
    items : SET [1:?] OF identification_item;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY applied_organization_assignment
  SUBTYPE OF (organization_assignment);
    items : SET [1:?] OF organization_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.' +
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              '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_relationship;
    name              : label;
    description       : OPTIONAL text;
    relating_approval : approval;
    related_approval  : approval;
END_ENTITY; -- 10303-41: approval_schema

ENTITY approval_role;
    role : 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: 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, 0.0
           , 1.0 ]));
  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 > 0.0);
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;
    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
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      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
               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) |
           ('INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'
              IN TYPEOF (amr)) AND NOT
           (verify_required_action_property
                (amr.related_method, 'oriented spindle stop')))));
END_ENTITY; -- 10303-238: integrated_cnc_schema
```



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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 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
```

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

  WR2:  (verify_optional_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
        (verify_rep_item_for_action_property    (SELF, 'waiting position',
         ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT']));
END_ENTITY; -- 10303-238: integrated_cnc_schema

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 (
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            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 ('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(
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              fcr.related_shape_aspect)) AND ('INTEGRATED_CNC_SCHEMA.BOSS'
              IN TYPEOF(fcr.relating_shape_aspect)))) = 1))) <= 1))) = 0);
    WR9: NOT (SELF\characterized_object.description = 'complex') OR (SIZEOF
              (QUERY (pds <* QUERY (pd <* USEDIN(SELF,
              '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 ('INTEGRATED_CNC_SCHEMA.BOSS'
              IN TYPEOF(fcr.relating_shape_aspect))) AND (fcr.
              related_shape_aspect.description IN [ 'angle taper',
              'directed taper' ]))) = 1))) <= 1))) = 0);
    WR11: NOT (SELF\characterized_object.description = 'rectangular') OR (
              SIZEOF(QUERY (pds <* QUERY (pd <* USEDIN(SELF,
              '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);
    WR12: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF
              )| ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.used_representation
              .name = 'maximum feature limit'))) >= 0;
END_ENTITY; -- 10303-522: aic_machining_feature

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)))
          AND ('INTEGRATED_CNC_SCHEMA.BOSS_TOP' IN TYPEOF(fcr.
          relating_shape_aspect)))) >= 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,
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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 = 'top radius'))) <= 1))) = 0))) = 0;
END_ENTITY; -- 10303-522: aic_machining_feature

ENTITY bottom_and_side_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing','finishing']);

  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 = 'roughing') OR
        ((verify_required_action_property (SELF, 'allowance side')) AND
         (verify_required_action_property (SELF, 'allowance bottom')));
END_ENTITY; -- 10303-238: integrated_cnc_schema

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
    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, 1.0);
  WHERE
    WR1: scl > 0.0;
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;
```

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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)))) = 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 (
              'INTEGRATED_CNC_SCHEMA.CHAMFER' IN TYPEOF(fcr.
              relating_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 (
              'INTEGRATED_CNC_SCHEMA.CHAMFER' IN TYPEOF(fcr.
              relating_shape_aspect))) AND (fcr.related_shape_aspect.
              description = 'second offset'))) = 1;
END_ENTITY; -- 10303-522: aic_machining_feature

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
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        (SIZEOF(QUERY (impl_rep <* QUERY (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,
        '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);
```



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    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)) AND (
              'INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET' IN TYPEOF(sdr.
              related_shape_aspect)))) = 1;
END_ENTITY; -- 10303-522: aic_machining_feature

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
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            (SIZEOF(QUERY (impl_rep <* QUERY (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;
END_ENTITY; -- 10303-522: aic_machining_feature

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')| (
              '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; -- 10303-522: aic_machining_feature

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

ENTITY class
  SUBTYPE OF (group);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY classification_assignment
  ABSTRACT SUPERTYPE;
    assigned_class : group;
    role           : classification_role;
END_ENTITY; -- 10303-41: management_resources_schema

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; -- 10303-522: aic_machining_feature

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
    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);
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') 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; -- 10303-522: aic_machining_feature

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')| (
```



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            '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)
            ))) = 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; -- 10303-522: aic_machining_feature

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

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 >= 0.0;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY connected_edge_set
  SUBTYPE OF (topological_representation_item);
    ces_edges : SET [1:?] OF edge;
END_ENTITY; -- 10303-42: topology_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
```

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  SUBTYPE OF (named_unit);
    name : label;
END_ENTITY; -- 10303-41: measure_schema

ENTITY contouring_turning_operation
  SUBTYPE OF (turning_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing','finishing']);

  WR2:  (verify_optional_action_property        (SELF, 'allowance')) AND
        (verify_length_measure_action_property  (SELF, 'allowance'));

  WR3:  NOT (SELF.description = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance'));
END_ENTITY; -- 10303-238: integrated_cnc_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);
    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))
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              )) <= 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(
              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_assignment
  ABSTRACT SUPERTYPE;
    assigned_date : date;
    role          : date_role;
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY date_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 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 datum
  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
              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 <> 1.0);
    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;
    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 directed_dimensional_location
  SUBTYPE OF (dimensional_location);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY direction
  SUBTYPE OF (geometric_representation_item);
    direction_ratios : LIST [2:3] OF REAL;
  WHERE
    WR1: SIZEOF(QUERY (tmp <* direction_ratios| (tmp <> 0.0))) > 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; -- 10303-522: aic_machining_feature

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;
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 document_with_class
  SUBTYPE OF (document);
    class : identifier;
END_ENTITY; -- 10303-41: document_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_rep_type_for_action_property   (SELF, 'dwell time step',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_DWELL_TIME_REPRESENTATION'])) AND
         (verify_rep_name_for_action_property   (SELF, 'dwell time step',
           ['dwell time']))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

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_rep_type_for_action_property    (SELF, 'dwell time bottom',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_DWELL_TIME_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property    (SELF, 'dwell time bottom',
           ['dwell time']));

  WR5:  (verify_optional_action_property        (SELF, 'feedrate on retract'))
AND
        (verify_rep_type_for_action_property    (SELF, 'feedrate on retract',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property    (SELF, 'feedrate on retract',
           ['relative speed']));

  WR6:  ((verify_optional_relating_amr_with_name  (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.DRILLING_TYPE_STRATEGY']))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY drilling_type_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  (verify_optional_action_property     (SELF, 'reduced cut at start')) AND
        (verify_rep_type_for_action_property (SELF, 'reduced cut at start',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property    (SELF, 'reduced cut at start',
           ['relative speed']));

  WR2:  (verify_optional_action_property
          (SELF, 'reduced feedrate at start')) AND
        (verify_rep_type_for_action_property
          (SELF, 'reduced feedrate at start',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property
          (SELF, 'reduced feedrate at start',
           ['relative speed']));

  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_rep_type_for_action_property
          (SELF, 'reduced cut at end',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property    (SELF, 'reduced cut at end',
           ['relative speed']));

  WR5:  (verify_optional_action_property
         (SELF, 'reduced feedrate at end')) AND
        (verify_rep_type_for_action_property
         (SELF, 'reduced feedrate at end',
```



```
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property
          (SELF, 'reduced feedrate at end',
           ['relative speed']));

  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 feedrate 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 feedrate at end'))));
END_ENTITY; -- 10303-238: integrated_cnc_schema

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

ENTITY edge_based_wireframe_model
  SUBTYPE OF (geometric_representation_item);
    ebwm_boundary : SET [1:?] OF connected_edge_set;
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY edge_based_wireframe_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: SIZEOF(QUERY (it <* SELF.items| NOT (SIZEOF([
              'INTEGRATED_CNC_SCHEMA.EDGE_BASED_WIREFRAME_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.EDGE_BASED_WIREFRAME_MODEL',
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' ] * TYPEOF(it)) = 1))) >=
               1;
    WR3: SIZEOF(QUERY (ebwm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.EDGE_BASED_WIREFRAME_MODEL' IN TYPEOF(
              it)))| NOT (SIZEOF(QUERY (eb <* ebwm\
              edge_based_wireframe_model.ebwm_boundary| NOT (SIZEOF(QUERY (
              edges <* eb.ces_edges| NOT (
              'INTEGRATED_CNC_SCHEMA.EDGE_CURVE' IN TYPEOF(edges)))) = 0)))
               = 0))) = 0;
    WR4: SIZEOF(QUERY (ebwm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.EDGE_BASED_WIREFRAME_MODEL' IN TYPEOF(
              it)))| NOT (SIZEOF(QUERY (eb <* ebwm\
              edge_based_wireframe_model.ebwm_boundary| NOT (SIZEOF(QUERY (
              pline_edges <* QUERY (edges <* eb.ces_edges| (
```



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              'INTEGRATED_CNC_SCHEMA.POLYLINE' IN TYPEOF(edges\edge_curve.
              edge_geometry)))| NOT (SIZEOF(pline_edges\edge_curve.
              edge_geometry\polyline.points) > 2))) = 0))) = 0))) = 0;
    WR5: SIZEOF(QUERY (ebwm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.EDGE_BASED_WIREFRAME_MODEL' IN TYPEOF(
              it)))| NOT (SIZEOF(QUERY (eb <* ebwm\
              edge_based_wireframe_model.ebwm_boundary| NOT (SIZEOF(QUERY (
              edges <* eb.ces_edges| NOT ((
              'INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(edges.
              edge_start)) AND ('INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN
              TYPEOF(edges.edge_end))))) = 0))) = 0))) = 0;
    WR6: SIZEOF(QUERY (ebwm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.EDGE_BASED_WIREFRAME_MODEL' IN TYPEOF(
              it)))| NOT (SIZEOF(QUERY (eb <* ebwm\
              edge_based_wireframe_model.ebwm_boundary| NOT (SIZEOF(QUERY (
              edges <* eb.ces_edges| NOT valid_wireframe_edge_curve(edges\
              edge_curve.edge_geometry))) = 0))) = 0))) = 0;
    WR7: SIZEOF(QUERY (ebwm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.EDGE_BASED_WIREFRAME_MODEL' IN TYPEOF(
              it)))| NOT (SIZEOF(QUERY (eb <* ebwm\
              edge_based_wireframe_model.ebwm_boundary| NOT (SIZEOF(QUERY (
              edges <* eb.ces_edges| NOT (valid_wireframe_vertex_point(
              edges.edge_start\vertex_point.vertex_geometry) AND
              valid_wireframe_vertex_point(edges.edge_end\vertex_point.
              vertex_geometry)))) = 0))) = 0))) = 0;
    WR8: SIZEOF(QUERY (mi <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' IN TYPEOF(it)))| NOT (
              'INTEGRATED_CNC_SCHEMA.' +
              'EDGE_BASED_WIREFRAME_SHAPE_REPRESENTATION' IN TYPEOF(mi\
              mapped_item.mapping_source.mapped_representation)))) = 0;
    WR9: SELF.context_of_items\geometric_representation_context.
              coordinate_space_dimension = 3;
END_ENTITY; -- 10303-501: aic_edge_based_wireframe

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,
```



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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);
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,
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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 =
              '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; -- 10303-522: aic_machining_feature

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
```



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ENTITY expression_representation_item
  SUBTYPE OF (representation_item, generic_expression);
END_ENTITY; -- 10303-238: integrated_cnc_schema

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_identification_assignment
  ABSTRACT SUPERTYPE
  SUBTYPE OF (identification_assignment);
    source : external_source;
END_ENTITY; -- 10303-41: management_resources_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_class
  SUBTYPE OF (externally_defined_item, class);
  WHERE
    WR1: 'INTEGRATED_CNC_SCHEMA.KNOWN_SOURCE' IN TYPEOF(SELF.source);
    WR2: SELF.source.name = 'ISO 13584 library';
    WR3: SIZEOF(QUERY (aoa <* USEDIN(SELF.source,
              'INTEGRATED_CNC_SCHEMA.APPLIED_ORGANIZATION_ASSIGNMENT.ITEMS'
              )| (aoa.role.name = 'library supplier'))) = 1;
    WR4: SIZEOF(QUERY (aoa <* USEDIN(SELF, 'INTEGRATED_CNC_SCHEMA.' +
              'APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT.ITEMS')| (aoa.
              role.name = 'class version'))) = 1;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY externally_defined_dimension_definition
  SUBTYPE OF (externally_defined_item, dimensional_size);
  WHERE
    WR1: (SELF\externally_defined_item.item_id = 'external size dimension')
               AND (SELF\externally_defined_item.source.source_id =
              'external size dimension specification');
    WR2: 1 >= SIZEOF(QUERY (adr <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.APPLIED_DOCUMENT_REFERENCE.ITEMS')| (
              adr.assigned_document.description =
              'external size dimension specification')));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY externally_defined_feature_definition
  SUBTYPE OF (feature_definition, externally_defined_item);
  WHERE
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WR1: ((((SELF\characterized_object.description = 'thread') AND (SELF\
        externally_defined_item.item_id = 'external thread')) AND (
        SELF\externally_defined_item.source.source_id =
        'external feature specification') OR ((SELF\
        characterized_object.description = 'gear') AND (SELF\
        externally_defined_item.item_id = 'external gear')) AND (SELF
        \externally_defined_item.source.source_id =
        'external feature specification')) OR ((SELF\
        characterized_object.description = 'marking') AND (SELF\
        externally_defined_item.item_id = 'external marking')) AND (
        SELF\externally_defined_item.source.source_id =
        'external feature specification')) OR ((SELF\
        characterized_object.description = 'knurl') AND (SELF\
        externally_defined_item.item_id = 'external knurl')) AND (
        SELF\externally_defined_item.source.source_id =
        'external feature specification');
WR2: NOT (SELF\characterized_object.description = 'thread') OR (SIZEOF(
        QUERY (pd <* USEDIN(SELF,
        '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 ((5 <= 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')| (
        '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 =
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           '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 (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);
  WR7: 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);
  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 = 'qualifier'))) <= 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| (
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          'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
          TYPEOF(it)) AND (it.name = 'hand'))) = 1))) = 0))) = 0);
WR10: NOT (SELF\characterized_object.description = 'thread') OR (SIZEOF
          (QUERY (pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
          (SIZEOF(QUERY (impl_rep <* QUERY (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);
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 = 'form'))) = 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| (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);
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.RATIO_MEASURE_WITH_UNIT' ] * TYPEOF(it
          )) = 2) AND (it.name = 'number of threads'))) = 1))) = 0))) =
           0);
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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| (
        'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
        TYPEOF(it)) AND (it.name = 'fit class 2'))) <= 1))) = 0))) =
        0;
WR15: SIZEOF(QUERY (pd <* USEDIN(SELF,
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
        (SIZEOF(QUERY (impl_rep <* QUERY (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 size'))) <= 1))) = 0))) = 0
        ;
WR16: NOT (SELF\characterized_object.description IN [ 'knurl', 'gear',
        '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);
WR17: NOT (SELF\characterized_object.description IN [ 'gear' ]) 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 (10 <= SIZEOF(pdr.
        used_representation.items))) AND (SIZEOF(pdr.
        used_representation.items) >= 11))) = 1))) = 1);
WR18: NOT (SELF\characterized_object.description IN [ 'gear' ]) OR (
        SIZEOF(QUERY (pd <* USEDIN(SELF,
        'INTEGRATED_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.RATIO_MEASURE_WITH_UNIT' ] * TYPEOF(it
            )) = 2) AND (it.name = 'number of teeth'))) = 1))) = 0))) = 0
            );
  WR19: NOT (SELF\characterized_object.description IN [ 'gear' ]) OR (
            SIZEOF(QUERY (pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
            (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'reference pressure angle')))
             = 1))) = 0))) = 0);
  WR20: NOT (SELF\characterized_object.description IN [ 'gear' ]) 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 = 'rake shift factor'))) = 1))) = 0)))
             = 0);
  WR21: NOT (SELF\characterized_object.description IN [ 'gear' ]) 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 = 'nominal tooth depth'))) = 1))) = 0)
            )) = 0);
  WR22: NOT (SELF\characterized_object.description IN [ 'gear' ]) 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 = 'face width'))) = 1))) = 0))) = 0);
  WR23: NOT (SELF\characterized_object.description IN [ 'gear' ]) 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 diameter'))) = 1))) = 0))) = 0)
            ;
  WR24: NOT (SELF\characterized_object.description IN [ 'gear' ]) 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 = 'module or diametral pitch')) AND
            ((it.description = 'module') OR (it.description =
            'diametral pitch')))) = 1))) = 0))) = 0);
  WR25: NOT (SELF\characterized_object.description IN [ 'gear' ]) OR (
            SIZEOF(QUERY (pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
            (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'normal attribute'))) = 1))) = 0)))
            = 0);
  WR26: NOT (SELF\characterized_object.description IN [ 'gear' ]) 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(QUERY (it <* impl_rep.
              used_representation.items| ((
              'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
              TYPEOF(it)) AND (it.name = 'internal or external gear')) AND
              ((it.description = 'internal') OR (it.description =
              'external')))) = 1))) = 0))) = 0);
    WR27: NOT (SELF\characterized_object.description IN [ 'gear' ]) OR (
              SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'root fillet radius'))) <= 1)
              )) = 0))) = 0);
END_ENTITY; -- 10303-522: aic_machining_feature

ENTITY externally_defined_general_property
  SUBTYPE OF (general_property, externally_defined_item);
  WHERE
    WR1: 'INTEGRATED_CNC_SCHEMA.KNOWN_SOURCE' IN TYPEOF(SELF.source);
    WR2: SELF.source.name = 'ISO 13584 library';
    WR3: SIZEOF(QUERY (aoa <* USEDIN(SELF, 'INTEGRATED_CNC_SCHEMA.' +
              'APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT.ITEMS')| (aoa.
              role.name = 'property version'))) = 1;
    WR4: SIZEOF(QUERY (ap <* USEDIN(SELF, 'INTEGRATED_CNC_SCHEMA.' +
              'EXTERNALLY_DEFINED_ITEM_RELATIONSHIP.RELATING_ITEM')| (ap.
              name = 'name scope') AND (
              'INTEGRATED_CNC_SCHEMA.EXTERNALLY_DEFINED_CLASS' IN TYPEOF(ap
              .related_item)))) >= 1;
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 externally_defined_item_relationship;
    name          : label;
    description   : OPTIONAL text;
    relating_item : externally_defined_item;
    related_item  : externally_defined_item;
END_ENTITY; -- 10303-41: external_reference_schema

ENTITY externally_defined_representation_with_parameters
```



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  SUBTYPE OF (representation);
  WHERE
    WR1: SIZEOF(USEDIN(SELF, 'INTEGRATED_CNC_SCHEMA.' +
              'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS')) = 1;
    WR2: SIZEOF(QUERY (adr <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.PLACEMENT' IN TYPEOF(adr)))) <= 1;
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY face
  SUPERTYPE OF (ONEOF(face_surface, oriented_face))
  SUBTYPE OF (topological_representation_item);
    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_based_surface_model
  SUBTYPE OF (geometric_representation_item);
    fbsm_faces : SET [1:?] OF connected_face_set;
END_ENTITY; -- 10303-42: geometric_model_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; -- 10303-522: aic_machining_feature

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 faceted_brep
  SUBTYPE OF (manifold_solid_brep);
```



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END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY faceted_brep_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: SIZEOF(QUERY (it <* items| NOT (SIZEOF([
              'INTEGRATED_CNC_SCHEMA.FACETED_BREP',
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM',
              'INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D' ] * TYPEOF(it)) =
              1))) = 0;
    WR2: SIZEOF(QUERY (it <* items| (SIZEOF([
              'INTEGRATED_CNC_SCHEMA.FACETED_BREP',
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' ] * TYPEOF(it)) = 1))) >
              0;
    WR3: SIZEOF(QUERY (fbrep <* QUERY (it <* items| (
              'INTEGRATED_CNC_SCHEMA.FACETED_BREP' IN TYPEOF(it)))| NOT (
              SIZEOF(QUERY (csh <* msb_shells(fbrep)| NOT (SIZEOF(QUERY (
              fcs <* csh\connected_face_set.cfs_faces| NOT ((
              'INTEGRATED_CNC_SCHEMA.FACE_SURFACE' IN TYPEOF(fcs)) AND ((
              'INTEGRATED_CNC_SCHEMA.PLANE' IN TYPEOF(fcs\face_surface.
              face_geometry)) AND ('INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT'
              IN TYPEOF(fcs\face_surface.face_geometry\elementary_surface.
              position.location)))))) = 0))) = 0))) = 0;
    WR4: SIZEOF(QUERY (fbrep <* QUERY (it <* items| (
              'INTEGRATED_CNC_SCHEMA.FACETED_BREP' IN TYPEOF(it)))| NOT (
              SIZEOF(QUERY (csh <* msb_shells(fbrep)| NOT (SIZEOF(QUERY (
              fcs <* csh\connected_face_set.cfs_faces| NOT (SIZEOF(QUERY (
              bnds <* fcs.bounds| ('INTEGRATED_CNC_SCHEMA.FACE_OUTER_BOUND'
               IN TYPEOF(bnds)))) = 1))) = 0))) = 0))) = 0;
    WR5: 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;
    WR6: 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;
    WR7: SIZEOF(QUERY (mi <* QUERY (it <* items| (
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' IN TYPEOF(it)))| NOT (
              'INTEGRATED_CNC_SCHEMA.FACETED_BREP_SHAPE_REPRESENTATION' IN
              TYPEOF(mi\mapped_item.mapping_source.mapped_representation)))
              ) = 0;
END_ENTITY; -- 10303-512: aic_faceted_brep

ENTITY facing_turning_operation
  SUBTYPE OF (turning_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing','finishing']);

  WR2:  (verify_optional_action_property        (SELF, 'allowance')) AND
        (verify_length_measure_action_property  (SELF, 'allowance'));

  WR3:  NOT (SELF.description = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance'));
```



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END_ENTITY; -- 10303-238: integrated_cnc_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; -- 10303-522: aic_machining_feature

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; -- 10303-522: aic_machining_feature

ENTITY feature_definition
  SUBTYPE OF (characterized_object);
  WHERE
    WR1: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
              | (
              'INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
              IN TYPEOF(pdr.used_representation)))) <= 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.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.GEAR',
               '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',
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              '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 (pdr <*
              get_property_definition_representations(SELF)| (
              'INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN TYPEOF
              (pdr.used_representation)) AND (pdr.used_representation.name
              = 'maximum feature limit'))) >= 0);
END_ENTITY; -- 10303-522: aic_machining_feature

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; -- 10303-522: aic_machining_feature
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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.' +
              '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.' +
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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 = '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 =
               '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; -- 10303-522: aic_machining_feature

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 =
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            '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 ('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;
    WR5: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
            | ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.used_representation
            .name = 'maximum feature limit'))) >= 0;
    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 (csa.name = 'uncut volume')) AND (SIZEOF(QUERY (sar <*
            csa.component_relationships| (
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar)) AND (SIZEOF([ 'INTEGRATED_CNC_SCHEMA.BOSS',
            'INTEGRATED_CNC_SCHEMA.PROTRUSION' ] * TYPEOF(sar.
            related_shape_aspect)) = 1))) = 1))) <= 1))) = 1;
    WR7: SIZEOF(QUERY (pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
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              (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'removal depth'))) <= 1))) = 0))) =
              0;
END_ENTITY; -- 10303-522: aic_machining_feature

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_optional_relating_amr_with_name  (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.FREEFORM_MILLING_STRATEGY']))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

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

         (verify_required_action_property       (SELF, 'cutmode')) AND
         (verify_enumeration_action_property    (SELF, 'cutmode',
           ['climb', 'conventional'])) AND

        (verify_required_action_property      (SELF, 'milling tolerances')) AND
         (verify_rep_type_for_action_property   (SELF, 'milling tolerances',
         ['INTEGRATED_CNC_SCHEMA.FREEFORM_MILLING_TOLERANCE_REPRESENTATION']))
AND

         (verify_optional_action_property       (SELF, 'stepover length')) AND
         (verify_length_measure_action_property (SELF, 'stepover length')) );
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  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; -- 10303-238: integrated_cnc_schema

ENTITY freeform_milling_tolerance_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:   (verify_required_rep_item       (SELF, 'chordal tolerance')) AND
         (verify_length_measure_rep_item (SELF, 'chordal tolerance'));

  WR2:   (verify_required_rep_item       (SELF, 'scallop height')) AND
         (verify_length_measure_rep_item (SELF, 'scallop height'));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY functionally_defined_transformation;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-43: representation_schema

ENTITY gear
  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 (10 <= SIZEOF(pdr.
              used_representation.items))) AND (SIZEOF(pdr.
              used_representation.items) <= 13))) = 1))) = 1;
    WR2: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear', 'spur gear',
              'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
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            (SIZEOF(QUERY (impl_rep <* QUERY (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 teeth'))) = 1))) = 0))) = 0
            );
    WR3: NOT (SELF\characterized_object.description IN [
            'straight bevel gear', 'helical bevel gear', 'spur gear',
            'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
            (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'reference pressure angle')))
             = 1))) = 0))) = 0);
    WR4: NOT (SELF\characterized_object.description IN [
            'straight bevel gear', 'helical bevel gear', 'spur gear',
            'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
            (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'rake shift factor'))) = 1))) = 0)))
             = 0);
    WR5: NOT (SELF\characterized_object.description IN [
            'straight bevel gear', 'helical bevel gear', 'spur gear',
            'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
            (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'nominal tooth depth'))) = 1))) = 0)
              )) = 0);
    WR6: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear', 'spur gear',
              'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'face width'))) = 1))) = 0))) = 0);
    WR7: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear', 'spur gear',
              'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 diameter'))) = 1))) = 0))) = 0)
              ;
    WR8: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear', 'spur gear',
              'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'module or diametral pitch')) AND
              ((it.description = 'module') OR (it.description =
              'diametral pitch')))) = 1))) = 0))) = 0);
    WR9: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear', 'spur gear',
              'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
              '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.DESCRIPTIVE_REPRESENTATION_ITEM' IN
              TYPEOF(it)) AND (it.name = 'internal or external gear')) AND
              ((it.description = 'internal') OR (it.description =
              'external')))) = 1))) = 0))) = 0);
    WR10: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear', 'spur gear',
              'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'normal attribute'))) = 1))) = 0)))
              = 0);
    WR11: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear', 'spur gear',
              'helical gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 radius'))) <= 1))) = 0)
              )) = 0);
    WR12: NOT (SELF\characterized_object.description IN [ 'helix gear',
              'helical bevel gear' ]) 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 = 'reference helix angle'))) =
              1))) = 0))) = 0);
    WR13: NOT (SELF\characterized_object.description IN [ 'helix gear',
              'helical bevel gear' ]) OR (SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
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              (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'gear tooth')) AND ((it.
              description = 'left hand tooth') OR (it.description =
              'right hand tooth')))) = 1))) = 0))) = 0);
    WR14: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear' ]) OR (SIZEOF(
              QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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);
    WR15: NOT (SELF\characterized_object.description IN [
              'straight bevel gear', 'helical bevel gear' ]) 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 = 'root angle'))) = 1))) = 0)))
               = 0);
    WR16: 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; -- 10303-522: aic_machining_feature
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ENTITY general_property;
    id          : identifier;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: product_property_definition_schema

ENTITY general_property_association;
    name               : label;
    description        : OPTIONAL text;
    base_definition    : general_property;
    derived_definition : derived_property_select;
  WHERE
    WR1: SIZEOF(USEDIN(derived_definition, 'INTEGRATED_CNC_SCHEMA.' +
              'GENERAL_PROPERTY_ASSOCIATION.' + 'DERIVED_DEFINITION')) = 1;
    WR2: derived_definition.name = base_definition.name;
END_ENTITY; -- 10303-41: product_property_definition_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_curve_set
  SUBTYPE OF (geometric_set);
  WHERE
    WR1: SIZEOF(QUERY (temp <* SELF\geometric_set.elements| (
              'INTEGRATED_CNC_SCHEMA.SURFACE' IN TYPEOF(temp)))) = 0;
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY geometric_intersection
  SUBTYPE OF (derived_shape_aspect);
  WHERE
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    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,
      cartesian_transformation_operator, curve, surface, edge_curve,
      face_surface, poly_loop, vertex_point, solid_model,
      right_circular_cylinder, block, shell_based_surface_model,
      face_based_surface_model, shell_based_wireframe_model,
      edge_based_wireframe_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
  SUPERTYPE OF (geometric_curve_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 >= 0.0);
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);
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    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 > 0.0);
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([
              '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 geometrically_bounded_wireframe_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: SIZEOF(QUERY (it <* SELF.items| NOT (SIZEOF(TYPEOF(it) * [
              'INTEGRATED_CNC_SCHEMA.GEOMETRIC_CURVE_SET',
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              'INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D',
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' ]) = 1))) = 0;
    WR2: SIZEOF(QUERY (it <* SELF.items| (SIZEOF(TYPEOF(it) * [
              'INTEGRATED_CNC_SCHEMA.GEOMETRIC_CURVE_SET',
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' ]) = 1))) >= 1;
    WR3: SIZEOF(QUERY (gcs <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.GEOMETRIC_CURVE_SET' IN TYPEOF(it)))|
              NOT (SIZEOF(QUERY (crv <* QUERY (elem <* gcs\geometric_set.
              elements| ('INTEGRATED_CNC_SCHEMA.CURVE' IN TYPEOF(elem)))|
              NOT valid_geometrically_bounded_wf_curve(crv))) = 0))) = 0;
    WR4: SIZEOF(QUERY (gcs <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.GEOMETRIC_CURVE_SET' IN TYPEOF(it)))|
              NOT (SIZEOF(QUERY (pnts <* QUERY (elem <* gcs\geometric_set.
              elements| ('INTEGRATED_CNC_SCHEMA.POINT' IN TYPEOF(elem)))|
              NOT valid_geometrically_bounded_wf_point(pnts))) = 0))) = 0;
    WR5: SIZEOF(QUERY (gcs <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.GEOMETRIC_CURVE_SET' IN TYPEOF(it)))|
              NOT (SIZEOF(QUERY (cnc <* QUERY (elem <* gcs\geometric_set.
              elements| ('INTEGRATED_CNC_SCHEMA.CONIC' IN TYPEOF(elem)))|
              NOT ('INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D' IN TYPEOF(cnc
              \conic.position)))) = 0))) = 0;
    WR6: SIZEOF(QUERY (gcs <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.GEOMETRIC_CURVE_SET' IN TYPEOF(it)))|
              NOT (SIZEOF(QUERY (pline <* QUERY (elem <* gcs\geometric_set.
              elements| ('INTEGRATED_CNC_SCHEMA.POLYLINE' IN TYPEOF(elem)))
              | NOT (SIZEOF(pline\polyline.points) > 2))) = 0))) = 0;
    WR7: SIZEOF(QUERY (mi <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' IN TYPEOF(it)))| NOT (
              'INTEGRATED_CNC_SCHEMA.' +
              'GEOMETRICALLY_BOUNDED_WIREFRAME_SHAPE_REPRESENTATION' IN
              TYPEOF(mi\mapped_item.mapping_source.mapped_representation)))
              ) = 0;
END_ENTITY; -- 10303-510: aic_geometrically_bounded_wireframe

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 grooving_turning_operation
  SUBTYPE OF (turning_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing', 'finishing', 'cutting in']);

  WR2:  (verify_optional_action_property     (SELF, 'dwell')) AND
        (verify_rep_type_for_action_property (SELF, 'dwell',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_DWELL_TIME_REPRESENTATION']));

  WR3:  (verify_optional_action_property        (SELF, 'allowance')) AND
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       (verify_length_measure_action_property  (SELF, 'allowance'));

  -- allowance propery required for roughing
  WR4:  NOT (SELF.description = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance'));

  -- allowance propery forbidden for cutting in
  WR5:  NOT (SELF.description = 'cutting in') OR
        (0 = SIZEOF (get_action_property (SELF, 'allowance')));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY group;
    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: 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.
              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,
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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) = 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
            );
    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')| (
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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 = '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))) AND (
          'INTEGRATED_CNC_SCHEMA.HOLE_BOTTOM' IN TYPEOF(fcr.
          relating_shape_aspect)))) >= 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',
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              '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; -- 10303-522: aic_machining_feature

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 identification_assignment
  ABSTRACT SUPERTYPE;
    assigned_id : identifier;
    role        : identification_role;
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY identification_role;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- 10303-41: management_resources_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; -- 10303-522: aic_machining_feature

ENTITY int_literal
  SUBTYPE OF (literal_number);
    SELF\literal_number.the_value : INTEGER;
END_ENTITY; -- 13584-20: iso13584_expressions_schema
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ENTITY int_numeric_variable
  SUBTYPE OF (numeric_variable);
END_ENTITY; -- 13584-20: iso13584_expressions_schema

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 known_source
  SUBTYPE OF (external_source, pre_defined_item);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY knurling_turning_operation
  SUBTYPE OF (turning_type_operation);
END_ENTITY; -- 10303-238: integrated_cnc_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 = 1.0) AND (SELF\
              named_unit.dimensions.mass_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.time_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0.0)) AND (
              SELF\named_unit.dimensions.thermodynamic_temperature_exponent
               = 0.0)) AND (SELF\named_unit.dimensions.
              amount_of_substance_exponent = 0.0)) AND (SELF\named_unit.
              dimensions.luminous_intensity_exponent = 0.0);
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
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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);
  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([
             '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; -- 10303-522: aic_machining_feature

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; -- 10303-522: aic_machining_feature

ENTITY loop
  SUPERTYPE OF (ONEOF(vertex_loop, edge_loop, poly_loop))
  SUBTYPE OF (topological_representation_item);
END_ENTITY; -- 10303-42: topology_schema

ENTITY machining_adaptive_control_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

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',
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         'plunge zigzag']);

  WR2:  (verify_optional_action_property       (SELF, 'tool orientation')) AND
        (verify_rep_item_for_action_property   (SELF, 'tool orientation',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION']));

  WR3:  NOT (SELF.description = 'along path') OR
        ((1 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP']))
AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH']))
        );

  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; -- 10303-238: integrated_cnc_schema

ENTITY machining_cutting_component
  SUBTYPE OF (action_resource,characterized_object);
  WHERE
  WR1:  (1 >= SIZEOF (USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.' +
           'MATERIAL_DESIGNATION.DEFINITIONS')));

  WR2:  (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))))
        )));

  WR3:  (verify_optional_resource_property     (SELF, 'expected life')) AND
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      (verify_time_measure_resource_property (SELF, 'expected life'));


  WR4:  NOT (SELF.kind.name = 'milling cutting edge') OR
        ((verify_required_resource_property
           (SELF, 'functional length')) AND
         (verify_length_measure_resource_property
           (SELF, 'functional length'))
        );

  WR5:  NOT (SELF.kind.name = 'turning cutting edge') OR
        ((verify_optional_resource_property
           (SELF, 'cutting edge length')) AND
         (verify_length_measure_resource_property
           (SELF, 'cutting edge length')) AND

         (verify_optional_resource_property
           (SELF, 'cutting edge angle')) AND
         (verify_angle_measure_resource_property
           (SELF, 'cutting edge angle')) AND

         (verify_optional_resource_property
           (SELF, 'cutting edge angle type')) AND
         (verify_rep_item_for_resource_property
           (SELF, 'cutting edge angle type',
           ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'])) AND

         (verify_optional_resource_property
           (SELF, 'tool included angle')) AND
         (verify_angle_measure_resource_property
           (SELF, 'tool included angle')) AND

         (verify_rep_type_for_resource_property
           (SELF, 'corner transitions',
           ['INTEGRATED_CNC_SCHEMA.'+
            'MACHINING_CUTTING_CORNER_REPRESENTATION'])) AND

         (verify_optional_resource_property
           (SELF, 'maximum side cutting depth')) AND
         (verify_length_measure_resource_property
           (SELF, 'maximum side cutting depth')) AND

         (verify_optional_resource_property
           (SELF, 'maximum end cutting depth')) AND
         (verify_length_measure_resource_property
           (SELF, 'maximum end cutting depth'))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_cutting_corner_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  ((verify_required_rep_item       (SELF, 'corner identity')) AND
         (verify_count_measure_rep_item  (SELF, 'corner identity'))
```



```
        );

  WR2:  NOT (SELF.name = 'chamfered corner') OR
        ((verify_required_rep_item       (SELF, 'chamfer angle')) AND
         (verify_angle_measure_rep_item  (SELF, 'chamfer angle')) AND

         (verify_optional_rep_item       (SELF, 'chamfer length')) AND
         (verify_length_measure_rep_item (SELF, 'chamfer length')) AND

         (verify_optional_rep_item       (SELF, 'chamfer width')) AND
         (verify_length_measure_rep_item (SELF, 'chamfer width'))
        );

  WR3:  NOT (SELF.name = 'rounded corner') OR
        ((verify_required_rep_item       (SELF, 'radius')) AND
         (verify_length_measure_rep_item (SELF, 'radius'))
        );

  WR4:  NOT (SELF.name = 'profiled corner') OR
        (1 = SIZEOF (QUERY (prep <* USEDIN (SELF, 'INTEGRATED_CNC_SCHEMA.' +
           'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
           (('INTEGRATED_CNC_SCHEMA.LINEAR_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.OPEN_PATH_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.PARTIAL_CIRCULAR_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.ROUNDED_U_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.SQUARE_U_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.TEE_PROFILE'
                IN TYPEOF(prep.definition)) OR
            ('INTEGRATED_CNC_SCHEMA.VEE_PROFILE'
                IN TYPEOF(prep.definition)))
        )));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_dwell_time_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  (SELF.name IN ['dwell time', 'dwell revolution']);

  WR2:  NOT (SELF.name = 'dwell time') OR
        ((verify_required_rep_item       (SELF, 'dwell time')) AND
         (verify_time_measure_rep_item   (SELF, 'dwell time'))
        );

  WR3:  NOT (SELF.name = 'dwell revolution') OR
        ((verify_required_rep_item       (SELF, 'dwell revolution')) AND
         (verify_count_measure_rep_item  (SELF, 'dwell revolution'))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema
```



```
ENTITY machining_execution_resource
  SUBTYPE OF (action_resource);
  WHERE
  WR1:  ((verify_optional_resource_property      (SELF, 'feedrate')) AND
         (verify_rep_type_for_resource_property  (SELF, 'feedrate',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])));

  WR2:  ((verify_optional_resource_property     (SELF, 'spindle')) AND
         (verify_rep_type_for_resource_property (SELF, 'spindle',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])));

  WR3:  ((verify_optional_resource_property     (SELF, 'spindle power')) AND
         (verify_rep_item_for_resource_property (SELF, 'spindle power',
           ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'])));

  WR4:  ((verify_optional_resource_property
           (SELF, 'number of control axis')) AND
         (verify_count_measure_resource_property
           (SELF, 'number of control axis')));

  WR5:  ((verify_optional_resource_property
           (SELF, 'number of simultaneous axis')) AND
         (verify_count_measure_resource_property
           (SELF, 'number of simultaneous axis')));

  WR6:  ((verify_optional_resource_property
           (SELF, 'positioning accuracy')) AND
         (verify_length_measure_resource_property
           (SELF, 'positioning accuracy')));

  WR7:  ((verify_optional_resource_property    (SELF, 'table indexing')) AND
         (verify_enumeration_resource_property (SELF, 'table indexing',
          ['required', 'not required'])));

  WR8:  ((verify_optional_resource_property
           (SELF, 'table length')) AND
         (verify_length_measure_resource_property
           (SELF, 'table length')) AND

         (verify_optional_resource_property
           (SELF, 'table width')) AND
         (verify_length_measure_resource_property
           (SELF, 'table width')));

  WR9:  ((verify_optional_resource_property      (SELF, 'axis travel')) AND
         (0 = SIZEOF (QUERY (prop <* get_resource_property
                (SELF, 'axis travel') | NOT
          ((0 < SIZEOF (QUERY (prep <* USEDIN (prop,
           'INTEGRATED_CNC_SCHEMA.RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |
            (1 <= 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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                ))))
        ))));

  WR10: ((verify_optional_resource_property
           (SELF, 'work volume length')) AND
         (verify_length_measure_resource_property
           (SELF, 'work volume length')) AND

         (verify_optional_resource_property
           (SELF, 'work volume width')) AND
         (verify_length_measure_resource_property
           (SELF, 'work volume width')) AND

         (verify_optional_resource_property
           (SELF, 'work volume height')) AND
         (verify_length_measure_resource_property
           (SELF, 'work volume height'))
        );

  WR11:  (0 = SIZEOF (get_action_property (SELF, 'axis travel'))) OR
         ((0 = SIZEOF (get_action_property (SELF, 'work volume length'))) AND
          (0 = SIZEOF (get_action_property (SELF, 'work volume width'))) AND
          (0 = SIZEOF (get_action_property (SELF, 'work volume height'))));

END_ENTITY; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

ENTITY machining_feature_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_feature_sequence_relationship
  SUBTYPE OF (machining_feature_relationship, sequential_method);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_feed_speed_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  (SELF.name IN ['feed speed', 'feed per revolution',
         'feed per tooth', 'relative speed']);
```



```
  WR2:  NOT (SELF.name = 'feed speed') OR
        ((verify_required_rep_item             (SELF, 'feed speed')) AND
         (verify_linear_speed_measure_rep_item (SELF, 'feed speed'))
        );

  WR3:  NOT (SELF.name = 'feed per revolution') OR
        ((verify_required_rep_item       (SELF, 'feed per revolution')) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'feed per revolution') AND NOT (
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)))))
        );

  WR4:  NOT (SELF.name = 'feed per tooth') OR
        ((verify_required_rep_item       (SELF, 'feed per tooth')) AND
         (0 = SIZEOF (QUERY ( it <* SELF.items |
          (it.name = 'feed per tooth') AND NOT (
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)))))
        );

  WR5:  NOT (SELF.name = 'relative speed') OR
        ((verify_required_rep_item       (SELF, 'relative speed')) AND
         (verify_ratio_measure_rep_item  (SELF, 'relative speed'))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_final_feature_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

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_pressure_measure_action_property
           (SELF, 'coolant pressure')) AND

         (verify_optional_action_property       (SELF, 'mist')) AND
         (verify_enumeration_action_property    (SELF, 'mist',
           ['mist on', 'mist off'])) AND

         (verify_optional_action_property
           (SELF, 'through spindle coolant')) AND
         (verify_enumeration_action_property
           (SELF, 'through spindle coolant',
           ['through spindle coolant on', 'through spindle coolant off'])) AND
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        (verify_optional_action_property
          (SELF, 'through spindle pressure')) AND
        (verify_pressure_measure_action_property
          (SELF, 'through spindle pressure')) AND

        -- axis constraints property must contain zero or more ranges
        (0 = SIZEOF (QUERY (prop <* get_action_property
               (SELF, 'axis constraints') | NOT
                ((0 < SIZEOF (QUERY (prep <* USEDIN (prop,
           'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY') |
             (0 <= SIZEOF (QUERY (it <* prep.representation.items |
                ('INTEGRATED_CNC_SCHEMA.VALUE_RANGE' in TYPEOF(it)))))
               )))))))
       );

  WR2:  NOT (SELF.description = 'turning') 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 type')) AND
        (verify_enumeration_action_property    (SELF, 'coolant type',
          ['flood', 'mist', 'through tool'])) AND

        (verify_optional_action_property
          (SELF, 'coolant pressure')) AND
        (verify_pressure_measure_action_property
          (SELF, 'coolant pressure')) AND

        (verify_optional_action_property       (SELF, 'tail stock')) AND
        (verify_enumeration_action_property    (SELF, 'tail stock',
          ['tail stock used', 'tail stock not used'])) AND

        (verify_optional_action_property       (SELF, 'steady rest')) AND
        (verify_enumeration_action_property    (SELF, 'steady rest',
          ['steady rest used', 'steady rest not used'])) AND

        (verify_optional_action_property       (SELF, 'follow rest')) AND
        (verify_enumeration_action_property    (SELF, 'follow rest',
          ['follow rest used', 'follow rest not used']))
       );

  WR3:  NOT (SELF.description IN ['milling', 'turning']) OR
       ((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
```



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                   ('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
                    IN TYPEOF(ie)) )))
             ))))
           )))
         ))) AND

         (verify_optional_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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_MODEL_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_MODEL'])) 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; -- 10303-238: integrated_cnc_schema

ENTITY machining_functions_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

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', 'index table', 'load tool',
        'unload tool', 'legacy function']);

  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')));
```



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  WR4:  NOT (SELF.description = 'index pallet') OR
        ((verify_required_action_property       (SELF, 'pallet index')) AND
         (verify_count_measure_action_property  (SELF, 'pallet index')));

  WR5:  NOT (SELF.description = 'index table') OR
        ((verify_required_action_property       (SELF, 'table index')) AND
         (verify_count_measure_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)))));

  WR8:  NOT (SELF.description = 'legacy function') OR
        ((verify_required_action_property       (SELF, 'function text')) AND
         (verify_descriptive_action_property    (SELF, 'function text')));
END_ENTITY; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

ENTITY machining_operation
  SUBTYPE OF (action_method);
  WHERE
  WR1: ((verify_related_type_for_amr    (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOLPATH']))
       );

  WR2:  (verify_optional_action_property     (SELF, 'tool direction')) AND
        (verify_rep_type_for_action_property (SELF, 'tool direction',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_DIRECTION_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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY'])) AND

         (verify_required_relating_amr  (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS']))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_operation_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_operator_instruction
  SUBTYPE OF (action_method_with_associated_documents);
  WHERE
  WR1:  EXISTS (self.description) OR (0 < SIZEOF(self.documents));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_operator_instruction_relationship
  SUBTYPE OF (sequential_method);
```

```
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_process_body_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_process_branch_relationship
  SUBTYPE OF (machining_process_body_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_process_concurrent_relationship
  SUBTYPE OF (machining_process_body_relationship, concurrent_action_method);
END_ENTITY; -- 10303-238: integrated_cnc_schema

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_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', 'setup instructions']);

  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_with_name  (SELF, 'true branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'true branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE'])) AND

         (verify_optional_relating_amr_with_name  (SELF, 'false branch',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'false branch',
```



```
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'],
          ['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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BODY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BODY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );

  WR5:  NOT (SELF.description = 'parallel') OR
        ((2 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_CONCURRENT_RELATIONSHIP']))
        AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_CONCURRENT_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );

  WR6:  NOT (SELF.description = 'non-sequential') OR
        ((2 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BODY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BODY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );

  WR7:  NOT (SELF.description = 'selective') OR
        ((2 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_BRANCH_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']))
        );

  WR8:  NOT (SELF.description = 'setup instructions') OR
        ((verify_related_type_for_amr   (SELF,
         ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATOR_INSTRUCTION_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATOR_INSTRUCTION']))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

ENTITY machining_process_model_relationship
  SUBTYPE OF (sequential_method);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_process_sequence_relationship
  SUBTYPE OF (machining_process_body_relationship, sequential_method);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_project
          SUBTYPE OF (product);
  WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.' +
          'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | 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'))))
        )));


  WR2: (0 = SIZEOF (QUERY (pdf <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.' +
          'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | 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'))))
        )));


  WR3: (0 = SIZEOF (QUERY (pdf <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.' +
          'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | NOT

          (0 = SIZEOF (QUERY (pd <* USEDIN (pdf,
           'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION.FORMATION') | NOT

          -- it has one associated workplan.
          (1 = SIZEOF (QUERY (ppa <* USEDIN (pd,
             'INTEGRATED_CNC_SCHEMA.' +
             'PROCESS_PRODUCT_ASSOCIATION.DEFINED_PRODUCT') |
             (ppa.process.name = 'machining') AND
             ('INTEGRATED_CNC_SCHEMA.MACHINING_WORKPLAN'
               IN TYPEOF (ppa.process.chosen_method)))))
          )))
        )));
END_ENTITY; -- 10303-238: integrated_cnc_schema
```



```
ENTITY machining_project_workpiece_relationship
  SUBTYPE OF (product_definition_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

ENTITY machining_setup
  SUBTYPE OF (product);
  WHERE
  WR1: (0 = SIZEOF (QUERY (pdf <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.' +
          'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | NOT

          (0 = SIZEOF (QUERY (pd <* USEDIN (pdf,
           'INTEGRATED_CNC_SCHEMA.PRODUCT_DEFINITION.FORMATION') | NOT

          -- it has one associated security plane.
          (1 = SIZEOF (QUERY (prop <* USEDIN (pd,
             'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION') |
             (prop.name = 'security plane'))))
          )))
        )));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_setup_workpiece_relationship
  SUBTYPE OF (product_definition_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_spindle_speed_representation
  SUBTYPE OF (representation);
  WHERE
  WR1:  (SELF.name IN ['spindle speed', 'cutting speed', 'relative speed']);

  WR2:  NOT (SELF.name = 'spindle speed') OR
        ((verify_required_rep_item             (SELF, 'rotational speed')) AND
         (verify_rotary_speed_measure_rep_item (SELF, 'rotational speed'))
        );

  WR3:  NOT (SELF.name = 'cutting speed') OR
        ((verify_required_rep_item             (SELF, 'surface speed')) AND
         (verify_linear_speed_measure_rep_item (SELF, 'surface speed')) AND

         (verify_optional_rep_item
           (SELF, 'maximum rotational speed')) AND
         (verify_rotary_speed_measure_rep_item
           (SELF, 'maximum rotational speed'))
        );
```



```
  WR4:  NOT (SELF.name = 'relative speed') OR
        ((verify_required_rep_item             (SELF, 'relative speed')) AND
         (verify_ratio_measure_rep_item        (SELF, 'relative speed'))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_strategy
  SUBTYPE OF (action_method);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_strategy_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_technology
  SUBTYPE OF (action_method);
  WHERE
  WR1:  (verify_optional_action_property      (SELF, 'feedrate')) AND
        (verify_rep_type_for_action_property  (SELF, 'feedrate',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION']));

  WR2:  (verify_optional_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, 'spindle')) AND
         (verify_rep_type_for_action_property (SELF, 'spindle',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])) AND

         (verify_optional_action_property
           (SELF, 'synchronize spindle with feed')) AND
         (verify_enumeration_action_property
           (SELF, 'synchronize spindle with feed',
           ['synchronized', 'not synchronized'])) AND

         (verify_optional_action_property
           (SELF, 'inhibit feedrate override')) AND
         (verify_enumeration_action_property
           (SELF, 'inhibit feedrate override',
           ['override allowed', 'override not allowed'])) AND

         (verify_optional_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,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP']))
AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP'],
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       ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY']))
     );

  WR4:  NOT (SELF.description = 'milling') OR
      ((verify_required_relating_amr (SELF,
       ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP'])) OR

       (verify_required_action_property     (SELF, 'spindle') AND
        verify_rep_name_for_action_property (SELF, 'spindle',
         ['spindle speed', 'cutting speed']))
     );

  WR5:  NOT (SELF.description = 'milling') OR
      ((verify_required_relating_amr (SELF,
       ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP'])) OR

       (verify_required_action_property     (SELF, 'feedrate') AND
        verify_rep_name_for_action_property (SELF, 'feedrate',
         ['feed speed', 'feed per tooth']))
     );

  WR6:  NOT (SELF.description = 'turning') OR
      ((verify_optional_action_property     (SELF, 'spindle')) AND
       (verify_rep_type_for_action_property (SELF, 'spindle',
       ['INTEGRATED_CNC_SCHEMA.MACHINING_SPINDLE_SPEED_REPRESENTATION'])) AND
       (verify_rep_name_for_action_property (SELF, 'spindle',
         ['spindle speed', 'cutting speed'])) AND

       (verify_rep_name_for_action_property (SELF, 'feedrate',
         ['feed speed', 'feed per revolution'])) AND

       (verify_optional_action_property
         (SELF, 'synchronize spindle with z feed')) AND
       (verify_enumeration_action_property
         (SELF, 'synchronize spindle with z feed',
         ['synchronized', 'not synchronized'])) AND

       (verify_optional_action_property
         (SELF, 'inhibit feedrate override')) AND
       (verify_enumeration_action_property
         (SELF, 'inhibit feedrate override',
         ['override allowed', 'override not allowed'])) AND

       (verify_optional_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,
        ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP']))
AND
       (verify_related_type_for_amr   (SELF,
        ['INTEGRATED_CNC_SCHEMA.MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP'],
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          ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY']))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_technology_relationship
  SUBTYPE OF (action_method_relationship);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_tool
  SUBTYPE OF (action_resource);
  WHERE
  WR1:  NOT (SELF.kind.name = 'milling cutting tool') OR
        ((0 <= SIZEOF (QUERY (arr <* USEDIN (SELF,

'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE_RELATIONSHIP.RELATING_RESOURCE') |
          (('INTEGRATED_CNC_SCHEMA.MACHINING_CUTTING_COMPONENT'
             IN TYPEOF (arr.related_resource)) AND
           (arr.related_resource.kind.name = 'milling cutting edge') )))) AND

         (verify_optional_tool_body_item
           (SELF, 'overall assembly length')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'overall assembly length')) AND

         (verify_optional_tool_body_item
           (SELF, 'effective cutting diameter')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'effective cutting diameter')) AND

         (verify_optional_tool_body_item
           (SELF, 'maximum depth of cut')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'maximum depth of cut')) AND

         (verify_optional_tool_body_item (SELF, 'hand of cut')) AND
         (verify_enumeration_tool_body_item (SELF, 'hand of cut',
           ['left', 'right', 'neutral'])) AND

         (verify_optional_tool_body_item (SELF, 'coolant through tool')) AND
         (verify_enumeration_tool_body_item (SELF, 'coolant through tool',
           ['supported', 'not supported']))
        );

  WR2:  NOT ((SELF.kind.name = 'milling cutting tool') AND
        (SELF.description IN [ 'counterbore', 'countersink',
         'spade drill', 'spot drill', 'step drill', 'tapered drill',
         'twist drill', 'drill']))
        OR
        ((verify_optional_tool_body_item      (SELF, 'point angle')) AND
         (verify_angle_measure_tool_body_item (SELF, 'point angle'))
        );

  WR3:  NOT ((SELF.kind.name = 'milling cutting tool') AND
        (SELF.description = 'countersink'))
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      OR
      ((verify_optional_tool_body_item
         (SELF, 'minimum cutting diameter')) AND
       (verify_length_measure_tool_body_item
         (SELF, 'minimum cutting diameter')) AND

       (verify_required_tool_body_item
         (SELF, 'maximum usable length')) AND
       (verify_length_measure_tool_body_item
         (SELF, 'maximum usable length'))
      );

WR4:  NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description = 'tapered drill'))
      OR
      ((verify_required_tool_body_item      (SELF, 'taper angle')) AND
       (verify_angle_measure_tool_body_item (SELF, 'taper angle'))
      );


-- Could make this stronger if we want
WR5:  NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description = 'step drill'))
      OR
      ((verify_required_tool_body_item      (SELF, 'step diameters')) AND
       (verify_rep_item_for_tool_body
         (SELF, 'step diameters',
         ['INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM'])) AND

       (verify_required_tool_body_item      (SELF, 'step lengths')) AND
       (verify_rep_item_for_tool_body
         (SELF, 'step lengths',
         ['INTEGRATED_CNC_SCHEMA.COMPOUND_REPRESENTATION_ITEM']))
      );

WR6:  NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description IN [ 'ballnose endmill', 'bullnose endmill',
       'dovetail mill', 'endmill', 'facemill', 'profiled endmill',
       'shoulder mill', 'tee slot mill', 'thread mill', 'side mill']))
      OR
      ((verify_optional_tool_body_item
         (SELF, 'number of effective teeth')) AND
       (verify_count_measure_tool_body_item
         (SELF, 'number of effective teeth')) AND

       (verify_optional_tool_body_item       (SELF, 'edge radius')) AND
       (verify_length_measure_tool_body_item (SELF, 'edge radius'))
      );

WR7:  NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description IN [ 'ballnose endmill', 'bullnose endmill',
       'endmill', 'facemill', 'profiled endmill']))
      OR
      ((verify_optional_tool_body_item
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          (SELF, 'tool cutting edge angle')) AND
        (verify_angle_measure_tool_body_item
          (SELF, 'tool cutting edge angle'))
       );

  WR8:  NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'ballnose endmill'))
       OR verify_ballnose_endmill_dimensions (SELF);

  WR9:  NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'bullnose endmill'))
       OR verify_bullnose_endmill_dimensions (SELF);

  WR10: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'tee slot mill'))
       OR
       ((verify_optional_tool_body_item       (SELF, 'cutting width')) AND
        (verify_length_measure_tool_body_item (SELF, 'cutting width'))
       );

  WR11: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'dovetail mill'))
       OR
       ((verify_optional_tool_body_item       (SELF, 'included angle')) AND
        (verify_angle_measure_tool_body_item  (SELF, 'included angle'))
       );

  WR12: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description = 'side mill'))
       OR
       ((verify_optional_tool_body_item       (SELF, 'cutter width')) AND
        (verify_length_measure_tool_body_item (SELF, 'cutter width'))
       );


  WR13: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description IN [ 'thread mill', 'tapping tool',
        'combined drill and tap']))
       OR
       ((verify_required_tool_body_item  (SELF, 'thread form type')) AND
        (verify_rep_item_for_tool_body   (SELF, 'thread form type',
          ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'])) AND

        (verify_required_tool_body_item       (SELF, 'thread size')) AND
        (verify_length_measure_tool_body_item (SELF, 'thread size')) AND

        (verify_required_tool_body_item       (SELF, 'thread pitch')) AND
        (verify_length_measure_tool_body_item (SELF, 'thread pitch'))
       );


  WR14: NOT ((SELF.kind.name = 'milling cutting tool') AND
       (SELF.description IN [ 'tapping tool', 'combined drill and tap']))
       OR
```



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      ((verify_required_tool_body_item
         (SELF, 'taper thread count')) AND
       (verify_count_measure_tool_body_item
         (SELF, 'taper thread count'))
      );


WR15: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description IN [ 'reamer', 'combined drill and reamer',
       'tapered reamer']))
      OR
      ((verify_required_tool_body_item       (SELF, 'taper length')) AND
       (verify_length_measure_tool_body_item (SELF, 'taper length'))
      );

WR16: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description = 'tapered reamer'))
      OR
      ((verify_required_tool_body_item       (SELF, 'taper angle')) AND
       (verify_angle_measure_tool_body_item  (SELF, 'taper angle'))
      );

WR17: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description IN [ 'combined drill and reamer',
       'combined drill and tap']))
      OR
      ((verify_required_tool_body_item       (SELF, 'drill length')) AND
       (verify_length_measure_tool_body_item (SELF, 'drill length'))
      );


WR18: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description = 'boring tool'))
      OR
      ((verify_required_tool_body_item    (SELF, 'retract movement')) AND
       (verify_enumeration_tool_body_item (SELF, 'retract movement',
         ['permitted', 'forbidden']))
      );

WR19: NOT ((SELF.kind.name = 'milling cutting tool') AND
      (SELF.description = 'user defined milling tool'))
      OR
      ((verify_required_tool_body_item  (SELF, 'tool identifier')) AND
       (verify_rep_item_for_tool_body   (SELF, 'tool identifier',
         ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']))
      );


WR20: NOT (SELF.kind.name = 'turning cutting tool') OR
      ((verify_required_tool_body_item       (SELF, 'functional length')) AND
       (verify_length_measure_tool_body_item (SELF, 'functional length')) AND

       (verify_required_tool_body_item       (SELF, 'f dimension')) AND
       (verify_length_measure_tool_body_item (SELF, 'f dimension')) AND
```



```
         (verify_optional_tool_body_item
           (SELF, 'minimum cutting diameter')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'minimum cutting diameter')) AND

         (verify_optional_tool_body_item
           (SELF, 'a dimension on f')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'a dimension on f')) AND

         (verify_optional_tool_body_item
           (SELF, 'a dimension on lf')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'a dimension on lf')) AND

         (verify_optional_tool_body_item    (SELF, 'hand of cut')) AND
         (verify_enumeration_tool_body_item (SELF, 'hand of cut',
           ['left', 'right', 'neutral'])) AND

         (0 <= SIZEOF (QUERY (arr <* USEDIN (SELF,

'INTEGRATED_CNC_SCHEMA.ACTION_RESOURCE_RELATIONSHIP.RELATING_RESOURCE') |
          (('INTEGRATED_CNC_SCHEMA.MACHINING_CUTTING_COMPONENT'
             IN TYPEOF (arr.related_resource)) AND
           (arr.related_resource.kind.name = 'turning cutting edge') ))))
        );

  WR21: NOT ((SELF.kind.name = 'turning cutting tool') AND
        (SELF.description = 'turning threading tool'))
        OR
        ((verify_required_tool_body_item       (SELF, 'thread pitch')) AND
         (verify_length_measure_tool_body_item (SELF, 'thread pitch')) AND

         (verify_required_tool_body_item       (SELF, 'thread hand')) AND
         (verify_enumeration_tool_body_item    (SELF, 'thread hand',
           ['left', 'right'])) AND

         (verify_required_tool_body_item       (SELF, 'thread type')) AND
         (verify_enumeration_tool_body_item    (SELF, 'thread type',
           ['internal', 'external'])) AND

         (verify_required_tool_body_item       (SELF, 'thread profile')) AND
         (verify_enumeration_tool_body_item    (SELF, 'thread profile',
           ['full', 'partial'])) AND

         (verify_required_tool_body_item  (SELF, 'thread form type')) AND
         (verify_rep_item_for_tool_body   (SELF, 'thread form type',
           ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']))
        );

  WR22: NOT ((SELF.kind.name = 'turning cutting tool') AND
        (SELF.description = 'grooving tool'))
        OR
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        ((verify_required_tool_body_item
           (SELF, 'cutting width')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'cutting width')) AND

         (verify_required_tool_body_item
           (SELF, 'maximum grooving depth')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'maximum grooving depth')) AND

         (verify_optional_tool_body_item
           (SELF, 'corner radius')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'corner radius')) AND

         (verify_optional_tool_body_item
           (SELF, 'maximum axial grooving diameter')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'maximum axial grooving diameter')) AND

         (verify_optional_tool_body_item
           (SELF, 'minimum axial grooving diameter')) AND
         (verify_length_measure_tool_body_item
           (SELF, 'minimum axial grooving diameter'))
        );

  WR23: NOT ((SELF.kind.name = 'turning cutting tool') AND
        (SELF.description = 'knurling tool'))
        OR
        ((verify_required_tool_body_item    (SELF, 'knurl pattern')) AND
         (verify_enumeration_tool_body_item (SELF, 'knurl pattern',
           ['straight', 'diagonal', 'diamond'])) AND

         (verify_optional_tool_body_item       (SELF, 'cutting length')) AND
         (verify_length_measure_tool_body_item (SELF, 'cutting length')) AND

         (verify_optional_tool_body_item       (SELF, 'cutting angle')) AND
         (verify_angle_measure_tool_body_item  (SELF, 'cutting angle')) AND

         (verify_optional_tool_body_item       (SELF, 'cutting pitch')) AND
         (verify_length_measure_tool_body_item (SELF, 'cutting pitch'))
        );

  WR24: NOT ((SELF.kind.name = 'turning cutting tool') AND
        (SELF.description = 'user defined turning tool'))
        OR
        ((verify_required_tool_body_item  (SELF, 'tool identifier')) AND
         (verify_rep_item_for_tool_body   (SELF, 'tool identifier',
           ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']))
        );


  WR25: (1 >= SIZEOF (QUERY (rar <* USEDIN (SELF,
          'INTEGRATED_CNC_SCHEMA.REQUIREMENT_FOR_ACTION_RESOURCE.RESOURCES') |
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         ((1 = SIZEOF(rar.operations)) AND
          ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_USAGE'
           IN TYPEOF (rar\action_resource_requirement.operations[1])))
        )));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_tool_body_representation
  SUBTYPE OF (representation);
END_ENTITY; -- 10303-238: integrated_cnc_schema

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
        ((verify_required_rep_item       (SELF, '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
       ((verify_required_rep_item       (SELF, 'tool direction tilt angle')) AND
         (verify_angle_measure_rep_item  (SELF, 'tool direction tilt angle'))
AND

         (verify_required_rep_item       (SELF, 'tool direction yaw angle')) AND
         (verify_angle_measure_rep_item  (SELF, 'tool direction yaw angle'))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_tool_usage
  SUBTYPE OF (action_method);
  WHERE
  WR1:  ((verify_optional_action_property    (SELF, 'tool position')) AND
         (verify_descriptive_action_property (SELF, 'tool position')) AND

         (verify_optional_action_property    (SELF, 'tool carousel')) AND
         (verify_descriptive_action_property (SELF, 'tool carousel'))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_toolpath
  SUBTYPE OF (action_method);
  WHERE
  WR1:  (SELF.description IN ['feedstop', 'axis trajectory',
        'cutter location trajectory', 'cutter contact trajectory',
        'approach lift path angle', 'approach lift path tangent',
        'connect security plane', 'connect direct']);

  WR2:  (verify_optional_action_property        (SELF, 'priority')) AND
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      (verify_enumeration_action_property     (SELF, 'priority',
       ['required', 'suggested']));

WR3:  (verify_optional_action_property        (SELF, 'trajectory type')) AND
      (verify_enumeration_action_property     (SELF, 'trajectory type',
       ['approach', 'lift', 'connect', 'non-contact',
        'contact', 'trajectory path']));

WR4:  ((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)) )))
       )))
      );

WR5:  (verify_optional_relating_amr   (SELF,
        ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY_RELATIONSHIP'])) AND
      (verify_related_type_for_amr    (SELF,
        ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY_RELATIONSHIP'],
        ['INTEGRATED_CNC_SCHEMA.MACHINING_TECHNOLOGY']));

WR6:  (verify_optional_relating_amr   (SELF,
        ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'])) AND
      (verify_related_type_for_amr    (SELF,
        ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS_RELATIONSHIP'],
        ['INTEGRATED_CNC_SCHEMA.MACHINING_FUNCTIONS']));


WR7:  NOT (SELF.description IN ['axis trajectory',
              'cutter location trajectory',
              'cutter contact trajectory']) OR
      ((verify_optional_action_property    (SELF, 'direction')) AND
       (verify_enumeration_action_property (SELF, 'direction',
        ['beginning to end', 'end to beginning']))
      );


WR8:  NOT (SELF.description = 'connect security plane') OR
      ((verify_optional_action_property     (SELF, 'up direction')) AND
       (verify_rep_item_for_action_property (SELF, 'up direction',
         ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

       (verify_optional_action_property     (SELF, 'down direction')) AND
       (verify_rep_item_for_action_property (SELF, 'down direction',
         ['INTEGRATED_CNC_SCHEMA.DIRECTION']))
      );

WR9:  NOT (SELF.description = 'feedstop') OR
      ((verify_required_action_property     (SELF, 'dwell')) AND
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         (verify_time_measure_action_property (SELF, 'dwell'))
        );

  WR10: NOT (SELF.description = 'axis trajectory') OR
        ((verify_required_action_property     (SELF, 'axis commands')) AND

         -- axis commands property must contain one or more bounded curves
        (0 = SIZEOF (QUERY (prop <* get_action_property (SELF, 'axis commands')
|
          NOT ((0 < SIZEOF (QUERY (prep <* USEDIN (prop,
              'INTEGRATED_CNC_SCHEMA.ACTION_PROPERTY_REPRESENTATION.PROPERTY')
|
              (1 <= SIZEOF (QUERY (it <* prep.representation.items |
                 ('INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE' in TYPEOF(it)))))
                )))))))
        );

  WR11: NOT (SELF.description IN ['approach lift path angle',
           'approach lift path tangent']) OR
        ((verify_required_action_property     (SELF, 'fix point')) AND
         (verify_rep_item_for_action_property (SELF, 'fix point',
           ['INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT'])) AND

        (verify_optional_action_property     (SELF, 'fix point direction')) AND
         (verify_rep_item_for_action_property (SELF, 'fix point direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION']))
        );

  WR12: NOT (SELF.description = 'approach lift path angle') OR
        ((verify_required_action_property      (SELF, 'angle')) AND
         (verify_angle_measure_action_property (SELF, 'angle')) AND

         (verify_required_action_property       (SELF, 'bend distance')) AND
         (verify_length_measure_action_property (SELF, 'bend distance'))
        );

  WR13: NOT (SELF.description = 'approach lift path tangent') OR
        ((verify_required_action_property       (SELF, 'radius')) AND
         (verify_length_measure_action_property (SELF, 'radius'))
        );

  WR14: NOT (SELF.description = 'cutter location trajectory') OR
        ((verify_required_action_property     (SELF, 'basic curve')) AND
         (verify_rep_item_for_action_property (SELF, 'basic curve',
           ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

         (verify_optional_action_property     (SELF, 'surface normal')) AND
         (verify_rep_item_for_action_property (SELF, 'surface normal',
           ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

         (verify_optional_action_property     (SELF, 'tool axis')) AND
         (verify_rep_item_for_action_property (SELF, 'tool axis',
           ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND
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        (verify_optional_action_property
         (SELF, 'path maximum deviation')) AND
        (verify_length_measure_action_property
         (SELF, 'path maximum deviation')) AND

        (verify_optional_action_property
         (SELF, 'tool axis maximum deviation')) AND
        (verify_angle_measure_action_property
         (SELF, 'tool axis maximum deviation'))
       );

  WR15: NOT (SELF.description = 'cutter contact trajectory') OR
       ((((verify_required_action_property     (SELF, 'basic curve')) AND
          (verify_rep_item_for_action_property (SELF, 'basic curve',
           ['INTEGRATED_CNC_SCHEMA.BOUNDED_PCURVE'])) )

          OR

         ((verify_required_action_property     (SELF, 'basic curve')) AND
          (verify_rep_item_for_action_property (SELF, 'basic curve',
           ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

          (verify_required_action_property     (SELF, 'surface normal')) AND
          (verify_rep_item_for_action_property (SELF, 'surface normal',
           ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) )
         ) AND

        (verify_optional_action_property     (SELF, 'tool axis')) AND
        (verify_rep_item_for_action_property (SELF, 'tool axis',
          ['INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'])) AND

        (verify_optional_action_property     (SELF, 'contact type')) AND
        (verify_enumeration_action_property  (SELF, 'contact type',
          ['side', 'front'])) AND

        (verify_optional_action_property
         (SELF, 'path maximum deviation')) AND
        (verify_length_measure_action_property
         (SELF, 'path maximum deviation')) AND

        (verify_optional_action_property
         (SELF, 'tool axis maximum deviation')) AND
        (verify_angle_measure_action_property
         (SELF, 'tool axis maximum deviation'))
       );

END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_toolpath_sequence_relationship
  SUBTYPE OF (sequential_method);
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_toolpath_speed_profile_representation
  SUBTYPE OF (representation);
```



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  WHERE
  WR1:  (1 = SIZEOF (QUERY ( it <* SELF.items |
          ( (('INTEGRATED_CNC_SCHEMA.BOUNDED_CURVE'
              IN TYPEOF(it))) OR

            (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
              IN TYPEOF(it)) AND
             (it.description IN ['rapid']))  OR

            ((SIZEOF([
              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT'] *
              TYPEOF(it)) = 2))
           )
        )));
END_ENTITY; -- 10303-238: integrated_cnc_schema

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']);

  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',
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      '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

    (verify_required_action_property       (SELF, 'computed offset')) AND
    (verify_rep_type_for_action_property   (SELF, 'computed offset',
     ['INTEGRATED_CNC_SCHEMA.MACHINING_OFFSET_VECTOR_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; -- 10303-238: integrated_cnc_schema

ENTITY machining_workingstep
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  ((verify_optional_action_property     (SELF, 'security plane')) AND
    (verify_rep_item_for_action_property (SELF, 'security plane',
     ['INTEGRATED_CNC_SCHEMA.ELEMENTARY_SURFACE'])));

  WR2:  NOT (SELF.description = 'machining') OR
   ((verify_required_relating_amr (SELF,
     ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_RELATIONSHIP'])) AND
    (verify_related_type_for_amr  (SELF,
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          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS'])) AND

         (verify_related_type_for_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FINAL_FEATURE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS'])) AND

         (verify_required_relating_amr  (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION']))
        );

  WR3:  NOT (SELF.description = 'turning') OR
        ((2 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_SEQUENCE_RELATIONSHIP']))
AND
         (verify_related_type_for_amr    (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_SEQUENCE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEATURE_PROCESS'])) AND

         (verify_required_relating_amr  (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION_RELATIONSHIP'])) AND
         (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_OPERATION_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.TURNING_TYPE_OPERATION']))
        );

  WR4:  NOT (SELF.description IN ['machining', 'turning']) OR
        (verify_optional_in_process_geometry (SELF));

  WR5:  ((verify_optional_action_property (SELF, 'toolpath orientation')) AND
         (verify_rep_item_for_action_property (SELF, 'toolpath orientation',
          ['INTEGRATED_CNC_SCHEMA.AXIS2_PLACEMENT_3D'])));

END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY machining_workplan
  SUBTYPE OF (machining_process_executable);
  WHERE
  WR1:  (1 <= get_count_of_relating_amr (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_SEQUENCE_RELATIONSHIP']))
AND
        (verify_related_type_for_amr   (SELF,
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_SEQUENCE_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_PROCESS_EXECUTABLE']));

  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 <*
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          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; -- 10303-238: integrated_cnc_schema

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| (
              '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\
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            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)))|
            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;
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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',
        '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;
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    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,
              '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')| (
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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.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 <* 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
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              TYPEOF(sdr.relating_shape_aspect)))) = 1))) = 1))) = 0;
END_ENTITY; -- 10303-522: aic_machining_feature

ENTITY mass_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    WR1: 'INTEGRATED_CNC_SCHEMA.MASS_UNIT' IN TYPEOF(SELF\measure_with_unit
              .unit_component);
END_ENTITY; -- 10303-41: measure_schema

ENTITY mass_unit
  SUBTYPE OF (named_unit);
  WHERE
    WR1: ((((((SELF\named_unit.dimensions.length_exponent = 0.0) AND (SELF\
              named_unit.dimensions.mass_exponent = 1.0)) AND (SELF\
              named_unit.dimensions.time_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0.0)) AND (
              SELF\named_unit.dimensions.thermodynamic_temperature_exponent
               = 0.0)) AND (SELF\named_unit.dimensions.
              amount_of_substance_exponent = 0.0)) AND (SELF\named_unit.
              dimensions.luminous_intensity_exponent = 0.0);
END_ENTITY; -- 10303-41: measure_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: SELF\property_definition.name, SELF\property_definition.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
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ENTITY measure_qualification;
    name              : label;
    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, mass_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_with_name  (SELF, 'approach',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'approach',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR3:  ((verify_optional_relating_amr_with_name  (SELF, 'retract',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'retract',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR4:  ((verify_optional_relating_amr_with_name  (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MILLING_TYPE_STRATEGY']))
        );
END_ENTITY; -- 10303-238: integrated_cnc_schema
```



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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'])) );

  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; -- 10303-238: integrated_cnc_schema

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; -- 10303-522: aic_machining_feature

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 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, mass_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 =
```



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            'circumscribed diameter')) OR (srwp_i.name = 'corner radius')
            ) OR (srwp_i.name = 'diameter across flats'))) = SIZEOF(pdr.
            used_representation.items)))) = 1))) = 1;
    WR5: SIZEOF(QUERY (pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
            (SIZEOF(QUERY (impl_rep <* QUERY (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; -- 10303-522: aic_machining_feature
```

```
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; -- 10303-238: integrated_cnc_schema

ENTITY non_manifold_surface_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: SIZEOF(QUERY (it <* SELF.items| NOT (SIZEOF([
              'INTEGRATED_CNC_SCHEMA.FACE_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.FACE_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.' +
              'NON_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| (
              'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(
              mr_it)))) > 0)))) = 0;
    WR4: SIZEOF(QUERY (fbsm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
              )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
              fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.cfs_faces| NOT (
              SIZEOF([ 'INTEGRATED_CNC_SCHEMA.FACE_SURFACE',
              'INTEGRATED_CNC_SCHEMA.ORIENTED_FACE' ] * TYPEOF(fa)) = 1)))
```

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          = 0))) = 0))) = 0;
WR5: SIZEOF(QUERY (fbsm <* QUERY (it <* SELF.items| (
          'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
          )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
          fbsm_faces| NOT (SIZEOF(QUERY (f_sf <* QUERY (fa <* cfs.
          cfs_faces| ('INTEGRATED_CNC_SCHEMA.FACE_SURFACE' IN TYPEOF(fa
          )))| NOT (('INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(
          f_sf)) OR nmsf_surface_check(f_sf\face_surface.face_geometry)
          ))) = 0))) = 0))) = 0;
WR6: SIZEOF(QUERY (fbsm <* QUERY (it <* SELF.items| (
          'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
          )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
          fbsm_faces| NOT (SIZEOF(QUERY (o_fa <* QUERY (fa <* cfs.
          cfs_faces| ('INTEGRATED_CNC_SCHEMA.ORIENTED_FACE' IN TYPEOF(
          fa)))| NOT (('INTEGRATED_CNC_SCHEMA.ADVANCED_FACE' IN TYPEOF(
          o_fa\oriented_face.face_element)) OR nmsf_surface_check(o_fa\
          oriented_face.face_element\face_surface.face_geometry)))) = 0
          ))) = 0))) = 0;
WR7: SIZEOF(QUERY (fbsm <* QUERY (it <* SELF.items| (
          'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
          )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
          fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.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 (fbsm <* QUERY (it <* SELF.items| (
          'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
          )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
          fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.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 (fbsm <* QUERY (it <* SELF.items| (
          'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
          )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
          fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.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_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',
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            'INTEGRATED_CNC_SCHEMA.SURFACE_CURVE' ] * TYPEOF(oe_cv.
            edge_element\edge_curve.edge_geometry)) = 1))) = 0))) = 0))))
             = 0))) = 0))) = 0;
    WR10: SIZEOF(QUERY (fbsm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
            )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
            fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.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
            nmsf_curve_check(oe.edge_element\edge_curve.edge_geometry)))
            = 0))) = 0)))) = 0))) = 0))) = 0;
    WR11: SIZEOF(QUERY (fbsm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
            )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
            fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.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 (fbsm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
            )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
            fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.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',
            '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 (fbsm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
            )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
            fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.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 (fbsm <* QUERY (it <* SELF.items| (
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              'INTEGRATED_CNC_SCHEMA.FACE_BASED_SURFACE_MODEL' IN TYPEOF(it
              )))| NOT (SIZEOF(QUERY (cfs <* fbsm\face_based_surface_model.
              fbsm_faces| NOT (SIZEOF(QUERY (fa <* cfs.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; -- 10303-508: aic_non_manifold_surface

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))
  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

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, '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; -- 10303-522: aic_machining_feature

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 organization_assignment
  ABSTRACT SUPERTYPE;
    assigned_organization : organization;
    role                  : organization_role;
END_ENTITY; -- 10303-41: management_resources_schema

ENTITY 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 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);
  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.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 ((2 <= SIZEOF(pdr.
              used_representation.items)) AND (SIZEOF(pdr.
              used_representation.items) <= 3)))) = 1))) = 1);
    WR3: SELF\characterized_object.description IN [ 'outer diameter',
              'outer diameter to shoulder' ];
    WR4: NOT (SELF\characterized_object.description = 'outer diameter') OR
              (SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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([
              '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
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            )))| 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 (
            'INTEGRATED_CNC_SCHEMA.OUTER_ROUND' IN TYPEOF(sdr.
            related_shape_aspect.of_shape.definition))) AND (sdr.name =
            'reduced size'))) = 1))) <= 1))) = 0);
    WR8: NOT (SELF\characterized_object.description =
            'outer diameter to shoulder') OR (SIZEOF(QUERY (pd <* USEDIN(
            SELF, 'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')
            | NOT (SIZEOF(QUERY (impl_rep <* QUERY (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);
    WR9: NOT (SELF\characterized_object.description =
            'outer diameter to shoulder') 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 = 'feature length'))) <= 1))) = 0))) =
             0);
END_ENTITY; -- 10303-522: aic_machining_feature
```



```
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',
              '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
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              )))| 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)) AND (
              'INTEGRATED_CNC_SCHEMA.OUTSIDE_PROFILE' IN TYPEOF(sdr.
              related_shape_aspect.of_shape.definition)))) = 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,
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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')| (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
        )))| 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
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            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)))| ('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
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              TYPEOF(pdr.used_representation)) AND (pdr.used_representation
              .name = 'removal direction'))) = 1))) = 0);
    WR12: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF
              )| ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.used_representation
              .name = 'maximum feature limit'))) >= 0;
END_ENTITY; -- 10303-522: aic_machining_feature

ENTITY parabola
  SUBTYPE OF (conic);
    focal_dist : length_measure;
  WHERE
    WR1: focal_dist <> 0.0;
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;
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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 = '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; -- 10303-522: aic_machining_feature

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
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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')
          | 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')| (
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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 = '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.' +
          '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')
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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)))) = 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; -- 10303-522: aic_machining_feature

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; -- 10303-522: aic_machining_feature

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)
            ;
    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(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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
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          (SIZEOF(QUERY (impl_rep <* QUERY (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 (SIZEOF(QUERY
          (pd <* USEDIN(SELF.related_shape_aspect,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
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              (SIZEOF(QUERY (impl_rep <* QUERY (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; -- 10303-522: aic_machining_feature

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.' +
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          '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,
          '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 =
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              '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; -- 10303-522: aic_machining_feature

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;
    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
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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.
              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'
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             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(
            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',
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              '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
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: SIZEOF(SELF.items) = 1;
    WR2: SIZEOF(QUERY (it <* SELF.items| ('INTEGRATED_CNC_SCHEMA.PLANE' IN
              TYPEOF(it)))) = 1;
END_ENTITY; -- 10303-522: aic_machining_feature

ENTITY plane
  SUBTYPE OF (elementary_surface);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY plane_angle_measure_with_unit
  SUBTYPE OF (measure_with_unit);
```

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  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 = 0.0) AND (SELF\
              named_unit.dimensions.mass_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.time_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0.0)) AND (
              SELF\named_unit.dimensions.thermodynamic_temperature_exponent
               = 0.0)) AND (SELF\named_unit.dimensions.
              amount_of_substance_exponent = 0.0)) AND (SELF\named_unit.
              dimensions.luminous_intensity_exponent = 0.0);
END_ENTITY; -- 10303-41: measure_schema

ENTITY plane_milling_operation
  SUBTYPE OF (milling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing','finishing']);

  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 = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance bottom'));
END_ENTITY; -- 10303-238: integrated_cnc_schema

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
  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,
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          '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 (pdr <* get_property_definition_representations(SELF)
          | (
          'INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
          IN TYPEOF(pdr.used_representation)))) = 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 ((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.' +
          '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,
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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)))| (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,
          '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
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          TYPEOF(sdr.relating_shape_aspect)) AND (
          'INTEGRATED_CNC_SCHEMA.POCKET' IN TYPEOF(sdr.
          related_shape_aspect.of_shape.definition)))) = 1))) = 1))) =
          0;
WR11: NOT (SELF\characterized_object.description IN [ 'complex',
          'non-circular cutout', 'recess' ]) OR (SIZEOF(QUERY (pds <*
          QUERY (pd <* USEDIN(SELF,
          '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.relating_shape_aspect)) AND (
          'INTEGRATED_CNC_SCHEMA.POCKET' IN TYPEOF(fcr.
          related_shape_aspect.of_shape.definition))) AND (fcr.
          related_shape_aspect.description IN [ 'angle taper',
          'directed taper' ]))) = 1))) <= 1))) = 0);
WR12: NOT (SELF\characterized_object.description = 'circular cutout')
          OR (SIZEOF(QUERY (pds <* QUERY (pd <* USEDIN(SELF,
          '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 (
          'INTEGRATED_CNC_SCHEMA.POCKET' IN TYPEOF(sdr.
          related_shape_aspect.of_shape.definition))) AND (sdr.
          relating_shape_aspect.description = 'through'))) = 1))) = 1))
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            ) = 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 (
            'INTEGRATED_CNC_SCHEMA.POCKET' IN TYPEOF(sdr.
            related_shape_aspect.of_shape.definition))) AND (sdr.
            relating_shape_aspect.description IN [ 'planar', 'complex' ])
            )) = 1))) = 1))) = 0);
    WR15: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF
            )| ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.used_representation
            .name = 'maximum feature limit'))) >= 0;
    WR16: NOT (SELF\characterized_object.description IN [
            'closed rectangular', 'open rectangular', 'complex', 'recess'
             ]) OR (SIZEOF(QUERY (pds <* USEDIN(SELF,
            '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 (csa.name = 'uncut volume')) AND (SIZEOF(QUERY (sar <*
            csa.component_relationships| (
            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar)) AND (SIZEOF([ 'INTEGRATED_CNC_SCHEMA.BOSS',
            'INTEGRATED_CNC_SCHEMA.PROTRUSION' ] * TYPEOF(sar.
            related_shape_aspect)) = 1))) = 1))) <= 1))) = 1);
    WR17: NOT (SELF\characterized_object.description IN [
            'closed rectangular', 'open rectangular' ]) OR (SIZEOF(QUERY
            (pds <* QUERY (pd <* USEDIN(SELF,
            '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.relating_shape_aspect)) AND (
            'INTEGRATED_CNC_SCHEMA.POCKET' IN TYPEOF(fcr.
            related_shape_aspect.of_shape.definition))) AND (fcr.
            related_shape_aspect.description IN [ 'angle taper',
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               'directed taper' ])))) >= 1))) <= 1))) = 0);
END_ENTITY; -- 10303-522: aic_machining_feature

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')
              | 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,
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              '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([
              '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))) AND (
              'INTEGRATED_CNC_SCHEMA.POCKET_BOTTOM' IN TYPEOF(fcr.
              relating_shape_aspect)))) >= 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; -- 10303-522: aic_machining_feature

ENTITY point
  SUPERTYPE OF (ONEOF(cartesian_point, point_on_curve, point_on_surface,
      point_replica, 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 point_replica
  SUBTYPE OF (point);
    parent_pt      : point;
    transformation : cartesian_transformation_operator;
  WHERE
    WR1: transformation.dim = parent_pt.dim;
    WR2: acyclic_point_replica(SELF, parent_pt);
END_ENTITY; -- 10303-42: geometry_schema

ENTITY poly_loop
  SUBTYPE OF (loop, geometric_representation_item);
    polygon : LIST [3:?] OF UNIQUE cartesian_point;
END_ENTITY; -- 10303-42: topology_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))
              OR (SIZEOF(SELF\geometric_tolerance_with_datum_reference.
              datum_system) <= 3);
END_ENTITY; -- 10303-519: aic_geometric_tolerances

ENTITY pre_defined_item;
    name : label;
END_ENTITY; -- 10303-41: external_reference_schema

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;
    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_formation_with_specified_source
  SUBTYPE OF (product_definition_formation);
    make_or_buy : source;
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: SELF\property_definition.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);
  UNIQUE
    UR1: SELF\product_definition_relationship.id,
         SELF\product_definition_relationship.relating_product_definition,
         SELF\product_definition_relationship.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(QUERY
               (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 (
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            'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
            TYPEOF(sar)))| ('INTEGRATED_CNC_SCHEMA.OUTSIDE_PROFILE' IN
            TYPEOF(fcr.related_shape_aspect.of_shape.definition)) AND (
            'INTEGRATED_CNC_SCHEMA.PROFILE_FLOOR' IN TYPEOF(fcr.
            relating_shape_aspect)))) >= 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);
END_ENTITY; -- 10303-522: aic_machining_feature

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 > 0.0);
    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
```

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    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')| (
              '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;
    WR3: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
              | ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.used_representation
```



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              .name = 'maximum feature limit'))) >= 0;
END_ENTITY; -- 10303-522: aic_machining_feature

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 = 0.0) AND (SELF\
              named_unit.dimensions.mass_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.time_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0.0)) AND (
              SELF\named_unit.dimensions.thermodynamic_temperature_exponent
               = 0.0)) AND (SELF\named_unit.dimensions.
              amount_of_substance_exponent = 0.0)) AND (SELF\named_unit.
              dimensions.luminous_intensity_exponent = 0.0);
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.
              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
```



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            <* 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',
            '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; -- 10303-522: aic_machining_feature
```

```
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, '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.
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        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' 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,
```

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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 = 'orientation'))) = 1))) = 0)))
               = 0;
END_ENTITY; -- 10303-522: aic_machining_feature

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));
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
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              )))| 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; -- 10303-522: aic_machining_feature

ENTITY reparametrised_composite_curve_segment
  SUBTYPE OF (composite_curve_segment);
    param_length : parameter_value;
  WHERE
    WR1: param_length > 0.0;
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;
    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; -- 10303-522: aic_machining_feature

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

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\
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              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' ];
    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 (pdr <* get_property_definition_representations(SELF)
              | ('INTEGRATED_CNC_SCHEMA.DIRECTION_SHAPE_REPRESENTATION' IN
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          TYPEOF(pdr.used_representation)) AND (pdr.used_representation
          .name = 'removal direction'))) = 1;
    WR5: NOT (SELF\characterized_object.description = 'open profile') OR (
          SIZEOF(QUERY (pds <* QUERY (pd <* USEDIN(SELF,
          '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,
          '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 <*
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            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);
    WR9: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
            | ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.used_representation
            .name = 'maximum feature limit'))) >= 0;
END_ENTITY; -- 10303-522: aic_machining_feature

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 ('INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP'
            IN TYPEOF(sar)))| ('INTEGRATED_CNC_SCHEMA.RIB_TOP_FLOOR' IN
            TYPEOF(sdr.relating_shape_aspect)) AND (
            'INTEGRATED_CNC_SCHEMA.RIB_TOP' IN TYPEOF(sdr.
            related_shape_aspect.of_shape.definition)))) = 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;
    WR3: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
            | ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.used_representation
            .name = 'maximum feature limit'))) >= 0;
END_ENTITY; -- 10303-522: aic_machining_feature

ENTITY rib_top_floor
  SUBTYPE OF (shape_aspect);
  WHERE
    WR1: 'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_DEFINITION' IN TYPEOF(
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              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))) AND (
              'INTEGRATED_CNC_SCHEMA.RIB_TOP_FLOOR' IN TYPEOF(fcr.
              relating_shape_aspect)))) >= 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; -- 10303-522: aic_machining_feature

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
```



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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')| (
              '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)) AND (
              'INTEGRATED_CNC_SCHEMA.ROUND_HOLE' IN TYPEOF(fcr.
              related_shape_aspect.of_shape.definition)))) = 1))) = 1))) =
              0;
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    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)) AND (
              'INTEGRATED_CNC_SCHEMA.ROUND_HOLE' IN TYPEOF(fcr.
              related_shape_aspect.of_shape.definition)))) = 1))) <= 1))) =
               0;
    WR5: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
              | (
              'INTEGRATED_CNC_SCHEMA.SHAPE_REPRESENTATION_WITH_PARAMETERS'
              IN TYPEOF(pdr.used_representation)))) = 1;
END_ENTITY; -- 10303-522: aic_machining_feature

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.' +
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              '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;
    WR4: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
              | ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
              TYPEOF(pdr.used_representation)) AND (pdr.used_representation
              .name = 'maximum feature limit'))) >= 0;
END_ENTITY; -- 10303-522: aic_machining_feature

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) >= 1) AND (SIZEOF(impl_rep.
              used_representation.items) <= 2))) = 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 = 'depth'))) = 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([
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              '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;
    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;
END_ENTITY; -- 10303-522: aic_machining_feature

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;
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]);
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    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 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;
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    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; -- 10303-522: aic_machining_feature

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;
    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))) = 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',
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              'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
              'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' ] *
              TYPEOF(it)) = 1))) = 0;
END_ENTITY; -- 10303-522: aic_machining_feature

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 shell_based_wireframe_model
  SUBTYPE OF (geometric_representation_item);
    sbwm_boundary : SET [1:?] OF shell;
  WHERE
    WR1: constraints_geometry_shell_based_wireframe_model(SELF);
END_ENTITY; -- 10303-42: geometric_model_schema

ENTITY shell_based_wireframe_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    WR1: SIZEOF(QUERY (it <* SELF.items| NOT (SIZEOF([
              'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_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_WIREFRAME_MODEL',
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' ] * TYPEOF(it)) = 1))) >=
               1;
    WR3: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
              (it)))| NOT (SIZEOF(QUERY (ws <* QUERY (sb <* sbwm\
              shell_based_wireframe_model.sbwm_boundary| (
              'INTEGRATED_CNC_SCHEMA.WIRE_SHELL' IN TYPEOF(sb)))| NOT (
              SIZEOF(QUERY (eloop <* QUERY (wsb <* ws\wire_shell.
              wire_shell_extent| ('INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN
              TYPEOF(wsb)))| NOT (SIZEOF(QUERY (el <* eloop\path.edge_list|
               NOT ('INTEGRATED_CNC_SCHEMA.EDGE_CURVE' IN TYPEOF(el.
              edge_element)))) = 0))) = 0))) = 0))) = 0;
    WR4: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
              (it)))| NOT (SIZEOF(QUERY (ws <* QUERY (sb <* sbwm\
              shell_based_wireframe_model.sbwm_boundary| (
              'INTEGRATED_CNC_SCHEMA.WIRE_SHELL' IN TYPEOF(sb)))| NOT (
              SIZEOF(QUERY (eloop <* QUERY (wsb <* ws\wire_shell.
              wire_shell_extent| ('INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN
              TYPEOF(wsb)))| NOT (SIZEOF(QUERY (pline_el <* QUERY (el <*
              eloop\path.edge_list| ('INTEGRATED_CNC_SCHEMA.POLYLINE' IN
              TYPEOF(el.edge_element\edge_curve.edge_geometry)))| NOT (
              SIZEOF(pline_el.edge_element\edge_curve.edge_geometry\
              polyline.points) > 2))) = 0))) = 0))) = 0))) = 0;
    WR5: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
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            'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
            (it)))| NOT (SIZEOF(QUERY (ws <* QUERY (sb <* sbwm\
            shell_based_wireframe_model.sbwm_boundary| (
            'INTEGRATED_CNC_SCHEMA.WIRE_SHELL' IN TYPEOF(sb)))| NOT (
            SIZEOF(QUERY (eloop <* QUERY (wsb <* ws\wire_shell.
            wire_shell_extent| ('INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN
            TYPEOF(wsb)))| NOT (SIZEOF(QUERY (el <* eloop\path.edge_list|
             NOT valid_wireframe_edge_curve(el.edge_element\edge_curve.
            edge_geometry))) = 0))) = 0))) = 0))) = 0;
    WR6: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
            (it)))| NOT (SIZEOF(QUERY (ws <* QUERY (sb <* sbwm\
            shell_based_wireframe_model.sbwm_boundary| (
            'INTEGRATED_CNC_SCHEMA.WIRE_SHELL' IN TYPEOF(sb)))| NOT (
            SIZEOF(QUERY (eloop <* QUERY (wsb <* ws\wire_shell.
            wire_shell_extent| ('INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN
            TYPEOF(wsb)))| NOT (SIZEOF(QUERY (el <* eloop\path.edge_list|
             NOT (('INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(el.
            edge_element.edge_start)) AND (
            'INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(el.
            edge_element.edge_end))))) = 0))) = 0))) = 0))) = 0;
    WR7: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
            (it)))| NOT (SIZEOF(QUERY (ws <* QUERY (sb <* sbwm\
            shell_based_wireframe_model.sbwm_boundary| (
            'INTEGRATED_CNC_SCHEMA.WIRE_SHELL' IN TYPEOF(sb)))| NOT (
            SIZEOF(QUERY (eloop <* QUERY (wsb <* ws\wire_shell.
            wire_shell_extent| ('INTEGRATED_CNC_SCHEMA.EDGE_LOOP' IN
            TYPEOF(wsb)))| NOT (SIZEOF(QUERY (el <* eloop\path.edge_list|
             NOT (valid_wireframe_vertex_point(el.edge_element.edge_start
            \vertex_point.vertex_geometry) AND
            valid_wireframe_vertex_point(el.edge_element.edge_end\
            vertex_point.vertex_geometry)))) = 0))) = 0))) = 0))) = 0;
    WR8: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
            (it)))| NOT (SIZEOF(QUERY (ws <* QUERY (sb <* sbwm\
            shell_based_wireframe_model.sbwm_boundary| (
            'INTEGRATED_CNC_SCHEMA.WIRE_SHELL' IN TYPEOF(sb)))| NOT (
            SIZEOF(QUERY (vloop <* QUERY (wsb <* ws\wire_shell.
            wire_shell_extent| ('INTEGRATED_CNC_SCHEMA.VERTEX_LOOP' IN
            TYPEOF(wsb)))| NOT ('INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN
            TYPEOF(vloop\vertex_loop.loop_vertex)))) = 0))) = 0))) = 0;
    WR9: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
            (it)))| NOT (SIZEOF(QUERY (ws <* QUERY (sb <* sbwm\
            shell_based_wireframe_model.sbwm_boundary| (
            'INTEGRATED_CNC_SCHEMA.WIRE_SHELL' IN TYPEOF(sb)))| NOT (
            SIZEOF(QUERY (vloop <* QUERY (wsb <* ws\wire_shell.
            wire_shell_extent| ('INTEGRATED_CNC_SCHEMA.VERTEX_LOOP' IN
            TYPEOF(wsb)))| NOT valid_wireframe_vertex_point(vloop\
            vertex_loop.loop_vertex\vertex_point.vertex_geometry))) = 0))
            ) = 0))) = 0;
    WR10: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
            'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
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              (it)))| NOT (SIZEOF(QUERY (vs <* QUERY (sb <* sbwm\
              shell_based_wireframe_model.sbwm_boundary| (
              'INTEGRATED_CNC_SCHEMA.VERTEX_SHELL' IN TYPEOF(sb)))| NOT (
              'INTEGRATED_CNC_SCHEMA.VERTEX_POINT' IN TYPEOF(vs\
              vertex_shell.vertex_shell_extent.loop_vertex)))) = 0))) = 0;
    WR11: SIZEOF(QUERY (sbwm <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.SHELL_BASED_WIREFRAME_MODEL' IN TYPEOF
              (it)))| NOT (SIZEOF(QUERY (vs <* QUERY (sb <* sbwm\
              shell_based_wireframe_model.sbwm_boundary| (
              'INTEGRATED_CNC_SCHEMA.VERTEX_SHELL' IN TYPEOF(sb)))| NOT
              valid_wireframe_vertex_point(vs\vertex_shell.
              vertex_shell_extent.loop_vertex\vertex_point.vertex_geometry)
              )) = 0))) = 0;
    WR12: SIZEOF(QUERY (mi <* QUERY (it <* SELF.items| (
              'INTEGRATED_CNC_SCHEMA.MAPPED_ITEM' IN TYPEOF(it)))| NOT (
              'INTEGRATED_CNC_SCHEMA.' +
              'SHELL_BASED_WIREFRAME_SHAPE_REPRESENTATION' IN TYPEOF(mi\
              mapped_item.mapping_source.mapped_representation)))) = 0;
    WR13: SELF.context_of_items\geometric_representation_context.
              coordinate_space_dimension = 3;
END_ENTITY; -- 10303-502: aic_shell_based_wireframe

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 ['roughing','finishing']);

  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 = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance side'));
END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY simple_generic_expression
  ABSTRACT SUPERTYPE OF (ONEOF(generic_literal, generic_variable))
  SUBTYPE OF (generic_expression);
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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.
              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
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          )))| 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)) AND (fcr.relating_shape_aspect.
          description IN [ 'open', 'radiused', 'flat', 'woodruff' ]))
          AND ('INTEGRATED_CNC_SCHEMA.SLOT' IN TYPEOF(fcr.
          related_shape_aspect.of_shape.definition)))) = 1))) = 2) OR (
          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)) AND (fcr.relating_shape_aspect.
          description IN [ 'loop' ])) AND ('INTEGRATED_CNC_SCHEMA.SLOT'
           IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)))) =
           1))) = 1)))) = 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 = '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)) AND (fcr.relating_shape_aspect.
          description IN [ 'loop' ])) AND ('INTEGRATED_CNC_SCHEMA.SLOT'
           IN TYPEOF(fcr.related_shape_aspect.of_shape.definition)))) =
           1))) = 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')| (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 (
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            '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 IN [ 'complex',
            'complete circular' ]))) = 1))) = 1))) = 0);
    WR6: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
            | ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
            TYPEOF(pdr.used_representation)) AND (pdr.used_representation
            .name = 'maximum feature limit'))) >= 0;
END_ENTITY; -- 10303-522: aic_machining_feature

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',
            'loop' ];
    WR3: NOT (SELF.description IN [ 'open', 'radiused', 'loop' ]) 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,
            '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(
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              SELF, 'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')
              | NOT (SIZEOF(QUERY (impl_rep <* QUERY (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.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)))
              AND ('INTEGRATED_CNC_SCHEMA.SLOT_END' IN TYPEOF(fcr.
              relating_shape_aspect)))) >= 1;
END_ENTITY; -- 10303-522: aic_machining_feature

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 = 0.0) AND (SELF\
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              named_unit.dimensions.mass_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.time_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0.0)) AND (
              SELF\named_unit.dimensions.thermodynamic_temperature_exponent
               = 0.0)) AND (SELF\named_unit.dimensions.
              amount_of_substance_exponent = 0.0)) AND (SELF\named_unit.
              dimensions.luminous_intensity_exponent = 0.0);
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,
              '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; -- 10303-522: aic_machining_feature

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) <= 7))) = 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 = 'width')) OR (srwp_i.name = 'first angle'
              )) OR (srwp_i.name = 'second angle')) OR (srwp_i.name =
              'first radius')) OR (srwp_i.name = 'second radius')) OR (
              srwp_i.name = 'profile limit')) OR (srwp_i.name = 'depth')))
              = SIZEOF(pdr.used_representation.items)))) = 1))) = 1;
    WR5: SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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.' +
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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 = '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.
            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.
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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 = '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;
    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.
              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;
END_ENTITY; -- 10303-522: aic_machining_feature

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')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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.' +
```



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                '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;
    WR4: SIZEOF(QUERY (pdr <* get_property_definition_representations(SELF)
                | ('INTEGRATED_CNC_SCHEMA.PLANAR_SHAPE_REPRESENTATION' IN
                TYPEOF(pdr.used_representation)) AND (pdr.used_representation
                .name = 'maximum feature limit'))) >= 0;
    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 (csa.name = 'uncut volume')) AND (SIZEOF(QUERY (sar <*
                csa.component_relationships| (
                'INTEGRATED_CNC_SCHEMA.FEATURE_COMPONENT_RELATIONSHIP' IN
                TYPEOF(sar)) AND (SIZEOF([ 'INTEGRATED_CNC_SCHEMA.BOSS',
                'INTEGRATED_CNC_SCHEMA.PROTRUSION' ] * TYPEOF(sar.
                related_shape_aspect)) = 1))) = 1))) <= 1))) = 1;
END_ENTITY; -- 10303-522: aic_machining_feature

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);
```



```
    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, 1.0));
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
```

```
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; -- 10303-238: integrated_cnc_schema

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.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')| (
              'INTEGRATED_CNC_SCHEMA.' +
```



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        '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))) = 0)
        ;
WR8: NOT (SELF.description = 'directed taper') OR (SIZEOF(QUERY (pd <*
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              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; -- 10303-522: aic_machining_feature

ENTITY tapping_operation
  SUBTYPE OF (drilling_type_operation);
  WHERE
  WR1:  (SELF.description IN ['tapping','thread drilling']);

  WR2:  NOT (SELF.description = 'tapping') OR
        ((verify_optional_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_optional_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; -- 10303-238: integrated_cnc_schema

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.' +
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          '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')| (
          '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 = '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.
            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))
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              ) = 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; -- 10303-522: aic_machining_feature

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.' +
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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 = '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,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
            (SIZEOF(QUERY (impl_rep <* QUERY (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.
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            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.
            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.' +
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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 = '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;
    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| (
            'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND (it.name = 'fit class 2'))) <= 1))) = 0))) =
            0;
    WR15: SIZEOF(QUERY (pd <* USEDIN(SELF,
            'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
            (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'nominal size'))) <= 1))) = 0))) = 0
            ;
    WR16: 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 = 'thread runout') AND (SIZEOF(QUERY (sdr <*
            QUERY (sar <* USEDIN(sa_occ,
            'INTEGRATED_CNC_SCHEMA.SHAPE_ASPECT_RELATIONSHIP.' +
            'RELATED_SHAPE_ASPECT')| (sar.description =
            'thread runout usage') AND (
            'INTEGRATED_CNC_SCHEMA.SHAPE_DEFINING_RELATIONSHIP' IN TYPEOF
            (sar)))| ('INTEGRATED_CNC_SCHEMA.THREAD_RUNOUT' IN TYPEOF(sdr
            .relating_shape_aspect)))) <= 1))) = 1))) = 0;
END_ENTITY; -- 10303-522: aic_machining_feature

ENTITY thread_runout
  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 (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 [
            'length of runout', 'pitch or dimension', 'included or extra'
             ]))) > 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')| (
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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 = 'length of runout'))) = 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| ((
              'INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM' IN
              TYPEOF(it)) AND (it.name = 'pitch or dimension')) AND (it.
              description IN [ 'pitch', 'pitch or dimension' ]))) = 1))) =
              0))) = 0;
    WR7: SIZEOF(QUERY (pd <* USEDIN(SELF,
              'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 = 'included or extra')) AND (it.
              description IN [ 'included', 'extra' ]))) = 1))) = 0))) = 0;
END_ENTITY; -- 10303-522: aic_machining_feature

ENTITY threading_turning_operation
  SUBTYPE OF (turning_type_operation);
  WHERE
  WR1:  (SELF.description IN ['roughing','finishing']);

  WR2:  (verify_optional_action_property        (SELF, 'allowance')) AND
        (verify_length_measure_action_property  (SELF, 'allowance'));

  WR3:  NOT (SELF.description = 'roughing') OR
        (verify_required_action_property (SELF, 'allowance'));
END_ENTITY; -- 10303-238: integrated_cnc_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 = 0.0) AND (SELF\
              named_unit.dimensions.mass_exponent = 0.0)) AND (SELF\
              named_unit.dimensions.time_exponent = 1.0)) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0.0)) AND (
              SELF\named_unit.dimensions.thermodynamic_temperature_exponent
               = 0.0)) AND (SELF\named_unit.dimensions.
              amount_of_substance_exponent = 0.0)) AND (SELF\named_unit.
              dimensions.luminous_intensity_exponent = 0.0);
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, vertex_shell,
      wire_shell, connected_edge_set, connected_face_set, loop ANDOR path))
  SUBTYPE OF (representation_item);
END_ENTITY; -- 10303-42: topology_schema

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
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    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; -- 10303-522: aic_machining_feature

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')| NOT
              (SIZEOF(QUERY (impl_rep <* QUERY (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 =
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          '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.' +
          '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,
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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 = '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.
            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,
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              '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; -- 10303-522: aic_machining_feature

ENTITY turning_type_operation
  SUBTYPE OF (machining_operation);
  WHERE
  WR1:  ((verify_optional_relating_amr_with_name  (SELF, 'approach',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'approach',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR2:  ((verify_optional_relating_amr_with_name  (SELF, 'retract',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'retract',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.MACHINING_APPROACH_RETRACT_STRATEGY']))
        );

  WR3:  ((verify_optional_relating_amr_with_name  (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'])) AND
         (verify_related_type_for_amr_with_name   (SELF, 'machining',
          ['INTEGRATED_CNC_SCHEMA.MACHINING_STRATEGY_RELATIONSHIP'],
          ['INTEGRATED_CNC_SCHEMA.TURNING_TYPE_STRATEGY']))
        );

END_ENTITY; -- 10303-238: integrated_cnc_schema

ENTITY turning_type_strategy
  SUBTYPE OF (machining_strategy);
  WHERE
  WR1:  (SELF.description IN ['unidirectional', 'bidirectional',
          'contour', 'thread', 'grooving', 'multistep grooving',
          'explicit']);

  WR2:  ((verify_optional_action_property       (SELF, 'overcut length')) AND
         (verify_length_measure_action_property (SELF, 'overcut length'))
        );

  WR3:  ((verify_optional_action_property       (SELF, 'multiple passes')) AND
         (verify_enumeration_action_property    (SELF, 'multiple passes',
          ['multiple passes allowed', 'multiple passes not allowed']))
        );

  WR4:  ((verify_optional_action_property (SELF, 'cutting depth')) AND
         (0 = SIZEOF (QUERY (prop <*
           get_action_property (SELF, 'cutting depth') | NOT
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          (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 (SIZEOF([
                   'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
                   'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
                   TYPEOF(ie)) = 2))))
            ))))
          )))
        )))
       );

  WR5:  ((verify_optional_action_property     (SELF, 'variable feedrate')) AND
         (verify_rep_type_for_action_property (SELF, 'variable feedrate',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
         (verify_rep_name_for_action_property (SELF, 'variable feedrate',
           ['relative speed']))
       );

  WR6:  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, 'back path direction')) AND
         (verify_rep_item_for_action_property (SELF, 'back path direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

         (verify_optional_action_property     (SELF, 'lift direction')) AND
         (verify_rep_item_for_action_property (SELF, 'lift direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

         (verify_optional_action_property     (SELF, 'stepover direction')) AND
         (verify_rep_item_for_action_property (SELF, 'stepover direction',
           ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

         (verify_optional_action_property       (SELF, 'lift height')) AND
         (verify_length_measure_action_property (SELF, 'lift height')) AND

         (verify_optional_action_property     (SELF, 'lift feedrate')) AND
         (verify_rep_type_for_action_property (SELF, 'lift feedrate',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
         (verify_rep_name_for_action_property (SELF, 'lift feedrate',
           ['feed speed', 'feed per revolution'])) AND

         (verify_optional_action_property     (SELF, 'stepover feedrate')) AND
         (verify_rep_type_for_action_property (SELF, 'stepover feedrate',
           ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
         (verify_rep_name_for_action_property (SELF, 'stepover feedrate',
           ['feed speed', 'feed per revolution']))
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      );

WR7:  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_rep_item_for_action_property (SELF, 'stepover direction',
         ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

       (verify_optional_action_property     (SELF, 'stepover feedrate')) AND
       (verify_rep_type_for_action_property (SELF, 'stepover feedrate',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
       (verify_rep_name_for_action_property (SELF, 'stepover feedrate',
         ['feed speed', 'feed per revolution']))
      );

WR8:  NOT (SELF.description = 'contour') 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, 'back path direction')) AND
       (verify_rep_item_for_action_property (SELF, 'back path direction',
         ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

       (verify_optional_action_property     (SELF, 'lift direction')) AND
       (verify_rep_item_for_action_property (SELF, 'lift direction',
         ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

       (verify_optional_action_property     (SELF, 'stepover direction')) AND
       (verify_rep_item_for_action_property (SELF, 'stepover direction',
         ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

       (verify_optional_action_property       (SELF, 'lift height')) AND
       (verify_length_measure_action_property (SELF, 'lift height')) AND

       (verify_optional_action_property     (SELF, 'lift feedrate')) AND
       (verify_rep_type_for_action_property (SELF, 'lift feedrate',
        ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
       (verify_rep_name_for_action_property (SELF, 'lift feedrate',
         ['feed speed', 'feed per revolution'])) AND

       (verify_optional_action_property     (SELF, 'stepover feedrate')) AND
       (verify_rep_type_for_action_property (SELF, 'stepover feedrate',
         ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
       (verify_rep_name_for_action_property (SELF, 'stepover feedrate',
         ['feed speed', 'feed per revolution'])) AND

       (verify_optional_action_property
         (SELF, 'variable stepover feedrate')) AND
       (verify_rep_type_for_action_property
         (SELF, 'variable stepover feedrate',
```

```
          ['INTEGRATED_CNC_SCHEMA.MACHINING_FEED_SPEED_REPRESENTATION'])) AND
        (verify_rep_name_for_action_property
          (SELF, 'variable stepover feedrate', ['relative speed']))
       );

  WR9:  NOT (SELF.description = 'thread') OR
       ((verify_required_action_property     (SELF, 'cut in amount')) AND
        (verify_enumeration_action_property  (SELF, 'cut in amount',
          ['constant depth', 'variable depth', 'constant removal amount'])) AND

        (verify_required_action_property     (SELF, 'threading direction')) AND
        (verify_enumeration_action_property  (SELF, 'threading direction',
          ['left', 'right', 'center', 'left zigzag', 'right zigzag'])) AND

        (verify_optional_action_property       (SELF, 'path return angle')) AND
        (verify_angle_measure_action_property  (SELF, 'path return angle')) AND

        (verify_optional_action_property       (SELF, 'lift height')) AND
        (verify_length_measure_action_property (SELF, 'lift height'))
       );

  WR10: NOT (SELF.description IN ['grooving', 'multistep grooving']) OR
       ((verify_optional_action_property     (SELF, 'grooving direction')) AND
        (verify_rep_item_for_action_property (SELF, 'grooving direction',
          ['INTEGRATED_CNC_SCHEMA.DIRECTION'])) AND

        (verify_optional_action_property       (SELF, 'travel distance')) AND
        (verify_length_measure_action_property (SELF, 'travel distance'))
       );

  WR11: NOT (SELF.description = 'multistep grooving') OR
       ((verify_optional_action_property       (SELF, 'retract distance')) AND
        (verify_length_measure_action_property (SELF, 'retract distance'))
       );
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 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;
    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; -- 10303-238: integrated_cnc_schema

ENTITY value_representation_item
  SUBTYPE OF (representation_item);
    value_component : measure_value;
  WHERE
    WR1: SIZEOF(QUERY (rep <* using_representations(SELF)| NOT (
              'INTEGRATED_CNC_SCHEMA.GLOBAL_UNIT_ASSIGNED_CONTEXT' IN
              TYPEOF(rep.context_of_items)))) = 0;
END_ENTITY; -- 10303-43: representation_schema

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 >= 0.0;
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.
          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.' +
          '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')) OR (
          srwp_i.name = 'first length')) OR (srwp_i.name =
          'second length'))) = SIZEOF(pdr.used_representation.items))))
           = 1))) = 1;
WR5: SIZEOF(QUERY (pd <* USEDIN(SELF,
          'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION')| NOT
          (SIZEOF(QUERY (impl_rep <* QUERY (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;
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;
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.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 = 'first length'))) <= 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| ((
              '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 = 'second length'))) <= 1))) = 0))) = 0;
END_ENTITY; -- 10303-522: aic_machining_feature

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 vertex_shell
  SUBTYPE OF (topological_representation_item);
    vertex_shell_extent : vertex_loop;
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 wire_shell
  SUBTYPE OF (topological_representation_item);
    wire_shell_extent : SET [1:?] OF loop;
  WHERE
    WR1: NOT mixed_loop_type_set(wire_shell_extent);
END_ENTITY; -- 10303-42: topology_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'))))
```

```
        )));
END_RULE; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

RULE chamfer_requires_faces_or_features FOR
  (chamfer,
   property_definition_representation,
   feature_component_relationship);
WHERE
  WR1:  (0 = SIZEOF (QUERY (cf <* chamfer | NOT (

  -- chamfer relates two sets of faces in AP-224 style
  ((1 = SIZEOF (QUERY (pdr <* property_definition_representation |
        ((pdr.used_representation.name = 'chamfer face') AND
         (pdr.definition.definition :=: cf) AND
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
           IN TYPEOF (pdr.used_representation)))))) AND

   (1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.relating_shape_aspect :=: cf) AND
         (fcr.related_shape_aspect.description = 'first offset') AND
         ('INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET'
           IN TYPEOF (fcr.related_shape_aspect)) AND
         ((1 = SIZEOF (QUERY (pdr <* property_definition_representation |
               ((pdr.used_representation.name = 'first face shape') AND
                (pdr.definition.definition :=: fcr.related_shape_aspect) AND
                ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
                  IN TYPEOF (pdr.used_representation)))
         )))) )))) AND

   (1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.relating_shape_aspect :=: cf) AND
         (fcr.related_shape_aspect.description = 'second offset') AND
         ('INTEGRATED_CNC_SCHEMA.CHAMFER_OFFSET'
           IN TYPEOF (fcr.related_shape_aspect)) AND
```

```
         ((1 = SIZEOF (QUERY (pdr <* property_definition_representation |
               ((pdr.used_representation.name = 'second face shape') AND
                (pdr.definition.definition :=: fcr.related_shape_aspect) AND
                ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
                  IN TYPEOF (pdr.used_representation)))
         )))) ))))
  )
  OR
  -- chamfer relates two features in ISO 14649 style
  ((1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.name = 'first feature') AND
         (fcr.relating_shape_aspect.of_shape.definition :=: cf) AND
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
           IN TYPEOF (fcr.relating_shape_aspect))))))  AND

   (1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.name = 'second feature') AND
         (fcr.relating_shape_aspect.of_shape.definition :=: cf) AND
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
           IN TYPEOF (fcr.relating_shape_aspect)))))))
   ))));
END_RULE; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

RULE dependent_instantiable_derived_unit FOR
  (derived_unit);
WHERE
  WR1:  (0 = SIZEOF (QUERY (du <* derived_unit | NOT
           (1 <= SIZEOF (USEDIN (du, '')))
        )));
END_RULE; -- 10303-238: integrated_cnc_schema
```



```
RULE dependent_instantiable_named_unit FOR
  (named_unit);
WHERE
  WR1:  (0 = SIZEOF (QUERY (nu <* named_unit | NOT
           (1 <= SIZEOF (USEDIN (nu, '')))
        )));
END_RULE; -- 10303-238: integrated_cnc_schema

RULE edge_round_requires_faces_or_features FOR
  (edge_round,
   property_definition_representation,
   feature_component_relationship);
WHERE
  WR1:  (0 = SIZEOF (QUERY (er <* edge_round | NOT (

  -- edge round relates two sets of faces in AP-224 style
  ((1 = SIZEOF (QUERY (pdr <* property_definition_representation |
        ((pdr.used_representation.name = 'edge round face') AND
         (pdr.definition.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
           IN TYPEOF (pdr.used_representation)))))) AND

   (1 = SIZEOF (QUERY (pdr <* property_definition_representation |
        ((pdr.used_representation.name = 'first face shape') AND
         (pdr.definition.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
           IN TYPEOF (pdr.used_representation)))))) AND

   (1 = SIZEOF (QUERY (pdr <* property_definition_representation |
        ((pdr.used_representation.name = 'second face shape') AND
         (pdr.definition.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.FACE_SHAPE_REPRESENTATION'
           IN TYPEOF (pdr.used_representation))))))
  )
  OR
  -- edge round relates two features in ISO 14649 style
  ((1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.name = 'first feature') AND
         (fcr.relating_shape_aspect.of_shape.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
           IN TYPEOF (fcr.relating_shape_aspect))))))  AND

   (1 = SIZEOF (QUERY (fcr <* feature_component_relationship |
        ((fcr.name = 'second feature') AND
         (fcr.relating_shape_aspect.of_shape.definition :=: er) AND
         ('INTEGRATED_CNC_SCHEMA.COMPOSITE_SHAPE_ASPECT'
           IN TYPEOF (fcr.relating_shape_aspect)))))))
   ))));
END_RULE; -- 10303-238: integrated_cnc_schema

RULE feature_optional_machining_property_process FOR
  (shape_aspect,
   process_property_association);
```



```
WHERE
  WR1:  (0 = SIZEOF (QUERY (sa <* shape_aspect |
        (('INTEGRATED_CNC_SCHEMA.FEATURE_DEFINITION' IN TYPEOF (sa)) OR
         ('INTEGRATED_CNC_SCHEMA.TRANSITION_FEATURE' IN TYPEOF (sa)))
         AND NOT
         (1 >= SIZEOF (QUERY (ppa <* process_property_association |
            ((ppa.property_or_shape :=: sa) AND
             (ppa.process.name = 'machining')))))
        )));
END_RULE; -- 10303-238: integrated_cnc_schema

RULE nc_variable_compatible_initial_value FOR
  (expression_representation_item,
   representation_item_relationship);
WHERE
  -- each nc_variable has at most one one initial value
  WR1: (0 = SIZEOF (QUERY (nv <* expression_representation_item |
            ('INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'
              IN TYPEOF (nv)) AND 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
            ('INTEGRATED_CNC_SCHEMA.NUMERIC_VARIABLE'
              IN TYPEOF (rir.relating_representation_item))
            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; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

RULE restrict_unneeded_feature_usage FOR (feature_definition);
```



```
  WHERE
  WR1:  (0 = SIZEOF (QUERY (fd <* feature_definition |
         ('INTEGRATED_CNC_SCHEMA.FILLET' IN TYPEOF(fd)) OR
         ('INTEGRATED_CNC_SCHEMA.GEAR' IN TYPEOF(fd)) OR
         ('INTEGRATED_CNC_SCHEMA.MARKING' IN TYPEOF(fd)) OR
         ('INTEGRATED_CNC_SCHEMA.PROTRUSION' IN TYPEOF(fd)) OR
         ('INTEGRATED_CNC_SCHEMA.RIB_TOP' IN TYPEOF(fd))
        )));
END_RULE; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

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);
        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;
    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);
        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);
        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_point_replica (
    rep    : point_replica;
    parent : point
    ) : BOOLEAN;
    IF NOT ('INTEGRATED_CNC_SCHEMA.POINT_REPLICA' IN TYPEOF(parent)) THEN
      RETURN (TRUE);
    END_IF;
    IF parent :=: rep THEN
      RETURN (FALSE);
    ELSE
      RETURN (acyclic_point_replica(rep, parent\point_replica.parent_pt));
    END_IF;
END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION acyclic_product_category_relationship (
    relation : product_category_relationship;
    children : SET OF product_category
    ) : BOOLEAN;
  LOCAL
    x : SET OF product_category_relationship;
    local_children : SET OF product_category;
  END_LOCAL;
    REPEAT i := 1 TO HIINDEX(children);
      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);
        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);
      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;
    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);
        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 : direction;
    axis2 : direction;
    axis3 : direction
    ) : LIST [2:3] OF direction;
  LOCAL
    u : LIST [2:3] OF direction;
    factor : REAL;
    d1 : direction;
    d2 : direction;
  END_LOCAL;
    IF dim = 3 THEN
      d1 := NVL(normalise(axis3), dummy_gri || direction([ 0.0, 0.0, 1.0 ])
        );
      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 < 0.0 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, 0.0 ]), dummy_gri ||
            direction([ 0.0, 1.0 ]) ];
        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, 0.0 ]));
  END_LOCAL;
    RETURN ([ d, orthogonal_complement(d) ]);
END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION build_axes (
    axis          : direction;
    ref_direction : direction
    ) : LIST [3:3] OF direction;
  LOCAL
    d1 : direction;
    d2 : direction;
  END_LOCAL;
    d1 := NVL(normalise(axis), dummy_gri || direction([ 0.0, 0.0, 1.0 ]));
    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
    ) : BOOLEAN;
  LOCAL
    n_segments : INTEGER := SIZEOF(c.segments);
  END_LOCAL;
    REPEAT k := 1 TO n_segments;
      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);
      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_geometry_shell_based_wireframe_model (
    m : shell_based_wireframe_model
    ) : BOOLEAN;
  LOCAL
    result : BOOLEAN := TRUE;
  END_LOCAL;
    REPEAT j := 1 TO SIZEOF(m.sbwm_boundary);
      IF NOT ('INTEGRATED_CNC_SCHEMA.WIRE_SHELL' IN TYPEOF(m.sbwm_boundary[
        j])) AND NOT ('INTEGRATED_CNC_SCHEMA.VERTEX_SHELL' IN TYPEOF(m.
        sbwm_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
    result : BOOLEAN := TRUE;
    k : INTEGER;
    sum : INTEGER;
  END_LOCAL;
    sum := knot_mult[1];
    REPEAT i := 2 TO up_knots;
      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;
      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;
      REPEAT j := 1 TO s.n_v;
        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;
    REPEAT j := 1 TO s.n_v;
      IF s.segments[i][j].u_transition = discontinuous THEN
        RETURN (FALSE);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  REPEAT i := 1 TO s.n_u;
    REPEAT j := 1 TO s.n_v - 1;
      IF s.segments[i][j].v_transition = discontinuous THEN
        RETURN (FALSE);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  RETURN (TRUE);
END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION cross_product (
    arg1 : direction;
    arg2 : direction
    ) : vector;
  LOCAL
    mag : REAL;
    res : direction;
    v1 : LIST [3:3] OF REAL;
    v2 : LIST [3:3] OF REAL;
    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 := 0.0;
        REPEAT i := 1 TO 3;
          mag := mag + res.direction_ratios[i] * res.direction_ratios[i];
        END_REPEAT;
        IF mag > 0.0 THEN
          result := dummy_gri || vector(res, sqrt(mag));
        ELSE
          result := dummy_gri || vector(arg1, 0.0);
        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;
      IF b.weights[i] <= 0.0 THEN
        result := FALSE;
        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,
      0.0, 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);
        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
      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, 0.0, 0.0, 0.0, 0.0))
            ;
      gram :
          RETURN (dimensional_exponents(0.0, 1.0, 0.0, 0.0, 0.0, 0.0, 0.0))
            ;
      second :
          RETURN (dimensional_exponents(0.0, 0.0, 1.0, 0.0, 0.0, 0.0, 0.0))
            ;
      ampere :
          RETURN (dimensional_exponents(0.0, 0.0, 0.0, 1.0, 0.0, 0.0, 0.0))
            ;
      kelvin :
          RETURN (dimensional_exponents(0.0, 0.0, 0.0, 0.0, 1.0, 0.0, 0.0))
            ;
      mole :
          RETURN (dimensional_exponents(0.0, 0.0, 0.0, 0.0, 0.0, 1.0, 0.0))
            ;
      candela :
          RETURN (dimensional_exponents(0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0))
            ;
      radian :
          RETURN (dimensional_exponents(0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0))
            ;
      steradian :
          RETURN (dimensional_exponents(0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0))
            ;
```

```
      hertz :
          RETURN (dimensional_exponents(0.0, 0.0, -1.0, 0.0, 0.0, 0.0, 0.0)
            );
      newton :
          RETURN (dimensional_exponents(1.0, 1.0, -2.0, 0.0, 0.0, 0.0, 0.0)
            );
      pascal :
          RETURN (dimensional_exponents(-1.0, 1.0, -2.0, 0.0, 0.0, 0.0, 0.0
            ));
      joule :
          RETURN (dimensional_exponents(2.0, 1.0, -2.0, 0.0, 0.0, 0.0, 0.0)
            );
      watt :
          RETURN (dimensional_exponents(2.0, 1.0, -3.0, 0.0, 0.0, 0.0, 0.0)
            );
      coulomb :
          RETURN (dimensional_exponents(0.0, 0.0, 1.0, 1.0, 0.0, 0.0, 0.0))
            ;
      volt :
          RETURN (dimensional_exponents(2.0, 1.0, -3.0, -1.0, 0.0, 0.0, 0.0
            ));
      farad :
          RETURN (dimensional_exponents(-2.0, -1.0, 4.0, 1.0, 0.0, 0.0, 0.0
            ));
      ohm :
          RETURN (dimensional_exponents(2.0, 1.0, -3.0, -2.0, 0.0, 0.0, 0.0
            ));
      siemens :
          RETURN (dimensional_exponents(-2.0, -1.0, 3.0, 2.0, 0.0, 0.0, 0.0
            ));
      weber :
          RETURN (dimensional_exponents(2.0, 1.0, -2.0, -1.0, 0.0, 0.0, 0.0
            ));
      tesla :
          RETURN (dimensional_exponents(0.0, 1.0, -2.0, -1.0, 0.0, 0.0, 0.0
            ));
      henry :
          RETURN (dimensional_exponents(2.0, 1.0, -2.0, -2.0, 0.0, 0.0, 0.0
            ));
      degree_Celsius :
          RETURN (dimensional_exponents(0.0, 0.0, 0.0, 0.0, 1.0, 0.0, 0.0))
            ;
      lumen :
          RETURN (dimensional_exponents(0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0))
            ;
      lux :
          RETURN (dimensional_exponents(-2.0, 0.0, 0.0, 0.0, 0.0, 0.0, 1.0)
            );
      becquerel :
          RETURN (dimensional_exponents(0.0, 0.0, -1.0, 0.0, 0.0, 0.0, 0.0)
            );
      gray :
          RETURN (dimensional_exponents(2.0, 0.0, -2.0, 0.0, 0.0, 0.0, 0.0)
            );
```



```
      sievert :
          RETURN (dimensional_exponents(2.0, 0.0, -2.0, 0.0, 0.0, 0.0, 0.0)
            );
    OTHERWISE :
        RETURN (?);
    END_CASE;
END_FUNCTION; -- 10303-41: measure_schema

FUNCTION dot_product (
    arg1 : direction;
    arg2 : direction
    ) : REAL;
  LOCAL
    scalar : REAL;
    vec1 : direction;
    vec2 : direction;
    ndim : INTEGER;
  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 := 0.0;
          REPEAT i := 1 TO ndim;
            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
    ) : 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 : direction;
    arg    : direction
    ) : direction;
  LOCAL
    x_axis : direction;
    v : direction;
    z : direction;
    x_vec : vector;
  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, 0.0, 0.0 ]) AND (z.
          direction_ratios <> [ -1.0, 0.0, 0.0 ]) THEN
          v := dummy_gri || direction([ 1.0, 0.0, 0.0 ]);
```



```
        ELSE
          v := dummy_gri || direction([ 0.0, 1.0, 0.0 ]);
        END_IF;
      ELSE
        IF arg.dim <> 3 THEN
          RETURN (?);
        END_IF;
        IF cross_product(arg, z).magnitude = 0.0 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));
```



```
            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);
                        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));
      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);
              REPEAT j := 1 TO SIZEOF(sf\rectangular_composite_surface.
                segments[i]);
                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; -- 10303-238: integrated_cnc_schema

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;
          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;
          surfs := surfs * get_basis_surface(c\composite_curve.segments[i].
            parent_curve);
        END_REPEAT;
      END_IF;
    END_IF;
    RETURN (surfs);
END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION get_count_of_relating_amr (
```



```
    am :        action_method;
    amr_types : SET OF STRING
    ): INTEGER;

    RETURN (SIZEOF (QUERY (amr <* get_relating_amr (am) |
               (SIZEOF(amr_types * TYPEOF(amr)) =
                SIZEOF(amr_types)) )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION get_count_of_relating_amr_with_name (
    am :        action_method;
    amr_name :  STRING;
    amr_types : SET OF STRING
    ): INTEGER;

    RETURN (SIZEOF (QUERY (amr <* get_relating_amr (am) |
              ((amr.name = amr_name) AND
               (SIZEOF(amr_types * TYPEOF(amr)) =
                SIZEOF(amr_types))) )));
END_FUNCTION; -- 10303-238: integrated_cnc_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

FUNCTION get_property_definition_representations (
    c_def_instance : characterized_definition
    ) : SET OF property_definition_representation;
  LOCAL
    pd_set : SET OF property_definition := [];
    pdr_set : SET OF property_definition_representation := [];
  END_LOCAL;
    pd_set := bag_to_set(USEDIN(c_def_instance,
      'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION.DEFINITION'));
    IF SIZEOF(pd_set) < 1 THEN
      RETURN (pdr_set);
    END_IF;
    REPEAT i := 1 TO HIINDEX(pd_set);
      pdr_set := pdr_set + bag_to_set(USEDIN(pd_set[i],
        'INTEGRATED_CNC_SCHEMA.PROPERTY_DEFINITION_REPRESENTATION.DEFINITION'
        ));
    END_REPEAT;
    RETURN (pdr_set);
END_FUNCTION; -- 10303-41: product_property_representation_schema

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; -- 10303-238: integrated_cnc_schema

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; -- 10303-238: integrated_cnc_schema

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 get_tool_body_item (
    mt :             machining_tool;
    prop_name :      STRING
    ): SET OF representation_item;

    LOCAL
      props : SET OF resource_property;
      preps : SET OF resource_property_representation;
      items : SET OF representation_item;
    END_LOCAL;

    props := get_resource_property (mt, 'tool body');
    REPEAT i := 1 TO HIINDEX(props);
        preps := preps + USEDIN (props[i], 'INTEGRATED_CNC_SCHEMA.'+
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY');
    END_REPEAT;

    REPEAT i := 1 TO HIINDEX(preps);
        IF ('INTEGRATED_CNC_SCHEMA.MACHINING_TOOL_BODY_REPRESENTATION'
                IN TYPEOF (preps[i].representation))
        THEN
            items := items + preps[i].representation.items;
        END_IF;
    END_REPEAT;

    RETURN (bag_to_set (QUERY (it <* items | (it.name = prop_name))));
END_FUNCTION; -- 10303-238: integrated_cnc_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;

    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;

    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);
        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]));
    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);
          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);
      loops := loops + f.bounds[i].bound;
    END_REPEAT;
    RETURN (loops);
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);
      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 [low:u] 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;
        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);
      s := s + l[i];
    END_REPEAT;
    RETURN (s);
END_FUNCTION; -- 10303-42: topology_schema

FUNCTION make_array_of_array (
    lis  : LIST [1:?] OF LIST [1:?] OF GENERIC : T;
    low1 : INTEGER;
    u1   : INTEGER;
    low2 : INTEGER;
    u2   : INTEGER
    ) : ARRAY [low1:u1] OF ARRAY [low2:u2] 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);
      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);
      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
      '*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);
                    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

FUNCTION nmsf_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);
    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 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 (nmsf_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 (nmsf_curve_check(cv\offset_curve_3d.basis_curve));
            ELSE
              IF 'INTEGRATED_CNC_SCHEMA.PCURVE' IN TYPEOF(cv) THEN
                RETURN (nmsf_curve_check(cv\pcurve.reference_to_curve\
                  representation.items[1]) AND nmsf_surface_check(cv\pcurve
                  .basis_surface));
```



```
              ELSE
                IF 'INTEGRATED_CNC_SCHEMA.SURFACE_CURVE' IN TYPEOF(cv) THEN
                  IF nmsf_curve_check(cv\surface_curve.curve_3d) THEN
                    REPEAT i := 1 TO SIZEOF(cv\surface_curve.
                      associated_geometry);
                      IF 'INTEGRATED_CNC_SCHEMA.SURFACE' IN TYPEOF(cv\
                        surface_curve.associated_geometry[i]) THEN
                        IF NOT nmsf_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 nmsf_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;
    END_IF;
    RETURN (FALSE);
END_FUNCTION; -- 10303-508: aic_non_manifold_surface

FUNCTION nmsf_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 (nmsf_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 (nmsf_surface_check(surf\offset_surface.basis_surface));
        ELSE
          IF 'INTEGRATED_CNC_SCHEMA.SURFACE_REPLICA' IN TYPEOF(surf) THEN
```



```
          RETURN (nmsf_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; -- 10303-508: aic_non_manifold_surface

FUNCTION normalise (
    arg : vector_or_direction
    ) : vector_or_direction;
  LOCAL
    ndim : INTEGER;
    v : direction;
    result : vector_or_direction;
    vec : vector;
    mag : REAL;
  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 = 0.0 THEN
            RETURN (?);
          ELSE
            vec := dummy_gri || vector(v, 1.0);
          END_IF;
        END;
      ELSE
        v := dummy_gri || direction(arg.direction_ratios);
      END_IF;
      mag := 0.0;
      REPEAT i := 1 TO ndim;
        mag := mag + v.direction_ratios[i] * v.direction_ratios[i];
      END_REPEAT;
      IF mag > 0.0 THEN
        mag := sqrt(mag);
        REPEAT i := 1 TO ndim;
          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;
  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
    ) : LOGICAL;
  LOCAL
    n : INTEGER;
    p : LOGICAL := TRUE;
  END_LOCAL;
    n := SIZEOF(a_path.edge_list);
    REPEAT i := 2 TO n;
      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 (
    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 < 0.0 THEN
        REPEAT i := 1 TO SIZEOF(v.direction_ratios);
          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 : direction;
    x_axis : direction;
```

```
    arg    : direction
    ) : direction;
  LOCAL
    y_axis : vector;
    v : direction;
    temp : vector;
  END_LOCAL;
    IF NOT EXISTS(arg) THEN
      v := dummy_gri || direction([ 0.0, 1.0, 0.0 ]);
    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);
      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
    result : BOOLEAN := TRUE;
  END_LOCAL;
    REPEAT i := 0 TO b.u_upper;
```



```
      REPEAT j := 0 TO b.v_upper;
        IF b.weights[i][j] <= 0.0 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
    new_check_items : SET OF founded_item_select;
    result_items : SET OF founded_item_select;
    next_items : SET OF founded_item_select;
  END_LOCAL;
    result_items := [];
    new_check_items := checked_items + item;
    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);
        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;
    result_bag : BAG OF representation;
    intermediate_items : SET OF founded_item_select;
  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);
        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);
        result_bag := USEDIN(intermediate_items[i],
          'INTEGRATED_CNC_SCHEMA.REPRESENTATION.ITEMS');
        IF SIZEOF(result_bag) > 0 THEN
          REPEAT j := 1 TO HIINDEX(result_bag);
            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
            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_geometrically_bounded_wf_curve (
  crv : curve
  ) : BOOLEAN;
  IF SIZEOF([ 'INTEGRATED_CNC_SCHEMA.POLYLINE',
    'INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE',
    'INTEGRATED_CNC_SCHEMA.ELLIPSE', 'INTEGRATED_CNC_SCHEMA.CIRCLE' ] *
    TYPEOF(crv)) = 1 THEN
    RETURN (TRUE);
  ELSE
    IF 'INTEGRATED_CNC_SCHEMA.TRIMMED_CURVE' IN TYPEOF(crv) THEN
      IF SIZEOF([ 'INTEGRATED_CNC_SCHEMA.LINE',
        'INTEGRATED_CNC_SCHEMA.PARABOLA',
        'INTEGRATED_CNC_SCHEMA.HYPERBOLA' ] * TYPEOF(crv\trimmed_curve.
        basis_curve)) = 1 THEN
        RETURN (TRUE);
      ELSE
        RETURN (valid_geometrically_bounded_wf_curve(crv\trimmed_curve.
          basis_curve));
```



```
        END_IF;
      ELSE
        IF 'INTEGRATED_CNC_SCHEMA.OFFSET_CURVE_3D' IN TYPEOF(crv) THEN
          RETURN (valid_geometrically_bounded_wf_curve(crv\offset_curve_3d.
            basis_curve));
        ELSE
          IF 'INTEGRATED_CNC_SCHEMA.CURVE_REPLICA' IN TYPEOF(crv) THEN
            RETURN (valid_geometrically_bounded_wf_curve(crv\curve_replica.
              parent_curve));
          ELSE
            IF 'INTEGRATED_CNC_SCHEMA.COMPOSITE_CURVE' IN TYPEOF(crv) THEN
              RETURN (SIZEOF(QUERY (ccs <* crv\composite_curve.segments|
                NOT valid_geometrically_bounded_wf_curve(ccs.parent_curve))
                ) = 0);
            END_IF;
          END_IF;
        END_IF;
      END_IF;
    END_IF;
    RETURN (FALSE);
END_FUNCTION; -- 10303-510: aic_geometrically_bounded_wireframe

FUNCTION valid_geometrically_bounded_wf_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 (valid_geometrically_bounded_wf_curve(pnt\point_on_curve.
          basis_curve));
      ELSE
        IF 'INTEGRATED_CNC_SCHEMA.POINT_REPLICA' IN TYPEOF(pnt) THEN
          RETURN (valid_geometrically_bounded_wf_point(pnt\point_replica.
            parent_pt));
        END_IF;
      END_IF;
    END_IF;
    RETURN (FALSE);
END_FUNCTION; -- 10303-510: aic_geometrically_bounded_wireframe

FUNCTION valid_measure_value (
    m : measure_value
    ) : BOOLEAN;
    IF 'REAL' IN TYPEOF(m) THEN
      RETURN (m > 0.0);
    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;
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;
    END_IF;
    RETURN (TRUE);
END_FUNCTION; -- 10303-41: measure_schema

FUNCTION valid_wireframe_edge_curve (
    crv : curve
    ) : BOOLEAN;
    IF SIZEOF([ 'INTEGRATED_CNC_SCHEMA.LINE', 'INTEGRATED_CNC_SCHEMA.CONIC'
      , 'INTEGRATED_CNC_SCHEMA.B_SPLINE_CURVE',
      'INTEGRATED_CNC_SCHEMA.POLYLINE' ] * TYPEOF(crv)) = 1 THEN
      RETURN (TRUE);
    ELSE
      IF 'INTEGRATED_CNC_SCHEMA.CURVE_REPLICA' IN TYPEOF(crv) THEN
        RETURN (valid_wireframe_edge_curve(crv\curve_replica.parent_curve))
          ;
      ELSE
        IF 'INTEGRATED_CNC_SCHEMA.OFFSET_CURVE_3D' IN TYPEOF(crv) THEN
          RETURN (valid_wireframe_edge_curve(crv\offset_curve_3d.
            basis_curve));
        END_IF;
      END_IF;
    END_IF;
    RETURN (FALSE);
END_FUNCTION; -- 10303-502: aic_shell_based_wireframe

FUNCTION valid_wireframe_vertex_point (
    pnt : point
    ) : BOOLEAN;
    IF 'INTEGRATED_CNC_SCHEMA.CARTESIAN_POINT' IN TYPEOF(pnt) THEN
      RETURN (TRUE);
    ELSE
      IF 'INTEGRATED_CNC_SCHEMA.POINT_REPLICA' IN TYPEOF(pnt) THEN
        RETURN (valid_wireframe_vertex_point(pnt\point_replica.parent_pt));
      END_IF;
    END_IF;
    RETURN (FALSE);
END_FUNCTION; -- 10303-502: aic_shell_based_wireframe

FUNCTION vector_difference (
    arg1 : vector_or_direction;
    arg2 : vector_or_direction
    ) : vector;
  LOCAL
    result : vector;
    res : direction;
```



```
    vec1 : direction;
    vec2 : direction;
    mag : REAL;
    mag1 : REAL;
    mag2 : REAL;
    ndim : INTEGER;
  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 := 1.0;
          vec1 := arg1;
        END_IF;
        IF 'INTEGRATED_CNC_SCHEMA.VECTOR' IN TYPEOF(arg2) THEN
          mag2 := arg2.magnitude;
          vec2 := arg2.orientation;
        ELSE
          mag2 := 1.0;
          vec2 := arg2;
        END_IF;
        vec1 := normalise(vec1);
        vec2 := normalise(vec2);
        ndim := SIZEOF(vec1.direction_ratios);
        mag := 0.0;
        res := dummy_gri || direction(vec1.direction_ratios);
        REPEAT i := 1 TO ndim;
          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 > 0.0 THEN
          result := dummy_gri || vector(res, sqrt(mag));
        ELSE
          result := dummy_gri || vector(vec1, 0.0);
        END_IF;
      END;
    END_IF;
    RETURN (result);
END_FUNCTION; -- 10303-42: geometry_schema

FUNCTION verify_angle_measure_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    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; -- 10303-238: integrated_cnc_schema

FUNCTION verify_angle_measure_rep_item (
    rep :       representation;
    prop_name : STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_angle_measure_resource_property (
    crd :       characterized_resource_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_resource_property (crd, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT']));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_angle_measure_tool_body_item (
    mt :        machining_tool;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_tool_body(mt, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.PLANE_ANGLE_MEASURE_WITH_UNIT']));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_ballnose_endmill_dimensions (
    mt :          machining_tool
    ): LOGICAL;

    LOCAL
      rads : SET OF REPRESENTATION_ITEM :=
        get_tool_body_item (mt, 'edge radius');
      dias : SET OF REPRESENTATION_ITEM :=
        get_tool_body_item (mt, 'effective cutting diameter');
    END_LOCAL;

    RETURN ((0 = SIZEOF(rads)) OR
            ((1 = SIZEOF(rads)) AND
             (1 = SIZEOF(dias)) AND
             (rads[1].value_component = dias[1].value_component/2))
        );
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_bullnose_endmill_dimensions (
    mt :          machining_tool
```



```
    ): LOGICAL;

    LOCAL
      rads : SET OF REPRESENTATION_ITEM :=
        get_tool_body_item (mt, 'edge radius');
      dias : SET OF REPRESENTATION_ITEM :=
        get_tool_body_item (mt, 'effective cutting diameter');
    END_LOCAL;

    RETURN  ((1 = SIZEOF(rads)) AND
             (1 = SIZEOF(dias)) AND
             (rads[1].value_component < dias[1].value_component/2)
        );
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_count_measure_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    -- 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.COUNT_MEASURE'
                  IN TYPEOF(it.value_component)))
           )))
        )))
    ))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_count_measure_rep_item (
    rep :       representation;
    prop_name : STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT
          (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
           ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
```



```
            IN TYPEOF(it.value_component))))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_count_measure_resource_property (
    crd :       characterized_resource_definition;
    prop_name : STRING
    ): LOGICAL;

    -- 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_resource_property (crd, 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.' +
                'RESOURCE_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.COUNT_MEASURE'
                  IN TYPEOF(it.value_component)))
           )))
        )))
    ))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_count_measure_tool_body_item (
    mt :          machining_tool;
    prop_name :   STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (it <* get_tool_body_item (mt, prop_name) | NOT
              (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
               ('INTEGRATED_CNC_SCHEMA.COUNT_MEASURE'
                  IN TYPEOF(it.value_component)))
        )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_descriptive_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_action_property(cad, prop_name,
        ['INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM']));
END_FUNCTION; -- 10303-238: integrated_cnc_schema
```

```
FUNCTION verify_enumeration_action_property (
    cad :         characterized_action_definition;
    prop_name :   STRING;
    prop_values : SET OF STRING
    ): LOGICAL;

    -- 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; -- 10303-238: integrated_cnc_schema

FUNCTION verify_enumeration_resource_property (
    crd :         characterized_resource_definition;
    prop_name :   STRING;
    prop_values : SET OF STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (prop <* get_resource_property (crd, prop_name) |

        NOT (
        -- there is at least one rep with matching rep items
        (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_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; -- 10303-238: integrated_cnc_schema

FUNCTION verify_enumeration_tool_body_item (
    mt :          machining_tool;
    prop_name :   STRING;
```



```
    prop_values : SET OF STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (it <* get_tool_body_item (mt, prop_name) | NOT
              (('INTEGRATED_CNC_SCHEMA.DESCRIPTIVE_REPRESENTATION_ITEM'
                  IN TYPEOF(it)) AND
               (it.description IN prop_values))
        )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_length_measure_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    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; -- 10303-238: integrated_cnc_schema

FUNCTION verify_length_measure_rep_item (
    rep :       representation;
    prop_name : STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_length_measure_resource_property (
    crd :       characterized_resource_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_resource_property (crd, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_length_measure_tool_body_item (
    mt :        machining_tool;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_tool_body(mt, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.LENGTH_MEASURE_WITH_UNIT']));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_linear_speed_measure_rep_item (
    rep :       representation;
```

```
    prop_name : STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT
          (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
           ('INTEGRATED_CNC_SCHEMA.NUMERIC_MEASURE'
            IN TYPEOF(it.value_component))))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_numeric_measure_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    -- 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.NUMERIC_MEASURE'
                 IN TYPEOF(it.value_component)))
           )))
        )))
    ))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_optional_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (1 >= SIZEOF (get_action_property (cad, prop_name)));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_optional_in_process_geometry (
    mpe : machining_process_executable
    ): LOGICAL;

    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.SHAPE_REPRESENTATION'
               IN TYPEOF (prep.representation))))))
          )))
      );
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_optional_relating_amr (
    am :        action_method;
    amr_types : SET OF STRING
    ): LOGICAL;

    RETURN (1 >= get_count_of_relating_amr (am, amr_types));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_optional_relating_amr_with_name (
    am :        action_method;
    amr_name :  STRING;
    amr_types : SET OF STRING
    ): LOGICAL;

    RETURN (1 >= get_count_of_relating_amr_with_name (
                am, amr_name, amr_types));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_optional_rep_item (
    rep :       representation;
    prop_name : STRING
    ): LOGICAL;

    RETURN (1 >= SIZEOF (QUERY ( it <* rep.items |
            (it.name = prop_name))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_optional_resource_property (
    crd :       characterized_resource_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (1 >= SIZEOF (get_resource_property (crd, prop_name)));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_optional_tool_body_item (
    mt :        machining_tool;
    prop_name : STRING
    ): LOGICAL;
```



```
    RETURN (1 >= SIZEOF (get_tool_body_item (mt, prop_name)));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_pressure_measure_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_numeric_measure_action_property (cad, prop_name));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_ratio_measure_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    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; -- 10303-238: integrated_cnc_schema

FUNCTION verify_ratio_measure_rep_item (
    rep :       representation;
    prop_name : STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.RATIO_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_related_type_for_amr (
    am :        action_method;
    amr_types : SET OF STRING;
    types :     SET OF STRING
    ): LOGICAL;

    RETURN  (0 = SIZEOF (QUERY (amr <* get_relating_amr (am) |
               (SIZEOF(amr_types * TYPEOF(amr)) =
                SIZEOF(amr_types)) AND
                NOT
               (SIZEOF(types * TYPEOF(amr.related_method)) =
                SIZEOF(types)) )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_related_type_for_amr_with_name (
    am :        action_method;
    amr_name :  STRING;
    amr_types : SET OF STRING;
    types :     SET OF STRING
    ): LOGICAL;
```

```
    RETURN  (0 = SIZEOF (QUERY (amr <* get_relating_amr (am) |
               (amr.name = amr_name) AND
               (SIZEOF(amr_types * TYPEOF(amr)) =
                SIZEOF(amr_types)) AND
                NOT
               (SIZEOF(types * TYPEOF(amr.related_method)) =
                SIZEOF(types)) )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_rep_item_for_action_property (
    cad :            characterized_action_definition;
    prop_name :      STRING;
    rep_item_types : SET OF STRING
    ): LOGICAL;

    -- 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 (rep_item_types * TYPEOF(it)) =
                SIZEOF (rep_item_types))))
           )))
        ))
    )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_rep_item_for_resource_property (
    crd :            characterized_resource_definition;
    prop_name :      STRING;
    rep_item_types : SET OF STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (prop <* get_resource_property (crd, prop_name) |
        NOT (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.' +
                'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |

           (0 < SIZEOF (QUERY (it <* prep.representation.items |
               (SIZEOF (rep_item_types * TYPEOF(it)) =
                SIZEOF (rep_item_types)))))
           )))
        )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema
```



```
FUNCTION verify_rep_item_for_tool_body (
    mt :             machining_tool;
    prop_name :      STRING;
    rep_item_types : SET OF STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (it <* get_tool_body_item (mt, prop_name) | NOT
              ((SIZEOF (rep_item_types * TYPEOF(it)) =
                SIZEOF (rep_item_types)))
        )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_rep_name_for_action_property (
    cad :        characterized_action_definition;
    prop_name :  STRING;
    desc_names : SET OF STRING
    ): LOGICAL;

    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') |
               (prep.representation.name IN desc_names)
                )))
        )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_rep_type_for_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING;
    rep_types : SET OF STRING
    ): LOGICAL;

    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') |

               (SIZEOF(rep_types * TYPEOF(prep.representation)) =
                SIZEOF(rep_types))
                )))
        )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_rep_type_for_resource_property (
    crd :       characterized_resource_definition;
    prop_name : STRING;
    rep_types : SET OF STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY (prop <*
            get_resource_property (crd, prop_name) | NOT
            (0 < SIZEOF (QUERY (prep <* USEDIN (prop, 'INTEGRATED_CNC_SCHEMA.'+
```



```
               'RESOURCE_PROPERTY_REPRESENTATION.PROPERTY') |

               (SIZEOF(rep_types * TYPEOF(prep.representation)) =
                SIZEOF(rep_types))
                )))
        )));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_required_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (1 = SIZEOF (get_action_property (cad, prop_name)));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_required_relating_amr (
    am :        action_method;
    amr_types : SET OF STRING
    ): LOGICAL;

    RETURN (1 = get_count_of_relating_amr (am, amr_types));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_required_relating_amr_with_name (
    am :        action_method;
    amr_name :  STRING;
    amr_types : SET OF STRING
    ): LOGICAL;

    RETURN (1 = get_count_of_relating_amr_with_name (
                am, amr_name, amr_types));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_required_rep_item (
    rep :       representation;
    prop_name : STRING
    ): LOGICAL;

    RETURN (1 = SIZEOF (QUERY ( it <* rep.items |
            (it.name = prop_name))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_required_resource_property (
    crd :       characterized_resource_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (1 = SIZEOF (get_resource_property (crd, prop_name)));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_required_tool_body_item (
    mt :        machining_tool;
    prop_name : STRING
```



```
    ): LOGICAL;

    RETURN (1 = SIZEOF (get_tool_body_item (mt, prop_name)));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_rotary_speed_measure_rep_item (
    rep :       representation;
    prop_name : STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT
          (('INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND
           ('INTEGRATED_CNC_SCHEMA.NUMERIC_MEASURE'
            IN TYPEOF(it.value_component))))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_time_measure_action_property (
    cad :       characterized_action_definition;
    prop_name : STRING
    ): LOGICAL;

    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; -- 10303-238: integrated_cnc_schema

FUNCTION verify_time_measure_rep_item (
    rep :       representation;
    prop_name : STRING
    ): LOGICAL;

    RETURN (0 = SIZEOF (QUERY ( it <* rep.items |
          (it.name = prop_name) AND NOT (SIZEOF([
           'INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
           'INTEGRATED_CNC_SCHEMA.TIME_MEASURE_WITH_UNIT'] *
            TYPEOF(it)) = 2))));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

FUNCTION verify_time_measure_resource_property (
    crd :       characterized_resource_definition;
    prop_name : STRING
    ): LOGICAL;

    RETURN (verify_rep_item_for_resource_property (crd, prop_name,
        ['INTEGRATED_CNC_SCHEMA.MEASURE_REPRESENTATION_ITEM',
         'INTEGRATED_CNC_SCHEMA.TIME_MEASURE_WITH_UNIT']));
END_FUNCTION; -- 10303-238: integrated_cnc_schema

END_SCHEMA; -- integrated_cnc_schema
```


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 name	Short name
ACTION	ACTION
ACTION_METHOD	ACTMTH
ACTION_METHOD_RELATIONSHIP	ACMTRL
ACTION_METHOD_WITH_ASSOCIATED_DOCUMENTS	AMWAD
ACTION_PROPERTY	ACTPRP
ACTION_PROPERTY_REPRESENTATION	ACPRRP
ACTION_RELATIONSHIP	ACTRLT
ACTION_RESOURCE	ACTRSR
ACTION_RESOURCE_RELATIONSHIP	ACRSRL
ACTION_RESOURCE_REQUIREMENT	ACRSRQ
ACTION_RESOURCE_REQUIREMENT_RELATIONSHIP	ARRR
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
APPLICATION_PROTOCOL_DEFINITION	APPRDF
APPLIED_APPROVAL_ASSIGNMENT	APAPAS
APPLIED_AREA	APPAR
APPLIED_CLASSIFICATION_ASSIGNMENT	APCLAS
APPLIED_DATE_AND_TIME_ASSIGNMENT	ADATA
APPLIED_DATE_ASSIGNMENT	APDTAS
APPLIED_DOCUMENT_REFERENCE	APDCRF
APPLIED_DOCUMENT_USAGE_CONSTRAINT_ASSIGNMENT	ADUCA
APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT	AEIA
APPLIED_IDENTIFICATION_ASSIGNMENT	APIDAS
APPLIED_ORGANIZATION_ASSIGNMENT	APORAS
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_RELATIONSHIP	APPRLT
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
BACK_BORING_OPERATION	BCBROP
BEZIER_CURVE	BZRCRV
BEZIER_SURFACE	BZRSRF
BINARY_BOOLEAN_EXPRESSION	BNBLEX
BINARY_GENERIC_EXPRESSION	BNGNEX
BLOCK	BLOCK
BLOCK_SHAPE_REPRESENTATION	BLSHRP
BOOLEAN_EXPRESSION	BLNEXP
BORING_OPERATION	BRNOPR
BOSS	BOSS
BOSS_TOP	BSSTP
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
CIRCULAR_PATTERN	CRCPTT
CIRCULAR_RUNOUT_TOLERANCE	CRRNTL
CLASS	CLASS
CLASSIFICATION_ASSIGNMENT	CLSASS
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
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_EDGE_SET	CNEDST

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
CONNECTED_FACE_SET	CNFCST
CONTEXT_DEPENDENT_SHAPE_REPRESENTATION	CDSR
CONTEXT_DEPENDENT_UNIT	CNDPUN
CONTOURING_TURNING_OPERATION	CNTROP
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_ASSIGNMENT	DTASS
DATE_ROLE	DTRL
DATE_TIME_ROLE	DTTMRL
DATUM	DATUM
DATUM_FEATURE	DTMFTR
DATUM_REFERENCE	DTMRFR
DATUM_TARGET	DTMTRG
DEFINITIONAL_REPRESENTATION	DFNRPR
DEGENERATE_PCURVE	DGNPCR
DEGENERATE_TOROIDAL_SURFACE	DGTRSR
DERIVED_SHAPE_ASPECT	DRSHAS
DERIVED_UNIT	DRVUNT

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
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
DIRECTED_DIMENSIONAL_LOCATION	DRDMLC
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
DOCUMENT_WITH_CLASS	DCWTCL
DRILLING_OPERATION	DRLOPR
DRILLING_TYPE_OPERATION	DRTYOP
DRILLING_TYPE_STRATEGY	DRTYST
EDGE	EDGE
EDGE_BASED_WIREFRAME_MODEL	EBWM
EDGE_BASED_WIREFRAME_SHAPE_REPRESENTATION	EBWSR

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
EDGE_CURVE	EDGCRV
EDGE_LOOP	EDGLP
EDGE_ROUND	EDGRND
ELEMENTARY_SURFACE	ELMSRF
ELLIPSE	ELLPS
ENVIRONMENT	ENVRNM
EVALUATED_DEGENERATE_PCURVE	EVDGPC
EXPANDED_UNCERTAINTY	EXPUNC
EXPRESSION	EXPRSS
EXPRESSION_REPRESENTATION_ITEM	EXRPIT
EXTENSION	EXTNSN
EXTERNAL_IDENTIFICATION_ASSIGNMENT	EXIDAS
EXTERNAL_SOURCE	EXTSRC
EXTERNALLY_DEFINED_CLASS	EXD0
EXTERNALLY_DEFINED_DIMENSION_DEFINITION	EDDD
EXTERNALLY_DEFINED_FEATURE_DEFINITION	EDFD
EXTERNALLY_DEFINED_GENERAL_PROPERTY	EDGP
EXTERNALLY_DEFINED_ITEM	EXDFIT
EXTERNALLY_DEFINED_ITEM_RELATIONSHIP	EDIR
EXTERNALLY_DEFINED_REPRESENTATION_WITH_PARAMETERS	EDRWP
FACE	FACE
FACE_BASED_SURFACE_MODEL	FBSM
FACE_BOUND	FCBND
FACE_OUTER_BOUND	FCOTBN
FACE_SHAPE_REPRESENTATION	FCSHRP
FACE_SURFACE	FCSRF
FACETED_BREP	FCTBR
FACETED_BREP_SHAPE_REPRESENTATION	FBSR

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
FACING_TURNING_OPERATION	FCTROP
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
FUNCTIONALLY_DEFINED_TRANSFORMATION	FNDFTR
GEAR	GEAR
GENERAL_PROPERTY	GNRPRP
GENERAL_PROPERTY_ASSOCIATION	GNPRAS
GENERIC_EXPRESSION	GNREXP
GENERIC_LITERAL	GNRLTR
GENERIC_VARIABLE	GNRVRB
GEOMETRIC_ALIGNMENT	GMTALG
GEOMETRIC_CURVE_SET	GMCRST
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
GEOMETRIC_TOLERANCE_WITH_DEFINED_UNIT	GTWDU
GEOMETRICALLY_BOUNDED_SURFACE_SHAPE_REPRESENTATION	GBSSR
GEOMETRICALLY_BOUNDED_WIREFRAME_SHAPE_-REPRESENTATION	GBWSR
GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT	GC
GLOBAL_UNIT_ASSIGNED_CONTEXT	GUAC
GROOVING_TURNING_OPERATION	GRTROP
GROUP	GROUP
HOLE_BOTTOM	HLBTT
HYPERBOLA	HYPRBL
ID_ATTRIBUTE	IDATT
IDENTIFICATION_ASSIGNMENT	IDNASS
IDENTIFICATION_ROLE	IDNRL
INSTANCED_FEATURE	INSFTR
INT_LITERAL	INTLTR
INT_NUMERIC_VARIABLE	INNMVR
INTERSECTION_CURVE	INTCRV
ITEM_DEFINED_TRANSFORMATION	ITDFTR
KNOWN_SOURCE	KNWSRC
KNURLING_TURNING_OPERATION	KNTROP
LENGTH_MEASURE_WITH_UNIT	LMWU
LENGTH_UNIT	LNGUNT
LIMITS_AND_FITS	LMANFT
LINE	LINE
LINE_PROFILE_TOLERANCE	LNP0
LINEAR_PROFILE	LNRPRF
LITERAL_NUMBER	LTRNMB
LOCAL_TIME	LCLTM

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
LOCATION_SHAPE_REPRESENTATION	LCSHRP
LOOP	LOOP
MACHINING_ADAPTIVE_CONTROL_RELATIONSHIP	MACR
MACHINING_APPROACH_RETRACT_STRATEGY	MARS
MACHINING_CUTTING_COMPONENT	MCCTCM
MACHINING_CUTTING_CORNER_REPRESENTATION	MCCR
MACHINING_DWELL_TIME_REPRESENTATION	MDTR
MACHINING_EXECUTION_RESOURCE	MCEXRS
MACHINING_FEATURE_PROCESS	MCFTPR
MACHINING_FEATURE_RELATIONSHIP	MCFTRL
MACHINING_FEATURE_SEQUENCE_RELATIONSHIP	MFSR
MACHINING_FEED_SPEED_REPRESENTATION	MFS0
MACHINING_FINAL_FEATURE_RELATIONSHIP	MFF0
MACHINING_FUNCTIONS	MCHFNC
MACHINING_FUNCTIONS_RELATIONSHIP	MCFNRL
MACHINING_NC_FUNCTION	MCNCFN
MACHINING_OFFSET_VECTOR_REPRESENTATION	MOVR
MACHINING_OPERATION	MCHOPR
MACHINING_OPERATION_RELATIONSHIP	MCOPRL
MACHINING_OPERATOR_INSTRUCTION	MCOPIN
MACHINING_OPERATOR_INSTRUCTION_RELATIONSHIP	MOI0
MACHINING_PROCESS_BODY_RELATIONSHIP	MPBR
MACHINING_PROCESS_BRANCH_RELATIONSHIP	MPB0
MACHINING_PROCESS_CONCURRENT_RELATIONSHIP	MPCR
MACHINING_PROCESS_EXECUTABLE	MCPREX
MACHINING_PROCESS_MODEL	MCPRMD
MACHINING_PROCESS_MODEL_RELATIONSHIP	MPMR
MACHINING_PROCESS_SEQUENCE_RELATIONSHIP	MPSR

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
MACHINING_PROJECT	MCHPRJ
MACHINING_PROJECT_WORKPIECE_RELATIONSHIP	MPWR
MACHINING_RAPID_MOVEMENT	MCRPMV
MACHINING_SETUP	MCH1
MACHINING_SETUP_WORKPIECE_RELATIONSHIP	MSW0
MACHINING_SPINDLE_SPEED_REPRESENTATION	MSS0
MACHINING_STRATEGY	MCHSTR
MACHINING_STRATEGY_RELATIONSHIP	MCSTRL
MACHINING_TECHNOLOGY	MCHTCH
MACHINING_TECHNOLOGY_RELATIONSHIP	MCTCRL
MACHINING_TOOL	MCHTL
MACHINING_TOOL_BODY_REPRESENTATION	MTBR
MACHINING_TOOL_DIRECTION_REPRESENTATION	MTD0
MACHINING_TOOL_USAGE	MCTLUS
MACHINING_TOOLPATH	MCHTLP
MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP	MTSR
MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION	MTSPR
MACHINING_TOUCH_PROBING	MCTCPR
MACHINING_WORKINGSTEP	MCHWRK
MACHINING_WORKPLAN	MCH0
MAKE_FROM_USAGE_OPTION	MFUO
MANIFOLD_SOLID_BREP	MNSLBR
MANIFOLD_SURFACE_SHAPE_REPRESENTATION	MSSR
MAPPED_ITEM	MPPITM
MARKING	MRKNG
MASS_MEASURE_WITH_UNIT	MMWU
MASS_UNIT	MSSUNT
MATERIAL_DESIGNATION	MTRDSG

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
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
NAME_ATTRIBUTE	NMATT
NAMED_UNIT	NMDUNT
NEXT_ASSEMBLY_USAGE_OCCURRENCE	NAUO
NGON_CLOSED_PROFILE	NGCLPR
NGON_SHAPE_REPRESENTATION	NGSHRP
NON_MANIFOLD_SURFACE_SHAPE_REPRESENTATION	NMSSR
NOT_EXPRESSION	NTEXP
NUMERIC_EXPRESSION	NMREXP
NUMERIC_VARIABLE	NMRVRB
OBJECT_ROLE	OBJRL
OFFSET_CURVE_3D	OFCR3D
OFFSET_SURFACE	OFFSRF
OPEN_PATH_PROFILE	OPPTPR
OPEN_SHELL	OPNSHL
OR_EXPRESSION	OREXP
ORDINAL_DATE	ORDDT

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
ORGANIZATION	ORGNZT
ORGANIZATION_ASSIGNMENT	ORGASS
ORGANIZATION_ROLE	ORGRL
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
PERSON_AND_ORGANIZATION_ROLE	PAOR
PERSONAL_ADDRESS	PRSADD
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
POINT_REPLICA	PNTRPL
POLY_LOOP	PLYLP
POLYLINE	PLYLN
POSITION_TOLERANCE	PSTTLR
PRE_DEFINED_ITEM	PRDFIT
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
PRODUCT_DEFINITION_CONTEXT	PRDFCN
PRODUCT_DEFINITION_FORMATION	PRDFFR
PRODUCT_DEFINITION_FORMATION_WITH_SPECIFIED_SOURCE	PDFWSS
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
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
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
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
SEAM_CURVE	SMCRV
SECURITY_CLASSIFICATION	SCRCLS
SECURITY_CLASSIFICATION_ASSIGNMENT	SCCLAS
SECURITY_CLASSIFICATION_LEVEL	SCCLLV
SEQUENTIAL_METHOD	SQNMTH
SERIAL_ACTION_METHOD	SRACMT
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
SHAPE_REPRESENTATION_WITH_PARAMETERS	SRWP
SHELL_BASED_SURFACE_MODEL	SBSM
SHELL_BASED_WIREFRAME_MODEL	SBWM
SHELL_BASED_WIREFRAME_SHAPE_REPRESENTATION	SBWSR
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

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
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
TEE_PROFILE	TPRF
THREAD	THREAD
THREAD_RUNOUT	THRRNT
THREADING_TURNING_OPERATION	THTROP
TIME_MEASURE_WITH_UNIT	TMWU
TIME_UNIT	TMUNT
TOLERANCE_VALUE	TLRVL
TOLERANCE_ZONE	TLRZN
TOLERANCE_ZONE_DEFINITION	TLZNDF

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
TOLERANCE_ZONE_FORM	TLZNFR
TOPOLOGICAL_REPRESENTATION_ITEM	TPRPIT
TOROIDAL_SURFACE	TRDSRF
TOTAL_RUNOUT_TOLERANCE	TTRNTL
TRANSITION_FEATURE	TRNFTR
TRIMMED_CURVE	TRMCRV
TURNED_KNURL	TRNKNR
TURNING_TYPE_OPERATION	TRTYOP
TURNING_TYPE_STRATEGY	TRTYST
TYPE_QUALIFIER	TYPQLF
UNARY_BOOLEAN_EXPRESSION	UNBLEX
UNARY_GENERIC_EXPRESSION	UNGNEX
UNCERTAINTY_MEASURE_WITH_UNIT	UMWU
UNCERTAINTY_QUALIFIER	UNCQLF
UNIFORM_CURVE	UNFCRV
UNIFORM_SURFACE	UNFSRF
VALUE_RANGE	VLRNG
VALUE_REPRESENTATION_ITEM	VLRPIT
VARIABLE	VRBL
VARIABLE_SEMANTICS	VRBSMN
VECTOR	VECTOR
VEE_PROFILE	VPRF
VERTEX	VERTEX
VERTEX_LOOP	VRTLP
VERTEX_POINT	VRTPNT
VERTEX_SHELL	VRTSHL
WEEK_OF_YEAR_AND_DAY_DATE	WOYADD
WIRE_SHELL	WRSHL

Table B.1 — AIM short names of entities (continued)

Entity name	Short name
XOR_EXPRESSION	XREXP

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’.

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 implementer and may be used in preparation for conformance testing by a testing laboratory. The completed PICS proforma is referred to as a PICS.

Question:

1. Please provide an identifier for the product or system for which conformance is claimed:

    Product name and current version number:______________________________

2. Please indicate the implementation method chosen:

    ISO 10303-21 exchange structure — preprocessor
    Preprocessor name and current version number:___________________________

    ISO 10303-21 exchange structure — postprocessor
    Postprocessor name and current version number:___________________________

3. This part of ISO 10303 defines four conformance classes. Each class is defined so as to include all the options specified by the preceeding class. Please indicate the highest numbered class for which conformance is claimed. Circle one:

    CC1: Tool path programming

    CC2: Closed-loop programming

    CC3: Feature-based programming

    CC4: Generative programming

4. If conformance to CC1: Tool path programming is claimed, answer the questions below.

    (a) Indicate which machining technologies are supported. Circle all that apply:

        milling
        turning

5. If conformance to CC2: Closed-loop programming is claimed, answer the questions below.

(a) Indicate which machining technologies are supported. Circle all that apply:

milling
turning

(b) Indicate which workpiece shape representations are supported. Circle all that apply:

advanced_brep_shape_representation
edge_based_wireframe_shape_representation
faceted_brep_shape_representation
geometrically_bounded_surface_shape_representation
geometrically_bounded_wireframe_shape_representation
manifold_surface_shape_representation
non_manifold_surface_shape_representation
shell_based_wireframe_shape_representation

6. If conformance to CC3: Feature-based programming is claimed, answer the questions below.

(a) Indicate which machining technologies are supported. Circle all that apply:

milling using 2.5D features only
milling using all features
turning using all features

(b) Indicate which workpiece shape representations are supported. Circle all that apply:

advanced_brep_shape_representation
edge_based_wireframe_shape_representation
faceted_brep_shape_representation
geometrically_bounded_surface_shape_representation
geometrically_bounded_wireframe_shape_representation
manifold_surface_shape_representation
non_manifold_surface_shape_representation
shell_based_wireframe_shape_representation

7. If conformance to CC4: Generative programming is claimed, answer the questions below.

(a) Indicate which machining technologies are supported. Circle all that apply:

milling using 2.5D features only
milling using all features
turning using all features

(b) Indicate which workpiece shape representations are supported. Circle all that apply:

advanced_brep_shape_representation
edge_based_wireframe_shape_representation

faceted_brep_shape_representation
geometrically_bounded_surface_shape_representation
geometrically_bounded_wireframe_shape_representation
manifold_surface_shape_representation
non_manifold_surface_shape_representation
shell_based_wireframe_shape_representation

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 integrated_cnc_schema in an open information system, the object identifiers are assigned as follows:

{ iso standard 10303 part(238) version(1) schema(1) integrated-cnc-schema(1) }

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

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 Annex B of ISO 14649-1.

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 clause 4, including the application objects referenced from ISO 14649 parts 10, 11, 12, 111 and 121. The graphical form of the application reference model is presented in EXPRESS-G. The application reference model is independent from any implementation method. EXPRESS-G is defined in Annex D of ISO 10303-11.

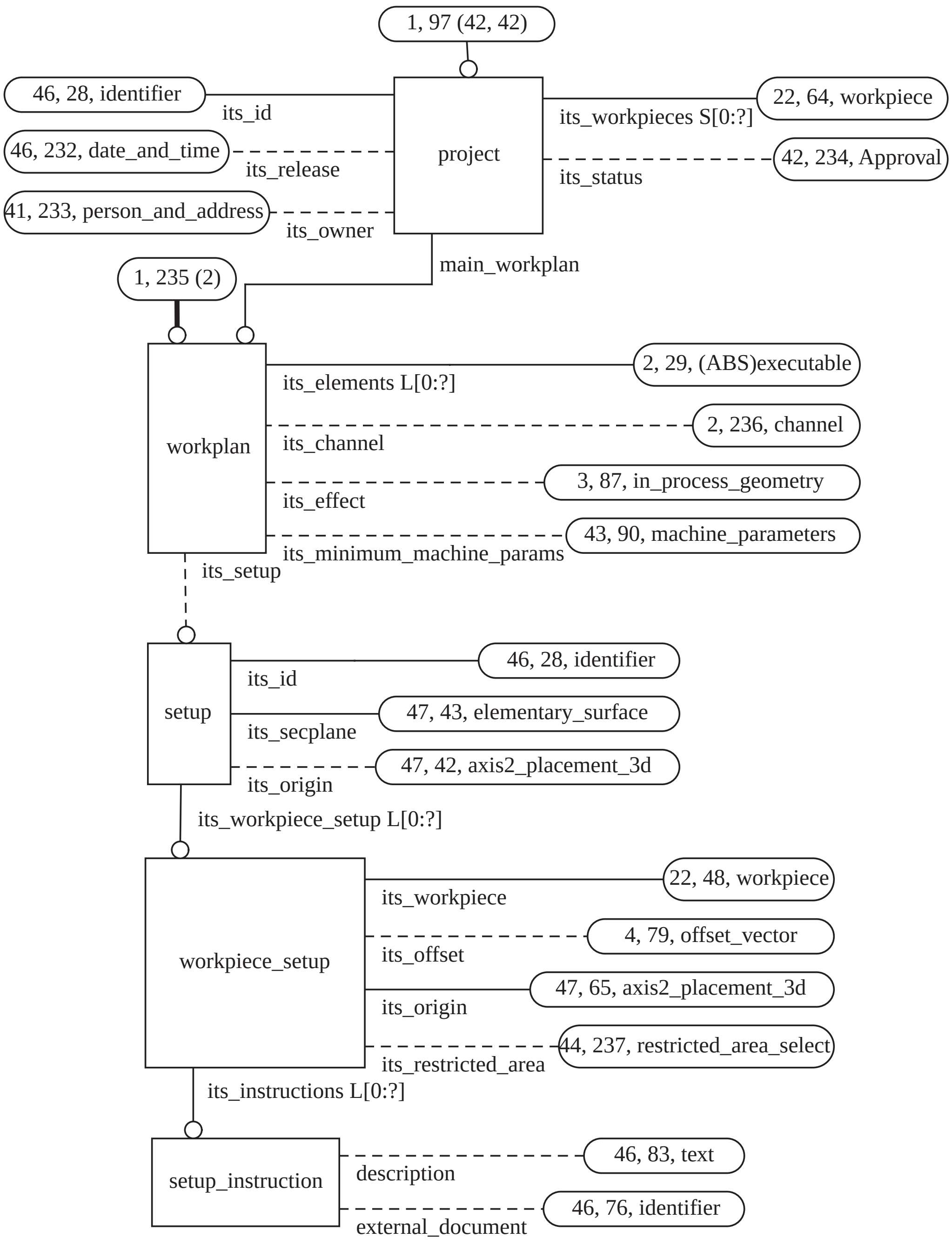


Figure G.1 — ARM diagram (1 of 48)

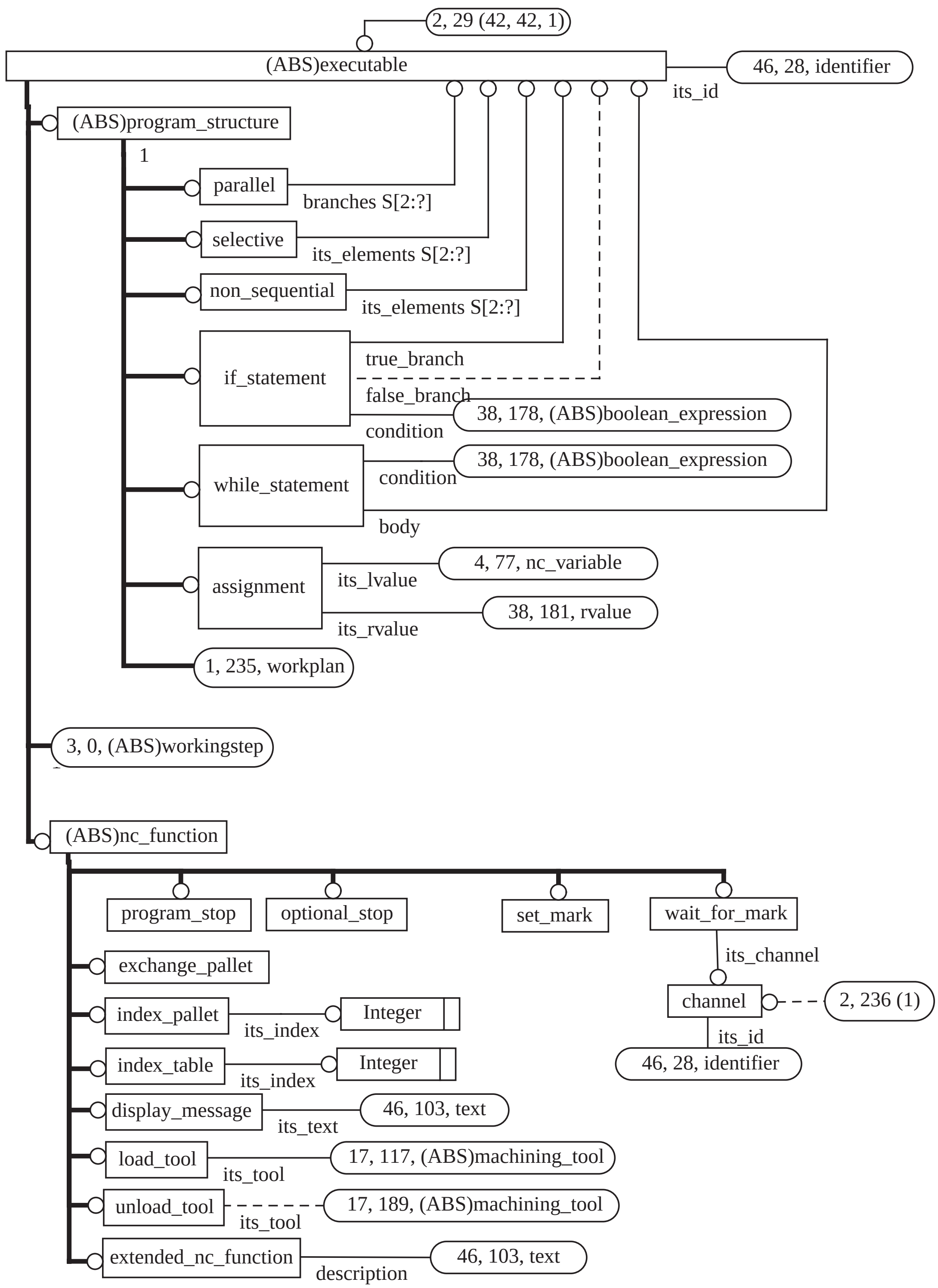


Figure G.2 — ARM diagram (2 of 48)

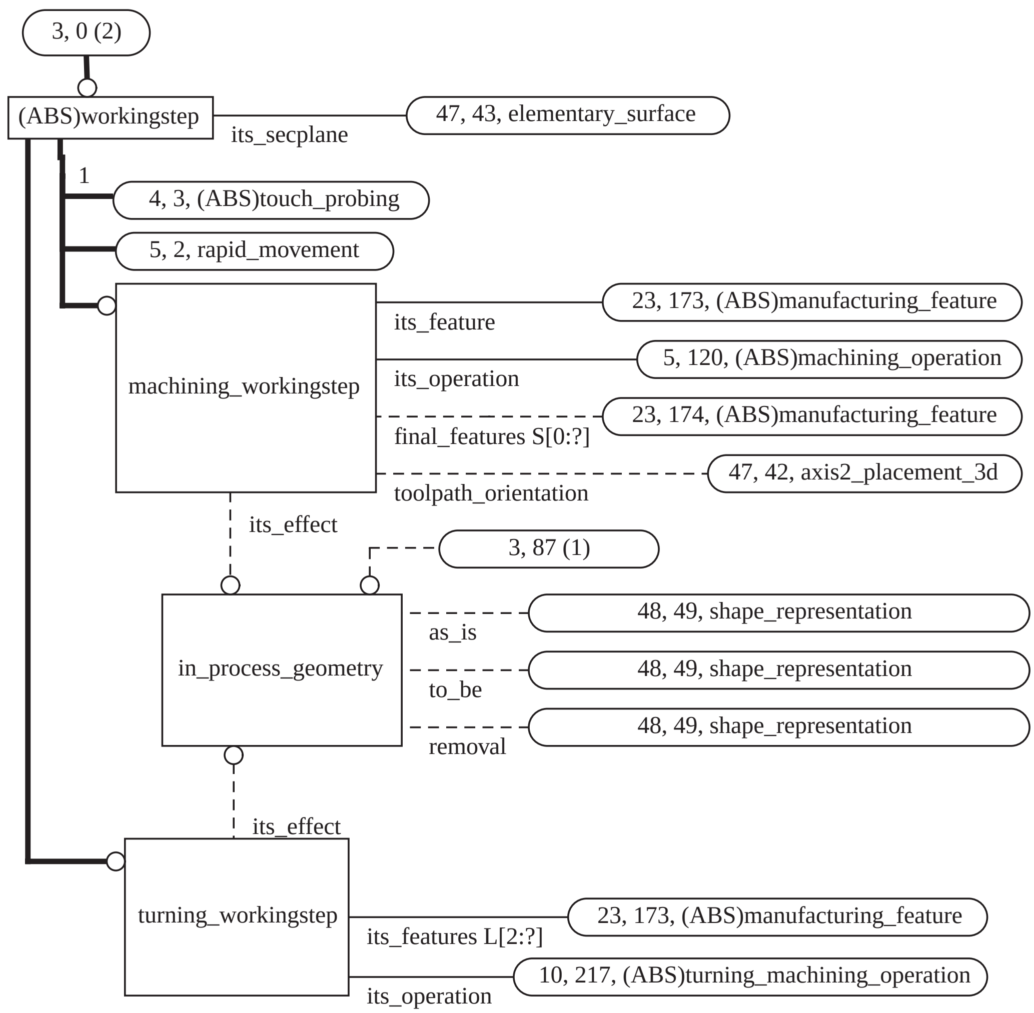


Figure G.3 — ARM diagram (3 of 48)

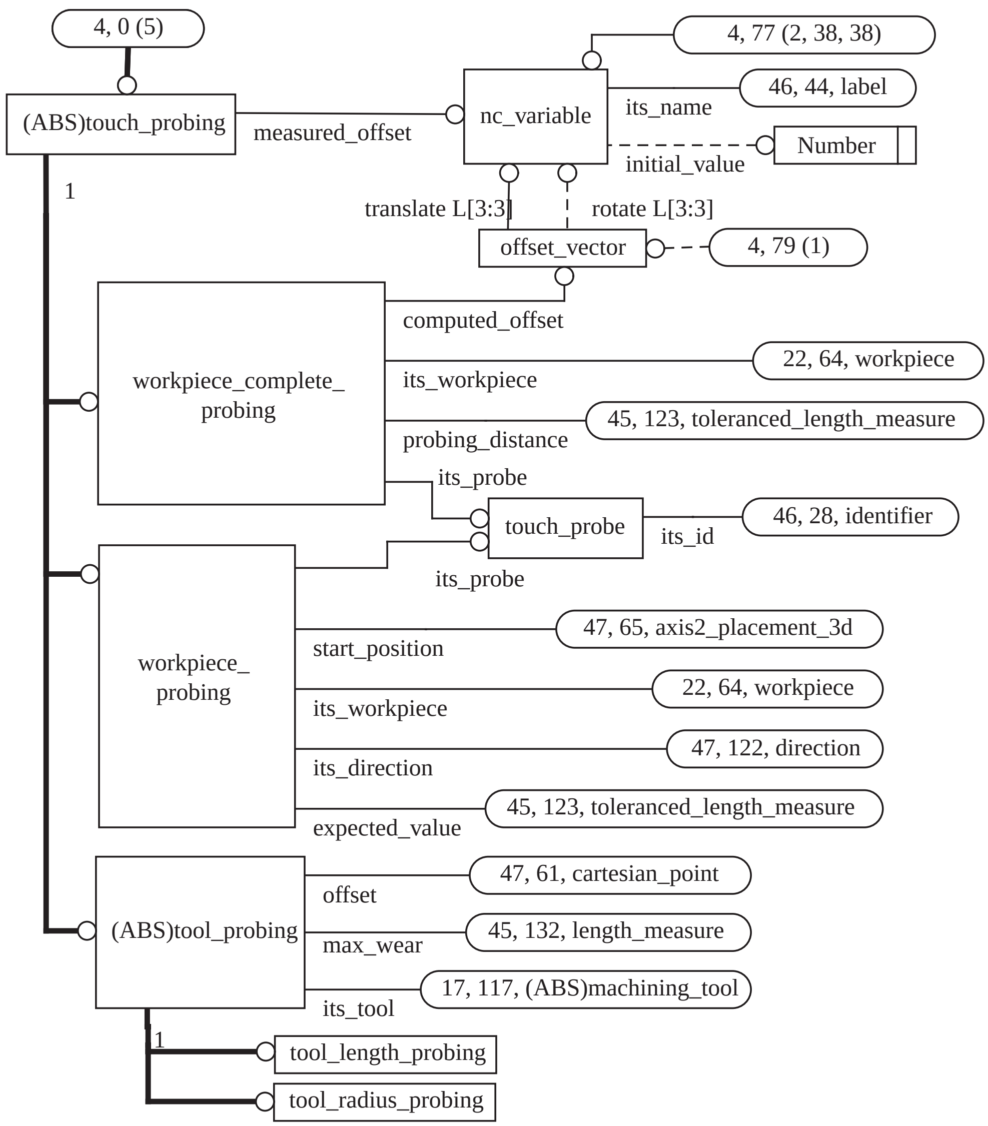


Figure G.4 — ARM diagram (4 of 48)

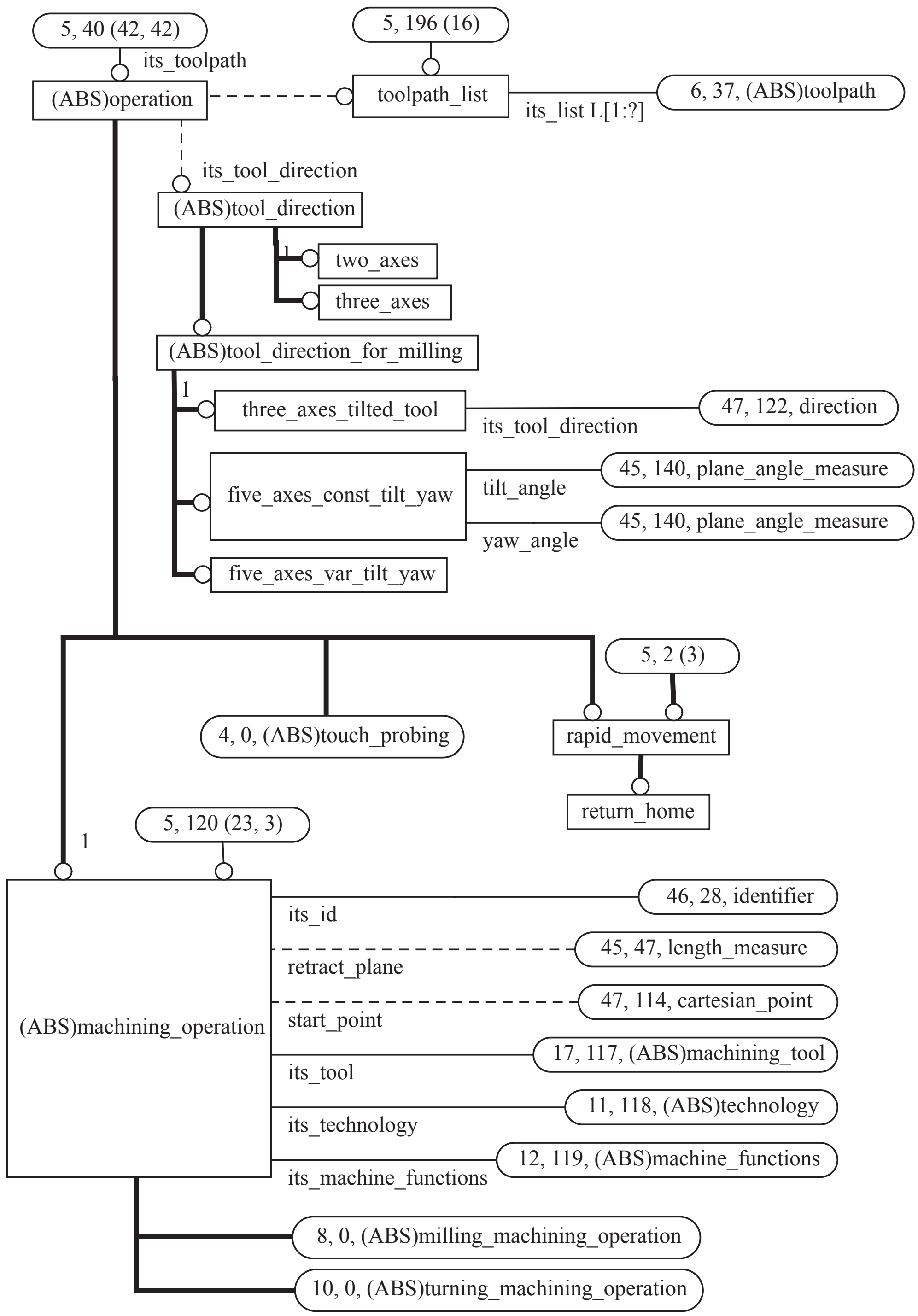


Figure G.5 — ARM diagram (5 of 48)

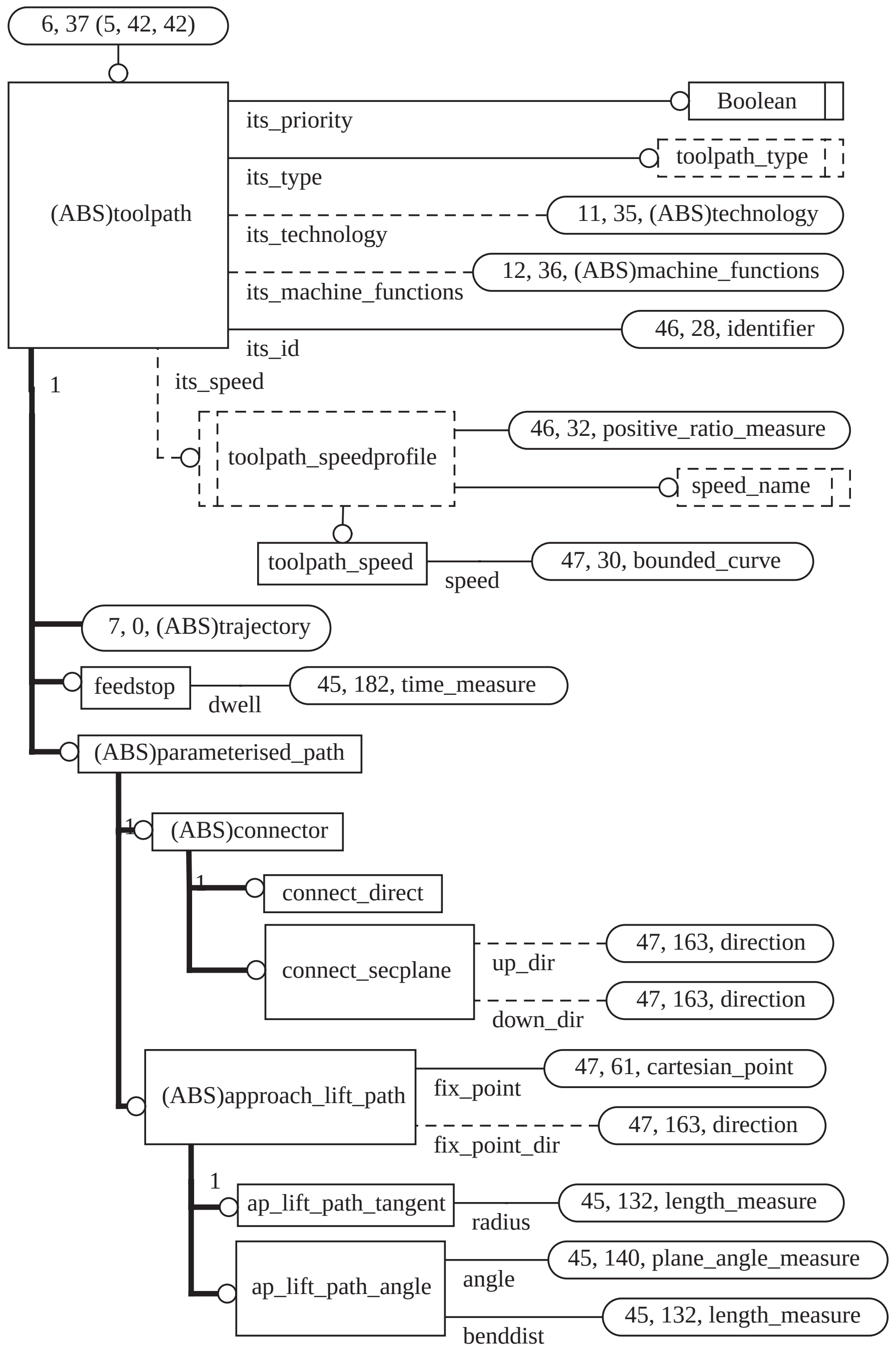


Figure G.6 — ARM diagram (6 of 48)

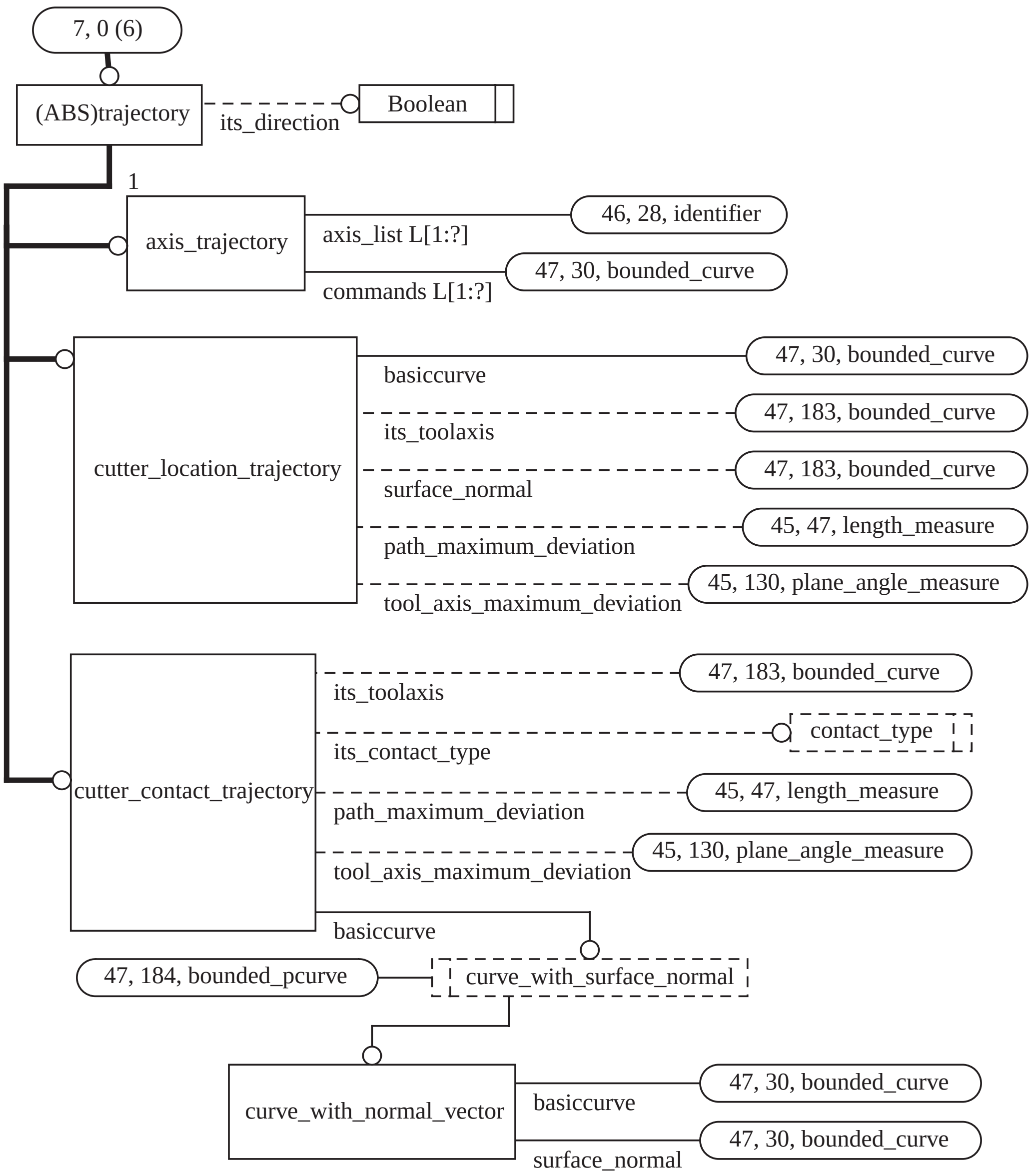


Figure G.7 — ARM diagram (7 of 48)

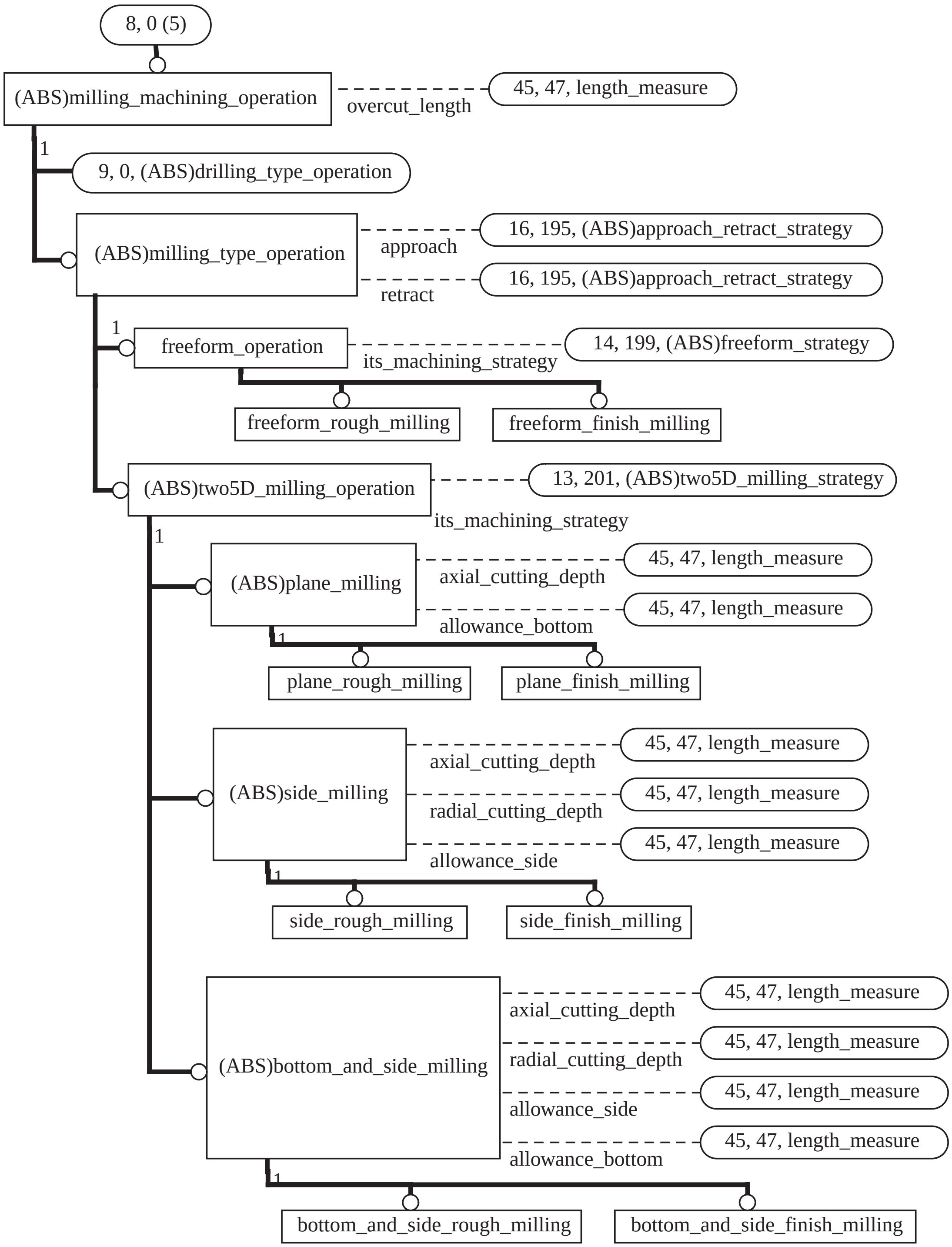


Figure G.8 — ARM diagram (8 of 48)

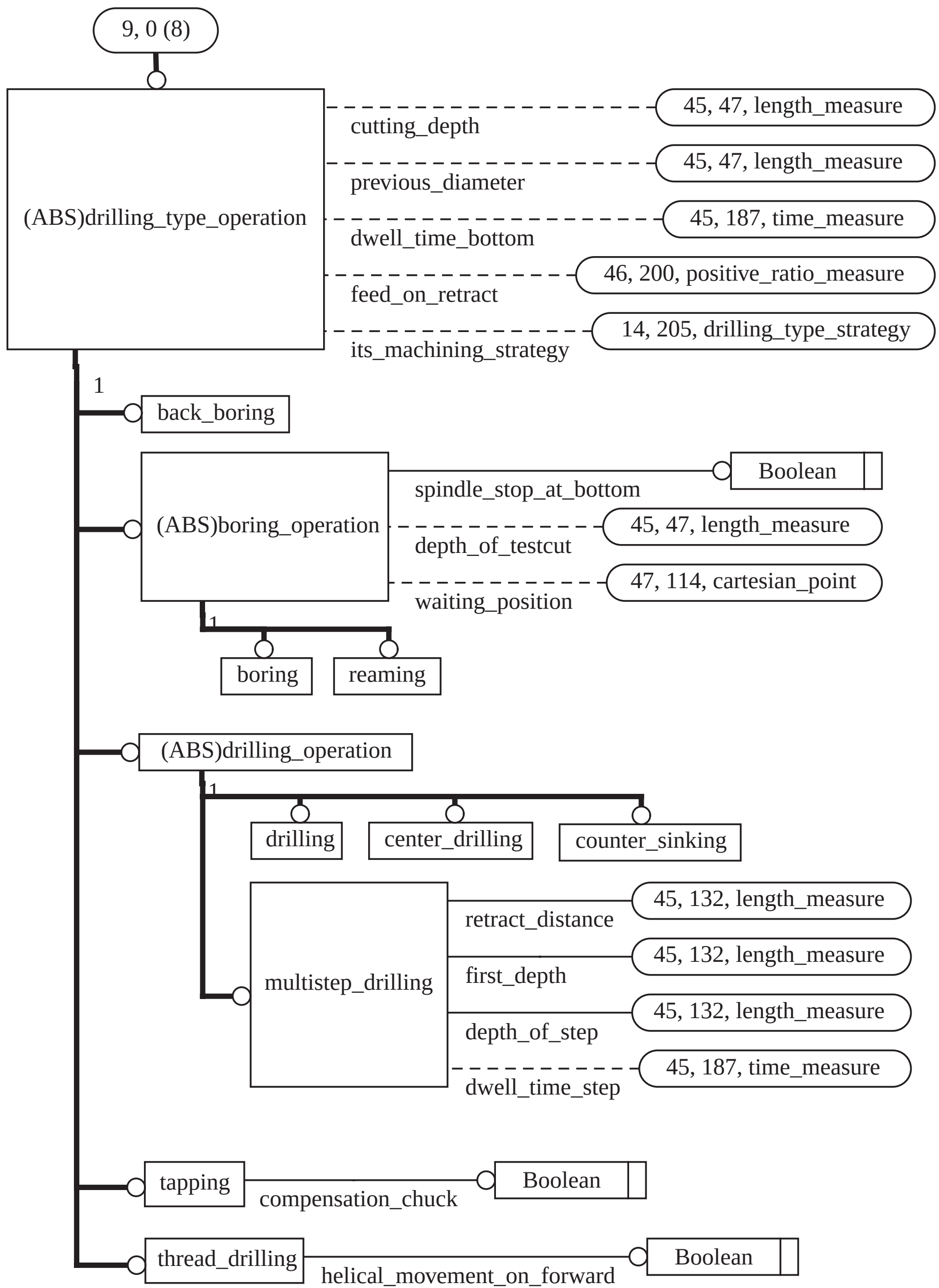


Figure G.9 — ARM diagram (9 of 48)

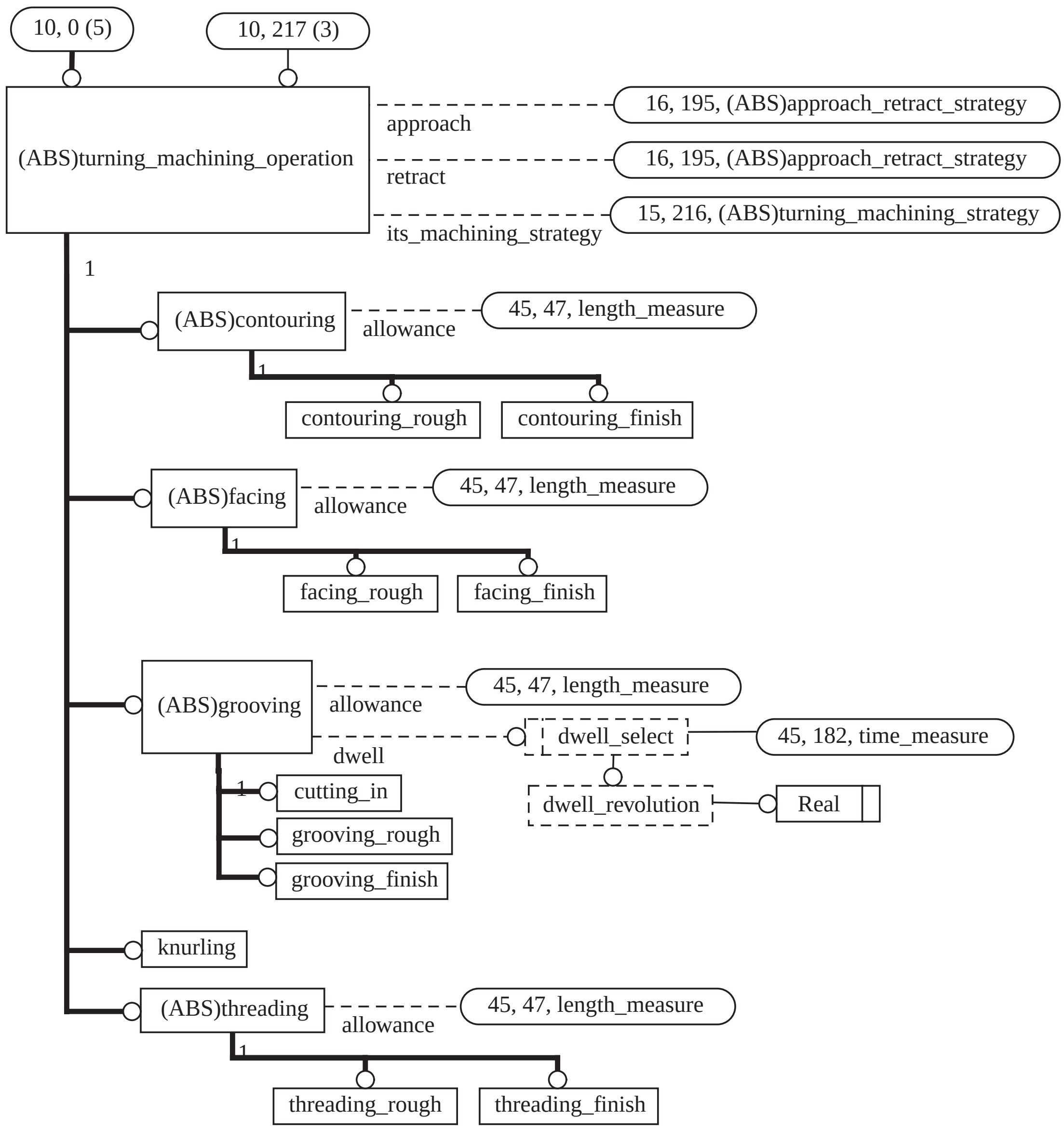


Figure G.10 — ARM diagram (10 of 48)

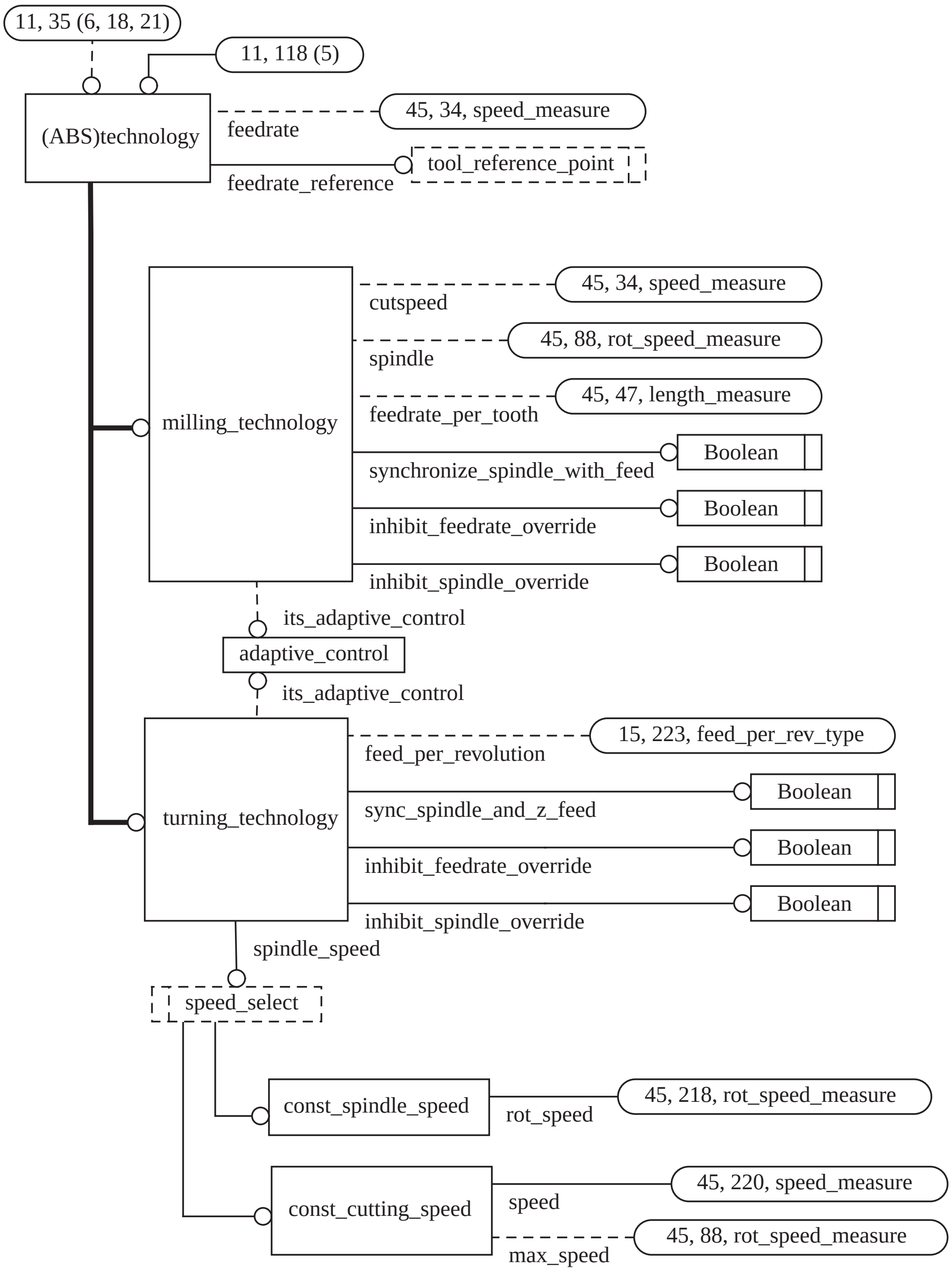


Figure G.11 — ARM diagram (11 of 48)

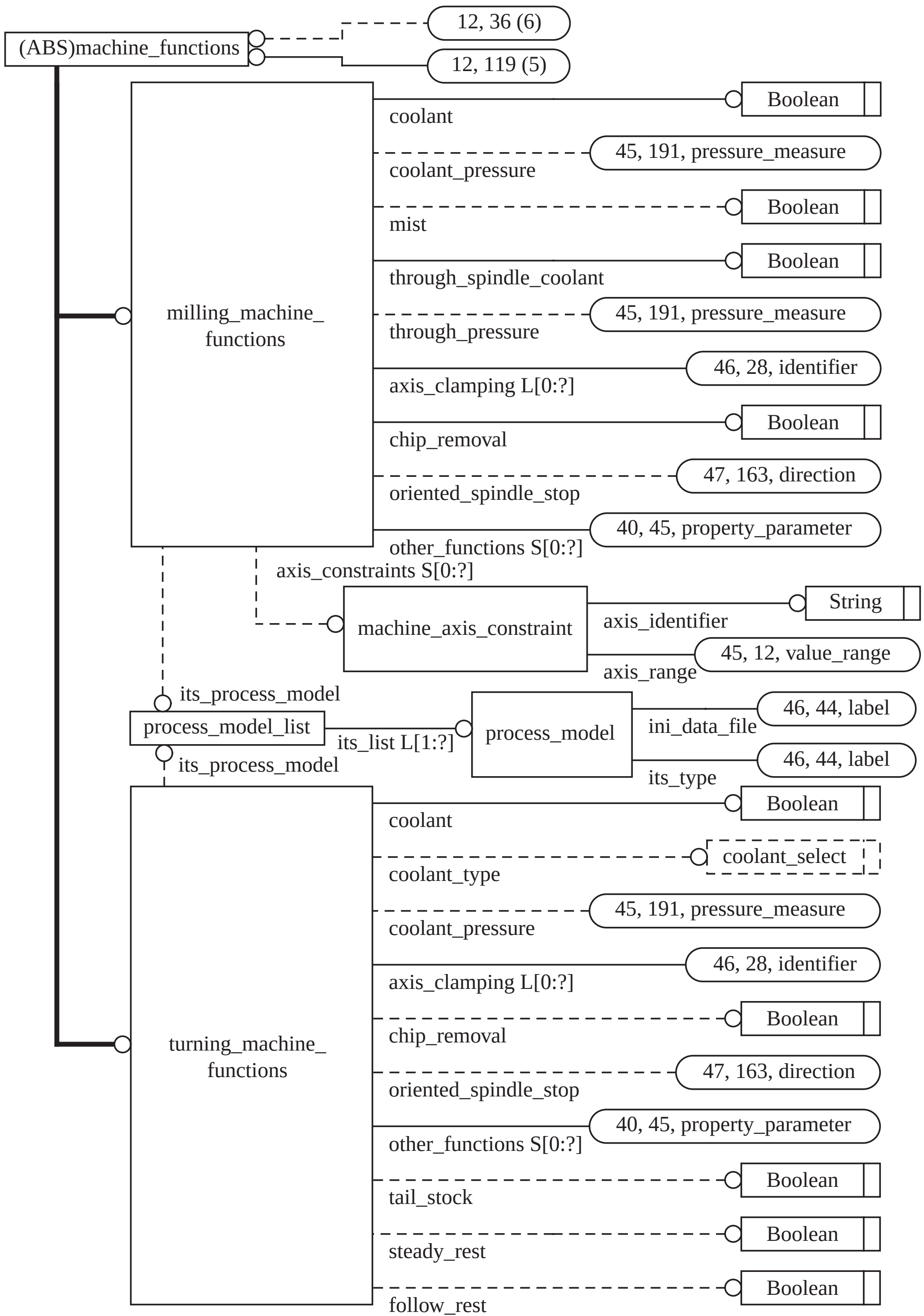


Figure G.12 — ARM diagram (12 of 48)

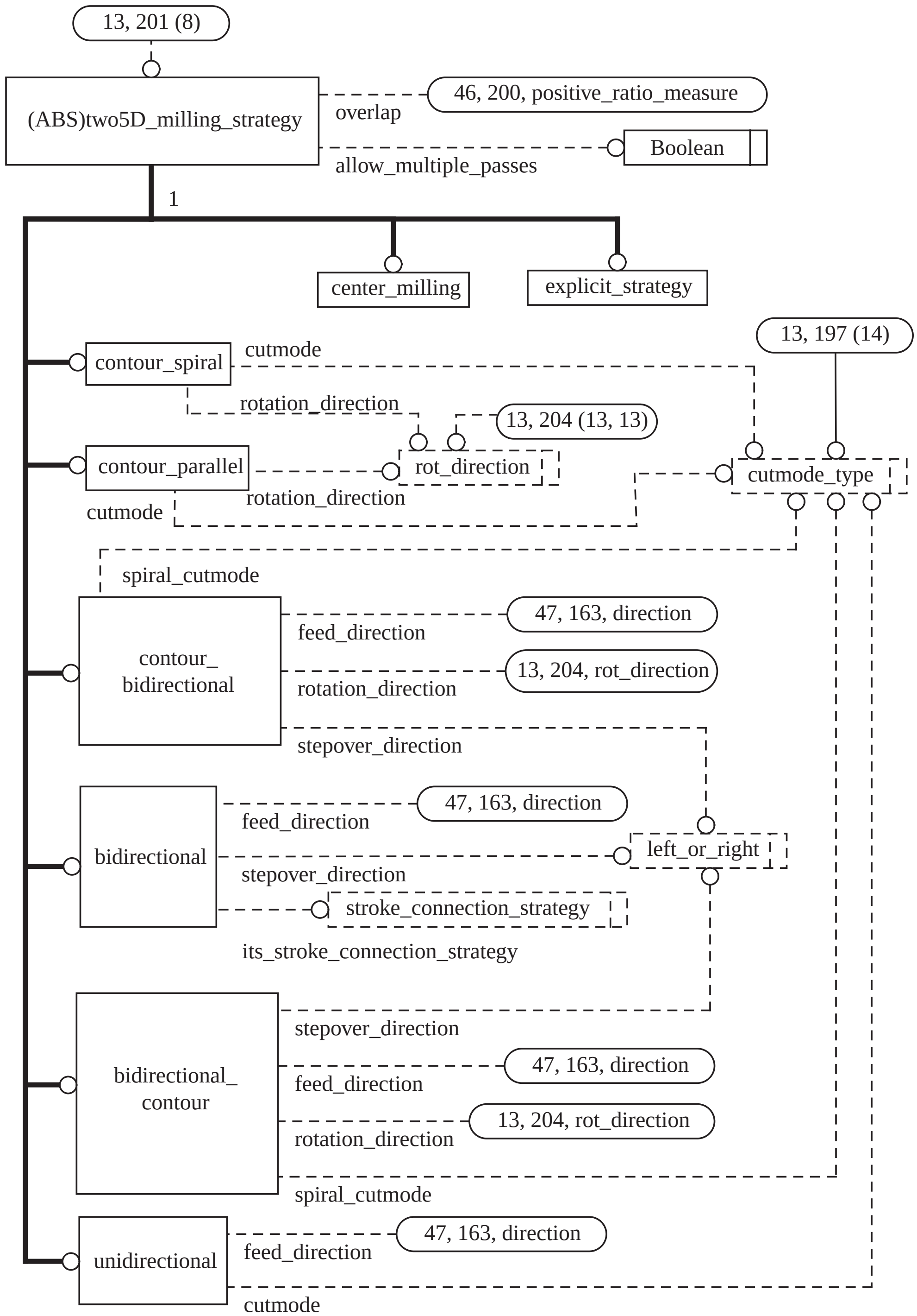


Figure G.13 — ARM diagram (13 of 48)

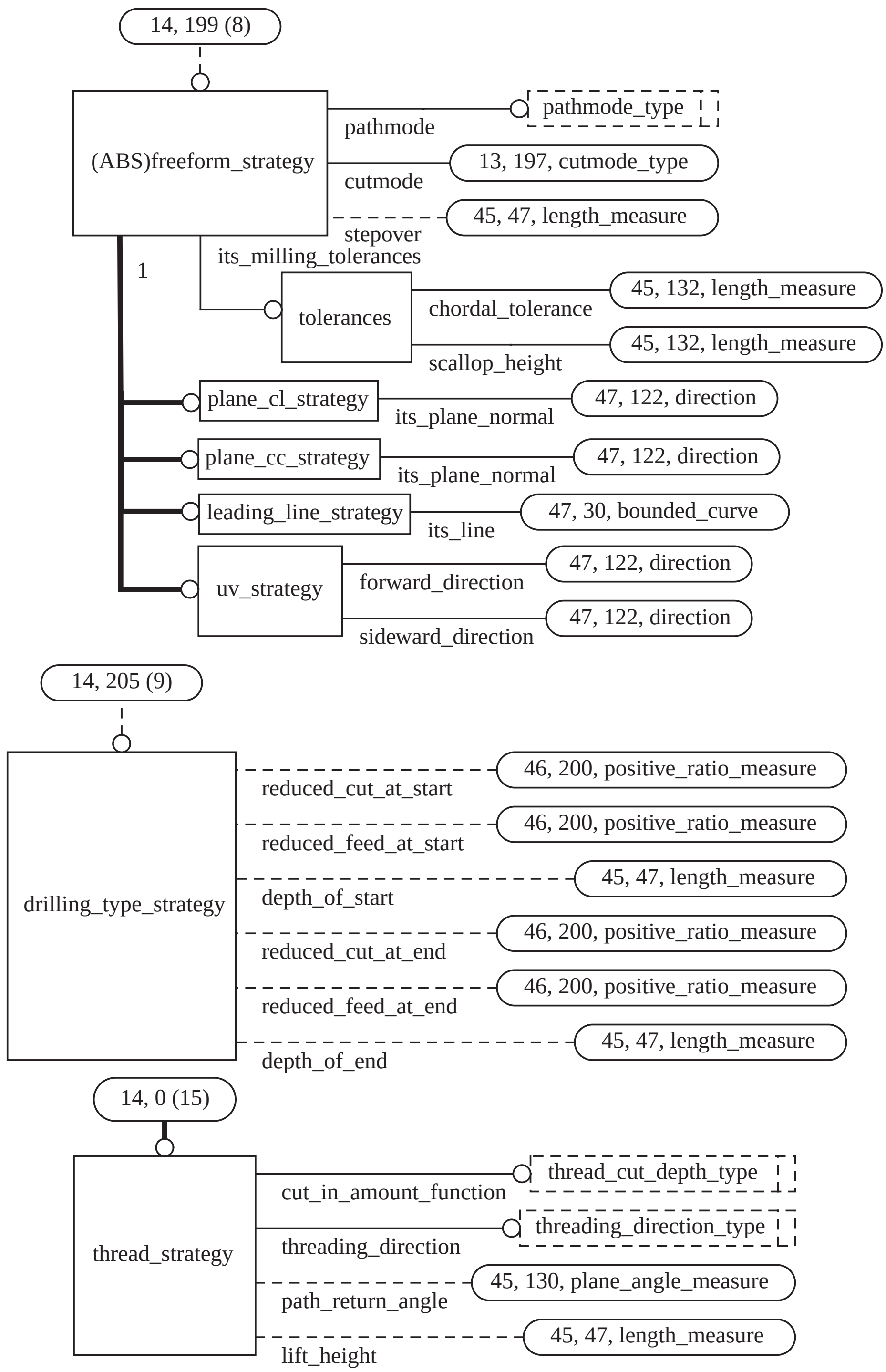


Figure G.14 — ARM diagram (14 of 48)

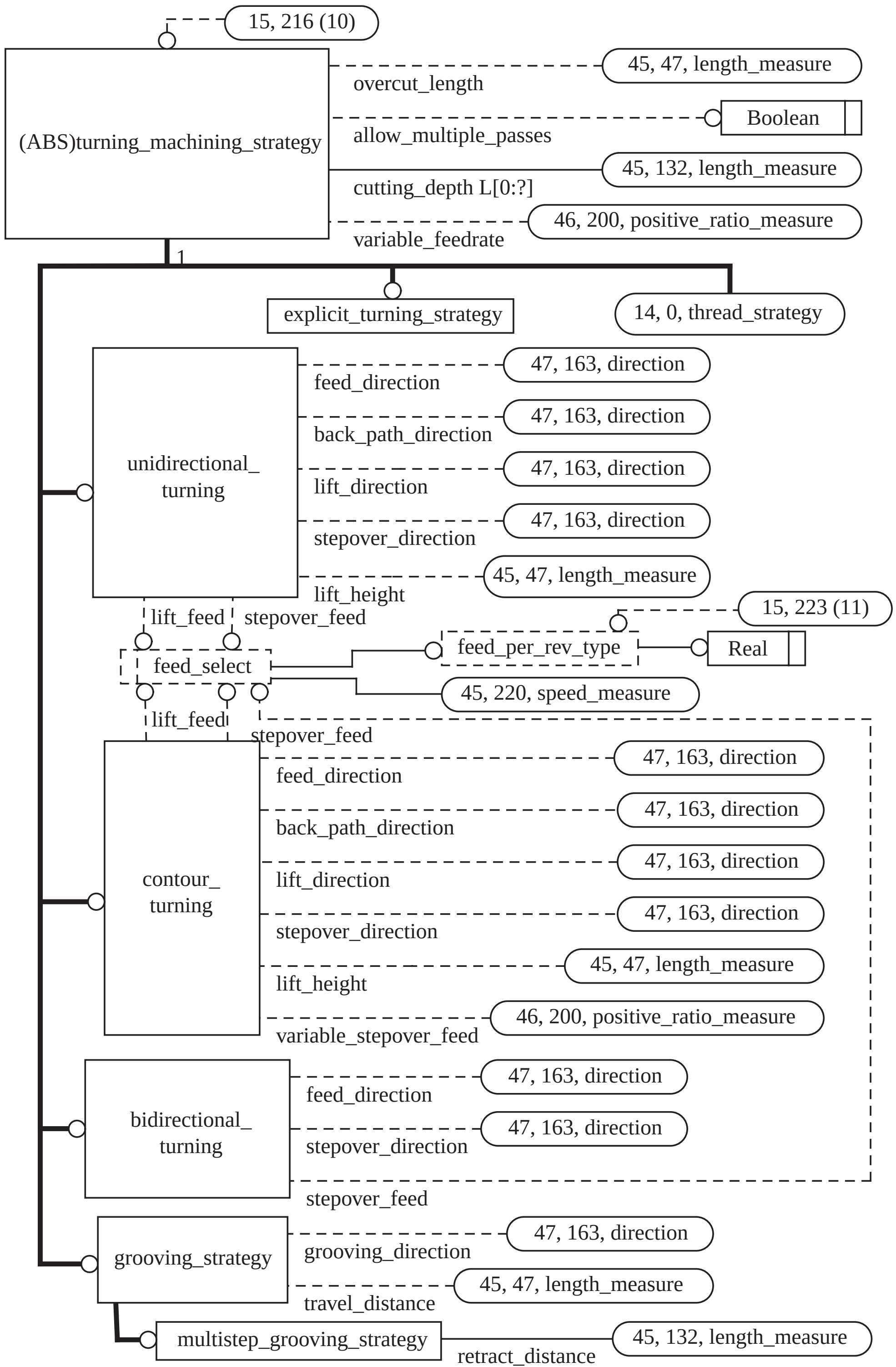


Figure G.15 — ARM diagram (15 of 48)

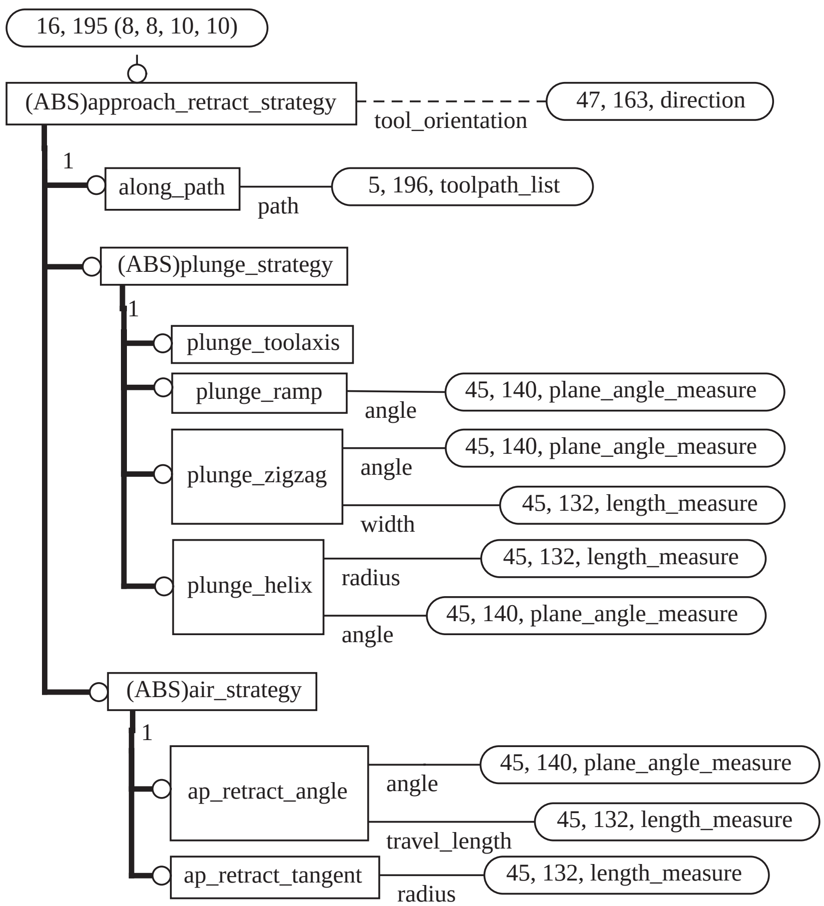


Figure G.16 — ARM diagram (16 of 48)

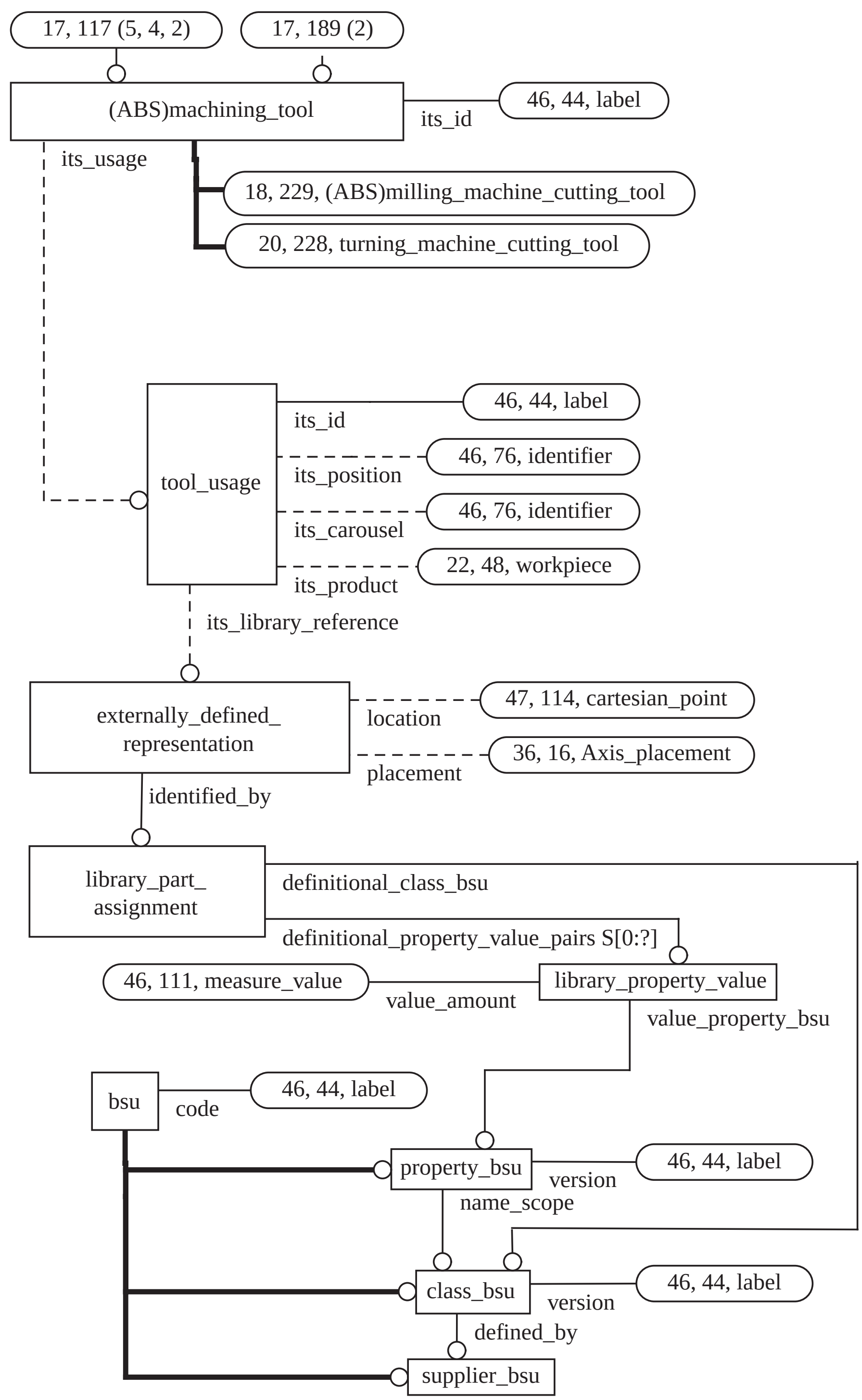


Figure G.17 — ARM diagram (17 of 48)

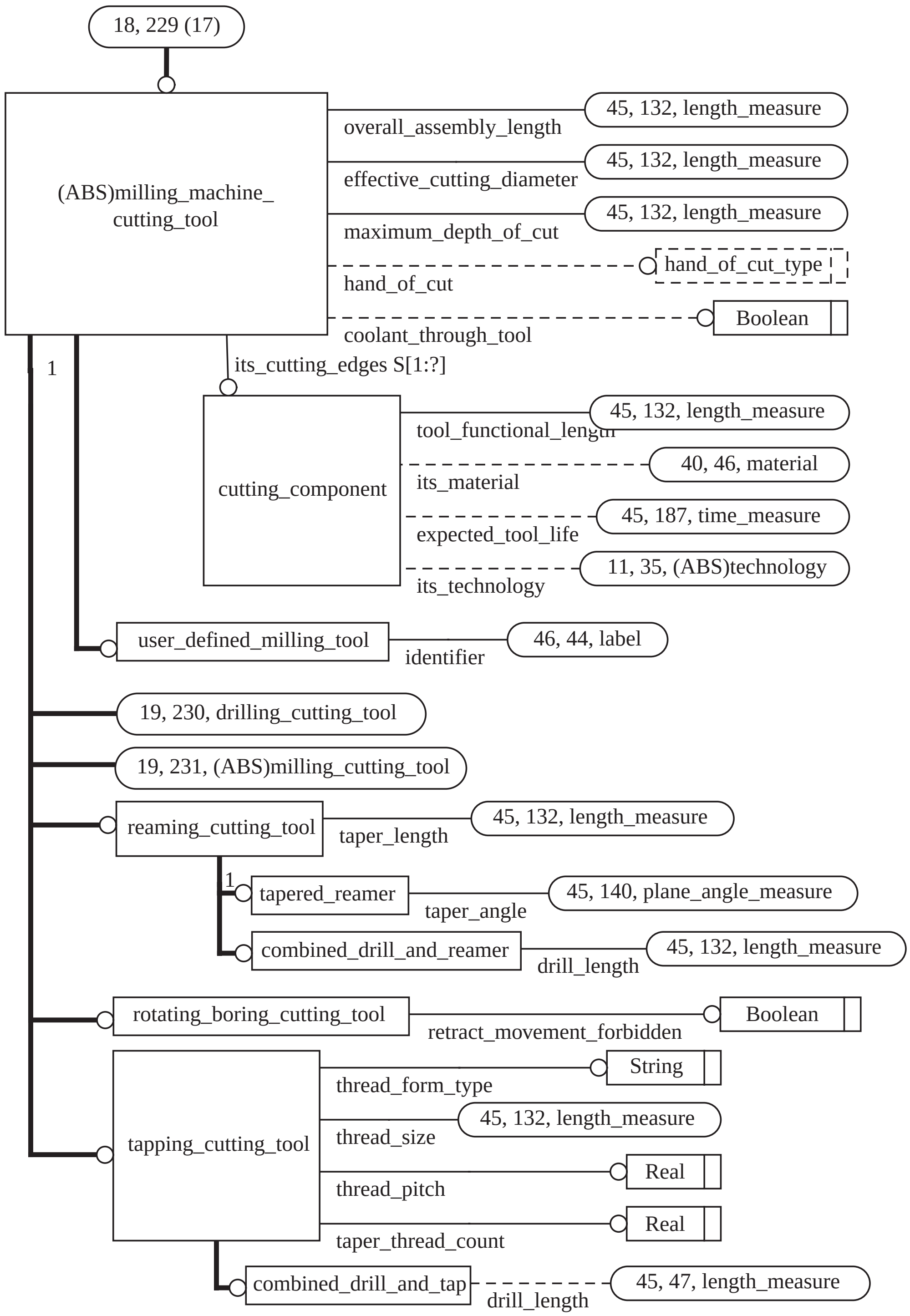


Figure G.18 — ARM diagram (18 of 48)

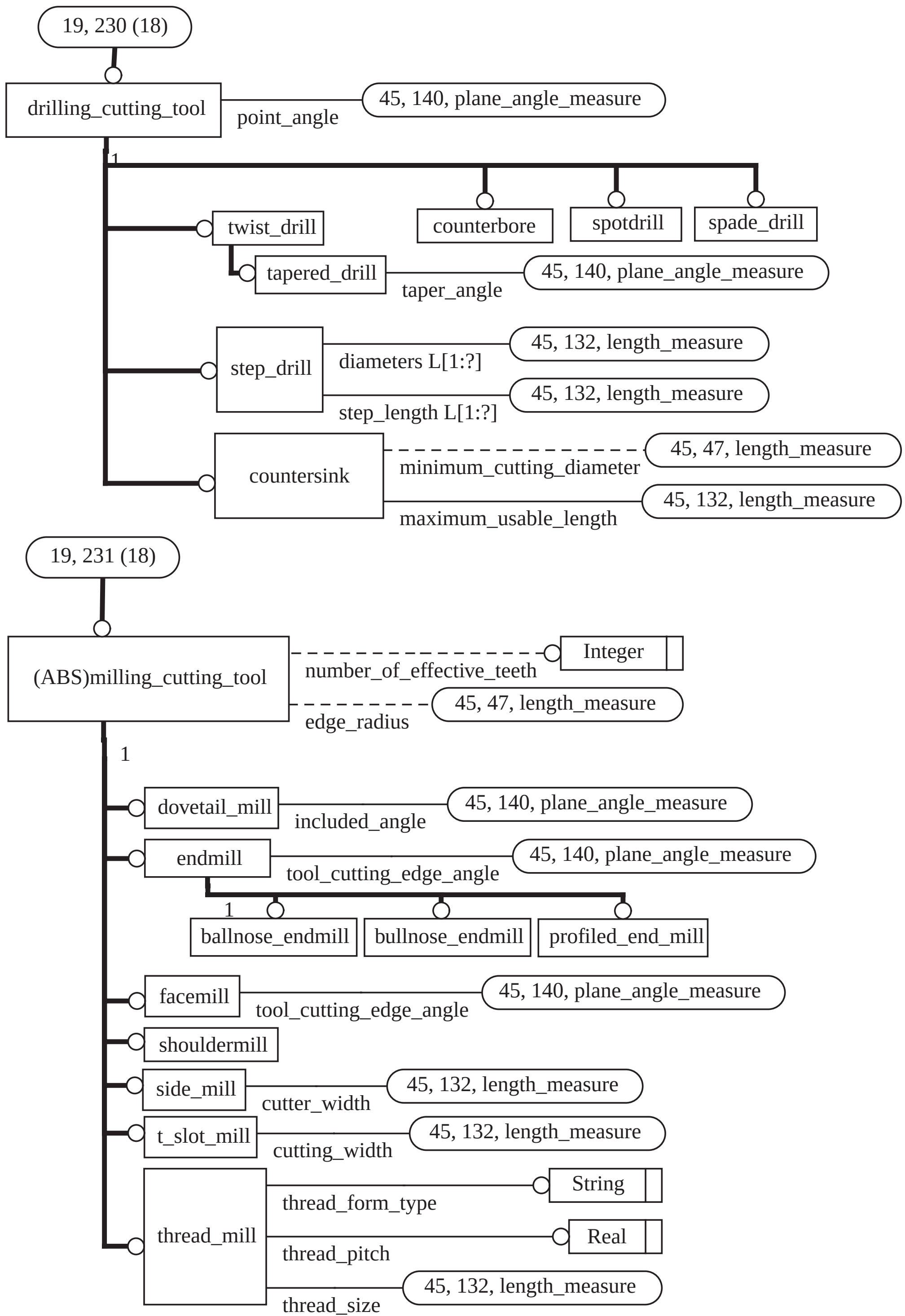


Figure G.19 — ARM diagram (19 of 48)

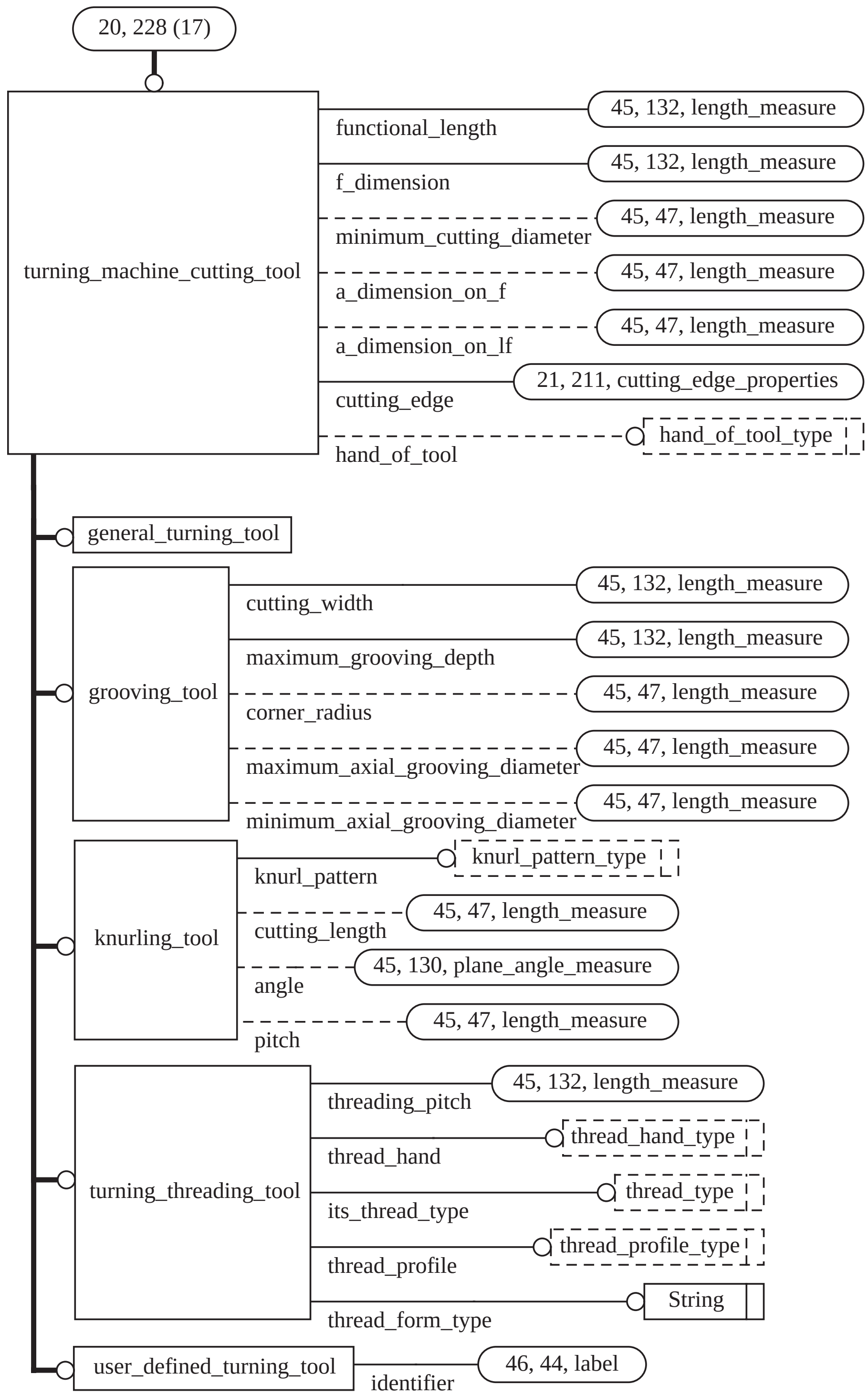


Figure G.20 — ARM diagram (20 of 48)

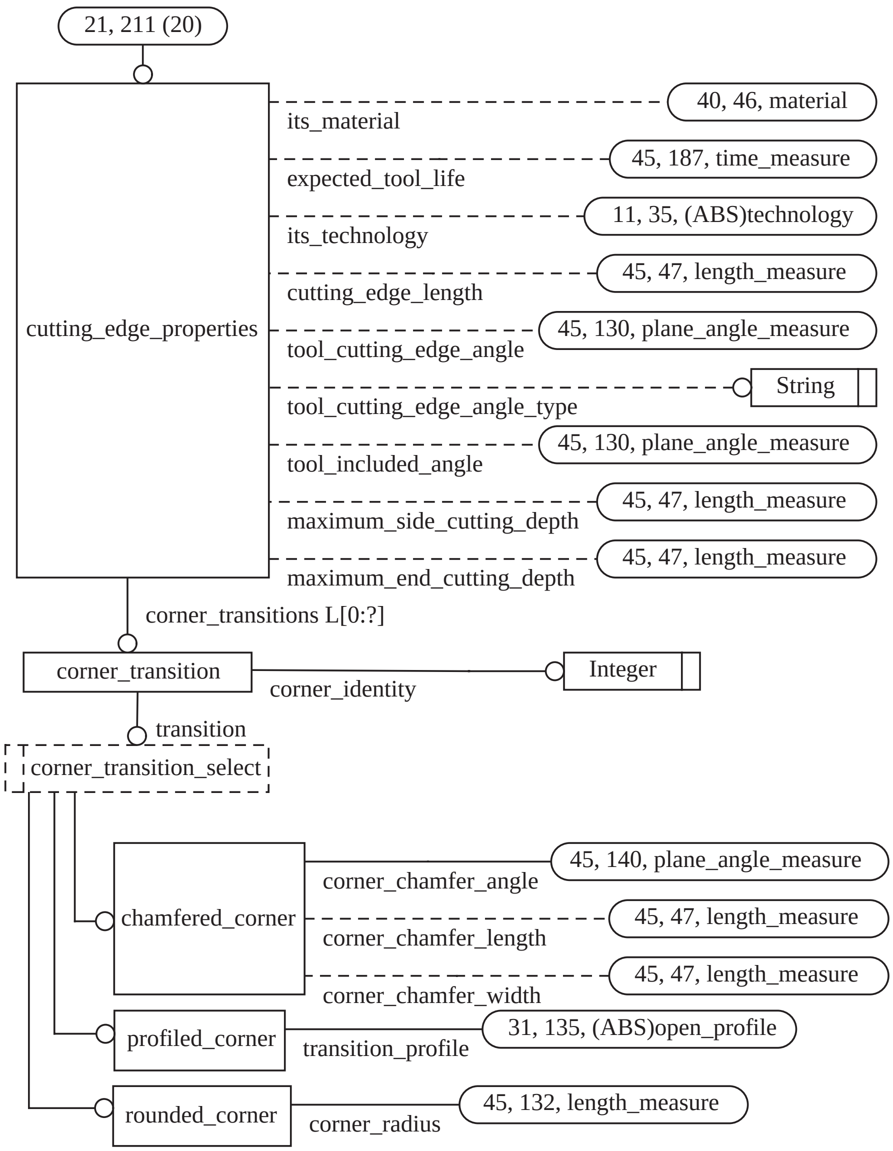


Figure G.21 — ARM diagram (21 of 48)

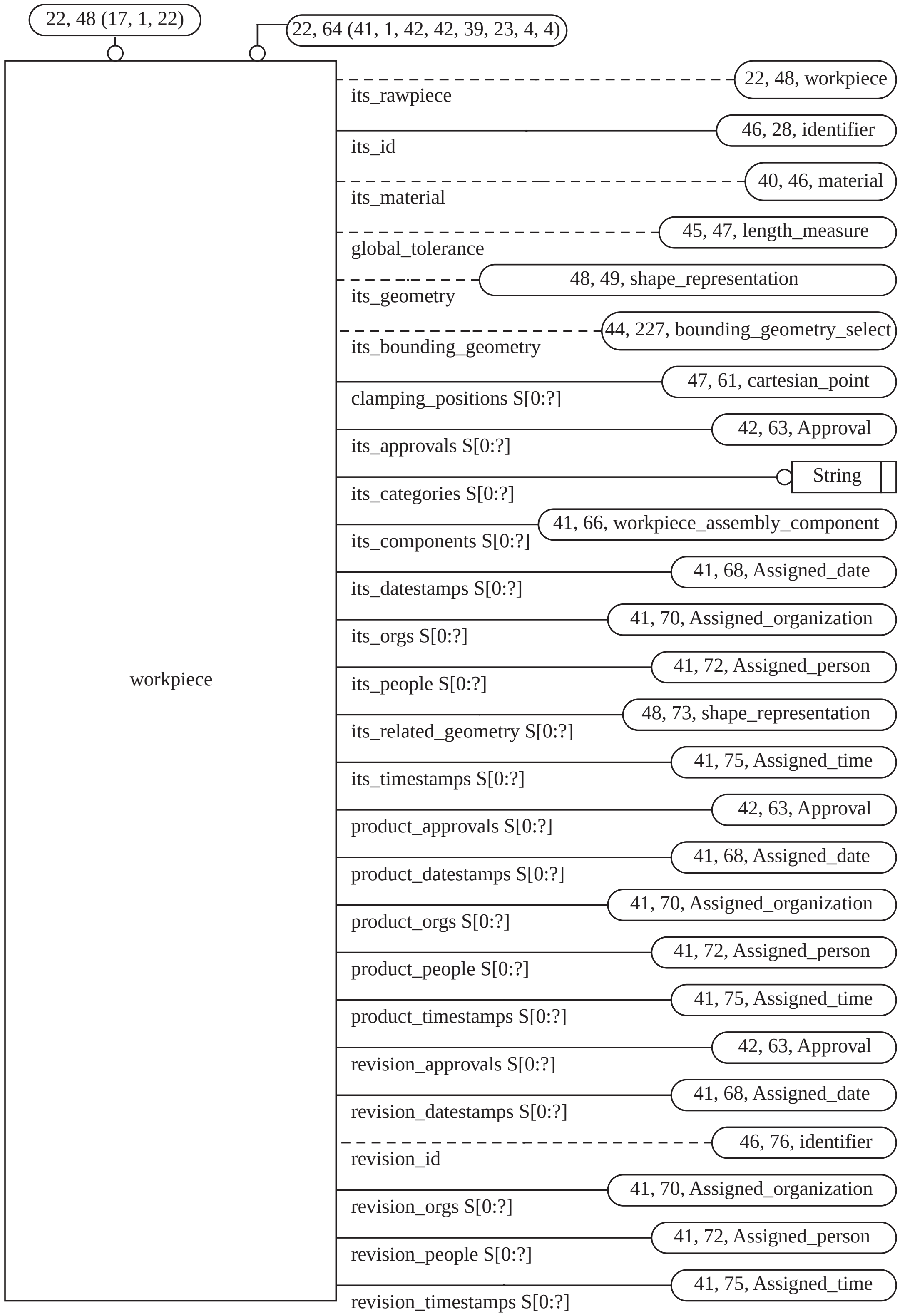


Figure G.22 — ARM diagram (22 of 48)

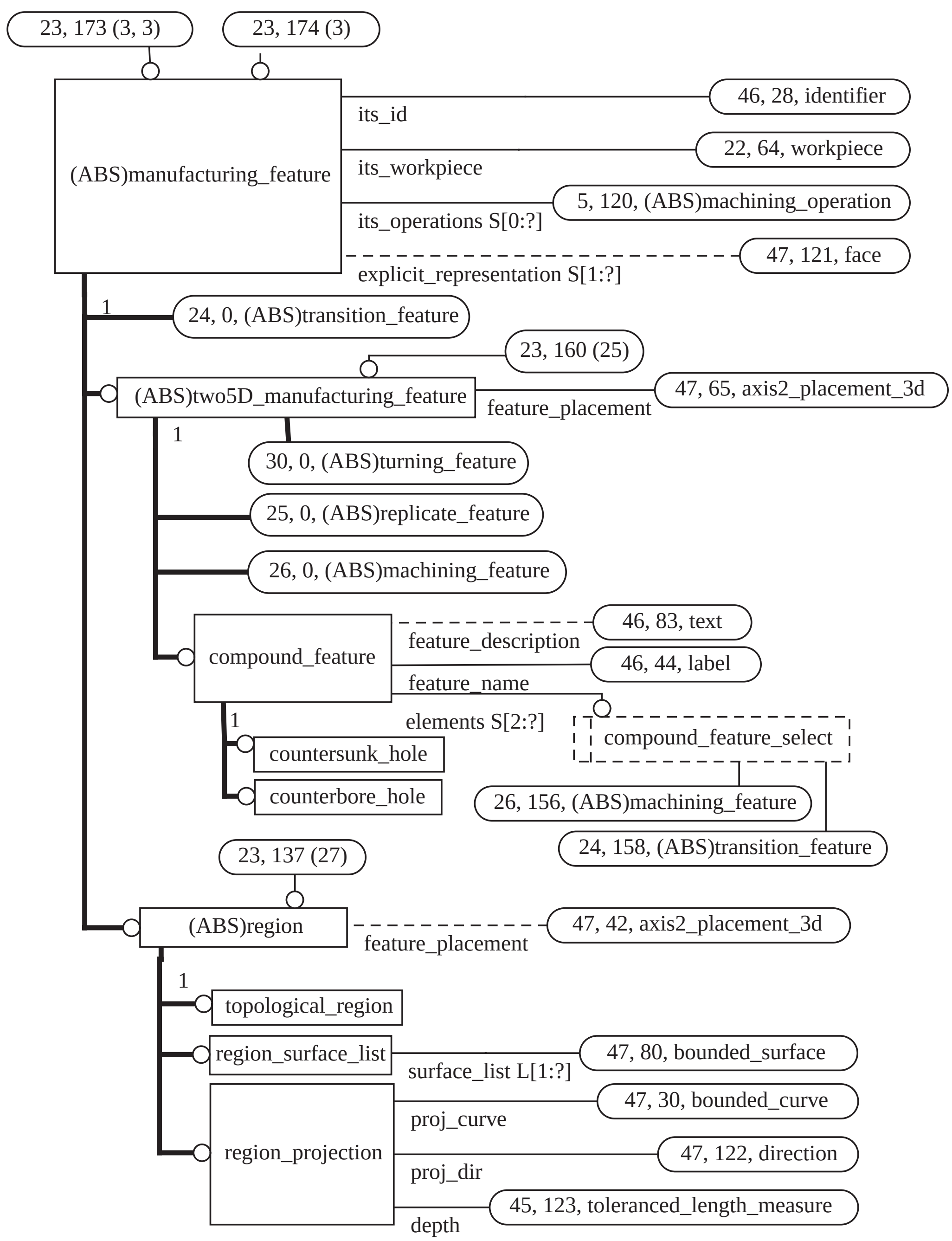


Figure G.23 — ARM diagram (23 of 48)

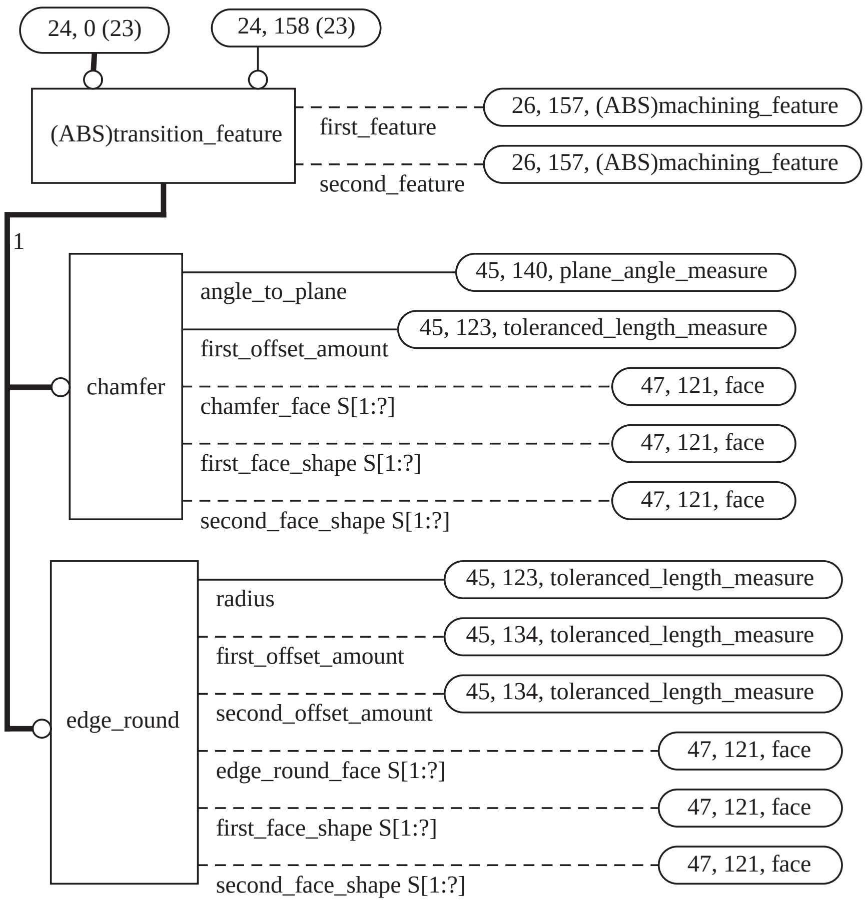


Figure G.24 — ARM diagram (24 of 48)

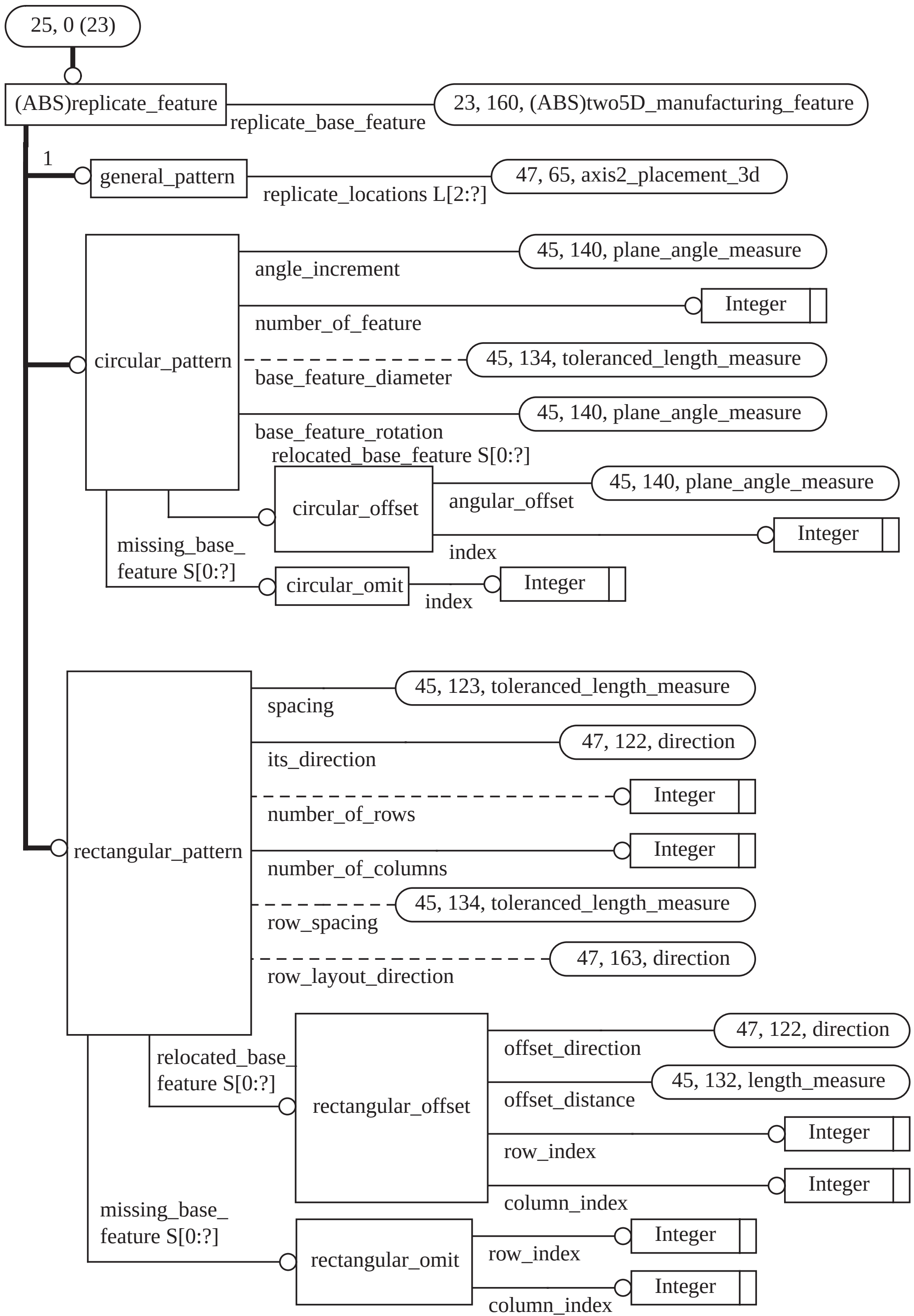


Figure G.25 — ARM diagram (25 of 48)

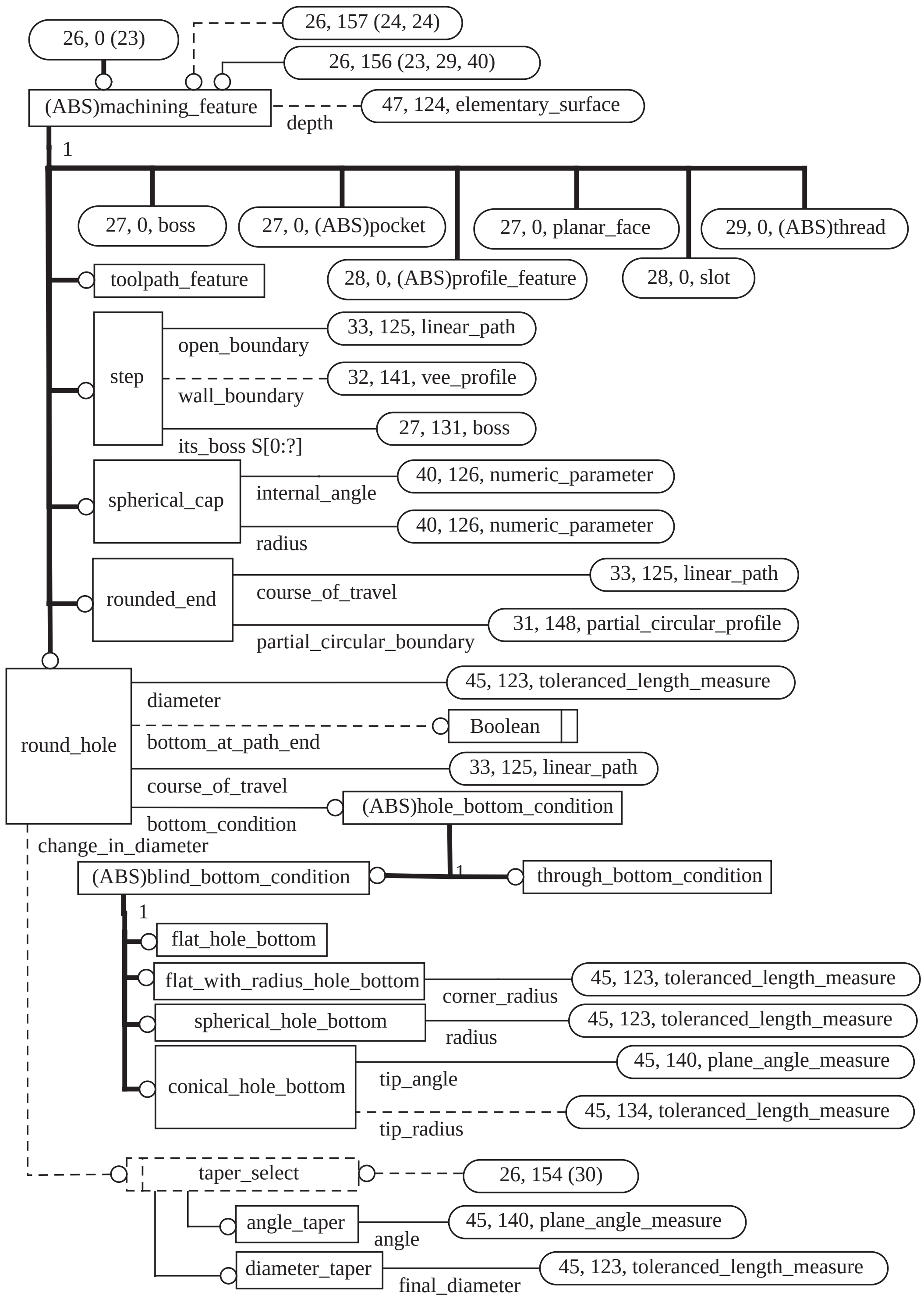


Figure G.26 — ARM diagram (26 of 48)

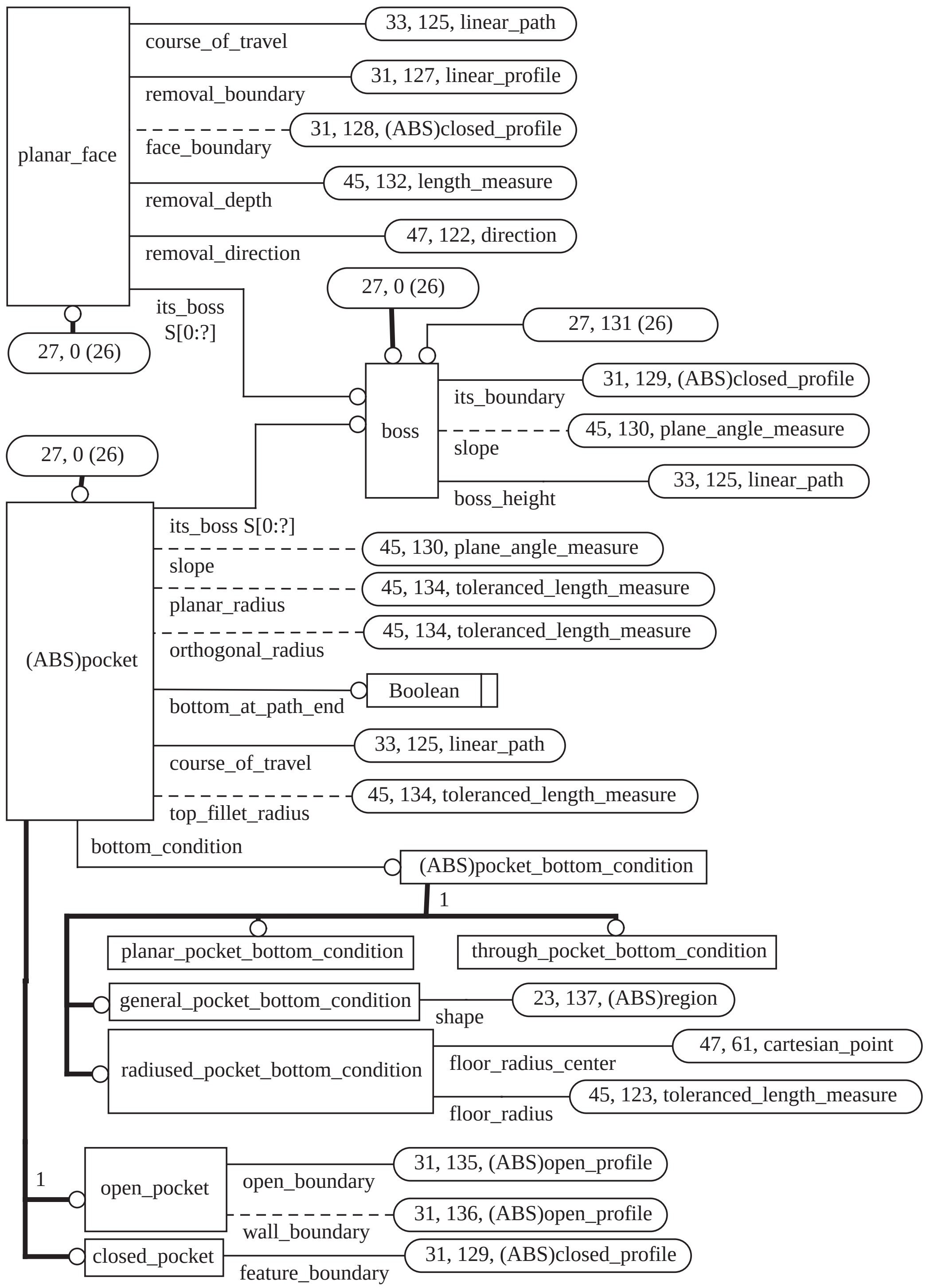


Figure G.27 — ARM diagram (27 of 48)

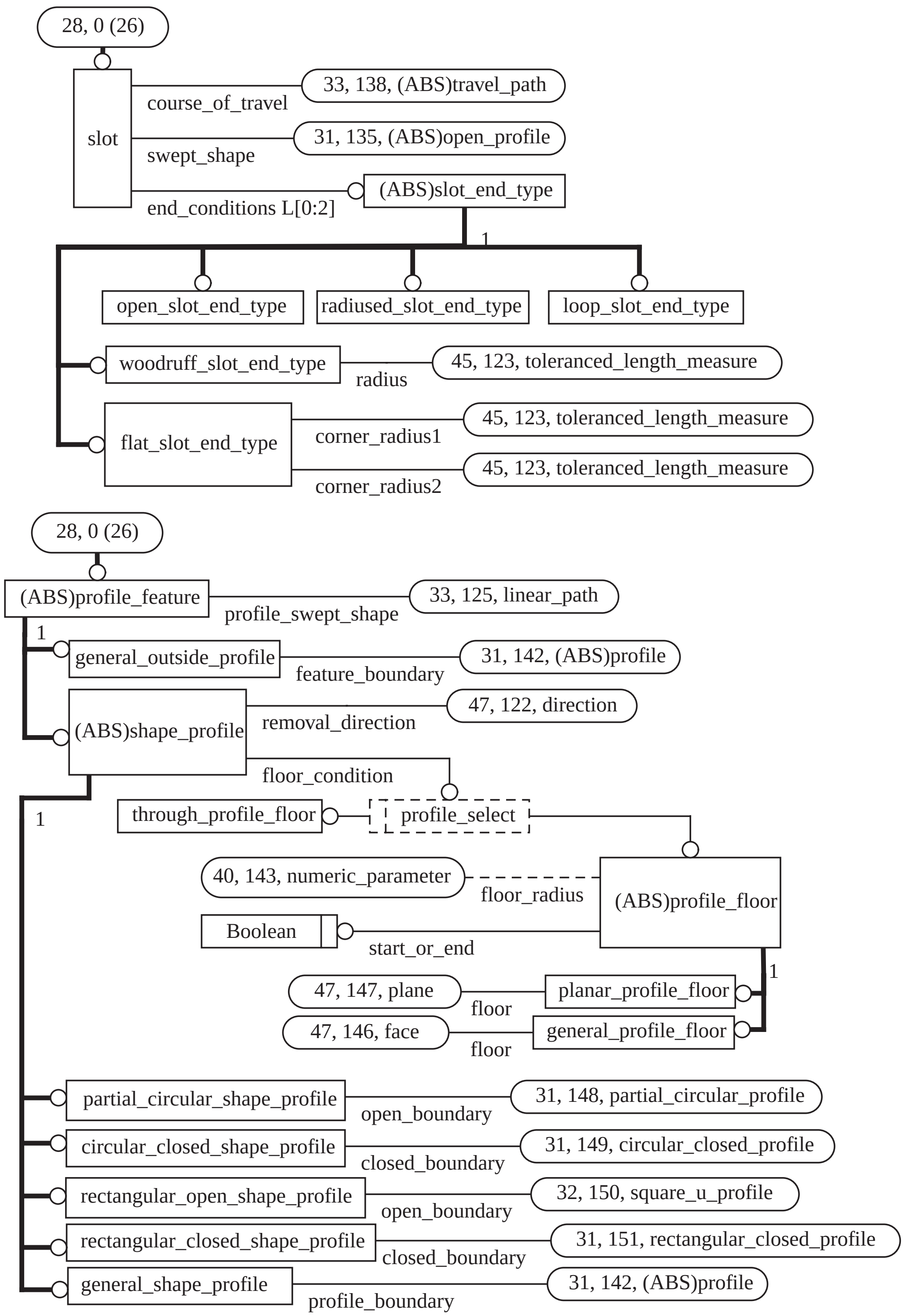


Figure G.28 — ARM diagram (28 of 48)

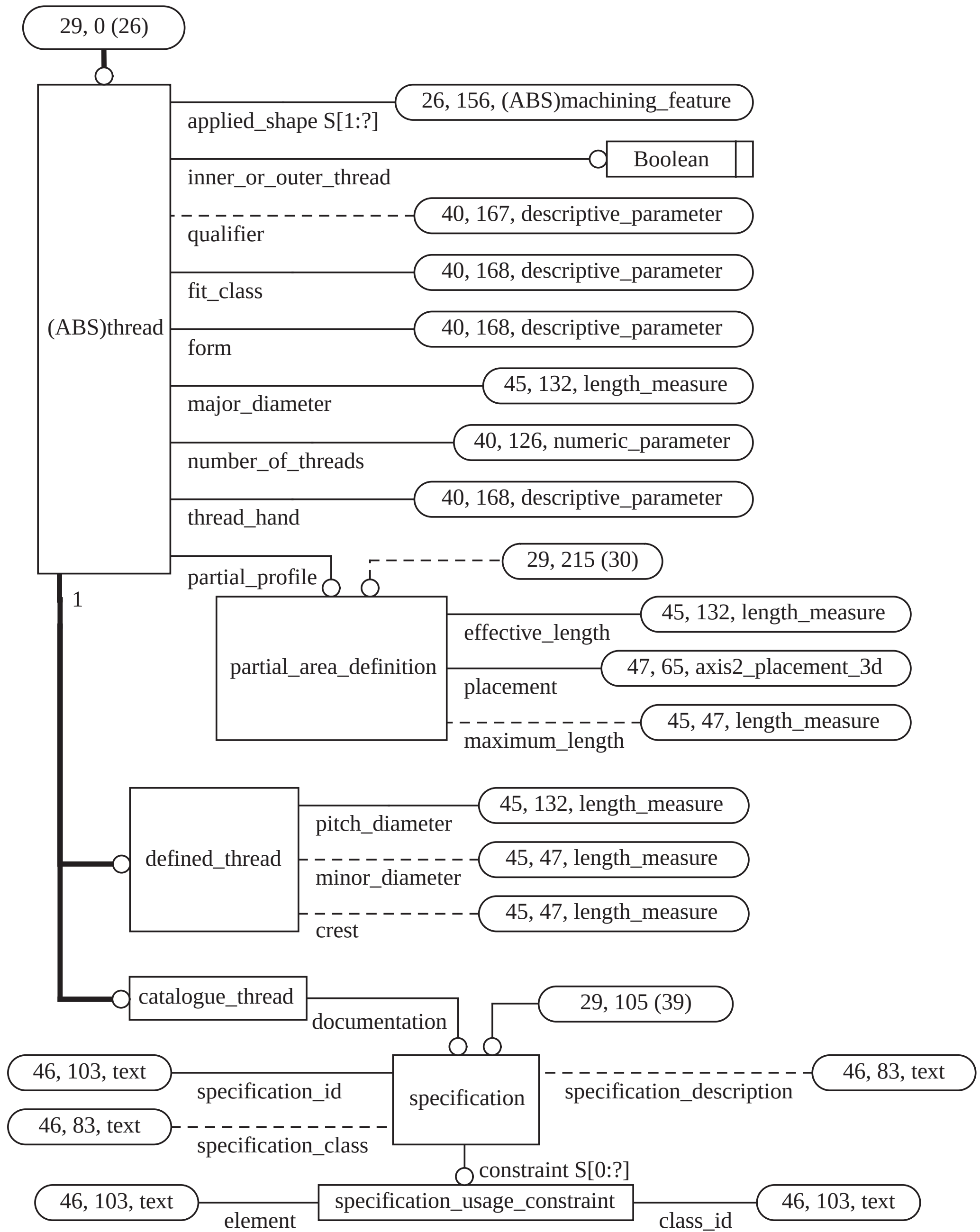


Figure G.29 — ARM diagram (29 of 48)

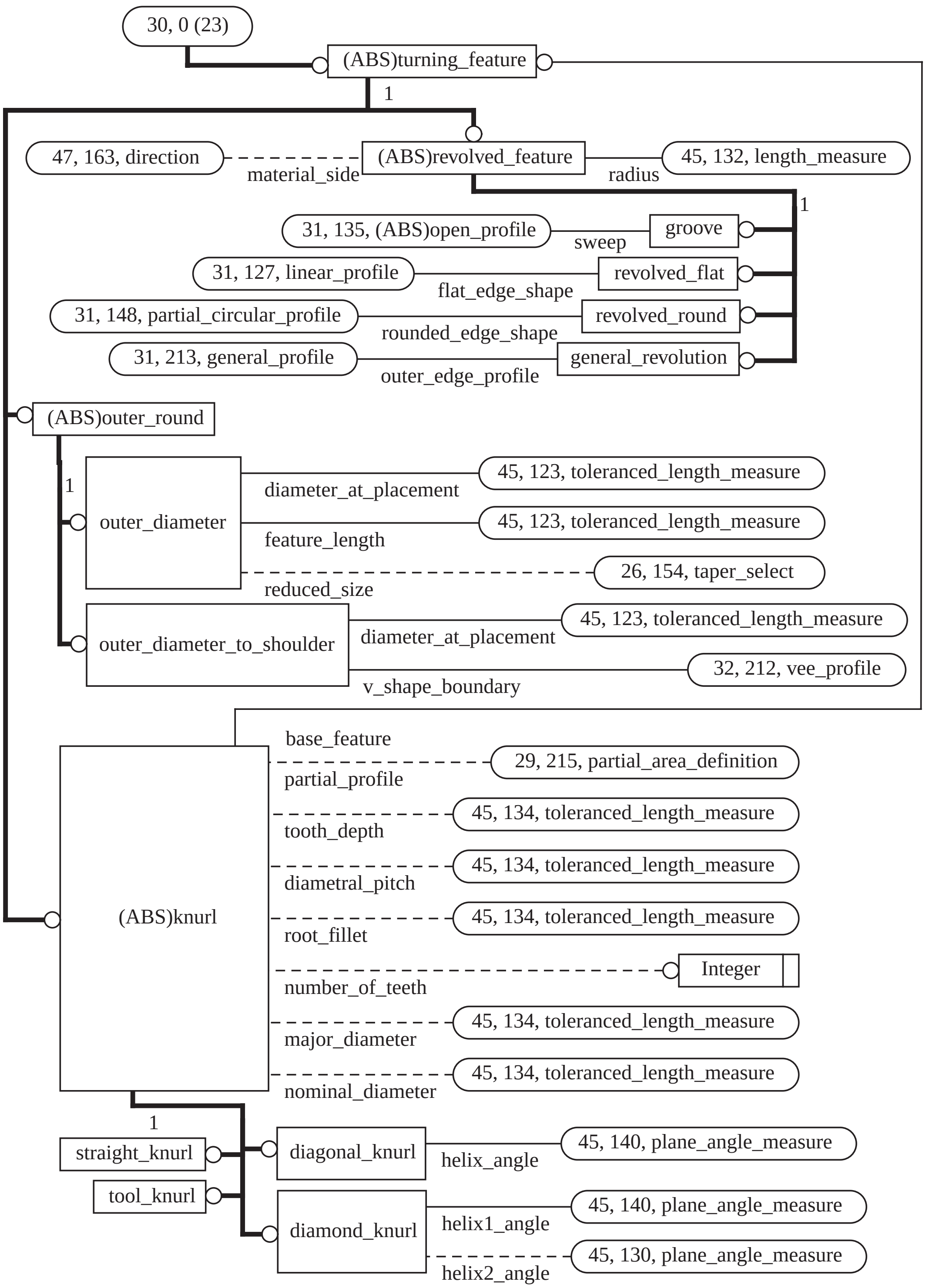


Figure G.30 — ARM diagram (30 of 48)

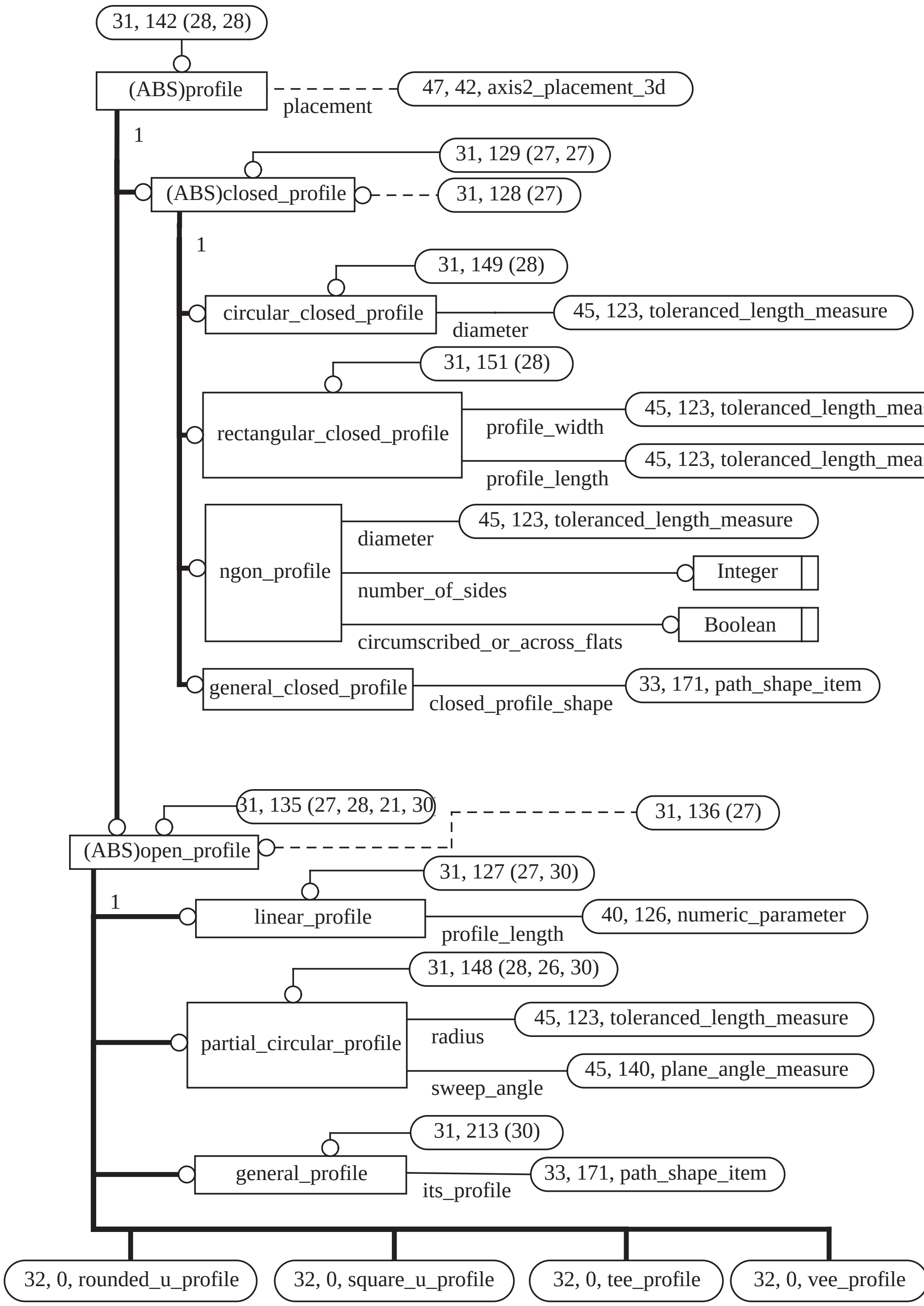


Figure G.31 — ARM diagram (31 of 48)

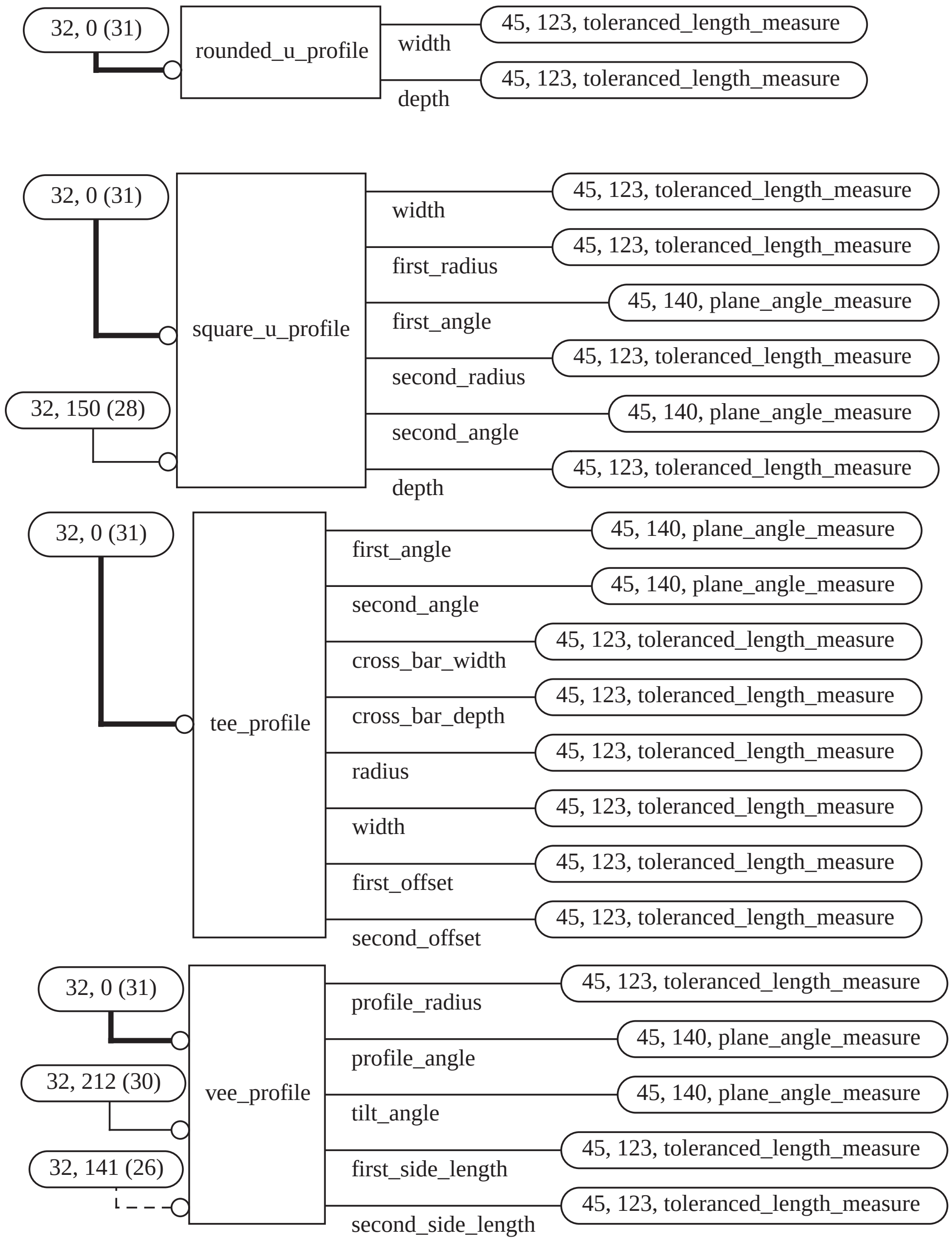


Figure G.32 — ARM diagram (32 of 48)

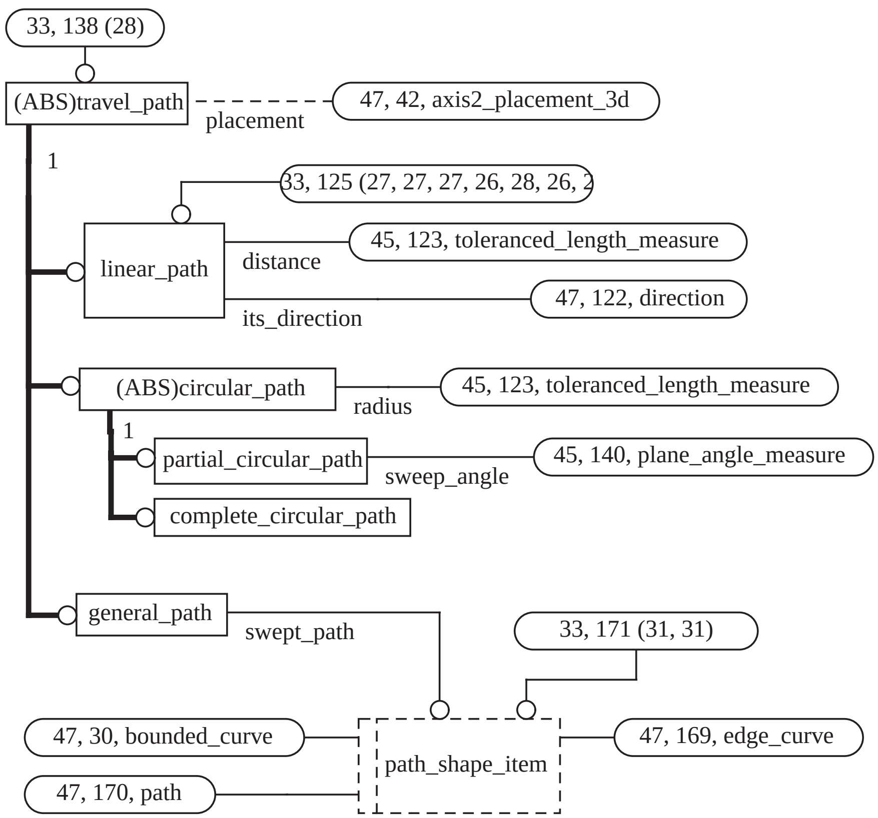


Figure G.33 — ARM diagram (33 of 48)

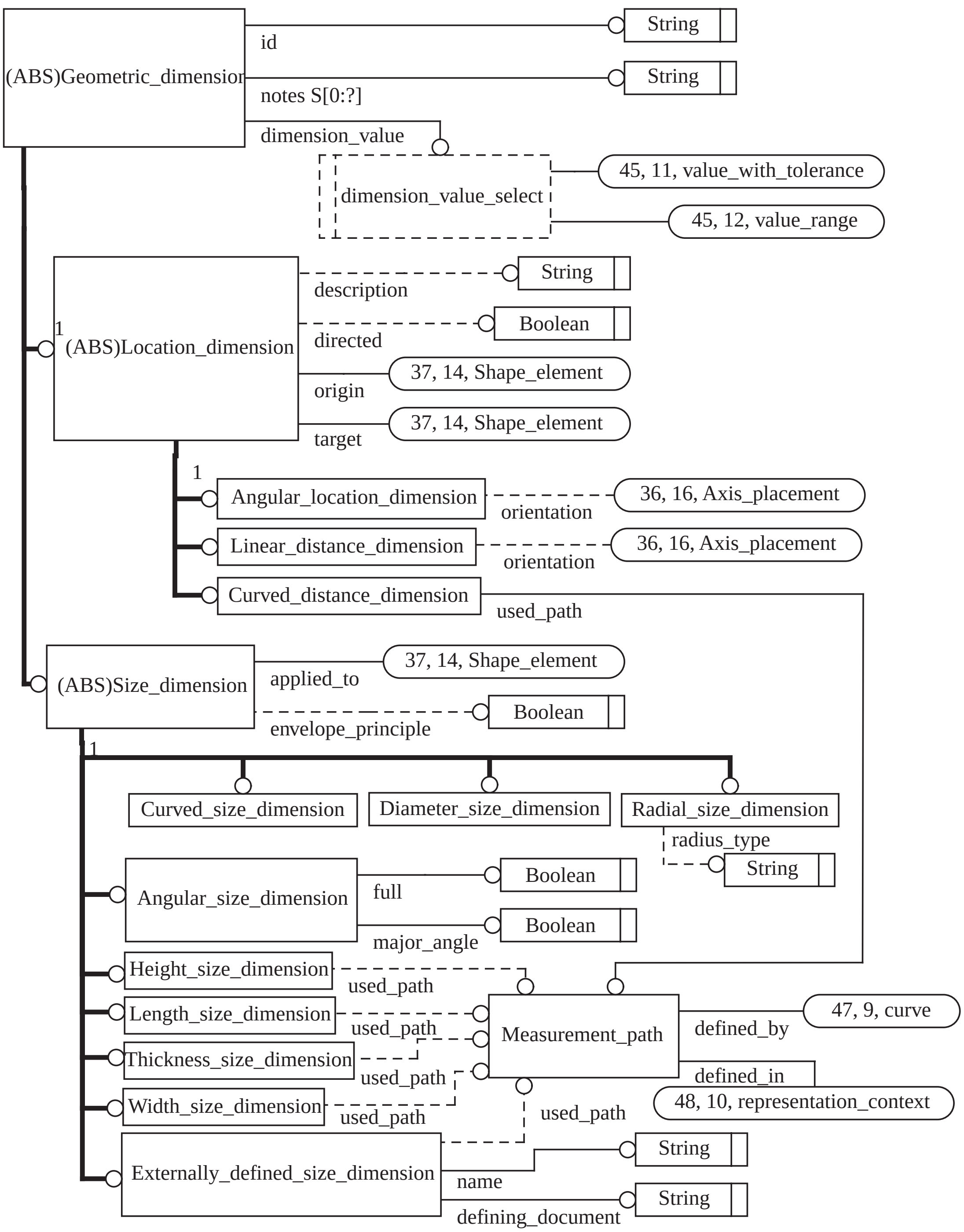


Figure G.34 — ARM diagram (34 of 48)

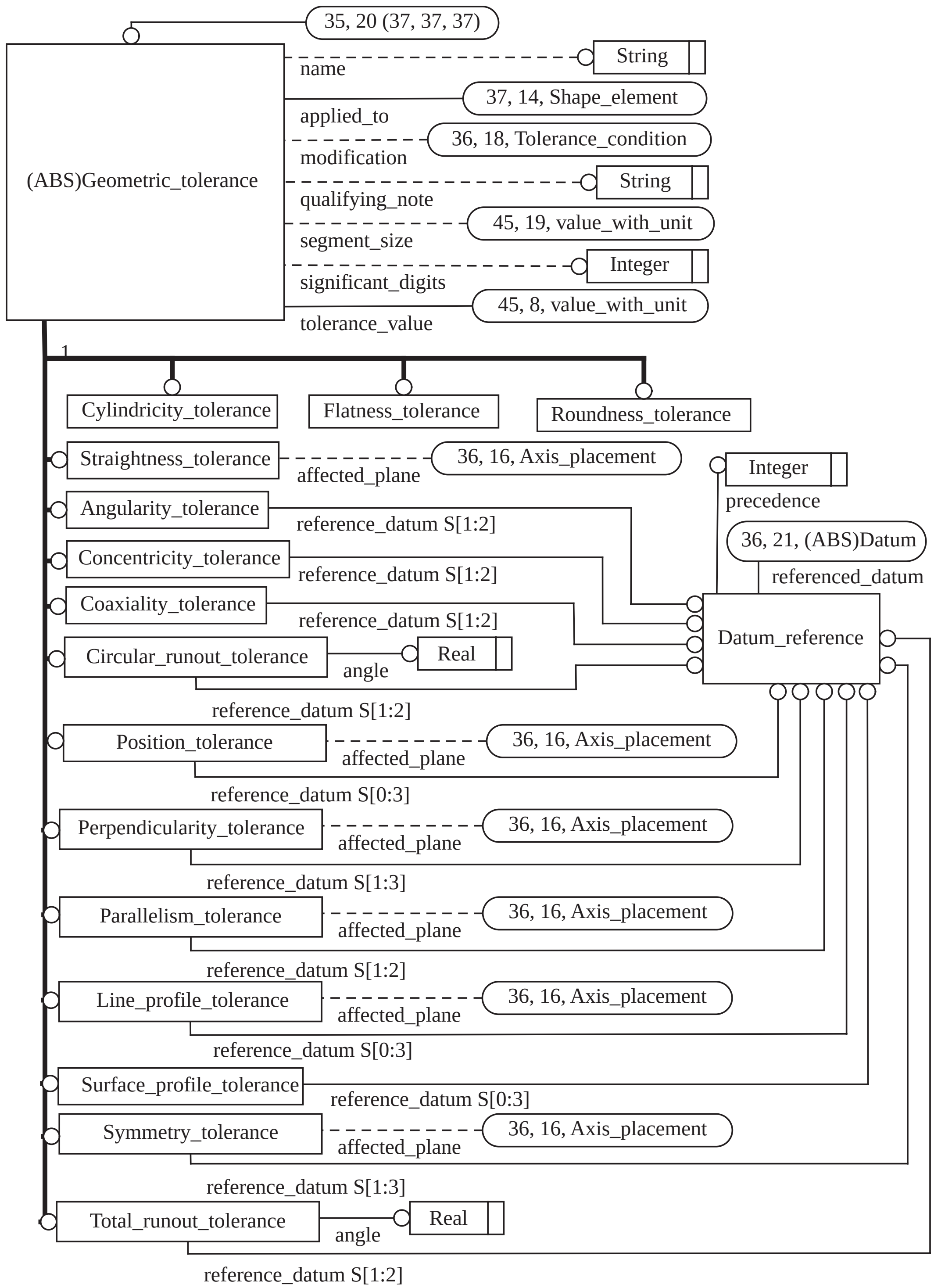


Figure G.35 — ARM diagram (35 of 48)

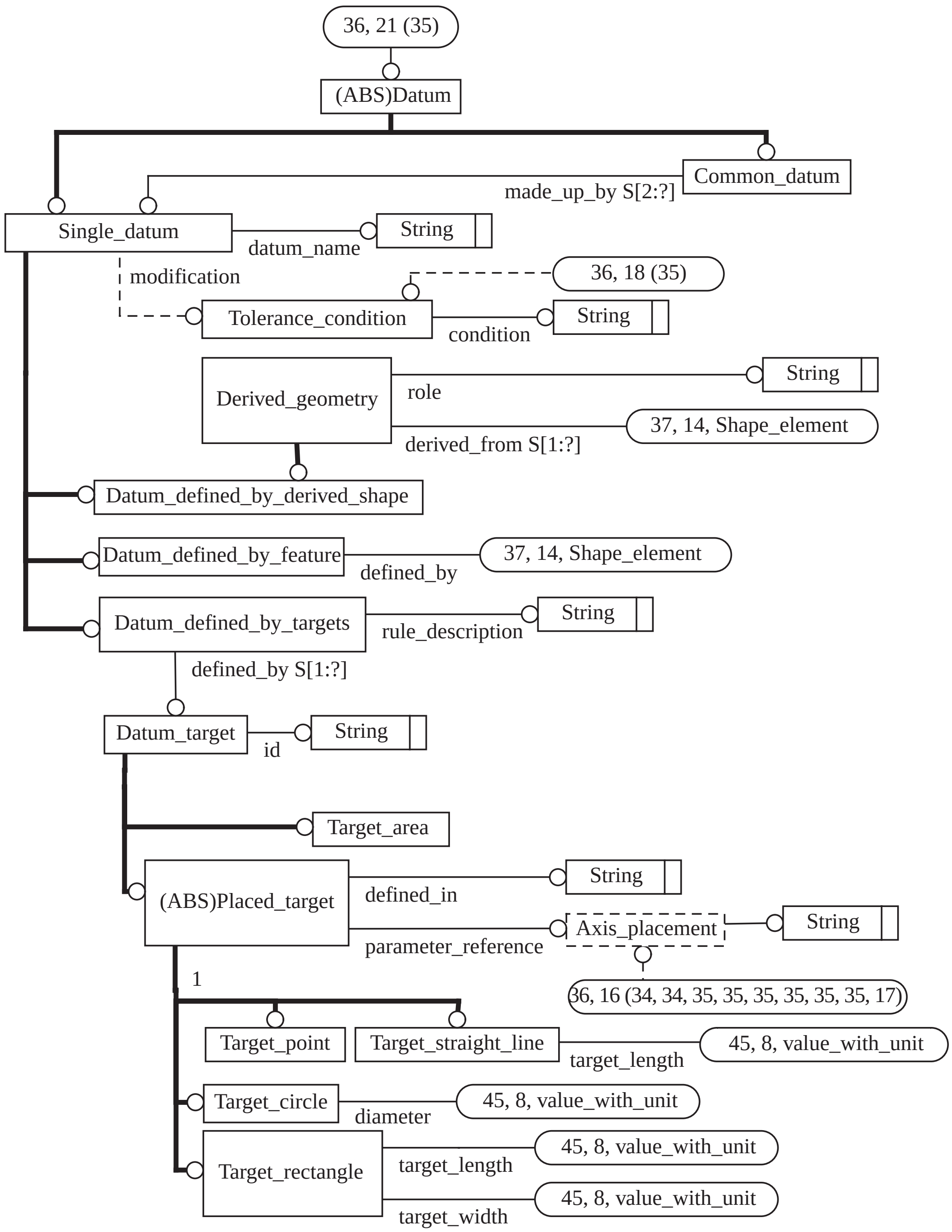


Figure G.36 — ARM diagram (36 of 48)

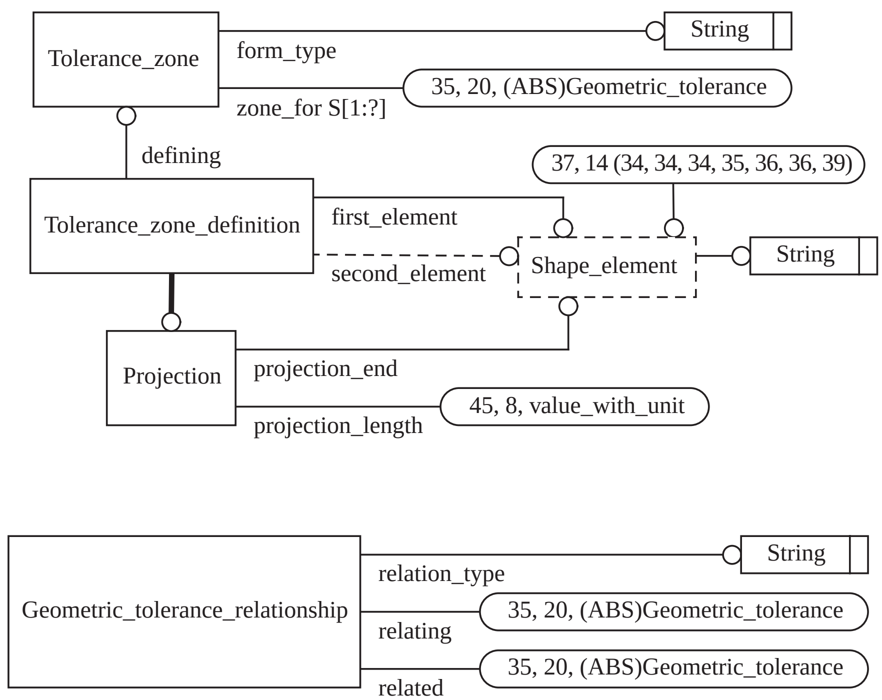


Figure G.37 — ARM diagram (37 of 48)

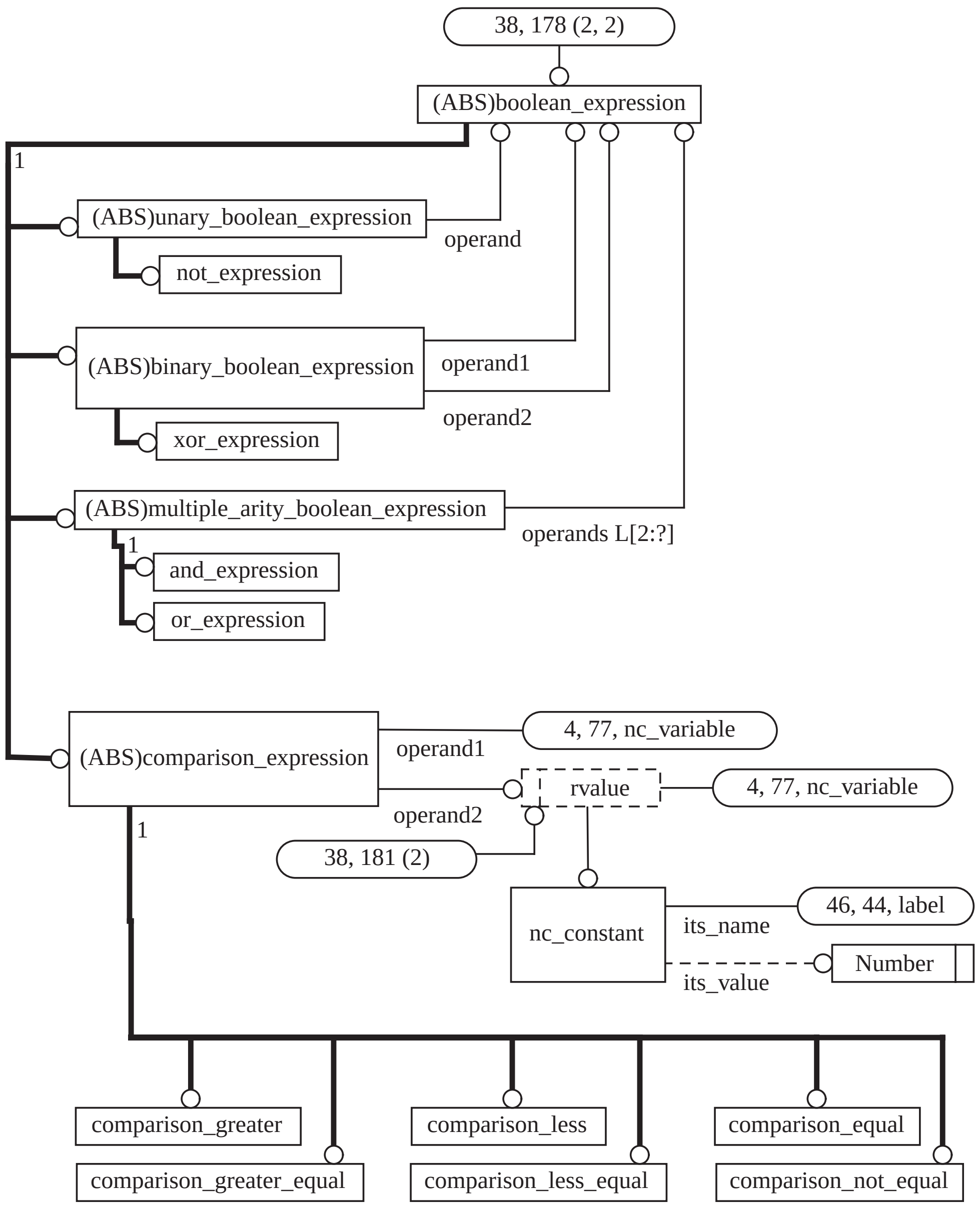


Figure G.38 — ARM diagram (38 of 48)

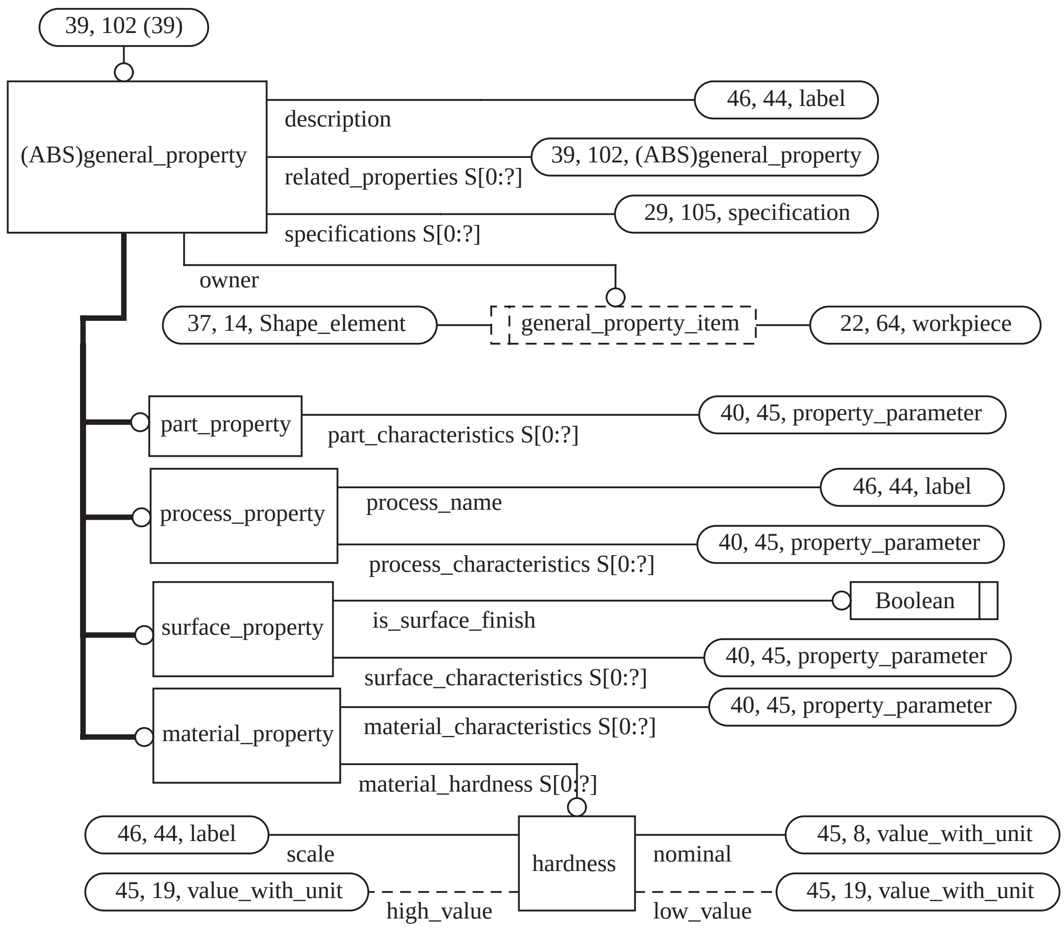


Figure G.39 — ARM diagram (39 of 48)

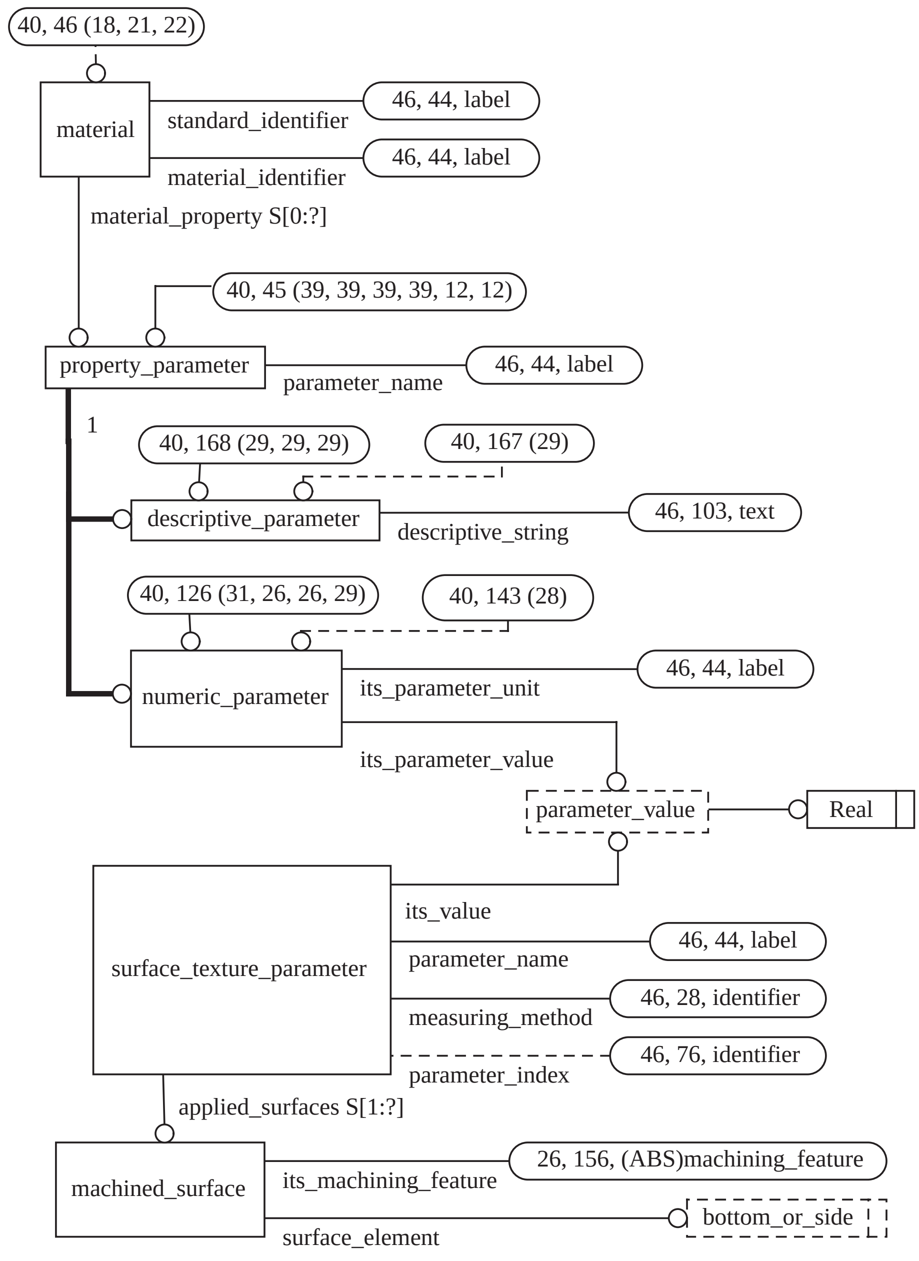


Figure G.40 — ARM diagram (40 of 48)

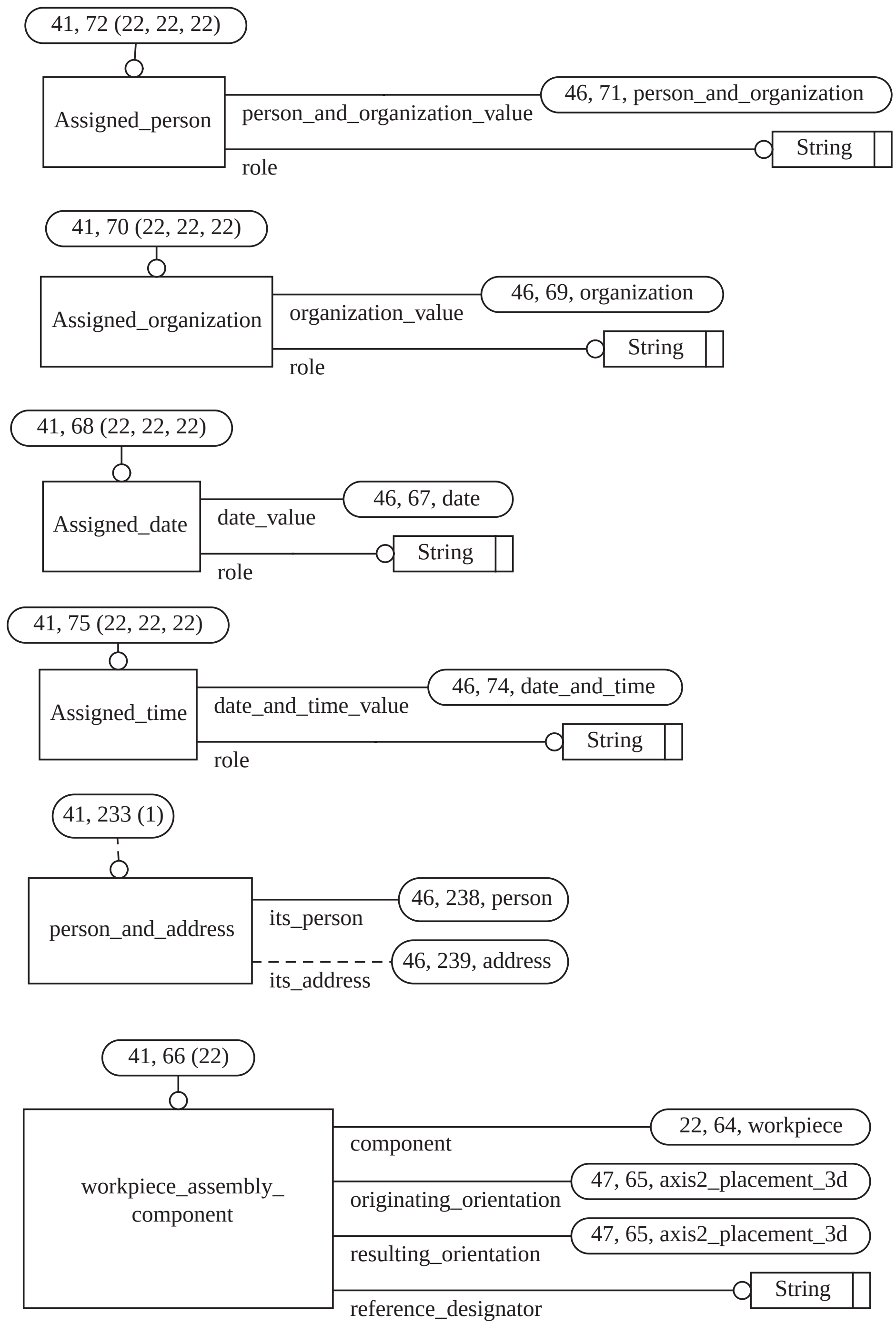


Figure G.41 — ARM diagram (41 of 48)

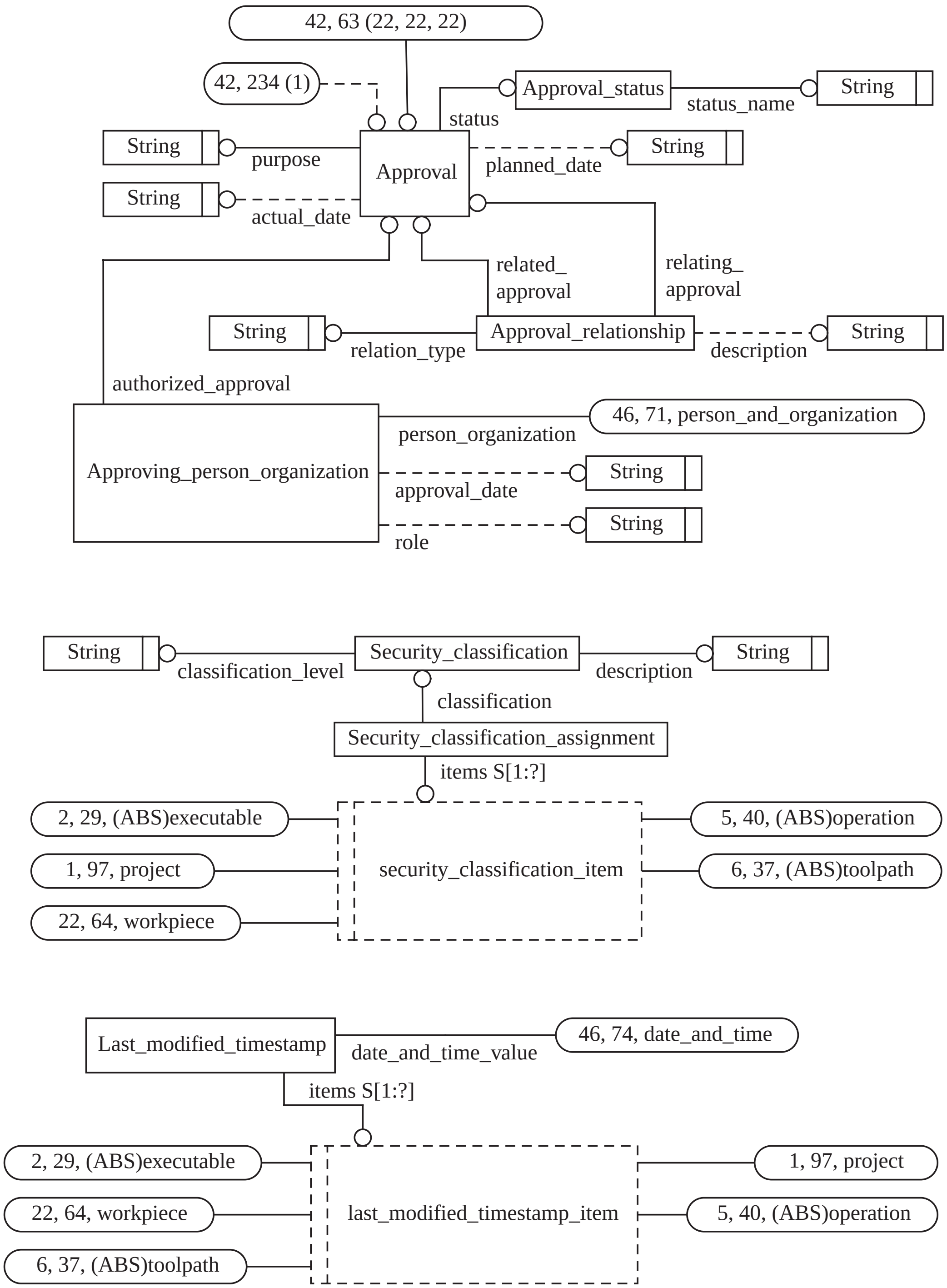


Figure G.42 — ARM diagram (42 of 48)

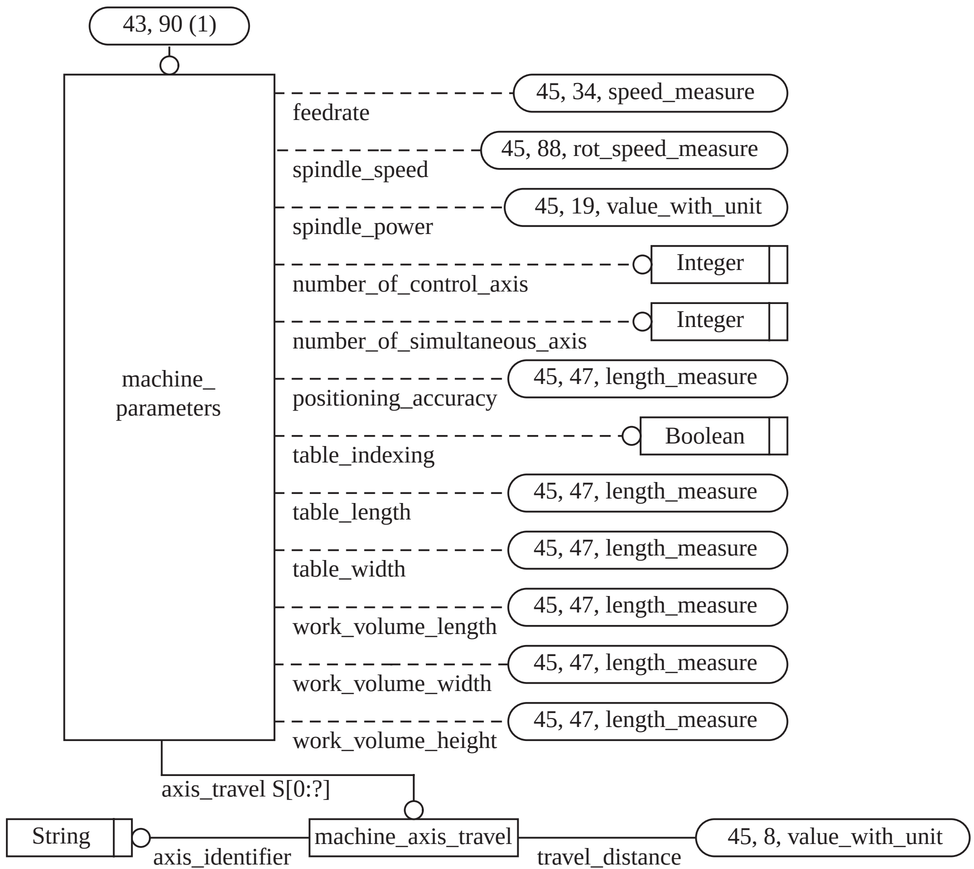


Figure G.43 — ARM diagram (43 of 48)

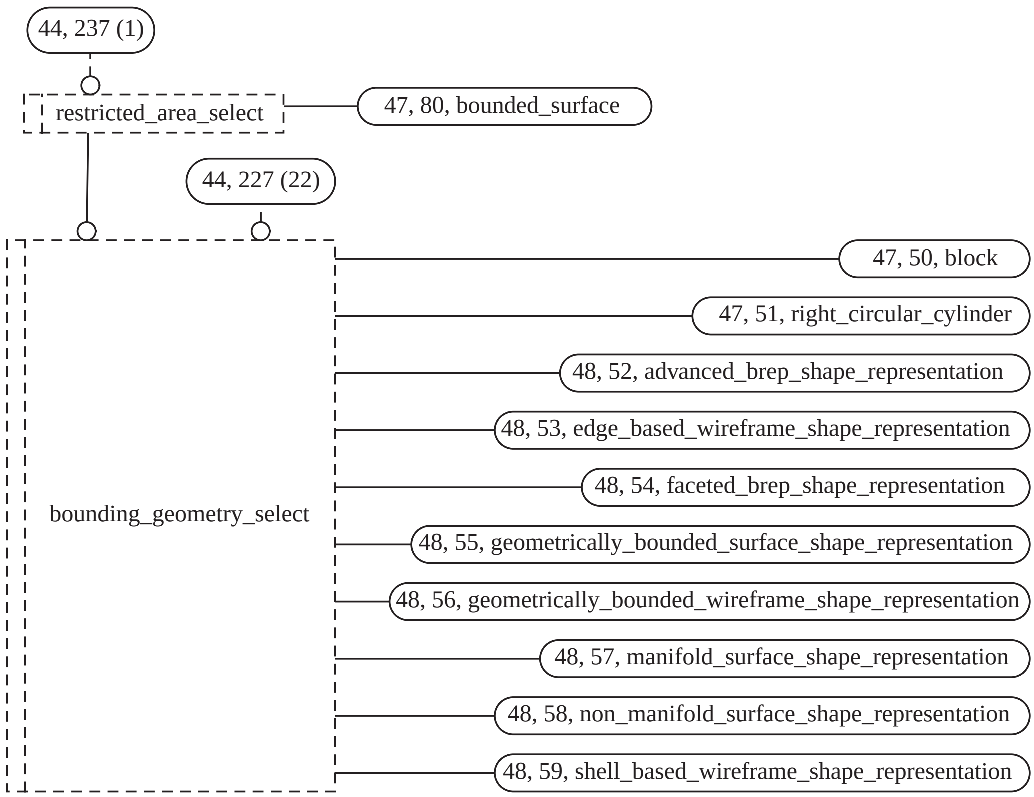


Figure G.44 — ARM diagram (44 of 48)

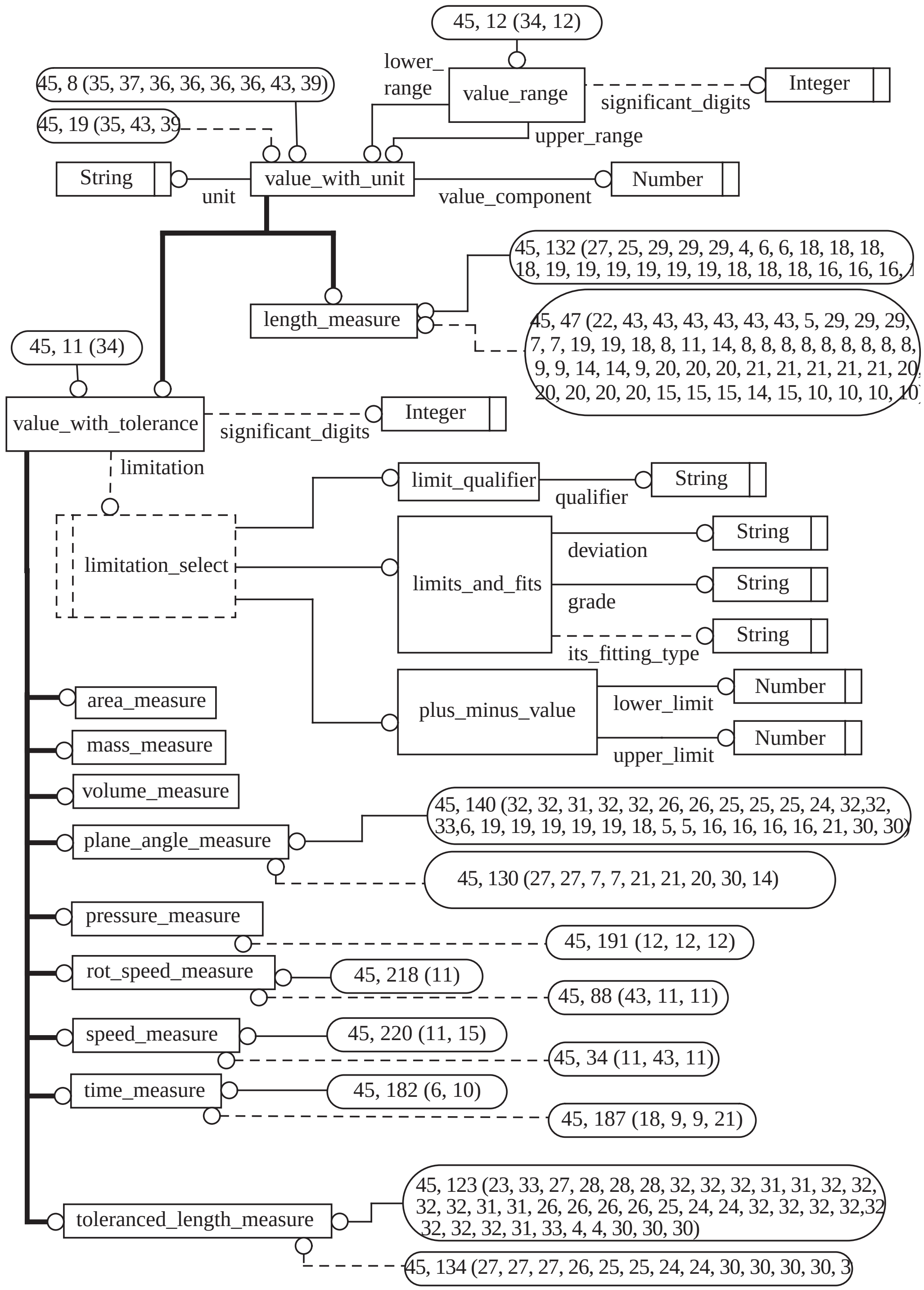
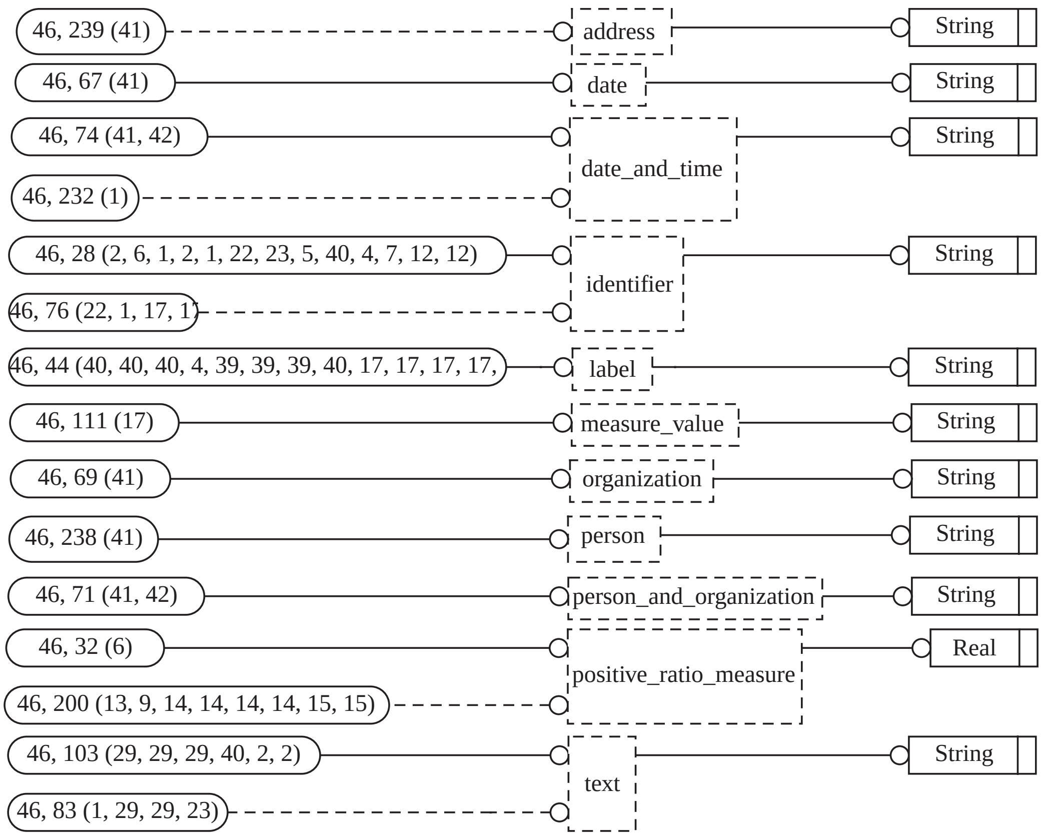
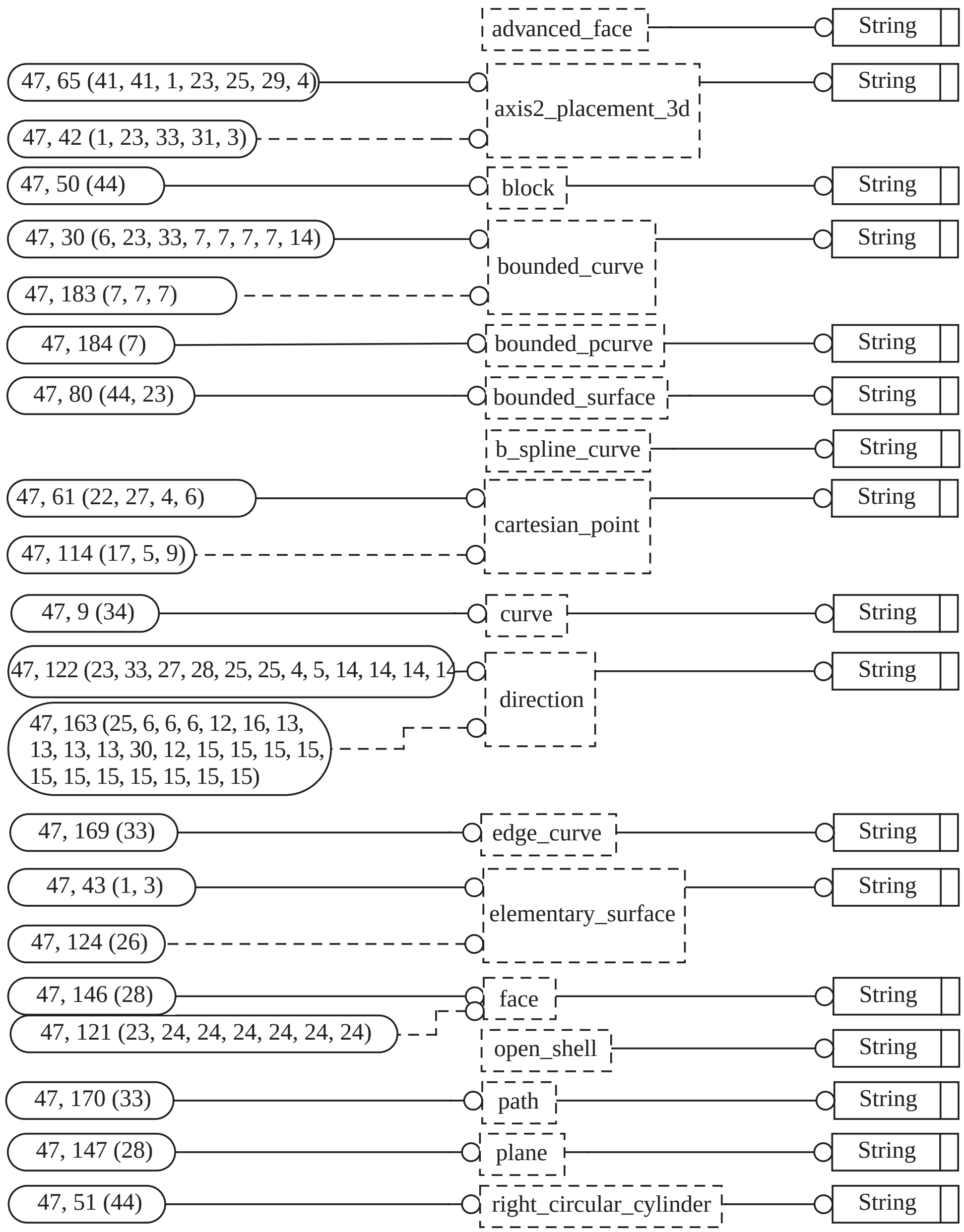


Figure G.45 — ARM diagram (45 of 48)



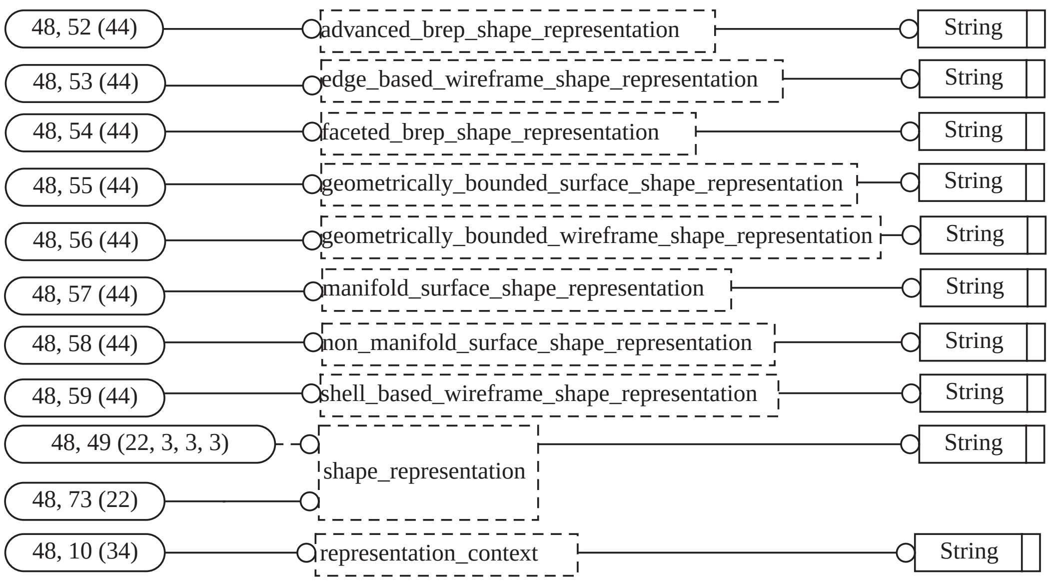
NOTE These are integrated resource definitions referenced by ISO 14649 but defined in ISO 10303-41. For the purposes of this application reference model these are treated as primitive types.

Figure G.46 — ARM diagram (46 of 48)



NOTE These are integrated resource definitions referenced by ISO 14649 but defined in ISO 10303-42. For the purposes of this application reference model these are treated as primitive types.

Figure G.47 — ARM diagram (47 of 48)



NOTE These are integrated resource definitions referenced by ISO 14649 but defined in AICs and other integrated resource parts. For the purposes of this application reference model these are treated as primitive types.

Figure G.48 — ARM diagram (48 of 48)

Annex H
(informative)

AIM EXPRESS-G

THIS ANNEX HAS NOT YET BEEN UPDATED TO THE FINAL AIM DEFINITIONS

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.

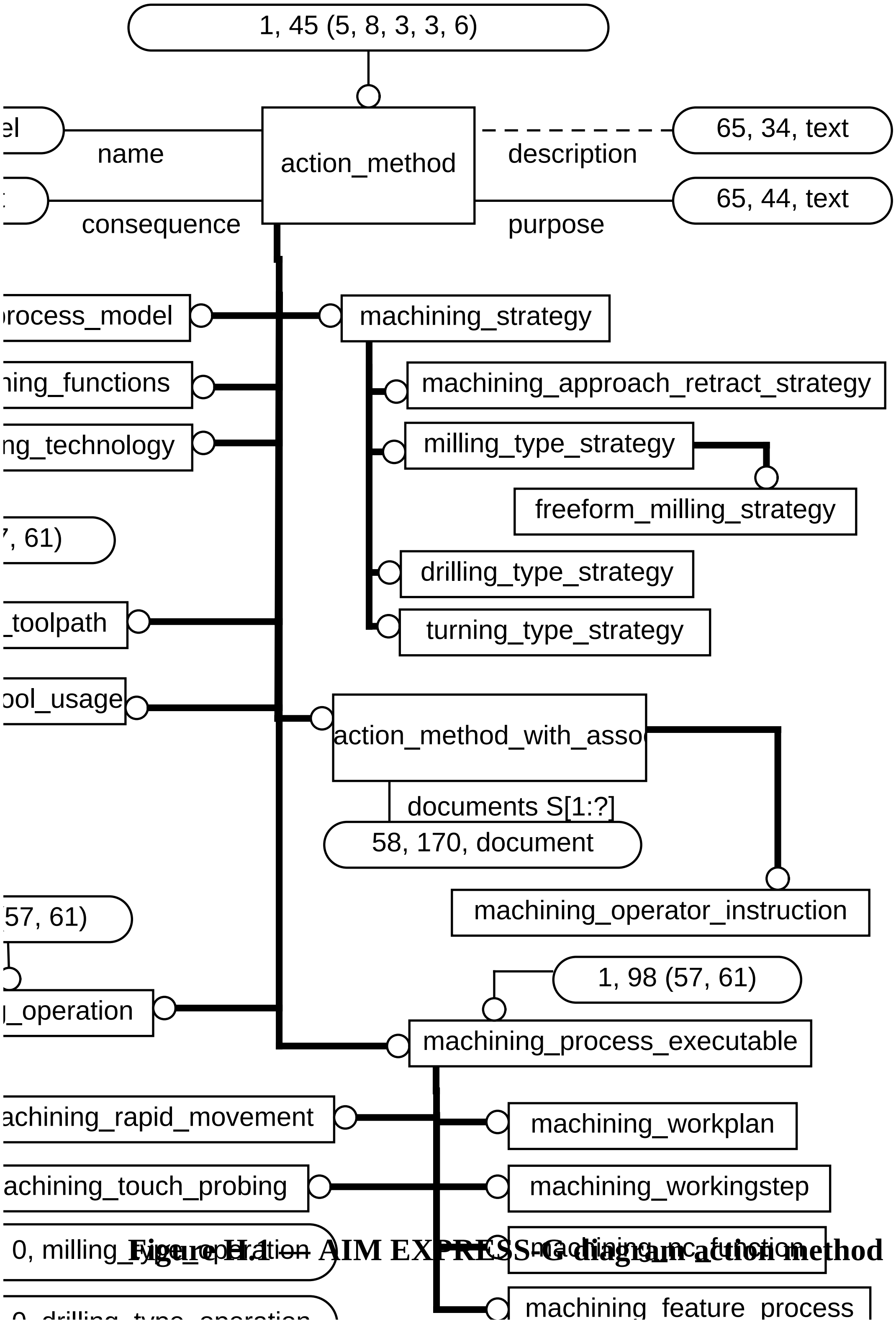


Figure H.1 — AIM EXPRESS-G diagram action method

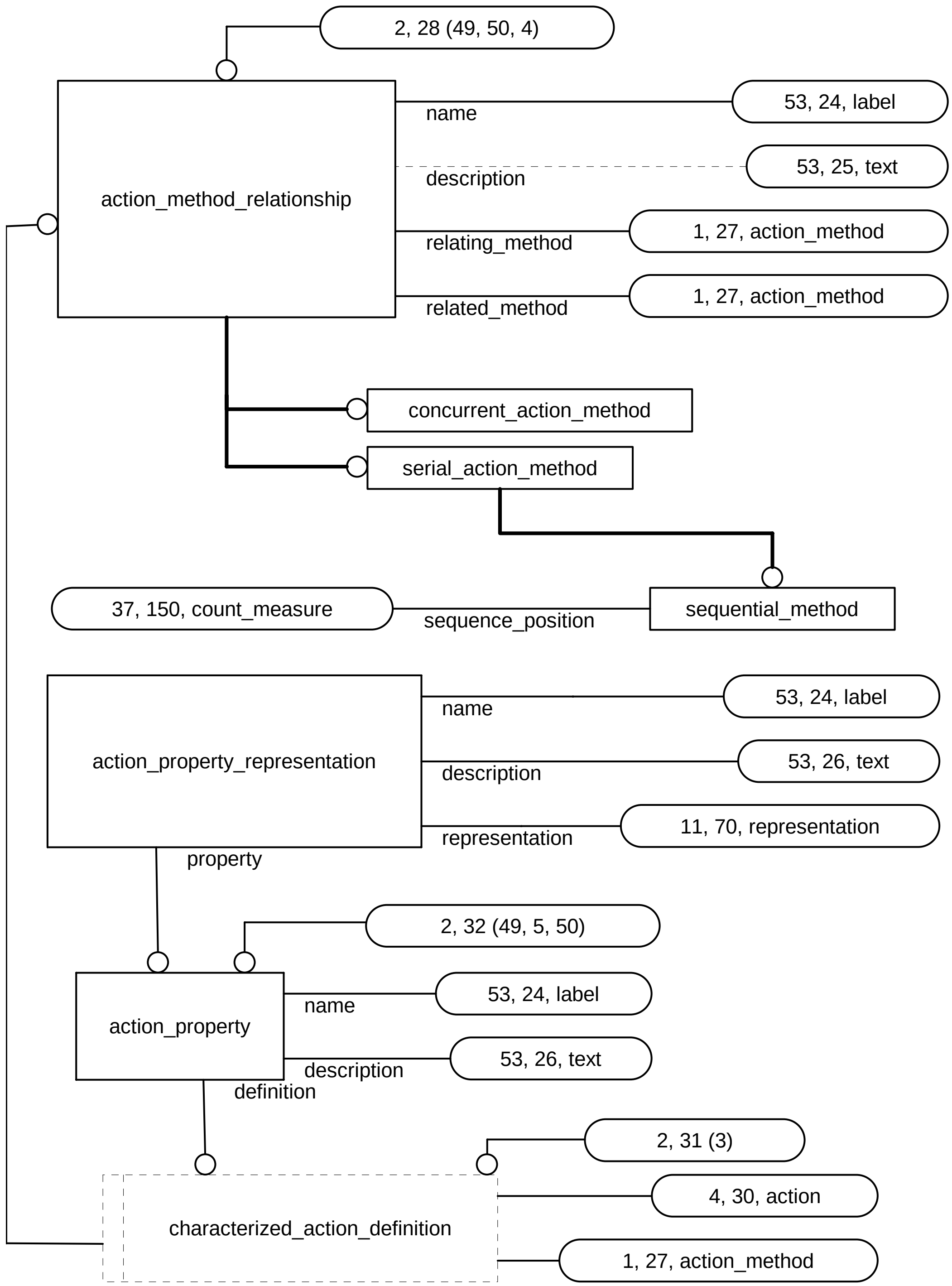


Figure H.2 — AIM EXPRESS-G diagram action method relationship

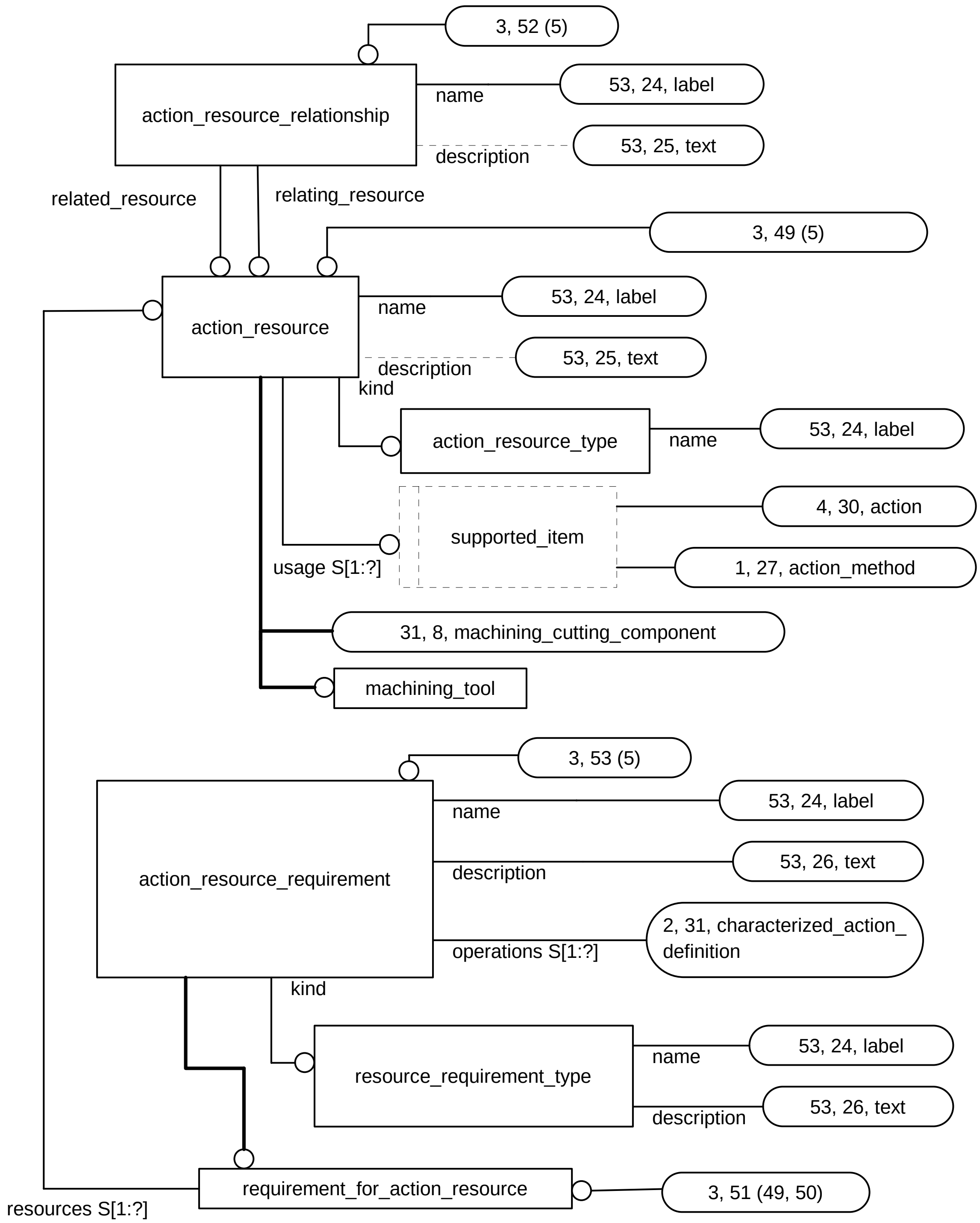


Figure H.3 — AIM EXPRESS-G diagram action resource

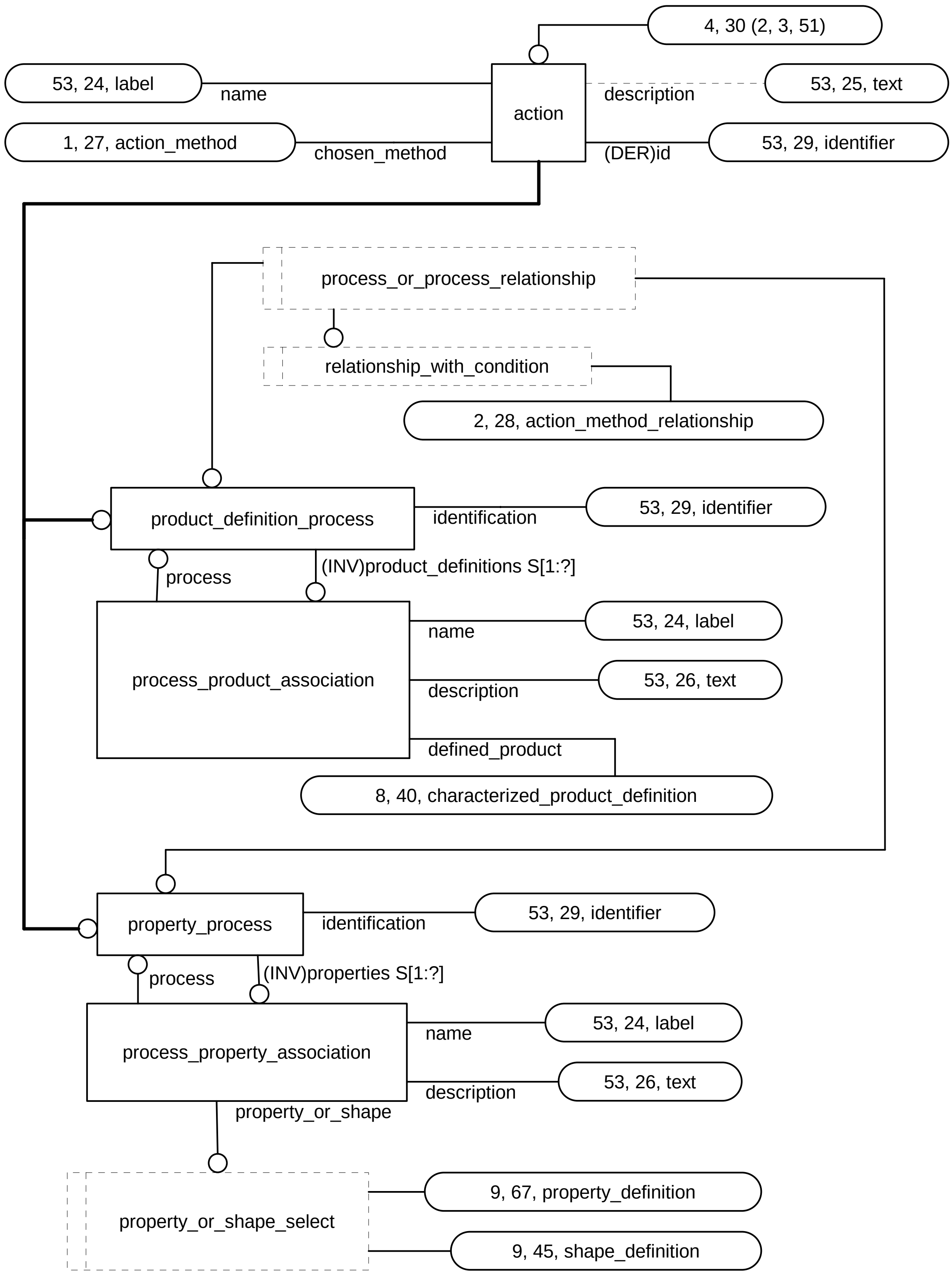


Figure H.4 — AIM EXPRESS-G diagram action

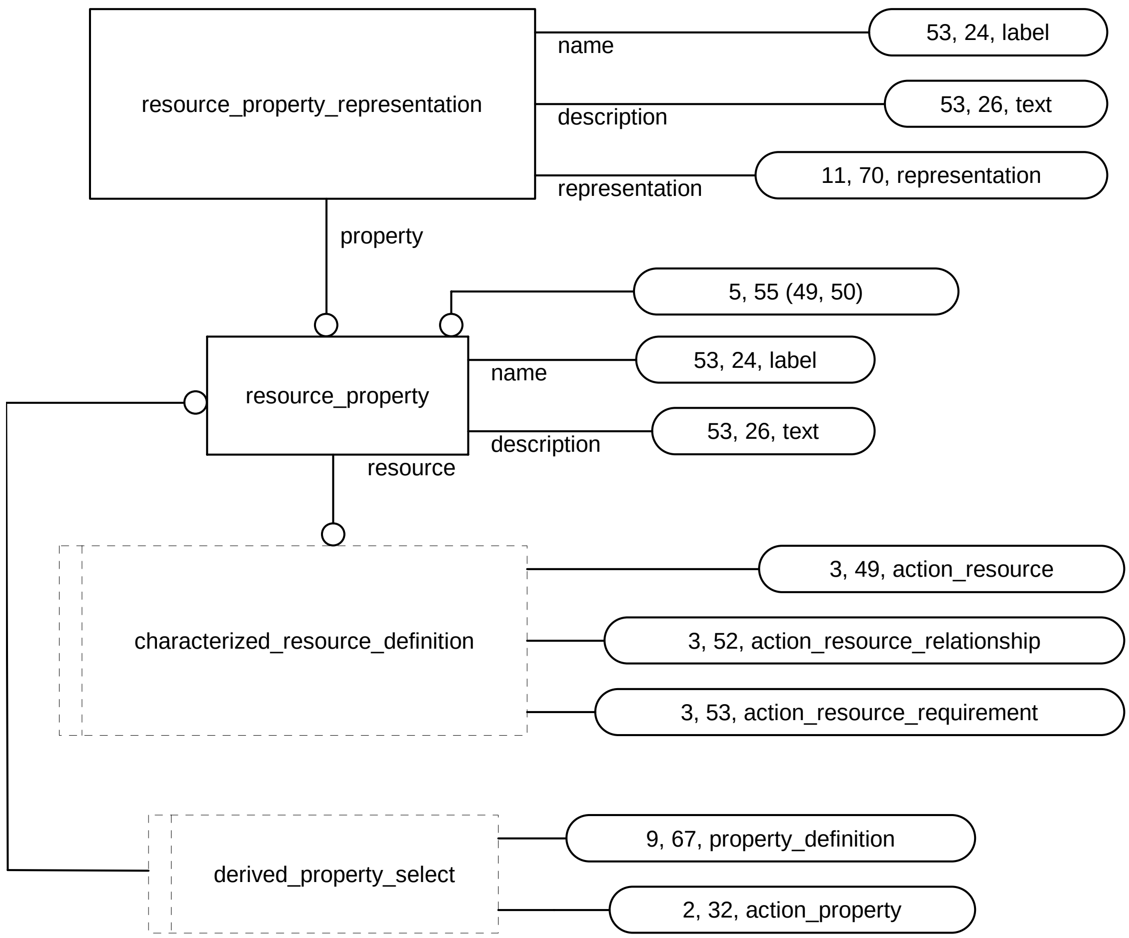


Figure H.5 — AIM EXPRESS-G diagram resource property

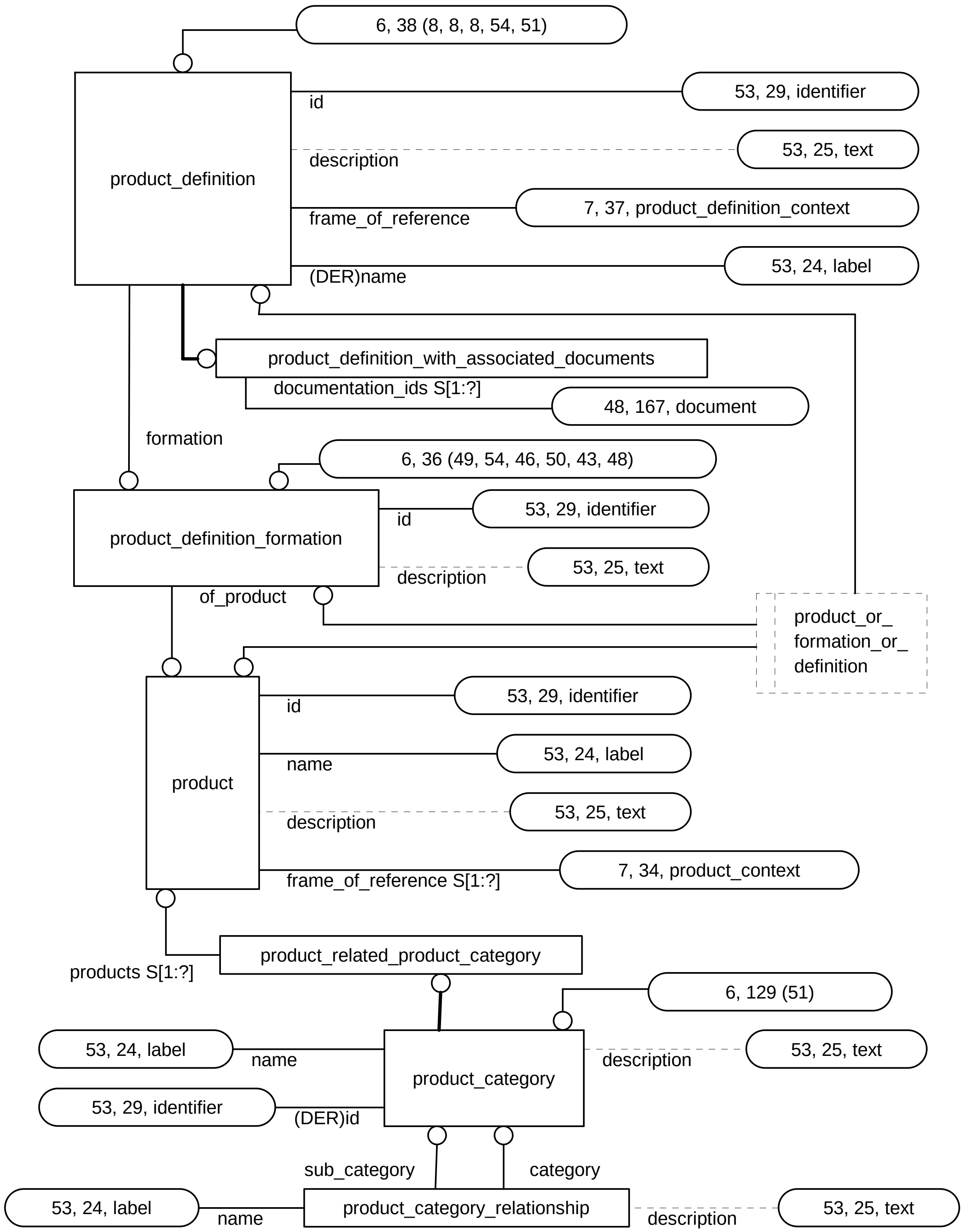


Figure H.6 — AIM EXPRESS-G diagram product

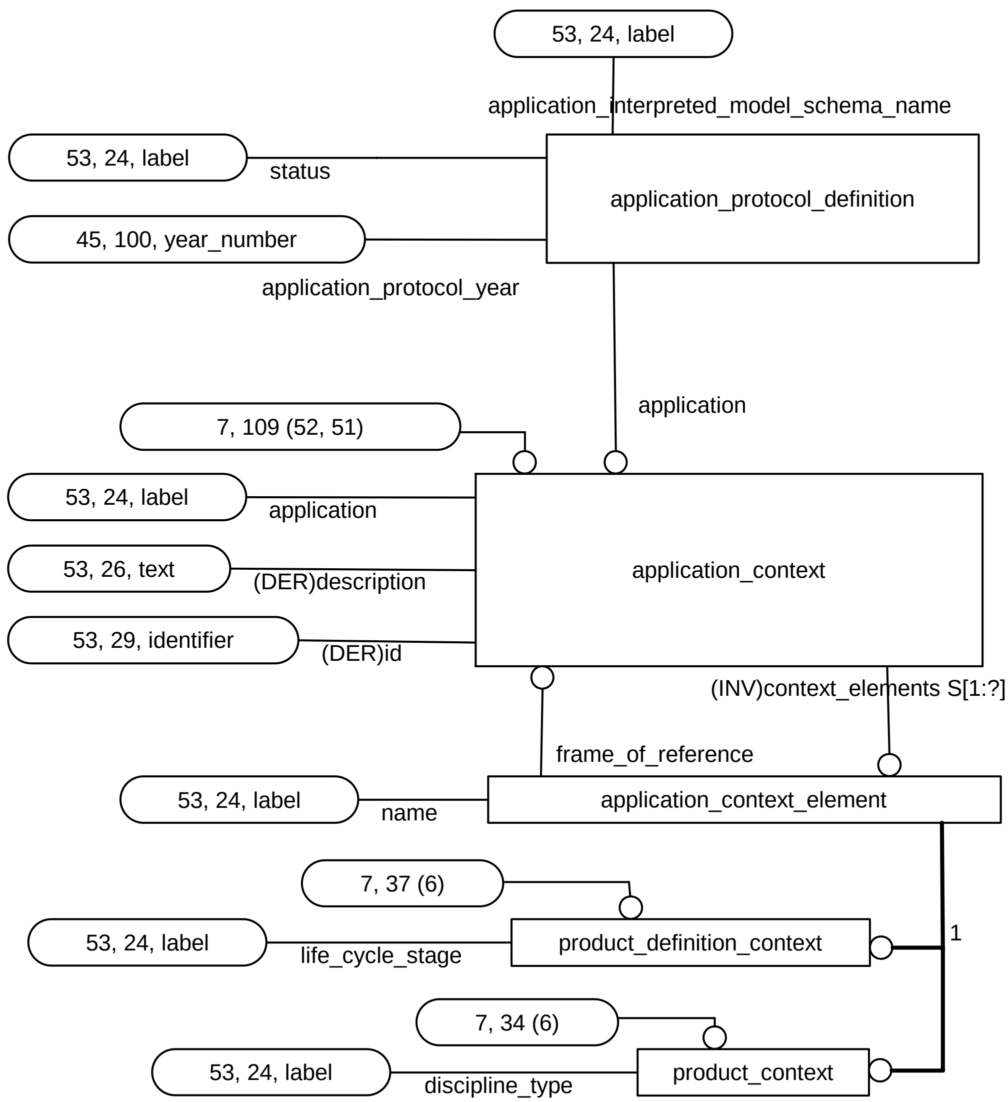


Figure H.7 — AIM EXPRESS-G diagram application context

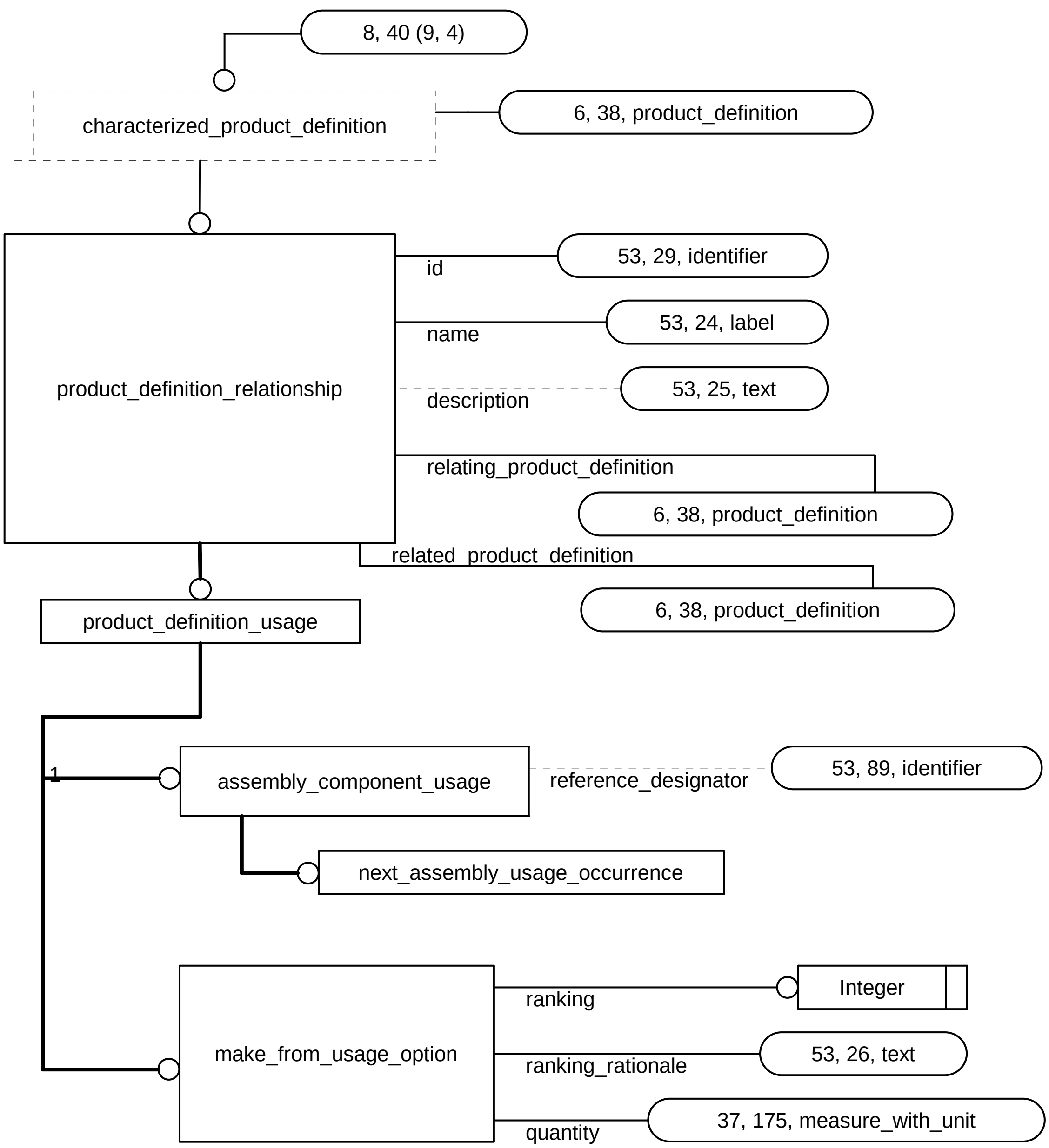


Figure H.8 — AIM EXPRESS-G diagramproduct definition relationship

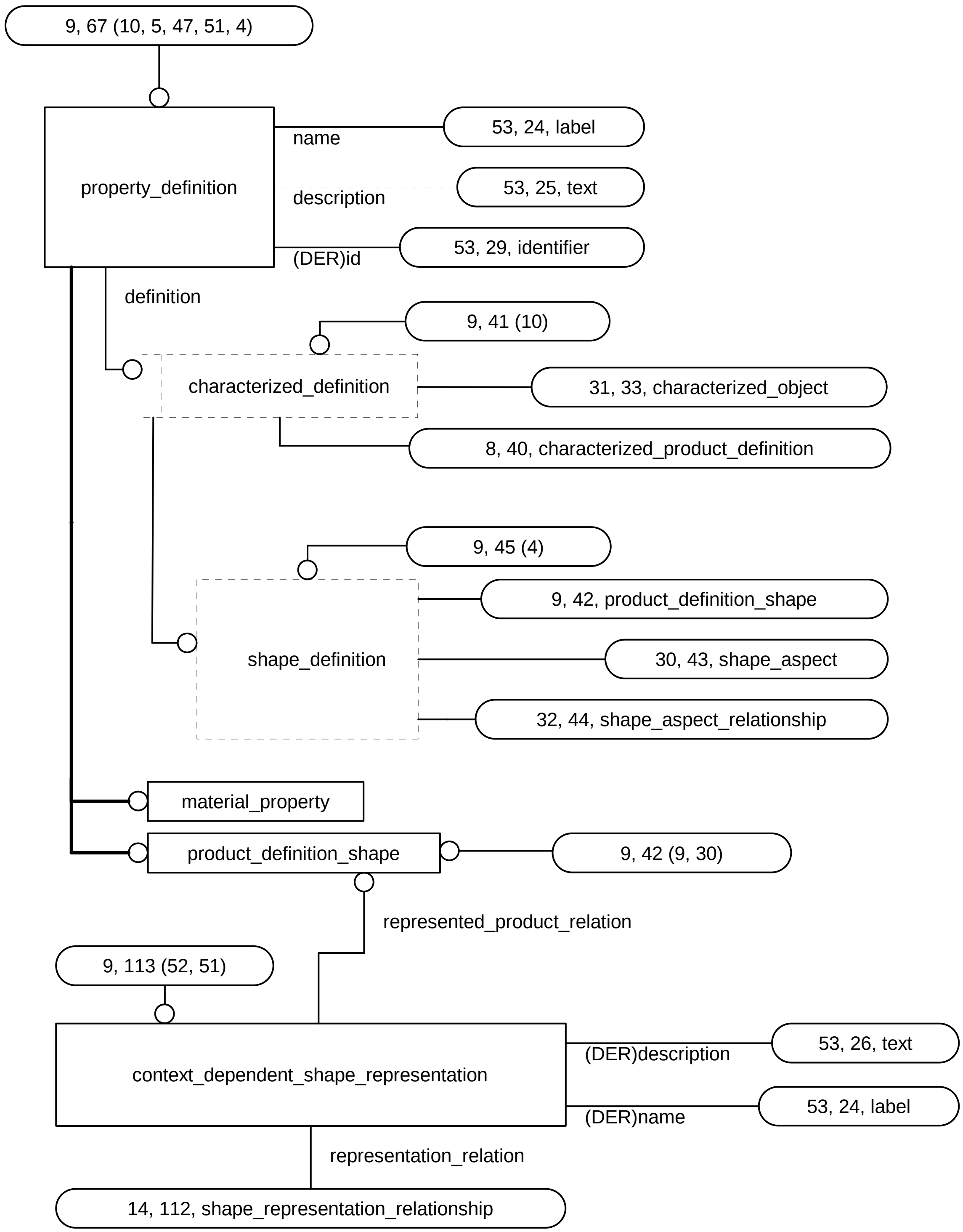


Figure H.9 — AIM EXPRESS-G diagram property definition

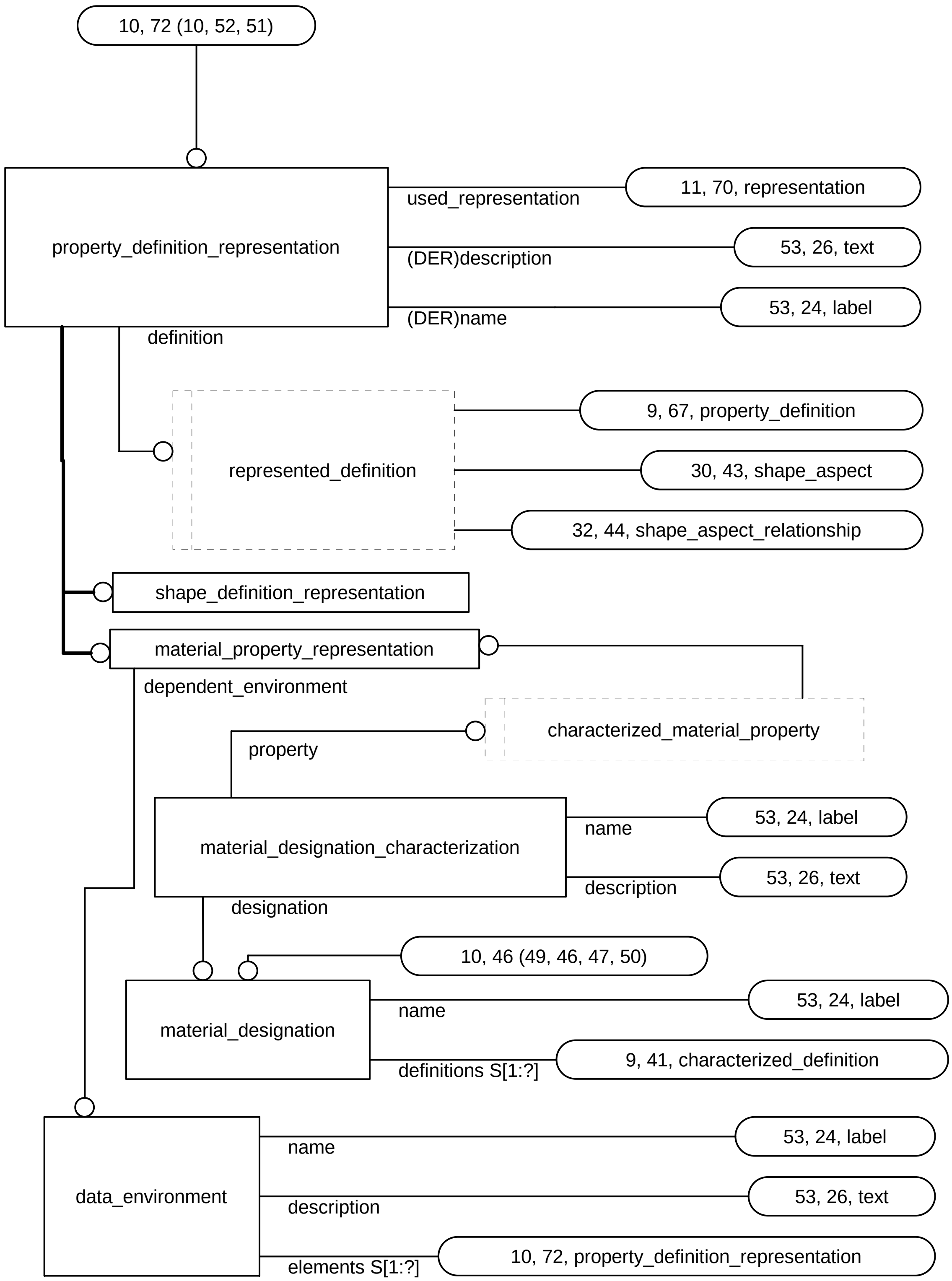


Figure H.10 — AIM EXPRESS-G diagram property definition representation

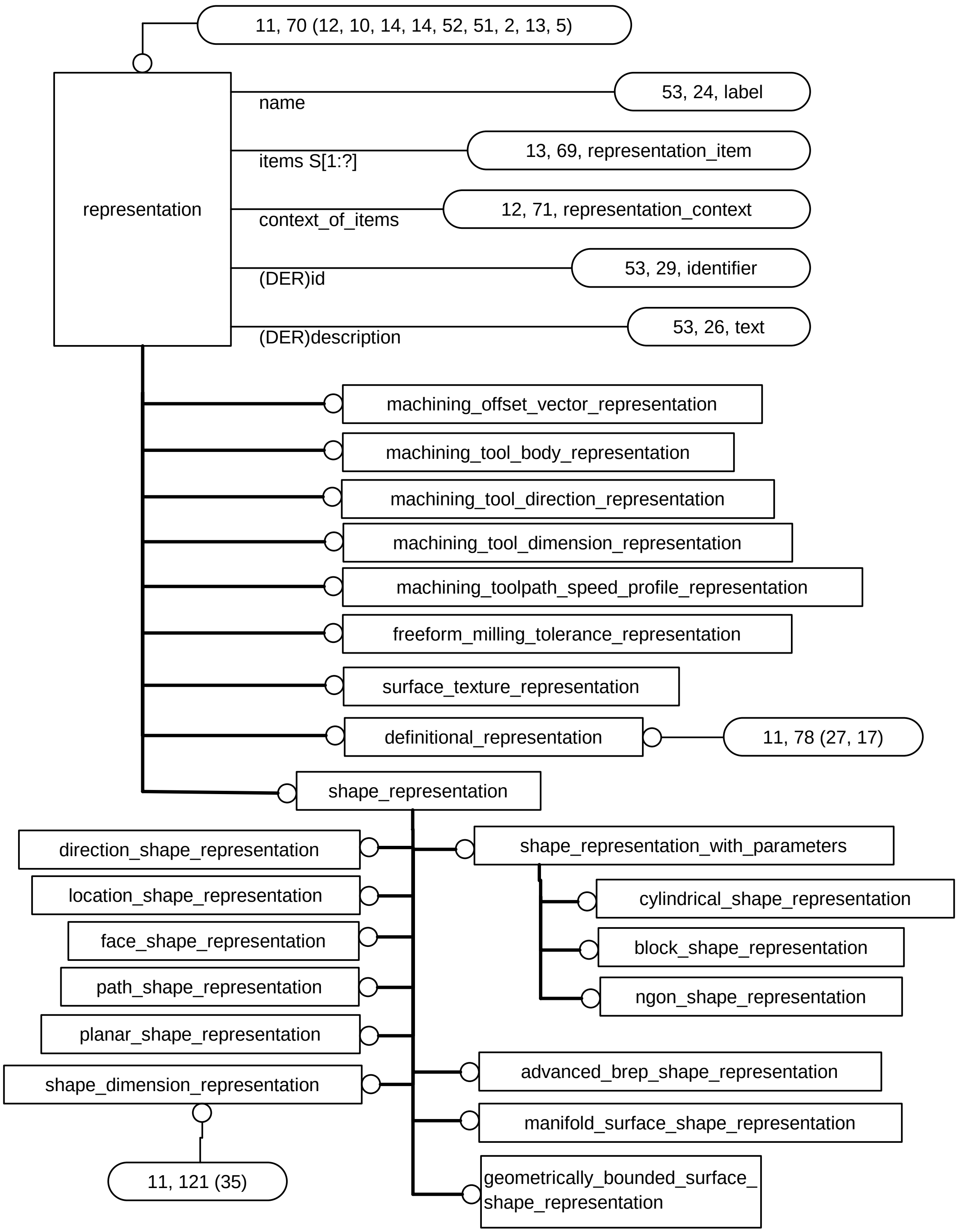


Figure H.11 — AIM EXPRESS-G diagram representation

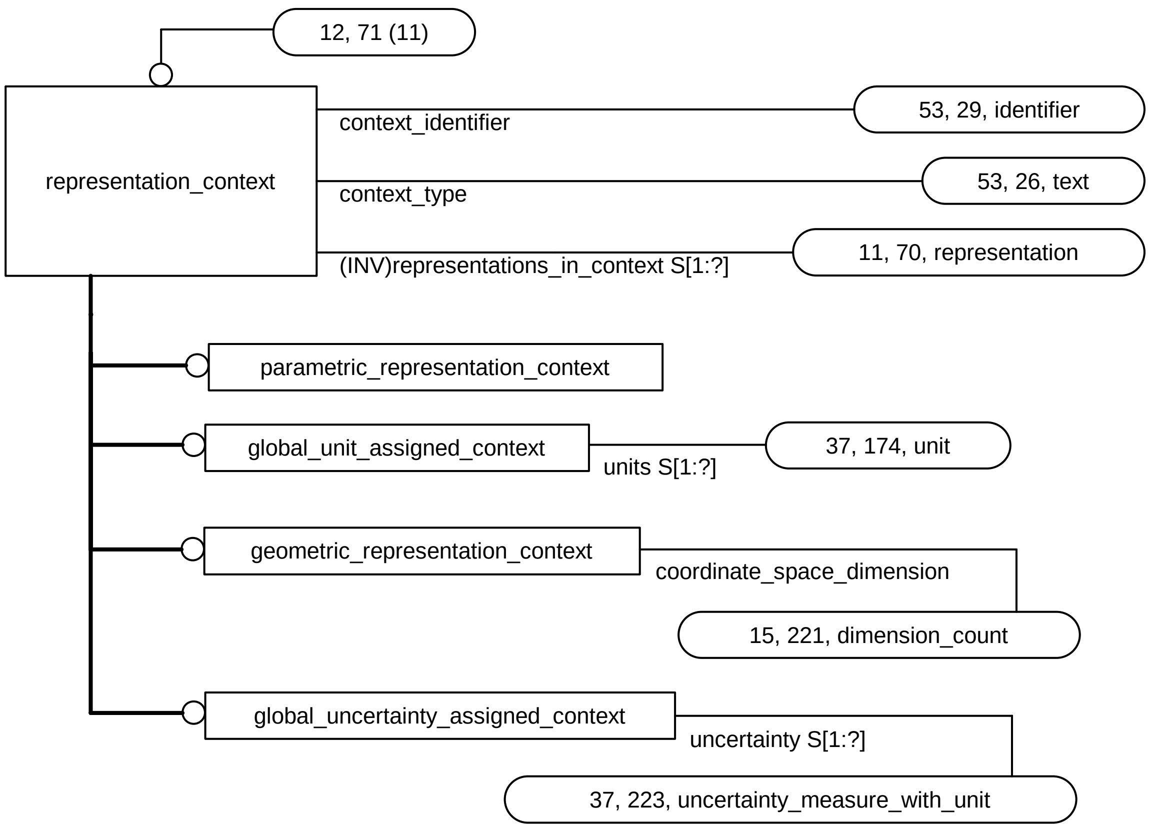


Figure H.12 — AIM EXPRESS-G diagram representation context

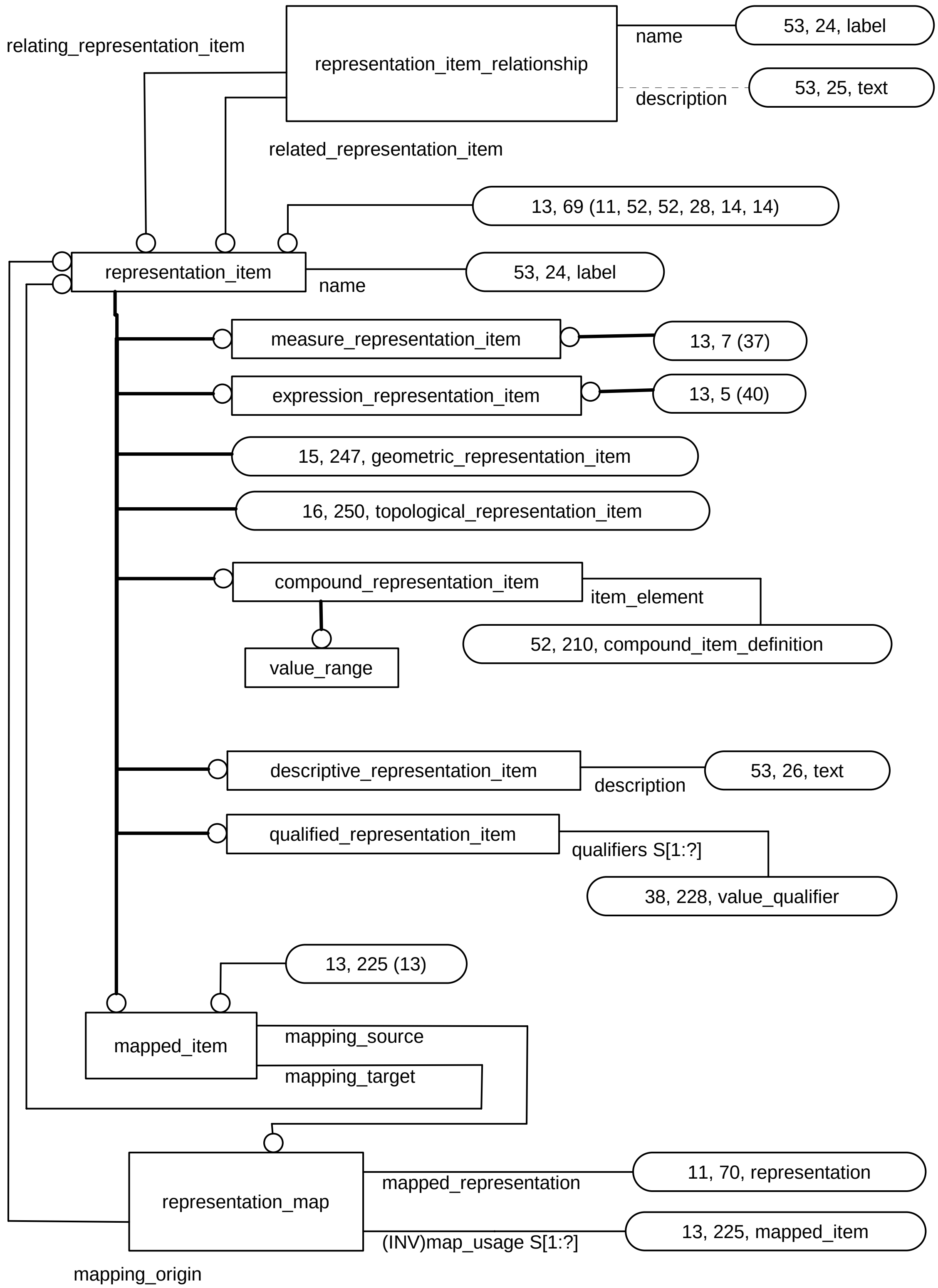


Figure H.13 — AIM EXPRESS-G diagram representation item

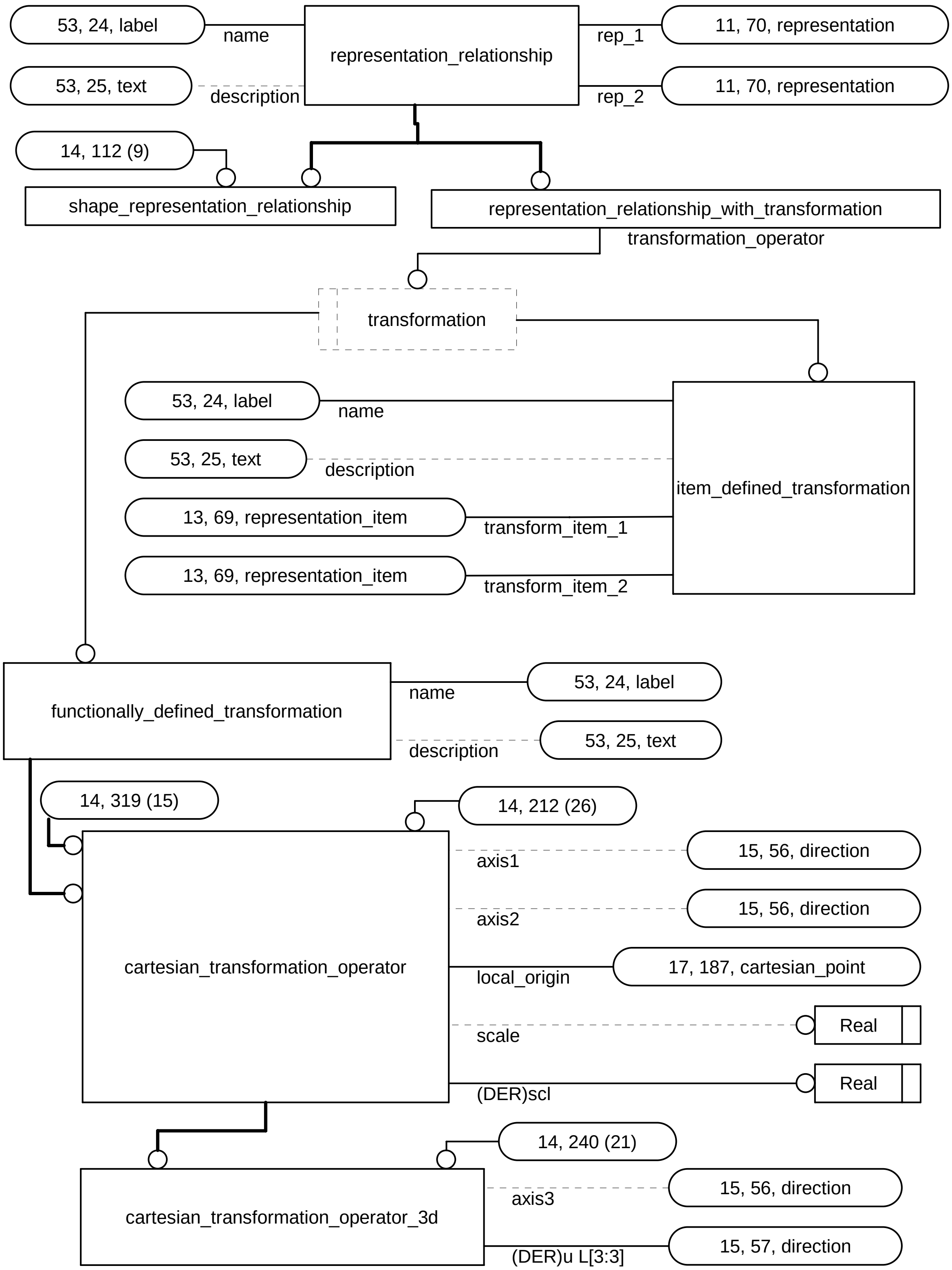


Figure H.14 — AIM EXPRESS-G diagram representation relationship

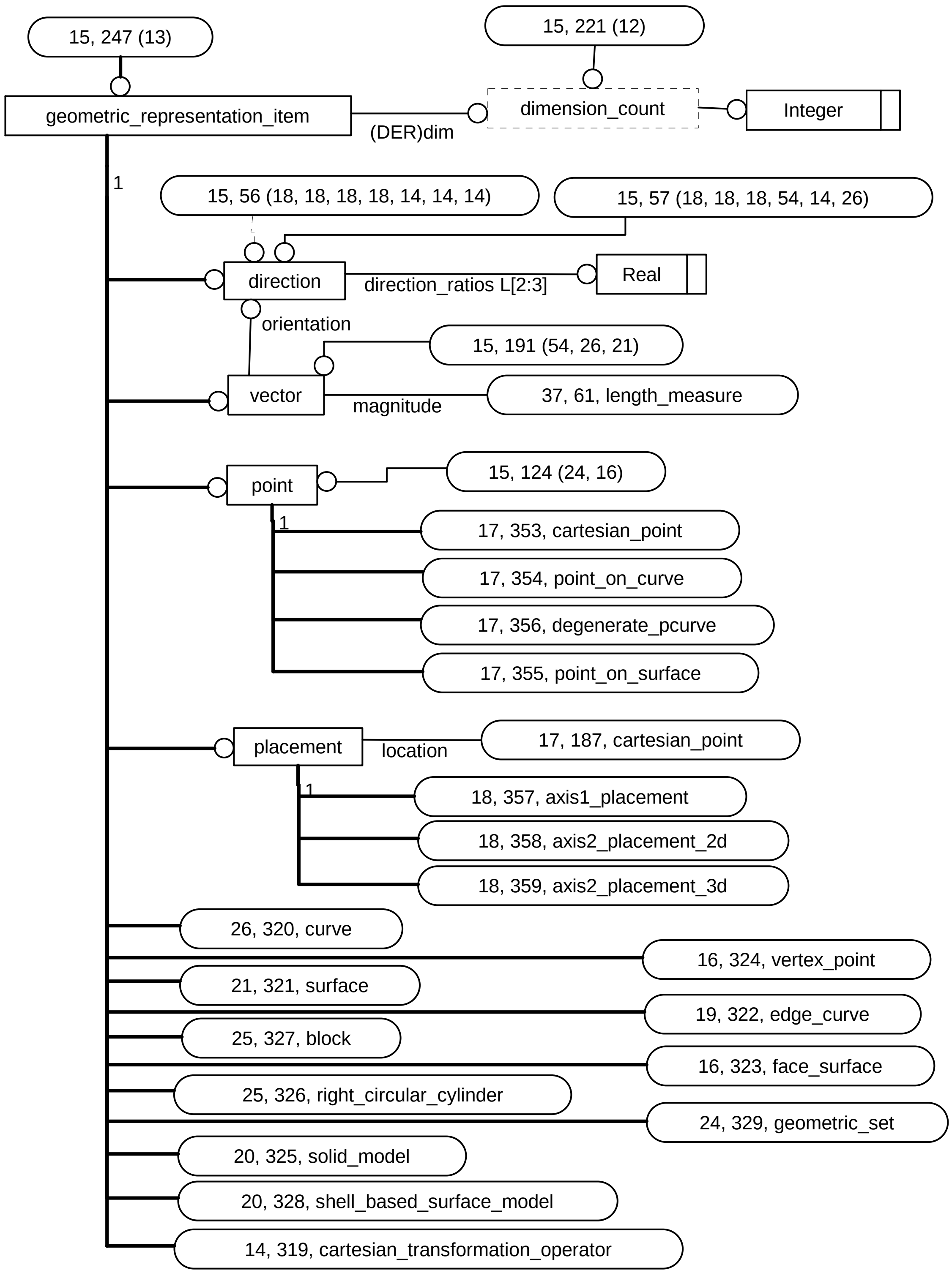


Figure H.15 — AIM EXPRESS-G diagram geometric representation item

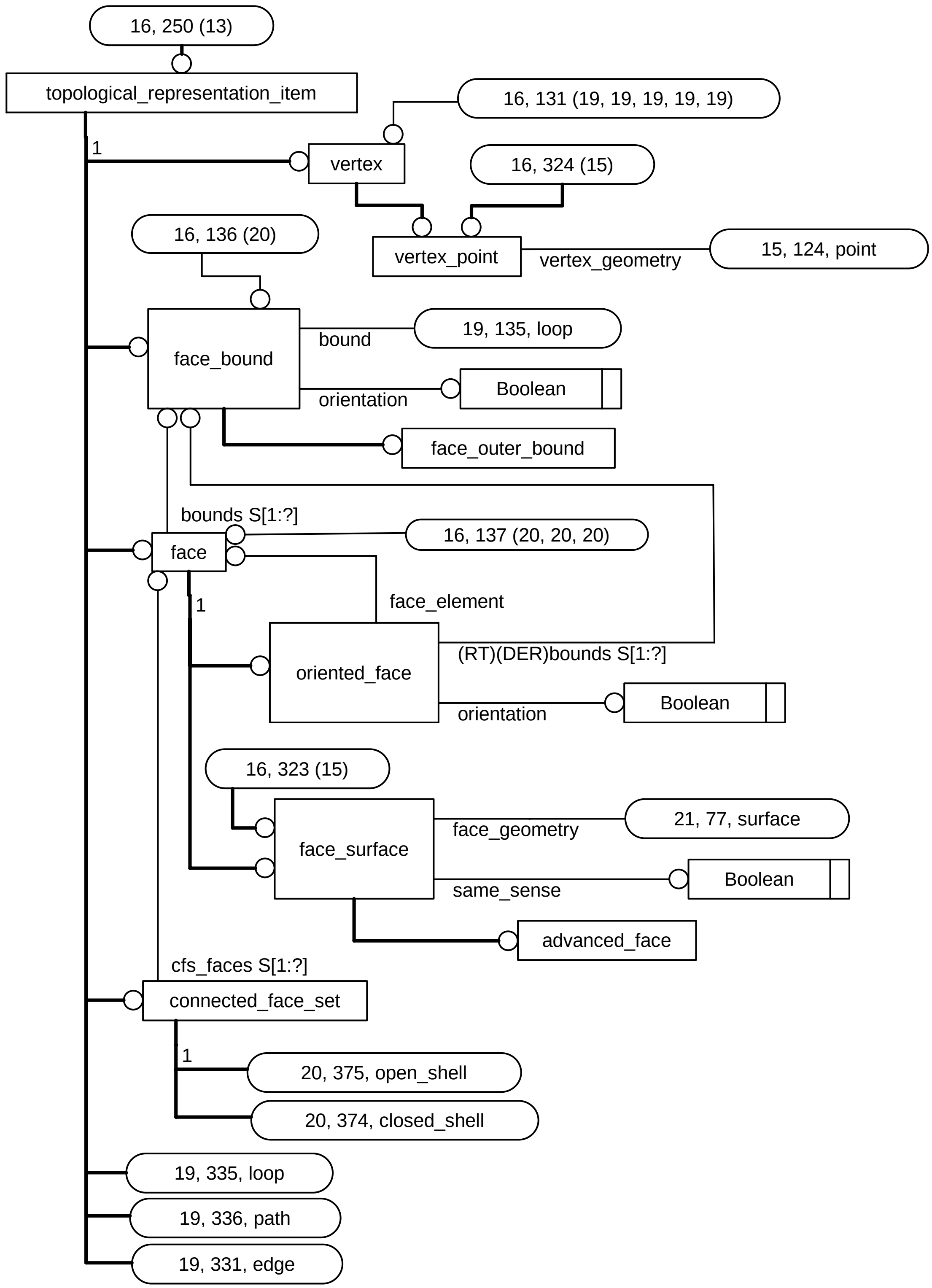


Figure H.16 — AIM EXPRESS-G diagram topological representation item

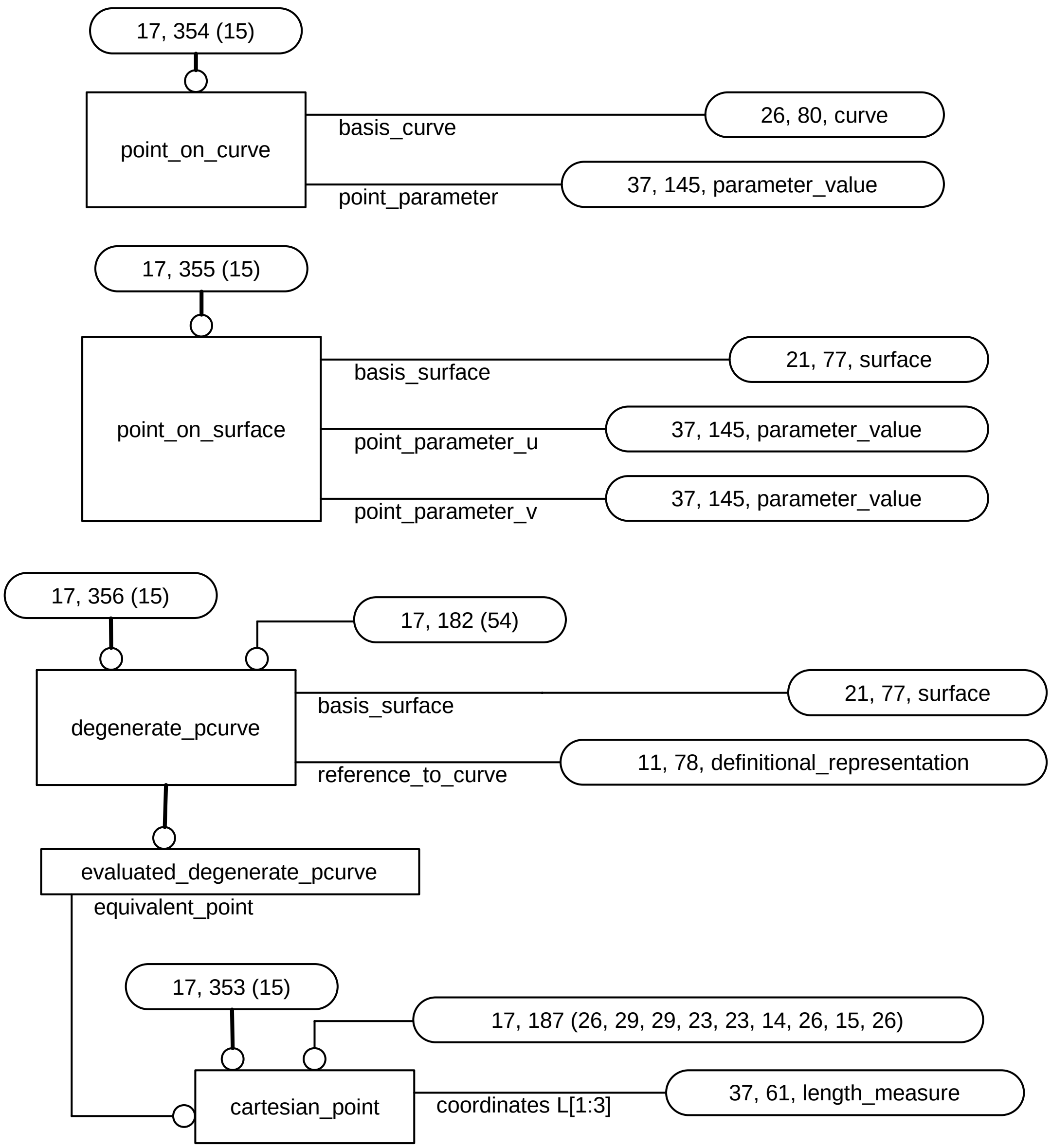


Figure H.17 — AIM EXPRESS-G diagram points

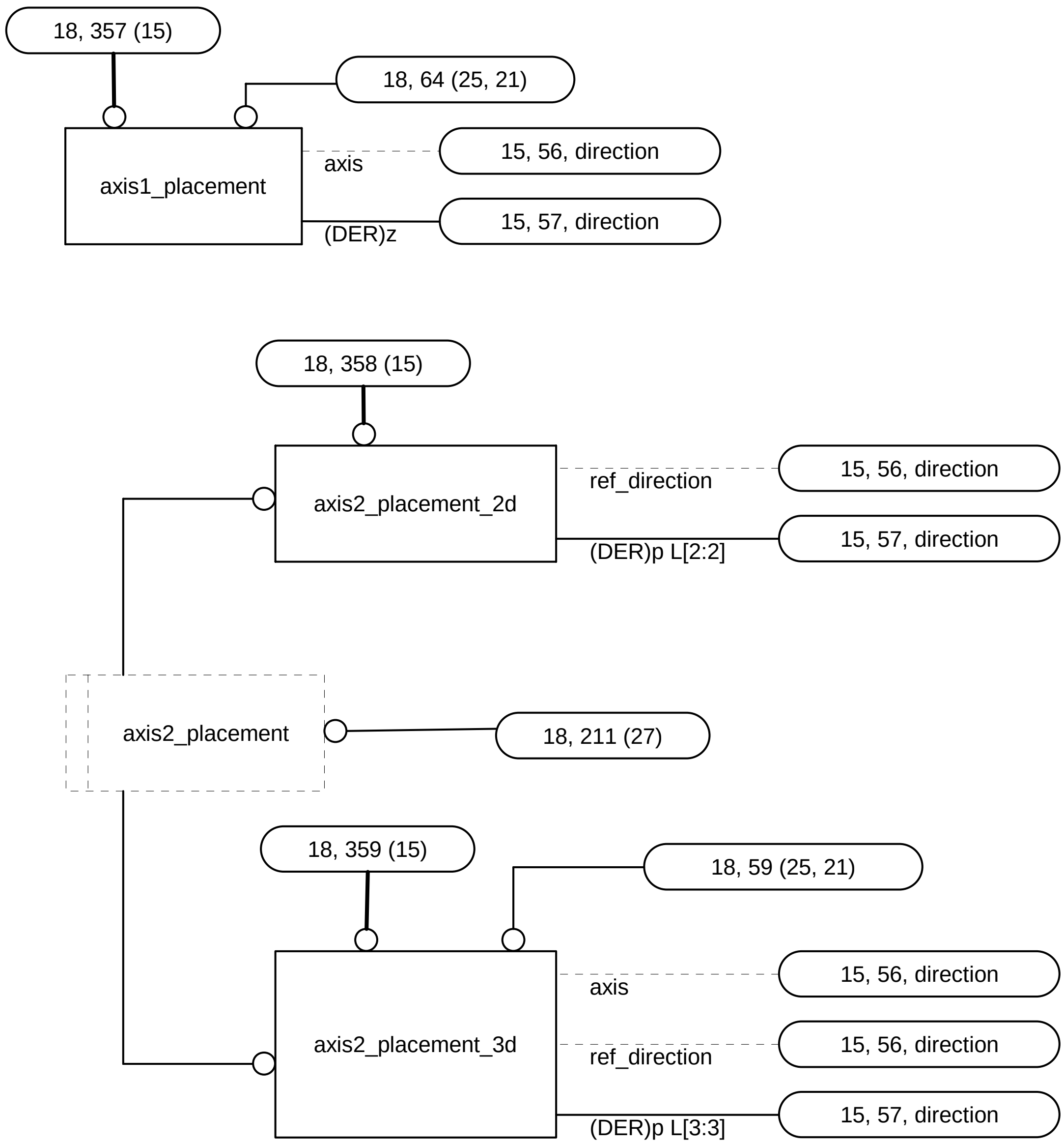


Figure H.18 — AIM EXPRESS-G diagram placements

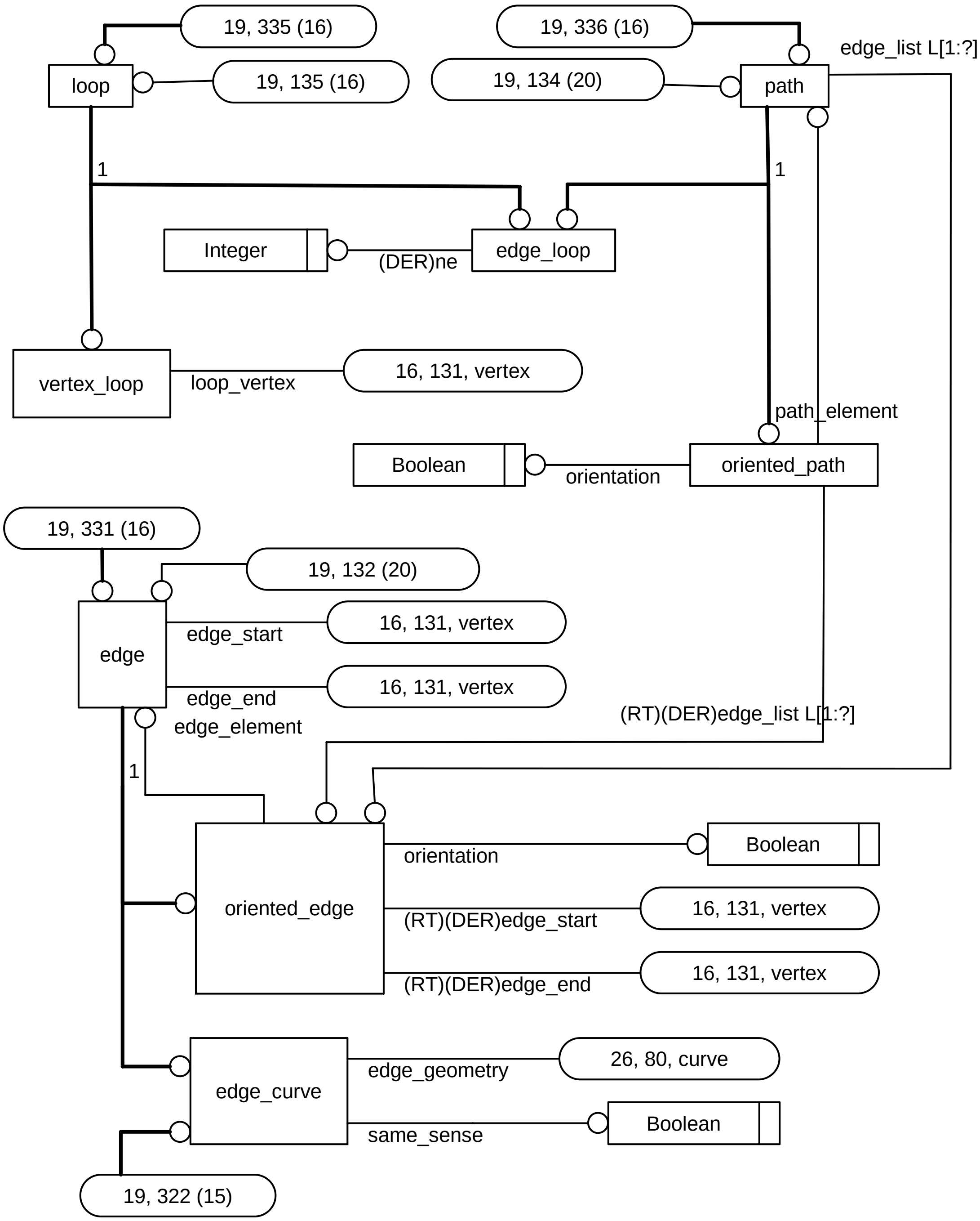


Figure H.19 — AIM EXPRESS-G diagram loop and edge

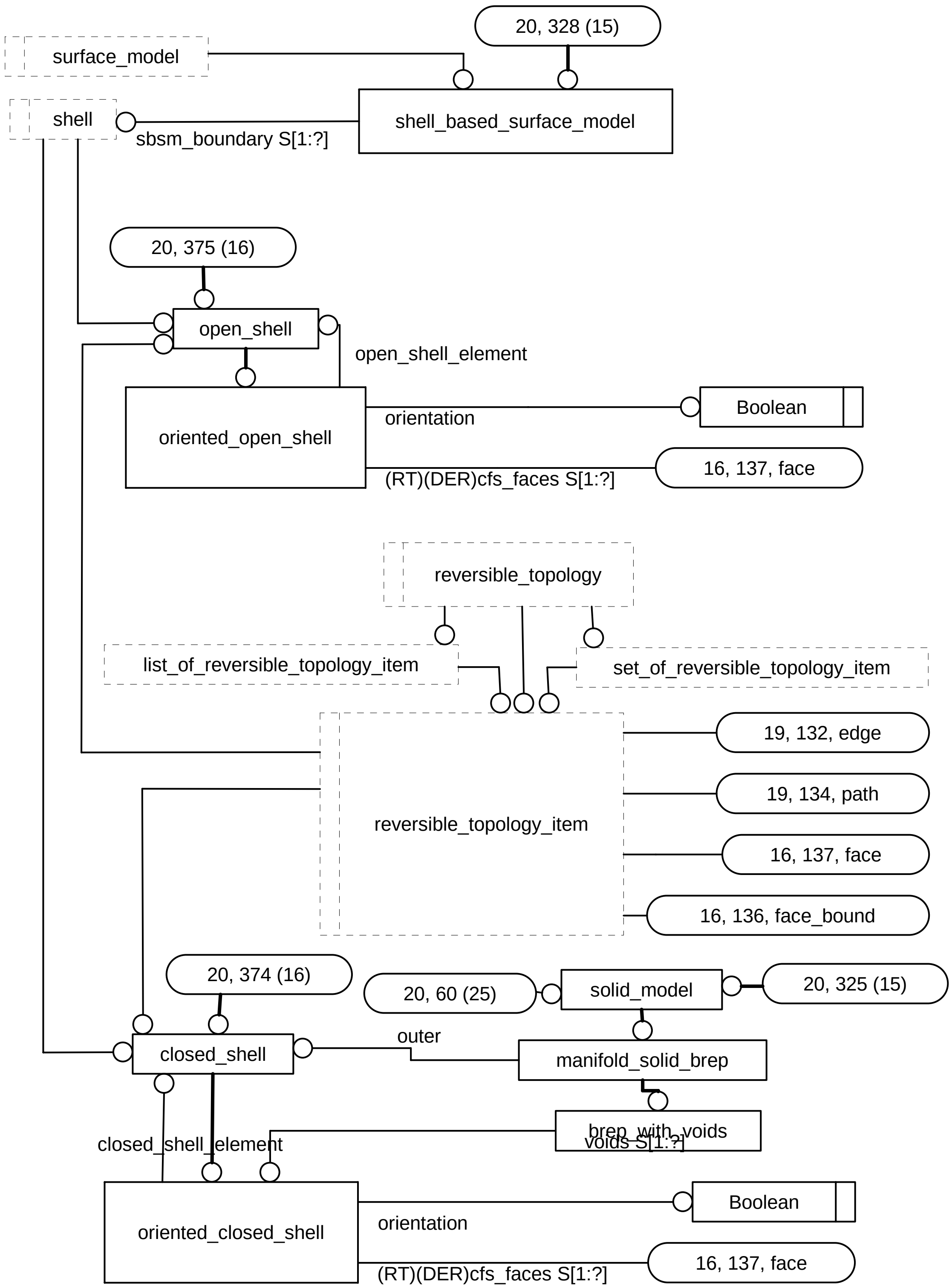


Figure H.20 — AIM EXPRESS-G diagram shells

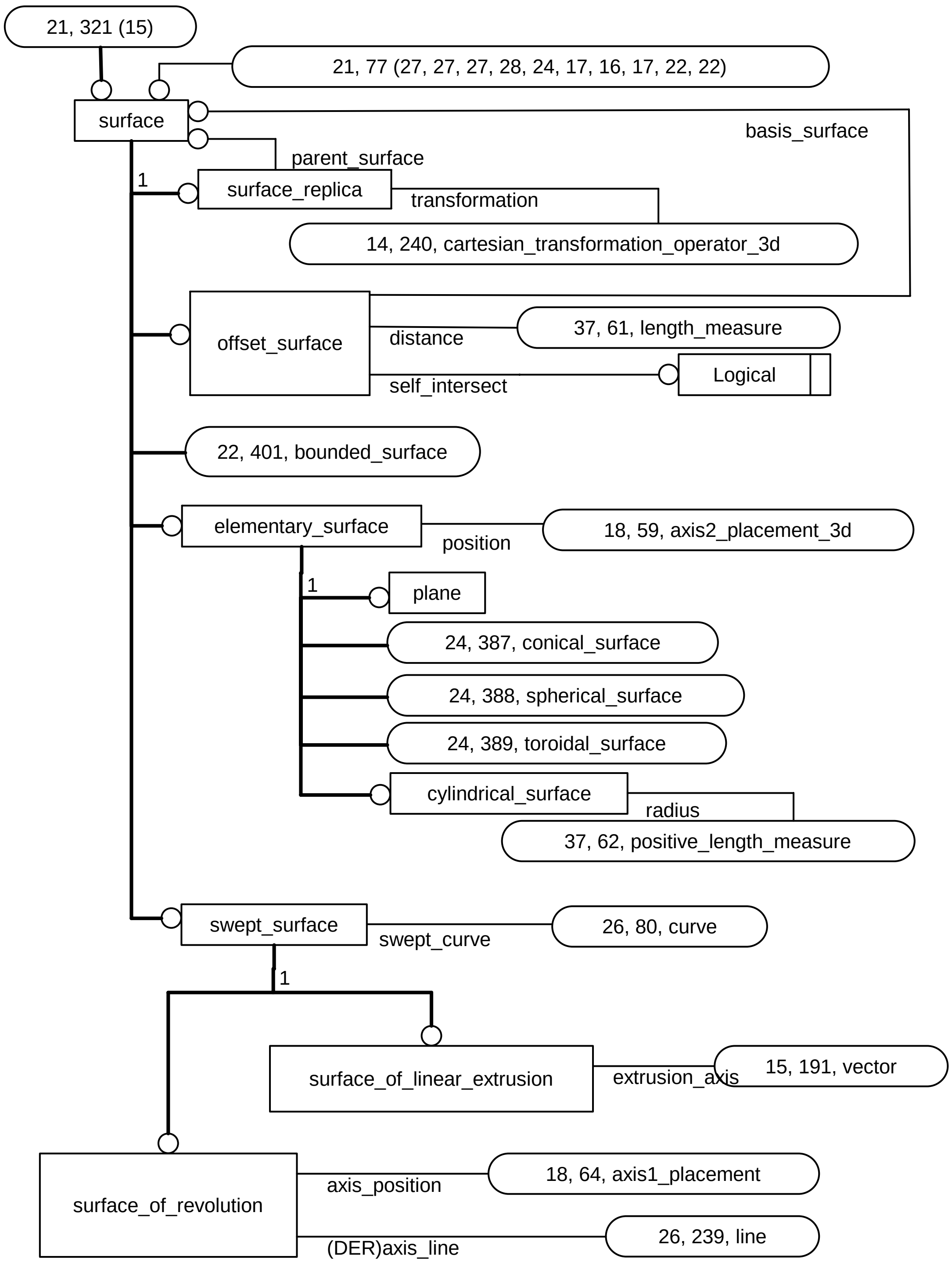


Figure H.21 — AIM EXPRESS-G diagram surface

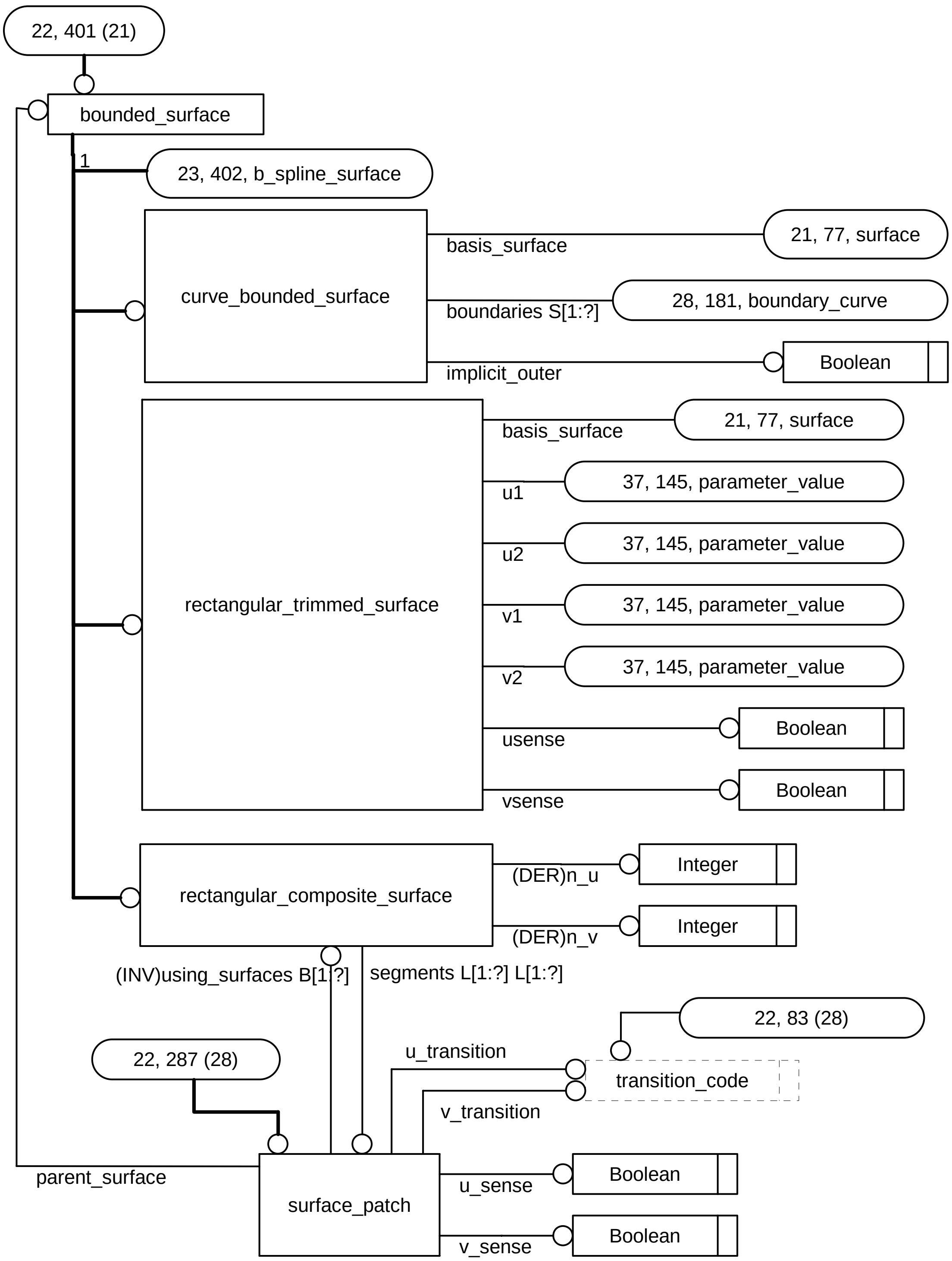


Figure H.22 — AIM EXPRESS-G diagram bounded surface

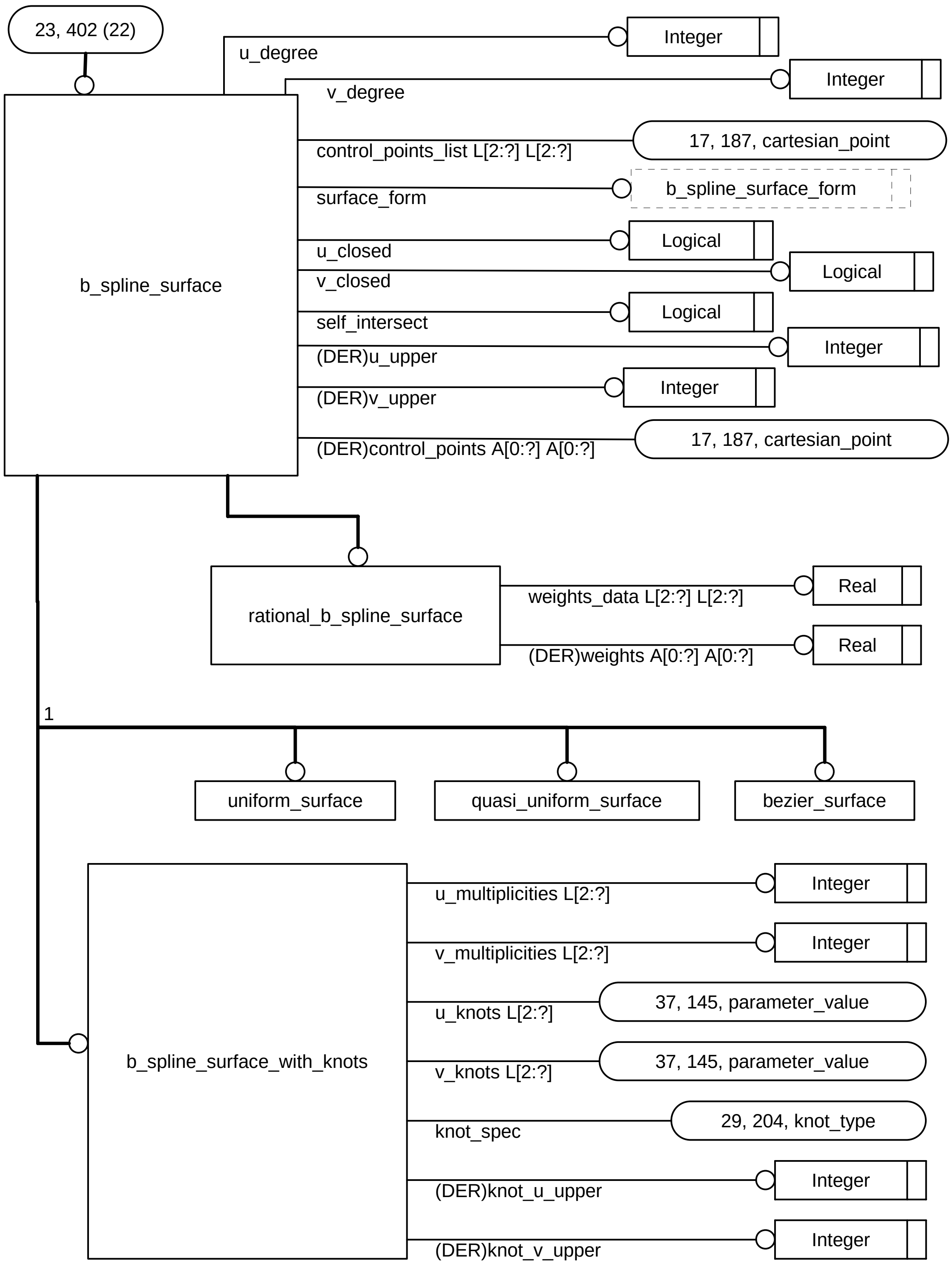


Figure H.23 — AIM EXPRESS-G diagram b-spline surface

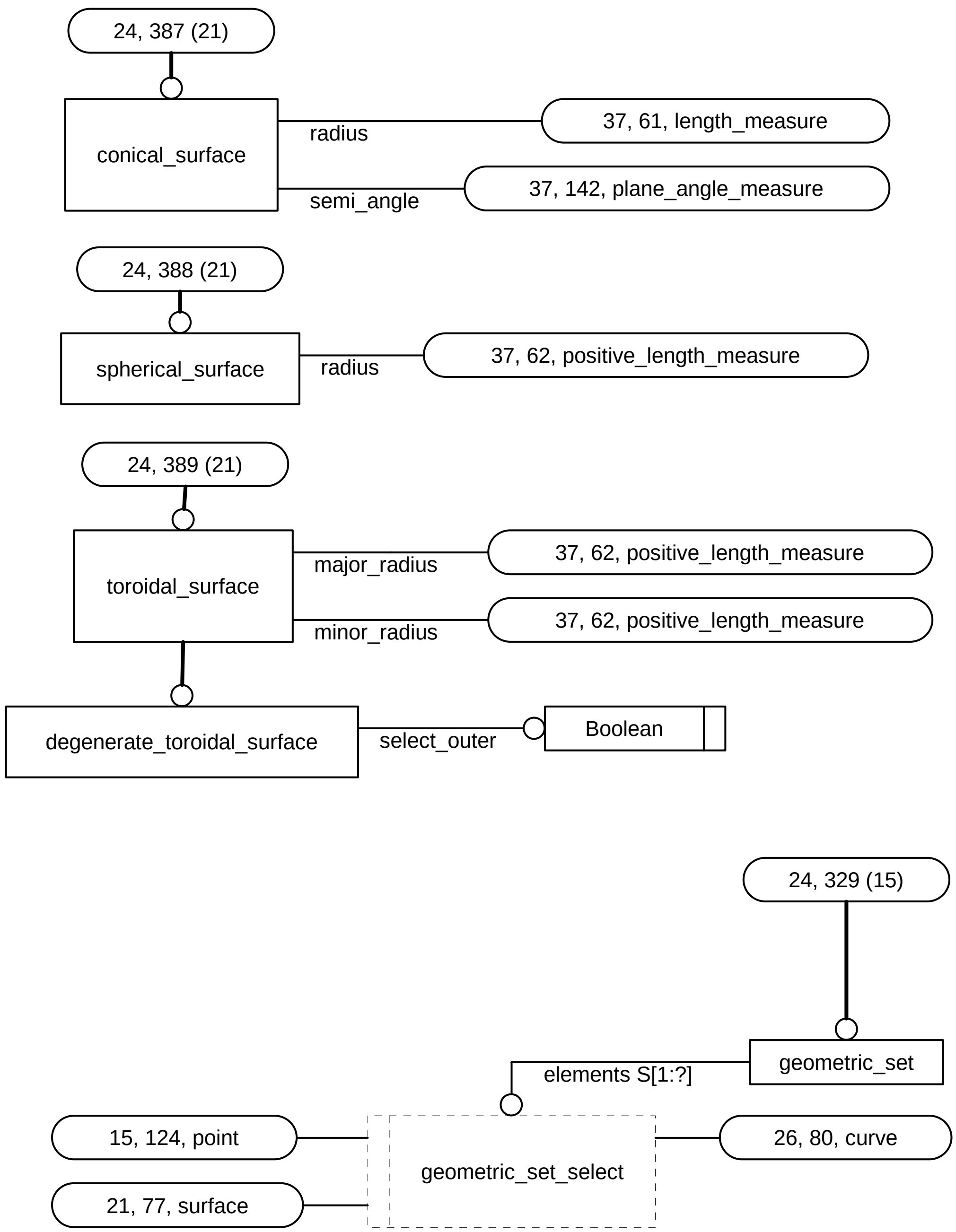


Figure H.24 — AIM EXPRESS-G diagram other surfaces

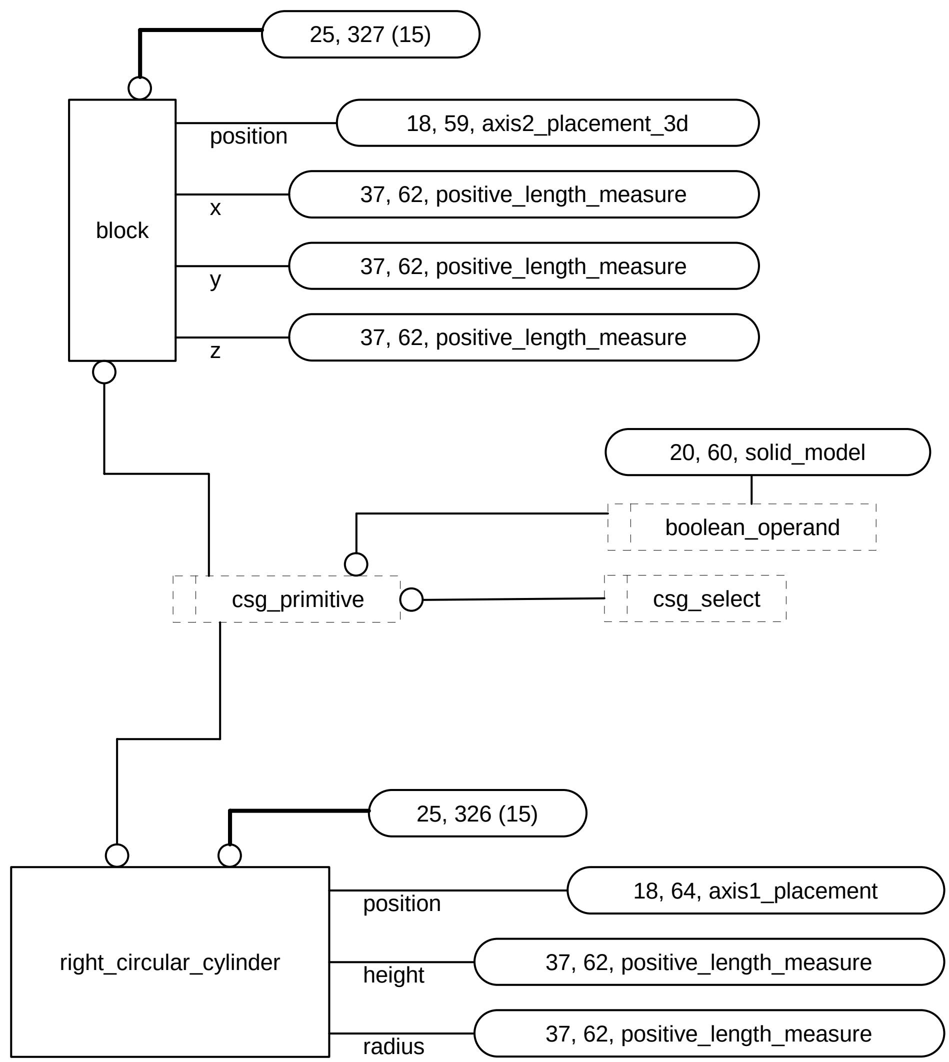


Figure H.25 — AIM EXPRESS-G diagram block and cylinder

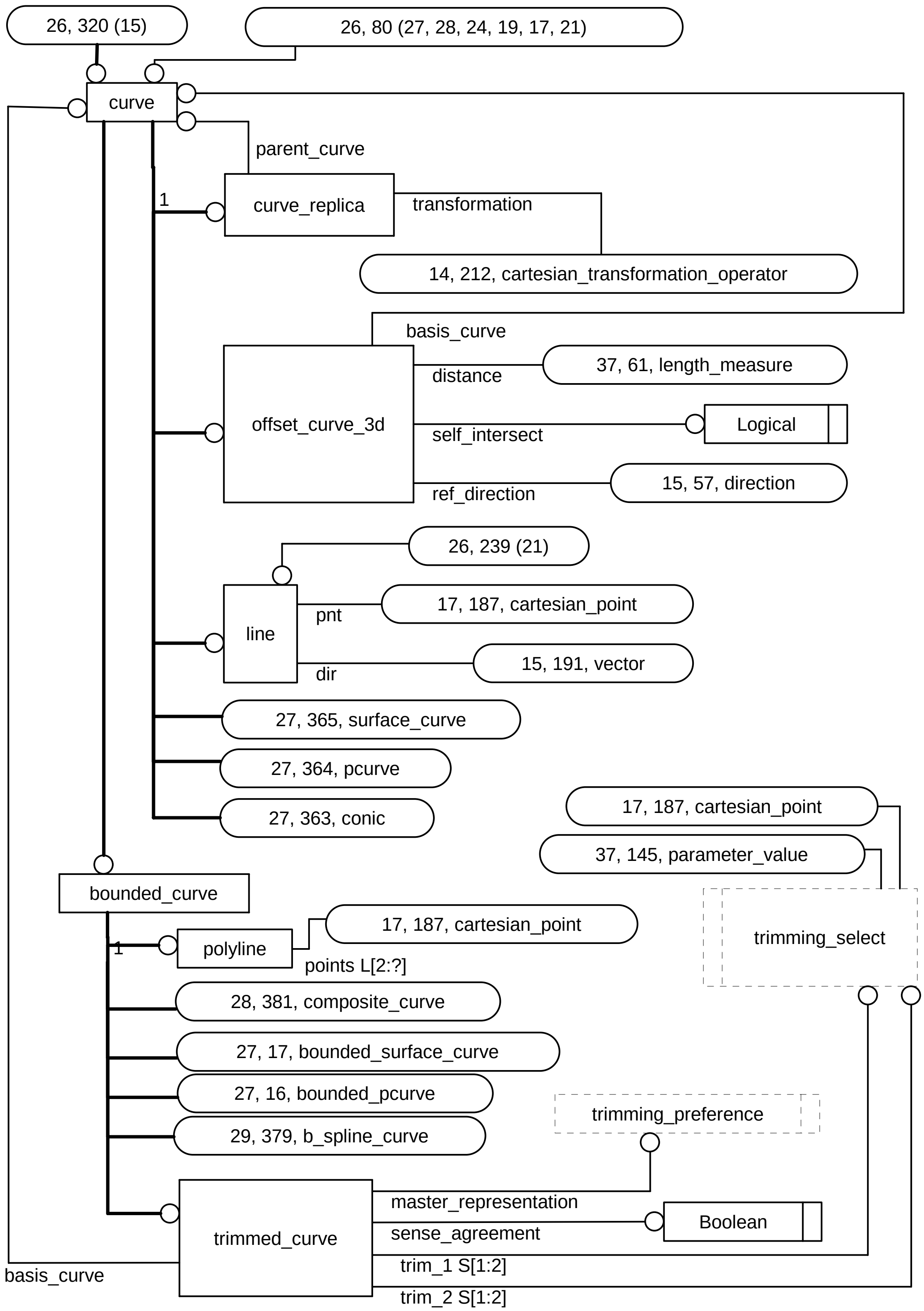


Figure H.26 — AIM EXPRESS-G diagram curve

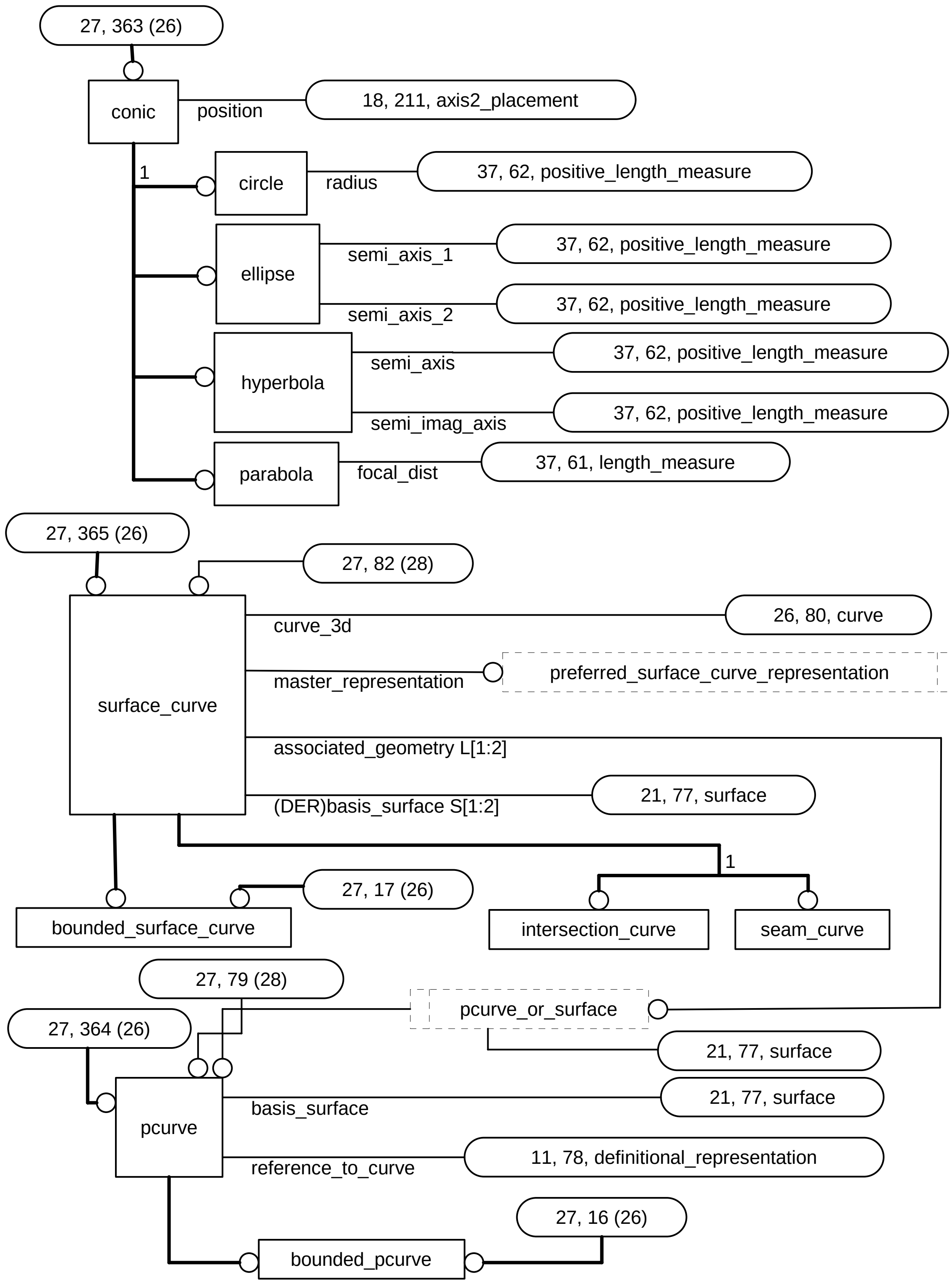


Figure H.27 — AIM EXPRESS-G diagram conics

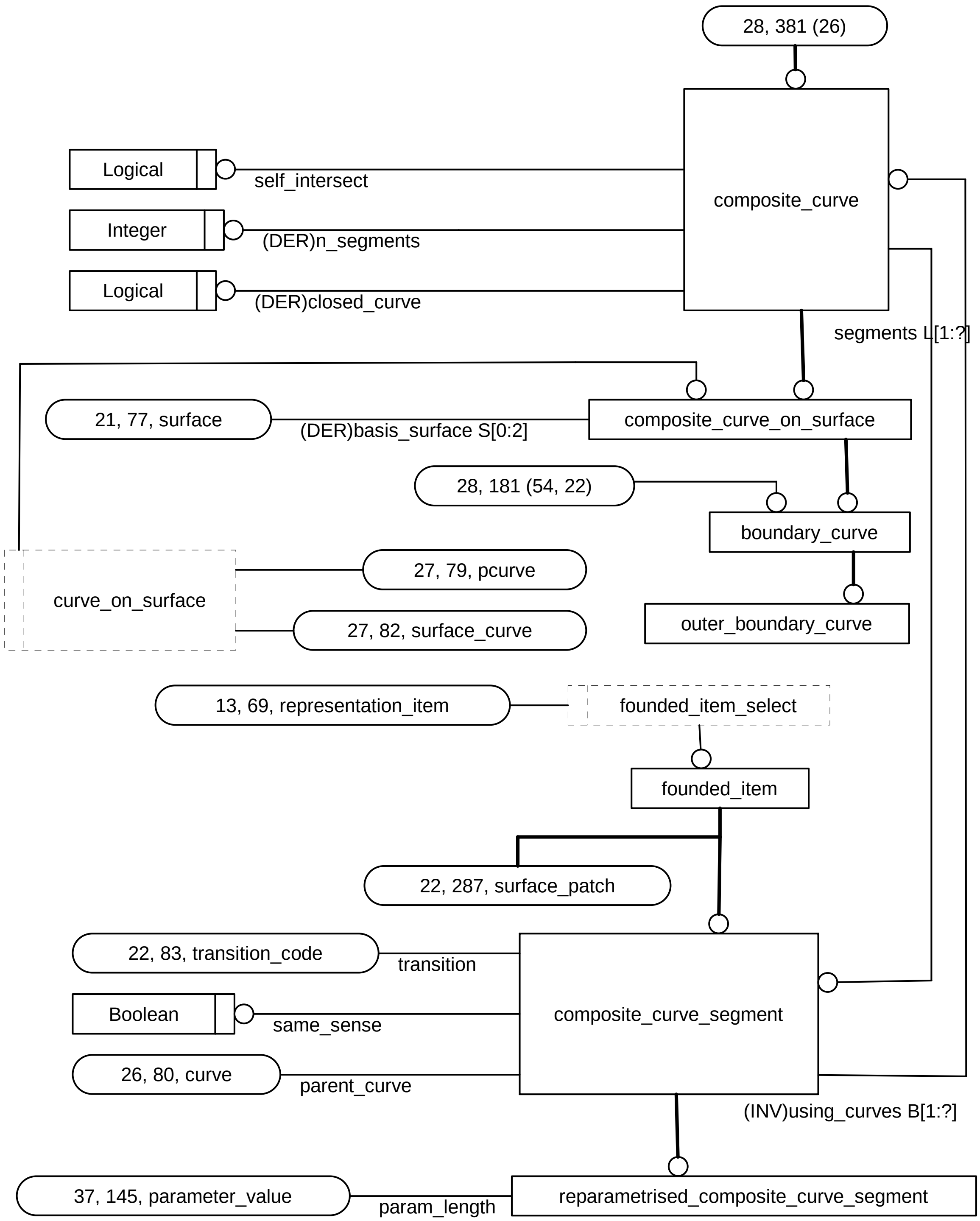


Figure H.28 — AIM EXPRESS-G diagram composite curve

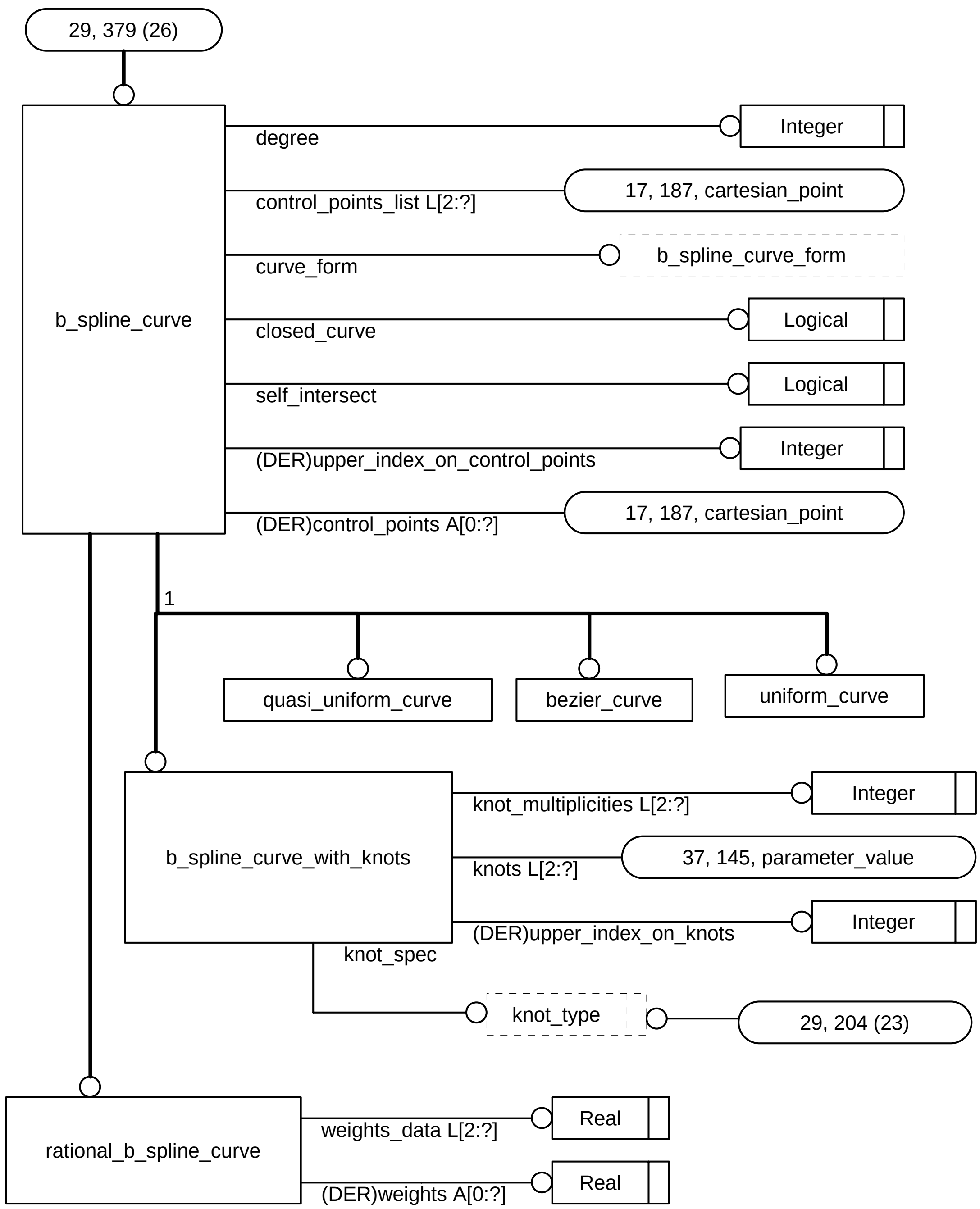


Figure H.29 — AIM EXPRESS-G diagram b-spline curve

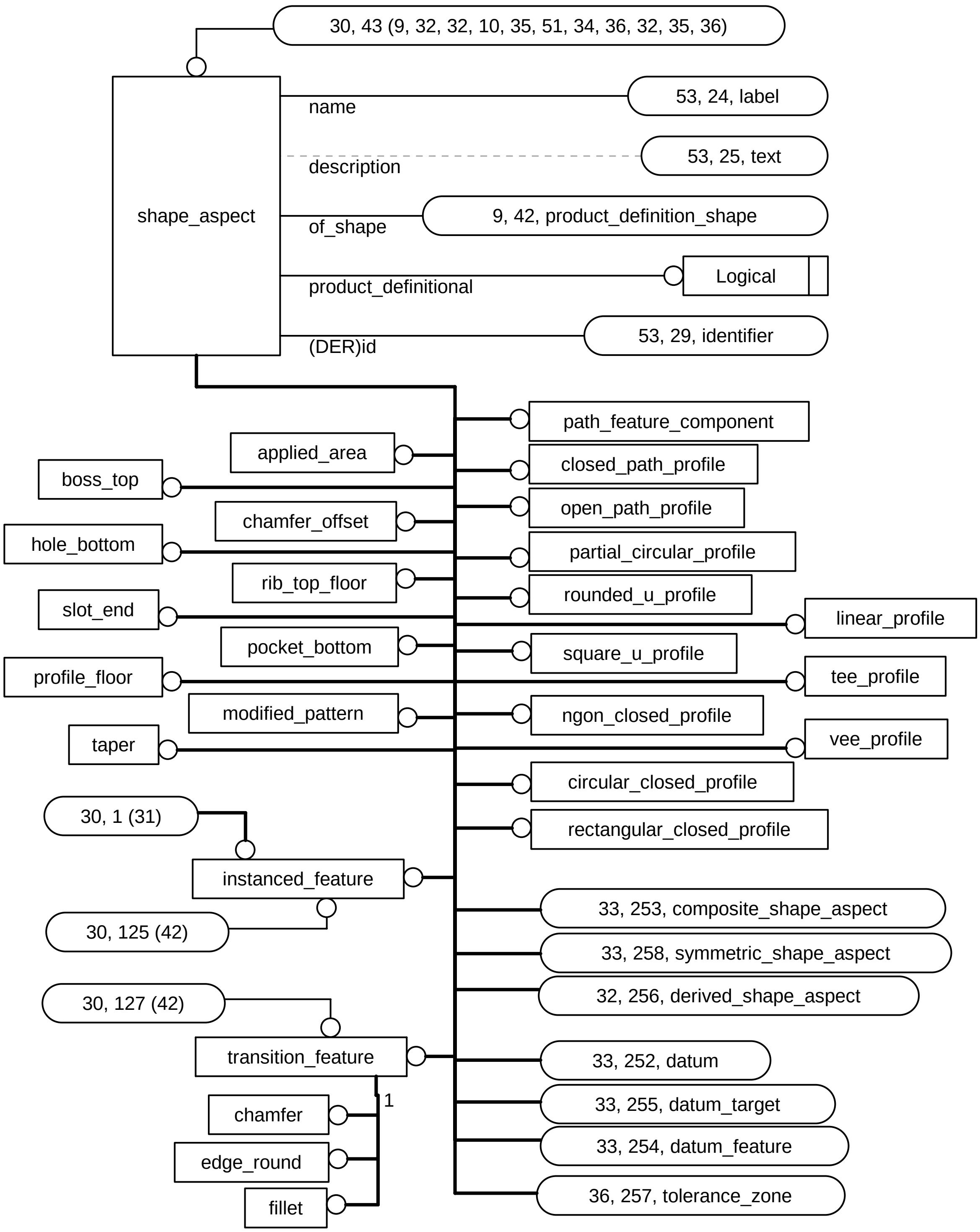


Figure H.30 — AIM EXPRESS-G diagram shape aspect

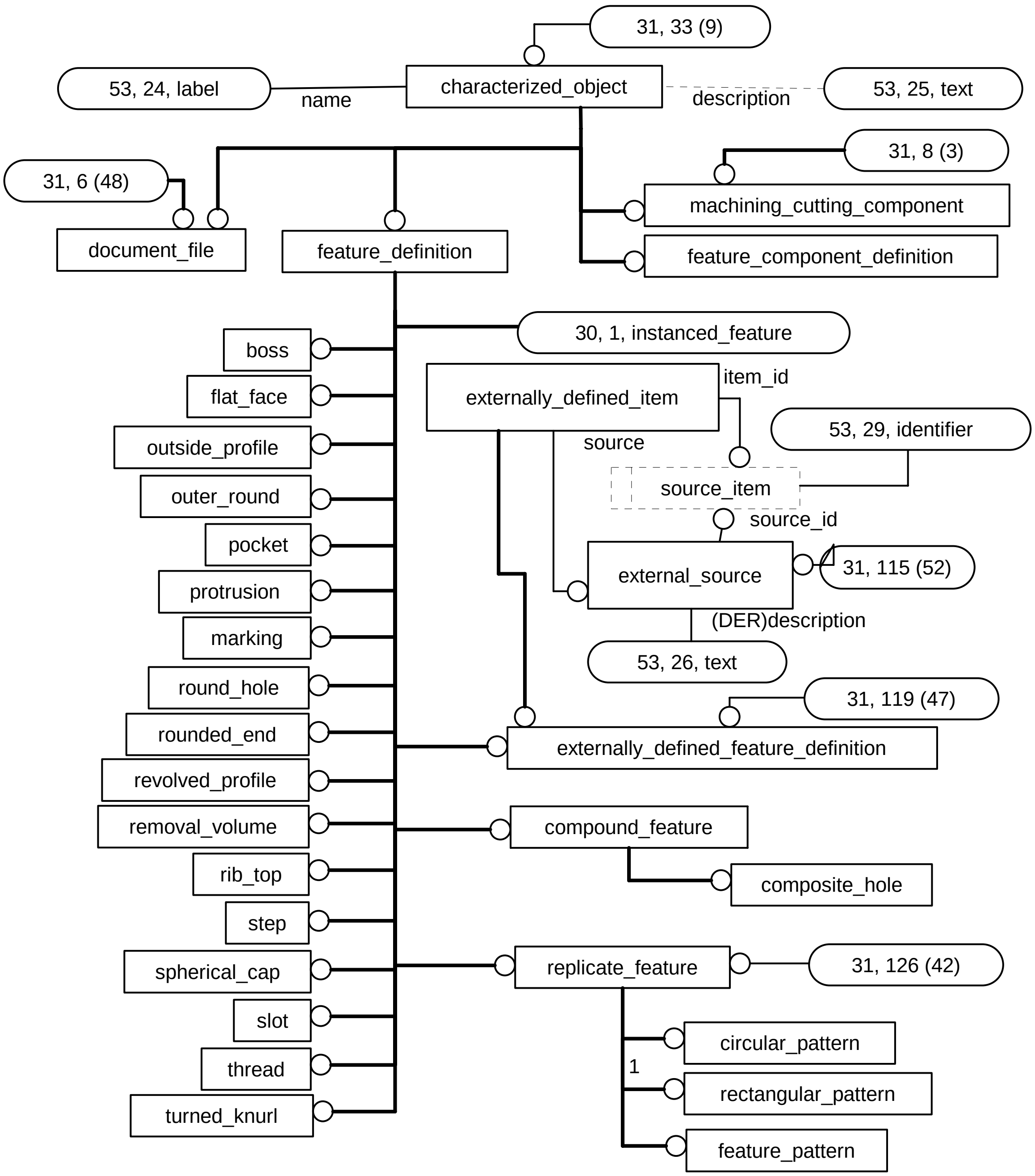


Figure H.31 — AIM EXPRESS-G diagram characterized object

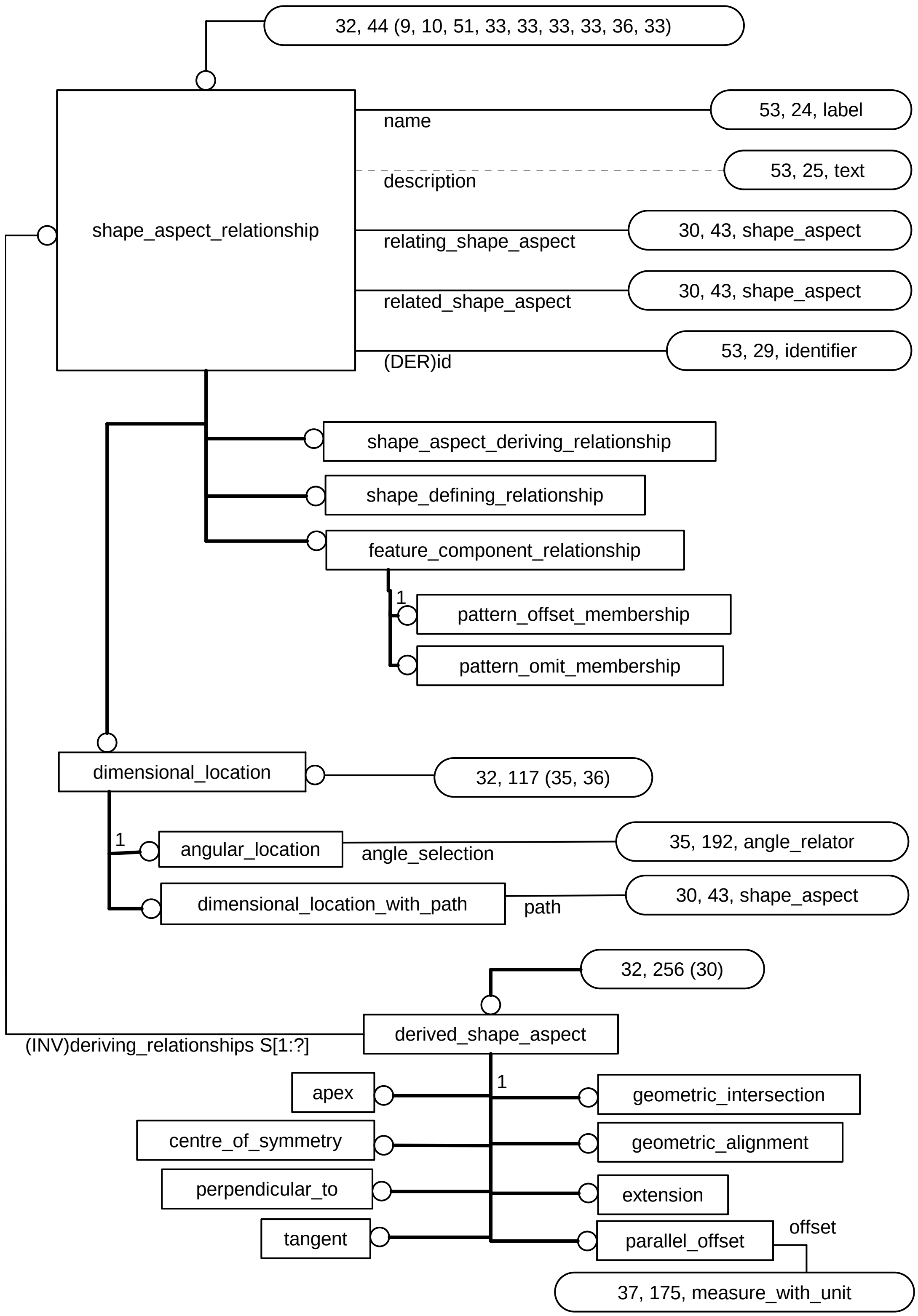


Figure H.32 — AIM EXPRESS-G diagram shape aspect relationship

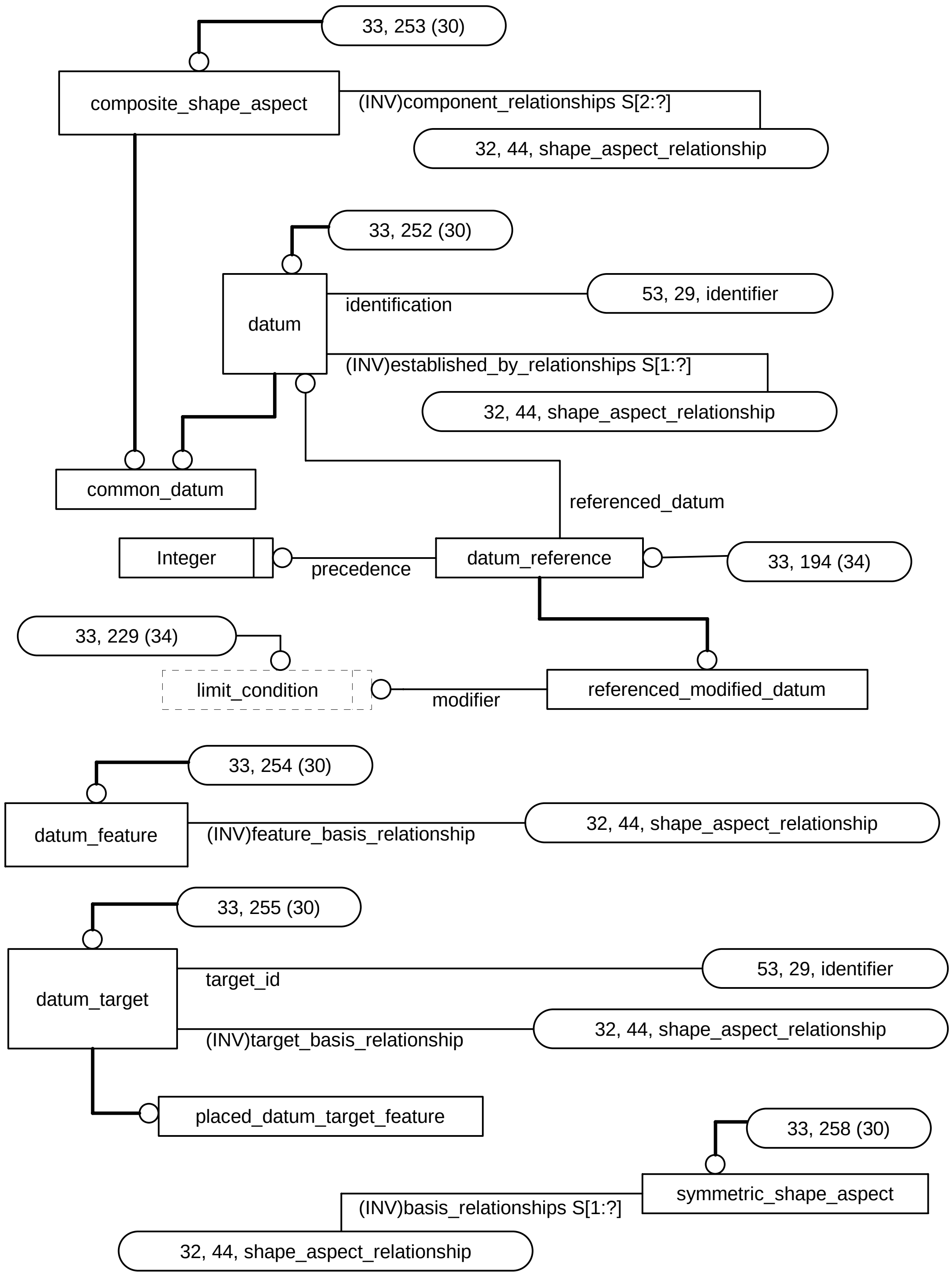


Figure H.33 — AIM EXPRESS-G diagram composite shape aspect

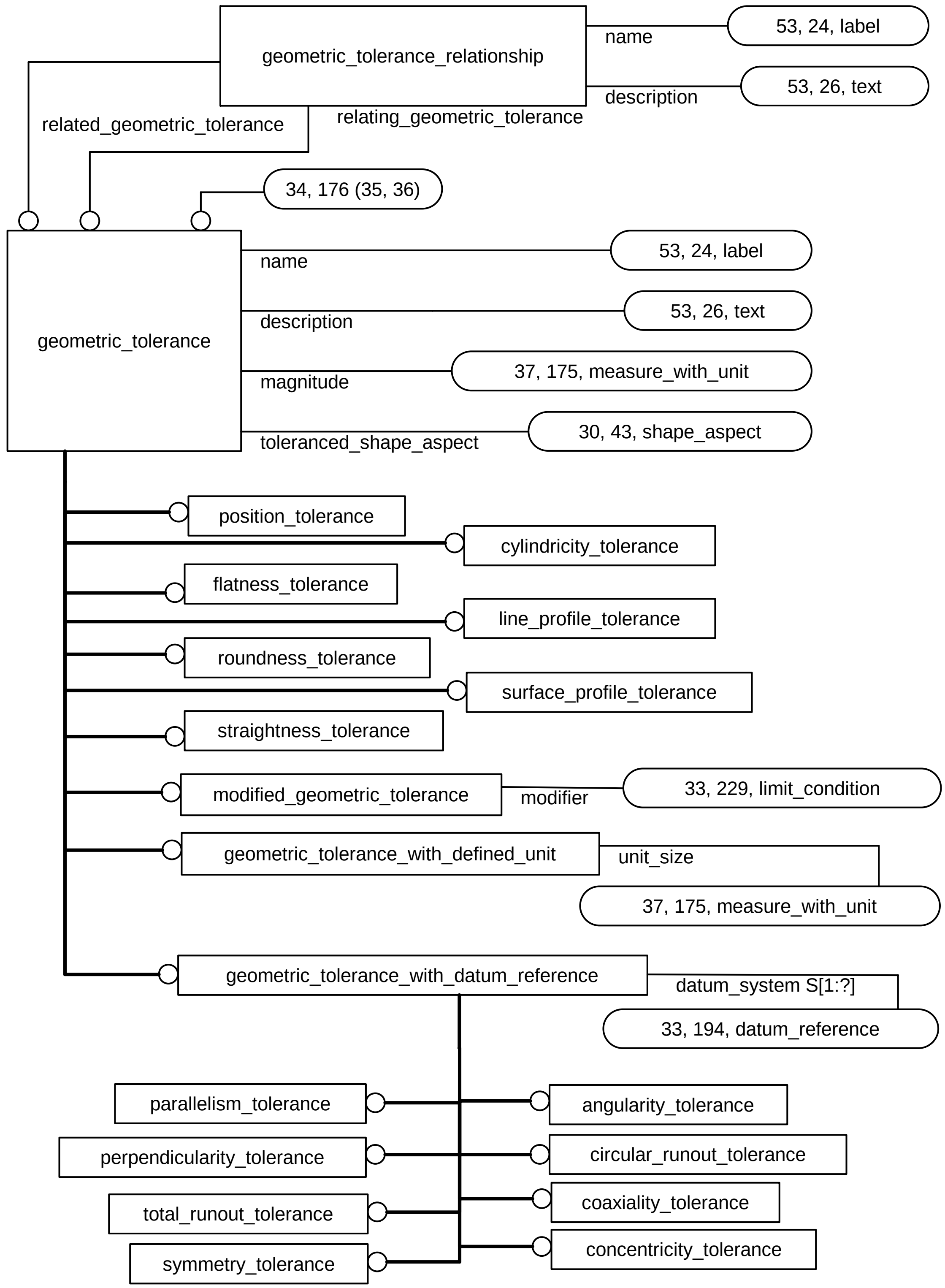


Figure H.34 — AIM EXPRESS-G diagram geometric tolerance

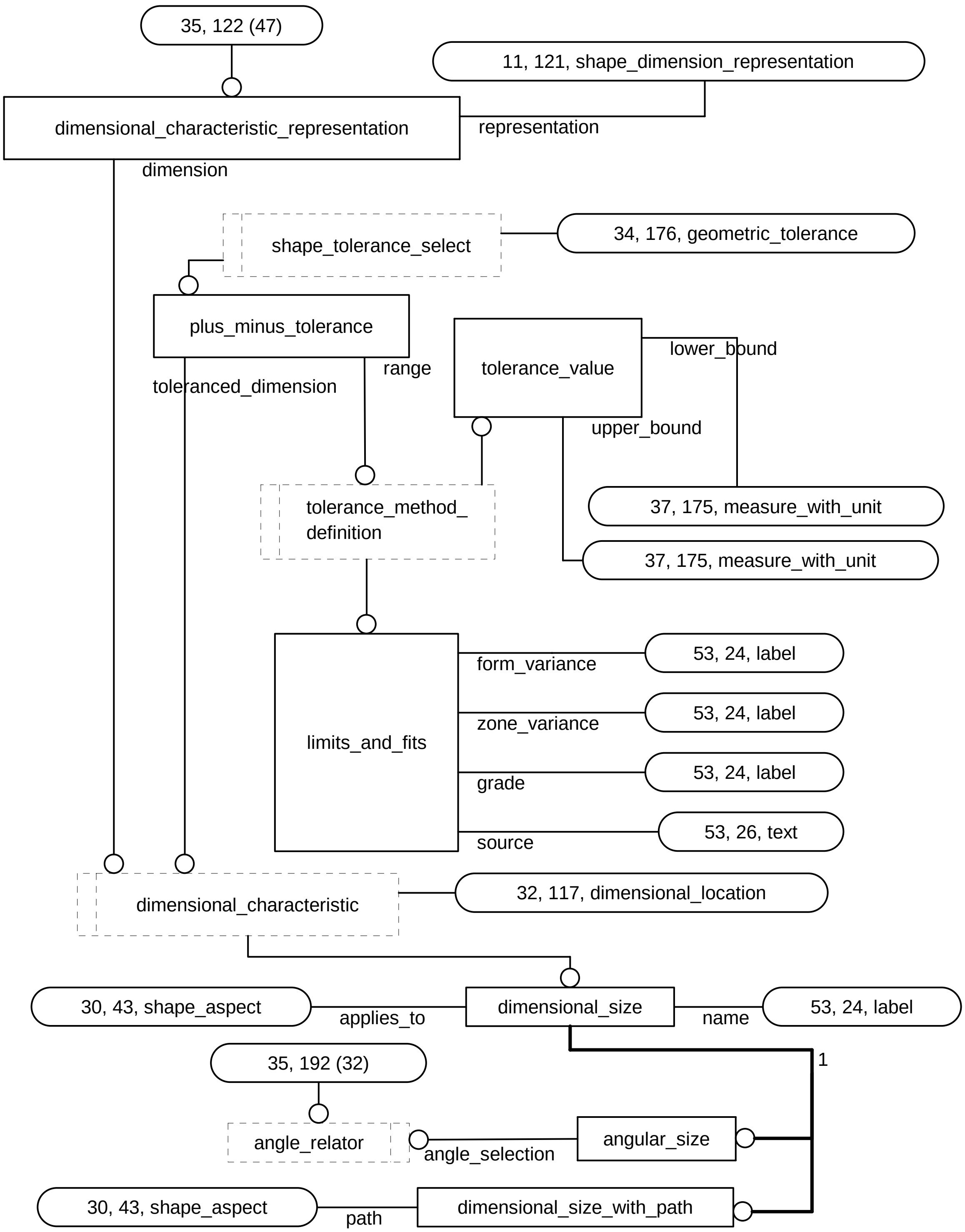


Figure H.35 — AIM EXPRESS-G diagram dimensional characteristic

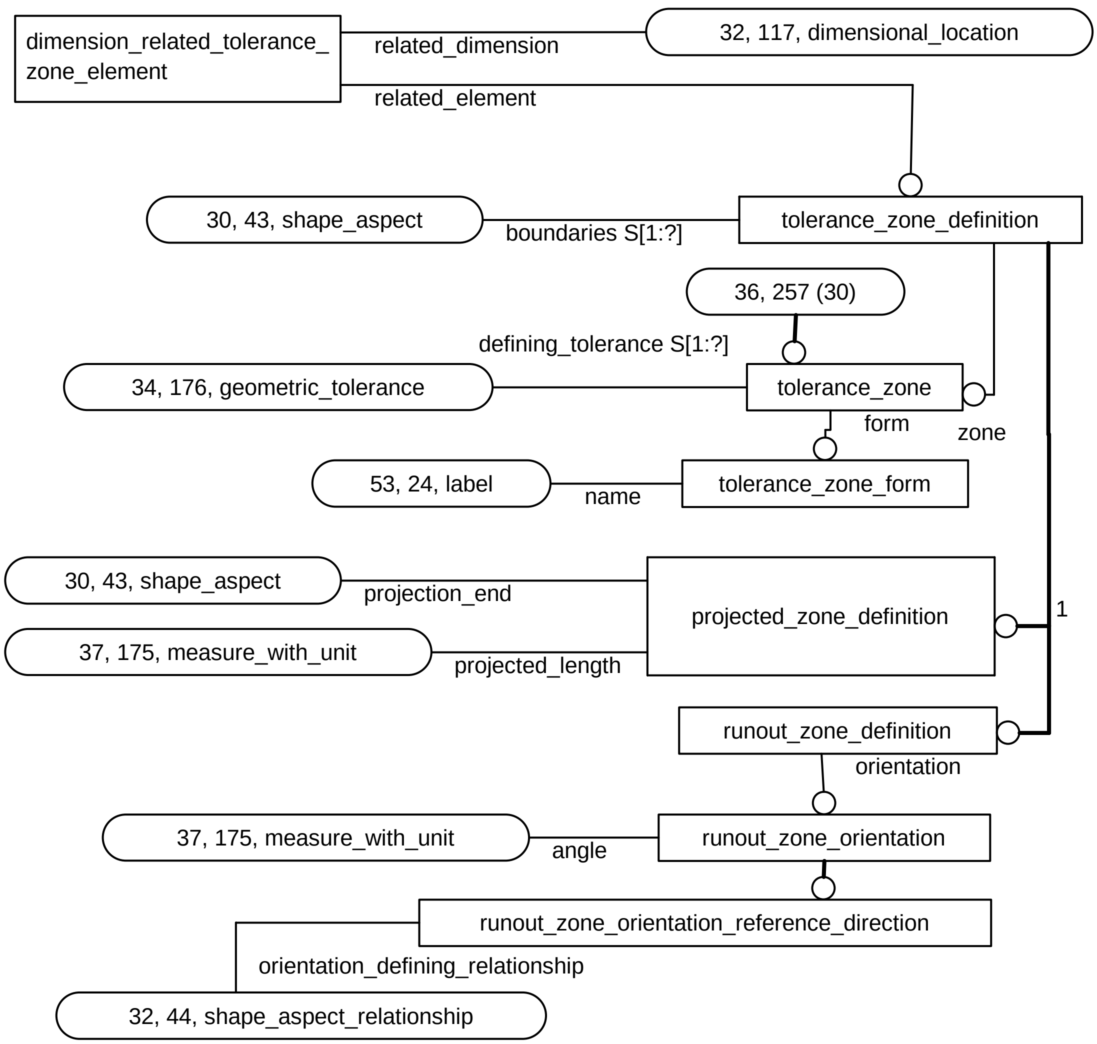


Figure H.36 — AIM EXPRESS-G diagram tolerance zone

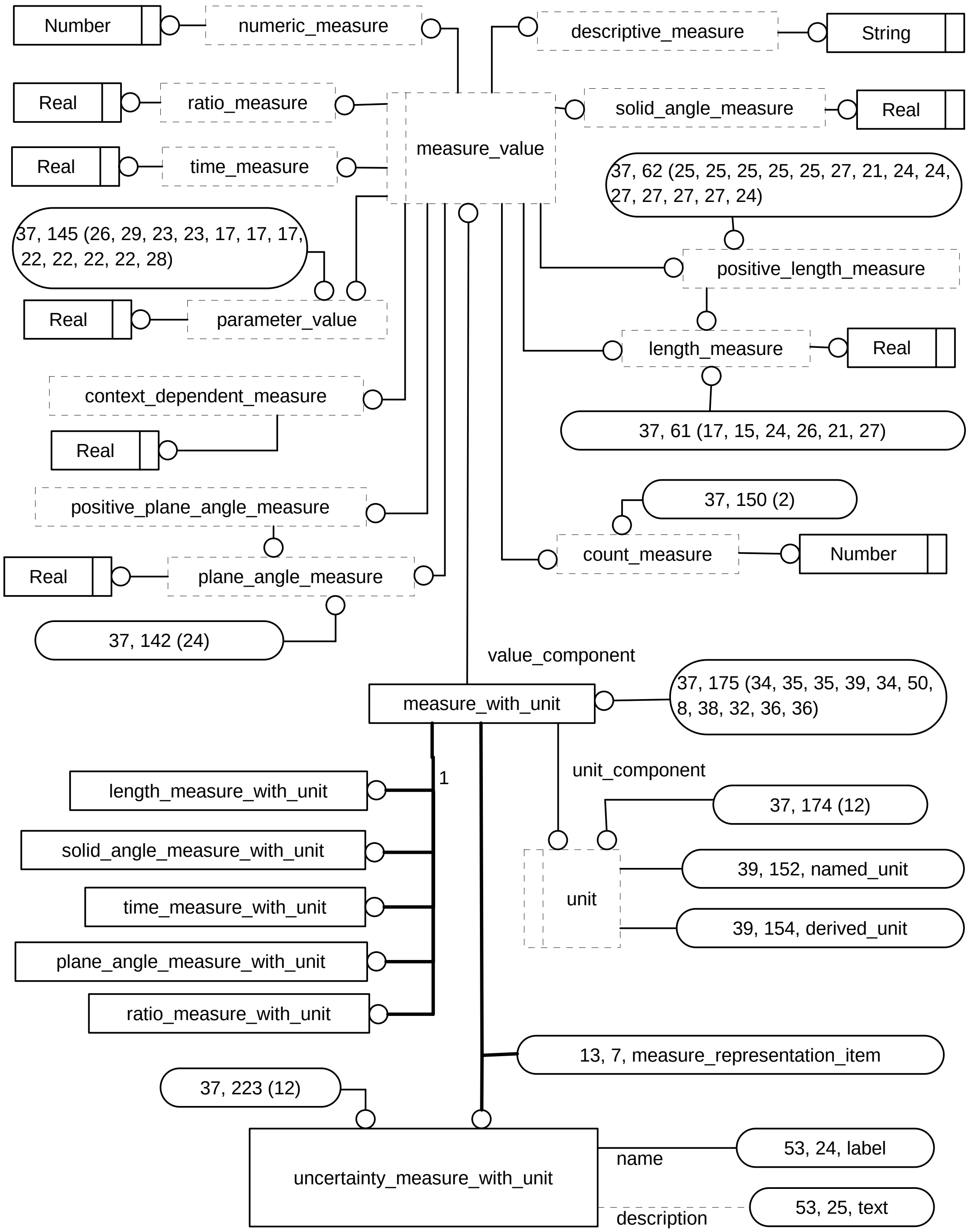


Figure H.37 — AIM EXPRESS-G diagram measure value

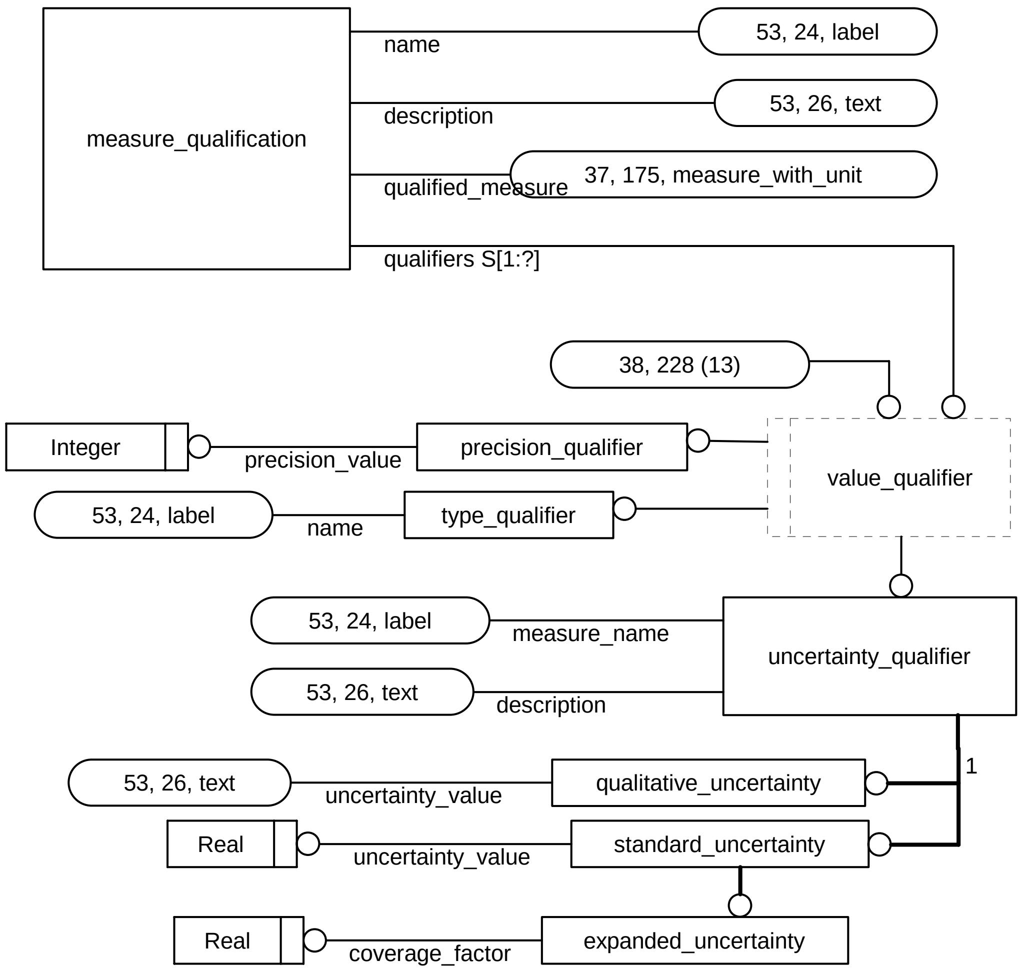


Figure H.38 — AIM EXPRESS-G diagram measure qualification

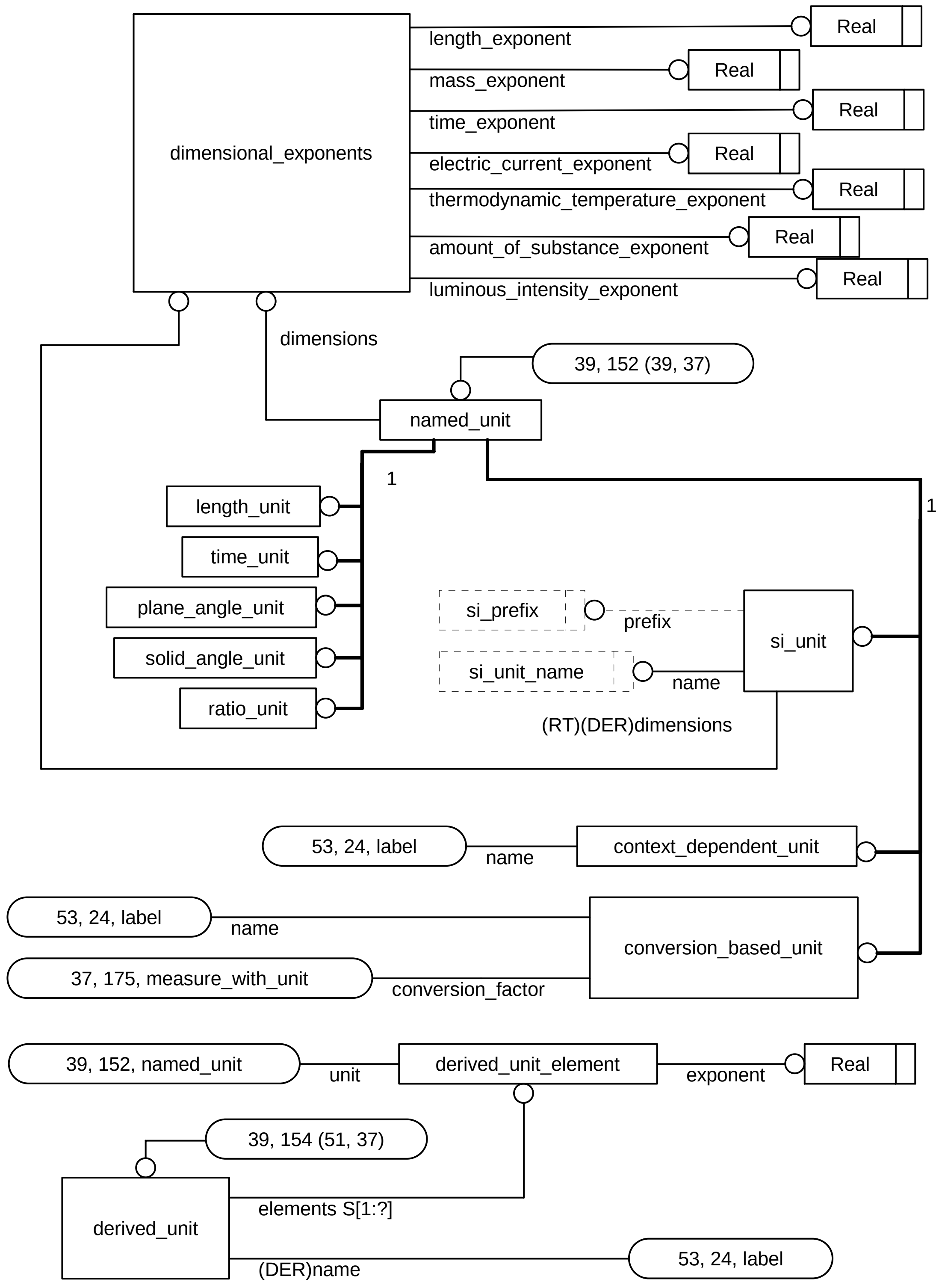


Figure H.39 — AIM EXPRESS-G diagram units

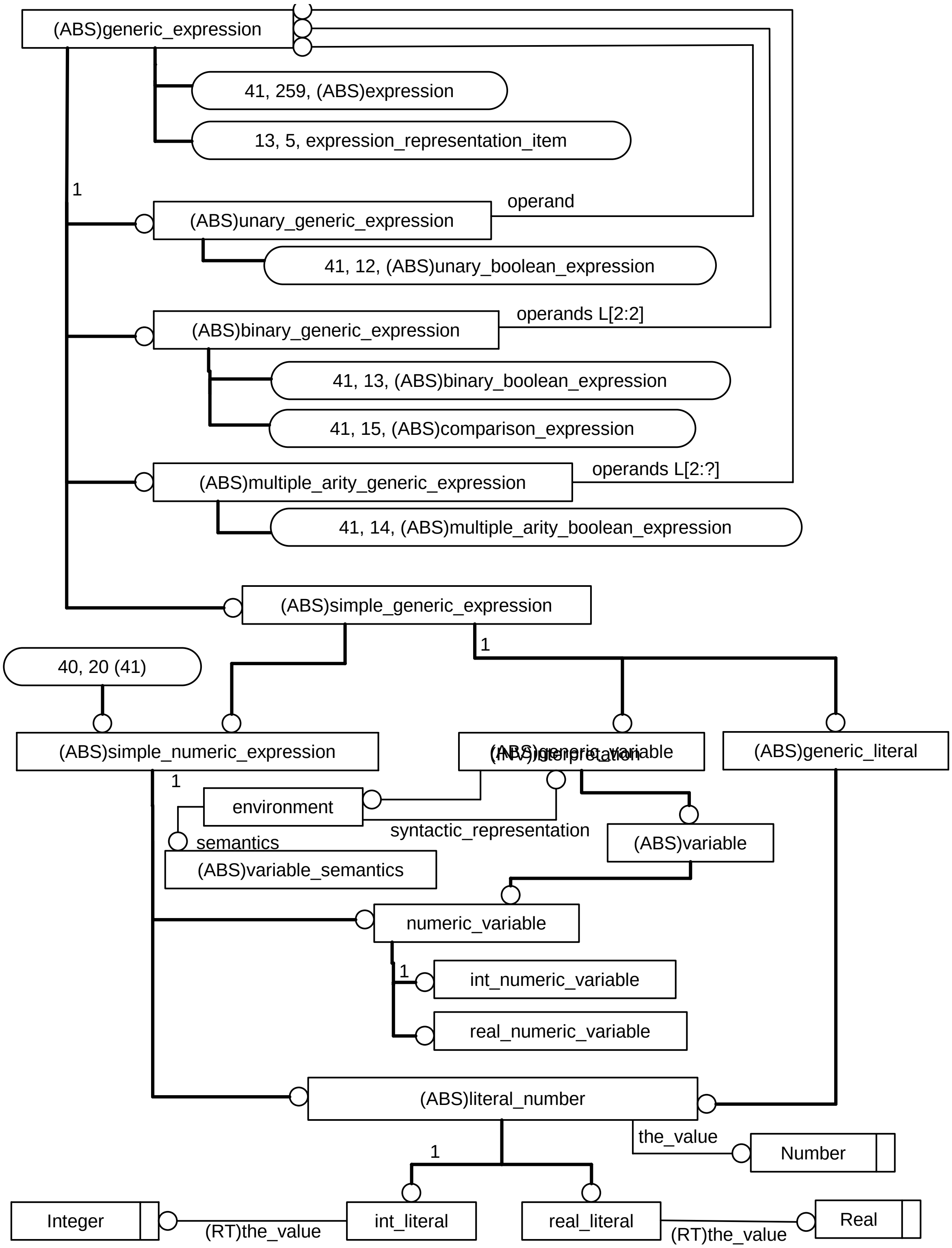


Figure H.40 — AIM EXPRESS-G diagram generic expression

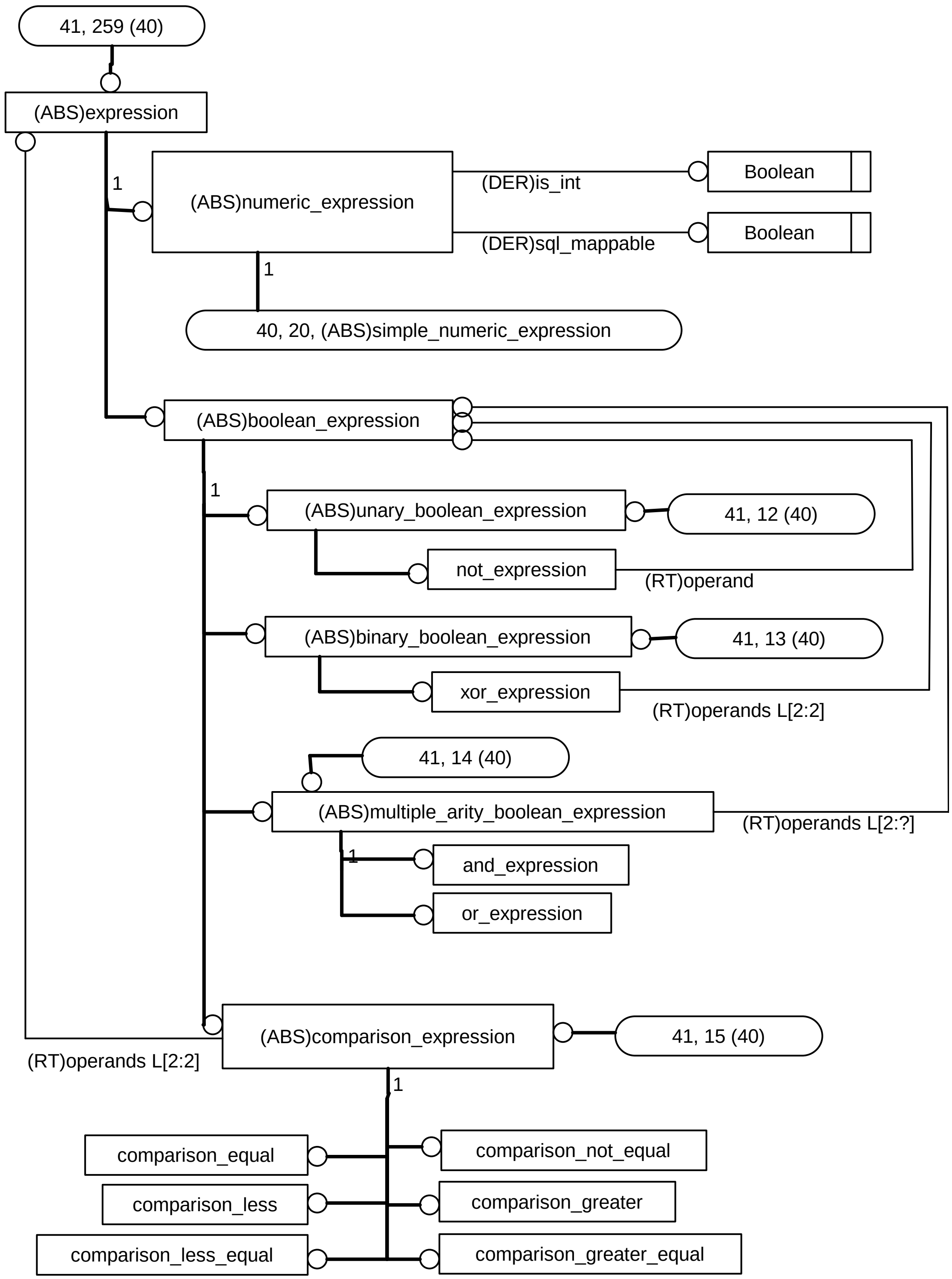


Figure H.41 — AIM EXPRESS-G diagram expression

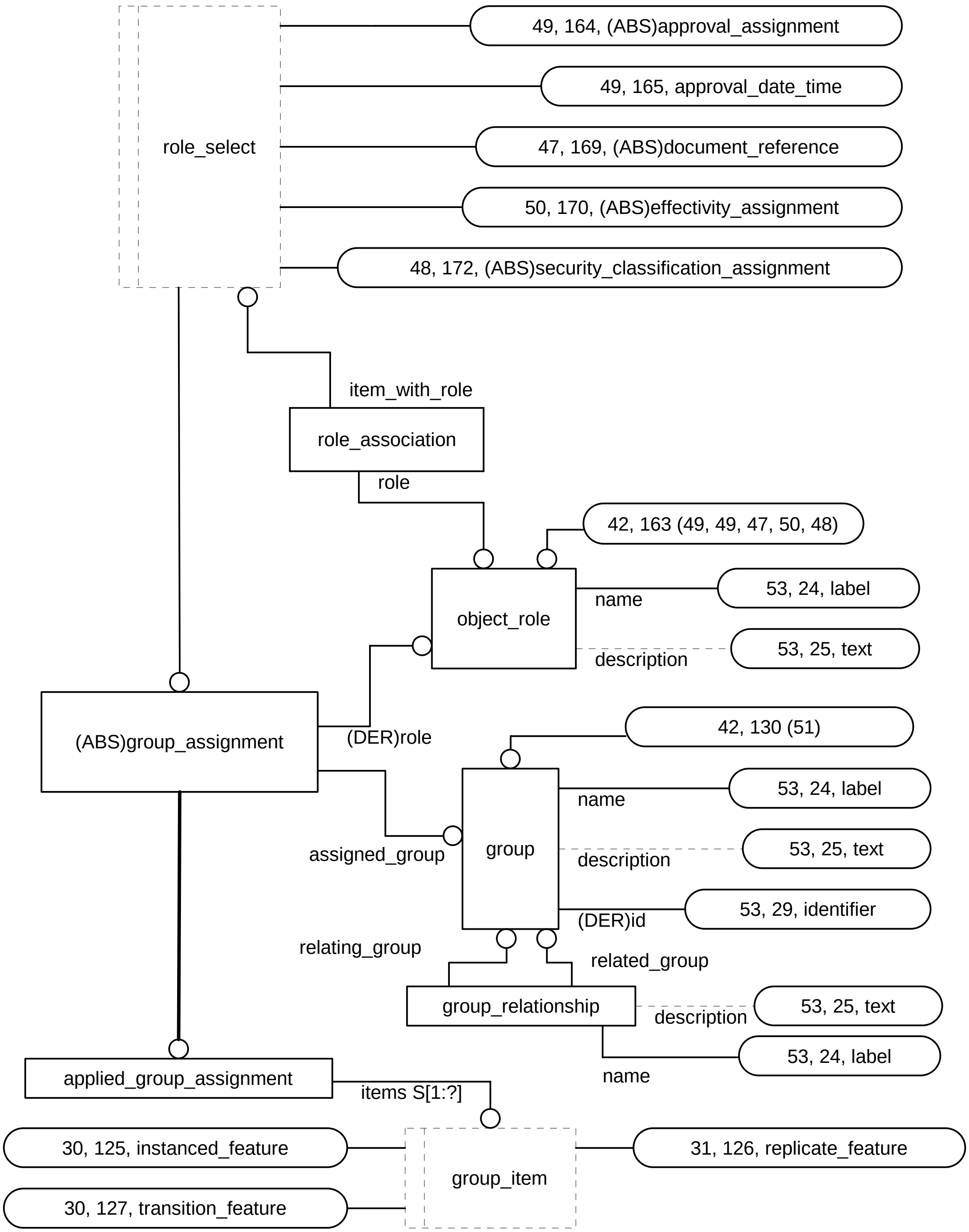


Figure H.42 — AIM EXPRESS-G diagram group

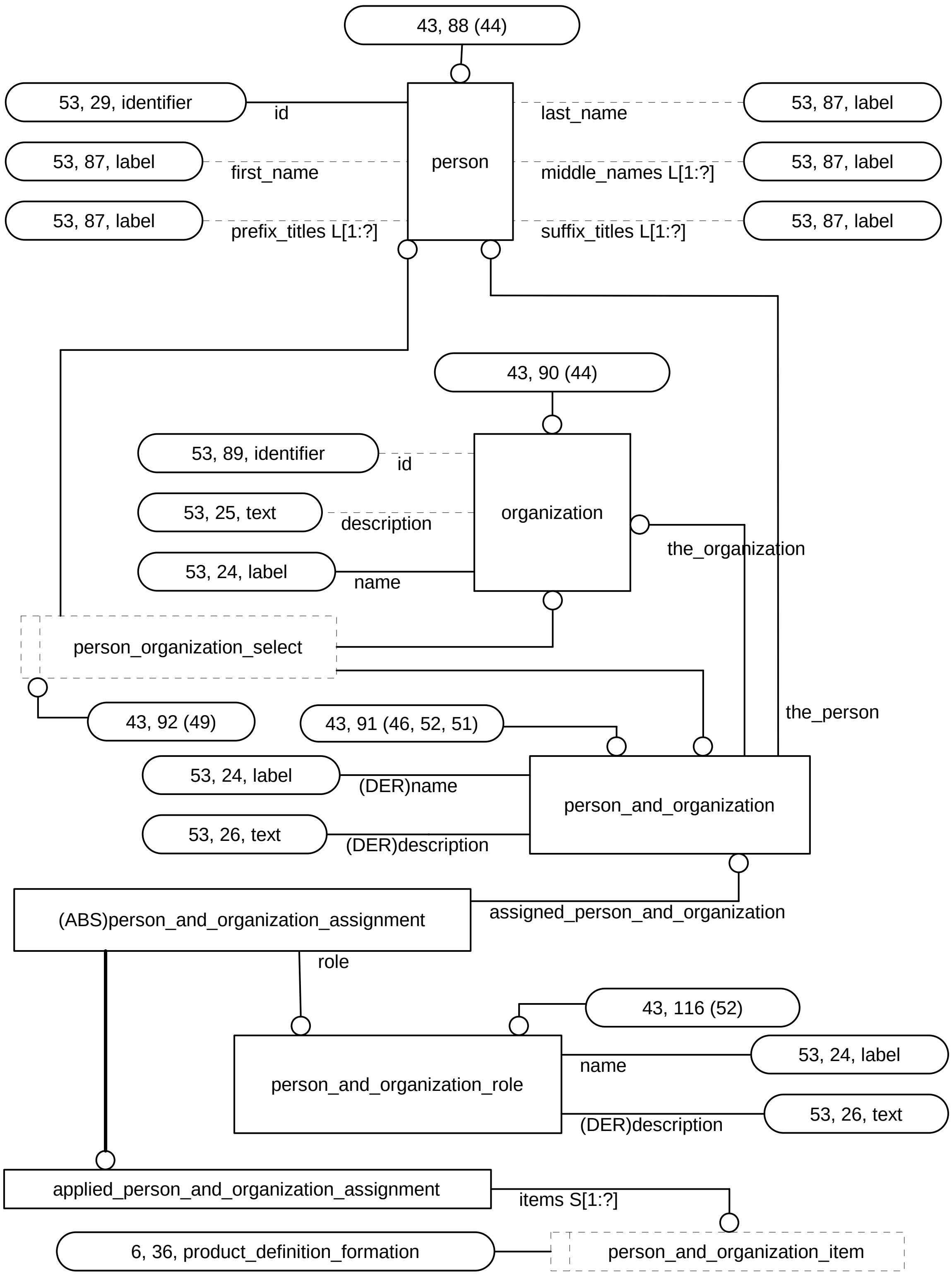


Figure H.43 — AIM EXPRESS-G diagram person and organization

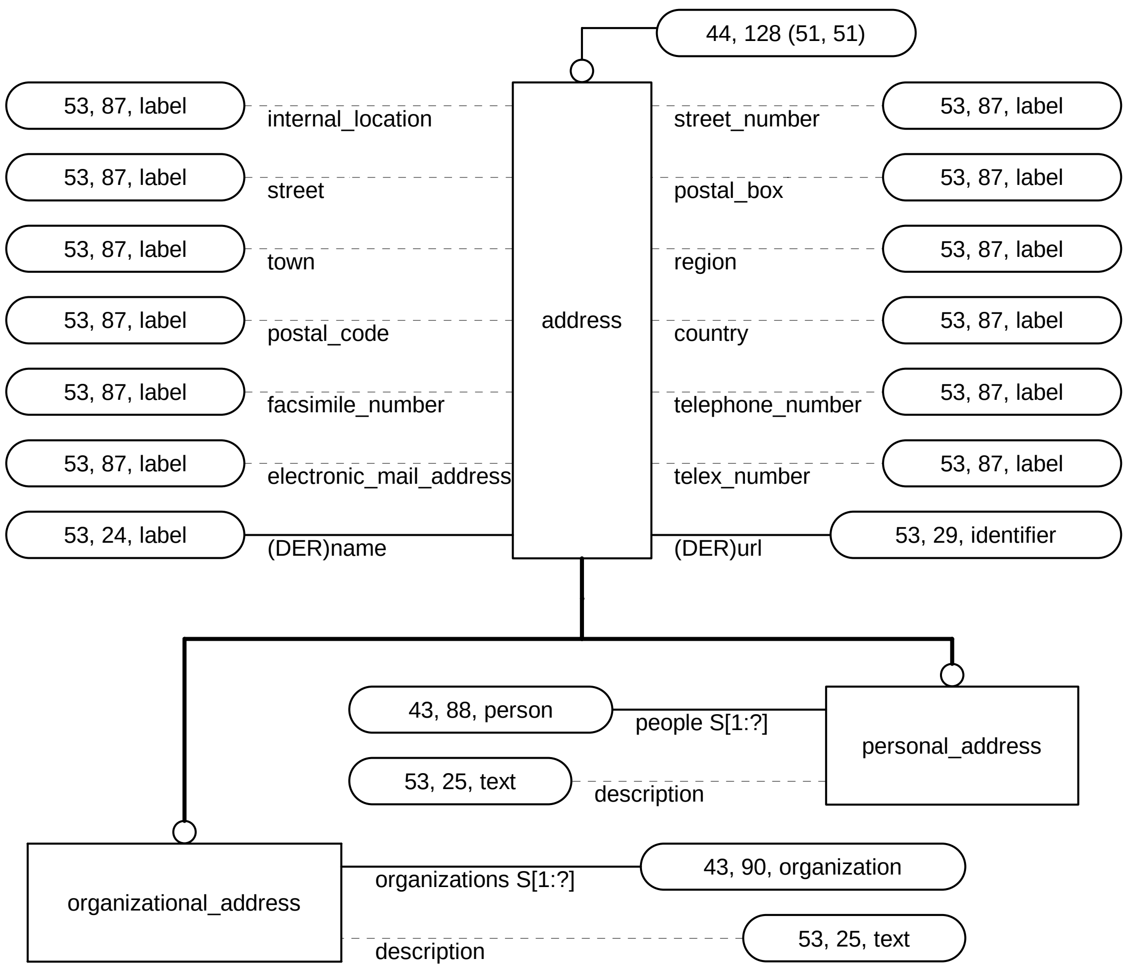


Figure H.44 — AIM EXPRESS-G diagram address

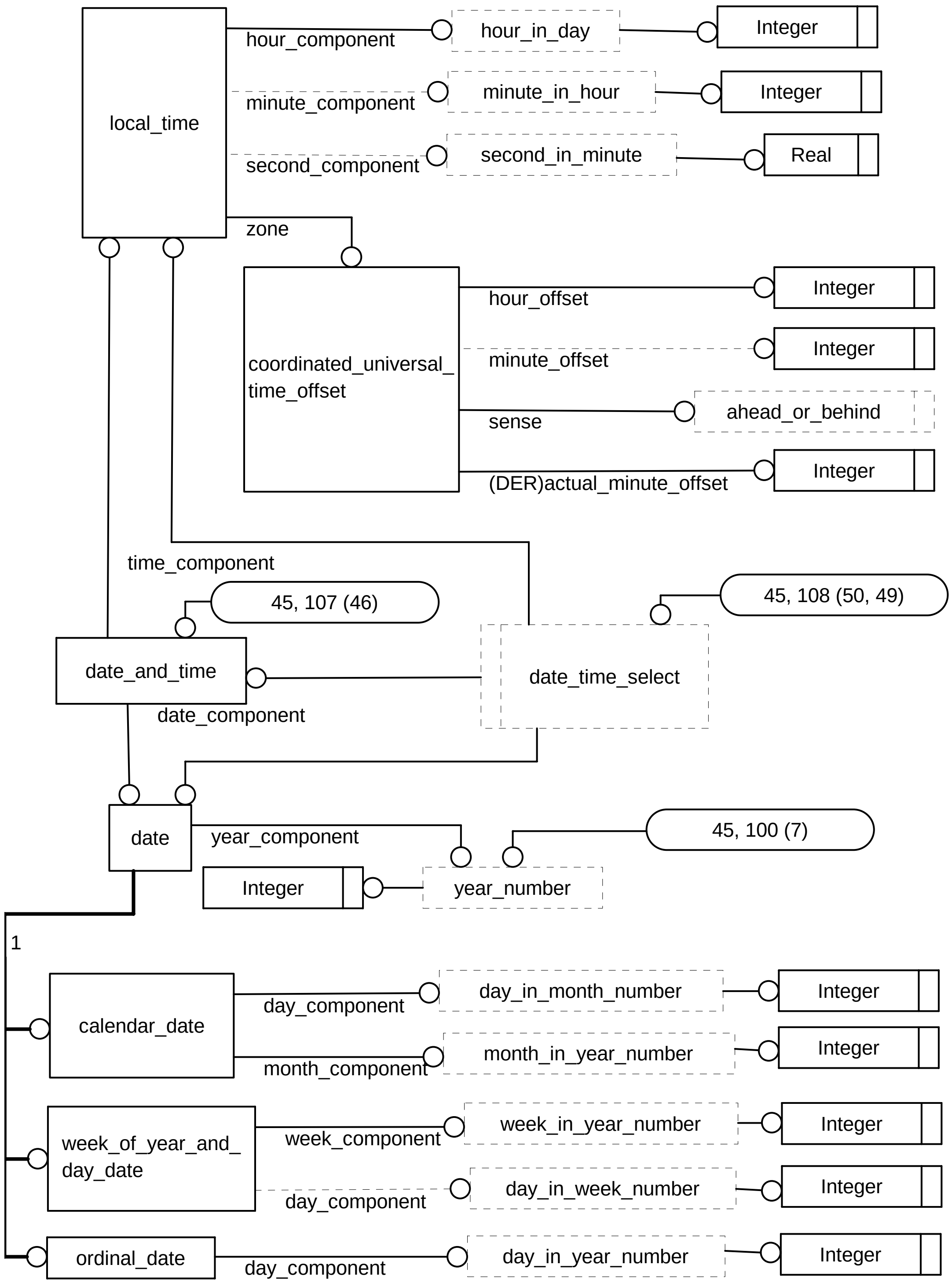


Figure H.45 — AIM EXPRESS-G diagram date and time

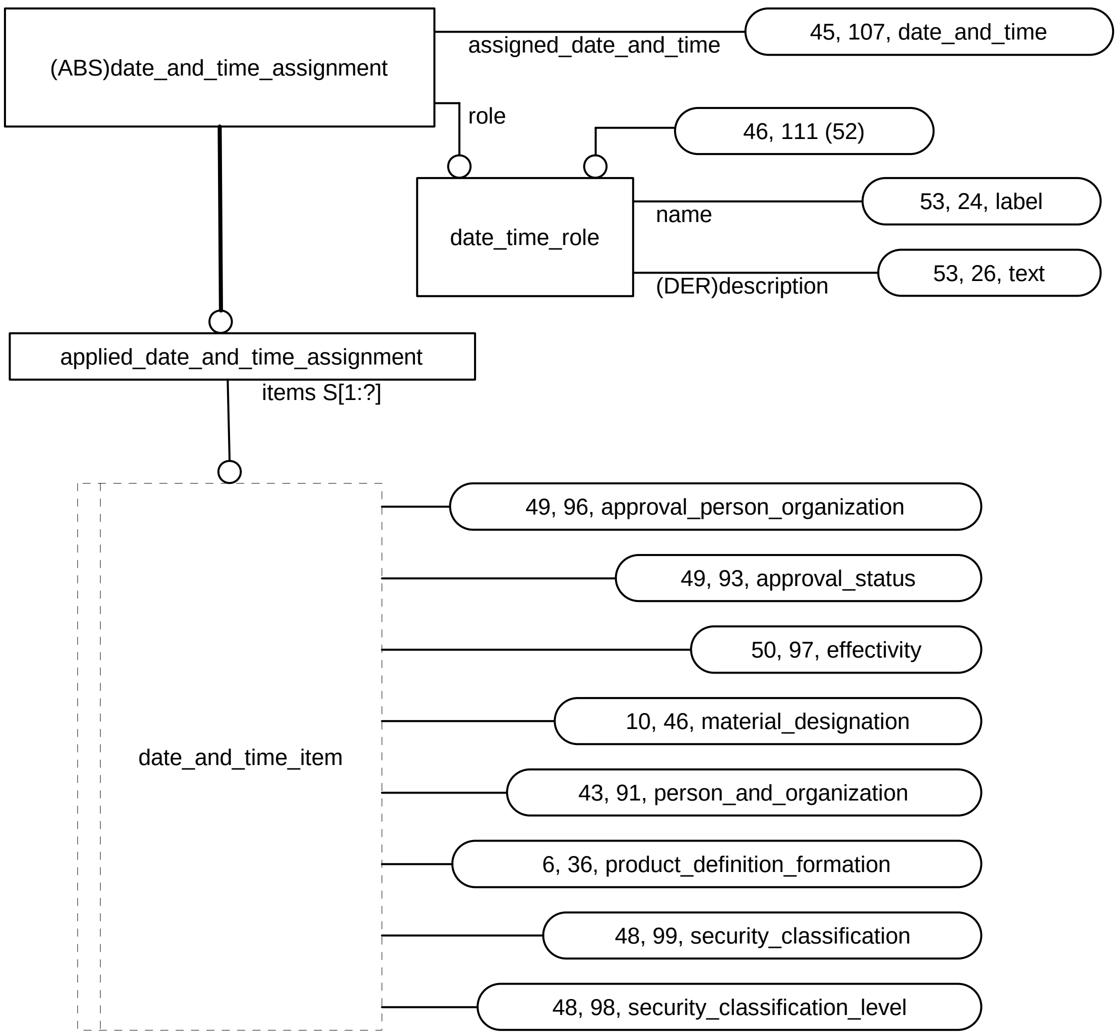


Figure H.46 — AIM EXPRESS-G diagram date and time assignment

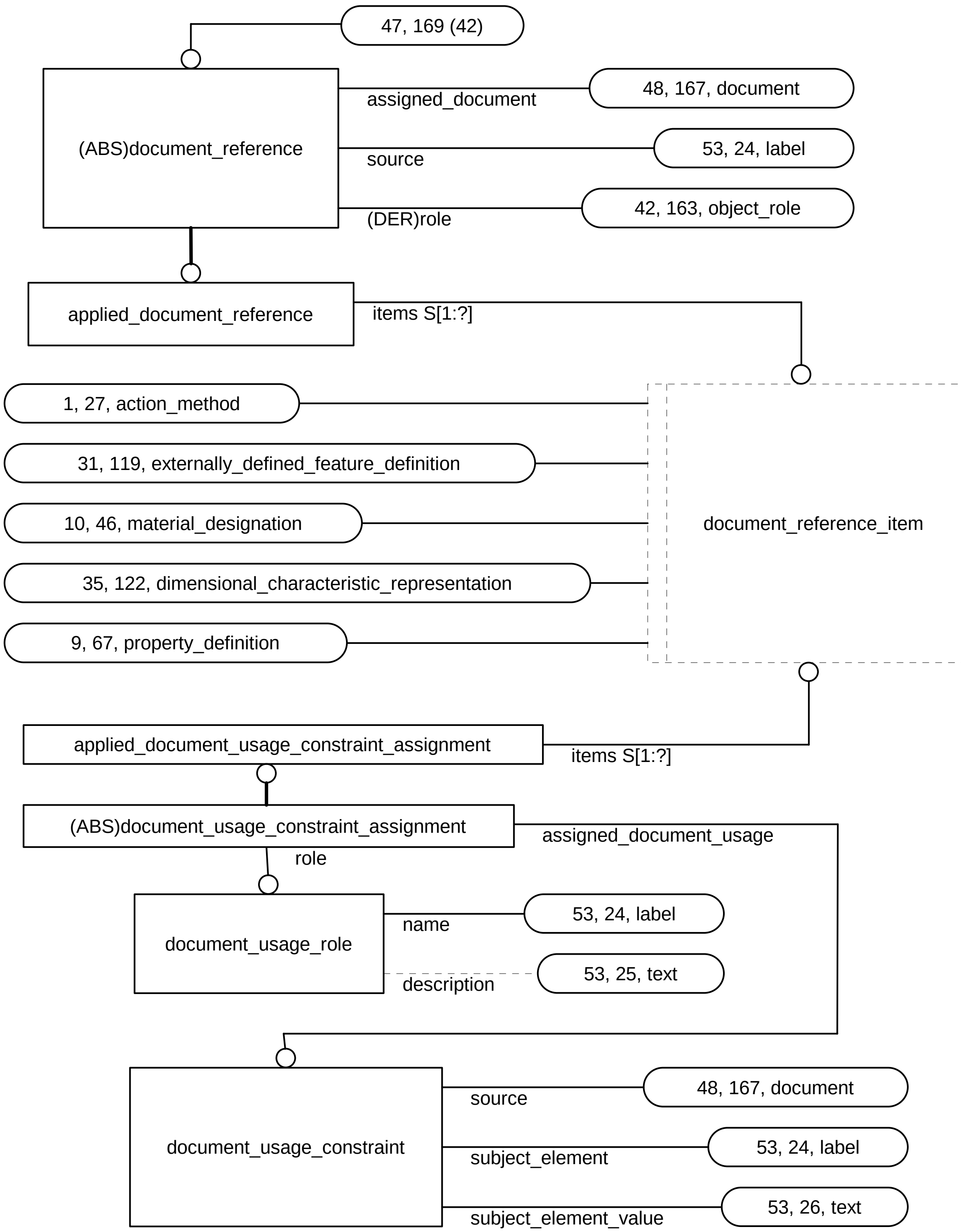


Figure H.47 — AIM EXPRESS-G diagram document reference

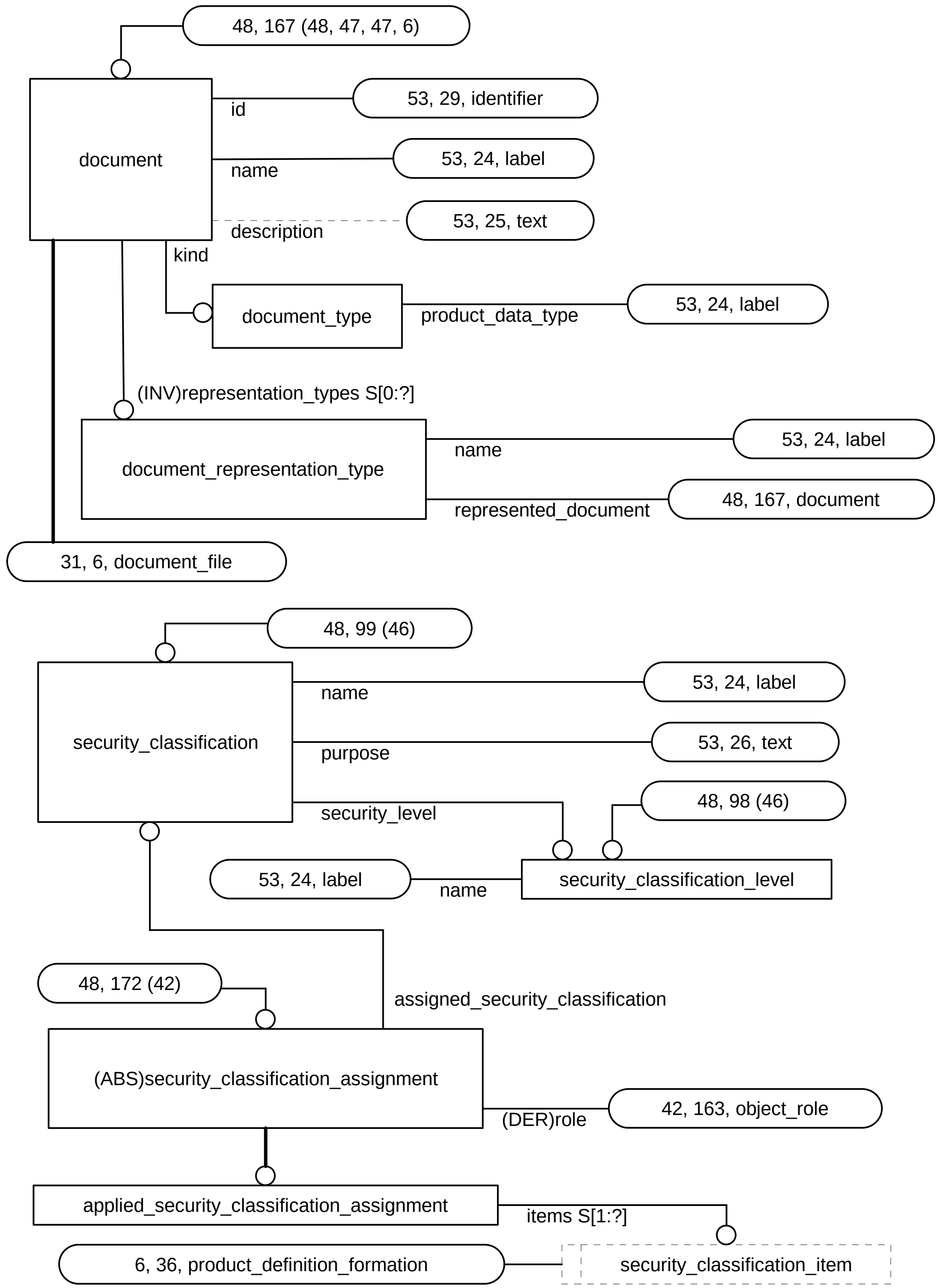


Figure H.48 — AIM EXPRESS-G diagram document

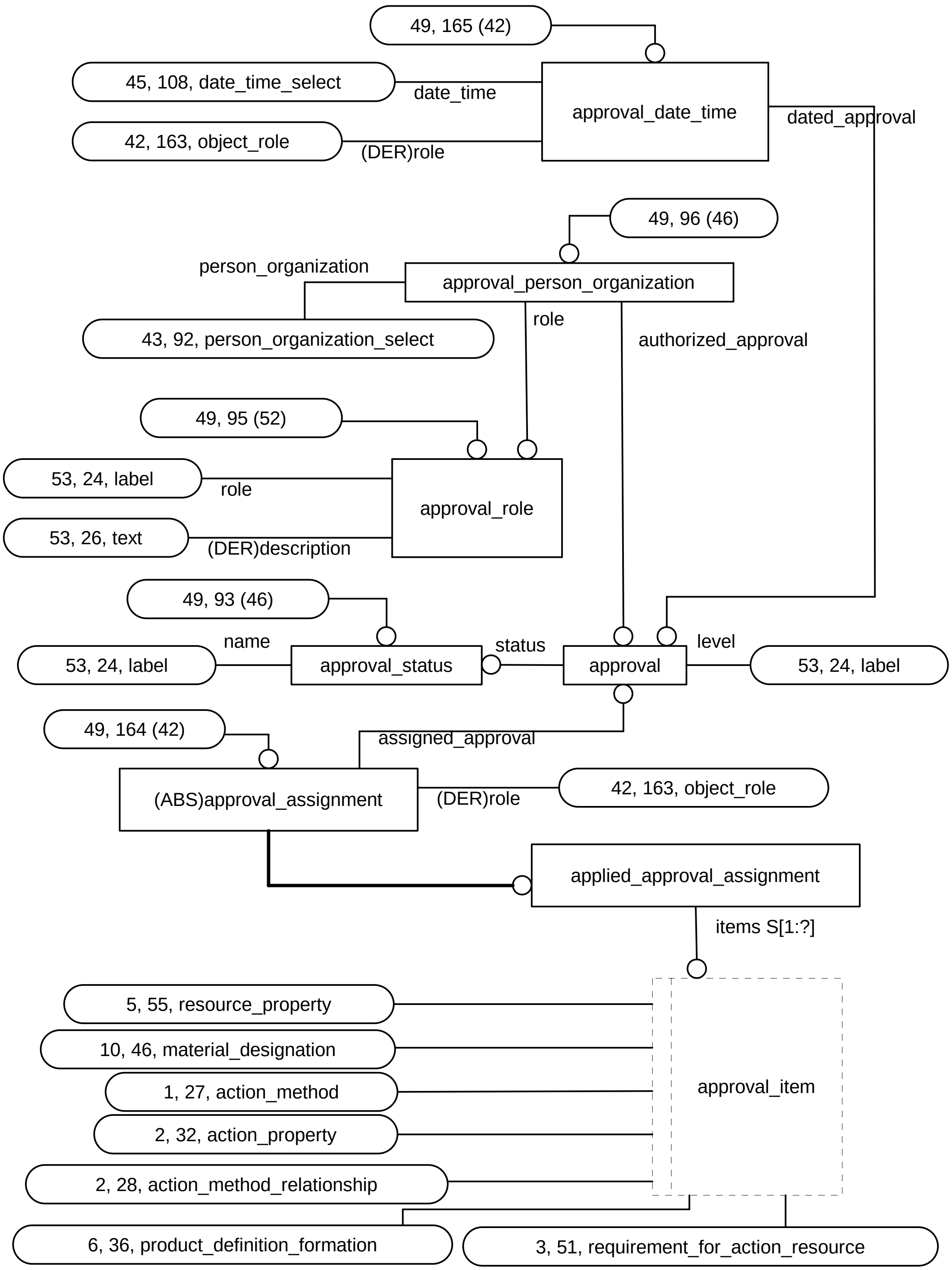


Figure H.49 — AIM EXPRESS-G diagram approval

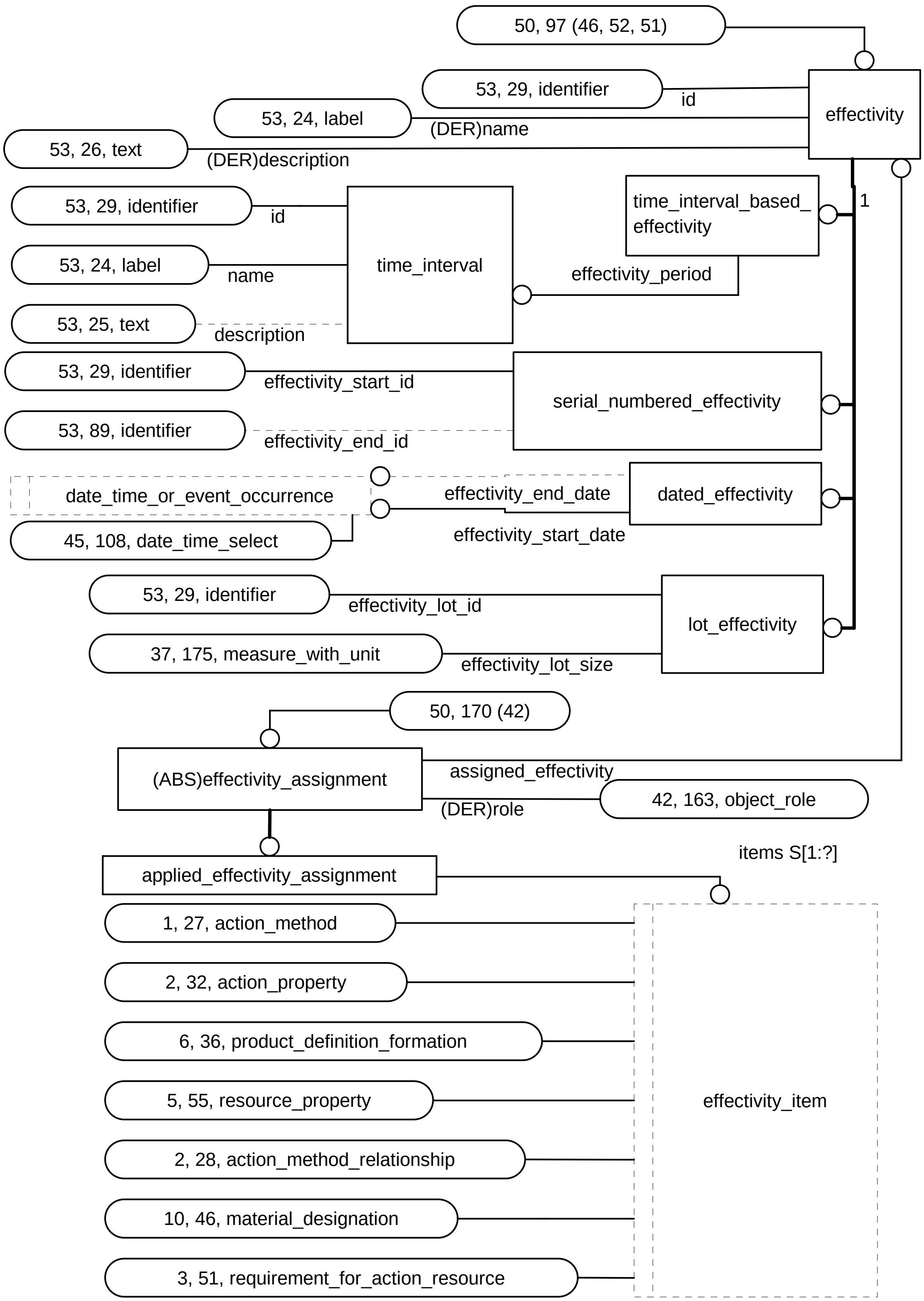


Figure H.50 — AIM EXPRESS-G diagram effectivity

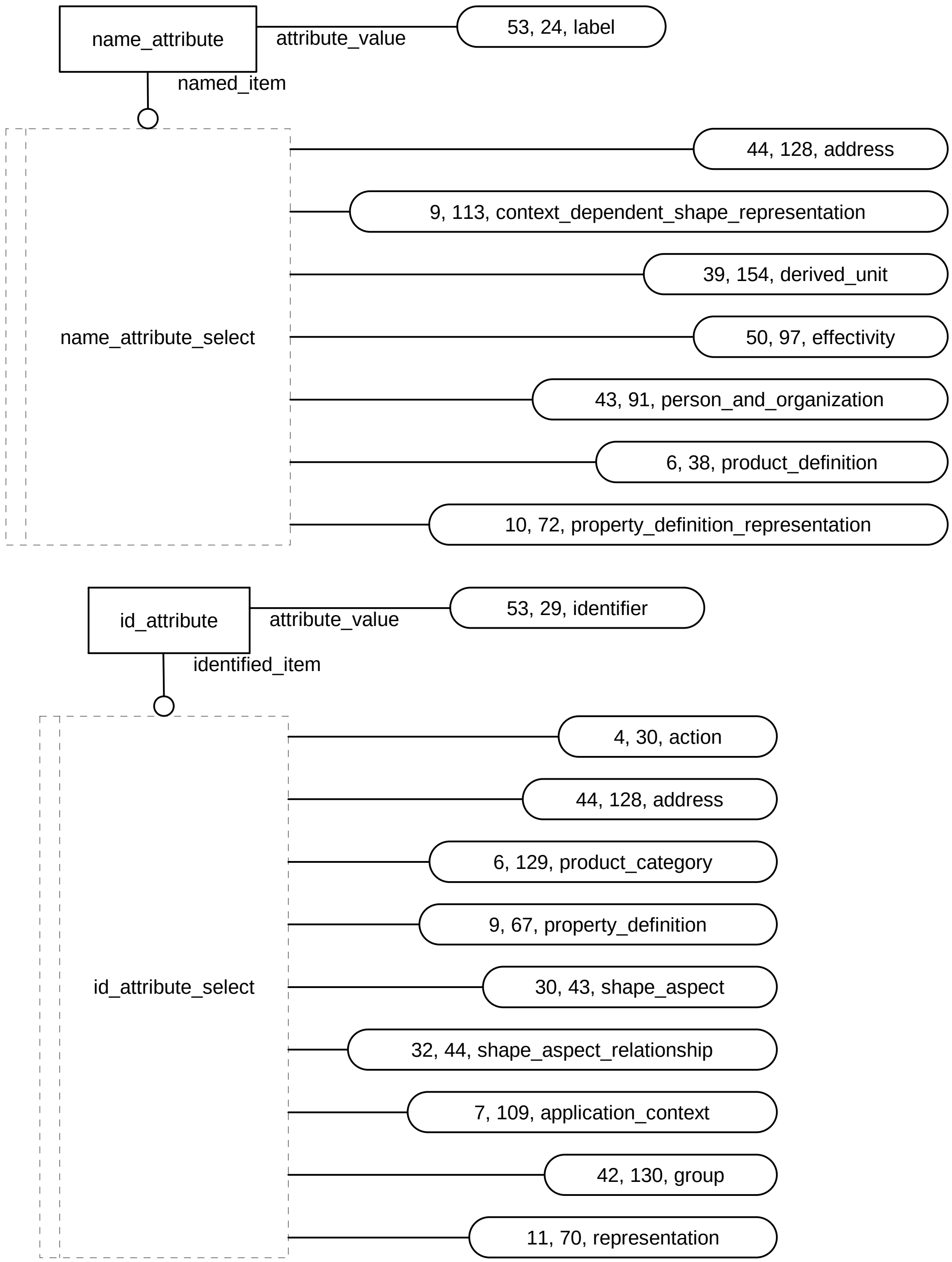


Figure H.51 — AIM EXPRESS-G diagram name attribute

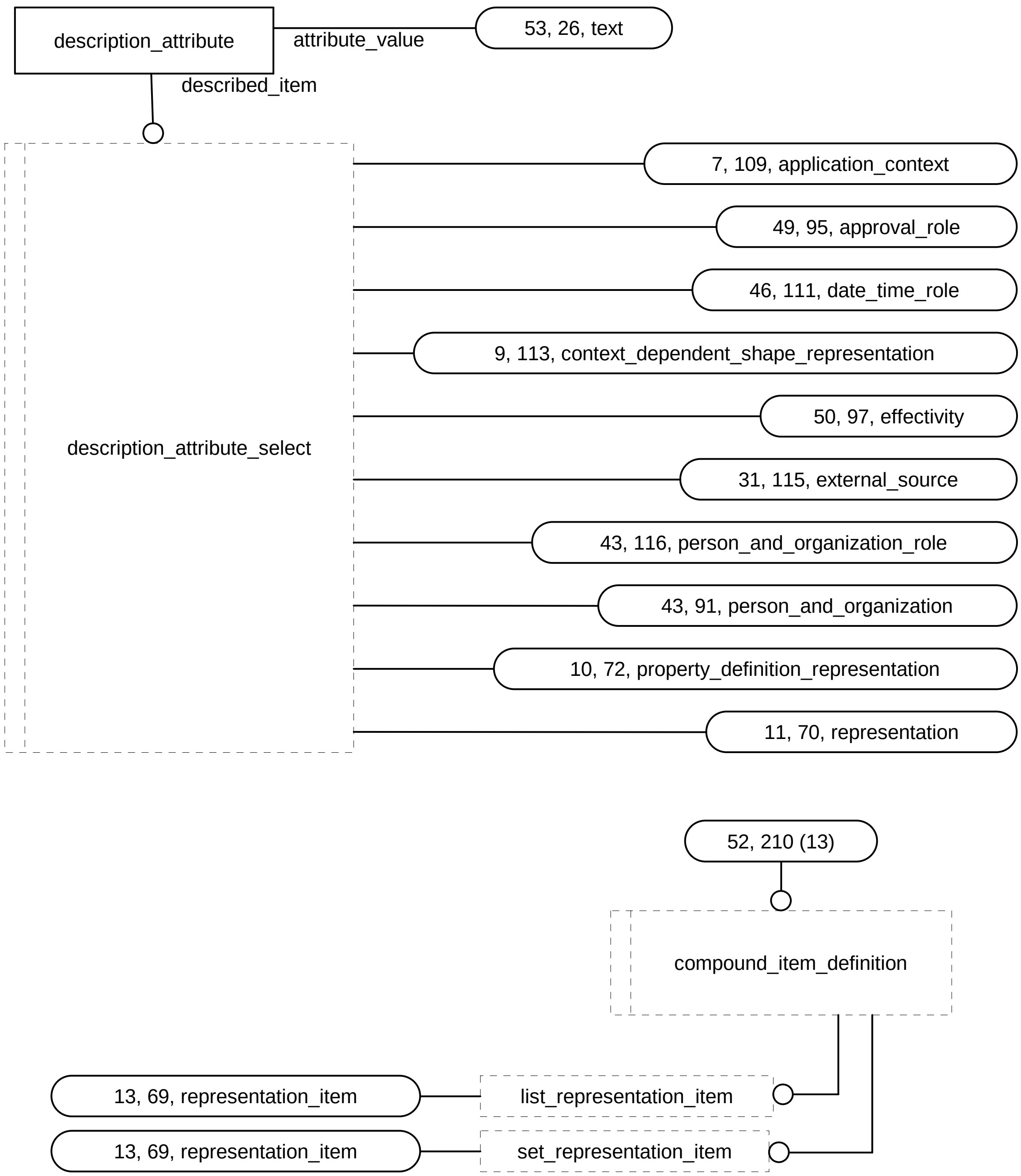


Figure H.52 — AIM EXPRESS-G diagram description attribute

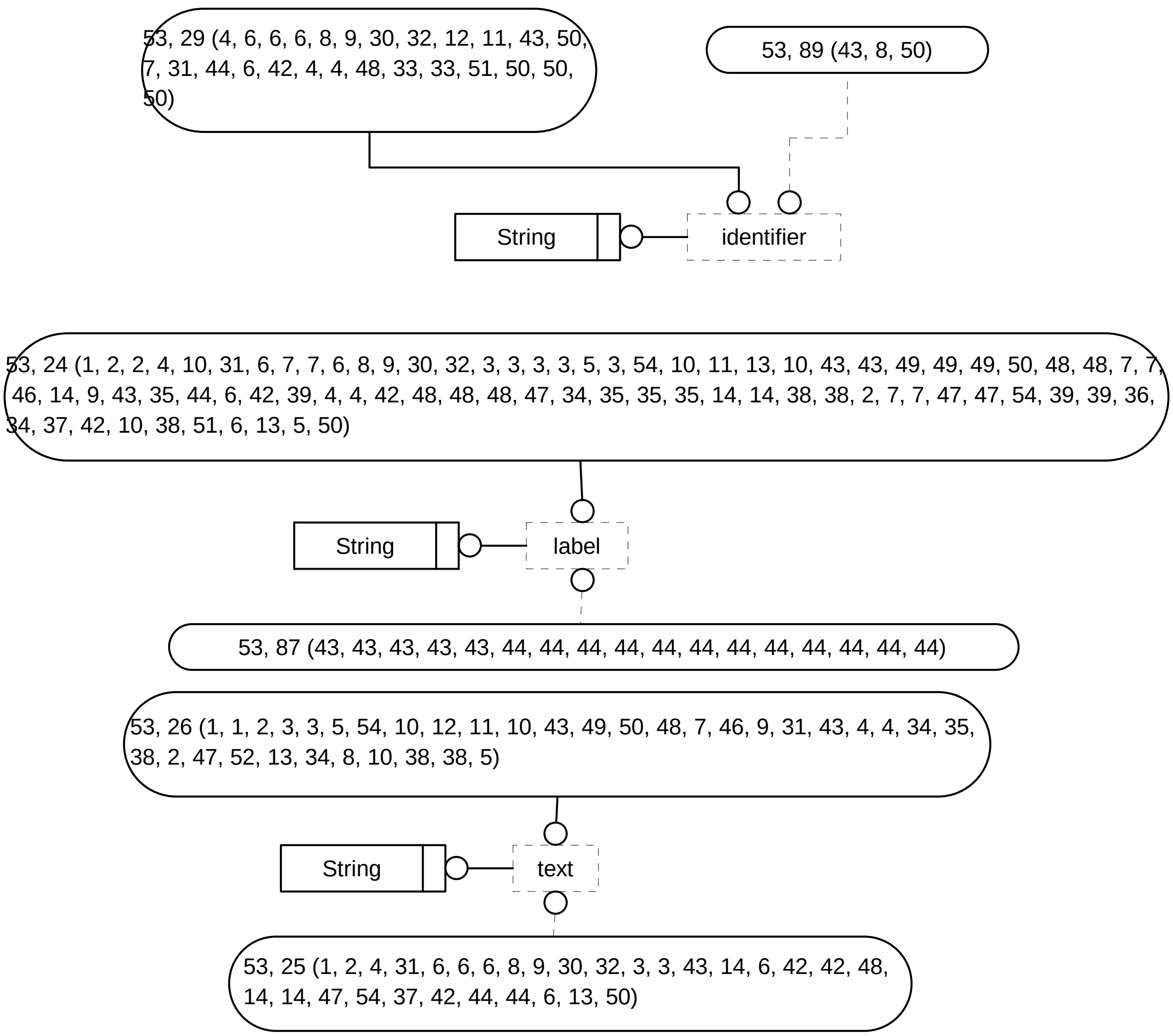


Figure H.53 — AIM EXPRESS-G diagram types

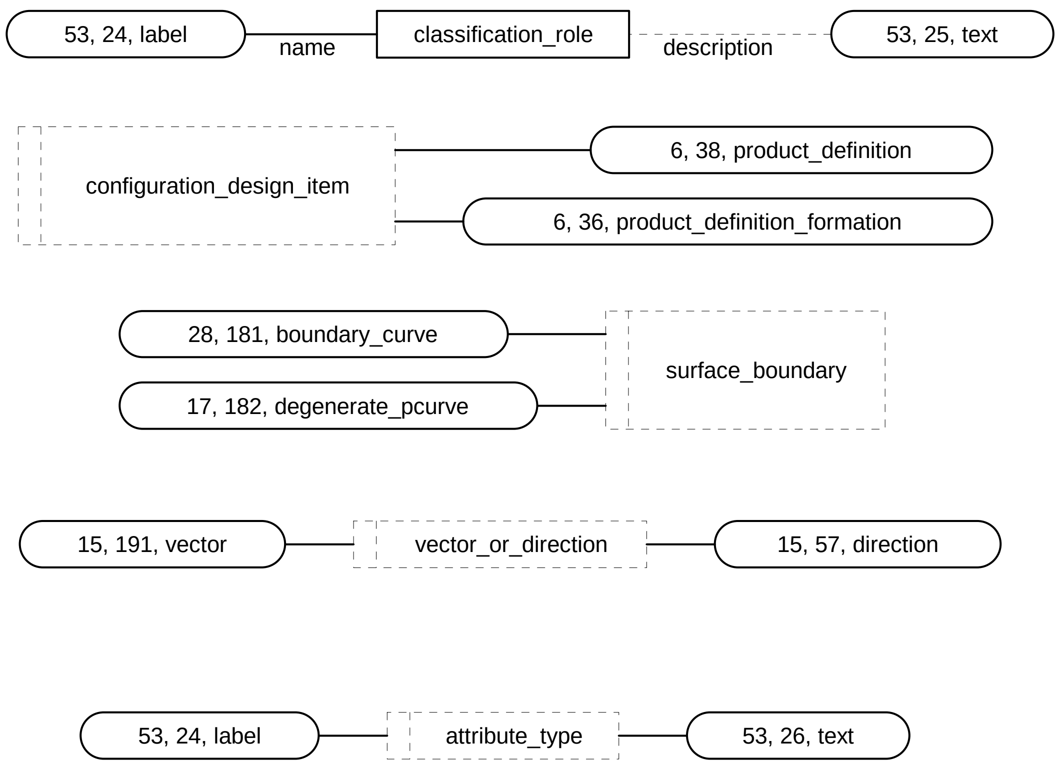


Figure H.54 — AIM EXPRESS-G diagram additional types

Annex J
(informative)

Computer interpretable listings

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. The content of this annex is available in computer-interpretable form and can be found at the following URLs:

Short names: `http://www.tc184-sc4.org/short_names`

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

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

Annex K
(informative)

Annotated examples

K.1 Introduction

This annex provides four example data sets to assist implementors in understanding the use and structure of this part of ISO 10303. The examples have been annotated with comments to illustrate the relationship between the application object concepts documented in 4.2 and the AIM instances organized according to the mapping paths documented in 5.1.

The first data set is a conformance class one example that describes a simple workplan for milling a block using explicit toolpaths. The second is a conformance class two example that adds workpiece and stock geometry descriptions to the first example. The third is a conformance class three example that describes a milling workplan for several features on a block. This was adapted from an ARM example that appears in ISO 14649-11. The fourth is a conformance class three example that describes a turning workplan for several features on a workpiece. This was adapted from an ARM example that appears in ISO 14649-12.

K.2 Annotation conventions

Each data set is described as an ISO 10303-21 exchange structure. The AIM instances are grouped by ARM application object with a comment at the beginning of each block show how the instances are arranged to describe the application object and associated parameters.

EXAMPLE The instances below represent a Milling_machine_functions application object.

```
/*************************************************
 * Application object: MILLING_MACHINE_FUNCTIONS (#50)
 * THROUGH_SPINDLE_COOLANT: #50, #51, #52, #53, #54: [through spindle coolant off]
 * CHIP_REMOVAL: #50, #55, #56, #57, #58: [chip removal off]
 * COOLANT: #50, #59, #60, #61, #62: [coolant on]
 */
#50=MACHINING_FUNCTIONS('','milling',' ',' ');

#51=ACTION_PROPERTY('through spindle coolant','',#50);
#52=ACTION_PROPERTY_REPRESENTATION('','',#51,#53);
#53=REPRESENTATION('',(#54),#31);
#54=DESCRIPTIVE_REPRESENTATION_ITEM('constant','through spindle coolant off');

#55=ACTION_PROPERTY('chip removal','',#50);
#56=ACTION_PROPERTY_REPRESENTATION('','',#55,#57);
#57=REPRESENTATION('',(#58),#31);
#58=DESCRIPTIVE_REPRESENTATION_ITEM('constant','chip removal off');

#59=ACTION_PROPERTY('coolant','',#50);
#60=ACTION_PROPERTY_REPRESENTATION('','',#59,#61);
#61=REPRESENTATION('',(#62),#31);
#62=DESCRIPTIVE_REPRESENTATION_ITEM('constant','coolant on');
```


In the example above, the first line of the comment indicates that the instances describe a Milling_-machine_functions application object. In parenthesis, instance #50 is identified as the AIM element for the application object and the starting instance for the reference paths given in the mapping tables.

In Table 8, the mapping table entry for Milling_machine_functions calls for an AIM element of type machining_functions and the reference path shown below:

machining_functions <=
action_method
{ action_method.description = 'milling' }

Instance #50 is the machining_functions instance at the start of the reference path. The second line simply states that machining_functions is a subtype of action_method. The final line of the path states that the description attribute has the value "milling." In instance #50, the second attribute (which the description attribute in ISO 10303-21 syntax) is is indeed "milling."

The rest of the comment indicates application object parameters and AIM instances that form the reference path given in the mapping tables. Consider the Milling_machine_functions coolant parameter and the corresponding reference path from Table 8:

machining_functions <=
action_method
characterized_action_definition = action_method
characterized_action_definition <-
action_property.definition
{ action_property.name = 'coolant' }
action_property <-
action_property_representation.property
action_property_representation
action_property_representation.representation ->
representation
representation.items[i] ->
representation_item =>
descriptive_representation_item
descriptive_representation_item.description
{ (descriptive_representation_item.description = 'coolant on')
(descriptive_representation_item.description = 'coolant off') }

The comment indicates that #50, #59, #60, #61, and #62 describe the coolant parameter. Instance #50 is the machining_functions instance at the start of the reference path. This is referred to by #59, an action property with a name of "coolant." This action_property is referred to by #60, which is an action_property_representation. This refers to #61, which is a representation that contains descriptive_representation_item #62 in its items set. The last lines of the reference path constrain the value of the description attribute to either "coolant on" or "coolant off." In instance #62, the value is "coolant on," which is also documented in at the end of the comment.

It is hoped that this annotation will assist implementors in understanding the use and structure of the application objects, mapping reference paths, and corresponding integrated representation for the examples that follow.

K.3 Machining project for CC1 and CC2 examples

The first two examples describe a machining project with a single workplan and single workingstep. The workplan specifies explicit toolpaths to mill a simple block as shown in Figure K.1. .

The workpiece for the project is a block 100mm square and 25mm high, with a 10mm wide by 10mm high step along two sides. The rawpiece is a block 100mm square and 25mm high. The origin is at the bottom of the part, on the corner opposite both steps. The toolpath was generated for a 20mm end-mill and starts at (0,0,40). The dashed toolpaths shown in Figure K.1 specify rapid feed and the solid toolpaths specify a feedrate of 250 mm/min..

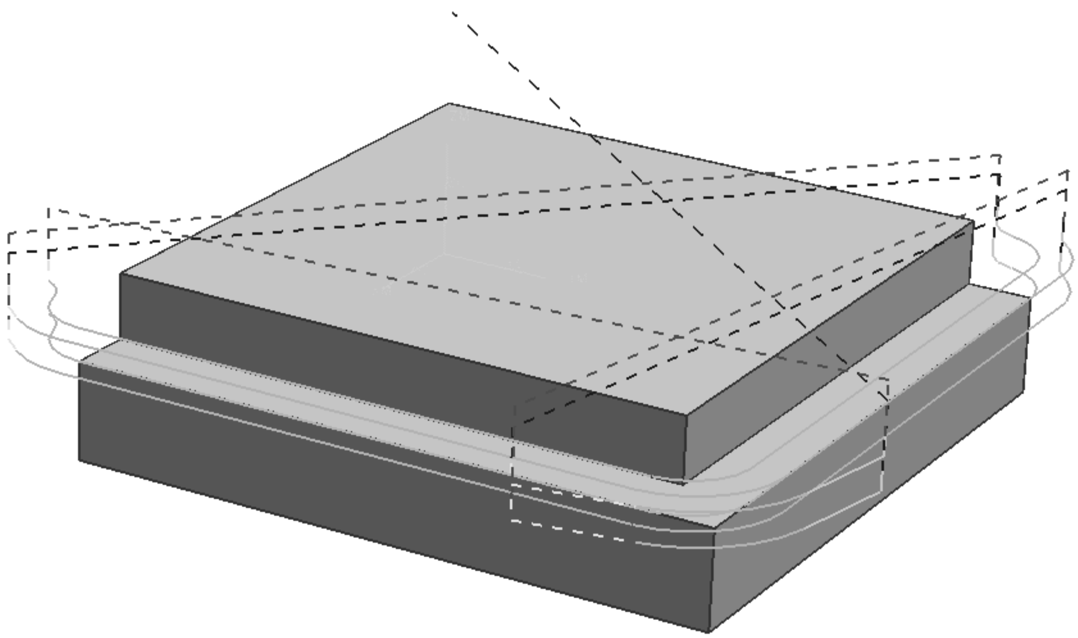


Figure K.1 — Example workpiece and toolpath

The example in K.4 is a conformance class one data set and contains only the machining workplan and toolpaths. The example in K.5 is a conformance class two data set, and contains the machining wor-plan, toolpaths, rawpiece geometry, and workpiece geometry.

K.4 Data set for CC1 example

The example below is a conformance class one (CC1) data set for the project described in K.3. This describes a machining workplan with one workingstep. The workingstep refers to a freeform milling operation which contains twelve cutter location toolpath segments.

```
ISO-10303-21;
HEADER;

FILE_DESCRIPTION(
```



```
/* description */ ('AP238 CC1 simple block example'),
/* implementation_level */ '2;1');

FILE_NAME(
/* name */ 'simple_block_cc1',
/* time_stamp */ '2006-07-06T11:54:14-04:00',
/* author */ ('Dave Loffredo (loffredo@steptools.com)'),
/* organization */ (''),
/* preprocessor_version */ 'ST-DEVELOPER v11',
/* originating_system */ 'Various',
/* authorisation */ '');

FILE_SCHEMA (('INTEGRATED_CNC_SCHEMA'));
ENDSEC;

DATA;

/************************************************
 * Application object: PROJECT (#10)
 * MAIN_WORKPLAN: #10, #11, #12, #575
 * ITS_ID: #10, #13, #14 ['New Project']
 * ITS_WORKPIECES [*]: #10, #15, #19
 */
#10=PRODUCT_DEFINITION('','',#13,#16);
#11=PROCESS_PRODUCT_ASSOCIATION('','',#10,#12);
#12=PRODUCT_DEFINITION_PROCESS('machining','',#575,'');
#13=PRODUCT_DEFINITION_FORMATION('','',#14);
#14=MACHINING_PROJECT('New Project','',$,(#18));
#15=MACHINING_PROJECT_WORKPIECE_RELATIONSHIP('','workpiece','',#10,#19);
#16=PRODUCT_DEFINITION_CONTEXT('CNC Machining',#17,'manufacturing');
#17=APPLICATION_CONTEXT(
'Application protocol for the exchange of CNC data');
#18=PRODUCT_CONTEXT('CNC Machining',#17,'manufacturing');

/************************************************
 * Application object: WORKPIECE (#19)
 * ITS_ID: #19 ['unnamed workpiece']
 * SHAPE_DEFINITION: #19, #20
 */
#19=PRODUCT_DEFINITION('unnamed workpiece','',#21,#16);
#20=PRODUCT_DEFINITION_SHAPE('','',#19);
#21=PRODUCT_DEFINITION_FORMATION('1.0','Workpiece',#22);
#22=PRODUCT('WP','AP-238 CC1',' ',(#18));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#23)
 * ITS_TYPE: #23, #24, #25, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #23, #28, #528
 * ITS_PRIORITY: #23, #29, #30, #31, #32 ['required']
 * RAPID_SPEED: #23, #33, #34, #35, #36 ['true']
 * ITS_ID: #23 ['WS 1 TP 1']
 * BASICCURVE: #23, #37, #38, #39, #40
 */
#23=MACHINING_TOOLPATH('WS 1 TP 1','cutter location trajectory','','');
```



```
#24=ACTION_PROPERTY('trajectory type','cutter location trajectory',#23);
#25=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#24,#26);
#26=REPRESENTATION('constant',(#27),#41);
#27=DESCRIPTIVE_REPRESENTATION_ITEM('constant','trajectory path');
#28=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#23,
#528);
#29=ACTION_PROPERTY('priority','cutter location trajectory',#23);
#30=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#29,#31);
#31=REPRESENTATION('constant',(#32),#41);
#32=DESCRIPTIVE_REPRESENTATION_ITEM('constant','required');
#33=ACTION_PROPERTY('speed profile','rapid',#23);
#34=ACTION_PROPERTY_REPRESENTATION('','rapid',#33,#35);
#35=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#36),#41);
#36=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#37=ACTION_PROPERTY('basic curve','cutter location trajectory',#23);
#38=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#37,#39);
#39=REPRESENTATION('',(#40),#42);
#40=POLYLINE('basic curve for WS 1 TP 1',(#44,#45,#46));
#41=REPRESENTATION_CONTEXT('','units not necessary');
#42=(
GEOMETRIC_REPRESENTATION_CONTEXT(3)
GLOBAL_UNIT_ASSIGNED_CONTEXT((#554,#551,#558))
REPRESENTATION_CONTEXT('MILLIMETRE DEGREE STERADIAN','')
);
#44=CARTESIAN_POINT('start point',(0.,0.,40.));
#45=CARTESIAN_POINT('',(76.6078,112.6997,28.));
#46=CARTESIAN_POINT('',(76.6078,112.6997,23.));

/**********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#47)
 * ITS_TYPE: #47, #48, #49, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #47, #50, #537
 * ITS_PRIORITY: #47, #51, #52, #31, #32 ['required']
 * ITS_ID: #47 ['WS 1 TP 2']
 * BASICCURVE: #47, #53, #54, #55, #56
 */
#47=MACHINING_TOOLPATH('WS 1 TP 2','cutter location trajectory','','');
#48=ACTION_PROPERTY('trajectory type','cutter location trajectory',#47);
#49=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#48,#26);
#50=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#47,
#537);
#51=ACTION_PROPERTY('priority','cutter location trajectory',#47);
#52=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#51,#31);
#53=ACTION_PROPERTY('basic curve','cutter location trajectory',#47);
#54=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#53,#55);
#55=REPRESENTATION('',(#56),#42);
#56=COMPOSITE_CURVE('composite curve for WS 1 TP 2',(#57,#61,#69),.F.);
#57=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#58);
#58=POLYLINE('basic curve for WS 1 TP 2',(#46,#59,#60));
#59=CARTESIAN_POINT('',(76.6078,112.6997,20.));
#60=CARTESIAN_POINT('',(93.5102,109.6997,20.));
#61=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#62);
#62=TRIMMED_CURVE('Arc for  in WS 1 TP 2',#63,(#60),(#68),.F.,.CARTESIAN.);
#63=CIRCLE('Circle for  in WS 1 TP 2',#64,19.8938);
```



```
#64=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 2',#65,#66,#67);
#65=CARTESIAN_POINT('Arc center for  in WS 1 TP 2',(90.0336,90.112,20.));
#66=DIRECTION('Z direction',(0.,0.,1.));
#67=DIRECTION('X direction',(1.,0.,0.));
#68=CARTESIAN_POINT('Arc end for  in WS 1 TP 2',(102.0069,105.9992,20.));
#69=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#70);
#70=TRIMMED_CURVE('Arc for  in WS 1 TP 2',#71,(#68),(#74),.F.,.CARTESIAN.);
#71=CIRCLE('Circle for  in WS 1 TP 2',#72,20.0085);
#72=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 2',#73,#66,#67);
#73=CARTESIAN_POINT('Arc center for  in WS 1 TP 2',(89.9986,89.9948,20.));
#74=CARTESIAN_POINT('Arc end for  in WS 1 TP 2',(109.6997,93.4889,20.));

/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#75)
 * ITS_TYPE: #75, #76, #77, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #75, #78, #537
 * ITS_PRIORITY: #75, #79, #80, #31, #32 ['required']
 * RAPID_SPEED: #75, #81, #82, #83, #84 ['true']
 * ITS_ID: #75 ['WS 1 TP 3']
 * BASICCURVE: #75, #85, #86, #87, #88
 */
#75=MACHINING_TOOLPATH('WS 1 TP 3','cutter location trajectory','','');
#76=ACTION_PROPERTY('trajectory type','cutter location trajectory',#75);
#77=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#76,#26);
#78=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#75,
#537);
#79=ACTION_PROPERTY('priority','cutter location trajectory',#75);
#80=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#79,#31);
#81=ACTION_PROPERTY('speed profile','rapid',#75);
#82=ACTION_PROPERTY_REPRESENTATION('','rapid',#81,#83);
#83=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#84),#41);
#84=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#85=ACTION_PROPERTY('basic curve','cutter location trajectory',#75);
#86=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#85,#87);
#87=REPRESENTATION('',(#88),#42);
#88=POLYLINE('basic curve for WS 1 TP 3',(#74,#89,#90,#91,#92,#93));
#89=CARTESIAN_POINT('',(112.6997,76.5738,20.));
#90=CARTESIAN_POINT('',(112.6997,76.5738,23.));
#91=CARTESIAN_POINT('',(112.6997,76.5738,28.));
#92=CARTESIAN_POINT('',(-12.6979,98.9837,28.));
#93=CARTESIAN_POINT('',(-12.6979,98.9837,23.));

/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#94)
 * ITS_TYPE: #94, #95, #96, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #94, #97, #537
 * ITS_PRIORITY: #94, #98, #99, #31, #32 ['required']
 * ITS_ID: #94 ['WS 1 TP 4']
 * BASICCURVE: #94, #100, #101, #102, #103
 */
#94=MACHINING_TOOLPATH('WS 1 TP 4','cutter location trajectory','','');
#95=ACTION_PROPERTY('trajectory type','cutter location trajectory',#94);
#96=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#95,#26);
#97=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#94,
```



```
#537);
#98=ACTION_PROPERTY('priority','cutter location trajectory',#94);
#99=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#98,#31);
#100=ACTION_PROPERTY('basic curve','cutter location trajectory',#94);
#101=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#100,
#102);
#102=REPRESENTATION('',(#103),#42);
#103=COMPOSITE_CURVE('composite curve for WS 1 TP 4',(#104,#108,#114,#120,
#126,#132,#137,#143),.F.);
#104=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#105);
#105=POLYLINE('basic curve for WS 1 TP 4',(#93,#106,#107));
#106=CARTESIAN_POINT('',(-12.6979,98.9837,20.));
#107=CARTESIAN_POINT('',(-9.5374,101.5877,20.));
#108=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#109);
#109=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#110,(#107),(#113),.F.,.CARTESIAN.);
#110=CIRCLE('Circle for  in WS 1 TP 4',#111,14.9775);
#111=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#112,#66,#67);
#112=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(-0.0136,90.028,20.));
#113=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(-1.9146,104.8844,20.));
#114=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#115);
#115=POLYLINE('basic curve for WS 1 TP 4',(#113,#116,#117,#118,#119));
#116=CARTESIAN_POINT('',(-1.7697,104.9029,20.));
#117=CARTESIAN_POINT('',(-0.3611,105.0001,20.));
#118=CARTESIAN_POINT('',(90.4542,105.0001,20.));
#119=CARTESIAN_POINT('',(90.539,104.9972,20.));
#120=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#121);
#121=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#122,(#119),(#125),.F.,.CARTESIAN.);
#122=CIRCLE('Circle for  in WS 1 TP 4',#123,14.8938);
#123=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#124,#66,#67);
#124=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(90.0336,90.112,20.));
#125=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(99.0019,102.003,20.));
#126=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#127);
#127=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#128,(#125),(#131),.F.,.CARTESIAN.);
#128=CIRCLE('Circle for  in WS 1 TP 4',#129,15.0085);
#129=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#130,#66,#67);
#130=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(89.9986,89.9948,20.));
#131=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(104.9966,90.5564,20.));
#132=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#133);
#133=POLYLINE('basic curve for WS 1 TP 4',(#131,#134,#135,#136));
#134=CARTESIAN_POINT('',(105.0001,90.4629,20.));
#135=CARTESIAN_POINT('',(105.0001,-0.2221,20.));
#136=CARTESIAN_POINT('',(104.9997,-0.2552,20.));
#137=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#138);
#138=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#139,(#136),(#142),.F.,.CARTESIAN.);
#139=CIRCLE('Circle for  in WS 1 TP 4',#140,14.8411);
#140=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#141,#66,#67);
#141=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(90.1599,-0.0584,20.));
#142=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(102.0037,-9.0016,20.));
#143=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#144);
#144=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#145,(#142),(#148),.F.,.CARTESIAN.);
#145=CIRCLE('Circle for  in WS 1 TP 4',#146,14.9146);
#146=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#147,#66,#67);
#147=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(90.0613,-0.0673,20.));
#148=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(101.5829,-9.5381,20.));
```



```
/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#149)
 * ITS_TYPE: #149, #150, #151, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #149, #152, #537
 * ITS_PRIORITY: #149, #153, #154, #31, #32 ['required']
 * RAPID_SPEED: #149, #155, #156, #157, #158 ['true']
 * ITS_ID: #149 ['WS 1 TP 5']
 * BASICCURVE: #149, #159, #160, #161, #162
 */
#149=MACHINING_TOOLPATH('WS 1 TP 5','cutter location trajectory','','');
#150=ACTION_PROPERTY('trajectory type','cutter location trajectory',#149);
#151=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#150,
#26);
#152=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#149,
#537);
#153=ACTION_PROPERTY('priority','cutter location trajectory',#149);
#154=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#153,
#31);
#155=ACTION_PROPERTY('speed profile','rapid',#149);
#156=ACTION_PROPERTY_REPRESENTATION('','rapid',#155,#157);
#157=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#158),#41);
#158=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#159=ACTION_PROPERTY('basic curve','cutter location trajectory',#149);
#160=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#159,
#161);
#161=REPRESENTATION('',(#162),#42);
#162=POLYLINE('basic curve for WS 1 TP 5',(#148,#163,#164,#165,#166,#167));
#163=CARTESIAN_POINT('',(98.9855,-12.6979,20.));
#164=CARTESIAN_POINT('',(98.9855,-12.6979,23.));
#165=CARTESIAN_POINT('',(98.9855,-12.6979,28.));
#166=CARTESIAN_POINT('',(-12.9971,88.1,28.));
#167=CARTESIAN_POINT('',(-12.9971,88.1,23.));

/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#168)
 * ITS_TYPE: #168, #169, #170, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #168, #171, #537
 * ITS_PRIORITY: #168, #172, #173, #31, #32 ['required']
 * ITS_ID: #168 ['WS 1 TP 6']
 * BASICCURVE: #168, #174, #175, #176, #177
 */
#168=MACHINING_TOOLPATH('WS 1 TP 6','cutter location trajectory','','');
#169=ACTION_PROPERTY('trajectory type','cutter location trajectory',#168);
#170=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#169,
#26);
#171=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#168,
#537);
#172=ACTION_PROPERTY('priority','cutter location trajectory',#168);
#173=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#172,
#31);
#174=ACTION_PROPERTY('basic curve','cutter location trajectory',#168);
#175=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#174,
#176);
```



```
#176=REPRESENTATION('',(#177),#42);
#177=COMPOSITE_CURVE('composite curve for WS 1 TP 6',(#178,#181,#187,#193,
#199,#203,#209,#215,#218,#224,#230,#236),.F.);
#178=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#179);
#179=POLYLINE('basic curve for WS 1 TP 6',(#167,#180));
#180=CARTESIAN_POINT('',(-12.9971,88.1,20.));
#181=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#182);
#182=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#183,(#180),(#186),.T.,.CARTESIAN.);
#183=CIRCLE('Circle for  in WS 1 TP 6',#184,7.);
#184=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#185,#66,#67);
#185=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(-16.4813,94.1712,20.));
#186=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(-9.6979,92.4432,20.));
#187=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#188);
#188=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#189,(#186),(#192),.F.,.CARTESIAN.);
#189=CIRCLE('Circle for  in WS 1 TP 6',#190,10.2831);
#190=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#191,#66,#67);
#191=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(0.2669,89.9048,20.));
#192=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(-8.8119,94.7336,20.));
#193=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#194);
#194=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#195,(#192),(#198),.F.,.CARTESIAN.);
#195=CIRCLE('Circle for  in WS 1 TP 6',#196,9.9775);
#196=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#197,#66,#67);
#197=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(-0.0136,90.028,20.));
#198=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(-1.28,99.9248,20.));
#199=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#200);
#200=POLYLINE('basic curve for WS 1 TP 6',(#198,#201,#202));
#201=CARTESIAN_POINT('',(-0.1889,100.0001,20.));
#202=CARTESIAN_POINT('',(90.3693,100.0001,20.));
#203=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#204);
#204=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#205,(#202),(#208),.F.,.CARTESIAN.);
#205=CIRCLE('Circle for  in WS 1 TP 6',#206,9.8938);
#206=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#207,#66,#67);
#207=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(90.0336,90.112,20.));
#208=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(95.9968,98.0068,20.));
#209=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#210);
#210=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#211,(#208),(#214),.F.,.CARTESIAN.);
#211=CIRCLE('Circle for  in WS 1 TP 6',#212,10.0085);
#212=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#213,#66,#67);
#213=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(89.9986,89.9948,20.));
#214=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(100.0001,90.3693,20.));
#215=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#216);
#216=POLYLINE('basic curve for WS 1 TP 6',(#214,#217));
#217=CARTESIAN_POINT('',(100.0001,-0.1889,20.));
#218=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#219);
#219=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#220,(#217),(#223),.F.,.CARTESIAN.);
#220=CIRCLE('Circle for  in WS 1 TP 6',#221,9.8411);
#221=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#222,#66,#67);
#222=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(90.1599,-0.0584,20.));
#223=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(98.0068,-5.9975,20.));
#224=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#225);
#225=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#226,(#223),(#229),.F.,.CARTESIAN.);
#226=CIRCLE('Circle for  in WS 1 TP 6',#227,9.9146);
#227=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#228,#66,#67);
#228=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(90.0613,-0.0673,20.));
```

```
#229=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(94.7336,-8.8119,20.));
#230=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#231);
#231=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#232,(#229),(#235),.F.,.CARTESIAN.);
#232=CIRCLE('Circle for  in WS 1 TP 6',#233,9.6195);
#233=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#234,#66,#67);
#234=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(90.1227,-0.3694,20.));
#235=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(92.4709,-9.6979,20.));
#236=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#237);
#237=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#238,(#235),(#241),.T.,.CARTESIAN.);
#238=CIRCLE('Circle for  in WS 1 TP 6',#239,7.);
#239=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#240,#66,#67);
#240=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(94.1797,-16.4862,20.));
#241=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(87.6325,-14.0095,20.));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#242)
 * ITS_TYPE: #242, #243, #244, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #242, #245, #537
 * ITS_PRIORITY: #242, #246, #247, #31, #32 ['required']
 * RAPID_SPEED: #242, #248, #249, #250, #251 ['true']
 * ITS_ID: #242 ['WS 1 TP 7']
 * BASICCURVE: #242, #252, #253, #254, #255
 */
#242=MACHINING_TOOLPATH('WS 1 TP 7','cutter location trajectory','','');
#243=ACTION_PROPERTY('trajectory type','cutter location trajectory',#242);
#244=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#243,
#26);
#245=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#242,
#537);
#246=ACTION_PROPERTY('priority','cutter location trajectory',#242);
#247=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#246,
#31);
#248=ACTION_PROPERTY('speed profile','rapid',#242);
#249=ACTION_PROPERTY_REPRESENTATION('','rapid',#248,#250);
#250=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#251),#41);
#251=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#252=ACTION_PROPERTY('basic curve','cutter location trajectory',#242);
#253=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#252,
#254);
#254=REPRESENTATION('',(#255),#42);
#255=POLYLINE('basic curve for WS 1 TP 7',(#241,#256,#257,#258,#259,#260));
#256=CARTESIAN_POINT('',(87.6325,-14.0095,23.));
#257=CARTESIAN_POINT('',(87.6325,-14.0095,31.));
#258=CARTESIAN_POINT('',(76.7996,112.6997,31.));
#259=CARTESIAN_POINT('',(76.7996,112.6997,23.));
#260=CARTESIAN_POINT('',(76.7996,112.6997,18.));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#261)
 * ITS_TYPE: #261, #262, #263, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #261, #264, #537
 * ITS_PRIORITY: #261, #265, #266, #31, #32 ['required']
 * ITS_ID: #261 ['WS 1 TP 8']
 * BASICCURVE: #261, #267, #268, #269, #270
```



```
 */
#261=MACHINING_TOOLPATH('WS 1 TP 8','cutter location trajectory','','');
#262=ACTION_PROPERTY('trajectory type','cutter location trajectory',#261);
#263=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#262,
#26);
#264=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#261,
#537);
#265=ACTION_PROPERTY('priority','cutter location trajectory',#261);
#266=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#265,
#31);
#267=ACTION_PROPERTY('basic curve','cutter location trajectory',#261);
#268=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#267,
#269);
#269=REPRESENTATION('',(#270),#42);
#270=COMPOSITE_CURVE('composite curve for WS 1 TP 8',(#271,#275,#281,#285,
#291,#295),.F.);
#271=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#272);
#272=POLYLINE('basic curve for WS 1 TP 8',(#260,#273,#274));
#273=CARTESIAN_POINT('',(76.7996,112.6997,15.));
#274=CARTESIAN_POINT('',(93.5151,109.6997,15.));
#275=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#276);
#276=TRIMMED_CURVE('Arc for  in WS 1 TP 8',#277,(#274),(#280),.F.,.CARTESIAN.);
#277=CIRCLE('Circle for  in WS 1 TP 8',#278,20.0969);
#278=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 8',#279,#66,#67);
#279=CARTESIAN_POINT('Arc center for  in WS 1 TP 8',(89.9649,89.9188,15.));
#280=CARTESIAN_POINT('Arc end for  in WS 1 TP 8',(101.6281,106.2851,15.));
#281=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#282);
#282=POLYLINE('basic curve for WS 1 TP 8',(#280,#283,#284));
#283=CARTESIAN_POINT('',(101.6318,106.2824,15.));
#284=CARTESIAN_POINT('',(101.6356,106.2798,15.));
#285=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#286);
#286=TRIMMED_CURVE('Arc for  in WS 1 TP 8',#287,(#284),(#290),.F.,.CARTESIAN.);
#287=CIRCLE('Circle for  in WS 1 TP 8',#288,19.9541);
#288=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 8',#289,#66,#67);
#289=CARTESIAN_POINT('Arc center for  in WS 1 TP 8',(90.0404,90.0404,15.));
#290=CARTESIAN_POINT('Arc end for  in WS 1 TP 8',(107.6374,99.4484,15.));
#291=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#292);
#292=POLYLINE('basic curve for WS 1 TP 8',(#290,#293,#294));
#293=CARTESIAN_POINT('',(107.6398,99.4439,15.));
#294=CARTESIAN_POINT('',(107.6422,99.4394,15.));
#295=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#296);
#296=TRIMMED_CURVE('Arc for  in WS 1 TP 8',#297,(#294),(#300),.F.,.CARTESIAN.);
#297=CIRCLE('Circle for  in WS 1 TP 8',#298,20.1824);
#298=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 8',#299,#66,#67);
#299=CARTESIAN_POINT('Arc center for  in WS 1 TP 8',(89.8342,89.9419,15.));
#300=CARTESIAN_POINT('Arc end for  in WS 1 TP 8',(109.6997,93.5045,15.));

/*************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#301)
 * ITS_TYPE: #301, #302, #303, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #301, #304, #537
 * ITS_PRIORITY: #301, #305, #306, #31, #32 ['required']
 * RAPID_SPEED: #301, #307, #308, #309, #310 ['true']
 * ITS_ID: #301 ['WS 1 TP 9']
```



```
 * BASICCURVE: #301, #311, #312, #313, #314
 */
#301=MACHINING_TOOLPATH('WS 1 TP 9','cutter location trajectory','','');
#302=ACTION_PROPERTY('trajectory type','cutter location trajectory',#301);
#303=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#302,
#26);
#304=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#301,
#537);
#305=ACTION_PROPERTY('priority','cutter location trajectory',#301);
#306=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#305,
#31);
#307=ACTION_PROPERTY('speed profile','rapid',#301);
#308=ACTION_PROPERTY_REPRESENTATION('','rapid',#307,#309);
#309=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#310),#41);
#310=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#311=ACTION_PROPERTY('basic curve','cutter location trajectory',#301);
#312=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#311,
#313);
#313=REPRESENTATION('',(#314),#42);
#314=POLYLINE('basic curve for WS 1 TP 9',(#300,#315,#316,#317,#318,#319,
#320));
#315=CARTESIAN_POINT('',(112.6997,76.7764,15.));
#316=CARTESIAN_POINT('',(112.6997,76.7764,18.));
#317=CARTESIAN_POINT('',(112.6997,76.7764,31.));
#318=CARTESIAN_POINT('',(-12.6979,98.9932,31.));
#319=CARTESIAN_POINT('',(-12.6979,98.9932,23.));
#320=CARTESIAN_POINT('',(-12.6979,98.9932,18.));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#321)
 * ITS_TYPE: #321, #322, #323, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #321, #324, #537
 * ITS_PRIORITY: #321, #325, #326, #31, #32 ['required']
 * ITS_ID: #321 ['WS 1 TP 10']
 * BASICCURVE: #321, #327, #328, #329, #330
 */
#321=MACHINING_TOOLPATH('WS 1 TP 10','cutter location trajectory','','');
#322=ACTION_PROPERTY('trajectory type','cutter location trajectory',#321);
#323=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#322,
#26);
#324=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#321,
#537);
#325=ACTION_PROPERTY('priority','cutter location trajectory',#321);
#326=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#325,
#31);
#327=ACTION_PROPERTY('basic curve','cutter location trajectory',#321);
#328=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#327,
#329);
#329=REPRESENTATION('',(#330),#42);
#330=COMPOSITE_CURVE('composite curve for WS 1 TP 10',(#331,#335,#341,#347,
#353,#357,#363,#367,#373,#378,#384),.F.);
#331=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#332);
#332=POLYLINE('basic curve for WS 1 TP 10',(#320,#333,#334));
#333=CARTESIAN_POINT('',(-12.6979,98.9932,15.));
```



```
#334=CARTESIAN_POINT('',(-9.5364,101.5958,15.));
#335=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#336);
#336=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#337,(#334),(#340),.F.,.CARTESIAN.);
#337=CIRCLE('Circle for  in WS 1 TP 10',#338,14.9952);
#338=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#339,#66,#67);
#339=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(-0.0061,90.0187,15.));
#340=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(-1.9172,104.8916,15.));
#341=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#342);
#342=POLYLINE('basic curve for WS 1 TP 10',(#340,#343,#344,#345,#346));
#343=CARTESIAN_POINT('',(-1.771,104.9104,15.));
#344=CARTESIAN_POINT('',(-0.3611,105.0076,15.));
#345=CARTESIAN_POINT('',(90.4695,105.0076,15.));
#346=CARTESIAN_POINT('',(90.5696,105.0036,15.));
#347=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#348);
#348=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#349,(#346),(#352),.F.,.CARTESIAN.);
#349=CIRCLE('Circle for  in WS 1 TP 10',#350,15.0969);
#350=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#351,#66,#67);
#351=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(89.9649,89.9188,15.));
#352=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(98.7264,102.2132,15.));
#353=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#354);
#354=POLYLINE('basic curve for WS 1 TP 10',(#352,#355,#356));
#355=CARTESIAN_POINT('',(98.7282,102.2119,15.));
#356=CARTESIAN_POINT('',(98.7301,102.2106,15.));
#357=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#358);
#358=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#359,(#356),(#362),.F.,.CARTESIAN.);
#359=CIRCLE('Circle for  in WS 1 TP 10',#360,14.9541);
#360=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#361,#66,#67);
#361=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(90.0404,90.0404,15.));
#362=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(103.228,97.091,15.));
#363=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#364);
#364=POLYLINE('basic curve for WS 1 TP 10',(#362,#365,#366));
#365=CARTESIAN_POINT('',(103.2292,97.0888,15.));
#366=CARTESIAN_POINT('',(103.2304,97.0865,15.));
#367=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#368);
#368=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#369,(#366),(#372),.F.,.CARTESIAN.);
#369=CIRCLE('Circle for  in WS 1 TP 10',#370,15.1824);
#370=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#371,#66,#67);
#371=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(89.8342,89.9419,15.));
#372=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(105.0032,90.5792,15.));
#373=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#374);
#374=POLYLINE('basic curve for WS 1 TP 10',(#372,#375,#376,#377));
#375=CARTESIAN_POINT('',(105.0076,90.4743,15.));
#376=CARTESIAN_POINT('',(105.0076,-0.222,15.));
#377=CARTESIAN_POINT('',(105.0072,-0.255,15.));
#378=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#379);
#379=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#380,(#377),(#383),.F.,.CARTESIAN.);
#380=CIRCLE('Circle for  in WS 1 TP 10',#381,14.8322);
#381=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#382,#66,#67);
#382=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(90.1763,-0.059,15.));
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```
#383=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(101.9997,-9.0144,15.));
#384=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#385);
#385=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#386,(#383),(#389),.F.,.CARTESIAN.);
#386=CIRCLE('Circle for  in WS 1 TP 10',#387,14.9841);
#387=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#388,#66,#67);
#388=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(90.012,-0.0245,15.));
#389=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(101.589,-9.5375,15.));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#390)
 * ITS_TYPE: #390, #391, #392, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #390, #393, #537
 * ITS_PRIORITY: #390, #394, #395, #31, #32 ['required']
 * RAPID_SPEED: #390, #396, #397, #398, #399 ['true']
 * ITS_ID: #390 ['WS 1 TP 11']
 * BASICCURVE: #390, #400, #401, #402, #403
 */
#390=MACHINING_TOOLPATH('WS 1 TP 11','cutter location trajectory','','');
#391=ACTION_PROPERTY('trajectory type','cutter location trajectory',#390);
#392=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#391,
#26);
#393=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#390,
#537);
#394=ACTION_PROPERTY('priority','cutter location trajectory',#390);
#395=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#394,
#31);
#396=ACTION_PROPERTY('speed profile','rapid',#390);
#397=ACTION_PROPERTY_REPRESENTATION('','rapid',#396,#398);
#398=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#399),#41);
#399=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#400=ACTION_PROPERTY('basic curve','cutter location trajectory',#390);
#401=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#400,
#402);
#402=REPRESENTATION('',(#403),#42);
#403=POLYLINE('basic curve for WS 1 TP 11',(#389,#404,#405,#406,#407,#408,
#409));
#404=CARTESIAN_POINT('',(98.992,-12.6979,15.));
#405=CARTESIAN_POINT('',(98.992,-12.6979,18.));
#406=CARTESIAN_POINT('',(98.992,-12.6979,31.));
#407=CARTESIAN_POINT('',(-12.9934,87.8423,31.));
#408=CARTESIAN_POINT('',(-12.9934,87.8423,23.));
#409=CARTESIAN_POINT('',(-12.9934,87.8423,18.));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#410)
 * ITS_TYPE: #410, #411, #412, #26, #27 ['trajectory path']
 * ITS_TECHNOLOGY: #410, #413, #537
 * ITS_PRIORITY: #410, #414, #415, #31, #32 ['required']
 * ITS_ID: #410 ['WS 1 TP 12']
 * BASICCURVE: #410, #416, #417, #418, #419
 */
#410=MACHINING_TOOLPATH('WS 1 TP 12','cutter location trajectory','','');
#411=ACTION_PROPERTY('trajectory type','cutter location trajectory',#410);
```



```
#412=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#411,
#26);
#413=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#410,
#537);
#414=ACTION_PROPERTY('priority','cutter location trajectory',#410);
#415=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#414,
#31);
#416=ACTION_PROPERTY('basic curve','cutter location trajectory',#410);
#417=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#416,
#418);
#418=REPRESENTATION('',(#419),#42);
#419=COMPOSITE_CURVE('composite curve for WS 1 TP 12',(#420,#423,#429,#434,
#440,#444,#450,#456,#462,#465,#471,#477),.F.);
#420=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#421);
#421=POLYLINE('basic curve for WS 1 TP 12',(#409,#422));
#422=CARTESIAN_POINT('',(-12.9934,87.8423,15.));
#423=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#424);
#424=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#425,(#422),(#428),.T.,.CARTESIAN.);
#425=CIRCLE('Circle for  in WS 1 TP 12',#426,7.);
#426=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#427,#66,#67);
#427=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(-16.5527,93.8698,15.));
#428=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(-9.6979,92.4515,15.));
#429=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#430);
#430=POLYLINE('basic curve for WS 1 TP 12',(#428,#431,#432,#433));
#431=CARTESIAN_POINT('',(-9.6772,92.5514,15.));
#432=CARTESIAN_POINT('',(-9.316,93.6425,15.));
#433=CARTESIAN_POINT('',(-8.8194,94.7336,15.));
#434=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#435);
#435=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#436,(#433),(#439),.F.,.CARTESIAN.);
#436=CIRCLE('Circle for  in WS 1 TP 12',#437,9.9952);
#437=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#438,#66,#67);
#438=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(-0.0061,90.0187,15.));
#439=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(-1.28,99.9324,15.));
#440=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#441);
#441=POLYLINE('basic curve for WS 1 TP 12',(#439,#442,#443));
#442=CARTESIAN_POINT('',(-0.1889,100.0076,15.));
#443=CARTESIAN_POINT('',(90.3693,100.0076,15.));
#444=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#445);
#445=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#446,(#443),(#449),.F.,.CARTESIAN.);
#446=CIRCLE('Circle for  in WS 1 TP 12',#447,10.0969);
#447=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#448,#66,#67);
#448=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(89.9649,89.9188,15.));
#449=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(95.8246,98.1414,15.));
#450=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#451);
#451=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#452,(#449),(#455),.F.,.CARTESIAN.);
#452=CIRCLE('Circle for  in WS 1 TP 12',#453,9.9541);
#453=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#454,#66,#67);
#454=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(90.0404,90.0404,15.));
#455=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(98.8187,94.7336,15.));
#456=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#457);
```

```
#457=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#458,(#455),(#461),.F.,.CARTESIAN.);
#458=CIRCLE('Circle for  in WS 1 TP 12',#459,10.1824);
#459=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#460,#66,#67);
#460=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(89.8342,89.9419,15.));
#461=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(100.0076,90.3693,15.));
#462=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#463);
#463=POLYLINE('basic curve for WS 1 TP 12',(#461,#464));
#464=CARTESIAN_POINT('',(100.0076,-0.1889,15.));
#465=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#466);
#466=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#467,(#464),(#470),.F.,.CARTESIAN.);
#467=CIRCLE('Circle for  in WS 1 TP 12',#468,9.8322);
#468=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#469,#66,#67);
#469=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(90.1763,-0.059,15.));
#470=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(98.0068,-6.005,15.));
#471=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#472);
#472=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#473,(#470),(#476),.F.,.CARTESIAN.);
#473=CIRCLE('Circle for  in WS 1 TP 12',#474,9.9841);
#474=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#475,#66,#67);
#475=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(90.012,-0.0245,15.));
#476=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(92.4833,-9.6979,15.));
#477=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#478);
#478=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#479,(#476),(#482),.T.,.CARTESIAN.);
#479=CIRCLE('Circle for  in WS 1 TP 12',#480,7.);
#480=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#481,#66,#67);
#481=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(94.216,-16.4801,15.));
#482=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(87.6601,-14.0265,15.));

/************************************************
 * Application object: DERIVED_UNIT (#483)
 * NAME: #483, #484 ['revolution/minute']
 */
#483=DERIVED_UNIT((#485));
#484=NAME_ATTRIBUTE('revolution/minute',#483);
#485=DERIVED_UNIT_ELEMENT(#547,-1.);

/************************************************
 * Application object: DERIVED_UNIT (#486)
 * NAME: #486, #487 ['millimetre/minute']
 */
#486=DERIVED_UNIT((#488,#489));
#487=NAME_ATTRIBUTE('millimetre/minute',#486);
#488=DERIVED_UNIT_ELEMENT(#554,1.);
#489=DERIVED_UNIT_ELEMENT(#547,-1.);

/************************************************
 * Application object: FREEFORM_OPERATION (#490)
 * ITS_TOOLPATH [1]: #490, #491, #23
 * ITS_TOOLPATH [2]: #490, #492, #47
 * ITS_TOOLPATH [3]: #490, #493, #75
 * ITS_TOOLPATH [4]: #490, #494, #94
```



```
 * ITS_TOOLPATH [5]: #490, #495, #149
 * ITS_TOOLPATH [6]: #490, #496, #168
 * ITS_TOOLPATH [7]: #490, #497, #242
 * ITS_TOOLPATH [8]: #490, #498, #261
 * ITS_TOOLPATH [9]: #490, #499, #301
 * ITS_TOOLPATH [10]: #490, #500, #321
 * ITS_TOOLPATH [11]: #490, #501, #390
 * ITS_TOOLPATH [12]: #490, #502, #410
 * ITS_TECHNOLOGY: #490, #503, #528
 * ITS_MACHINE_FUNCTIONS: #490, #504, #515
 * ITS_TOOL: #490, #580
 * ITS_ID: #490 ['WS 1']
 */
#490=FREEFORM_MILLING_OPERATION('WS 1','','','');
#491=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#23,1.);
#492=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#47,2.);
#493=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#75,3.);
#494=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#94,4.);
#495=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#149,5.);
#496=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#168,6.);
#497=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#242,7.);
#498=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#261,8.);
#499=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#301,9.);
#500=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#321,10.);
#501=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#390,11.);
#502=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#490,#410,12.);
#503=MACHINING_TECHNOLOGY_RELATIONSHIP('','',#490,#528);
#504=MACHINING_FUNCTIONS_RELATIONSHIP('','',#490,#515);

/***********************************************
 * Application object: MACHINING_WORKINGSTEP (#505)
 * ITS_OPERATION: #505, #506, #490
 * ITS_ID: #505 ['WS 1']
 * ITS_FEATURE: #505, #507, #508, #509, #510, #567
 */
#505=MACHINING_WORKINGSTEP('WS 1','machining','','');
#506=MACHINING_OPERATION_RELATIONSHIP('','machining',#505,#490);
#507=MACHINING_FEATURE_RELATIONSHIP('','machining',#505,#508);
#508=MACHINING_FEATURE_PROCESS('','machining','','');
#509=PROPERTY_PROCESS('machining','machining',#508,'');
#510=PROCESS_PROPERTY_ASSOCIATION('','machining',#509,#567);

/***********************************************
 * Application object: MILLING_MACHINE_FUNCTIONS (#515)
 * CHIP_REMOVAL: #515, #516, #517, #518, #519 ['chip removal off']
 * COOLANT: #515, #520, #521, #522, #523 ['coolant off']
 * THROUGH_SPINDLE_COOLANT: #515, #524, #525, #526, #527 ['through spindle
coolant off']
 */
#515=MACHINING_FUNCTIONS('','milling','','');
#516=ACTION_PROPERTY('chip removal','milling',#515);
#517=ACTION_PROPERTY_REPRESENTATION('','milling',#516,#518);
#518=REPRESENTATION('constant',(#519),#41);
#519=DESCRIPTIVE_REPRESENTATION_ITEM('constant','chip removal off');
```



```
#520=ACTION_PROPERTY('coolant','milling',#515);
#521=ACTION_PROPERTY_REPRESENTATION('','milling',#520,#522);
#522=REPRESENTATION('constant',(#523),#41);
#523=DESCRIPTIVE_REPRESENTATION_ITEM('constant','coolant off');
#524=ACTION_PROPERTY('through spindle coolant','milling',#515);
#525=ACTION_PROPERTY_REPRESENTATION('','milling',#524,#526);
#526=REPRESENTATION('constant',(#527),#41);
#527=DESCRIPTIVE_REPRESENTATION_ITEM('constant',
'through spindle coolant off');

/*************************************************
 * Application object: MILLING_TECHNOLOGY (#528)
 * SPINDLE: #528, #529, #530, #531, #532
 * FEEDRATE: #528, #533, #534, #535, #536
 */
#528=MACHINING_TECHNOLOGY('','milling','','');
#529=ACTION_PROPERTY('spindle','milling',#528);
#530=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#529,#531);
#531=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#532),#41);
#532=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(0.),
#483);
#533=ACTION_PROPERTY('feedrate','milling',#528);
#534=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#533,#535);
#535=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#536),#41);
#536=MEASURE_REPRESENTATION_ITEM('feed speed',NUMERIC_MEASURE(0.),#486);

/*************************************************
 * Application object: MILLING_TECHNOLOGY (#537)
 * SPINDLE: #537, #538, #539, #540, #541
 * FEEDRATE: #537, #542, #543, #544, #545
 */
#537=MACHINING_TECHNOLOGY('','milling','','');
#538=ACTION_PROPERTY('spindle','milling',#537);
#539=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#538,#540);
#540=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#541),#41);
#541=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(0.),
#483);
#542=ACTION_PROPERTY('feedrate','milling',#537);
#543=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#542,#544);
#544=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#545),#41);
#545=MEASURE_REPRESENTATION_ITEM('feed speed',NUMERIC_MEASURE(250.),#486);

/*************************************************
 * Application object: NAMED_UNIT (#546)
 */
#546=(
NAMED_UNIT(*)
SI_UNIT($,.SECOND.)
TIME_UNIT()
);

/*************************************************
 * Application object: NAMED_UNIT (#547)
 */
```

```
#547=(
CONVERSION_BASED_UNIT('minute',#549)
NAMED_UNIT(#548)
TIME_UNIT()
);
#548=DIMENSIONAL_EXPONENTS(0.,0.,1.,0.,0.,0.,0.);
#549=TIME_MEASURE_WITH_UNIT(TIME_MEASURE(60.),#546);

/***********************************************
 * Application object: NAMED_UNIT (#550)
 */
#550=(
NAMED_UNIT(*)
PLANE_ANGLE_UNIT()
SI_UNIT($,.RADIAN.)
);

/***********************************************
 * Application object: NAMED_UNIT (#551)
 */
#551=(
CONVERSION_BASED_UNIT('degree',#553)
NAMED_UNIT(#552)
PLANE_ANGLE_UNIT()
);
#552=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);
#553=PLANE_ANGLE_MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(0.01745329252),#550);

/***********************************************
 * Application object: NAMED_UNIT (#554)
 */
#554=(
LENGTH_UNIT()
NAMED_UNIT(*)
SI_UNIT(.MILLI.,.METRE.)
);

/***********************************************
 * Application object: NAMED_UNIT (#558)
 */
#558=(
NAMED_UNIT(*)
SI_UNIT($,.STERADIAN.)
SOLID_ANGLE_UNIT()
);


/***********************************************
 * Application object: TOOLPATH_FEATURE (#567)
 * ITS_WORKPIECE: #567, #20, #19
 * FEATURE_PLACEMENT: #567, #568, #569, #570, #571
 * ITS_ID: #567 ['']
 * ITS_OPERATIONS [*]: #567, #510, #509, #508, #507, #505, #506, #490
 */
```



```
#567=INSTANCED_FEATURE('','toolpath','','toolpath',#20,.F.);
#568=PRODUCT_DEFINITION_SHAPE('orientation','toolpath',#567);
#569=SHAPE_DEFINITION_REPRESENTATION(#568,#570);
#570=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#571),#42);
#571=AXIS2_PLACEMENT_3D('orientation',#572,#66,#67);
#572=CARTESIAN_POINT('origin',(0.,0.,0.));

/*************************************************
 * Application object: WORKPLAN (#575)
 * ITS_ELEMENTS [1]: #575, #576, #505
 * ITS_ID: #575 ['main workplan']
 */
#575=MACHINING_WORKPLAN('main workplan','','','');
#576=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#575,#505,1.);

/*************************************************
 * Application object: ENDMILL (#580)
 * ITS_ID: #580 ['1']
 * EFFECTIVE_CUTTING_DIAMETER: #580, #582, #583, #584, #585
 * MAXIMUM_DEPTH_OF_CUT: #580, #582, #583, #584, #586
 * HAND_OF_CUT: #580, #582, #583, #584, #587 ['right']
 * EDGE_RADIUS: #580, #582, #583, #584, #588
 */
#580=MACHINING_TOOL('1','',(#490),#581);
#581=ACTION_RESOURCE_TYPE('milling cutting tool');
#582=RESOURCE_PROPERTY('tool body','',#580);
#583=RESOURCE_PROPERTY_REPRESENTATION('','',#582,#584);
#584=MACHINING_TOOL_BODY_REPRESENTATION('endmill',(#585,#586,#587,#588),#41);
#585=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(20.),#554)
REPRESENTATION_ITEM('effective cutting diameter')
);
#586=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(20.),#554)
REPRESENTATION_ITEM('maximum depth of cut')
);
#587=DESCRIPTIVE_REPRESENTATION_ITEM('hand of cut','right');
#588=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.),#554)
REPRESENTATION_ITEM('edge radius')
);

#600=APPLICATION_PROTOCOL_DEFINITION('international standard',
'integrated_cnc_schema',2006,#17);
ENDSEC;
END-ISO-10303-21;
```

K.5 Data set for CC2 example

The example below is a conformance class two (CC2) data set for the project described in K.3. This describes the same machining workplan and toolpaths as the previous CC1 example, but also contains shape descriptions for both the workpiece and rawpiece.

```
ISO-10303-21;
HEADER;

FILE_DESCRIPTION(
/* description */ ('AP238 CC2 simple block example'),
/* implementation_level */ '2;1');

FILE_NAME(
/* name */ 'simple_block_cc2',
/* time_stamp */ '2006-07-06T12:30:22-04:00',
/* author */ ('Dave Loffredo (loffredo@steptools.com)'),
/* organization */ (''),
/* preprocessor_version */ 'ST-DEVELOPER v11',
/* originating_system */ 'Various',
/* authorisation */ '');

FILE_SCHEMA (('INTEGRATED_CNC_SCHEMA'));
ENDSEC;

DATA;

/************************************************
 * Application object: PROJECT (#10)
 * MAIN_WORKPLAN: #10, #11, #12, #1134
 * ITS_ID: #10, #13, #14 ['New Project']
 * ITS_WORKPIECES [*]: #10, #15, #19
 */
#10=PRODUCT_DEFINITION('','',#13,#16);
#11=PROCESS_PRODUCT_ASSOCIATION('','',#10,#12);
#12=PRODUCT_DEFINITION_PROCESS('machining','',#1134,'');
#13=PRODUCT_DEFINITION_FORMATION('','',#14);
#14=MACHINING_PROJECT('New Project','',$,(#18));
#15=MACHINING_PROJECT_WORKPIECE_RELATIONSHIP('','workpiece','',#10,#19);
#16=PRODUCT_DEFINITION_CONTEXT('CNC Machining',#17,'manufacturing');
#17=APPLICATION_CONTEXT(
'Application protocol for the exchange of CNC data');
#18=PRODUCT_CONTEXT('CNC Machining',#17,'manufacturing');

/************************************************
 * Application object: WORKPIECE (#19)
 * ITS_ID: #19, #24, #25 ['WP']
 * ITS_SUBASSEMBLY [*]: #19, #536
 * ITS_GEOMETRY: #19, #20, #21, #22
 * ITS_RAWPIECE: #19, #23, #315
 */
#19=PRODUCT_DEFINITION('','',#24,#16);
#20=PRODUCT_DEFINITION_SHAPE('','',#19);
```

```
#21=SHAPE_DEFINITION_REPRESENTATION(#20,#22);
#22=SHAPE_REPRESENTATION('parent',(#29),#1026);
#23=MAKE_FROM_USAGE_OPTION('','','',#19,#315,0,'',#33);
#24=PRODUCT_DEFINITION_FORMATION('1.0','Workpiece',#25);
#25=PRODUCT('WP','AP-238 CC2',' ',(#18));
#29=AXIS2_PLACEMENT_3D('owner',#30,#31,#32);
#30=CARTESIAN_POINT('owner',(0.,0.,0.));
#31=DIRECTION('owner',(0.,0.,1.));
#32=DIRECTION('owner',(1.,0.,0.));
#33=MEASURE_WITH_UNIT(COUNT_MEASURE(1.),#1099);

/***********************************************
 * Application object: WORKPIECE (#34)
 * ITS_ID: #34, #38, #39 ['WORKPIECE COMPONENT']
 * ITS_APPROVALS: #34, #44
 * ITS_GEOMETRY: #34, #35, #42, #43
 * ITS_RELATED_GEOMETRY [*]: #34, #35, #42, #43, #47, #48
 * ITS_TIMESTAMPS: #34, #36
 * PRODUCT_PEOPLE: #34, #38, #39, #40
 * REVISION_APPROVALS: #34, #38, #49, #510
 * REVISION_PEOPLE: #34, #38, #45
 * REVISION_PEOPLE: #34, #38, #50
 */
#34=PRODUCT_DEFINITION('WORKPIECE COMPONENT','',#38,#16);
#35=PRODUCT_DEFINITION_SHAPE('','',#34);
#36=APPLIED_DATE_AND_TIME_ASSIGNMENT(#37,#52,(#34));
#37=DATE_AND_TIME(#56,#57);
#38=PRODUCT_DEFINITION_FORMATION(' ',' ',#39);
#39=PRODUCT('loffDE0Bxyzt','loffDE0Bxyzt',' ',(#18));
#40=APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT(#41,#53,(#39));
#41=PERSON_AND_ORGANIZATION(#1101,#59);
#42=SHAPE_DEFINITION_REPRESENTATION(#35,#43);
#43=SHAPE_REPRESENTATION('loffDE0Bxyzt-none',(#60),#1026);
#44=APPLIED_APPROVAL_ASSIGNMENT(#516,(#34));
#45=APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT(#46,#54,(#38));
#46=PERSON_AND_ORGANIZATION(#1101,#64);
#47=SHAPE_REPRESENTATION_RELATIONSHIP('none',
'relationship between loffDE0Bxyzt-none and loffDE0Bxyzt-none',#43,#48);
#48=ADVANCED_BREP_SHAPE_REPRESENTATION('loffDE0Bxyzt-none',(#65),#1026);
#49=APPLIED_APPROVAL_ASSIGNMENT(#510,(#38));
#50=APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT(#51,#55,(#34,#38));
#51=PERSON_AND_ORGANIZATION(#1101,#314);
#52=DATE_TIME_ROLE('creation_date');
#53=PERSON_AND_ORGANIZATION_ROLE('design_owner');
#54=PERSON_AND_ORGANIZATION_ROLE('design_supplier');
#55=PERSON_AND_ORGANIZATION_ROLE('creator');
#56=CALENDAR_DATE(0,1,1);
#57=LOCAL_TIME(0,0,0.,#58);
#58=COORDINATED_UNIVERSAL_TIME_OFFSET(0,0,.BEHIND.);
#59=ORGANIZATION(' ',' ',' ');
#60=AXIS2_PLACEMENT_3D('child',#61,#62,#63);
#61=CARTESIAN_POINT('child',(0.,0.,0.));
#62=DIRECTION('child',(0.,0.,1.));
#63=DIRECTION('child',(1.,0.,0.));
```



```
#64=ORGANIZATION(' ',' ',' ');
#65=MANIFOLD_SOLID_BREP('WORKPIECE',#66);
#66=CLOSED_SHELL('',(#67,#123,#170,#208,#232,#249,#261,#285,#302));
#67=ADVANCED_FACE('WPface0',(#68),#118,.T.);
#68=FACE_OUTER_BOUND('',#69,.T.);
#69=EDGE_LOOP('',(#70,#80,#88,#96,#104,#112));
#70=ORIENTED_EDGE('',*,*,#71,.F.);
#71=EDGE_CURVE('',#72,#74,#76,.T.);
#72=VERTEX_POINT('',#73);
#73=CARTESIAN_POINT('',(90.,0.,15.));
#74=VERTEX_POINT('',#75);
#75=CARTESIAN_POINT('',(90.,90.,15.));
#76=LINE('',#77,#78);
#77=CARTESIAN_POINT('',(90.,45.,15.));
#78=VECTOR('',#79,1.);
#79=DIRECTION('',(0.,1.,0.));
#80=ORIENTED_EDGE('',*,*,#81,.F.);
#81=EDGE_CURVE('',#82,#72,#84,.T.);
#82=VERTEX_POINT('',#83);
#83=CARTESIAN_POINT('',(100.,0.,15.));
#84=LINE('',#85,#86);
#85=CARTESIAN_POINT('',(50.,0.,15.));
#86=VECTOR('',#87,1.);
#87=DIRECTION('',(-1.,0.,0.));
#88=ORIENTED_EDGE('',*,*,#89,.F.);
#89=EDGE_CURVE('',#90,#82,#92,.T.);
#90=VERTEX_POINT('',#91);
#91=CARTESIAN_POINT('',(100.,100.,15.));
#92=LINE('',#93,#94);
#93=CARTESIAN_POINT('',(100.,50.,15.));
#94=VECTOR('',#95,1.);
#95=DIRECTION('',(0.,-1.,0.));
#96=ORIENTED_EDGE('',*,*,#97,.F.);
#97=EDGE_CURVE('',#98,#90,#100,.T.);
#98=VERTEX_POINT('',#99);
#99=CARTESIAN_POINT('',(0.,100.,15.));
#100=LINE('',#101,#102);
#101=CARTESIAN_POINT('',(50.,100.,15.));
#102=VECTOR('',#103,1.);
#103=DIRECTION('',(1.,0.,0.));
#104=ORIENTED_EDGE('',*,*,#105,.F.);
#105=EDGE_CURVE('',#106,#98,#108,.T.);
#106=VERTEX_POINT('',#107);
#107=CARTESIAN_POINT('',(0.,90.,15.));
#108=LINE('',#109,#110);
#109=CARTESIAN_POINT('',(0.,50.,15.));
#110=VECTOR('',#111,1.);
#111=DIRECTION('',(0.,1.,0.));
#112=ORIENTED_EDGE('',*,*,#113,.F.);
#113=EDGE_CURVE('',#74,#106,#114,.T.);
#114=LINE('',#115,#116);
#115=CARTESIAN_POINT('',(45.,90.,15.));
#116=VECTOR('',#117,1.);
#117=DIRECTION('',(-1.,0.,0.));
```

```
#118=PLANE('',#119);
#119=AXIS2_PLACEMENT_3D('',#120,#121,#122);
#120=CARTESIAN_POINT('',(50.,50.,15.));
#121=DIRECTION('',(0.,0.,1.));
#122=DIRECTION('',(1.,0.,0.));
#123=ADVANCED_FACE('WPface1',(#124),#165,.T.);
#124=FACE_OUTER_BOUND('',#125,.T.);
#125=EDGE_LOOP('',(#126,#134,#135,#143,#151,#159));
#126=ORIENTED_EDGE('',*,*,#127,.T.);
#127=EDGE_CURVE('',#128,#82,#130,.T.);
#128=VERTEX_POINT('',#129);
#129=CARTESIAN_POINT('',(100.,0.,0.));
#130=LINE('',#131,#132);
#131=CARTESIAN_POINT('',(100.,0.,0.));
#132=VECTOR('',#133,1.);
#133=DIRECTION('',(0.,0.,1.));
#134=ORIENTED_EDGE('',*,*,#81,.T.);
#135=ORIENTED_EDGE('',*,*,#136,.T.);
#136=EDGE_CURVE('',#72,#137,#139,.T.);
#137=VERTEX_POINT('',#138);
#138=CARTESIAN_POINT('',(90.,0.,25.));
#139=LINE('',#140,#141);
#140=CARTESIAN_POINT('',(90.,0.,15.));
#141=VECTOR('',#142,1.);
#142=DIRECTION('',(0.,0.,1.));
#143=ORIENTED_EDGE('',*,*,#144,.T.);
#144=EDGE_CURVE('',#137,#145,#147,.T.);
#145=VERTEX_POINT('',#146);
#146=CARTESIAN_POINT('',(0.,0.,25.));
#147=LINE('',#148,#149);
#148=CARTESIAN_POINT('',(45.,0.,25.));
#149=VECTOR('',#150,1.);
#150=DIRECTION('',(-1.,0.,0.));
#151=ORIENTED_EDGE('',*,*,#152,.F.);
#152=EDGE_CURVE('',#153,#145,#155,.T.);
#153=VERTEX_POINT('',#154);
#154=CARTESIAN_POINT('',(0.,0.,0.));
#155=LINE('',#156,#157);
#156=CARTESIAN_POINT('',(0.,0.,0.));
#157=VECTOR('',#158,1.);
#158=DIRECTION('',(0.,0.,1.));
#159=ORIENTED_EDGE('',*,*,#160,.T.);
#160=EDGE_CURVE('',#153,#128,#161,.T.);
#161=LINE('',#162,#163);
#162=CARTESIAN_POINT('',(50.,0.,0.));
#163=VECTOR('',#164,1.);
#164=DIRECTION('',(1.,0.,0.));
#165=PLANE('',#166);
#166=AXIS2_PLACEMENT_3D('',#167,#168,#169);
#167=CARTESIAN_POINT('',(50.,0.,0.));
#168=DIRECTION('',(0.,-1.,0.));
#169=DIRECTION('',(0.,0.,-1.));
#170=ADVANCED_FACE('WPface2',(#171),#203,.T.);
#171=FACE_OUTER_BOUND('',#172,.T.);
```



```
#172=EDGE_LOOP('',(#173,#174,#182,#188,#189,#197));
#173=ORIENTED_EDGE('',*,*,#152,.T.);
#174=ORIENTED_EDGE('',*,*,#175,.T.);
#175=EDGE_CURVE('',#145,#176,#178,.T.);
#176=VERTEX_POINT('',#177);
#177=CARTESIAN_POINT('',(0.,90.,25.));
#178=LINE('',#179,#180);
#179=CARTESIAN_POINT('',(0.,45.,25.));
#180=VECTOR('',#181,1.);
#181=DIRECTION('',(0.,1.,0.));
#182=ORIENTED_EDGE('',*,*,#183,.F.);
#183=EDGE_CURVE('',#106,#176,#184,.T.);
#184=LINE('',#185,#186);
#185=CARTESIAN_POINT('',(0.,90.,15.));
#186=VECTOR('',#187,1.);
#187=DIRECTION('',(0.,0.,1.));
#188=ORIENTED_EDGE('',*,*,#105,.T.);
#189=ORIENTED_EDGE('',*,*,#190,.F.);
#190=EDGE_CURVE('',#191,#98,#193,.T.);
#191=VERTEX_POINT('',#192);
#192=CARTESIAN_POINT('',(0.,100.,0.));
#193=LINE('',#194,#195);
#194=CARTESIAN_POINT('',(0.,100.,0.));
#195=VECTOR('',#196,1.);
#196=DIRECTION('',(0.,0.,1.));
#197=ORIENTED_EDGE('',*,*,#198,.T.);
#198=EDGE_CURVE('',#191,#153,#199,.T.);
#199=LINE('',#200,#201);
#200=CARTESIAN_POINT('',(0.,50.,0.));
#201=VECTOR('',#202,1.);
#202=DIRECTION('',(0.,-1.,0.));
#203=PLANE('',#204);
#204=AXIS2_PLACEMENT_3D('',#205,#206,#207);
#205=CARTESIAN_POINT('',(0.,50.,0.));
#206=DIRECTION('',(-1.,0.,0.));
#207=DIRECTION('',(0.,0.,1.));
#208=ADVANCED_FACE('WPface3',(#209),#227,.T.);
#209=FACE_OUTER_BOUND('',#210,.T.);
#210=EDGE_LOOP('',(#211,#212,#213,#221));
#211=ORIENTED_EDGE('',*,*,#190,.T.);
#212=ORIENTED_EDGE('',*,*,#97,.T.);
#213=ORIENTED_EDGE('',*,*,#214,.F.);
#214=EDGE_CURVE('',#215,#90,#217,.T.);
#215=VERTEX_POINT('',#216);
#216=CARTESIAN_POINT('',(100.,100.,0.));
#217=LINE('',#218,#219);
#218=CARTESIAN_POINT('',(100.,100.,0.));
#219=VECTOR('',#220,1.);
#220=DIRECTION('',(0.,0.,1.));
#221=ORIENTED_EDGE('',*,*,#222,.T.);
#222=EDGE_CURVE('',#215,#191,#223,.T.);
#223=LINE('',#224,#225);
#224=CARTESIAN_POINT('',(50.,100.,0.));
#225=VECTOR('',#226,1.);
```



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#226=DIRECTION('',(-1.,0.,0.));
#227=PLANE('',#228);
#228=AXIS2_PLACEMENT_3D('',#229,#230,#231);
#229=CARTESIAN_POINT('',(50.,100.,0.));
#230=DIRECTION('',(0.,1.,0.));
#231=DIRECTION('',(0.,0.,1.));
#232=ADVANCED_FACE('WPface4',(#233),#244,.T.);
#233=FACE_OUTER_BOUND('',#234,.T.);
#234=EDGE_LOOP('',(#235,#241,#242,#243));
#235=ORIENTED_EDGE('',*,*,#236,.F.);
#236=EDGE_CURVE('',#128,#215,#237,.T.);
#237=LINE('',#238,#239);
#238=CARTESIAN_POINT('',(100.,50.,0.));
#239=VECTOR('',#240,1.);
#240=DIRECTION('',(0.,1.,0.));
#241=ORIENTED_EDGE('',*,*,#160,.F.);
#242=ORIENTED_EDGE('',*,*,#198,.F.);
#243=ORIENTED_EDGE('',*,*,#222,.F.);
#244=PLANE('',#245);
#245=AXIS2_PLACEMENT_3D('',#246,#247,#248);
#246=CARTESIAN_POINT('',(50.,50.,0.));
#247=DIRECTION('',(0.,0.,-1.));
#248=DIRECTION('',(-1.,0.,0.));
#249=ADVANCED_FACE('WPface5',(#250),#256,.T.);
#250=FACE_OUTER_BOUND('',#251,.T.);
#251=EDGE_LOOP('',(#252,#253,#254,#255));
#252=ORIENTED_EDGE('',*,*,#236,.T.);
#253=ORIENTED_EDGE('',*,*,#214,.T.);
#254=ORIENTED_EDGE('',*,*,#89,.T.);
#255=ORIENTED_EDGE('',*,*,#127,.F.);
#256=PLANE('',#257);
#257=AXIS2_PLACEMENT_3D('',#258,#259,#260);
#258=CARTESIAN_POINT('',(100.,50.,0.));
#259=DIRECTION('',(1.,0.,0.));
#260=DIRECTION('',(0.,0.,-1.));
#261=ADVANCED_FACE('WPface6',(#262),#280,.T.);
#262=FACE_OUTER_BOUND('',#263,.T.);
#263=EDGE_LOOP('',(#264,#265,#273,#279));
#264=ORIENTED_EDGE('',*,*,#144,.F.);
#265=ORIENTED_EDGE('',*,*,#266,.F.);
#266=EDGE_CURVE('',#267,#137,#269,.T.);
#267=VERTEX_POINT('',#268);
#268=CARTESIAN_POINT('',(90.,90.,25.));
#269=LINE('',#270,#271);
#270=CARTESIAN_POINT('',(90.,45.,25.));
#271=VECTOR('',#272,1.);
#272=DIRECTION('',(0.,-1.,0.));
#273=ORIENTED_EDGE('',*,*,#274,.F.);
#274=EDGE_CURVE('',#176,#267,#275,.T.);
#275=LINE('',#276,#277);
#276=CARTESIAN_POINT('',(45.,90.,25.));
#277=VECTOR('',#278,1.);
#278=DIRECTION('',(1.,0.,0.));
#279=ORIENTED_EDGE('',*,*,#175,.F.);
```

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#280=PLANE('',#281);
#281=AXIS2_PLACEMENT_3D('',#282,#283,#284);
#282=CARTESIAN_POINT('',(45.,45.,25.));
#283=DIRECTION('',(0.,0.,1.));
#284=DIRECTION('',(1.,0.,0.));
#285=ADVANCED_FACE('WPface7',(#286),#297,.T.);
#286=FACE_OUTER_BOUND('',#287,.T.);
#287=EDGE_LOOP('',(#288,#289,#290,#296));
#288=ORIENTED_EDGE('',*,*,#183,.T.);
#289=ORIENTED_EDGE('',*,*,#274,.T.);
#290=ORIENTED_EDGE('',*,*,#291,.F.);
#291=EDGE_CURVE('',#74,#267,#292,.T.);
#292=LINE('',#293,#294);
#293=CARTESIAN_POINT('',(90.,90.,15.));
#294=VECTOR('',#295,1.);
#295=DIRECTION('',(0.,0.,1.));
#296=ORIENTED_EDGE('',*,*,#113,.T.);
#297=PLANE('',#298);
#298=AXIS2_PLACEMENT_3D('',#299,#300,#301);
#299=CARTESIAN_POINT('',(45.,90.,15.));
#300=DIRECTION('',(0.,1.,0.));
#301=DIRECTION('',(0.,0.,1.));
#302=ADVANCED_FACE('WPface8',(#303),#309,.T.);
#303=FACE_OUTER_BOUND('',#304,.T.);
#304=EDGE_LOOP('',(#305,#306,#307,#308));
#305=ORIENTED_EDGE('',*,*,#71,.T.);
#306=ORIENTED_EDGE('',*,*,#291,.T.);
#307=ORIENTED_EDGE('',*,*,#266,.T.);
#308=ORIENTED_EDGE('',*,*,#136,.F.);
#309=PLANE('',#310);
#310=AXIS2_PLACEMENT_3D('',#311,#312,#313);
#311=CARTESIAN_POINT('',(90.,45.,15.));
#312=DIRECTION('',(1.,0.,0.));
#313=DIRECTION('',(0.,0.,-1.));
#314=ORGANIZATION(' ',' ',' ');

/*************************************************
 * Application object: WORKPIECE (#315)
 * ITS_ID: #315, #319, #320 ['RAWPIECE']
 * ITS_SUBASSEMBLY [*]: #315, #541
 * ITS_GEOMETRY: #315, #316, #317, #318
 */
#315=PRODUCT_DEFINITION('RAW','',#319,#16);
#316=PRODUCT_DEFINITION_SHAPE('','',#315);
#317=SHAPE_DEFINITION_REPRESENTATION(#316,#318);
#318=SHAPE_REPRESENTATION('parent',(#324),#1028);
#319=PRODUCT_DEFINITION_FORMATION('1.0','Workpiece',#320);
#320=PRODUCT('RAW','AP-238 CC2',' ',(#18));
#324=AXIS2_PLACEMENT_3D('owner',#325,#326,#327);
#325=CARTESIAN_POINT('owner',(0.,0.,0.));
#326=DIRECTION('owner',(0.,0.,1.));
#327=DIRECTION('owner',(1.,0.,0.));

/*************************************************
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 * Application object: WORKPIECE (#328)
 * ITS_ID: #328, #332, #333 ['RAWPIECE COMPONENT']
 * ITS_APPROVALS: #328, #338
 * ITS_GEOMETRY: #328, #329, #336, #337
 * ITS_RELATED_GEOMETRY [*]: #328, #329, #336, #337, #341, #342
 * ITS_TIMESTAMPS: #328, #330
 * PRODUCT_PEOPLE: #328, #332, #333, #334
 * REVISION_APPROVALS: #328, #332, #343
 * REVISION_PEOPLE: #328, #332, #339
 * REVISION_PEOPLE: #328, #332, #344, #345
 */
#328=PRODUCT_DEFINITION('RAWPIECE COMPONENT','',#332,#16);
#329=PRODUCT_DEFINITION_SHAPE('','',#328);
#330=APPLIED_DATE_AND_TIME_ASSIGNMENT(#331,#346,(#328));
#331=DATE_AND_TIME(#350,#351);
#332=PRODUCT_DEFINITION_FORMATION(' ',' ',#333);
#333=PRODUCT('RAWPIECE COMPONENT','loffDE0Bxyzv',' ',(#18));
#334=APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT(#335,#347,(#333));
#335=PERSON_AND_ORGANIZATION(#1102,#353);
#336=SHAPE_DEFINITION_REPRESENTATION(#329,#337);
#337=SHAPE_REPRESENTATION('loffDE0Bxyzv-none',(#354),#1028);
#338=APPLIED_APPROVAL_ASSIGNMENT(#523,(#328));
#339=APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT(#340,#348,(#332));
#340=PERSON_AND_ORGANIZATION(#1102,#358);
#341=SHAPE_REPRESENTATION_RELATIONSHIP('none',
'relationship between loffDE0Bxyzv-none and loffDE0Bxyzv-none',#337,#342);
#342=ADVANCED_BREP_SHAPE_REPRESENTATION('loffDE0Bxyzv-none',(#359),#1028);
#343=APPLIED_APPROVAL_ASSIGNMENT(#517,(#332));
#344=APPLIED_PERSON_AND_ORGANIZATION_ASSIGNMENT(#345,#349,(#328,#332));
#345=PERSON_AND_ORGANIZATION(#1102,#509);
#346=DATE_TIME_ROLE('creation_date');
#347=PERSON_AND_ORGANIZATION_ROLE('design_owner');
#348=PERSON_AND_ORGANIZATION_ROLE('design_supplier');
#349=PERSON_AND_ORGANIZATION_ROLE('creator');
#350=CALENDAR_DATE(0,1,1);
#351=LOCAL_TIME(0,0,0.,#352);
#352=COORDINATED_UNIVERSAL_TIME_OFFSET(0,0,.BEHIND.);
#353=ORGANIZATION(' ',' ',' ');
#354=AXIS2_PLACEMENT_3D('child',#355,#356,#357);
#355=CARTESIAN_POINT('child',(0.,0.,0.));
#356=DIRECTION('child',(0.,0.,1.));
#357=DIRECTION('child',(1.,0.,0.));
#358=ORGANIZATION(' ',' ',' ');
#359=MANIFOLD_SOLID_BREP('RAWPIECE',#360);
#360=CLOSED_SHELL('',(#361,#401,#432,#456,#480,#497));
#361=ADVANCED_FACE('RPface0',(#362),#396,.T.);
#362=FACE_OUTER_BOUND('',#363,.T.);
#363=EDGE_LOOP('',(#364,#374,#382,#390));
#364=ORIENTED_EDGE('',*,*,#365,.F.);
#365=EDGE_CURVE('',#366,#368,#370,.T.);
#366=VERTEX_POINT('',#367);
#367=CARTESIAN_POINT('',(100.,0.,25.));
#368=VERTEX_POINT('',#369);
#369=CARTESIAN_POINT('',(0.,0.,25.));
```

```
#370=LINE('',#371,#372);
#371=CARTESIAN_POINT('',(50.,0.,25.));
#372=VECTOR('',#373,1.);
#373=DIRECTION('',(-1.,0.,0.));
#374=ORIENTED_EDGE('',*,*,#375,.F.);
#375=EDGE_CURVE('',#376,#366,#378,.T.);
#376=VERTEX_POINT('',#377);
#377=CARTESIAN_POINT('',(100.,100.,25.));
#378=LINE('',#379,#380);
#379=CARTESIAN_POINT('',(100.,50.,25.));
#380=VECTOR('',#381,1.);
#381=DIRECTION('',(0.,-1.,0.));
#382=ORIENTED_EDGE('',*,*,#383,.F.);
#383=EDGE_CURVE('',#384,#376,#386,.T.);
#384=VERTEX_POINT('',#385);
#385=CARTESIAN_POINT('',(0.,100.,25.));
#386=LINE('',#387,#388);
#387=CARTESIAN_POINT('',(50.,100.,25.));
#388=VECTOR('',#389,1.);
#389=DIRECTION('',(1.,0.,0.));
#390=ORIENTED_EDGE('',*,*,#391,.F.);
#391=EDGE_CURVE('',#368,#384,#392,.T.);
#392=LINE('',#393,#394);
#393=CARTESIAN_POINT('',(0.,50.,25.));
#394=VECTOR('',#395,1.);
#395=DIRECTION('',(0.,1.,0.));
#396=PLANE('',#397);
#397=AXIS2_PLACEMENT_3D('',#398,#399,#400);
#398=CARTESIAN_POINT('',(50.,50.,25.));
#399=DIRECTION('',(0.,0.,1.));
#400=DIRECTION('',(1.,0.,0.));
#401=ADVANCED_FACE('RPface1',(#402),#427,.T.);
#402=FACE_OUTER_BOUND('',#403,.T.);
#403=EDGE_LOOP('',(#404,#412,#413,#421));
#404=ORIENTED_EDGE('',*,*,#405,.T.);
#405=EDGE_CURVE('',#406,#366,#408,.T.);
#406=VERTEX_POINT('',#407);
#407=CARTESIAN_POINT('',(100.,0.,0.));
#408=LINE('',#409,#410);
#409=CARTESIAN_POINT('',(100.,0.,0.));
#410=VECTOR('',#411,1.);
#411=DIRECTION('',(0.,0.,1.));
#412=ORIENTED_EDGE('',*,*,#365,.T.);
#413=ORIENTED_EDGE('',*,*,#414,.F.);
#414=EDGE_CURVE('',#415,#368,#417,.T.);
#415=VERTEX_POINT('',#416);
#416=CARTESIAN_POINT('',(0.,0.,0.));
#417=LINE('',#418,#419);
#418=CARTESIAN_POINT('',(0.,0.,0.));
#419=VECTOR('',#420,1.);
#420=DIRECTION('',(0.,0.,1.));
#421=ORIENTED_EDGE('',*,*,#422,.T.);
#422=EDGE_CURVE('',#415,#406,#423,.T.);
#423=LINE('',#424,#425);
```



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#424=CARTESIAN_POINT('',(50.,0.,0.));
#425=VECTOR('',#426,1.);
#426=DIRECTION('',(1.,0.,0.));
#427=PLANE('',#428);
#428=AXIS2_PLACEMENT_3D('',#429,#430,#431);
#429=CARTESIAN_POINT('',(50.,0.,0.));
#430=DIRECTION('',(0.,-1.,0.));
#431=DIRECTION('',(0.,0.,-1.));
#432=ADVANCED_FACE('RPface2',(#433),#451,.T.);
#433=FACE_OUTER_BOUND('',#434,.T.);
#434=EDGE_LOOP('',(#435,#436,#437,#445));
#435=ORIENTED_EDGE('',*,*,#414,.T.);
#436=ORIENTED_EDGE('',*,*,#391,.T.);
#437=ORIENTED_EDGE('',*,*,#438,.F.);
#438=EDGE_CURVE('',#439,#384,#441,.T.);
#439=VERTEX_POINT('',#440);
#440=CARTESIAN_POINT('',(0.,100.,0.));
#441=LINE('',#442,#443);
#442=CARTESIAN_POINT('',(0.,100.,0.));
#443=VECTOR('',#444,1.);
#444=DIRECTION('',(0.,0.,1.));
#445=ORIENTED_EDGE('',*,*,#446,.T.);
#446=EDGE_CURVE('',#439,#415,#447,.T.);
#447=LINE('',#448,#449);
#448=CARTESIAN_POINT('',(0.,50.,0.));
#449=VECTOR('',#450,1.);
#450=DIRECTION('',(0.,-1.,0.));
#451=PLANE('',#452);
#452=AXIS2_PLACEMENT_3D('',#453,#454,#455);
#453=CARTESIAN_POINT('',(0.,50.,0.));
#454=DIRECTION('',(-1.,0.,0.));
#455=DIRECTION('',(0.,0.,1.));
#456=ADVANCED_FACE('RPface3',(#457),#475,.T.);
#457=FACE_OUTER_BOUND('',#458,.T.);
#458=EDGE_LOOP('',(#459,#460,#461,#469));
#459=ORIENTED_EDGE('',*,*,#438,.T.);
#460=ORIENTED_EDGE('',*,*,#383,.T.);
#461=ORIENTED_EDGE('',*,*,#462,.F.);
#462=EDGE_CURVE('',#463,#376,#465,.T.);
#463=VERTEX_POINT('',#464);
#464=CARTESIAN_POINT('',(100.,100.,0.));
#465=LINE('',#466,#467);
#466=CARTESIAN_POINT('',(100.,100.,0.));
#467=VECTOR('',#468,1.);
#468=DIRECTION('',(0.,0.,1.));
#469=ORIENTED_EDGE('',*,*,#470,.T.);
#470=EDGE_CURVE('',#463,#439,#471,.T.);
#471=LINE('',#472,#473);
#472=CARTESIAN_POINT('',(50.,100.,0.));
#473=VECTOR('',#474,1.);
#474=DIRECTION('',(-1.,0.,0.));
#475=PLANE('',#476);
#476=AXIS2_PLACEMENT_3D('',#477,#478,#479);
#477=CARTESIAN_POINT('',(50.,100.,0.));
```

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#478=DIRECTION('',(0.,1.,0.));
#479=DIRECTION('',(0.,0.,1.));
#480=ADVANCED_FACE('RPface4',(#481),#492,.T.);
#481=FACE_OUTER_BOUND('',#482,.T.);
#482=EDGE_LOOP('',(#483,#489,#490,#491));
#483=ORIENTED_EDGE('',*,*,#484,.F.);
#484=EDGE_CURVE('',#406,#463,#485,.T.);
#485=LINE('',#486,#487);
#486=CARTESIAN_POINT('',(100.,50.,0.));
#487=VECTOR('',#488,1.);
#488=DIRECTION('',(0.,1.,0.));
#489=ORIENTED_EDGE('',*,*,#422,.F.);
#490=ORIENTED_EDGE('',*,*,#446,.F.);
#491=ORIENTED_EDGE('',*,*,#470,.F.);
#492=PLANE('',#493);
#493=AXIS2_PLACEMENT_3D('',#494,#495,#496);
#494=CARTESIAN_POINT('',(50.,50.,0.));
#495=DIRECTION('',(0.,0.,-1.));
#496=DIRECTION('',(-1.,0.,0.));
#497=ADVANCED_FACE('RPface5',(#498),#504,.T.);
#498=FACE_OUTER_BOUND('',#499,.T.);
#499=EDGE_LOOP('',(#500,#501,#502,#503));
#500=ORIENTED_EDGE('',*,*,#484,.T.);
#501=ORIENTED_EDGE('',*,*,#462,.T.);
#502=ORIENTED_EDGE('',*,*,#375,.T.);
#503=ORIENTED_EDGE('',*,*,#405,.F.);
#504=PLANE('',#505);
#505=AXIS2_PLACEMENT_3D('',#506,#507,#508);
#506=CARTESIAN_POINT('',(100.,50.,0.));
#507=DIRECTION('',(1.,0.,0.));
#508=DIRECTION('',(0.,0.,-1.));
#509=ORGANIZATION(' ',' ',' ');

/***********************************************
 * Application object: APPROVAL (#510)
 * PURPOSE: #510 ['']
 * APPROVAL_DATE_TIME: #510, #511, #512
 * STATUS: #510, #524
 */
#510=APPROVAL(#524,'');
#511=APPROVAL_DATE_TIME(#512,#510);
#512=DATE_AND_TIME(#513,#514);
#513=CALENDAR_DATE(0,1,1);
#514=LOCAL_TIME(0,0,0.,#515);
#515=COORDINATED_UNIVERSAL_TIME_OFFSET(0,0,.BEHIND.);

/***********************************************
 * Application object: APPROVAL (#516)
 * PURPOSE: #516 [' ']
 * STATUS: #516, #525
 */
#516=APPROVAL(#525,' ');

/***********************************************
```

```
 * Application object: APPROVAL (#517)
 * PURPOSE: #517 ['']
 * APPROVAL_DATE_TIME: #517, #518, #519
 * STATUS: #517, #526
 */
#517=APPROVAL(#526,'');
#518=APPROVAL_DATE_TIME(#519,#517);
#519=DATE_AND_TIME(#520,#521);
#520=CALENDAR_DATE(0,1,1);
#521=LOCAL_TIME(0,0,0.,#522);
#522=COORDINATED_UNIVERSAL_TIME_OFFSET(0,0,.BEHIND.);

/************************************************
 * Application object: APPROVAL (#523)
 * PURPOSE: #523 [' ']
 * STATUS: #523, #527
 */
#523=APPROVAL(#527,' ');

/************************************************
 * Application object: APPROVAL_STATUS (#524)
 * STATUS_NAME: #524 ['']
 */
#524=APPROVAL_STATUS('');

/************************************************
 * Application object: APPROVAL_STATUS (#525)
 * STATUS_NAME: #525 ['not_yet_approved']
 */
#525=APPROVAL_STATUS('not_yet_approved');

/************************************************
 * Application object: APPROVAL_STATUS (#526)
 * STATUS_NAME: #526 ['']
 */
#526=APPROVAL_STATUS('');

/************************************************
 * Application object: APPROVAL_STATUS (#527)
 * STATUS_NAME: #527 ['not_yet_approved']
 */
#527=APPROVAL_STATUS('not_yet_approved');

/************************************************
 * Application object: APPROVING_PERSON_ORGANIZATION (#528)
 * ROLE: #528, #529 ['approver']
 * PERSON_ORGANIZATION: #528, #530
 * AUTHORIZED_APPROVAL: #528, #510
 */
#528=APPROVAL_PERSON_ORGANIZATION(#530,#510,#529);
#529=APPROVAL_ROLE('approver');
#530=PERSON_AND_ORGANIZATION(#1101,#531);
#531=ORGANIZATION(' ',' ',' ');
```

```
/**********************************************
 * Application object: APPROVING_PERSON_ORGANIZATION (#532)
 * ROLE: #532, #533 ['approver']
 * PERSON_ORGANIZATION: #532, #534
 * AUTHORIZED_APPROVAL: #532, #517
 */
#532=APPROVAL_PERSON_ORGANIZATION(#534,#517,#533);
#533=APPROVAL_ROLE('approver');
#534=PERSON_AND_ORGANIZATION(#1102,#535);
#535=ORGANIZATION(' ',' ',' ');

/**********************************************
 * Application object: ASSEMBLY (#536)
 * ITEM_TRANSFORM: #536, #537, #538, #539, #540
 * CHILD_WORKPIECE: #536, #34
 */
#536=NEXT_ASSEMBLY_USAGE_OCCURRENCE('','','',#19,#34,'');
#537=PRODUCT_DEFINITION_SHAPE('','',#536);
#538=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#539,#537);
#539=(
REPRESENTATION_RELATIONSHIP('','',#43,#22)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#540)
SHAPE_REPRESENTATION_RELATIONSHIP()
);
#540=ITEM_DEFINED_TRANSFORMATION('','',#60,#29);

/**********************************************
 * Application object: ASSEMBLY (#541)
 * ITEM_TRANSFORM: #541, #542, #543, #544, #545
 * CHILD_WORKPIECE: #541, #328
 */
#541=NEXT_ASSEMBLY_USAGE_OCCURRENCE('','','',#315,#328,'');
#542=PRODUCT_DEFINITION_SHAPE('','',#541);
#543=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#544,#542);
#544=(
REPRESENTATION_RELATIONSHIP('','',#337,#318)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#545)
SHAPE_REPRESENTATION_RELATIONSHIP()
);
#545=ITEM_DEFINED_TRANSFORMATION('','',#354,#324);

/**********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#546)
 * ITS_TYPE: #546, #547, #548, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #546, #551, #1053
 * ITS_PRIORITY: #546, #552, #553, #554, #555 ['required']
 * RAPID_SPEED: #546, #556, #557, #558, #559 ['true']
 * ITS_ID: #546 ['WS 1 TP 1']
 * BASICCURVE: #546, #560, #561, #562, #563
 */
#546=MACHINING_TOOLPATH('WS 1 TP 1','cutter location trajectory','','');
#547=ACTION_PROPERTY('trajectory type','cutter location trajectory',#546);
#548=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#547,
#549);
```



```
#549=REPRESENTATION('constant',(#550),#564);
#550=DESCRIPTIVE_REPRESENTATION_ITEM('constant','trajectory path');
#551=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#546,
#1053);
#552=ACTION_PROPERTY('priority','cutter location trajectory',#546);
#553=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#552,
#554);
#554=REPRESENTATION('constant',(#555),#564);
#555=DESCRIPTIVE_REPRESENTATION_ITEM('constant','required');
#556=ACTION_PROPERTY('speed profile','rapid',#546);
#557=ACTION_PROPERTY_REPRESENTATION('','rapid',#556,#558);
#558=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#559),#564);
#559=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#560=ACTION_PROPERTY('basic curve','cutter location trajectory',#546);
#561=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#560,
#562);
#562=REPRESENTATION('',(#563),#565);
#563=POLYLINE('basic curve for WS 1 TP 1',(#567,#568,#569));
#564=REPRESENTATION_CONTEXT('','units not necessary');
#565=(
GEOMETRIC_REPRESENTATION_CONTEXT(3)
GLOBAL_UNIT_ASSIGNED_CONTEXT((#1071,#1075,#1091))
REPRESENTATION_CONTEXT('MILLIMETRE DEGREE STERADIAN','')
);
#567=CARTESIAN_POINT('start point',(0.,0.,40.));
#568=CARTESIAN_POINT('',(76.6078,112.6997,28.));
#569=CARTESIAN_POINT('',(76.6078,112.6997,23.));

/*************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#570)
 * ITS_TYPE: #570, #571, #572, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #570, #573, #1062
 * ITS_PRIORITY: #570, #574, #575, #554, #555 ['required']
 * ITS_ID: #570 ['WS 1 TP 2']
 * BASICCURVE: #570, #576, #577, #578, #579
 */
#570=MACHINING_TOOLPATH('WS 1 TP 2','cutter location trajectory','','');
#571=ACTION_PROPERTY('trajectory type','cutter location trajectory',#570);
#572=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#571,
#549);
#573=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#570,
#1062);
#574=ACTION_PROPERTY('priority','cutter location trajectory',#570);
#575=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#574,
#554);
#576=ACTION_PROPERTY('basic curve','cutter location trajectory',#570);
#577=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#576,
#578);
#578=REPRESENTATION('',(#579),#565);
#579=COMPOSITE_CURVE('composite curve for WS 1 TP 2',(#580,#584,#592),.F.);
#580=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#581);
#581=POLYLINE('basic curve for WS 1 TP 2',(#569,#582,#583));
#582=CARTESIAN_POINT('',(76.6078,112.6997,20.));
#583=CARTESIAN_POINT('',(93.5102,109.6997,20.));
```



```
#584=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#585);
#585=TRIMMED_CURVE('Arc for  in WS 1 TP 2',#586,(#583),(#591),.F.,.CARTESIAN.);
#586=CIRCLE('Circle for  in WS 1 TP 2',#587,19.8938);
#587=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 2',#588,#589,#590);
#588=CARTESIAN_POINT('Arc center for  in WS 1 TP 2',(90.0336,90.112,20.));
#589=DIRECTION('Z direction',(0.,0.,1.));
#590=DIRECTION('X direction',(1.,0.,0.));
#591=CARTESIAN_POINT('Arc end for  in WS 1 TP 2',(102.0069,105.9992,20.));
#592=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#593);
#593=TRIMMED_CURVE('Arc for  in WS 1 TP 2',#594,(#591),(#597),.F.,.CARTESIAN.);
#594=CIRCLE('Circle for  in WS 1 TP 2',#595,20.0085);
#595=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 2',#596,#589,#590);
#596=CARTESIAN_POINT('Arc center for  in WS 1 TP 2',(89.9986,89.9948,20.));
#597=CARTESIAN_POINT('Arc end for  in WS 1 TP 2',(109.6997,93.4889,20.));

/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#598)
 * ITS_TYPE: #598, #599, #600, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #598, #601, #1062
 * ITS_PRIORITY: #598, #602, #603, #554, #555 ['required']
 * RAPID_SPEED: #598, #604, #605, #606, #607 ['true']
 * ITS_ID: #598 ['WS 1 TP 3']
 * BASICCURVE: #598, #608, #609, #610, #611
 */
#598=MACHINING_TOOLPATH('WS 1 TP 3','cutter location trajectory','','');
#599=ACTION_PROPERTY('trajectory type','cutter location trajectory',#598);
#600=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#599,
#549);
#601=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#598,
#1062);
#602=ACTION_PROPERTY('priority','cutter location trajectory',#598);
#603=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#602,
#554);
#604=ACTION_PROPERTY('speed profile','rapid',#598);
#605=ACTION_PROPERTY_REPRESENTATION('','rapid',#604,#606);
#606=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#607),#564);
#607=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#608=ACTION_PROPERTY('basic curve','cutter location trajectory',#598);
#609=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#608,
#610);
#610=REPRESENTATION('',(#611),#565);
#611=POLYLINE('basic curve for WS 1 TP 3',(#597,#612,#613,#614,#615,#616));
#612=CARTESIAN_POINT('',(112.6997,76.5738,20.));
#613=CARTESIAN_POINT('',(112.6997,76.5738,23.));
#614=CARTESIAN_POINT('',(112.6997,76.5738,28.));
#615=CARTESIAN_POINT('',(-12.6979,98.9837,28.));
#616=CARTESIAN_POINT('',(-12.6979,98.9837,23.));

/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#617)
 * ITS_TYPE: #617, #618, #619, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #617, #620, #1062
 * ITS_PRIORITY: #617, #621, #622, #554, #555 ['required']
 * ITS_ID: #617 ['WS 1 TP 4']
```



```
 * BASICCURVE: #617, #623, #624, #625, #626
 */
#617=MACHINING_TOOLPATH('WS 1 TP 4','cutter location trajectory','','');
#618=ACTION_PROPERTY('trajectory type','cutter location trajectory',#617);
#619=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#618,
#549);
#620=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#617,
#1062);
#621=ACTION_PROPERTY('priority','cutter location trajectory',#617);
#622=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#621,
#554);
#623=ACTION_PROPERTY('basic curve','cutter location trajectory',#617);
#624=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#623,
#625);
#625=REPRESENTATION('',(#626),#565);
#626=COMPOSITE_CURVE('composite curve for WS 1 TP 4',(#627,#631,#637,#643,
#649,#655,#660,#666),.F.);
#627=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#628);
#628=POLYLINE('basic curve for WS 1 TP 4',(#616,#629,#630));
#629=CARTESIAN_POINT('',(-12.6979,98.9837,20.));
#630=CARTESIAN_POINT('',(-9.5374,101.5877,20.));
#631=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#632);
#632=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#633,(#630),(#636),.F.,.CARTESIAN.);
#633=CIRCLE('Circle for  in WS 1 TP 4',#634,14.9775);
#634=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#635,#589,#590);
#635=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(-0.0136,90.028,20.));
#636=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(-1.9146,104.8844,20.));
#637=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#638);
#638=POLYLINE('basic curve for WS 1 TP 4',(#636,#639,#640,#641,#642));
#639=CARTESIAN_POINT('',(-1.7697,104.9029,20.));
#640=CARTESIAN_POINT('',(-0.3611,105.0001,20.));
#641=CARTESIAN_POINT('',(90.4542,105.0001,20.));
#642=CARTESIAN_POINT('',(90.539,104.9972,20.));
#643=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#644);
#644=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#645,(#642),(#648),.F.,.CARTESIAN.);
#645=CIRCLE('Circle for  in WS 1 TP 4',#646,14.8938);
#646=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#647,#589,#590);
#647=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(90.0336,90.112,20.));
#648=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(99.0019,102.003,20.));
#649=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#650);
#650=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#651,(#648),(#654),.F.,.CARTESIAN.);
#651=CIRCLE('Circle for  in WS 1 TP 4',#652,15.0085);
#652=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#653,#589,#590);
#653=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(89.9986,89.9948,20.));
#654=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(104.9966,90.5564,20.));
#655=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#656);
#656=POLYLINE('basic curve for WS 1 TP 4',(#654,#657,#658,#659));
#657=CARTESIAN_POINT('',(105.0001,90.4629,20.));
#658=CARTESIAN_POINT('',(105.0001,-0.2221,20.));
#659=CARTESIAN_POINT('',(104.9997,-0.2552,20.));
#660=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#661);
#661=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#662,(#659),(#665),.F.,.CARTESIAN.);
#662=CIRCLE('Circle for  in WS 1 TP 4',#663,14.8411);
#663=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#664,#589,#590);
```

```
#664=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(90.1599,-0.0584,20.));
#665=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(102.0037,-9.0016,20.));
#666=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#667);
#667=TRIMMED_CURVE('Arc for  in WS 1 TP 4',#668,(#665),(#671),.F.,.CARTESIAN.);
#668=CIRCLE('Circle for  in WS 1 TP 4',#669,14.9146);
#669=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 4',#670,#589,#590);
#670=CARTESIAN_POINT('Arc center for  in WS 1 TP 4',(90.0613,-0.0673,20.));
#671=CARTESIAN_POINT('Arc end for  in WS 1 TP 4',(101.5829,-9.5381,20.));

/**************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#672)
 * ITS_TYPE: #672, #673, #674, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #672, #675, #1062
 * ITS_PRIORITY: #672, #676, #677, #554, #555 ['required']
 * RAPID_SPEED: #672, #678, #679, #680, #681 ['true']
 * ITS_ID: #672 ['WS 1 TP 5']
 * BASICCURVE: #672, #682, #683, #684, #685
 */
#672=MACHINING_TOOLPATH('WS 1 TP 5','cutter location trajectory','','');
#673=ACTION_PROPERTY('trajectory type','cutter location trajectory',#672);
#674=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#673,
#549);
#675=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#672,
#1062);
#676=ACTION_PROPERTY('priority','cutter location trajectory',#672);
#677=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#676,
#554);
#678=ACTION_PROPERTY('speed profile','rapid',#672);
#679=ACTION_PROPERTY_REPRESENTATION('','rapid',#678,#680);
#680=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#681),#564);
#681=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#682=ACTION_PROPERTY('basic curve','cutter location trajectory',#672);
#683=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#682,
#684);
#684=REPRESENTATION('',(#685),#565);
#685=POLYLINE('basic curve for WS 1 TP 5',(#671,#686,#687,#688,#689,#690));
#686=CARTESIAN_POINT('',(98.9855,-12.6979,20.));
#687=CARTESIAN_POINT('',(98.9855,-12.6979,23.));
#688=CARTESIAN_POINT('',(98.9855,-12.6979,28.));
#689=CARTESIAN_POINT('',(-12.9971,88.1,28.));
#690=CARTESIAN_POINT('',(-12.9971,88.1,23.));

/**************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#691)
 * ITS_TYPE: #691, #692, #693, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #691, #694, #1062
 * ITS_PRIORITY: #691, #695, #696, #554, #555 ['required']
 * ITS_ID: #691 ['WS 1 TP 6']
 * BASICCURVE: #691, #697, #698, #699, #700
 */
#691=MACHINING_TOOLPATH('WS 1 TP 6','cutter location trajectory','','');
#692=ACTION_PROPERTY('trajectory type','cutter location trajectory',#691);
#693=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#692,
#549);
```



```
#694=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#691,
#1062);
#695=ACTION_PROPERTY('priority','cutter location trajectory',#691);
#696=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#695,
#554);
#697=ACTION_PROPERTY('basic curve','cutter location trajectory',#691);
#698=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#697,
#699);
#699=REPRESENTATION('',(#700),#565);
#700=COMPOSITE_CURVE('composite curve for WS 1 TP 6',(#701,#704,#710,#716,
#722,#726,#732,#738,#741,#747,#753,#759),.F.);
#701=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#702);
#702=POLYLINE('basic curve for WS 1 TP 6',(#690,#703));
#703=CARTESIAN_POINT('',(-12.9971,88.1,20.));
#704=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#705);
#705=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#706,(#703),(#709),.T.,.CARTESIAN.);
#706=CIRCLE('Circle for  in WS 1 TP 6',#707,7.);
#707=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#708,#589,#590);
#708=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(-16.4813,94.1712,20.));
#709=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(-9.6979,92.4432,20.));
#710=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#711);
#711=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#712,(#709),(#715),.F.,.CARTESIAN.);
#712=CIRCLE('Circle for  in WS 1 TP 6',#713,10.2831);
#713=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#714,#589,#590);
#714=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(0.2669,89.9048,20.));
#715=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(-8.8119,94.7336,20.));
#716=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#717);
#717=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#718,(#715),(#721),.F.,.CARTESIAN.);
#718=CIRCLE('Circle for  in WS 1 TP 6',#719,9.9775);
#719=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#720,#589,#590);
#720=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(-0.0136,90.028,20.));
#721=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(-1.28,99.9248,20.));
#722=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#723);
#723=POLYLINE('basic curve for WS 1 TP 6',(#721,#724,#725));
#724=CARTESIAN_POINT('',(-0.1889,100.0001,20.));
#725=CARTESIAN_POINT('',(90.3693,100.0001,20.));
#726=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#727);
#727=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#728,(#725),(#731),.F.,.CARTESIAN.);
#728=CIRCLE('Circle for  in WS 1 TP 6',#729,9.8938);
#729=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#730,#589,#590);
#730=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(90.0336,90.112,20.));
#731=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(95.9968,98.0068,20.));
#732=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#733);
#733=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#734,(#731),(#737),.F.,.CARTESIAN.);
#734=CIRCLE('Circle for  in WS 1 TP 6',#735,10.0085);
#735=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#736,#589,#590);
#736=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(89.9986,89.9948,20.));
#737=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(100.0001,90.3693,20.));
#738=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#739);
#739=POLYLINE('basic curve for WS 1 TP 6',(#737,#740));
#740=CARTESIAN_POINT('',(100.0001,-0.1889,20.));
#741=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#742);
#742=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#743,(#740),(#746),.F.,.CARTESIAN.);
#743=CIRCLE('Circle for  in WS 1 TP 6',#744,9.8411);
```



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#744=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#745,#589,#590);
#745=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(90.1599,-0.0584,20.));
#746=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(98.0068,-5.9975,20.));
#747=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#748);
#748=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#749,(#746),(#752),.F.,.CARTESIAN.);
#749=CIRCLE('Circle for  in WS 1 TP 6',#750,9.9146);
#750=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#751,#589,#590);
#751=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(90.0613,-0.0673,20.));
#752=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(94.7336,-8.8119,20.));
#753=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#754);
#754=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#755,(#752),(#758),.F.,.CARTESIAN.);
#755=CIRCLE('Circle for  in WS 1 TP 6',#756,9.6195);
#756=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#757,#589,#590);
#757=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(90.1227,-0.3694,20.));
#758=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(92.4709,-9.6979,20.));
#759=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#760);
#760=TRIMMED_CURVE('Arc for  in WS 1 TP 6',#761,(#758),(#764),.T.,.CARTESIAN.);
#761=CIRCLE('Circle for  in WS 1 TP 6',#762,7.);
#762=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 6',#763,#589,#590);
#763=CARTESIAN_POINT('Arc center for  in WS 1 TP 6',(94.1797,-16.4862,20.));
#764=CARTESIAN_POINT('Arc end for  in WS 1 TP 6',(87.6325,-14.0095,20.));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#765)
 * ITS_TYPE: #765, #766, #767, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #765, #768, #1062
 * ITS_PRIORITY: #765, #769, #770, #554, #555 ['required']
 * RAPID_SPEED: #765, #771, #772, #773, #774 ['true']
 * ITS_ID: #765 ['WS 1 TP 7']
 * BASICCURVE: #765, #775, #776, #777, #778
 */
#765=MACHINING_TOOLPATH('WS 1 TP 7','cutter location trajectory','','');
#766=ACTION_PROPERTY('trajectory type','cutter location trajectory',#765);
#767=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#766,
#549);
#768=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#765,
#1062);
#769=ACTION_PROPERTY('priority','cutter location trajectory',#765);
#770=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#769,
#554);
#771=ACTION_PROPERTY('speed profile','rapid',#765);
#772=ACTION_PROPERTY_REPRESENTATION('','rapid',#771,#773);
#773=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#774),#564);
#774=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#775=ACTION_PROPERTY('basic curve','cutter location trajectory',#765);
#776=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#775,
#777);
#777=REPRESENTATION('',(#778),#565);
#778=POLYLINE('basic curve for WS 1 TP 7',(#764,#779,#780,#781,#782,#783));
#779=CARTESIAN_POINT('',(87.6325,-14.0095,23.));
#780=CARTESIAN_POINT('',(87.6325,-14.0095,31.));
#781=CARTESIAN_POINT('',(76.7996,112.6997,31.));
#782=CARTESIAN_POINT('',(76.7996,112.6997,23.));
#783=CARTESIAN_POINT('',(76.7996,112.6997,18.));
```



```
/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#784)
 * ITS_TYPE: #784, #785, #786, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #784, #787, #1062
 * ITS_PRIORITY: #784, #788, #789, #554, #555 ['required']
 * ITS_ID: #784 ['WS 1 TP 8']
 * BASICCURVE: #784, #790, #791, #792, #793
 */
#784=MACHINING_TOOLPATH('WS 1 TP 8','cutter location trajectory','','');
#785=ACTION_PROPERTY('trajectory type','cutter location trajectory',#784);
#786=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#785,
#549);
#787=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#784,
#1062);
#788=ACTION_PROPERTY('priority','cutter location trajectory',#784);
#789=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#788,
#554);
#790=ACTION_PROPERTY('basic curve','cutter location trajectory',#784);
#791=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#790,
#792);
#792=REPRESENTATION('',(#793),#565);
#793=COMPOSITE_CURVE('composite curve for WS 1 TP 8',(#794,#798,#804,#808,
#814,#818),.F.);
#794=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#795);
#795=POLYLINE('basic curve for WS 1 TP 8',(#783,#796,#797));
#796=CARTESIAN_POINT('',(76.7996,112.6997,15.));
#797=CARTESIAN_POINT('',(93.5151,109.6997,15.));
#798=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#799);
#799=TRIMMED_CURVE('Arc for  in WS 1 TP 8',#800,(#797),(#803),.F.,.CARTESIAN.);
#800=CIRCLE('Circle for  in WS 1 TP 8',#801,20.0969);
#801=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 8',#802,#589,#590);
#802=CARTESIAN_POINT('Arc center for  in WS 1 TP 8',(89.9649,89.9188,15.));
#803=CARTESIAN_POINT('Arc end for  in WS 1 TP 8',(101.6281,106.2851,15.));
#804=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#805);
#805=POLYLINE('basic curve for WS 1 TP 8',(#803,#806,#807));
#806=CARTESIAN_POINT('',(101.6318,106.2824,15.));
#807=CARTESIAN_POINT('',(101.6356,106.2798,15.));
#808=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#809);
#809=TRIMMED_CURVE('Arc for  in WS 1 TP 8',#810,(#807),(#813),.F.,.CARTESIAN.);
#810=CIRCLE('Circle for  in WS 1 TP 8',#811,19.9541);
#811=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 8',#812,#589,#590);
#812=CARTESIAN_POINT('Arc center for  in WS 1 TP 8',(90.0404,90.0404,15.));
#813=CARTESIAN_POINT('Arc end for  in WS 1 TP 8',(107.6374,99.4484,15.));
#814=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#815);
#815=POLYLINE('basic curve for WS 1 TP 8',(#813,#816,#817));
#816=CARTESIAN_POINT('',(107.6398,99.4439,15.));
#817=CARTESIAN_POINT('',(107.6422,99.4394,15.));
#818=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#819);
#819=TRIMMED_CURVE('Arc for  in WS 1 TP 8',#820,(#817),(#823),.F.,.CARTESIAN.);
#820=CIRCLE('Circle for  in WS 1 TP 8',#821,20.1824);
#821=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 8',#822,#589,#590);
#822=CARTESIAN_POINT('Arc center for  in WS 1 TP 8',(89.8342,89.9419,15.));
#823=CARTESIAN_POINT('Arc end for  in WS 1 TP 8',(109.6997,93.5045,15.));
```

```
/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#824)
 * ITS_TYPE: #824, #825, #826, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #824, #827, #1062
 * ITS_PRIORITY: #824, #828, #829, #554, #555 ['required']
 * RAPID_SPEED: #824, #830, #831, #832, #833 ['true']
 * ITS_ID: #824 ['WS 1 TP 9']
 * BASICCURVE: #824, #834, #835, #836, #837
 */
#824=MACHINING_TOOLPATH('WS 1 TP 9','cutter location trajectory','','');
#825=ACTION_PROPERTY('trajectory type','cutter location trajectory',#824);
#826=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#825,
#549);
#827=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#824,
#1062);
#828=ACTION_PROPERTY('priority','cutter location trajectory',#824);
#829=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#828,
#554);
#830=ACTION_PROPERTY('speed profile','rapid',#824);
#831=ACTION_PROPERTY_REPRESENTATION('','rapid',#830,#832);
#832=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#833),#564);
#833=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#834=ACTION_PROPERTY('basic curve','cutter location trajectory',#824);
#835=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#834,
#836);
#836=REPRESENTATION('',(#837),#565);
#837=POLYLINE('basic curve for WS 1 TP 9',(#823,#838,#839,#840,#841,#842,
#843));
#838=CARTESIAN_POINT('',(112.6997,76.7764,15.));
#839=CARTESIAN_POINT('',(112.6997,76.7764,18.));
#840=CARTESIAN_POINT('',(112.6997,76.7764,31.));
#841=CARTESIAN_POINT('',(-12.6979,98.9932,31.));
#842=CARTESIAN_POINT('',(-12.6979,98.9932,23.));
#843=CARTESIAN_POINT('',(-12.6979,98.9932,18.));

/***********************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#844)
 * ITS_TYPE: #844, #845, #846, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #844, #847, #1062
 * ITS_PRIORITY: #844, #848, #849, #554, #555 ['required']
 * ITS_ID: #844 ['WS 1 TP 10']
 * BASICCURVE: #844, #850, #851, #852, #853
 */
#844=MACHINING_TOOLPATH('WS 1 TP 10','cutter location trajectory','','');
#845=ACTION_PROPERTY('trajectory type','cutter location trajectory',#844);
#846=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#845,
#549);
#847=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#844,
#1062);
#848=ACTION_PROPERTY('priority','cutter location trajectory',#844);
#849=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#848,
#554);
#850=ACTION_PROPERTY('basic curve','cutter location trajectory',#844);
```



```
#851=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#850,
#852);
#852=REPRESENTATION('',(#853),#565);
#853=COMPOSITE_CURVE('composite curve for WS 1 TP 10',(#854,#858,#864,#870,
#876,#880,#886,#890,#896,#901,#907),.F.);
#854=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#855);
#855=POLYLINE('basic curve for WS 1 TP 10',(#843,#856,#857));
#856=CARTESIAN_POINT('',(-12.6979,98.9932,15.));
#857=CARTESIAN_POINT('',(-9.5364,101.5958,15.));
#858=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#859);
#859=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#860,(#857),(#863),.F.,.CARTESIAN.);
#860=CIRCLE('Circle for  in WS 1 TP 10',#861,14.9952);
#861=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#862,#589,#590);
#862=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(-0.0061,90.0187,15.));
#863=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(-1.9172,104.8916,15.));
#864=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#865);
#865=POLYLINE('basic curve for WS 1 TP 10',(#863,#866,#867,#868,#869));
#866=CARTESIAN_POINT('',(-1.771,104.9104,15.));
#867=CARTESIAN_POINT('',(-0.3611,105.0076,15.));
#868=CARTESIAN_POINT('',(90.4695,105.0076,15.));
#869=CARTESIAN_POINT('',(90.5696,105.0036,15.));
#870=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#871);
#871=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#872,(#869),(#875),.F.,.CARTESIAN.);
#872=CIRCLE('Circle for  in WS 1 TP 10',#873,15.0969);
#873=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#874,#589,#590);
#874=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(89.9649,89.9188,15.));
#875=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(98.7264,102.2132,15.));
#876=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#877);
#877=POLYLINE('basic curve for WS 1 TP 10',(#875,#878,#879));
#878=CARTESIAN_POINT('',(98.7282,102.2119,15.));
#879=CARTESIAN_POINT('',(98.7301,102.2106,15.));
#880=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#881);
#881=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#882,(#879),(#885),.F.,.CARTESIAN.);
#882=CIRCLE('Circle for  in WS 1 TP 10',#883,14.9541);
#883=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#884,#589,#590);
#884=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(90.0404,90.0404,15.));
#885=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(103.228,97.091,15.));
#886=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#887);
#887=POLYLINE('basic curve for WS 1 TP 10',(#885,#888,#889));
#888=CARTESIAN_POINT('',(103.2292,97.0888,15.));
#889=CARTESIAN_POINT('',(103.2304,97.0865,15.));
#890=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#891);
#891=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#892,(#889),(#895),.F.,.CARTESIAN.);
#892=CIRCLE('Circle for  in WS 1 TP 10',#893,15.1824);
#893=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#894,#589,#590);
#894=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(89.8342,89.9419,15.));
#895=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(105.0032,90.5792,15.));
#896=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#897);
#897=POLYLINE('basic curve for WS 1 TP 10',(#895,#898,#899,#900));
#898=CARTESIAN_POINT('',(105.0076,90.4743,15.));
```



```
#899=CARTESIAN_POINT('',(105.0076,-0.222,15.));
#900=CARTESIAN_POINT('',(105.0072,-0.255,15.));
#901=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#902);
#902=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#903,(#900),(#906),.F.,.CARTESIAN.);
#903=CIRCLE('Circle for  in WS 1 TP 10',#904,14.8322);
#904=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#905,#589,#590);
#905=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(90.1763,-0.059,15.));
#906=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(101.9997,-9.0144,15.));
#907=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#908);
#908=TRIMMED_CURVE('Arc for  in WS 1 TP
10',#909,(#906),(#912),.F.,.CARTESIAN.);
#909=CIRCLE('Circle for  in WS 1 TP 10',#910,14.9841);
#910=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 10',#911,#589,#590);
#911=CARTESIAN_POINT('Arc center for  in WS 1 TP 10',(90.012,-0.0245,15.));
#912=CARTESIAN_POINT('Arc end for  in WS 1 TP 10',(101.589,-9.5375,15.));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#913)
 * ITS_TYPE: #913, #914, #915, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #913, #916, #1062
 * ITS_PRIORITY: #913, #917, #918, #554, #555 ['required']
 * RAPID_SPEED: #913, #919, #920, #921, #922 ['true']
 * ITS_ID: #913 ['WS 1 TP 11']
 * BASICCURVE: #913, #923, #924, #925, #926
 */
#913=MACHINING_TOOLPATH('WS 1 TP 11','cutter location trajectory','','');
#914=ACTION_PROPERTY('trajectory type','cutter location trajectory',#913);
#915=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#914,
#549);
#916=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#913,
#1062);
#917=ACTION_PROPERTY('priority','cutter location trajectory',#913);
#918=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#917,
#554);
#919=ACTION_PROPERTY('speed profile','rapid',#913);
#920=ACTION_PROPERTY_REPRESENTATION('','rapid',#919,#921);
#921=MACHINING_TOOLPATH_SPEED_PROFILE_REPRESENTATION('',(#922),#564);
#922=DESCRIPTIVE_REPRESENTATION_ITEM('','rapid');
#923=ACTION_PROPERTY('basic curve','cutter location trajectory',#913);
#924=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#923,
#925);
#925=REPRESENTATION('',(#926),#565);
#926=POLYLINE('basic curve for WS 1 TP 11',(#912,#927,#928,#929,#930,#931,
#932));
#927=CARTESIAN_POINT('',(98.992,-12.6979,15.));
#928=CARTESIAN_POINT('',(98.992,-12.6979,18.));
#929=CARTESIAN_POINT('',(98.992,-12.6979,31.));
#930=CARTESIAN_POINT('',(-12.9934,87.8423,31.));
#931=CARTESIAN_POINT('',(-12.9934,87.8423,23.));
#932=CARTESIAN_POINT('',(-12.9934,87.8423,18.));

/************************************************
 * Application object: CUTTER_LOCATION_TRAJECTORY (#933)
```

```
 * ITS_TYPE: #933, #934, #935, #549, #550 ['trajectory path']
 * ITS_TECHNOLOGY: #933, #936, #1062
 * ITS_PRIORITY: #933, #937, #938, #554, #555 ['required']
 * ITS_ID: #933 ['WS 1 TP 12']
 * BASICCURVE: #933, #939, #940, #941, #942
 */
#933=MACHINING_TOOLPATH('WS 1 TP 12','cutter location trajectory','','');
#934=ACTION_PROPERTY('trajectory type','cutter location trajectory',#933);
#935=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#934,
#549);
#936=MACHINING_TECHNOLOGY_RELATIONSHIP('','cutter location trajectory',#933,
#1062);
#937=ACTION_PROPERTY('priority','cutter location trajectory',#933);
#938=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#937,
#554);
#939=ACTION_PROPERTY('basic curve','cutter location trajectory',#933);
#940=ACTION_PROPERTY_REPRESENTATION('','cutter location trajectory',#939,
#941);
#941=REPRESENTATION('',(#942),#565);
#942=COMPOSITE_CURVE('composite curve for WS 1 TP 12',(#943,#946,#952,#957,
#963,#967,#973,#979,#985,#988,#994,#1000),.F.);
#943=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#944);
#944=POLYLINE('basic curve for WS 1 TP 12',(#932,#945));
#945=CARTESIAN_POINT('',(-12.9934,87.8423,15.));
#946=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#947);
#947=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#948,(#945),(#951),.T.,.CARTESIAN.);
#948=CIRCLE('Circle for  in WS 1 TP 12',#949,7.);
#949=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#950,#589,#590);
#950=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(-16.5527,93.8698,15.));
#951=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(-9.6979,92.4515,15.));
#952=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#953);
#953=POLYLINE('basic curve for WS 1 TP 12',(#951,#954,#955,#956));
#954=CARTESIAN_POINT('',(-9.6772,92.5514,15.));
#955=CARTESIAN_POINT('',(-9.316,93.6425,15.));
#956=CARTESIAN_POINT('',(-8.8194,94.7336,15.));
#957=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#958);
#958=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#959,(#956),(#962),.F.,.CARTESIAN.);
#959=CIRCLE('Circle for  in WS 1 TP 12',#960,9.9952);
#960=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#961,#589,#590);
#961=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(-0.0061,90.0187,15.));
#962=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(-1.28,99.9324,15.));
#963=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#964);
#964=POLYLINE('basic curve for WS 1 TP 12',(#962,#965,#966));
#965=CARTESIAN_POINT('',(-0.1889,100.0076,15.));
#966=CARTESIAN_POINT('',(90.3693,100.0076,15.));
#967=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#968);
#968=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#969,(#966),(#972),.F.,.CARTESIAN.);
#969=CIRCLE('Circle for  in WS 1 TP 12',#970,10.0969);
#970=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#971,#589,#590);
#971=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(89.9649,89.9188,15.));
#972=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(95.8246,98.1414,15.));
```



```
#973=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#974);
#974=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#975,(#972),(#978),.F.,.CARTESIAN.);
#975=CIRCLE('Circle for  in WS 1 TP 12',#976,9.9541);
#976=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#977,#589,#590);
#977=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(90.0404,90.0404,15.));
#978=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(98.8187,94.7336,15.));
#979=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#980);
#980=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#981,(#978),(#984),.F.,.CARTESIAN.);
#981=CIRCLE('Circle for  in WS 1 TP 12',#982,10.1824);
#982=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#983,#589,#590);
#983=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(89.8342,89.9419,15.));
#984=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(100.0076,90.3693,15.));
#985=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#986);
#986=POLYLINE('basic curve for WS 1 TP 12',(#984,#987));
#987=CARTESIAN_POINT('',(100.0076,-0.1889,15.));
#988=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#989);
#989=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#990,(#987),(#993),.F.,.CARTESIAN.);
#990=CIRCLE('Circle for  in WS 1 TP 12',#991,9.8322);
#991=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#992,#589,#590);
#992=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(90.1763,-0.059,15.));
#993=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(98.0068,-6.005,15.));
#994=COMPOSITE_CURVE_SEGMENT(.CONTINUOUS.,.T.,#995);
#995=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#996,(#993),(#999),.F.,.CARTESIAN.);
#996=CIRCLE('Circle for  in WS 1 TP 12',#997,9.9841);
#997=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#998,#589,#590);
#998=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(90.012,-0.0245,15.));
#999=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(92.4833,-9.6979,15.));
#1000=COMPOSITE_CURVE_SEGMENT(.DISCONTINUOUS.,.T.,#1001);
#1001=TRIMMED_CURVE('Arc for  in WS 1 TP
12',#1002,(#999),(#1005),.T.,.CARTESIAN.);
#1002=CIRCLE('Circle for  in WS 1 TP 12',#1003,7.);
#1003=AXIS2_PLACEMENT_3D('Arc placement for  in WS 1 TP 12',#1004,#589,#590);
#1004=CARTESIAN_POINT('Arc center for  in WS 1 TP 12',(94.216,-16.4801,15.));
#1005=CARTESIAN_POINT('Arc end for  in WS 1 TP 12',(87.6601,-14.0265,15.));

/************************************************
 * Application object: DERIVED_UNIT (#1006)
 */
#1006=DERIVED_UNIT((#1007));
#1007=DERIVED_UNIT_ELEMENT(#1095,-1.);

/************************************************
 * Application object: DERIVED_UNIT (#1008)
 */
#1008=DERIVED_UNIT((#1009,#1010));
#1009=DERIVED_UNIT_ELEMENT(#1071,1.);
#1010=DERIVED_UNIT_ELEMENT(#1095,-1.);

/************************************************
 * Application object: FREEFORM_OPERATION (#1011)
```



```
 * ITS_TOOLPATH [1]: #1011, #1012, #546
 * ITS_TOOLPATH [2]: #1011, #1013, #570
 * ITS_TOOLPATH [3]: #1011, #1014, #598
 * ITS_TOOLPATH [4]: #1011, #1015, #617
 * ITS_TOOLPATH [5]: #1011, #1016, #672
 * ITS_TOOLPATH [6]: #1011, #1017, #691
 * ITS_TOOLPATH [7]: #1011, #1018, #765
 * ITS_TOOLPATH [8]: #1011, #1019, #784
 * ITS_TOOLPATH [9]: #1011, #1020, #824
 * ITS_TOOLPATH [10]: #1011, #1021, #844
 * ITS_TOOLPATH [11]: #1011, #1022, #913
 * ITS_TOOLPATH [12]: #1011, #1023, #933
 * ITS_TECHNOLOGY: #1011, #1024, #1053
 * ITS_MACHINE_FUNCTIONS: #1011, #1025, #1040
 * ITS_TOOL: #1011, #1150
 * ITS_ID: #1011 ['WS 1']
 */
#1011=FREEFORM_MILLING_OPERATION('WS 1','','','');
#1012=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#546,1.);
#1013=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#570,2.);
#1014=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#598,3.);
#1015=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#617,4.);
#1016=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#672,5.);
#1017=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#691,6.);
#1018=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#765,7.);
#1019=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#784,8.);
#1020=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#824,9.);
#1021=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#844,10.);
#1022=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#913,11.);
#1023=MACHINING_TOOLPATH_SEQUENCE_RELATIONSHIP('','',#1011,#933,12.);
#1024=MACHINING_TECHNOLOGY_RELATIONSHIP('','',#1011,#1053);
#1025=MACHINING_FUNCTIONS_RELATIONSHIP('','',#1011,#1040);

/**********************************************
 * Application object: GEOMETRIC_CONTEXT (#1026)
 * LENGTH_UNIT: #1026, #1072 ['millimetre']
 * PLANE_ANGLE_UNIT: #1026, #1078 ['degree']
 * SOLID_ANGLE_UNIT: #1026, #1092 ['steradian']
 * DIMENSIONS: #1026 [3]
 */
#1026=(
GEOMETRIC_REPRESENTATION_CONTEXT(3)
GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT((#1027))
GLOBAL_UNIT_ASSIGNED_CONTEXT((#1071,#1075,#1091))
REPRESENTATION_CONTEXT('simple_block_workpiece',
'TOP_LEVEL_ASSEMBLY_PART')
);
#1027=UNCERTAINTY_MEASURE_WITH_UNIT(LENGTH_MEASURE(2.E-005),#1071,
'DISTANCE_ACCURACY_VALUE','Maximum Tolerance applied to model');

/**********************************************
 * Application object: GEOMETRIC_CONTEXT (#1028)
 * LENGTH_UNIT: #1028, #1074 ['millimetre']
 * PLANE_ANGLE_UNIT: #1028, #1084 ['degree']
```

```
 * SOLID_ANGLE_UNIT: #1028, #1094 ['steradian']
 * DIMENSIONS: #1028 [3]
 */
#1028=(
GEOMETRIC_REPRESENTATION_CONTEXT(3)
GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT((#1029))
GLOBAL_UNIT_ASSIGNED_CONTEXT((#1071,#1075,#1091))
REPRESENTATION_CONTEXT('simple_block_rawpiece','TOP_LEVEL_ASSEMBLY_PART')
);
#1029=UNCERTAINTY_MEASURE_WITH_UNIT(LENGTH_MEASURE(2.E-005),#1071,
'DISTANCE_ACCURACY_VALUE','Maximum Tolerance applied to model');

/************************************************
 * Application object: MACHINING_WORKINGSTEP (#1030)
 * ITS_OPERATION: #1030, #1031, #1011
 * ITS_ID: #1030 ['WS 1']
 * ITS_FEATURE: #1030, #1032, #1033, #1034, #1035, #1117
 */
#1030=MACHINING_WORKINGSTEP('WS 1','machining','','');
#1031=MACHINING_OPERATION_RELATIONSHIP('','machining',#1030,#1011);
#1032=MACHINING_FEATURE_RELATIONSHIP('','machining',#1030,#1033);
#1033=MACHINING_FEATURE_PROCESS('','machining','','');
#1034=PROPERTY_PROCESS('machining','machining',#1033,'');
#1035=PROCESS_PROPERTY_ASSOCIATION('','machining',#1034,#1117);

/************************************************
 * Application object: MILLING_MACHINE_FUNCTIONS (#1040)
 * CHIP_REMOVAL: #1040, #1041, #1042, #1043, #1044 ['chip removal off']
 * COOLANT: #1040, #1045, #1046, #1047, #1048 ['coolant off']
 * THROUGH_SPINDLE_COOLANT: #1040, #1049, #1050, #1051, #1052 ['through spindle
coolant off']
 */
#1040=MACHINING_FUNCTIONS('','milling','','');
#1041=ACTION_PROPERTY('chip removal','milling',#1040);
#1042=ACTION_PROPERTY_REPRESENTATION('','milling',#1041,#1043);
#1043=REPRESENTATION('constant',(#1044),#564);
#1044=DESCRIPTIVE_REPRESENTATION_ITEM('constant','chip removal off');
#1045=ACTION_PROPERTY('coolant','milling',#1040);
#1046=ACTION_PROPERTY_REPRESENTATION('','milling',#1045,#1047);
#1047=REPRESENTATION('constant',(#1048),#564);
#1048=DESCRIPTIVE_REPRESENTATION_ITEM('constant','coolant off');
#1049=ACTION_PROPERTY('through spindle coolant','milling',#1040);
#1050=ACTION_PROPERTY_REPRESENTATION('','milling',#1049,#1051);
#1051=REPRESENTATION('constant',(#1052),#564);
#1052=DESCRIPTIVE_REPRESENTATION_ITEM('constant',
'through spindle coolant off');

/************************************************
 * Application object: MILLING_TECHNOLOGY (#1053)
 * SPINDLE: #1053, #1054, #1055, #1056, #1057
 * FEEDRATE: #1053, #1058, #1059, #1060, #1061
 */
#1053=MACHINING_TECHNOLOGY('','milling','','');
#1054=ACTION_PROPERTY('spindle','milling',#1053);
```



```
#1055=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#1054,
#1056);
#1056=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#1057),#564);
#1057=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(0.),
#1006);
#1058=ACTION_PROPERTY('feedrate','milling',#1053);
#1059=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#1058,#1060);
#1060=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#1061),#564);
#1061=MEASURE_REPRESENTATION_ITEM('feed speed',NUMERIC_MEASURE(0.),#1008);

/**********************************************
 * Application object: MILLING_TECHNOLOGY (#1062)
 * SPINDLE: #1062, #1063, #1064, #1065, #1066
 * FEEDRATE: #1062, #1067, #1068, #1069, #1070
 */
#1062=MACHINING_TECHNOLOGY('','milling','','');
#1063=ACTION_PROPERTY('spindle','milling',#1062);
#1064=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#1063,
#1065);
#1065=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#1066),#564);
#1066=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(0.),
#1006);
#1067=ACTION_PROPERTY('feedrate','milling',#1062);
#1068=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#1067,#1069);
#1069=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#1070),#564);
#1070=MEASURE_REPRESENTATION_ITEM('feed speed',NUMERIC_MEASURE(250.),#1008);

/**********************************************
 * Application object: NAMED_UNIT (#1071)
 */
#1071=(
LENGTH_UNIT()
NAMED_UNIT(*)
SI_UNIT(.MILLI.,.METRE.)
);

/**********************************************
 * Application object: NAMED_UNIT (#1075)
 */
#1075=(
CONVERSION_BASED_UNIT('degree',#1077)
NAMED_UNIT(#1076)
PLANE_ANGLE_UNIT()
);
#1076=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);
#1077=PLANE_ANGLE_MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(0.01745329252),#1087);

/**********************************************
 * Application object: NAMED_UNIT (#1087)
 */
#1087=(
NAMED_UNIT(*)
PLANE_ANGLE_UNIT()
SI_UNIT($,.RADIAN.)
```

```
);

/**************************************************
 * Application object: NAMED_UNIT (#1091)
 */
#1091=(
NAMED_UNIT(*)
SI_UNIT($,.STERADIAN.)
SOLID_ANGLE_UNIT()
);

/**************************************************
 * Application object: NAMED_UNIT (#1095)
 */
#1095=(
CONVERSION_BASED_UNIT('minute',#1097)
NAMED_UNIT(#1096)
TIME_UNIT()
);
#1096=DIMENSIONAL_EXPONENTS(0.,0.,1.,0.,0.,0.,0.);
#1097=TIME_MEASURE_WITH_UNIT(TIME_MEASURE(60.),#1098);

/**************************************************
 * Application object: NAMED_UNIT (#1098)
 */
#1098=(
NAMED_UNIT(*)
SI_UNIT($,.SECOND.)
TIME_UNIT()
);

/**************************************************
 * Application object: NAMED_UNIT (#1099)
 */
#1099=CONTEXT_DEPENDENT_UNIT(#1100,'count');
#1100=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);

/**************************************************
 * Application object: PERSON_AND_ADDRESS (#1101)
 */
#1101=PERSON(' ',' ',' ',(' '),$,$);

/**************************************************
 * Application object: PERSON_AND_ADDRESS (#1102)
 */
#1102=PERSON(' ',' ',' ',(' '),$,$);

/**************************************************
 * Application object: TOOLPATH_FEATURE (#1111)
 * ITS_WORKPIECE: #1111, #20, #19
 * FEATURE_PLACEMENT: #1111, #1112, #1113, #1114, #1115
 * ITS_ID: #1111 ['']
 */
#1111=INSTANCED_FEATURE('','toolpath','','toolpath',#20,.F.);
```



```
#1112=PRODUCT_DEFINITION_SHAPE('orientation','toolpath',#1111);
#1113=SHAPE_DEFINITION_REPRESENTATION(#1112,#1114);
#1114=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#1115),#565);
#1115=AXIS2_PLACEMENT_3D('orientation',#1116,#589,#590);
#1116=CARTESIAN_POINT('origin',(0.,0.,0.));

/************************************************
 * Application object: TOOLPATH_FEATURE (#1117)
 * ITS_WORKPIECE: #1117, #20, #19
 * FEATURE_PLACEMENT: #1117, #1118, #1119, #1120, #1121
 * ITS_ID: #1117 ['']
 * ITS_OPERATIONS [*]: #1117, #1122, #1123, #1124, #1125, #1126, #1127, #1011
 * ITS_OPERATIONS [*]: #1117, #1035, #1034, #1033, #1032, #1030, #1031, #1011
 */
#1117=INSTANCED_FEATURE('','toolpath','','toolpath',#20,.F.);
#1118=PRODUCT_DEFINITION_SHAPE('orientation','toolpath',#1117);
#1119=SHAPE_DEFINITION_REPRESENTATION(#1118,#1120);
#1120=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#1121),#1128);
#1121=AXIS2_PLACEMENT_3D('orientation',#1129,#1130,#1131);
#1122=PROCESS_PROPERTY_ASSOCIATION('','toolpath',#1123,#1117);
#1123=PROPERTY_PROCESS('machining','toolpath',#1124,'');
#1124=MACHINING_FEATURE_PROCESS('','toolpath','','');
#1125=MACHINING_FEATURE_RELATIONSHIP('','toolpath',#1126,#1124);
#1126=MACHINING_WORKINGSTEP('','toolpath','','');
#1127=MACHINING_OPERATION_RELATIONSHIP('','toolpath',#1126,#1011);
#1128=(
GEOMETRIC_REPRESENTATION_CONTEXT(3)
GLOBAL_UNIT_ASSIGNED_CONTEXT((#1071,#1075,#1091))
REPRESENTATION_CONTEXT('MILLIMETRE DEGREE STERADIAN','')
);
#1129=CARTESIAN_POINT('origin',(0.,0.,0.));
#1130=DIRECTION('Z direction',(0.,0.,1.));
#1131=DIRECTION('X direction',(1.,0.,0.));

/************************************************
 * Application object: WORKPLAN (#1134)
 * ITS_ELEMENTS [1]: #1134, #1135, #1030
 * ITS_ID: #1134 ['main workplan']
 */
#1134=MACHINING_WORKPLAN('main workplan','','','');
#1135=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#1134,#1030,1.);

/************************************************
 * Application object: ENDMILL (#1150)
 * ITS_ID: #1150 ['1']
 * EFFECTIVE_CUTTING_DIAMETER: #1150, #1152, #1153, #1154, #1155
 * MAXIMUM_DEPTH_OF_CUT: #1150, #1152, #1153, #1154, #1156
 * HAND_OF_CUT: #1150, #1152, #1153, #1154, #1157 ['right']
 * EDGE_RADIUS: #1150, #1152, #1153, #1154, #1158
 */
#1150=MACHINING_TOOL('1','',(#1011),#1151);
#1151=ACTION_RESOURCE_TYPE('milling cutting tool');
#1152=RESOURCE_PROPERTY('tool body','',#1150);
#1153=RESOURCE_PROPERTY_REPRESENTATION('','',#1152,#1154);
```



```
#1154=MACHINING_TOOL_BODY_REPRESENTATION('endmill',(#1155,#1156,#1157,
 #1158),#564);
#1155=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(20.),#1071)
REPRESENTATION_ITEM('effective cutting diameter')
);
#1156=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(20.),#1071)
REPRESENTATION_ITEM('maximum depth of cut')
);
#1157=DESCRIPTIVE_REPRESENTATION_ITEM('hand of cut','right');
#1158=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.),#1071)
REPRESENTATION_ITEM('edge radius')
);

#1160=APPLICATION_PROTOCOL_DEFINITION('international standard',
'integrated_cnc_schema',2006,#17);
ENDSEC;
END-ISO-10303-21;
```

K.6 Data set for ISO 14649-11 example #1 (CC3)

The following test case is defined by Annex E of ISO 14649-11. It defines a simple machining project for a block that contains a hole and a pocket as shown in Figure K.2. The data set follows the original ordering of application object instances in the ISO 14649-11 example. This example is a conformance class three file and contains no toolpaths. The processing system must generate toolpaths from the supplied features in order to machine the part. .

```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION(
/* description */ ('AP238 AIM version of ISO14649-11 example #1'),
/* implementation_level */ '2;1');

FILE_NAME(
/* name */ 'p11_example1_aim',
/* time_stamp */ '2006-06-22T10:50:52-04:00',
/* author */ ('Dave Loffredo (loffredo@steptools.com)'),
/* organization */ (''),
/* preprocessor_version */ 'ST-DEVELOPER v11',
/* originating_system */ '',
/* authorisation */ '');

FILE_SCHEMA (('INTEGRATED_CNC_SCHEMA'));
```


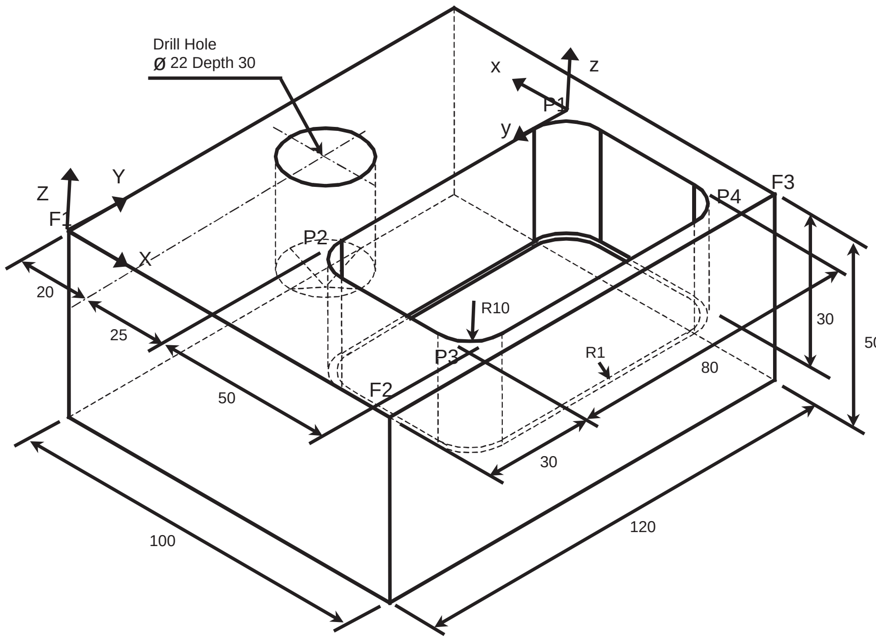

Figure K.2 — Workpiece from ISO 14649-11 example #1

```
ENDSEC;

DATA;

/************************************************
 * Application object: PROPERTY_PARAMETER (#100)
 * PARAMETER_NAME: #100 ['E=200000N/M2']
 */
#100=REPRESENTATION_ITEM('E=200000N/M2');

/************************************************
 * Application object: MATERIAL (#200)
 * MATERIAL_IDENTIFIER: #200 ['STEEL']
 * STANDARD_IDENTIFIER: #200, #201, #202 ['ST-50']
 * MATERIAL_PROPERTY [*]: #200, #203, #204, #205, #100
 */
#200=MATERIAL_DESIGNATION('STEEL',(#307,#407));
#201=APPLIED_DOCUMENT_REFERENCE(#202,'',(#200));
#202=DOCUMENT('ST-50','','',$);
#203=MATERIAL_DESIGNATION_CHARACTERIZATION('','',#200,#204);
#204=MATERIAL_PROPERTY_REPRESENTATION($,#205,$);
#205=REPRESENTATION('',(#100),$);

/************************************************
 * Application object: WORKPIECE (#300)
 * ITS_ID: #300 ['STOCK']
 * ITS_BOUNDING_GEOMETRY: #300, #301, #302, #303, #304, #305
 * ITS_MATERIAL [1]: #300, #306, #307, #200
 */
#300=PRODUCT_DEFINITION('STOCK','',#308,#312);
```



```
#301=MAKE_FROM_USAGE_OPTION('','','',#300,#302,0,'',$);
#302=PRODUCT_DEFINITION($,$,$,#312);
#303=PRODUCT_DEFINITION_SHAPE('','',#302);
#304=SHAPE_DEFINITION_REPRESENTATION(#303,#305);
#305=BLOCK_SHAPE_REPRESENTATION($,(#313,#317,#318,#319),$);
#306=MAKE_FROM_USAGE_OPTION('','','',#300,#307,1,'',$);
#307=PRODUCT_DEFINITION('','',$,$);
#308=PRODUCT_DEFINITION_FORMATION('1.0','Workpiece',#309);
#309=PRODUCT('WP','AP-238 CC1',' ',(#310));
#310=PRODUCT_CONTEXT('CNC Machining',#311,'manufacturing');
#311=APPLICATION_CONTEXT(
'Application protocol for the exchange of CNC data');
#312=PRODUCT_DEFINITION_CONTEXT('CNC Machining',#311,'manufacturing');
#313=AXIS2_PLACEMENT_3D('orientation',#314,#315,#316);
#314=CARTESIAN_POINT('',(0.,0.,0.));
#315=DIRECTION('',(0.,0.,1.));
#316=DIRECTION('',(1.,0.,0.));
#317=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(100.),#1601)
REPRESENTATION_ITEM('length')
);
#318=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(100.),#1601)
REPRESENTATION_ITEM('width')
);
#319=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(100.),#1601)
REPRESENTATION_ITEM('height')
);
#320=APPLICATION_PROTOCOL_DEFINITION('international standard',
'integrated_cnc_schema',2006,#311);

/************************************************
 * Application object: WORKPIECE (#400)
 * ITS_ID: #400 ['SIMPLE WORKPIECE']
 * GLOBAL_TOLERANCE: #400, #402, #403, #404, #405
 * ITS_MATERIAL [1]: #400, #406, #407, #200
 * CLAMPING_POSITIONS [*]: #400, #408, #409, #410, #411
 * CLAMPING_POSITIONS [*]: #400, #408, #409, #410, #415
 * CLAMPING_POSITIONS [*]: #400, #408, #409, #410, #419
 * CLAMPING_POSITIONS [*]: #400, #408, #409, #410, #423
 * ITS_RAWPIECE: #400, #424, #300
 * SHAPE_DEFINITION: #400, #401
 */
#400=PRODUCT_DEFINITION('SIMPLE WORKPIECE','',#425,#312);
#401=PRODUCT_DEFINITION_SHAPE('','',#400);
#402=PROPERTY_DEFINITION('global tolerance','',#400);
#403=PROPERTY_DEFINITION_REPRESENTATION(#402,#404);
```



```
#404=SHAPE_REPRESENTATION('',(#405),#427);
#405=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.01),#1601)
REPRESENTATION_ITEM('')
);
#406=MAKE_FROM_USAGE_OPTION('','','',#400,#407,1,'',$);
#407=PRODUCT_DEFINITION('','',$,$);
#408=PROPERTY_DEFINITION('clamping position','',#400);
#409=PROPERTY_DEFINITION_REPRESENTATION(#408,#410);
#410=SHAPE_REPRESENTATION('',(#411,#415,#419,#423),#427);
#411=CARTESIAN_POINT('CLAMPING_POSITION1',(0.,20.,25.));
#415=CARTESIAN_POINT('CLAMPING_POSITION2',(100.,20.,25.));
#419=CARTESIAN_POINT('CLAMPING_POSITION3',(0.,100.,25.));
#423=CARTESIAN_POINT('CLAMPING_POSITION4',(100.,100.,25.));
#424=MAKE_FROM_USAGE_OPTION('','','',#400,#300,0,'',#433);
#425=PRODUCT_DEFINITION_FORMATION('1.0','Workpiece',#426);
#426=PRODUCT('WP','AP-238 CC1',' ',(#310));
#427=(
GEOMETRIC_REPRESENTATION_CONTEXT(3)
GLOBAL_UNIT_ASSIGNED_CONTEXT((#1601,#428,#432))
REPRESENTATION_CONTEXT('MILLIMETRE DEGREE STERADIAN','')
);
#428=(
CONVERSION_BASED_UNIT('degree',#430)
NAMED_UNIT(#429)
PLANE_ANGLE_UNIT()
);
#429=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);
#430=PLANE_ANGLE_MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(0.01745329252),#431);
#431=(
NAMED_UNIT(*)
PLANE_ANGLE_UNIT()
SI_UNIT($,.RADIAN.)
);
#432=(
NAMED_UNIT(*)
SI_UNIT($,.STERADIAN.)
SOLID_ANGLE_UNIT()
);
#433=MEASURE_WITH_UNIT(COUNT_MEASURE(1.),#434);
#434=CONTEXT_DEPENDENT_UNIT(#435,'count');
#435=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);

/**********************************************
 * Application object: CUTTING_COMPONENT (#500)
 * TOOL_OFFSET_LENGTH: #500, #501, #502, #503, #504
 */
#500=MACHINING_CUTTING_COMPONENT('','',$,$,'','');
#501=RESOURCE_PROPERTY('offset length','',#500);
#502=RESOURCE_PROPERTY_REPRESENTATION('','',#501,#503);
#503=REPRESENTATION('',(#504),#505);
#504=(
```



```
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(80.),#1601)
REPRESENTATION_ITEM('')
);
#505=REPRESENTATION_CONTEXT('','units not necessary');

/**************************************************
 * Application object: ENDMILL (#600)
 * ITS_ID: #600 ['MILL 20MM']
 * ITS_CUTTING_EDGE [*]: #600, #605, #500
 * ITS_CUTTING_EDGE [*]: #600, #606, #500
 * ITS_CUTTING_EDGE [*]: #600, #607, #500
 * ITS_CUTTING_EDGE [*]: #600, #608, #500
 * OVERALL_ASSEMBLY_LENGTH: #600, #609, #610, #700, #704
 * EFFECTIVE_CUTTING_DIAMETER: #600, #609, #610, #700, #705
 * MAXIMUM_DEPTH_OF_CUT: #600, #609, #610, #700, #706
 * HAND_OF_CUT: #600, #609, #610, #700, #702 ['right']
 * COOLANT_THROUGH_TOOL: #600, #609, #610, #700, #701 ['not supported']
 * NUMBER_OF_EFFECTIVE_TEETH: #600, #609, #610, #700, #703 [4]
 * EDGE_RADIUS: #600, #609, #610, #700, #707
 */
#600=MACHINING_TOOL('MILL 20MM','endmill',(#4300,#4000,#1300),#611);
#605=ACTION_RESOURCE_RELATIONSHIP('','',#600,#500);
#606=ACTION_RESOURCE_RELATIONSHIP('','',#600,#500);
#607=ACTION_RESOURCE_RELATIONSHIP('','',#600,#500);
#608=ACTION_RESOURCE_RELATIONSHIP('','',#600,#500);
#609=RESOURCE_PROPERTY('tool body','',#600);
#610=RESOURCE_PROPERTY_REPRESENTATION('','',#609,#700);
#611=ACTION_RESOURCE_TYPE('milling cutting tool');

#700=MACHINING_TOOL_BODY_REPRESENTATION('endmill',(#702,#701,#703,#704,
 #705,#706,#707),#505);
#701=DESCRIPTIVE_REPRESENTATION_ITEM('coolant through tool',
'not supported');
#702=DESCRIPTIVE_REPRESENTATION_ITEM('hand of cut','right');
#703=MEASURE_REPRESENTATION_ITEM('number of effective teeth',
 COUNT_MEASURE(4.),#434);
#704=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(80.),#1601)
REPRESENTATION_ITEM('overall assembly length')
);
#705=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(20.),#1601)
REPRESENTATION_ITEM('effective cutting diameter')
);
#706=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(30.),#1601)
```

```
REPRESENTATION_ITEM('maximum depth of cut')
);
#707=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.05),#1601)
REPRESENTATION_ITEM('edge radius')
);

/************************************************
 * Application object: MILLING_TECHNOLOGY (#800)
 * SYNCHRONIZE_SPINDLE_WITH_FEED: #800, #801, #802, #803, #804 ['not
synchronized']
 * FEEDRATE_PER_TOOTH: #800, #805, #806, #807, #808
 * SPINDLE: #800, #809, #810, #811, #812
 * CUTSPEED: #800, #813, #814, #815, #816
 * INHIBIT_FEEDRATE_OVERRIDE: #800, #817, #818, #819, #820 ['override not
allowed']
 * FEEDRATE: #800, #821, #822, #823, #824
 * FEEDRATE_REFERENCE: #800, #825, #826, #827, #828 ['tool center point']
 * INHIBIT_SPINDLE_OVERRIDE: #800, #829, #830, #831, #832 ['override not
allowed']
 */
#800=MACHINING_TECHNOLOGY('','milling','','');
#801=ACTION_PROPERTY('synchronize spindle with feed','milling',#800);
#802=ACTION_PROPERTY_REPRESENTATION('','milling',#801,#803);
#803=REPRESENTATION('',(#804),#505);
#804=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#805=ACTION_PROPERTY('feedrate','milling',#800);
#806=ACTION_PROPERTY_REPRESENTATION('feed per tooth','milling',#805,#807);
#807=MACHINING_FEED_SPEED_REPRESENTATION('feed per tooth',(#808),#505);
#808=MEASURE_REPRESENTATION_ITEM('feed per tooth',$,#833);
#809=ACTION_PROPERTY('spindle','milling',#800);
#810=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#809,#811);
#811=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#812),#505);
#812=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(12.),
#837);
#813=ACTION_PROPERTY('spindle','milling',#800);
#814=ACTION_PROPERTY_REPRESENTATION('surface speed','milling',#813,#815);
#815=MACHINING_SPINDLE_SPEED_REPRESENTATION('cutting speed',(#816),#505);
#816=MEASURE_REPRESENTATION_ITEM('surface speed',$,#837);
#817=ACTION_PROPERTY('inhibit feedrate override','milling',#800);
#818=ACTION_PROPERTY_REPRESENTATION('','milling',#817,#819);
#819=REPRESENTATION('',(#820),#505);
#820=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#821=ACTION_PROPERTY('feedrate','milling',#800);
#822=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#821,#823);
#823=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#824),#505);
#824=MEASURE_REPRESENTATION_ITEM('feed speed',NUMERIC_MEASURE(0.04),#833);
#825=ACTION_PROPERTY('feedrate reference','milling',#800);
#826=ACTION_PROPERTY_REPRESENTATION('','milling',#825,#827);
#827=REPRESENTATION('',(#828),#505);
#828=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#829=ACTION_PROPERTY('inhibit spindle override','milling',#800);
```



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#830=ACTION_PROPERTY_REPRESENTATION('','milling',#829,#831);
#831=REPRESENTATION('',(#832),#505);
#832=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#833=DERIVED_UNIT((#834,#835));
#834=DERIVED_UNIT_ELEMENT(#1601,1.);
#835=DERIVED_UNIT_ELEMENT(#836,-1.);
#836=(
NAMED_UNIT(*)
SI_UNIT($,.SECOND.)
TIME_UNIT()
);
#837=DERIVED_UNIT((#838));
#838=DERIVED_UNIT_ELEMENT(#836,-1.);
#839=NAME_ATTRIBUTE('millimetre/second',#833);
#840=NAME_ATTRIBUTE('rotation/second',#837);

/***********************************************
 * Application object: MILLING_MACHINE_FUNCTIONS (#900)
 * CHIP_REMOVAL: #900, #901, #902, #903, #904 ['chip removal on']
 * COOLANT: #900, #905, #906, #907, #908 ['coolant on']
 * THROUGH_SPINDLE_COOLANT: #900, #909, #910, #911, #912 ['through spindle
coolant off']
 */
#900=MACHINING_FUNCTIONS('','milling','','');
#901=ACTION_PROPERTY('chip removal','milling',#900);
#902=ACTION_PROPERTY_REPRESENTATION('','milling',#901,#903);
#903=REPRESENTATION('constant',(#904),#505);
#904=DESCRIPTIVE_REPRESENTATION_ITEM('constant','chip removal on');
#905=ACTION_PROPERTY('coolant','milling',#900);
#906=ACTION_PROPERTY_REPRESENTATION('','milling',#905,#907);
#907=REPRESENTATION('constant',(#908),#505);
#908=DESCRIPTIVE_REPRESENTATION_ITEM('constant','coolant on');
#909=ACTION_PROPERTY('through spindle coolant','milling',#900);
#910=ACTION_PROPERTY_REPRESENTATION('','milling',#909,#911);
#911=REPRESENTATION('constant',(#912),#505);
#912=DESCRIPTIVE_REPRESENTATION_ITEM('constant',
'through spindle coolant off');

/***********************************************
 * Application object: PLUNGE_RAMP (#1000)
 * ANGLE: #1000, #1001, #1002, #1003, #1004
 */
#1000=MACHINING_APPROACH_RETRACT_STRATEGY('','plunge ramp','','');
#1001=ACTION_PROPERTY('plunge angle','plunge ramp',#1000);
#1002=ACTION_PROPERTY_REPRESENTATION('','plunge ramp',#1001,#1003);
#1003=REPRESENTATION('',(#1004),#505);
#1004=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(45.),#428)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);

/***********************************************
```

```
 * Application object: PLUNGE_RAMP (#1100)
 * ANGLE: #1100, #1101, #1102, #1103, #1104
 */
#1100=MACHINING_APPROACH_RETRACT_STRATEGY('','plunge ramp','','');
#1101=ACTION_PROPERTY('plunge angle','plunge ramp',#1100);
#1102=ACTION_PROPERTY_REPRESENTATION('','plunge ramp',#1101,#1103);
#1103=REPRESENTATION('',(#1104),#505);
#1104=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(45.),#428)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);

/**********************************************
 * Application object: BIDIRECTIONAL (#1200)
 * FEED_DIRECTION: #1200, #1201, #1202, #1203, #1204
 * STEPOVER_DIRECTION: #1200, #1205, #1206, #1207, #1208 ['left']
 * OVERLAP: #1200, #1209, #1210, #1211, #1212
 * ALLOW_MULTIPLE_PASSES: #1200, #1213, #1214, #1215, #1216 ['multiple passes
allowed']
 */
#1200=MILLING_TYPE_STRATEGY('','bidirectional','','');
#1201=ACTION_PROPERTY('feed direction','bidirectional',#1200);
#1202=ACTION_PROPERTY_REPRESENTATION('','bidirectional',#1201,#1203);
#1203=REPRESENTATION('',(#1204),#505);
#1204=DIRECTION('STRATEGY PLANAR FACE1: 1.DIRECTION',(0.,1.,0.));
#1205=ACTION_PROPERTY('stepover direction','bidirectional',#1200);
#1206=ACTION_PROPERTY_REPRESENTATION('','bidirectional',#1205,#1207);
#1207=REPRESENTATION('',(#1208),#505);
#1208=DESCRIPTIVE_REPRESENTATION_ITEM('','left');
#1209=ACTION_PROPERTY('overlap ratio','bidirectional',#1200);
#1210=ACTION_PROPERTY_REPRESENTATION('','bidirectional',#1209,#1211);
#1211=REPRESENTATION('',(#1212),#505);
#1212=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(RATIO_MEASURE(5.),#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);
#1213=ACTION_PROPERTY('multiple passes','bidirectional',#1200);
#1214=ACTION_PROPERTY_REPRESENTATION('','bidirectional',#1213,#1215);
#1215=REPRESENTATION('',(#1216),#505);
#1216=DESCRIPTIVE_REPRESENTATION_ITEM('','multiple passes allowed');
#1217=RATIO_UNIT(#1218);
#1218=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);

/**********************************************
 * Application object: PLANE_FINISH_MILLING (#1300)
 * RETRACT: #1300, #1301, #1100
 * APPROACH: #1300, #1302, #1000
 * ITS_TECHNOLOGY: #1300, #1303, #800
 * OVERCUT_LENGTH: #1300, #1304, #1305, #1306, #1307
 * ITS_TOOL: #1300, #600
```



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 * RETRACT_PLANE: #1300, #1308, #1309, #1310, #1311
 * AXIAL_CUTTING_DEPTH: #1300, #1312, #1313, #1314, #1315
 * ITS_MACHINING_STRATEGY: #1300, #1316, #1200
 * ALLOWANCE_BOTTOM: #1300, #1317, #1318, #1319, #1320
 * ITS_MACHINE_FUNCTIONS: #1300, #1321, #900
 * ITS_ID: #1300 ['FINISH PLANAR FACE1']
 */
#1300=PLANE_MILLING_OPERATION('FINISH PLANAR FACE1','finishing','','');
#1301=MACHINING_STRATEGY_RELATIONSHIP('retract','finishing',#1300,#1100);
#1302=MACHINING_STRATEGY_RELATIONSHIP('approach','finishing',#1300,#1000);
#1303=MACHINING_TECHNOLOGY_RELATIONSHIP('','finishing',#1300,#800);
#1304=ACTION_PROPERTY('overcut length','finishing',#1300);
#1305=ACTION_PROPERTY_REPRESENTATION('','finishing',#1304,#1306);
#1306=REPRESENTATION('',(#1307),#505);
#1307=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(5.),#1601)
REPRESENTATION_ITEM('')
);
#1308=ACTION_PROPERTY('retract plane','finishing',#1300);
#1309=ACTION_PROPERTY_REPRESENTATION('','finishing',#1308,#1310);
#1310=REPRESENTATION('',(#1311),#505);
#1311=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(10.),#1601)
REPRESENTATION_ITEM('')
);
#1312=ACTION_PROPERTY('axial cutting depth','finishing',#1300);
#1313=ACTION_PROPERTY_REPRESENTATION('','finishing',#1312,#1314);
#1314=REPRESENTATION('',(#1315),#505);
#1315=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(2.5),#1601)
REPRESENTATION_ITEM('')
);
#1316=MACHINING_STRATEGY_RELATIONSHIP('machining','finishing',#1300,#1200);
#1317=ACTION_PROPERTY('allowance bottom','finishing',#1300);
#1318=ACTION_PROPERTY_REPRESENTATION('','finishing',#1317,#1319);
#1319=REPRESENTATION('',(#1320),#505);
#1320=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#1321=MACHINING_FUNCTIONS_RELATIONSHIP('','finishing',#1300,#900);

/************************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#1400)
 * VALUE_COMPONENT: #1400 [120]
 ***********************************************
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 * Application object: QUALIFIED_PLUS_MINUS_VALUE (#1400)
 * UPPER_LIMIT: #1400, #1401 [0.3]
 * LOWER_LIMIT: #1400, #1402 [0.3]
 */
#1400=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(120.),#1601)
QUALIFIED_REPRESENTATION_ITEM((#1402,#1401))
REPRESENTATION_ITEM('distance')
);
#1401=STANDARD_UNCERTAINTY('upper limit','',0.3);
#1402=STANDARD_UNCERTAINTY('lower limit','',0.3);

/************************************************
 * Application object: LINEAR_PATH (#1500)
 * ITS_DIRECTION: #1500, #1501, #1502, #1503, #1504
 * DISTANCE: #1500, #1505, #1506, #1507, #1400
 */
#1500=PATH_FEATURE_COMPONENT('','linear',#1509,.F.);
#1501=PROPERTY_DEFINITION('','linear',#1500);
#1502=PROPERTY_DEFINITION_REPRESENTATION(#1501,#1503);
#1503=DIRECTION_SHAPE_REPRESENTATION('',(#1504),#505);
#1504=DIRECTION('COURSE OF TRAVEL DIRECTION',(0.,1.,0.));
#1505=PROPERTY_DEFINITION('','linear',#1500);
#1506=SHAPE_DEFINITION_REPRESENTATION(#1505,#1507);
#1507=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#1400),#427);
#1508=FEATURE_COMPONENT_DEFINITION('feature component','shared by all');
#1509=PRODUCT_DEFINITION_SHAPE('feature component',$,#1508);

/************************************************
 * Application object: NUMERIC_PARAMETER (#1600)
 * ITS_PARAMETER_UNIT: #1600, #1601
 * ITS_PARAMETER_VALUE: #1600 [100]
 * PARAMETER_NAME: #1600 ['PROFILE LENGTH']
 */
#1600=MEASURE_REPRESENTATION_ITEM('PROFILE LENGTH',NUMERIC_MEASURE(100.),
#1601);
#1601=(
LENGTH_UNIT()
NAMED_UNIT(*)
SI_UNIT(.MILLI.,.METRE.)
);

/************************************************
 * Application object: LINEAR_PROFILE (#1700)
 * PROFILE_LENGTH: #1700, #1701, #1702, #1703, #1600
 */
#1700=LINEAR_PROFILE('','',#1509,.F.);
#1701=PROPERTY_DEFINITION('profile length','',#1700);
#1702=SHAPE_DEFINITION_REPRESENTATION(#1701,#1703);
#1703=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#1600),#427);

/************************************************
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 * Application object: PLANAR_FACE (#1800)
 * FEATURE_PLACEMENT: #1800, #1801, #1802, #1803, #1804
 * COURSE_OF_TRAVEL: #1800, #1801, #1805, #1806, #1500
 * REMOVAL_DEPTH: #1800, #1801, #1802, #1803, #1807
 * ITS_WORKPIECE: #1800, #401, #400
 * DEPTH: #1800, #1801, #1808, #1809, #1810
 * REMOVAL_BOUNDARY: #1800, #1801, #1811, #1812, #1700
 * ITS_ID: #1800 ['PLANAR FACE1']
 */
#1800=(
CHARACTERIZED_OBJECT('','')
FEATURE_DEFINITION()
FLAT_FACE()
INSTANCED_FEATURE()
SHAPE_ASPECT('PLANAR FACE1','',#401,.T.)
);
#1801=PRODUCT_DEFINITION_SHAPE('','',#1800);
#1802=SHAPE_DEFINITION_REPRESENTATION(#1801,#1803);
#1803=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#1804,#1807),#427);
#1804=AXIS2_PLACEMENT_3D('orientation',#1813,#1814,#1815);
#1805=SHAPE_ASPECT('','course of travel occurrence',#1801,.F.);
#1806=SHAPE_DEFINING_RELATIONSHIP('course of travel',
'path feature component usage',#1500,#1805);
#1807=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('removal depth')
);
#1808=SHAPE_DEFINITION_REPRESENTATION(#1801,#1809);
#1809=SHAPE_REPRESENTATION('maximum feature limit',(#1810),#427);
#1810=PLANE('PLANAR FACE1-DEPTH PLANE',#1816);
#1811=SHAPE_ASPECT('','removal boundary occurrence',#1801,.F.);
#1812=SHAPE_DEFINING_RELATIONSHIP('removal boundary','profile usage',#1700,
#1811);
#1813=CARTESIAN_POINT('PLANAR FACE1:LOCATION ',(0.,0.,5.));
#1814=DIRECTION(' AXIS ',(0.,0.,1.));
#1815=DIRECTION(' REF_DIRECTION',(1.,0.,0.));
#1816=AXIS2_PLACEMENT_3D('PLANAR FACE1',#1817,#1818,#1819);
#1817=CARTESIAN_POINT('PLANAR FACE1:DEPTH ',(0.,0.,-5.));
#1818=DIRECTION(' AXIS ',(0.,0.,1.));
#1819=DIRECTION(' REF_DIRECTION',(1.,0.,0.));

/***********************************************
 * Application object: MACHINING_WORKINGSTEP (#1900)
 * ITS_OPERATION: #1900, #1901, #1300
 * ITS_FEATURE: #1900, #1902, #1903, #1904, #1905, #1800
 * ITS_SECPLANE: #1900, #1906, #1907, #1908, #1909
 * ITS_ID: #1900 ['WS FINISH PLANAR FACE1']
 */
#1900=MACHINING_WORKINGSTEP('WS FINISH PLANAR FACE1','machining','','');
#1901=MACHINING_OPERATION_RELATIONSHIP('','machining',#1900,#1300);
#1902=MACHINING_FEATURE_RELATIONSHIP('','machining',#1900,#1903);
#1903=MACHINING_FEATURE_PROCESS('','machining','','');
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#1904=PROPERTY_PROCESS('machining','machining',#1903,'');
#1905=PROCESS_PROPERTY_ASSOCIATION('','machining',#1904,#1800);
#1906=ACTION_PROPERTY('security plane','machining',#1900);
#1907=ACTION_PROPERTY_REPRESENTATION('','machining',#1906,#1908);
#1908=REPRESENTATION('',(#1909),#505);
#1909=PLANE('SECURITY PLANE',#1910);
#1910=AXIS2_PLACEMENT_3D('PLANE1',#1911,#1912,#1913);
#1911=CARTESIAN_POINT('SECPLANE1: LOCATION ',(0.,0.,30.));
#1912=DIRECTION(' AXIS ',(0.,0.,1.));
#1913=DIRECTION(' REF_DIRECTION',(1.,0.,0.));

/************************************************
 * Application object: DRILLING_CUTTING_TOOL (#2000)
 * ITS_ID: #2000 ['DRILL 20MM']
 * OVERALL_ASSEMBLY_LENGTH: #2000, #2005, #2006, #2100, #2104
 * EFFECTIVE_CUTTING_DIAMETER: #2000, #2005, #2006, #2100, #2105
 * MAXIMUM_DEPTH_OF_CUT: #2000, #2005, #2006, #2100, #2106
 * HAND_OF_CUT: #2000, #2005, #2006, #2100, #2102 ['right']
 * COOLANT_THROUGH_TOOL: #2000, #2005, #2006, #2100, #2103 ['not supported']
 * POINT_ANGLE: #2000, #2005, #2006, #2100, #2107
 */
#2000=MACHINING_TOOL('DRILL 20MM','drill',(#2500),#2007);
#2005=RESOURCE_PROPERTY('tool body','',#2000);
#2006=RESOURCE_PROPERTY_REPRESENTATION('','',#2005,#2100);
#2007=ACTION_RESOURCE_TYPE('milling cutting tool');

#2100=MACHINING_TOOL_BODY_REPRESENTATION('drill', (#2102,
 #2103,#2104,#2105,#2106,#2107),#505);
#2102=DESCRIPTIVE_REPRESENTATION_ITEM('hand of cut','right');
#2103=DESCRIPTIVE_REPRESENTATION_ITEM('coolant through tool',
'not supported');
#2104=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(90.),#1601)
REPRESENTATION_ITEM('overall assembly length')
);
#2105=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(20.),#1601)
REPRESENTATION_ITEM('effective cutting diameter')
);
#2106=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(70.),#1601)
REPRESENTATION_ITEM('maximum depth of cut')
);
#2107=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(120.),#428)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('point angle')
```

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);


/***********************************************
 * Application object: MILLING_TECHNOLOGY (#2300)
 * SYNCHRONIZE_SPINDLE_WITH_FEED: #2300, #2301, #2302, #2303, #2304 ['not
synchronized']
 * FEEDRATE_PER_TOOTH: #2300, #2305, #2306, #2307, #2308
 * SPINDLE: #2300, #2309, #2310, #2311, #2312
 * CUTSPEED: #2300, #2313, #2314, #2315, #2316
 * INHIBIT_FEEDRATE_OVERRIDE: #2300, #2317, #2318, #2319, #2320 ['override not
allowed']
 * FEEDRATE: #2300, #2321, #2322, #2323, #2324
 * FEEDRATE_REFERENCE: #2300, #2325, #2326, #2327, #2328 ['tool center point']
 * INHIBIT_SPINDLE_OVERRIDE: #2300, #2329, #2330, #2331, #2332 ['override not
allowed']
 */
#2300=MACHINING_TECHNOLOGY('','milling','','');
#2301=ACTION_PROPERTY('synchronize spindle with feed','milling',#2300);
#2302=ACTION_PROPERTY_REPRESENTATION('','milling',#2301,#2303);
#2303=REPRESENTATION('',(#2304),#505);
#2304=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#2305=ACTION_PROPERTY('feedrate','milling',#2300);
#2306=ACTION_PROPERTY_REPRESENTATION('feed per tooth','milling',#2305,#2307);
#2307=MACHINING_FEED_SPEED_REPRESENTATION('feed per tooth',(#2308),#505);
#2308=MEASURE_REPRESENTATION_ITEM('feed per tooth',$,#833);
#2309=ACTION_PROPERTY('spindle','milling',#2300);
#2310=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#2309,
#2311);
#2311=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#2312),#505);
#2312=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(16.),
#837);
#2313=ACTION_PROPERTY('spindle','milling',#2300);
#2314=ACTION_PROPERTY_REPRESENTATION('surface speed','milling',#2313,#2315);
#2315=MACHINING_SPINDLE_SPEED_REPRESENTATION('cutting speed',(#2316),#505);
#2316=MEASURE_REPRESENTATION_ITEM('surface speed',$,#837);
#2317=ACTION_PROPERTY('inhibit feedrate override','milling',#2300);
#2318=ACTION_PROPERTY_REPRESENTATION('','milling',#2317,#2319);
#2319=REPRESENTATION('',(#2320),#505);
#2320=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2321=ACTION_PROPERTY('feedrate','milling',#2300);
#2322=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#2321,#2323);
#2323=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#2324),#505);
#2324=MEASURE_REPRESENTATION_ITEM('feed speed',NUMERIC_MEASURE(0.03),#833);
#2325=ACTION_PROPERTY('feedrate reference','milling',#2300);
#2326=ACTION_PROPERTY_REPRESENTATION('','milling',#2325,#2327);
#2327=REPRESENTATION('',(#2328),#505);
#2328=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#2329=ACTION_PROPERTY('inhibit spindle override','milling',#2300);
#2330=ACTION_PROPERTY_REPRESENTATION('','milling',#2329,#2331);
#2331=REPRESENTATION('',(#2332),#505);
#2332=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');

/***********************************************
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 * Application object: DRILLING_TYPE_STRATEGY (#2400)
 * REDUCED_CUT_AT_END: #2400, #2401, #2402, #2403, #2404
 * REDUCED_CUT_AT_START: #2400, #2405, #2406, #2407, #2408
 * DEPTH_OF_END: #2400, #2409, #2410, #2411, #2412
 * REDUCED_FEED_AT_END: #2400, #2413, #2414, #2415, #2416
 * DEPTH_OF_START: #2400, #2417, #2418, #2419, #2420
 * REDUCED_FEED_AT_START: #2400, #2421, #2422, #2423, #2424
 */
#2400=DRILLING_TYPE_STRATEGY('','','','');
#2401=ACTION_PROPERTY('reduced cut at end','',#2400);
#2402=ACTION_PROPERTY_REPRESENTATION('relative speed','',#2401,#2403);
#2403=MACHINING_SPINDLE_SPEED_REPRESENTATION('relative speed',(#2404),#505);
#2404=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(RATIO_MEASURE(50.),#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);
#2405=ACTION_PROPERTY('reduced cut at start','',#2400);
#2406=ACTION_PROPERTY_REPRESENTATION('relative speed','',#2405,#2407);
#2407=MACHINING_SPINDLE_SPEED_REPRESENTATION('relative speed',(#2408),#505);
#2408=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(RATIO_MEASURE(75.),#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);
#2409=ACTION_PROPERTY('depth of end','',#2400);
#2410=ACTION_PROPERTY_REPRESENTATION('','',#2409,#2411);
#2411=REPRESENTATION('',(#2412),#505);
#2412=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(8.),#1601)
REPRESENTATION_ITEM('')
);
#2413=ACTION_PROPERTY('reduced feedrate at end','',#2400);
#2414=ACTION_PROPERTY_REPRESENTATION('relative speed','',#2413,#2415);
#2415=MACHINING_FEED_SPEED_REPRESENTATION('relative speed',(#2416),#505);
#2416=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(RATIO_MEASURE(75.),#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);
#2417=ACTION_PROPERTY('depth of start','',#2400);
#2418=ACTION_PROPERTY_REPRESENTATION('','',#2417,#2419);
#2419=REPRESENTATION('',(#2420),#505);
#2420=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(2.),#1601)
REPRESENTATION_ITEM('')
);
```



```
#2421=ACTION_PROPERTY('reduced feedrate at start','',#2400);
#2422=ACTION_PROPERTY_REPRESENTATION('relative speed','',#2421,#2423);
#2423=MACHINING_FEED_SPEED_REPRESENTATION('relative speed',(#2424),#505);
#2424=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(RATIO_MEASURE(50.),#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);

/***********************************************
 * Application object: DRILLING (#2500)
 * RETRACT_PLANE: #2500, #2501, #2502, #2503, #2504
 * ITS_TECHNOLOGY: #2500, #2505, #2300
 * ITS_ID: #2500 ['DRILL HOLE1']
 * ITS_TOOL: #2500, #2000
 * CUTTING_DEPTH: #2500, #2506, #2507, #2508, #2509
 * PREVIOUS_DIAMETER: #2500, #2510, #2511, #2512, #2513
 * OVERCUT_LENGTH: #2500, #2514, #2515, #2516, #2517
 * FEED_ON_RETRACT: #2500, #2518, #2519, #2520, #2521
 * ITS_MACHINING_STRATEGY: #2500, #2522, #2400
 * ITS_MACHINE_FUNCTIONS: #2500, #2523, #900
 */
#2500=DRILLING_OPERATION('DRILL HOLE1','drilling','','');
#2501=ACTION_PROPERTY('retract plane','drilling',#2500);
#2502=ACTION_PROPERTY_REPRESENTATION('','drilling',#2501,#2503);
#2503=REPRESENTATION('',(#2504),#505);
#2504=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(10.),#1601)
REPRESENTATION_ITEM('')
);
#2505=MACHINING_TECHNOLOGY_RELATIONSHIP('','drilling',#2500,#2300);
#2506=ACTION_PROPERTY('cutting depth','drilling',#2500);
#2507=ACTION_PROPERTY_REPRESENTATION('','drilling',#2506,#2508);
#2508=REPRESENTATION('',(#2509),#505);
#2509=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(30.),#1601)
REPRESENTATION_ITEM('')
);
#2510=ACTION_PROPERTY('previous diameter','drilling',#2500);
#2511=ACTION_PROPERTY_REPRESENTATION('','drilling',#2510,#2512);
#2512=REPRESENTATION('',(#2513),#505);
#2513=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.),#1601)
REPRESENTATION_ITEM('')
);
#2514=ACTION_PROPERTY('overcut length','drilling',#2500);
#2515=ACTION_PROPERTY_REPRESENTATION('','drilling',#2514,#2516);
```



```
#2516=REPRESENTATION('',(#2517),#505);
#2517=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#2518=ACTION_PROPERTY('feedrate on retract','drilling',#2500);
#2519=ACTION_PROPERTY_REPRESENTATION('relative speed','drilling',#2518,#2520);
#2520=MACHINING_FEED_SPEED_REPRESENTATION('relative speed',(#2521),#505);
#2521=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(RATIO_MEASURE(0.),#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);
#2522=MACHINING_STRATEGY_RELATIONSHIP('machining','drilling',#2500,#2400);
#2523=MACHINING_FUNCTIONS_RELATIONSHIP('','drilling',#2500,#900);

/************************************************
 * Application object: REAMING_CUTTING_TOOL (#2600)
 * ITS_ID: #2600 ['REAMER 22MM']
 * ITS_CUTTING_EDGE [*]: #2600, #2601, #500
 * ITS_CUTTING_EDGE [*]: #2600, #2602, #500
 * ITS_CUTTING_EDGE [*]: #2600, #2603, #500
 * ITS_CUTTING_EDGE [*]: #2600, #2604, #500
 * OVERALL_ASSEMBLY_LENGTH: #2600, #2605, #2606, #2700, #2703
 * EFFECTIVE_CUTTING_DIAMETER: #2600, #2605, #2606, #2700, #2704
 * MAXIMUM_DEPTH_OF_CUT: #2600, #2605, #2606, #2700, #2705
 * HAND_OF_CUT: #2600, #2605, #2606, #2700, #2701 ['right']
 * COOLANT_THROUGH_TOOL: #2600, #2605, #2606, #2700, #2702 ['not supported']
 */
#2600=MACHINING_TOOL('REAMER 22MM','reamer',(#3000),#2607);
#2601=ACTION_RESOURCE_RELATIONSHIP('','',#2600,#500);
#2602=ACTION_RESOURCE_RELATIONSHIP('','',#2600,#500);
#2603=ACTION_RESOURCE_RELATIONSHIP('','',#2600,#500);
#2604=ACTION_RESOURCE_RELATIONSHIP('','',#2600,#500);
#2605=RESOURCE_PROPERTY('tool body','',#2600);
#2606=RESOURCE_PROPERTY_REPRESENTATION('','',#2605,#2700);
#2607=ACTION_RESOURCE_TYPE('milling cutting tool');

#2700=MACHINING_TOOL_BODY_REPRESENTATION('reamer',(#2701,#2702,#2703,
 #2704,#2705),#505);
#2701=DESCRIPTIVE_REPRESENTATION_ITEM('hand of cut','right');
#2702=DESCRIPTIVE_REPRESENTATION_ITEM('coolant through tool',
'not supported');
#2703=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(100.),#1601)
REPRESENTATION_ITEM('overall assembly length')
);
#2704=(
LENGTH_MEASURE_WITH_UNIT()
```

```
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(22.),#1601)
REPRESENTATION_ITEM('effective cutting diameter')
);
#2705=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(60.),#1601)
REPRESENTATION_ITEM('maximum depth of cut')
);

/************************************************
 * Application object: MILLING_TECHNOLOGY (#2800)
 * SYNCHRONIZE_SPINDLE_WITH_FEED: #2800, #2801, #2802, #2803, #2804 ['not
synchronized']
 * FEEDRATE_PER_TOOTH: #2800, #2805, #2806, #2807, #2808
 * SPINDLE: #2800, #2809, #2810, #2811, #2812
 * CUTSPEED: #2800, #2813, #2814, #2815, #2816
 * INHIBIT_FEEDRATE_OVERRIDE: #2800, #2817, #2818, #2819, #2820 ['override not
allowed']
 * FEEDRATE: #2800, #2821, #2822, #2823, #2824
 * FEEDRATE_REFERENCE: #2800, #2825, #2826, #2827, #2828 ['tool center point']
 * INHIBIT_SPINDLE_OVERRIDE: #2800, #2829, #2830, #2831, #2832 ['override not
allowed']
 */
#2800=MACHINING_TECHNOLOGY('','milling','','');
#2801=ACTION_PROPERTY('synchronize spindle with feed','milling',#2800);
#2802=ACTION_PROPERTY_REPRESENTATION('','milling',#2801,#2803);
#2803=REPRESENTATION('',(#2804),#505);
#2804=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#2805=ACTION_PROPERTY('feedrate','milling',#2800);
#2806=ACTION_PROPERTY_REPRESENTATION('feed per tooth','milling',#2805,#2807);
#2807=MACHINING_FEED_SPEED_REPRESENTATION('feed per tooth',(#2808),#505);
#2808=MEASURE_REPRESENTATION_ITEM('feed per tooth',$,#833);
#2809=ACTION_PROPERTY('spindle','milling',#2800);
#2810=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#2809,
#2811);
#2811=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#2812),#505);
#2812=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(18.),
#837);
#2813=ACTION_PROPERTY('spindle','milling',#2800);
#2814=ACTION_PROPERTY_REPRESENTATION('surface speed','milling',#2813,#2815);
#2815=MACHINING_SPINDLE_SPEED_REPRESENTATION('cutting speed',(#2816),#505);
#2816=MEASURE_REPRESENTATION_ITEM('surface speed',$,#837);
#2817=ACTION_PROPERTY('inhibit feedrate override','milling',#2800);
#2818=ACTION_PROPERTY_REPRESENTATION('','milling',#2817,#2819);
#2819=REPRESENTATION('',(#2820),#505);
#2820=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2821=ACTION_PROPERTY('feedrate','milling',#2800);
#2822=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#2821,#2823);
#2823=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#2824),#505);
#2824=MEASURE_REPRESENTATION_ITEM('feed speed',NUMERIC_MEASURE(0.03),#833);
#2825=ACTION_PROPERTY('feedrate reference','milling',#2800);
#2826=ACTION_PROPERTY_REPRESENTATION('','milling',#2825,#2827);
```



```
#2827=REPRESENTATION('',(#2828),#505);
#2828=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#2829=ACTION_PROPERTY('inhibit spindle override','milling',#2800);
#2830=ACTION_PROPERTY_REPRESENTATION('','milling',#2829,#2831);
#2831=REPRESENTATION('',(#2832),#505);
#2832=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');

/*************************************************
 * Application object: DRILLING_TYPE_STRATEGY (#2900)
 * REDUCED_CUT_AT_END: #2900, #2901, #2902, #2903, #2904
 * REDUCED_CUT_AT_START: #2900, #2905, #2906, #2907, #2908
 * DEPTH_OF_END: #2900, #2909, #2910, #2911, #2912
 * REDUCED_FEED_AT_END: #2900, #2913, #2914, #2915, #2916
 * DEPTH_OF_START: #2900, #2917, #2918, #2919, #2920
 * REDUCED_FEED_AT_START: #2900, #2921, #2922, #2923, #2924
 */
#2900=DRILLING_TYPE_STRATEGY('','','','');
#2901=ACTION_PROPERTY('reduced cut at end','',#2900);
#2902=ACTION_PROPERTY_REPRESENTATION('relative speed','',#2901,#2903);
#2903=MACHINING_SPINDLE_SPEED_REPRESENTATION('relative speed',(#2904),#505);
#2904=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);
#2905=ACTION_PROPERTY('reduced cut at start','',#2900);
#2906=ACTION_PROPERTY_REPRESENTATION('relative speed','',#2905,#2907);
#2907=MACHINING_SPINDLE_SPEED_REPRESENTATION('relative speed',(#2908),#505);
#2908=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);
#2909=ACTION_PROPERTY('depth of end','',#2900);
#2910=ACTION_PROPERTY_REPRESENTATION('','',#2909,#2911);
#2911=REPRESENTATION('',(#2912),#505);
#2912=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#2913=ACTION_PROPERTY('reduced feedrate at end','',#2900);
#2914=ACTION_PROPERTY_REPRESENTATION('relative speed','',#2913,#2915);
#2915=MACHINING_FEED_SPEED_REPRESENTATION('relative speed',(#2916),#505);
#2916=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);
#2917=ACTION_PROPERTY('depth of start','',#2900);
```



```
#2918=ACTION_PROPERTY_REPRESENTATION('','',#2917,#2919);
#2919=REPRESENTATION('',(#2920),#505);
#2920=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#2921=ACTION_PROPERTY('reduced feedrate at start','',#2900);
#2922=ACTION_PROPERTY_REPRESENTATION('relative speed','',#2921,#2923);
#2923=MACHINING_FEED_SPEED_REPRESENTATION('relative speed',(#2924),#505);
#2924=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);

/************************************************
 * Application object: REAMING (#3000)
 * ITS_MACHINE_FUNCTIONS: #3000, #3001, #900
 * RETRACT_PLANE: #3000, #3002, #3003, #3004, #3005
 * ITS_TOOL: #3000, #2600
 * FEED_ON_RETRACT: #3000, #3006, #3007, #3008, #3009
 * PREVIOUS_DIAMETER: #3000, #3010, #3011, #3012, #3013
 * ITS_MACHINING_STRATEGY: #3000, #3014, #2900
 * ITS_ID: #3000 ['REAM HOLE1']
 * ITS_TECHNOLOGY: #3000, #3015, #2800
 * OVERCUT_LENGTH: #3000, #3016, #3017, #3018, #3019
 * CUTTING_DEPTH: #3000, #3020, #3021, #3022, #3023
 * DEPTH_OF_TESTCUT: #3000, #3024, #3025, #3026, #3027
 */
#3000=BORING_OPERATION('REAM HOLE1','reaming','','');
#3001=MACHINING_FUNCTIONS_RELATIONSHIP('','reaming',#3000,#900);
#3002=ACTION_PROPERTY('retract plane','reaming',#3000);
#3003=ACTION_PROPERTY_REPRESENTATION('','reaming',#3002,#3004);
#3004=REPRESENTATION('',(#3005),#505);
#3005=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(10.),#1601)
REPRESENTATION_ITEM('')
);
#3006=ACTION_PROPERTY('feedrate on retract','reaming',#3000);
#3007=ACTION_PROPERTY_REPRESENTATION('relative speed','reaming',#3006,#3008);
#3008=MACHINING_FEED_SPEED_REPRESENTATION('relative speed',(#3009),#505);
#3009=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(RATIO_MEASURE(1.),#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('relative speed')
);
#3010=ACTION_PROPERTY('previous diameter','reaming',#3000);
#3011=ACTION_PROPERTY_REPRESENTATION('','reaming',#3010,#3012);
```

```
#3012=REPRESENTATION('',(#3013),#505);
#3013=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(20.),#1601)
REPRESENTATION_ITEM('')
);
#3014=MACHINING_STRATEGY_RELATIONSHIP('machining','reaming',#3000,#2900);
#3015=MACHINING_TECHNOLOGY_RELATIONSHIP('','reaming',#3000,#2800);
#3016=ACTION_PROPERTY('overcut length','reaming',#3000);
#3017=ACTION_PROPERTY_REPRESENTATION('','reaming',#3016,#3018);
#3018=REPRESENTATION('',(#3019),#505);
#3019=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#3020=ACTION_PROPERTY('cutting depth','reaming',#3000);
#3021=ACTION_PROPERTY_REPRESENTATION('','reaming',#3020,#3022);
#3022=REPRESENTATION('',(#3023),#505);
#3023=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(30.),#1601)
REPRESENTATION_ITEM('')
);
#3024=ACTION_PROPERTY('testcut depth','reaming',#3000);
#3025=ACTION_PROPERTY_REPRESENTATION('','reaming',#3024,#3026);
#3026=REPRESENTATION('',(#3027),#505);
#3027=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(5.),#1601)
REPRESENTATION_ITEM('')
);

/************************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#3100)
 * VALUE_COMPONENT: #3100 [22]
 ***********************************************
 * Application object: QUALIFIED_PLUS_MINUS_VALUE (#3100)
 */
#3100=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(22.),#1601)
QUALIFIED_REPRESENTATION_ITEM($)
REPRESENTATION_ITEM('diameter')
);

/************************************************
 * Application object: THROUGH_BOTTOM_CONDITION (#3200)
 */
```



```
#3200=HOLE_BOTTOM('','through',#1509,.F.);

/************************************************
 * Application object: ROUND_HOLE (#3300)
 * ITS_WORKPIECE: #3300, #401, #400
 * ITS_ID: #3300 ['HOLE1 D=22MM']
 * COURSE_OF_TRAVEL: #3300, #3301, #3302, #3303, #3500
 * FEATURE_PLACEMENT: #3300, #3301, #3304, #3305, #3306
 * DEPTH: #3300, #3301, #3307, #3308, #3309
 * DIAMETER: #3300, #3301, #3310, #3311, #3400
 * BOTTOM_CONDITION: #3300, #3301, #3312, #3313, #3200
 */
#3300=(
CHARACTERIZED_OBJECT('','')
FEATURE_DEFINITION()
INSTANCED_FEATURE()
ROUND_HOLE()
SHAPE_ASPECT('HOLE1 D=22MM','',#401,.T.)
);
#3301=PRODUCT_DEFINITION_SHAPE('','',#3300);
#3302=SHAPE_ASPECT('','hole depth occurrence',#3301,.F.);
#3303=SHAPE_DEFINING_RELATIONSHIP('hole depth',
'path feature component usage',#3500,#3302);
#3304=SHAPE_DEFINITION_REPRESENTATION(#3301,#3305);
#3305=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#3306),#427);
#3306=AXIS2_PLACEMENT_3D('orientation',#3314,#3507,$);
#3307=SHAPE_DEFINITION_REPRESENTATION(#3301,#3308);
#3308=SHAPE_REPRESENTATION('maximum feature limit',(#3309),#427);
#3309=PLANE('DEPTH SURFACE FOR ROUND HOLE1',#3315);
#3310=SHAPE_ASPECT('','diameter occurrence',#3301,.F.);
#3311=SHAPE_DEFINING_RELATIONSHIP('diameter','profile usage',#3400,#3310);
#3312=SHAPE_ASPECT('','bottom condition occurrence',#3301,.F.);
#3313=FEATURE_COMPONENT_RELATIONSHIP('','hole bottom usage',#3200,#3312);
#3314=CARTESIAN_POINT('HOLE1: LOCATION ',(20.,60.,0.));
#3315=AXIS2_PLACEMENT_3D('HOLE1',#3316,#3317,#3318);
#3316=CARTESIAN_POINT('HOLE1: DEPTH ',(0.,0.,-30.));
#3317=DIRECTION(' AXIS ',(0.,0.,1.));
#3318=DIRECTION(' REF_DIRECTION',(1.,0.,0.));

/************************************************
 * Application object: CIRCULAR_CLOSED_PROFILE (#3400)
 * PLACEMENT: #3400, #3401, #3402, #3403, #3306
 * DIAMETER: #3400, #3401, #3402, #3403, #3100
 */
#3400=CIRCULAR_CLOSED_PROFILE('','',#1509,.F.);
#3401=PROPERTY_DEFINITION('','',#3400);
#3402=SHAPE_DEFINITION_REPRESENTATION(#3401,#3403);
#3403=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#3100,#3306),#427);

/************************************************
 * Application object: LINEAR_PATH (#3500)
 * PLACEMENT: #3500, #3501, #3502, #3503, #3306
 * ITS_DIRECTION: #3500, #3504, #3505, #3506, #3507
 * DISTANCE: #3500, #3501, #3502, #3503, #3508
```



```
 */
#3500=PATH_FEATURE_COMPONENT('','linear',#1509,.F.);
#3501=PROPERTY_DEFINITION('','linear',#3500);
#3502=SHAPE_DEFINITION_REPRESENTATION(#3501,#3503);
#3503=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#3508,#3306),#427);
#3504=PROPERTY_DEFINITION('','linear',#3500);
#3505=PROPERTY_DEFINITION_REPRESENTATION(#3504,#3506);
#3506=DIRECTION_SHAPE_REPRESENTATION('',(#3507),#505);
#3507=DIRECTION(' AXIS ',(0.,0.,1.));
#3508=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(30.),#1601)
REPRESENTATION_ITEM('distance')
);

/************************************************
 * Application object: MACHINING_WORKINGSTEP (#3600)
 * ITS_OPERATION: #3600, #3601, #2500
 * ITS_FEATURE: #3600, #3602, #3603, #3604, #3605, #3300
 * ITS_SECPLANE: #3600, #3606, #3607, #3608, #1909
 * ITS_ID: #3600 ['WS DRILL HOLE1']
 */
#3600=MACHINING_WORKINGSTEP('WS DRILL HOLE1','machining','','');
#3601=MACHINING_OPERATION_RELATIONSHIP('','machining',#3600,#2500);
#3602=MACHINING_FEATURE_RELATIONSHIP('','machining',#3600,#3603);
#3603=MACHINING_FEATURE_PROCESS('','machining','','');
#3604=PROPERTY_PROCESS('machining','machining',#3603,'');
#3605=PROCESS_PROPERTY_ASSOCIATION('','machining',#3604,#3300);
#3606=ACTION_PROPERTY('security plane','machining',#3600);
#3607=ACTION_PROPERTY_REPRESENTATION('','machining',#3606,#3608);
#3608=REPRESENTATION('',(#1909),#505);

/************************************************
 * Application object: MACHINING_WORKINGSTEP (#3700)
 * ITS_OPERATION: #3700, #3701, #3000
 * ITS_FEATURE: #3700, #3702, #3703, #3704, #3705, #3300
 * ITS_SECPLANE: #3700, #3706, #3707, #3708, #1909
 * ITS_ID: #3700 ['WS REAM HOLE1']
 */
#3700=MACHINING_WORKINGSTEP('WS REAM HOLE1','machining','','');
#3701=MACHINING_OPERATION_RELATIONSHIP('','machining',#3700,#3000);
#3702=MACHINING_FEATURE_RELATIONSHIP('','machining',#3700,#3703);
#3703=MACHINING_FEATURE_PROCESS('','machining','','');
#3704=PROPERTY_PROCESS('machining','machining',#3703,'');
#3705=PROCESS_PROPERTY_ASSOCIATION('','machining',#3704,#3300);
#3706=ACTION_PROPERTY('security plane','machining',#3700);
#3707=ACTION_PROPERTY_REPRESENTATION('','machining',#3706,#3708);
#3708=REPRESENTATION('',(#1909),#505);

/************************************************
 * Application object: MILLING_TECHNOLOGY (#3800)
 * SYNCHRONIZE_SPINDLE_WITH_FEED: #3800, #3801, #3802, #3803, #3804 ['not
synchronized']
```

```
 * FEEDRATE_PER_TOOTH: #3800, #3805, #3806, #3807, #3808
 * SPINDLE: #3800, #3809, #3810, #3811, #3812
 * CUTSPEED: #3800, #3813, #3814, #3815, #3816
 * INHIBIT_FEEDRATE_OVERRIDE: #3800, #3817, #3818, #3819, #3820 ['override not
allowed']
 * FEEDRATE: #3800, #3821, #3822, #3823, #3824
 * FEEDRATE_REFERENCE: #3800, #3825, #3826, #3827, #3828 ['tool center point']
 * INHIBIT_SPINDLE_OVERRIDE: #3800, #3829, #3830, #3831, #3832 ['override not
allowed']
 */
#3800=MACHINING_TECHNOLOGY('','milling','','');
#3801=ACTION_PROPERTY('synchronize spindle with feed','milling',#3800);
#3802=ACTION_PROPERTY_REPRESENTATION('','milling',#3801,#3803);
#3803=REPRESENTATION('',(#3804),#505);
#3804=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#3805=ACTION_PROPERTY('feedrate','milling',#3800);
#3806=ACTION_PROPERTY_REPRESENTATION('feed per tooth','milling',#3805,#3807);
#3807=MACHINING_FEED_SPEED_REPRESENTATION('feed per tooth',(#3808),#505);
#3808=MEASURE_REPRESENTATION_ITEM('feed per tooth',$,#833);
#3809=ACTION_PROPERTY('spindle','milling',#3800);
#3810=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#3809,
#3811);
#3811=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#3812),#505);
#3812=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(20.),
#837);
#3813=ACTION_PROPERTY('spindle','milling',#3800);
#3814=ACTION_PROPERTY_REPRESENTATION('surface speed','milling',#3813,#3815);
#3815=MACHINING_SPINDLE_SPEED_REPRESENTATION('cutting speed',(#3816),#505);
#3816=MEASURE_REPRESENTATION_ITEM('surface speed',$,#837);
#3817=ACTION_PROPERTY('inhibit feedrate override','milling',#3800);
#3818=ACTION_PROPERTY_REPRESENTATION('','milling',#3817,#3819);
#3819=REPRESENTATION('',(#3820),#505);
#3820=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#3821=ACTION_PROPERTY('feedrate','milling',#3800);
#3822=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#3821,#3823);
#3823=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#3824),#505);
#3824=MEASURE_REPRESENTATION_ITEM('feed speed',$,#833);
#3825=ACTION_PROPERTY('feedrate reference','milling',#3800);
#3826=ACTION_PROPERTY_REPRESENTATION('','milling',#3825,#3827);
#3827=REPRESENTATION('',(#3828),#505);
#3828=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#3829=ACTION_PROPERTY('inhibit spindle override','milling',#3800);
#3830=ACTION_PROPERTY_REPRESENTATION('','milling',#3829,#3831);
#3831=REPRESENTATION('',(#3832),#505);
#3832=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');

/*************************************************
 * Application object: CONTOUR_BIDIRECTIONAL (#3900)
 * OVERLAP: #3900, #3901, #3902, #3903, #3904
 */
#3900=MILLING_TYPE_STRATEGY('','contour bidirectional','','');
#3901=ACTION_PROPERTY('overlap ratio','contour bidirectional',#3900);
#3902=ACTION_PROPERTY_REPRESENTATION('','contour bidirectional',#3901,#3903);
#3903=REPRESENTATION('',(#3904),#505);
```



```
#3904=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);

/**********************************************
 * Application object: BOTTOM_AND_SIDE_ROUGH_MILLING (#4000)
 * OVERCUT_LENGTH: #4000, #4001, #4002, #4003, #4004
 * RADIAL_CUTTING_DEPTH: #4000, #4005, #4006, #4007, #4008
 * ITS_ID: #4000 ['ROUGH POCKET1']
 * ALLOWANCE_SIDE: #4000, #4009, #4010, #4011, #4012
 * AXIAL_CUTTING_DEPTH: #4000, #4013, #4014, #4015, #4016
 * RETRACT_PLANE: #4000, #4017, #4018, #4019, #4020
 * ITS_TOOL: #4000, #600
 * ITS_MACHINING_STRATEGY: #4000, #4021, #3900
 * ITS_TECHNOLOGY: #4000, #4022, #3800
 * ITS_MACHINE_FUNCTIONS: #4000, #4023, #900
 * ALLOWANCE_BOTTOM: #4000, #4024, #4025, #4026, #4027
 */
#4000=BOTTOM_AND_SIDE_MILLING_OPERATION('ROUGH POCKET1','roughing','','');
#4001=ACTION_PROPERTY('overcut length','roughing',#4000);
#4002=ACTION_PROPERTY_REPRESENTATION('','roughing',#4001,#4003);
#4003=REPRESENTATION('',(#4004),#505);
#4004=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#4005=ACTION_PROPERTY('radial cutting depth','roughing',#4000);
#4006=ACTION_PROPERTY_REPRESENTATION('','roughing',#4005,#4007);
#4007=REPRESENTATION('',(#4008),#505);
#4008=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(5.),#1601)
REPRESENTATION_ITEM('')
);
#4009=ACTION_PROPERTY('allowance side','roughing',#4000);
#4010=ACTION_PROPERTY_REPRESENTATION('','roughing',#4009,#4011);
#4011=REPRESENTATION('',(#4012),#505);
#4012=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(1.),#1601)
REPRESENTATION_ITEM('')
);
#4013=ACTION_PROPERTY('axial cutting depth','roughing',#4000);
#4014=ACTION_PROPERTY_REPRESENTATION('','roughing',#4013,#4015);
#4015=REPRESENTATION('',(#4016),#505);
#4016=(
LENGTH_MEASURE_WITH_UNIT()
```



```
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(2.5),#1601)
REPRESENTATION_ITEM('')
);
#4017=ACTION_PROPERTY('retract plane','roughing',#4000);
#4018=ACTION_PROPERTY_REPRESENTATION('','roughing',#4017,#4019);
#4019=REPRESENTATION('',(#4020),#505);
#4020=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(15.),#1601)
REPRESENTATION_ITEM('')
);
#4021=MACHINING_STRATEGY_RELATIONSHIP('machining','roughing',#4000,#3900);
#4022=MACHINING_TECHNOLOGY_RELATIONSHIP('','roughing',#4000,#3800);
#4023=MACHINING_FUNCTIONS_RELATIONSHIP('','roughing',#4000,#900);
#4024=ACTION_PROPERTY('allowance bottom','roughing',#4000);
#4025=ACTION_PROPERTY_REPRESENTATION('','roughing',#4024,#4026);
#4026=REPRESENTATION('',(#4027),#505);
#4027=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.5),#1601)
REPRESENTATION_ITEM('')
);

/**************************************************
 * Application object: MILLING_TECHNOLOGY (#4100)
 * SYNCHRONIZE_SPINDLE_WITH_FEED: #4100, #4101, #4102, #4103, #4104 ['not
synchronized']
 * FEEDRATE_PER_TOOTH: #4100, #4105, #4106, #4107, #4108
 * SPINDLE: #4100, #4109, #4110, #4111, #4112
 * CUTSPEED: #4100, #4113, #4114, #4115, #4116
 * INHIBIT_FEEDRATE_OVERRIDE: #4100, #4117, #4118, #4119, #4120 ['override not
allowed']
 * FEEDRATE: #4100, #4121, #4122, #4123, #4124
 * FEEDRATE_REFERENCE: #4100, #4125, #4126, #4127, #4128 ['tool center point']
 * INHIBIT_SPINDLE_OVERRIDE: #4100, #4129, #4130, #4131, #4132 ['override not
allowed']
 */
#4100=MACHINING_TECHNOLOGY('','milling','','');
#4101=ACTION_PROPERTY('synchronize spindle with feed','milling',#4100);
#4102=ACTION_PROPERTY_REPRESENTATION('','milling',#4101,#4103);
#4103=REPRESENTATION('',(#4104),#505);
#4104=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#4105=ACTION_PROPERTY('feedrate','milling',#4100);
#4106=ACTION_PROPERTY_REPRESENTATION('feed per tooth','milling',#4105,#4107);
#4107=MACHINING_FEED_SPEED_REPRESENTATION('feed per tooth',(#4108),#505);
#4108=MEASURE_REPRESENTATION_ITEM('feed per tooth',$,#833);
#4109=ACTION_PROPERTY('spindle','milling',#4100);
#4110=ACTION_PROPERTY_REPRESENTATION('rotational speed','milling',#4109,
#4111);
#4111=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#4112),#505);
#4112=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(20.),
```



```
#837);
#4113=ACTION_PROPERTY('spindle','milling',#4100);
#4114=ACTION_PROPERTY_REPRESENTATION('surface speed','milling',#4113,#4115);
#4115=MACHINING_SPINDLE_SPEED_REPRESENTATION('cutting speed',(#4116),#505);
#4116=MEASURE_REPRESENTATION_ITEM('surface speed',$,#837);
#4117=ACTION_PROPERTY('inhibit feedrate override','milling',#4100);
#4118=ACTION_PROPERTY_REPRESENTATION('','milling',#4117,#4119);
#4119=REPRESENTATION('',(#4120),#505);
#4120=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#4121=ACTION_PROPERTY('feedrate','milling',#4100);
#4122=ACTION_PROPERTY_REPRESENTATION('feed speed','milling',#4121,#4123);
#4123=MACHINING_FEED_SPEED_REPRESENTATION('feed speed',(#4124),#505);
#4124=MEASURE_REPRESENTATION_ITEM('feed speed',$,#833);
#4125=ACTION_PROPERTY('feedrate reference','milling',#4100);
#4126=ACTION_PROPERTY_REPRESENTATION('','milling',#4125,#4127);
#4127=REPRESENTATION('',(#4128),#505);
#4128=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#4129=ACTION_PROPERTY('inhibit spindle override','milling',#4100);
#4130=ACTION_PROPERTY_REPRESENTATION('','milling',#4129,#4131);
#4131=REPRESENTATION('',(#4132),#505);
#4132=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');

/************************************************
 * Application object: CONTOUR_PARALLEL (#4200)
 * CUTMODE: #4200, #4201, #4202, #4203, #4204 ['conventional']
 * ROTATION_DIRECTION: #4200, #4205, #4206, #4207, #4208 ['clockwise']
 * ALLOW_MULTIPLE_PASSES: #4200, #4209, #4210, #4211, #4212 ['multiple passes
allowed']
 * OVERLAP: #4200, #4213, #4214, #4215, #4216
 */
#4200=MILLING_TYPE_STRATEGY('','contour parallel','','');
#4201=ACTION_PROPERTY('cutmode','contour parallel',#4200);
#4202=ACTION_PROPERTY_REPRESENTATION('','contour parallel',#4201,#4203);
#4203=REPRESENTATION('',(#4204),#505);
#4204=DESCRIPTIVE_REPRESENTATION_ITEM('','conventional');
#4205=ACTION_PROPERTY('rotation direction','contour parallel',#4200);
#4206=ACTION_PROPERTY_REPRESENTATION('','contour parallel',#4205,#4207);
#4207=REPRESENTATION('',(#4208),#505);
#4208=DESCRIPTIVE_REPRESENTATION_ITEM('','clockwise');
#4209=ACTION_PROPERTY('multiple passes','contour parallel',#4200);
#4210=ACTION_PROPERTY_REPRESENTATION('','contour parallel',#4209,#4211);
#4211=REPRESENTATION('',(#4212),#505);
#4212=DESCRIPTIVE_REPRESENTATION_ITEM('','multiple passes allowed');
#4213=ACTION_PROPERTY('overlap ratio','contour parallel',#4200);
#4214=ACTION_PROPERTY_REPRESENTATION('','contour parallel',#4213,#4215);
#4215=REPRESENTATION('',(#4216),#505);
#4216=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(RATIO_MEASURE(5.),#1217)
RATIO_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);

/************************************************
```

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 * Application object: BOTTOM_AND_SIDE_FINISH_MILLING (#4300)
 * AXIAL_CUTTING_DEPTH: #4300, #4301, #4302, #4303, #4304
 * ALLOWANCE_SIDE: #4300, #4305, #4306, #4307, #4308
 * RETRACT_PLANE: #4300, #4309, #4310, #4311, #4312
 * ALLOWANCE_BOTTOM: #4300, #4313, #4314, #4315, #4316
 * ITS_MACHINING_STRATEGY: #4300, #4317, #4200
 * ITS_ID: #4300 ['FINISHPOCKET1']
 * RADIAL_CUTTING_DEPTH: #4300, #4318, #4319, #4320, #4321
 * OVERCUT_LENGTH: #4300, #4322, #4323, #4324, #4325
 * ITS_MACHINE_FUNCTIONS: #4300, #4326, #900
 * ITS_TOOL: #4300, #600
 * ITS_TECHNOLOGY: #4300, #4327, #4100
 */
#4300=BOTTOM_AND_SIDE_MILLING_OPERATION('FINISHPOCKET1','finishing','',
'');
#4301=ACTION_PROPERTY('axial cutting depth','finishing',#4300);
#4302=ACTION_PROPERTY_REPRESENTATION('','finishing',#4301,#4303);
#4303=REPRESENTATION('',(#4304),#505);
#4304=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(2.),#1601)
REPRESENTATION_ITEM('')
);
#4305=ACTION_PROPERTY('allowance side','finishing',#4300);
#4306=ACTION_PROPERTY_REPRESENTATION('','finishing',#4305,#4307);
#4307=REPRESENTATION('',(#4308),#505);
#4308=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#4309=ACTION_PROPERTY('retract plane','finishing',#4300);
#4310=ACTION_PROPERTY_REPRESENTATION('','finishing',#4309,#4311);
#4311=REPRESENTATION('',(#4312),#505);
#4312=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(15.),#1601)
REPRESENTATION_ITEM('')
);
#4313=ACTION_PROPERTY('allowance bottom','finishing',#4300);
#4314=ACTION_PROPERTY_REPRESENTATION('','finishing',#4313,#4315);
#4315=REPRESENTATION('',(#4316),#505);
#4316=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#4317=MACHINING_STRATEGY_RELATIONSHIP('machining','finishing',#4300,#4200);
#4318=ACTION_PROPERTY('radial cutting depth','finishing',#4300);
#4319=ACTION_PROPERTY_REPRESENTATION('','finishing',#4318,#4320);
```

```
#4320=REPRESENTATION('',(#4321),#505);
#4321=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(10.),#1601)
REPRESENTATION_ITEM('')
);
#4322=ACTION_PROPERTY('overcut length','finishing',#4300);
#4323=ACTION_PROPERTY_REPRESENTATION('','finishing',#4322,#4324);
#4324=REPRESENTATION('',(#4325),#505);
#4325=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT($,#1601)
REPRESENTATION_ITEM('')
);
#4326=MACHINING_FUNCTIONS_RELATIONSHIP('','finishing',#4300,#900);
#4327=MACHINING_TECHNOLOGY_RELATIONSHIP('','finishing',#4300,#4100);

/*************************************************
 * Application object: PLANAR_POCKET_BOTTOM_CONDITION (#4400)
 */
#4400=POCKET_BOTTOM('','planar',#1509,.F.);

/*************************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#4500)
 * VALUE_COMPONENT: #4500 [1]
 * UPPER_LIMIT: #4500, #4501 [0.1]
 * LOWER_LIMIT: #4500, #4502 [0.1]
 */
#4500=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(1.),#1601)
QUALIFIED_REPRESENTATION_ITEM((#4502,#4501))
REPRESENTATION_ITEM('fillet radius')
);
#4501=STANDARD_UNCERTAINTY('upper limit','',0.1);
#4502=STANDARD_UNCERTAINTY('lower limit','',0.1);

/*************************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#4600)
 * VALUE_COMPONENT: #4600 [10]
 ***********************************************
 * Application object: QUALIFIED_PLUS_MINUS_VALUE (#4600)
 * UPPER_LIMIT: #4600, #4601 [0.1]
 * LOWER_LIMIT: #4600, #4602 [0.1]
 */
#4600=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(10.),#1601)
QUALIFIED_REPRESENTATION_ITEM((#4602,#4601))
REPRESENTATION_ITEM('orthogonal fillet radius')
```



```
);
#4601=STANDARD_UNCERTAINTY('upper limit','',0.1);
#4602=STANDARD_UNCERTAINTY('lower limit','',0.1);

/***********************************************
 * Application object: GENERAL_CLOSED_PROFILE (#4700)
 * CLOSED_PROFILE_SHAPE: #4700, #4701, #4702, #4703, #4704
 */
#4700=CLOSED_PATH_PROFILE('','',#1509,.F.);
#4701=PROPERTY_DEFINITION('','',#4700);
#4702=PROPERTY_DEFINITION_REPRESENTATION(#4701,#4703);
#4703=PATH_SHAPE_REPRESENTATION('',(#4704),#427);
#4704=POLYLINE('CONTOUR OF POCKET1',(#4705,#4706,#4707,#4708,#4705));
#4705=CARTESIAN_POINT('P1',(0.,0.,0.));
#4706=CARTESIAN_POINT('P2',(0.,80.,0.));
#4707=CARTESIAN_POINT('P3',(-50.,80.,0.));
#4708=CARTESIAN_POINT('P4',(-50.,0.,0.));

/***********************************************
 * Application object: CLOSED_POCKET (#4800)
 * ITS_WORKPIECE: #4800, #401, #400
 * BOTTOM_CONDITION: #4800, #4801, #4802, #4803, #4400
 * ORTHOGONAL_RADIUS: #4800, #4801, #4804, #4805, #4600
 * ITS_ID: #4800 ['POCKET1']
 * FEATURE_BOUNDARY: #4800, #4801, #4806, #4807, #4700
 * FEATURE_PLACEMENT: #4800, #4801, #4804, #4805, #4808
 * DEPTH: #4800, #4801, #4809, #4810, #4811
 * COURSE_OF_TRAVEL: #4800, #4801, #4812, #4813, #4900
 * BASE_RADIUS: #4800, #4801, #4804, #4805, #4500
 */
#4800=(
CHARACTERIZED_OBJECT('','')
FEATURE_DEFINITION()
INSTANCED_FEATURE()
POCKET()
SHAPE_ASPECT('POCKET1','',#401,.T.)
);
#4801=PRODUCT_DEFINITION_SHAPE('','',#4800);
#4802=SHAPE_ASPECT('','bottom condition occurrence',#4801,.F.);
#4803=FEATURE_COMPONENT_RELATIONSHIP('pocket depth end',
'pocket bottom usage',#4400,#4802);
#4804=SHAPE_DEFINITION_REPRESENTATION(#4801,#4805);
#4805=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#4808,#4500,#4600),#427);
#4806=SHAPE_ASPECT('','boundary occurrence',#4801,.F.);
#4807=SHAPE_DEFINING_RELATIONSHIP('','profile usage',#4700,#4806);
#4808=AXIS2_PLACEMENT_3D('orientation',#4814,#4907,#4815);
#4809=SHAPE_DEFINITION_REPRESENTATION(#4801,#4810);
#4810=SHAPE_REPRESENTATION('maximum feature limit',(#4811),#427);
#4811=PLANE('DEPTH SURFACE FOR POCKET1',#4816);
#4812=SHAPE_ASPECT('','pocket depth occurrence',#4801,.F.);
#4813=SHAPE_DEFINING_RELATIONSHIP('pocket depth',
'path feature component usage',#4900,#4812);
#4814=CARTESIAN_POINT('POCKET1: LOCATION ',(45.,110.,0.));
#4815=DIRECTION(' REF_DIRECTION',(-1.,0.,0.));
```

```
#4816=AXIS2_PLACEMENT_3D('POCKET1',#4817,#4818,#4819);
#4817=CARTESIAN_POINT('POCKET1: DEPTH ',(0.,0.,-30.));
#4818=DIRECTION(' AXIS ',(0.,0.,1.));
#4819=DIRECTION(' REF_DIRECTION',(1.,0.,0.));

/**********************************************
 * Application object: LINEAR_PATH (#4900)
 * PLACEMENT: #4900, #4901, #4902, #4903, #4808
 * ITS_DIRECTION: #4900, #4904, #4905, #4906, #4907
 * DISTANCE: #4900, #4901, #4902, #4903, #4908
 */
#4900=PATH_FEATURE_COMPONENT('','linear',#1509,.F.);
#4901=PROPERTY_DEFINITION('','linear',#4900);
#4902=SHAPE_DEFINITION_REPRESENTATION(#4901,#4903);
#4903=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#4908,#4808),#427);
#4904=PROPERTY_DEFINITION('','linear',#4900);
#4905=PROPERTY_DEFINITION_REPRESENTATION(#4904,#4906);
#4906=DIRECTION_SHAPE_REPRESENTATION('',(#4907),#505);
#4907=DIRECTION(' AXIS ',(0.,0.,-1.));
#4908=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(30.),#1601)
REPRESENTATION_ITEM('distance')
);

/**********************************************
 * Application object: MACHINING_WORKINGSTEP (#5000)
 * ITS_OPERATION: #5000, #5001, #4000
 * ITS_FEATURE: #5000, #5002, #5003, #5004, #5005, #4800
 * ITS_SECPLANE: #5000, #5006, #5007, #5008, #1909
 * ITS_ID: #5000 ['WS ROUGH POCKET1']
 */
#5000=MACHINING_WORKINGSTEP('WS ROUGH POCKET1','machining','','');
#5001=MACHINING_OPERATION_RELATIONSHIP('','machining',#5000,#4000);
#5002=MACHINING_FEATURE_RELATIONSHIP('','machining',#5000,#5003);
#5003=MACHINING_FEATURE_PROCESS('','machining','','');
#5004=PROPERTY_PROCESS('machining','machining',#5003,'');
#5005=PROCESS_PROPERTY_ASSOCIATION('','machining',#5004,#4800);
#5006=ACTION_PROPERTY('security plane','machining',#5000);
#5007=ACTION_PROPERTY_REPRESENTATION('','machining',#5006,#5008);
#5008=REPRESENTATION('',(#1909),#505);

/**********************************************
 * Application object: MACHINING_WORKINGSTEP (#5100)
 * ITS_OPERATION: #5100, #5101, #4300
 * ITS_FEATURE: #5100, #5102, #5103, #5104, #5105, #4800
 * ITS_SECPLANE: #5100, #5106, #5107, #5108, #1909
 * ITS_ID: #5100 ['WS FINISH POCKET1']
 */
#5100=MACHINING_WORKINGSTEP('WS FINISH POCKET1','machining','','');
#5101=MACHINING_OPERATION_RELATIONSHIP('','machining',#5100,#4300);
#5102=MACHINING_FEATURE_RELATIONSHIP('','machining',#5100,#5103);
#5103=MACHINING_FEATURE_PROCESS('','machining','','');
```



```
#5104=PROPERTY_PROCESS('machining','machining',#5103,'');
#5105=PROCESS_PROPERTY_ASSOCIATION('','machining',#5104,#4800);
#5106=ACTION_PROPERTY('security plane','machining',#5100);
#5107=ACTION_PROPERTY_REPRESENTATION('','machining',#5106,#5108);
#5108=REPRESENTATION('',(#1909),#505);

/*************************************************
 * Application object: REAL_VARIABLE (#5200)
 * ITS_NAME: #5200 ['']
 */
#5200=(
EXPRESSION()
EXPRESSION_REPRESENTATION_ITEM()
GENERIC_EXPRESSION()
GENERIC_VARIABLE()
NUMERIC_EXPRESSION()
NUMERIC_VARIABLE()
REAL_NUMERIC_VARIABLE()
REPRESENTATION_ITEM('')
SIMPLE_GENERIC_EXPRESSION()
SIMPLE_NUMERIC_EXPRESSION()
VARIABLE()
);

/*************************************************
 * Application object: REAL_VARIABLE (#5300)
 * ITS_NAME: #5300 ['']
 */
#5300=(
EXPRESSION()
EXPRESSION_REPRESENTATION_ITEM()
GENERIC_EXPRESSION()
GENERIC_VARIABLE()
NUMERIC_EXPRESSION()
NUMERIC_VARIABLE()
REAL_NUMERIC_VARIABLE()
REPRESENTATION_ITEM('')
SIMPLE_GENERIC_EXPRESSION()
SIMPLE_NUMERIC_EXPRESSION()
VARIABLE()
);

/*************************************************
 * Application object: OFFSET_VECTOR (#5400)
 * TRANSLATE [*]: #5400, #5401, #5200
 * TRANSLATE [*]: #5400, #5402, #5200
 * TRANSLATE [*]: #5400, #5403, #5200
 * ROTATE [*]: #5400, #5404, #5300
 * ROTATE [*]: #5400, #5405, #5300
 * ROTATE [*]: #5400, #5406, #5300
 */
#5400=MACHINING_OFFSET_VECTOR_REPRESENTATION('',(#5401,#5402,#5403,#5404,
#5405,#5406),#427);
#5401=COMPOUND_REPRESENTATION_ITEM('translate',LIST_REPRESENTATION_ITEM((#5200)
```

```
));
#5402=COMPOUND_REPRESENTATION_ITEM('translate',LIST_REPRESENTATION_ITEM((#5200)
));
#5403=COMPOUND_REPRESENTATION_ITEM('translate',LIST_REPRESENTATION_ITEM((#5200)
));
#5404=COMPOUND_REPRESENTATION_ITEM('rotate',LIST_REPRESENTATION_ITEM((#5300)));
#5405=COMPOUND_REPRESENTATION_ITEM('rotate',LIST_REPRESENTATION_ITEM((#5300)));
#5406=COMPOUND_REPRESENTATION_ITEM('rotate',LIST_REPRESENTATION_ITEM((#5300)));

/***********************************************
 * Application object: WORKPIECE_SETUP (#5500)
 * ITS_OFFSET: #5500, #5501, #5502, #5400
 * ITS_WORKPIECE: #5500, #400
 * ITS_ORIGIN: #5500, #5503, #5504, #5505, #5506, #5507
 */
#5500=MACHINING_SETUP_WORKPIECE_RELATIONSHIP('','','',#5600,#400);
#5501=PROPERTY_DEFINITION('computed offset','',#5500);
#5502=PROPERTY_DEFINITION_REPRESENTATION(#5501,#5400);
#5503=PRODUCT_DEFINITION_SHAPE('','',#5500);
#5504=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#5505,#5503);
#5505=(
REPRESENTATION_RELATIONSHIP('','',$,$)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#5506)
SHAPE_REPRESENTATION_RELATIONSHIP()
);
#5506=ITEM_DEFINED_TRANSFORMATION('','',$,#5507);
#5507=AXIS2_PLACEMENT_3D('WORKPIECE',#5508,#5509,#5510);
#5508=CARTESIAN_POINT('WORKPIECE1:LOCATION ',(0.,0.,0.));
#5509=DIRECTION(' AXIS ',(0.,0.,1.));
#5510=DIRECTION(' REF_DIRECTION',(1.,0.,0.));

/***********************************************
 * Application object: SETUP (#5600)
 * ITS_ID: #5600, #5601, #5602 ['SETUP1']
 * ITS_WORKPIECE_SETUP [*]: #5600, #5500
 * ITS_SECPLANE: #5600, #5603, #5604, #5605, #1909
 * ITS_ORIGIN: #5600, #5606, #5607, #5608, #5609
 */
#5600=PRODUCT_DEFINITION('','',#5601,#312);
#5601=PRODUCT_DEFINITION_FORMATION('','',#5602);
#5602=MACHINING_SETUP('SETUP1','',$,(#310));
#5603=PROPERTY_DEFINITION('security plane','',#5600);
#5604=PROPERTY_DEFINITION_REPRESENTATION(#5603,#5605);
#5605=REPRESENTATION('',(#1909),#505);
#5606=PRODUCT_DEFINITION_SHAPE('orientation','',#5600);
#5607=SHAPE_DEFINITION_REPRESENTATION(#5606,#5608);
#5608=REPRESENTATION('',(#5609),#505);
#5609=AXIS2_PLACEMENT_3D('orientation',#5610,#5611,#5612);
#5610=CARTESIAN_POINT('SETUP1: LOCATION ',(150.,90.,40.));
#5611=DIRECTION(' AXIS ',(0.,0.,1.));
#5612=DIRECTION(' REF_DIRECTION',(1.,0.,0.));

/***********************************************
 * Application object: WORKPLAN (#5700)
```



```
 * ITS_SETUP: #5700, #5701, #5702, #5600
 * ITS_ELEMENTS [1]: #5700, #5703, #1900
 * ITS_ELEMENTS [2]: #5700, #5704, #3600
 * ITS_ELEMENTS [3]: #5700, #5705, #3700
 * ITS_ELEMENTS [4]: #5700, #5706, #5000
 * ITS_ELEMENTS [5]: #5700, #5707, #5100
 * ITS_ID: #5700 ['MAIN WORKPLAN']
 */
#5700=MACHINING_WORKPLAN('MAIN WORKPLAN','','','');
#5701=PRODUCT_DEFINITION_PROCESS('setup','',#5700,'');
#5702=PROCESS_PRODUCT_ASSOCIATION('','',#5600,#5701);
#5703=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#5700,#1900,1.);
#5704=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#5700,#3600,2.);
#5705=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#5700,#3700,3.);
#5706=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#5700,#5000,4.);
#5707=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#5700,#5100,5.);

/*************************************************
 * Application object: PROJECT (#5800)
 * MAIN_WORKPLAN: #5800, #5801, #5802, #5700
 * ITS_ID: #5800, #5803, #5804 ['EXECUTE EXAMPLE1']
 * ITS_WORKPIECES [*]: #5800, #5805, #400
 */
#5800=PRODUCT_DEFINITION('','',#5803,#312);
#5801=PROCESS_PRODUCT_ASSOCIATION('','',#5800,#5802);
#5802=PRODUCT_DEFINITION_PROCESS('machining','',#5700,'');
#5803=PRODUCT_DEFINITION_FORMATION('','',#5804);
#5804=MACHINING_PROJECT('EXECUTE EXAMPLE1','',$,(#310));
#5805=MACHINING_PROJECT_WORKPIECE_RELATIONSHIP('','workpiece','',#5800,#400);
ENDSEC;
END-ISO-10303-21;
```

K.7 Data set for ISO 14649-12 example #1 (CC3)

The following example is defined by ISO 14649-12 Annex D and describes a machining project for a turned part containing the features shown in Figure K.3. The data set follows the original ordering of application object instances in the ISO 14649-12 example. This example is a conformance class three file and contains no toolpaths. The processing system must generate toolpaths from the supplied features in order to machine the part.

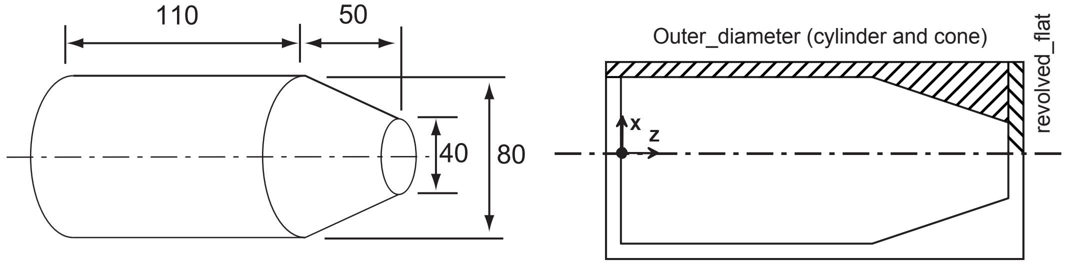

Figure K.3 — Workpiece from ISO 14649-12 example #1


```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION(
/* description */ ('AP238 AIM version of IS014649-12 example #1'),
/* implementation_level */ '2;1');

FILE_NAME(
/* name */ 'p12_example1_aim',
/* time_stamp */ '2006-06-15T16:49:14-04:00',
/* author */ ('Dave Loffredo (loffredo@steptools.com)'),
/* organization */ (''),
/* preprocessor_version */ 'ST-DEVELOPER v11',
/* originating_system */ '',
/* authorisation */ '');

FILE_SCHEMA (('INTEGRATED_CNC_SCHEMA'));
ENDSEC;

DATA;

/************************************************
 * Application object: WORKPIECE (#100)
 * ITS_MATERIAL [1]: #100, #102, #103, #200
 * ITS_ID: #100 ['SIMPLE WORKPIECE']
 * SHAPE_DEFINITION: #100, #101
 * GLOBAL_TOLERANCE: #100, #104, #105, #106, #107
 */
#100=PRODUCT_DEFINITION('SIMPLE WORKPIECE','',#108,#112);
#101=PRODUCT_DEFINITION_SHAPE('','',#100);
#102=MAKE_FROM_USAGE_OPTION('','','',#100,#103,1,'',$);
#103=PRODUCT_DEFINITION('','',$,$);
#104=PROPERTY_DEFINITION('global tolerance','',#100);
#105=PROPERTY_DEFINITION_REPRESENTATION(#104,#106);
#106=SHAPE_REPRESENTATION('',(#107),#113);
#107=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.01),#119)
REPRESENTATION_ITEM('')
);
#108=PRODUCT_DEFINITION_FORMATION('1.0','Workpiece',#109);
#109=PRODUCT('WP','AP-238 CC1',' ',(#110));
#110=PRODUCT_CONTEXT('CNC Machining',#111,'manufacturing');
#111=APPLICATION_CONTEXT(
'Application protocol for the exchange of CNC data');
#112=PRODUCT_DEFINITION_CONTEXT('CNC Machining',#111,'manufacturing');
#113=(
GEOMETRIC_REPRESENTATION_CONTEXT(3)
GLOBAL_UNIT_ASSIGNED_CONTEXT((#119,#114,#118))
REPRESENTATION_CONTEXT('MILLIMETRE DEGREE STERADIAN','')
);
#114=(
CONVERSION_BASED_UNIT('degree',#116)
NAMED_UNIT(#115)
```

```
PLANE_ANGLE_UNIT()
);
#115=DIMENSIONAL_EXPONENTS(0.,0.,0.,0.,0.,0.,0.);
#116=PLANE_ANGLE_MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(0.01745329252),#117);
#117=(
NAMED_UNIT(*)
PLANE_ANGLE_UNIT()
SI_UNIT($,.RADIAN.)
);
#118=(
NAMED_UNIT(*)
SI_UNIT($,.STERADIAN.)
SOLID_ANGLE_UNIT()
);
#119=(
LENGTH_UNIT()
NAMED_UNIT(*)
SI_UNIT(.MILLI.,.METRE.)
);
#120=(
NAMED_UNIT(*)
SI_UNIT($,.SECOND.)
TIME_UNIT()
);
#121=APPLICATION_PROTOCOL_DEFINITION('international standard',
'integrated_cnc_schema',2006,#111);

/***********************************************
 * Application object: MATERIAL (#200)
 * MATERIAL_PROPERTY [*]: #200, #201, #202, #203, #300
 * MATERIAL_IDENTIFIER: #200 ['E 295']
 * STANDARD_IDENTIFIER: #200, #204, #205 ['DIN EN 10027-1']
 */
#200=MATERIAL_DESIGNATION('E 295',(#103));
#201=MATERIAL_DESIGNATION_CHARACTERIZATION('','',#200,#202);
#202=MATERIAL_PROPERTY_REPRESENTATION($,#203,$);
#203=REPRESENTATION('',(#300),$);
#204=APPLIED_DOCUMENT_REFERENCE(#205,'',(#200));
#205=DOCUMENT('DIN EN 10027-1','','',$);

/***********************************************
 * Application object: NUMERIC_PARAMETER (#300)
 * ITS_PARAMETER_VALUE: #300 [2e+011]
 * ITS_PARAMETER_UNIT: #300, #301
 * PARAMETER_NAME: #300 ['ELASTIC MODULUS']
 */
#300=MEASURE_REPRESENTATION_ITEM('ELASTIC
MODULUS',NUMERIC_MEASURE(200000000000.),
#301);
#301=SI_UNIT(*,$,.PASCAL.);

/***********************************************
 * Application object: REVOLVED_FLAT (#400)
 * FLAT_EDGE_SHAPE: #400, #401, #402, #403, #3800
```



```
 * RADIUS: #400, #404, #405, #406, #407
 * MATERIAL_SIDE: #400, #408, #409, #410, #411
 * ITS_ID: #400 ['END FACE']
 * ITS_WORKPIECE: #400, #101, #100
 * FEATURE_PLACEMENT: #400, #404, #405, #406, #412
 */
#400=(
CHARACTERIZED_OBJECT('','flat')
FEATURE_DEFINITION()
INSTANCED_FEATURE()
REVOLVED_PROFILE()
SHAPE_ASPECT('END FACE','flat',#101,.F.)
);
#401=PRODUCT_DEFINITION_SHAPE('','flat edge shape',#400);
#402=SHAPE_ASPECT('','flat edge shape occurrence',#401,.F.);
#403=SHAPE_DEFINING_RELATIONSHIP('','profile usage',#3800,#402);
#404=PRODUCT_DEFINITION_SHAPE('','flat',#400);
#405=SHAPE_DEFINITION_REPRESENTATION(#404,#406);
#406=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#412,#407),#113);
#407=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.),#119)
REPRESENTATION_ITEM('radius')
);
#408=PRODUCT_DEFINITION_SHAPE('','flat',#400);
#409=PROPERTY_DEFINITION_REPRESENTATION(#408,#410);
#410=DIRECTION_SHAPE_REPRESENTATION('removal direction',(#411),#113);
#411=DIRECTION('END FACE: FRONT',(0.,0.,-1.));
#412=AXIS2_PLACEMENT_3D('orientation',#414,$,$);
#413=REPRESENTATION_CONTEXT('','units not necessary');
#414=CARTESIAN_POINT('END FACE: LOCATION',(0.,0.,160.));

/************************************************
 * Application object: OUTER_DIAMETER (#500)
 * ITS_ID: #500 ['CONE']
 * REDUCED_SIZE: #500, #501, #502, #503, #4100
 * FEATURE_LENGTH: #500, #504, #505, #506, #4000
 * FEATURE_PLACEMENT: #500, #504, #505, #506, #507
 * ITS_WORKPIECE: #500, #101, #100
 * DIAMETER_AT_PLACEMENT: #500, #504, #505, #506, #3700
 */
#500=(
CHARACTERIZED_OBJECT('','outer diameter')
FEATURE_DEFINITION()
INSTANCED_FEATURE()
OUTER_ROUND()
SHAPE_ASPECT('CONE','outer diameter',#101,.F.)
);
#501=PRODUCT_DEFINITION_SHAPE('','outer diameter',#500);
#502=SHAPE_ASPECT('','reduced size occurrence',#501,.F.);
#503=FEATURE_COMPONENT_RELATIONSHIP('reduced size','taper usage',#4100,#502);
#504=PRODUCT_DEFINITION_SHAPE('','outer diameter',#500);
#505=SHAPE_DEFINITION_REPRESENTATION(#504,#506);
```



```
#506=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#507,#3700,#4000),#113);
#507=AXIS2_PLACEMENT_3D('orientation',#508,$,$);
#508=CARTESIAN_POINT('CONE: LOCATION',(0.,0.,160.));

/***********************************************
 * Application object: OUTER_DIAMETER (#600)
 * ITS_ID: #600 ['CYLINDER']
 * FEATURE_LENGTH: #600, #601, #602, #603, #3600
 * FEATURE_PLACEMENT: #600, #601, #602, #603, #604
 * ITS_WORKPIECE: #600, #101, #100
 * DIAMETER_AT_PLACEMENT: #600, #601, #602, #603, #3500
 */
#600=(
CHARACTERIZED_OBJECT('','outer diameter')
FEATURE_DEFINITION()
INSTANCED_FEATURE()
OUTER_ROUND()
SHAPE_ASPECT('CYLINDER','outer diameter',#101,.F.)
);
#601=PRODUCT_DEFINITION_SHAPE('','outer diameter',#600);
#602=SHAPE_DEFINITION_REPRESENTATION(#601,#603);
#603=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#604,#3500,#3600),#113);
#604=AXIS2_PLACEMENT_3D('orientation',#605,$,$);
#605=CARTESIAN_POINT('CYLINDER: LOCATION',(0.,0.,110.));

/***********************************************
 * Application object: FACING_ROUGH (#700)
 * ITS_TECHNOLOGY: #700, #701, #2000
 * RETRACT: #700, #702, #3100
 * ALLOWANCE: #700, #703, #704, #705, #706
 * ITS_ID: #700 ['ROUGH END FACE']
 * APPROACH: #700, #707, #3000
 * ITS_TOOL: #700, #4300
 * ITS_MACHINING_STRATEGY: #700, #708, #2800
 * ITS_MACHINE_FUNCTIONS: #700, #709, #1900
 */
#700=FACING_TURNING_OPERATION('ROUGH END FACE','roughing','','');
#701=MACHINING_TECHNOLOGY_RELATIONSHIP('','roughing',#700,#2000);
#702=MACHINING_STRATEGY_RELATIONSHIP('retract','roughing',#700,#3100);
#703=ACTION_PROPERTY('allowance','roughing',#700);
#704=ACTION_PROPERTY_REPRESENTATION('','roughing',#703,#705);
#705=REPRESENTATION('',(#706),#413);
#706=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.5),#119)
REPRESENTATION_ITEM('')
);
#707=MACHINING_STRATEGY_RELATIONSHIP('approach','roughing',#700,#3000);
#708=MACHINING_STRATEGY_RELATIONSHIP('machining','roughing',#700,#2800);
#709=MACHINING_FUNCTIONS_RELATIONSHIP('','roughing',#700,#1900);

/***********************************************
 * Application object: FACING_FINISH (#800)
```



```
 * APPROACH: #800, #801, #3000
 * ALLOWANCE: #800, #802, #803, #804, #805
 * ITS_TOOL: #800, #4600
 * ITS_TECHNOLOGY: #800, #806, #2100
 * ITS_MACHINE_FUNCTIONS: #800, #807, #1900
 * ITS_MACHINING_STRATEGY: #800, #808, #2900
 * ITS_ID: #800 ['FINISH END FACE']
 * RETRACT: #800, #809, #3100
 */
#800=FACING_TURNING_OPERATION('FINISH END FACE','finishing','','');
#801=MACHINING_STRATEGY_RELATIONSHIP('approach','finishing',#800,#3000);
#802=ACTION_PROPERTY('allowance','finishing',#800);
#803=ACTION_PROPERTY_REPRESENTATION('','finishing',#802,#804);
#804=REPRESENTATION('',(#805),#413);
#805=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.),#119)
REPRESENTATION_ITEM('')
);
#806=MACHINING_TECHNOLOGY_RELATIONSHIP('','finishing',#800,#2100);
#807=MACHINING_FUNCTIONS_RELATIONSHIP('','finishing',#800,#1900);
#808=MACHINING_STRATEGY_RELATIONSHIP('machining','finishing',#800,#2900);
#809=MACHINING_STRATEGY_RELATIONSHIP('retract','finishing',#800,#3100);

/************************************************
 * Application object: CONTOURING_ROUGH (#900)
 * APPROACH: #900, #901, #3400
 * RETRACT: #900, #902, #3400
 * ITS_TOOL: #900, #4300
 * ITS_ID: #900 ['ROUGH CONTOUR']
 * ALLOWANCE: #900, #903, #904, #905, #906
 * ITS_MACHINING_STRATEGY: #900, #907, #3200
 * ITS_MACHINE_FUNCTIONS: #900, #908, #1900
 * ITS_TECHNOLOGY: #900, #909, #2200
 */
#900=CONTOURING_TURNING_OPERATION('ROUGH CONTOUR','roughing','','');
#901=MACHINING_STRATEGY_RELATIONSHIP('approach','roughing',#900,#3400);
#902=MACHINING_STRATEGY_RELATIONSHIP('retract','roughing',#900,#3400);
#903=ACTION_PROPERTY('allowance','roughing',#900);
#904=ACTION_PROPERTY_REPRESENTATION('','roughing',#903,#905);
#905=REPRESENTATION('',(#906),#413);
#906=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.5),#119)
REPRESENTATION_ITEM('')
);
#907=MACHINING_STRATEGY_RELATIONSHIP('machining','roughing',#900,#3200);
#908=MACHINING_FUNCTIONS_RELATIONSHIP('','roughing',#900,#1900);
#909=MACHINING_TECHNOLOGY_RELATIONSHIP('','roughing',#900,#2200);

/************************************************
 * Application object: CONTOURING_FINISH (#1000)
```



```
 * ITS_MACHINING_STRATEGY: #1000, #1001, #3300
 * ITS_ID: #1000 ['FINISH CONTOUR']
 * APPROACH: #1000, #1002, #3400
 * ITS_MACHINE_FUNCTIONS: #1000, #1003, #1900
 * ITS_TOOL: #1000, #4600
 * ITS_TECHNOLOGY: #1000, #1004, #2300
 * ALLOWANCE: #1000, #1005, #1006, #1007, #1008
 * RETRACT: #1000, #1009, #3400
 */
#1000=CONTOURING_TURNING_OPERATION('FINISH CONTOUR','finishing','','');
#1001=MACHINING_STRATEGY_RELATIONSHIP('machining','finishing',#1000,#3300);
#1002=MACHINING_STRATEGY_RELATIONSHIP('approach','finishing',#1000,#3400);
#1003=MACHINING_FUNCTIONS_RELATIONSHIP('','finishing',#1000,#1900);
#1004=MACHINING_TECHNOLOGY_RELATIONSHIP('','finishing',#1000,#2300);
#1005=ACTION_PROPERTY('allowance','finishing',#1000);
#1006=ACTION_PROPERTY_REPRESENTATION('','finishing',#1005,#1007);
#1007=REPRESENTATION('',(#1008),#413);
#1008=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.),#119)
REPRESENTATION_ITEM('')
);
#1009=MACHINING_STRATEGY_RELATIONSHIP('retract','finishing',#1000,#3400);

/***********************************************
 * Application object: PROJECT (#1100)
 * MAIN_WORKPLAN: #1100, #1101, #1102, #1200
 * ITS_ID: #1100, #1103, #1104 ['TURNING EXAMPLE 1']
 * ITS_WORKPIECES [*]: #1100, #1105, #100
 */
#1100=PRODUCT_DEFINITION('','',#1103,#112);
#1101=PROCESS_PRODUCT_ASSOCIATION('','',#1100,#1102);
#1102=PRODUCT_DEFINITION_PROCESS('machining','',#1200,'');
#1103=PRODUCT_DEFINITION_FORMATION('','',#1104);
#1104=MACHINING_PROJECT('TURNING EXAMPLE 1','',$,(#110));
#1105=MACHINING_PROJECT_WORKPIECE_RELATIONSHIP('','workpiece','',#1100,#100);

/***********************************************
 * Application object: WORKPLAN (#1200)
 * ITS_ID: #1200 ['MAIN WORKPLAN']
 * ITS_SETUP: #1200, #1201, #1202, #1700
 * ITS_ELEMENTS [1]: #1200, #1203, #1300
 * ITS_ELEMENTS [2]: #1200, #1204, #1400
 * ITS_ELEMENTS [3]: #1200, #1205, #1500
 * ITS_ELEMENTS [4]: #1200, #1206, #1600
 */
#1200=MACHINING_WORKPLAN('MAIN WORKPLAN','','','');
#1201=PRODUCT_DEFINITION_PROCESS('setup','',#1200,'');
#1202=PROCESS_PRODUCT_ASSOCIATION('','',#1700,#1201);
#1203=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#1200,#1300,1.);
#1204=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#1200,#1400,2.);
#1205=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#1200,#1500,3.);
#1206=MACHINING_PROCESS_SEQUENCE_RELATIONSHIP('','',#1200,#1600,4.);
```



```
/***********************************************
 * Application object: MACHINING_WORKINGSTEP (#1300)
 * ITS_FEATURE: #1300, #1301, #1302, #1303, #1304, #400
 * ITS_ID: #1300 ['WS ROUGH END FACE']
 * ITS_SECPLANE: #1300, #1305, #1306, #1307, #1308
 * ITS_OPERATION: #1300, #1309, #700
 */
#1300=MACHINING_WORKINGSTEP('WS ROUGH END FACE','machining','','');
#1301=MACHINING_FEATURE_RELATIONSHIP('','machining',#1300,#1302);
#1302=MACHINING_FEATURE_PROCESS('','machining','','');
#1303=PROPERTY_PROCESS('machining','machining',#1302,'');
#1304=PROCESS_PROPERTY_ASSOCIATION('','machining',#1303,#400);
#1305=ACTION_PROPERTY('security plane','machining',#1300);
#1306=ACTION_PROPERTY_REPRESENTATION('','machining',#1305,#1307);
#1307=REPRESENTATION('',(#1308),#413);
#1308=PLANE('SECURITY PLANE',#1310);
#1309=MACHINING_OPERATION_RELATIONSHIP('','machining',#1300,#700);
#1310=AXIS2_PLACEMENT_3D('SECURITY PLANE',#1311,$,$);
#1311=CARTESIAN_POINT('SECPLANE: LOCATION',(90.,0.,200.));

/***********************************************
 * Application object: MACHINING_WORKINGSTEP (#1400)
 * ITS_FEATURE: #1400, #1401, #1402, #1403, #1404, #400
 * ITS_ID: #1400 ['WS FINISH END FACE']
 * ITS_SECPLANE: #1400, #1405, #1406, #1407, #1308
 * ITS_OPERATION: #1400, #1408, #800
 */
#1400=MACHINING_WORKINGSTEP('WS FINISH END FACE','machining','','');
#1401=MACHINING_FEATURE_RELATIONSHIP('','machining',#1400,#1402);
#1402=MACHINING_FEATURE_PROCESS('','machining','','');
#1403=PROPERTY_PROCESS('machining','machining',#1402,'');
#1404=PROCESS_PROPERTY_ASSOCIATION('','machining',#1403,#400);
#1405=ACTION_PROPERTY('security plane','machining',#1400);
#1406=ACTION_PROPERTY_REPRESENTATION('','machining',#1405,#1407);
#1407=REPRESENTATION('',(#1308),#413);
#1408=MACHINING_OPERATION_RELATIONSHIP('','machining',#1400,#800);

/***********************************************
 * Application object: TURNING_WORKINGSTEP (#1500)
 * ITS_ID: #1500 ['WS ROUGH CONTOUR']
 * ITS_SECPLANE: #1500, #1501, #1502, #1503, #1308
 * ITS_OPERATION: #1500, #1504, #900
 * ITS_FEATURES [*]: #1500, #1505, #1506, #1507, #1508, #500
 * ITS_FEATURES [*]: #1500, #1509, #1510, #1511, #1512, #600
 */
#1500=MACHINING_WORKINGSTEP('WS ROUGH CONTOUR','turning','','');
#1501=ACTION_PROPERTY('security plane','turning',#1500);
#1502=ACTION_PROPERTY_REPRESENTATION('','turning',#1501,#1503);
#1503=REPRESENTATION('',(#1308),#413);
#1504=MACHINING_OPERATION_RELATIONSHIP('','turning',#1500,#900);
#1505=MACHINING_FEATURE_SEQUENCE_RELATIONSHIP('','turning',#1500,#1506,0.);
#1506=MACHINING_FEATURE_PROCESS('','turning','','');
#1507=PROPERTY_PROCESS('machining','turning',#1506,'');
```



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#1508=PROCESS_PROPERTY_ASSOCIATION('','turning',#1507,#500);
#1509=MACHINING_FEATURE_SEQUENCE_RELATIONSHIP('','turning',#1500,#1510,0.);
#1510=MACHINING_FEATURE_PROCESS('','turning','','');
#1511=PROPERTY_PROCESS('machining','turning',#1510,'');
#1512=PROCESS_PROPERTY_ASSOCIATION('','turning',#1511,#600);

/**************************************************
 * Application object: TURNING_WORKINGSTEP (#1600)
 * ITS_ID: #1600 ['WS FINISH CONTOUR']
 * ITS_SECPLANE: #1600, #1601, #1602, #1603, #1308
 * ITS_OPERATION: #1600, #1604, #1000
 * ITS_FEATURES [*]: #1600, #1605, #1606, #1607, #1608, #500
 * ITS_FEATURES [*]: #1600, #1609, #1610, #1611, #1612, #600
 */
#1600=MACHINING_WORKINGSTEP('WS FINISH CONTOUR','turning','','');
#1601=ACTION_PROPERTY('security plane','turning',#1600);
#1602=ACTION_PROPERTY_REPRESENTATION('','turning',#1601,#1603);
#1603=REPRESENTATION('',(#1308),#413);
#1604=MACHINING_OPERATION_RELATIONSHIP('','turning',#1600,#1000);
#1605=MACHINING_FEATURE_SEQUENCE_RELATIONSHIP('','turning',#1600,#1606,0.);
#1606=MACHINING_FEATURE_PROCESS('','turning','','');
#1607=PROPERTY_PROCESS('machining','turning',#1606,'');
#1608=PROCESS_PROPERTY_ASSOCIATION('','turning',#1607,#500);
#1609=MACHINING_FEATURE_SEQUENCE_RELATIONSHIP('','turning',#1600,#1610,0.);
#1610=MACHINING_FEATURE_PROCESS('','turning','','');
#1611=PROPERTY_PROCESS('machining','turning',#1610,'');
#1612=PROCESS_PROPERTY_ASSOCIATION('','turning',#1611,#600);

/**************************************************
 * Application object: SETUP (#1700)
 * ITS_SECPLANE: #1700, #1701, #1702, #1703, #1308
 * ITS_WORKPIECE_SETUP [*]: #1700, #1800
 * ITS_ID: #1700, #1704, #1705 ['SETUP FOR TURNING EXAMPLE 1']
 */
#1700=PRODUCT_DEFINITION('','',#1704,#112);
#1701=PROPERTY_DEFINITION('security plane','',#1700);
#1702=PROPERTY_DEFINITION_REPRESENTATION(#1701,#1703);
#1703=REPRESENTATION('',(#1308),#413);
#1704=PRODUCT_DEFINITION_FORMATION('','',#1705);
#1705=MACHINING_SETUP('SETUP FOR TURNING EXAMPLE 1','',$,(#110));

/**************************************************
 * Application object: WORKPIECE_SETUP (#1800)
 * ITS_ORIGIN: #1800, #1801, #1802, #1803, #1804, #1805
 * ITS_WORKPIECE: #1800, #100
 */
#1800=MACHINING_SETUP_WORKPIECE_RELATIONSHIP('','','',#1700,#100);
#1801=PRODUCT_DEFINITION_SHAPE('','',#1800);
#1802=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#1803,#1801);
#1803=(
REPRESENTATION_RELATIONSHIP('','',$,$)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#1804)
SHAPE_REPRESENTATION_RELATIONSHIP()
);
```



```
#1804=ITEM_DEFINED_TRANSFORMATION('','',$,#1805);
#1805=AXIS2_PLACEMENT_3D('WORKPIECE',#1806,#1807,#1808);
#1806=CARTESIAN_POINT('WORKPIECE: LOCATION',(0.,0.,0.));
#1807=DIRECTION('WORKPIECE: AXIS',(0.,0.,1.));
#1808=DIRECTION('WORKPIECE: REF_DIRECTION',(1.,0.,0.));

/************************************************
 * Application object: TURNING_MACHINE_FUNCTIONS (#1900)
 * COOLANT: #1900, #1901, #1902, #1903, #1904 ['coolant on']
 * CHIP_REMOVAL: #1900, #1905, #1906, #1907, #1908 ['chip removal off']
 */
#1900=MACHINING_FUNCTIONS('','turning','','');
#1901=ACTION_PROPERTY('coolant','turning',#1900);
#1902=ACTION_PROPERTY_REPRESENTATION('','turning',#1901,#1903);
#1903=REPRESENTATION('',(#1904),#413);
#1904=DESCRIPTIVE_REPRESENTATION_ITEM('','coolant on');
#1905=ACTION_PROPERTY('chip removal','turning',#1900);
#1906=ACTION_PROPERTY_REPRESENTATION('','turning',#1905,#1907);
#1907=REPRESENTATION('',(#1908),#413);
#1908=DESCRIPTIVE_REPRESENTATION_ITEM('','chip removal off');

/************************************************
 * Application object: TURNING_TECHNOLOGY (#2000)
 * INHIBIT_SPINDLE_OVERRIDE: #2000, #2001, #2002, #2003, #2004 ['override not
allowed']
 * SYNC_SPINDLE_AND_Z_FEED: #2000, #2005, #2006, #2007, #2008 ['not
synchronized']
 * FEEDRATE_PER_REVOLUTION: #2000, #2009, #2010, #2011, #2012
 * FEEDRATE_REFERENCE: #2000, #2013, #2014, #2015, #2016 ['tool center point']
 * INHIBIT_FEEDRATE_OVERRIDE: #2000, #2017, #2018, #2019, #2020 ['override not
allowed']
 * SPINDLE_SPEED: #2000, #2021, #2022, #2400
 */
#2000=MACHINING_TECHNOLOGY('','turning','','');
#2001=ACTION_PROPERTY('inhibit spindle override','turning',#2000);
#2002=ACTION_PROPERTY_REPRESENTATION('','turning',#2001,#2003);
#2003=REPRESENTATION('',(#2004),#413);
#2004=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2005=ACTION_PROPERTY('synchronize spindle with z feed','turning',#2000);
#2006=ACTION_PROPERTY_REPRESENTATION('','turning',#2005,#2007);
#2007=REPRESENTATION('',(#2008),#413);
#2008=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#2009=ACTION_PROPERTY('feedrate','turning',#2000);
#2010=ACTION_PROPERTY_REPRESENTATION('feed per revolution','turning',#2009,
#2011);
#2011=MACHINING_FEED_SPEED_REPRESENTATION('feed per revolution',(#2012),
#413);
#2012=MEASURE_REPRESENTATION_ITEM('feed per revolution',NUMERIC_MEASURE(0.3),
#2023);
#2013=ACTION_PROPERTY('feedrate reference','turning',#2000);
#2014=ACTION_PROPERTY_REPRESENTATION('','turning',#2013,#2015);
#2015=REPRESENTATION('',(#2016),#413);
#2016=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#2017=ACTION_PROPERTY('inhibit feedrate override','turning',#2000);
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#2018=ACTION_PROPERTY_REPRESENTATION('','turning',#2017,#2019);
#2019=REPRESENTATION('',(#2020),#413);
#2020=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2021=ACTION_PROPERTY('spindle','turning',#2000);
#2022=ACTION_PROPERTY_REPRESENTATION('spindle speed','turning',#2021,#2400);
#2023=DERIVED_UNIT((#2024,#2025));
#2024=DERIVED_UNIT_ELEMENT(#119,1.);
#2025=DERIVED_UNIT_ELEMENT(#120,-1.);
#2026=NAME_ATTRIBUTE('millimetre/second',#2023);

/***********************************************
 * Application object: TURNING_TECHNOLOGY (#2100)
 * INHIBIT_SPINDLE_OVERRIDE: #2100, #2101, #2102, #2103, #2104 ['override not
allowed']
 * SYNC_SPINDLE_AND_Z_FEED: #2100, #2105, #2106, #2107, #2108 ['not
synchronized']
 * FEEDRATE_PER_REVOLUTION: #2100, #2109, #2110, #2111, #2112
 * FEEDRATE_REFERENCE: #2100, #2113, #2114, #2115, #2116 ['tool center point']
 * INHIBIT_FEEDRATE_OVERRIDE: #2100, #2117, #2118, #2119, #2120 ['override not
allowed']
 * SPINDLE_SPEED: #2100, #2121, #2122, #2500
 */
#2100=MACHINING_TECHNOLOGY('','turning','','');
#2101=ACTION_PROPERTY('inhibit spindle override','turning',#2100);
#2102=ACTION_PROPERTY_REPRESENTATION('','turning',#2101,#2103);
#2103=REPRESENTATION('',(#2104),#413);
#2104=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2105=ACTION_PROPERTY('synchronize spindle with z feed','turning',#2100);
#2106=ACTION_PROPERTY_REPRESENTATION('','turning',#2105,#2107);
#2107=REPRESENTATION('',(#2108),#413);
#2108=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#2109=ACTION_PROPERTY('feedrate','turning',#2100);
#2110=ACTION_PROPERTY_REPRESENTATION('feed per revolution','turning',#2109,
#2111);
#2111=MACHINING_FEED_SPEED_REPRESENTATION('feed per revolution',(#2112),
#413);
#2112=MEASURE_REPRESENTATION_ITEM('feed per revolution',NUMERIC_MEASURE(0.2),
#2023);
#2113=ACTION_PROPERTY('feedrate reference','turning',#2100);
#2114=ACTION_PROPERTY_REPRESENTATION('','turning',#2113,#2115);
#2115=REPRESENTATION('',(#2116),#413);
#2116=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#2117=ACTION_PROPERTY('inhibit feedrate override','turning',#2100);
#2118=ACTION_PROPERTY_REPRESENTATION('','turning',#2117,#2119);
#2119=REPRESENTATION('',(#2120),#413);
#2120=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2121=ACTION_PROPERTY('spindle','turning',#2100);
#2122=ACTION_PROPERTY_REPRESENTATION('spindle speed','turning',#2121,#2500);

/***********************************************
 * Application object: TURNING_TECHNOLOGY (#2200)
 * INHIBIT_SPINDLE_OVERRIDE: #2200, #2201, #2202, #2203, #2204 ['override not
allowed']
 * SYNC_SPINDLE_AND_Z_FEED: #2200, #2205, #2206, #2207, #2208 ['not
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synchronized']
 * FEEDRATE_PER_REVOLUTION: #2200, #2209, #2210, #2211, #2212
 * FEEDRATE_REFERENCE: #2200, #2213, #2214, #2215, #2216 ['tool center point']
 * INHIBIT_FEEDRATE_OVERRIDE: #2200, #2217, #2218, #2219, #2220 ['override not
allowed']
 * SPINDLE_SPEED: #2200, #2221, #2222, #2600
 */
#2200=MACHINING_TECHNOLOGY('','turning','','');
#2201=ACTION_PROPERTY('inhibit spindle override','turning',#2200);
#2202=ACTION_PROPERTY_REPRESENTATION('','turning',#2201,#2203);
#2203=REPRESENTATION('',(#2204),#413);
#2204=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2205=ACTION_PROPERTY('synchronize spindle with z feed','turning',#2200);
#2206=ACTION_PROPERTY_REPRESENTATION('','turning',#2205,#2207);
#2207=REPRESENTATION('',(#2208),#413);
#2208=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#2209=ACTION_PROPERTY('feedrate','turning',#2200);
#2210=ACTION_PROPERTY_REPRESENTATION('feed per revolution','turning',#2209,
#2211);
#2211=MACHINING_FEED_SPEED_REPRESENTATION('feed per revolution',(#2212),
#413);
#2212=MEASURE_REPRESENTATION_ITEM('feed per revolution',NUMERIC_MEASURE(0.3),
#2023);
#2213=ACTION_PROPERTY('feedrate reference','turning',#2200);
#2214=ACTION_PROPERTY_REPRESENTATION('','turning',#2213,#2215);
#2215=REPRESENTATION('',(#2216),#413);
#2216=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#2217=ACTION_PROPERTY('inhibit feedrate override','turning',#2200);
#2218=ACTION_PROPERTY_REPRESENTATION('','turning',#2217,#2219);
#2219=REPRESENTATION('',(#2220),#413);
#2220=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2221=ACTION_PROPERTY('spindle','turning',#2200);
#2222=ACTION_PROPERTY_REPRESENTATION('spindle speed','turning',#2221,#2600);

/************************************************
 * Application object: TURNING_TECHNOLOGY (#2300)
 * INHIBIT_SPINDLE_OVERRIDE: #2300, #2301, #2302, #2303, #2304 ['override not
allowed']
 * SYNC_SPINDLE_AND_Z_FEED: #2300, #2305, #2306, #2307, #2308 ['not
synchronized']
 * FEEDRATE_PER_REVOLUTION: #2300, #2309, #2310, #2311, #2312
 * FEEDRATE_REFERENCE: #2300, #2313, #2314, #2315, #2316 ['tool center point']
 * INHIBIT_FEEDRATE_OVERRIDE: #2300, #2317, #2318, #2319, #2320 ['override not
allowed']
 * SPINDLE_SPEED: #2300, #2321, #2322, #2700
 */
#2300=MACHINING_TECHNOLOGY('','turning','','');
#2301=ACTION_PROPERTY('inhibit spindle override','turning',#2300);
#2302=ACTION_PROPERTY_REPRESENTATION('','turning',#2301,#2303);
#2303=REPRESENTATION('',(#2304),#413);
#2304=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2305=ACTION_PROPERTY('synchronize spindle with z feed','turning',#2300);
#2306=ACTION_PROPERTY_REPRESENTATION('','turning',#2305,#2307);
#2307=REPRESENTATION('',(#2308),#413);
```



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#2308=DESCRIPTIVE_REPRESENTATION_ITEM('','not synchronized');
#2309=ACTION_PROPERTY('feedrate','turning',#2300);
#2310=ACTION_PROPERTY_REPRESENTATION('feed per revolution','turning',#2309,
#2311);
#2311=MACHINING_FEED_SPEED_REPRESENTATION('feed per revolution',(#2312),
#413);
#2312=MEASURE_REPRESENTATION_ITEM('feed per revolution',NUMERIC_MEASURE(0.2),
#2023);
#2313=ACTION_PROPERTY('feedrate reference','turning',#2300);
#2314=ACTION_PROPERTY_REPRESENTATION('','turning',#2313,#2315);
#2315=REPRESENTATION('',(#2316),#413);
#2316=DESCRIPTIVE_REPRESENTATION_ITEM('','tool center point');
#2317=ACTION_PROPERTY('inhibit feedrate override','turning',#2300);
#2318=ACTION_PROPERTY_REPRESENTATION('','turning',#2317,#2319);
#2319=REPRESENTATION('',(#2320),#413);
#2320=DESCRIPTIVE_REPRESENTATION_ITEM('','override not allowed');
#2321=ACTION_PROPERTY('spindle','turning',#2300);
#2322=ACTION_PROPERTY_REPRESENTATION('spindle speed','turning',#2321,#2700);

/***********************************************
 * Application object: CONST_SPINDLE_SPEED (#2400)
 * ROT_SPEED: #2400, #2401
 */
#2400=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#2401),#413);
#2401=MEASURE_REPRESENTATION_ITEM('rotational speed',NUMERIC_MEASURE(5.),
#2402);
#2402=DERIVED_UNIT((#2403));
#2403=DERIVED_UNIT_ELEMENT(#120,-1.);
#2404=NAME_ATTRIBUTE('revolution/second',#2402);

/***********************************************
 * Application object: CONST_CUTTING_SPEED (#2500)
 * SPEED: #2500, #2501
 * MAX_SPEED: #2500, #2502
 */
#2500=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#2501,#2502),
#413);
#2501=MEASURE_REPRESENTATION_ITEM('surface speed',NUMERIC_MEASURE(2.5),#2023);
#2502=MEASURE_REPRESENTATION_ITEM('maximum rotational
speed',NUMERIC_MEASURE(10.),
#2023);

/***********************************************
 * Application object: CONST_CUTTING_SPEED (#2600)
 * SPEED: #2600, #2601
 * MAX_SPEED: #2600, #2602
 */
#2600=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#2601,#2602),
#413);
#2601=MEASURE_REPRESENTATION_ITEM('surface speed',NUMERIC_MEASURE(2.5),#2023);
#2602=MEASURE_REPRESENTATION_ITEM('maximum rotational
speed',NUMERIC_MEASURE(10.),
#2023);
```

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/**********************************************
 * Application object: CONST_CUTTING_SPEED (#2700)
 * SPEED: #2700, #2701
 * MAX_SPEED: #2700, #2702
 */
#2700=MACHINING_SPINDLE_SPEED_REPRESENTATION('spindle speed',(#2701,#2702),
#413);
#2701=MEASURE_REPRESENTATION_ITEM('surface speed',NUMERIC_MEASURE(2.2),#2023);
#2702=MEASURE_REPRESENTATION_ITEM('maximum rotational
speed',NUMERIC_MEASURE(10.),
#2023);

/**********************************************
 * Application object: UNIDIRECTIONAL_TURNING (#2800)
 * LIFT_HEIGHT: #2800, #2801, #2802, #2803, #2804
 * CUTTING_DEPTH [*]: #2800, #2805, #2806, #2807, #2808, #2809
 * BACK_PATH_DIRECTION: #2800, #2810, #2811, #2812, #2813
 */
#2800=TURNING_TYPE_STRATEGY('','unidirectional','','');
#2801=ACTION_PROPERTY('lift height','unidirectional',#2800);
#2802=ACTION_PROPERTY_REPRESENTATION('','unidirectional',#2801,#2803);
#2803=REPRESENTATION('',(#2804),#413);
#2804=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(2.),#119)
REPRESENTATION_ITEM('')
);
#2805=ACTION_PROPERTY('cutting depth','unidirectional',#2800);
#2806=ACTION_PROPERTY_REPRESENTATION('','unidirectional',#2805,#2807);
#2807=REPRESENTATION('',(#2808),$);
#2808=COMPOUND_REPRESENTATION_ITEM('',LIST_REPRESENTATION_ITEM((#2809)));
#2809=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(3.),#119)
REPRESENTATION_ITEM('')
);
#2810=ACTION_PROPERTY('back path direction','unidirectional',#2800);
#2811=ACTION_PROPERTY_REPRESENTATION('','unidirectional',#2810,#2812);
#2812=REPRESENTATION('',(#2813),#413);
#2813=DIRECTION('FACING DIRECTION',(-1.,0.,0.));

/**********************************************
 * Application object: UNIDIRECTIONAL_TURNING (#2900)
 * LIFT_HEIGHT: #2900, #2901, #2902, #2903, #2904
 * CUTTING_DEPTH [*]: #2900, #2905, #2906, #2907, #2908, #2909
 * BACK_PATH_DIRECTION: #2900, #2910, #2911, #2912, #2813
 */
#2900=TURNING_TYPE_STRATEGY('','unidirectional','','');
#2901=ACTION_PROPERTY('lift height','unidirectional',#2900);
#2902=ACTION_PROPERTY_REPRESENTATION('','unidirectional',#2901,#2903);
#2903=REPRESENTATION('',(#2904),#413);
#2904=(
```



```
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(2.),#119)
REPRESENTATION_ITEM('')
);
#2905=ACTION_PROPERTY('cutting depth','unidirectional',#2900);
#2906=ACTION_PROPERTY_REPRESENTATION('','unidirectional',#2905,#2907);
#2907=REPRESENTATION('',(#2908),$);
#2908=COMPOUND_REPRESENTATION_ITEM('',LIST_REPRESENTATION_ITEM((#2909)));
#2909=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.5),#119)
REPRESENTATION_ITEM('')
);
#2910=ACTION_PROPERTY('back path direction','unidirectional',#2900);
#2911=ACTION_PROPERTY_REPRESENTATION('','unidirectional',#2910,#2912);
#2912=REPRESENTATION('',(#2813),#413);

/*************************************************
 * Application object: AP_RETRACT_TANGENT (#3000)
 * RADIUS: #3000, #3001, #3002, #3003, #3004
 */
#3000=MACHINING_APPROACH_RETRACT_STRATEGY('','approach retract tangent',
'','');
#3001=ACTION_PROPERTY('travel radius','approach retract tangent',#3000);
#3002=ACTION_PROPERTY_REPRESENTATION('','approach retract tangent',#3001,
#3003);
#3003=REPRESENTATION('',(#3004),#413);
#3004=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(60.),#119)
REPRESENTATION_ITEM('')
);

/*************************************************
 * Application object: AP_RETRACT_ANGLE (#3100)
 * ANGLE: #3100, #3101, #3102, #3103, #3104
 * TRAVEL_LENGTH: #3100, #3105, #3106, #3107, #3108
 */
#3100=MACHINING_APPROACH_RETRACT_STRATEGY('','approach retract angle','',
'');
#3101=ACTION_PROPERTY('travel angle','approach retract angle',#3100);
#3102=ACTION_PROPERTY_REPRESENTATION('','approach retract angle',#3101,#3103);
#3103=REPRESENTATION('',(#3104),#413);
#3104=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(100.),#114)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);
#3105=ACTION_PROPERTY('travel length','approach retract angle',#3100);
#3106=ACTION_PROPERTY_REPRESENTATION('','approach retract angle',#3105,#3107);
```



```
#3107=REPRESENTATION('',(#3108),#413);
#3108=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(2.),#119)
REPRESENTATION_ITEM('')
);

/***********************************************
 * Application object: UNIDIRECTIONAL_TURNING (#3200)
 * LIFT_HEIGHT: #3200, #3201, #3202, #3203, #3204
 * CUTTING_DEPTH [*]: #3200, #3205, #3206, #3207, #3208, #3209
 */
#3200=TURNING_TYPE_STRATEGY('','unidirectional','','');
#3201=ACTION_PROPERTY('lift height','unidirectional',#3200);
#3202=ACTION_PROPERTY_REPRESENTATION('','unidirectional',#3201,#3203);
#3203=REPRESENTATION('',(#3204),#413);
#3204=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(2.),#119)
REPRESENTATION_ITEM('')
);
#3205=ACTION_PROPERTY('cutting depth','unidirectional',#3200);
#3206=ACTION_PROPERTY_REPRESENTATION('','unidirectional',#3205,#3207);
#3207=REPRESENTATION('',(#3208),$);
#3208=COMPOUND_REPRESENTATION_ITEM('',LIST_REPRESENTATION_ITEM((#3209)));
#3209=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(3.),#119)
REPRESENTATION_ITEM('')
);

/***********************************************
 * Application object: CONTOUR_TURNING (#3300)
 * CUTTING_DEPTH [*]: #3300, #3301, #3302, #3303, #3304, #3305
 * LIFT_DIRECTION: #3300, #3306, #3307, #3308, #3309
 */
#3300=TURNING_TYPE_STRATEGY('','contour','','');
#3301=ACTION_PROPERTY('cutting depth','contour',#3300);
#3302=ACTION_PROPERTY_REPRESENTATION('','contour',#3301,#3303);
#3303=REPRESENTATION('',(#3304),$);
#3304=COMPOUND_REPRESENTATION_ITEM('',LIST_REPRESENTATION_ITEM((#3305)));
#3305=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.5),#119)
REPRESENTATION_ITEM('')
);
#3306=ACTION_PROPERTY('lift direction','contour',#3300);
#3307=ACTION_PROPERTY_REPRESENTATION('','contour',#3306,#3308);
#3308=REPRESENTATION('',(#3309),#413);
#3309=DIRECTION('STEPOVER DIRECTION FOR CONTOUR',(1.,0.,0.));
```



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/************************************************
 * Application object: AP_RETRACT_ANGLE (#3400)
 * ANGLE: #3400, #3401, #3402, #3403, #3404
 * TRAVEL_LENGTH: #3400, #3405, #3406, #3407, #3408
 */
#3400=MACHINING_APPROACH_RETRACT_STRATEGY('','approach retract angle','',
'');
#3401=ACTION_PROPERTY('travel angle','approach retract angle',#3400);
#3402=ACTION_PROPERTY_REPRESENTATION('','approach retract angle',#3401,#3403);
#3403=REPRESENTATION('',(#3404),#413);
#3404=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(45.),#114)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);
#3405=ACTION_PROPERTY('travel length','approach retract angle',#3400);
#3406=ACTION_PROPERTY_REPRESENTATION('','approach retract angle',#3405,#3407);
#3407=REPRESENTATION('',(#3408),#413);
#3408=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(4.),#119)
REPRESENTATION_ITEM('')
);

/************************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#3500)
 * VALUE_COMPONENT: #3500 [80]
 ***********************************************
 * Application object: QUALIFIED_PLUS_MINUS_VALUE (#3500)
 * LOWER_LIMIT: #3500, #3501 [0.1]
 * UPPER_LIMIT: #3500, #3502 [0.1]
 */
#3500=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(80.),#119)
QUALIFIED_REPRESENTATION_ITEM((#3501,#3502))
REPRESENTATION_ITEM('diameter')
);
#3501=STANDARD_UNCERTAINTY('lower limit','',0.1);
#3502=STANDARD_UNCERTAINTY('upper limit','',0.1);

/************************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#3600)
 * VALUE_COMPONENT: #3600 [110]
 ***********************************************
 * Application object: QUALIFIED_PLUS_MINUS_VALUE (#3600)
 * LOWER_LIMIT: #3600, #3601 [0.1]
 * UPPER_LIMIT: #3600, #3602 [0.1]
 */
#3600=(
```



```
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(110.),#119)
QUALIFIED_REPRESENTATION_ITEM((#3601,#3602))
REPRESENTATION_ITEM('length')
);
#3601=STANDARD_UNCERTAINTY('lower limit','',0.1);
#3602=STANDARD_UNCERTAINTY('upper limit','',0.1);

/**********************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#3700)
 * VALUE_COMPONENT: #3700 [40]
 **********************************************
 * Application object: QUALIFIED_PLUS_MINUS_VALUE (#3700)
 * LOWER_LIMIT: #3700, #3701 [0]
 * UPPER_LIMIT: #3700, #3702 [0.2]
 */
#3700=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(40.),#119)
QUALIFIED_REPRESENTATION_ITEM((#3701,#3702))
REPRESENTATION_ITEM('diameter')
);
#3701=STANDARD_UNCERTAINTY('lower limit','',0.);
#3702=STANDARD_UNCERTAINTY('upper limit','',0.2);

/**********************************************
 * Application object: LINEAR_PROFILE (#3800)
 * PROFILE_LENGTH: #3800, #3801, #3802, #3803, #3900
 */
#3800=LINEAR_PROFILE('','flat edge shape',#3805,.F.);
#3801=PRODUCT_DEFINITION_SHAPE('profile length','',#3800);
#3802=SHAPE_DEFINITION_REPRESENTATION(#3801,#3803);
#3803=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#3900),#113);
#3804=FEATURE_COMPONENT_DEFINITION('feature component','shared by all');
#3805=PRODUCT_DEFINITION_SHAPE('feature component',$,#3804);

/**********************************************
 * Application object: NUMERIC_PARAMETER (#3900)
 * ITS_PARAMETER_VALUE: #3900 [20]
 * ITS_PARAMETER_UNIT: #3900, #119
 * PARAMETER_NAME: #3900 ['LINEAR PROFILE LENGTH']
 */
#3900=MEASURE_REPRESENTATION_ITEM('LINEAR PROFILE LENGTH',NUMERIC_MEASURE(20.),
#119);

/**********************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#4000)
 * VALUE_COMPONENT: #4000 [50]
 **********************************************
 * Application object: QUALIFIED_PLUS_MINUS_VALUE (#4000)
 * LOWER_LIMIT: #4000, #4001 [0.1]
 * UPPER_LIMIT: #4000, #4002 [0.1]
```

```
 */
#4000=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(50.),#119)
QUALIFIED_REPRESENTATION_ITEM((#4001,#4002))
REPRESENTATION_ITEM('length')
);
#4001=STANDARD_UNCERTAINTY('lower limit','',0.1);
#4002=STANDARD_UNCERTAINTY('upper limit','',0.1);

/***********************************************
 * Application object: DIAMETER_TAPER (#4100)
 * FINAL_DIAMETER: #4100, #4101, #4102, #4103, #4200
 */
#4100=TAPER('','diameter taper',#4104,.F.);
#4101=PRODUCT_DEFINITION_SHAPE('final diameter','diameter taper',#4100);
#4102=SHAPE_DEFINITION_REPRESENTATION(#4101,#4103);
#4103=SHAPE_REPRESENTATION_WITH_PARAMETERS('',(#4200),#113);
#4104=PRODUCT_DEFINITION_SHAPE('','diameter taper',#4105);
#4105=FEATURE_COMPONENT_DEFINITION('','diameter taper');

/***********************************************
 * Application object: TOLERANCED_LENGTH_MEASURE (#4200)
 * VALUE_COMPONENT: #4200 [80]
 **********************************************
 * Application object: QUALIFIED_PLUS_MINUS_VALUE (#4200)
 * LOWER_LIMIT: #4200, #4201 [0.1]
 * UPPER_LIMIT: #4200, #4202 [0.1]
 */
#4200=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(80.),#119)
QUALIFIED_REPRESENTATION_ITEM((#4201,#4202))
REPRESENTATION_ITEM('final diameter')
);
#4201=STANDARD_UNCERTAINTY('lower limit','',0.1);
#4202=STANDARD_UNCERTAINTY('upper limit','',0.1);

/***********************************************
 * Application object: GENERAL_TURNING_TOOL (#4300)
 * ITS_ID: #4300 ['ROUGHING TOOL']
 * FUNCTIONAL_LENGTH: #4300, #4301, #4302, #4400, #4402 [120]
 * F_DIMENSION: #4300, #4301, #4302, #4400, #4403 [45]
 * CUTTING_EDGE: #4300, #4404, #4450
 * HAND_OF_TOOL: #4300, #4301, #4302, #4400, #4401 ['left']
 */
#4300=MACHINING_TOOL('ROUGHING TOOL','general turning tool',
  (#900,#700),#4303);
#4301=RESOURCE_PROPERTY('tool body','',#4300);
#4302=RESOURCE_PROPERTY_REPRESENTATION('','',#4301,#4400);
#4303=ACTION_RESOURCE_TYPE('turning cutting tool');
```



```
#4400=MACHINING_TOOL_BODY_REPRESENTATION('',(#4401,#4402,#4403),#413);
#4401=DESCRIPTIVE_REPRESENTATION_ITEM('hand of cut','left');
#4402=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(120.),#119)
REPRESENTATION_ITEM('functional length')
);
#4403=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(45.),#119)
REPRESENTATION_ITEM('f dimension')
);
#4404=ACTION_RESOURCE_RELATIONSHIP('',$,#4300,#4450);

/************************************************
 * Application object: CUTTING_EDGE_PROPERTIES (#4450)
 * ITS_MATERIAL: #4450, #4500
 * CUTTING_EDGE_LENGTH: #4450, #4453, #4454, #4455, #4456 [10.0]
 * TOOL_CUTTING_EDGE_ANGLE: #4450, #4457, #4458, #4459, #4460 [110.0]
 * TOOL_INCLUDED_ANGLE: #4450, #4461, #4462, #4463, #4464 [25.0]
 */
#4450=MACHINING_CUTTING_COMPONENT('','',(),#4452,'',$);
#4452=ACTION_RESOURCE_TYPE('turning cutting edge');

#4453=RESOURCE_PROPERTY('cutting edge length','',#4450);
#4454=RESOURCE_PROPERTY_REPRESENTATION('','',#4453,#4455);
#4455=REPRESENTATION('',(#4456),#413);
#4456=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(10.),#119)
REPRESENTATION_ITEM('')
);

#4457=RESOURCE_PROPERTY('cutting edge angle','',#4450);
#4458=RESOURCE_PROPERTY_REPRESENTATION('','',#4457,#4459);
#4459=REPRESENTATION('',(#4460),#413);
#4460=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(110.),#114)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);

#4461=RESOURCE_PROPERTY('tool included angle','',#4450);
#4462=RESOURCE_PROPERTY_REPRESENTATION('','',#4461,#4463);
#4463=REPRESENTATION('',(#4464),#413);
#4464=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(25.),#114)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
```



```
);


/***********************************************
 * Application object: MATERIAL (#4500)
 * MATERIAL_IDENTIFIER: #4500 ['TIN']
 * STANDARD_IDENTIFIER: #4500, #4501, #4502 ['TIN']
 */
#4500=MATERIAL_DESIGNATION('TIN',(#4450));
#4501=APPLIED_DOCUMENT_REFERENCE(#4502,'',(#4500));
#4502=DOCUMENT('TIN','','',$);

/***********************************************
 * Application object: GENERAL_TURNING_TOOL (#4600)
 * ITS_ID: #4600 ['FINISHING TOOL']
 * FUNCTIONAL_LENGTH: #4600, #4601, #4602, #4700, #4702 [120]
 * F_DIMENSION: #4600, #4601, #4602, #4700, #4703 [45]
 * CUTTING_EDGE: #4600, #4704, #4750
 * HAND_OF_TOOL: #4600, #4601, #4602, #4700, #4701 ['left']
 */
#4600=MACHINING_TOOL('FINISHING TOOL','general turning tool',
  (#1000,#800),#4303);
#4601=RESOURCE_PROPERTY('tool body','',#4600);
#4602=RESOURCE_PROPERTY_REPRESENTATION('','',#4601,#4700);

#4700=MACHINING_TOOL_BODY_REPRESENTATION('',(#4701,#4702,#4703),#413);
#4701=DESCRIPTIVE_REPRESENTATION_ITEM('hand of cut','left');
#4702=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(120.0),#119)
REPRESENTATION_ITEM('functional length')
);
#4703=(
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(45.),#119)
REPRESENTATION_ITEM('f dimension')
);
#4704=ACTION_RESOURCE_RELATIONSHIP('',$,#4600,#4750);


/***********************************************
 * Application object: CUTTING_EDGE_PROPERTIES (#4750)
 * ITS_MATERIAL: #4750, #4800
 * CUTTING_EDGE_LENGTH: #4750, #4753, #4754, #4755, #4756 [15.0]
 * TOOL_CUTTING_EDGE_ANGLE: #4750, #4757, #4758, #4759, #4760 [110.0]
 * TOOL_INCLUDED_ANGLE: #4750, #4761, #4762, #4763, #4764 [15.0]
 */
#4750=MACHINING_CUTTING_COMPONENT('','',(),#4452,'',$);
#4753=RESOURCE_PROPERTY('cutting edge length','',#4750);
#4754=RESOURCE_PROPERTY_REPRESENTATION('','',#4753,#4755);
#4755=REPRESENTATION('',(#4756),#413);
#4756=(
```



```
LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(15.),#119)
REPRESENTATION_ITEM('')
);

#4757=RESOURCE_PROPERTY('cutting edge angle','',#4750);
#4758=RESOURCE_PROPERTY_REPRESENTATION('','',#4757,#4759);
#4759=REPRESENTATION('',(#4760),#413);
#4760=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(110.),#114)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);

#4761=RESOURCE_PROPERTY('tool included angle','',#4750);
#4762=RESOURCE_PROPERTY_REPRESENTATION('','',#4761,#4763);
#4763=REPRESENTATION('',(#4764),#413);
#4764=(
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(PLANE_ANGLE_MEASURE(15.),#114)
PLANE_ANGLE_MEASURE_WITH_UNIT()
REPRESENTATION_ITEM('')
);


/*************************************************
 * Application object: MATERIAL (#4800)
 * MATERIAL_IDENTIFIER: #4800 ['TIN']
 * STANDARD_IDENTIFIER: #4800, #4801, #4802 ['TIN']
 */
#4800=MATERIAL_DESIGNATION('TIN',(#4750));
#4801=APPLIED_DOCUMENT_REFERENCE(#4802,'',(#4800));
#4802=DOCUMENT('TIN','','',$);
ENDSEC;
END-ISO-10303-21;
```


Bibliography

[1] ISO 2692:1988, *Technical drawings — Geometrical tolerancing — Maximum material principle*

[2] ISO 6983-1:1982, *Numerical control of machines — Program format and definition of address words — Part 1: Data format for positioning, line motion and contouring control systems*

[3] ISO 5458:1998, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Positional tolerancing*

[4] 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*

[5] ISO 10303-214:2003, *Industrial automation systems and integration — Product data and exchange — Part 214: Application protocol: Core data for automotive mechanical design processes*

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

[7] ISO 10303-240:2005, *Industrial automation systems and integration — Product data and exchange — Part 240: Application protocol: Process plans for machined products*

[8] ISO 13399-1:2006, *Cutting tool data representation and exchange — Part 1: Overview, fundamental principles and general information model*

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Document change log

This log lists the changes between versions of this document, most recent first.

Version 4.1 (2006-07-14)

Expanded fundamental concepts and operations section (5.2.1) to include some discussion and examples of boolean and symbolic properties, as well as discussion of instance sharing and direction vector normalization. The ARM EXPRESS-G diagrams in Annex G are now updated. Annex K is now complete, with annotated CC1 and CC2 examples for machining a simple block, and CC3 examples corresponding to the ISO 14649-11 and 12 examples.

Various editorial changes to boilerplate text and formatting to satisfy the latest version of the ISO directives and the SC4 supplemental directives (sc4n1655wd6).

Some fine-tuning to mapping paths in round_hole.bottom_at_path_end, pocket.bottom_at_path_end, and profile_feature.swept_profile_shape to match the AP224 specification and common usage. Made the EXPRESS and text description for manufacturing_feature.explicit_representation consistently go all the way down to faces. Previously one went to faces, while the other stopped at the representation.

The AP224 feature_description and feature_name text fields were missing from compound_feature. Added to clause 4.2 and mappings for harmonization. These just map to characterized_object name and description.

Forgot about assignments to the product in the workpiece PDM fields, so had to add approval, time, date, person, and org assignment fields for that. Also needed workpiece its_related_geometry to document the common AP 203/214 AIM usage where the actual advanced brep shape of a workpiece is related to the its_geometry shape rep by a shape_representation_relationship (but is not an assembly).

Version 4.0 (2006-06-21)

Preparing for IS publication. The normative main body of the document is complete released for review prior to the Tolouse SC4 meeting. The informative annexes in the back still need a little more work (regenerate the ARM/AIM EXPRESS-G diagrams and add two more P21 examples) before the publication checklists are complete.

A few notable changes are described below. See the issue log (wg3n2099) and the SEDS issues submitted to SC1 (wg2n2100) for complete details on the resolutions to each of the DIS ballot comments.

The fundamental concepts and operations section (5.2.1) has been significantly expanded with additional discussion and examples to further clarifies the feature placements, use of measurements and units, contexts, and toolpath curves.

In response to editorial comments, clause 4.2 has been reorganized slightly to make the ARM easier to follow. It now contains entries for all Application Objects so that it is easier to understand what AOs are present and where they come from. Where an AO is imported from ISO 14649, the entry in 4.2 is a normative reference to the defining ISO 14649 document, but it includes an informative note with the EXPRESS description and text directing the reader to the other document for the definition and usage.

All mappings and references have been updated to match final published ISO 14649 documents. In the tool parts, ISO 14649 Parts 10/111/121 revised and moved parameters from Tool_dimension and the Tool_body subtypes into the machining_tool hierarchy. Although the mapping tables needed some changes, the underlying AIM representation did not change much. Parameters are still in a machining_tool_body_representation related to the machining_tool. The type of tool is now given by the description of the machining_tool, rather than the name of the representation. The machining_tool_dimension_representation AIM instance was no longer needed and was eliminated. The machining_cutting_corner_representation AIM instance was added to handle the corner transition information added to Part 121.

Version 3.1, issued as wg3n1534 for DIS ballot (2004-10-29)

Added harmonized GD&T definitions finalized at the Bath and Seattle SC4 meetings, as well as additional changes suggested by WG12 to make instance data easier to understand. These are described in detail below. Incorporated many editorial changes as a result of working through the review checklists and finalizing the document for DIS ballot. Many of the changes involved required boilerplate text and formatting changes. Other notable changes include:

Extended clause 3 with references to many GD&T and CNC-related terms defined in other standards (ISO 1011, 2806, 5459, and the 14649 parts).

Reworked the description of UOFs in clause 4.1 to conform to the SC4 directives. Each UOF calls out the application objects imported from ISO 14649 in a normal list rather than as a note. Also added descriptions for the UOFs that were imported from ISO 14649. We already had descriptions for the other UOFs, like GD&T and management.

In clause 5.1, updated the “Source” column in each mapping table so that it lists the document unambiguiously as “10303-xx” rather than just “xx”. Also replaced usage of “NEW” with “10303-238” and “PLIB” with “13584-20”.

In clause 6, replaced the single “everything” conformance class with four classes that go from the simple only-toolpath usage all the way to full generative machining from features with reasonable classes in-between.

Added EXPRESS-G diagrams in annex G for all application objects. This includes all objects defined by the ISO 14649 parts as well as all of the GD&T, PDM and other ones added in clause 4.

Added annex K with sample XML descriptions for the ISO 14649 examples from parts 11 and 12.

<u>Harmonized GD&T Definitions</u>

Added the application objects and associated mappings for the harmonized GD&T definitions. The application objects use the naming conventions established by Module 1050/AP 214, and have notes giving the equivalent AP 224 terminology. See the GD&T UOF listing for all 49 new objects.

In addition, the measure UOF has been reworked to merge the ISO14649 notion of toleranced lengths with the GD&T notion of toleranced measure values that can be lengths, angles, etc. Added several new base types for all measure values (value_with_unit, value_with_tolerance) and then redefined the ISO 14649 measure types so that they now have an explicit unit and, in most cases, can also have a tolerance qualification. This allows us to specify plus/minus, maximum, or minimum qualifiers to other process parameters (angles, times, speeds, etc.)

New AIM Subtypes for Relationships

Originally, all relationships were mapped as plain action_method_relationships with special strings in the name field. In Bath, at a special session hosted by WG12, an agreement was reached to add subtypes for action_method_relationships in the AP 238 mappings to make the data clearer.

A survey of the mapping tables and EXPRESS rules identified 18 distinct relationships in the model. Some of them are used in more than one place. The relationships are listed in the following sections with the current string (and subtype if used), the objects that are pointed to by the relating and related attributes, and then the proposed new subtype.

The new action_method_relationship subtypes are shown below. Indenting is used to show some further subtyping.

```
machining_adaptive_control_relationship
machining_functions_relationship
machining_operation_relationship
machining_operator_instruction_relationship
machining_process_model_relationship
machining_strategy_relationship
machining_technology_relationship
machining_toolpath_sequence_relationship

machining_feature_relationship
    machining_feature_sequence_relationship (and sequential_method)

machining_final_feature_relationship

machining_process_body_relationship
    machining_process_sequence_relationship (and sequential_method)
    machining_process_concurrent_relationship (and concurrent_action_method)
    machining_process_branch_relationship
```

In addition, the following subtypes of product_definition_relationship are used:

```
machining_setup_workpiece_relationship
machining_project_workpiece_relationship
```

General Relationships

'operation'	
ing	machining_workingstep
ed	machining_operation
	==> machining_operation_relationship

'technology'	
ing	machining_operation

ing	machining_toolpath
ed	machining_technology
	==> machining_technology_relationship

'machine functions'

ing	machining_operation
ing	machining_toolpath
ed	machining_functions
	==> machining_functions_relationship

'toolpath' and sequential_method

ing	machining_operation
ing	machining_approach_retract_strategy
ed	machining_toolpath
	==> machining_toolpath_sequence_relationship (sequential_method subtype)

'adaptive control'

ing	machining_technology
ed	machining_technology
	==> machining_adaptive_control_relationship

'process model' and sequential_method

ing	machining_functions
ed	machining_process_model
	==> machining_process_model_relationship (sequential_method subtype)

workpiece setup to instructions and sequential_method

ing	machining_process_executable (is this right?)
ed	machining_operator_instruction
	==> machining_operator_instruction_relationship

<u>Machining Strategies</u>

The following three will be handled by the machining_strategy_relationship relation and the name will be used to distinguish between the different types of strategies. It is expected that future ISO 14649 parts may introduce new types of strategies, so this allows us to integrate that in a consistent fashion.

'approach strategy'

ing	milling_type_operation
ing	turning_type_operation
ed	machining_approach_retract_strategy
	==> machining_strategy_relationship with name "approach"

'retract strategy'

ing	milling_type_operation
ing	turning_type_operation
ed	machining_approach_retract_strategy
	==> machining_strategy_relationship with name "retract"

'machining strategy'
ing drilling_type_operation
ing milling_type_operation
ing turning_type_operation
ing freeform_milling_operation
ed drilling_type_strategy
ed freeform_milling_strategy
ed milling_type_strategy
ed turning_type_strategy
==> machining_strategy_relationship with name "machining"

Executable Control Flow

The control-flow relationships between the executables (workplan, if/then, while, selective, parallel, and concurrent) will handled by machining_process_body_relationship and subtypes.

'workplan element' and sequential_method
ing machining_workplan
ed machining_process_executable
==> machining_process_sequence_relationship

'concurrent element' and concurrent_action_method
ing machining_process_executable (concurrent and parallel)
ed machining_process_executable
=> machining_process_concurrent_relationship

'body'
ing machining_process_executable (while)
ed machining_process_executable
=> machining_process_body_relationship

The following three branches will be handled by one subtype and the name will be used to distinguish between them in the true/false case.

'true branch'
ing machining_process_executable (if/then)
ed machining_process_executable
==> machining_process_branch_relationship with name "true branch"

'false branch'
ing machining_process_executable (if/then)
ed machining_process_executable
==> machining_process_branch_relationship with name "false branch"
'branch'
ing machining_process_executable (selective)
ed machining_process_executable
==> machining_process_branch_relationship

Features To Workingstep

Originally, the feature was on the ING side of the relationship and workingstep on the ED side. This was done based on the notion that the feature process executable behaved like a "workplan" collection of workingsteps for the feature. However, this caused confusion in practice, since the workingstep is already the ING side of the relation for operation, and there is a reasonable expectation for the feature relationship to behave in the same way. So, as part of this update, the sides of the relation are now as described below.

Also added a global rule called feature_optional_machining_process_property to document that a feature should have at most one process property with a name of "machining". It was unclear from the mapping table whether each workingstep/feature relationship used a separate process_property and feature_machining_executable for each or whether they were all collected through one.

'process feature' (also sequential method for turning)

ing	machining workingstep (previously was -ED)
ed	machining_feature_process (previously was -ING)
	==> machining_feature_relationship (for normal machining_workingsteps)
	==> machining_feature_sequence_relationship (for turning workingsteps, this is a subtype of the plain feature_relationship and sequential_method because the turning workingstep has a list of features rather than just one)

'final feature'

ing	machining workingstep (previously was -ED)
ed	machining_feature_process (previously was -ING)
	==> machining_final_feature_relationship

Product Definition Relationships

'workpiece'

ing	product_definition (project)
ed	product_definition (workpiece)
	==> machining_project_workpiece_relationship

'workpiece'

ing	product_definition (setup)
ed	product_definition (workpiece)
	==> machining_setup_workpiece_relationship

The mappings have been updated as described, and the local constraints in the AIM subtypes have been updated for the new mappings. In order to document the constraints, the following EXPRESS functions were either added or modified

- FUNCTION verify_optional_relating_amr (MODIFIED)
- FUNCTION verify_optional_relating_amr_with_name (NEW)
- FUNCTION verify_required_relating_amr (MODIFIED)
- FUNCTION verify_required_relating_amr_with_name (NEW)
- FUNCTION verify_related_type_for_amr (MODIFIED)
- FUNCTION verify_related_type_for_amr_with_name (NEW)

- FUNCTION get_count_of_relating_amr (NEW)
- FUNCTION get_count_of_relating_amr_with_name (NEW)

Due to the new handling of related/relating in the relationships between feature and workingstep, the following EXPRESS functions were no longer used and were deleted:

- FUNCTION get_related_amr
- FUNCTION verify_required_related_amr
- FUNCTION verify_relating_type_for_amr

Other Changes

Relaxed the type of the Toolpath_speed parameter from b_spline_curve to allow the more general bounded_curve. Updated mapping and machining_toolpath_speed_profile_representation where rules.

Added definition for nc_legacy_function capability along with restrictions in the definition to prohibit trivial/pathological use for things that can be done using the existing capabilities.

Added a tool holder profile attribute to the cutting_tool application object. This is defined as a surface of revolution and is required to for collision checking. Without it, the volume of space between the end of the tool flutes and the spindle was not defined.

Added maximum deviation parameters for cutter contact and cutter location trajectory toolpath application objects. These are necessary to permit controllers to make reasonable tradeoffs between accuracy and speed.

Added machine axis constraint description for limiting the solution space for axis motion on machines which might have multiple tool position solutions.

Added new AIM subtypes of product called machining_setup and machining_project. These replace the use of product category for Setup and Project. Constraints handled by the following global rules have been folded into the new subtypes as local rules and the globals have been eliminated.

- RULE machining_project_requires_owner
- RULE machining_project_requires_release_date
- RULE machining_project_requires_workplan
- RULE machining_setup_requires_security_plane

Changed machining_operator_instruction so that it is now a subtype of action_method_with_associated_documents. Updated the mapping for the document attribute to use the inherited set of documents rather than a document assignment.

Clarified the slot to slot_end mapping. The name attribute of feature_component_relationship must be either "course of travel start" or "course of travel end", but was not called out in the mappings.

The FDIS Part 111 definitions have changed dramatically between the v13 and v14 versions of the document. There is no longer a concept of a separate tool body object and all cutting_tool and component definitions have been removed from Part 10. This will require a change in all of the tool mappings but this has been deferred until an updated Part 121 is available that is compatible with the new Part 111.

Version 3.0, issued as wg3n1460 (2004-06-09)

Incorporated comments from NWI/CD ballot. Many editorial fixes and notes added, as well as more substantial changes described below. One of the more significant additions is the new "Fundamental concepts and assumptions" section which attempts to clarify the AIM representation of features and relationship to the ISO 14649 definitions. See 5.2.1 for more information.

Added support for the turning process data defined by ISO 14649-12 and 121. This results in three new mapping tables for the turning features, turning process data, and turning tools. The EXPRESS rules for some representation subtypes began to get lengthy, so we abstracted the common idioms into new "verify" functions. The following definitions are either new or have been updated to include new local rules for the turning model:

- ENTITY contouring_turning_operation
- ENTITY facing_turning_operation
- ENTITY grooving_turning_operation
- ENTITY knurling_turning_operation
- ENTITY machining_dwell_time_representation
- ENTITY machining_feed_speed_representation
- ENTITY machining_functions (updated)
- ENTITY machining_spindle_speed_representation
- ENTITY machining_technology (updated)
- ENTITY machining_tool (updated)
- ENTITY machining_tool_body_representation (updated)
- ENTITY machining_tool_dimension_representation (updated)
- ENTITY machining_workingstep (updated)
- ENTITY threading_turning_operation
- ENTITY turning_type_operation
- ENTITY turning_type_strategy

- FUNCTION get_related_amr
- FUNCTION verify_angle_measure_rep_item
- FUNCTION verify_length_measure_rep_item
- FUNCTION verify_linear_speed_measure_action_property
- FUNCTION verify_linear_speed_measure_rep_item
- FUNCTION verify_numeric_measure_action_property
- FUNCTION verify_optional_rep_item
- FUNCTION verify_pressure_measure_action_property
- FUNCTION verify_pressure_measure_rep_item
- FUNCTION verify_relating_type_for_amr
- FUNCTION verify_rep_desc_for_action_property
- FUNCTION verify_rep_type_for_action_property

- FUNCTION verify_ratio_measure_rep_item
- FUNCTION verify_required_related_amr
- FUNCTION verify_required_rep_item
- FUNCTION verify_rotary_speed_measure_action_property
- FUNCTION verify_rotary_speed_measure_rep_item
- FUNCTION verify_time_measure_rep_item

Added in additional ARM entities and the associated mappings to clarify the handling of approval data. The information requirements have been harmonized with the approval module (ISO 10303-1012).

Completed the mappings for all of the toolpath subtypes. For the toolpath its_type attribute we used the property name "movement type" rather than "trajectory type" to avoid confusion with the trajectory structure. Suggest the attribute be renamed in the ARM as well since we have two overlapping type notions: one from the structure (class hierarchy) and one from the attribute. Added local rules to the machining_toolpath and machining_toolpath_speed_profile_representation entities for the mappings.

Extended the mappings for transition features to allow both styles of relationships. Transition features as defined by ISO 14649-10 relate two features, but for compatibility with AP 224 and AP 214, transition features must also be allowed to relate two sets of faces. Relating two features is done in a way similar to compound feature. Corrected mappings for edge_round radius, first offset, and second offset that contained cut-and-paste errors from chamfer. Also, the ISO 14649 edge round is really equivalent to the AP 224 constant radius subtype of edge round, not the general case. Updated the mapping with the associated constraint on the shape_aspect description to bring this out.

Based on comments and discussions at the Seoul ISO, it became clear that the adaptive_control ARM concept was not a strategy, but rather, a type of machining technology. Deleted the subtype machining_adaptive_control_strategy (previously clause 5.2.3.1.46) and changed the mapping to go to a machining_technology instance with a description of "adaptive control". Also, based on those discussions, changed the machining_operator_instruction type to be a direct subtype of action_method rather than a subtype of machining process executable.

Added a new global rule restrict_unneeded_feature_usage which restricts the protrusion, marking, fillet, rib_top features that are present for compatibility with AP 224 until ISO 14649-10 or some other part requires them. A similar rule added to restrict the turning feature has been removed now that the turning model is present.

<u>Changes That Affect Existing Applications Based on the CD version</u>

When updating to the latest version of the AP 238 specification, an existing CD application or data file will need the following changes in order to conform to the DIS. The following lists the ARM attribute and the change that was made in the AIM mapping tables.

<u>FEEDS, SPEEDS, AND DWELLS</u>

Updated mappings for the feedrate, spindle, cutspeed, and dwell attributes to be consistent across both milling and turning. These now call for a special representation and name/description strings. The pair of either/or attributes feedrate/feed_per_tooth on milling_technology used to be separate properties but have been merged into one, called "feedrate". The either/or has been moved down into the representation. The spindle/cutspeed attributes also now map to a single "spindle" property.

<u>TECHNOLOGY.feedrate</u>

- Property name still "feedrate"
- Uses machining_feed_speed_representation
- rep and length measure both need names "feed speed"

<u>MILLING_TECHNOLOGY.feedrate_per_tooth</u>

- Property name changed to "feedrate"
- Uses machining_feed_speed_representation
- rep and length measure both need names "feed per tooth"

<u>MILLING_TECHNOLOGY.cutspeed</u>
<u>MILLING_TECHNOLOGY.spindle</u>

- Both now use property name "spindle"
- Uses machining_spindle_speed_representation
- For cutspeed rep name "cutting speed"
- For cutspeed measure rep item name "surface speed"
- For spindle rep name "spindle speed"
- For spindle measure rep item name "rotational speed"

<u>DRILLING_TYPE_OPERATION.dwell_time_bottom</u>

- Uses machining_dwell_time_representation
- rep and time measure both need names "dwell time"

<u>DRILLING_TYPE_OPERATION.feed_on_retract</u>

- Property name now "feedrate on retract"
- Uses machining_feed_speed_representation
- rep and ratio measure both need names "relative speed"

<u>DRILLING_TYPE_STRATEGY.reduced_cut_at_start</u>
<u>DRILLING_TYPE_STRATEGY.reduced_cut_at_end</u>

- Uses machining_spindle_speed_representation
- rep and ratio measure both need names "relative speed"

<u>DRILLING_TYPE_STRATEGY.reduced_feed_at_start</u>
<u>DRILLING_TYPE_STRATEGY.reduced_feed_at_end</u>

- Property name now "reduced feedrate at start"
- Property name now "reduced feedrate at end"
- Uses machining_feed_speed_representation
- rep and ratio measure both need names "relative speed"

<u>MULTISTEP_DRILLING.dwell_time_step</u>

- Uses machining_dwell_time_representation
- rep and time measure both need names "dwell time"

Changed the action_method description strings that indicate finishing or roughing operations. All operations now use "finishing" or "roughing". Previously, these were "finish milling" and "rough milling" but when adding the turning definitions were changed to a single set of strings consistant across all of the operations.

BOTTOM_AND_SIDE_FINISH_MILLING
BOTTOM_AND_SIDE_ROUGH_MILLING
PLANE_FINISH_MILLING
PLANE_ROUGH_MILLING
SIDE_FINISH_MILLING
SIDE_ROUGH_MILLING

- action_method.description now "finishing" for finish
- action_method.description now "roughing" for rough

The mapping for the tool dimension ARM concept has been changed to leave room for describing turning or other kinds of tools in the future. The machining_tool_dimension_representation AIM instance now requires representation.name = "milling". In the future, other kinds of tools will use a different name.

In mapping for TOOL_DIMENSION, the tool_top_angle was changed to tool_tip_half_angle. The attribute used to be called tool_top_angle, but was changed between DIS and FDIS versions of ISO 14649-111

TOOL_DIMENSION

- representation.name must now be "milling" (previously, it was unspecified)

TOOL_DIMENSION.tool_top_angle/tool_tip_half_angle

- angle measure name must now be "tool tip half angle" (attribute changed in 14649-111)

Corrected "if", "selective", and "while" mappings to use the name field of action_method_relationship like all other AMR mappings, rather than the description field. The sequential_method that relates an executable to a workplan now requires a name of "workplan element". Previously these did not require a name, but this change will distinguish them from sequential methods used for toolpaths and other relationships. Similarly, the mappings for "parallel" and "non-sequential" both call out a name of "concurrent element" for their entries.

IF_STATEMENT.true_branch
IF_STATEMENT.false_branch

- action_method_relationship.name of "true branch" (previously used description att instead)
- action_method_relationship.name of "false branch" (previously used description att instead)

SELECTIVE.its_elements

- action_method_relationship.name of "branch" (previously used description att instead)

WHILE_STATEMENT.body

- action_method_relationship.name of "body" (previously used description att instead)

WORKPLAN.its_elements
- action_method_relationship.name of "workplan element" (previously unspecified)

NON_SEQUENTIAL.its_elements
PARALLEL.branches
- action_method_relationship.name of "concurrent element" (previously unspecified)

As part of putting in the mapping for the new turning_workingstep concept, I realized that I had forgot to call out a description string to distinguish the existing mapping for machining_workingstep from that of the workingstep supertype concept (and then the new turning subtype). The mapping for machining_workingstep has been updated to call out an action_method.description = "machining", and the turning subtype calls out a description of "turning". This leave room in case other technology parts of ISO 14649 need to do similar things.

MACHINING_WORKINGSTEP
- action_method.description must now be "machining" (previously unspecified)

Slightly changed the way that features are related to machining workingstep and the new turning workingstep. The feature describing the actual volume removed by the machining operation in this workingstep is called "process feature". In a machining_workingstep there is one, and it is required. It is also possible to relate a set of features with the workingstep to document features visible on the final part that the machining operation contributes to. These are related with the name "final feature".   I have added an ARM definition for this to 4.2.

Also corrected EXPRESS rules for these relationships in machining_workingstep, which had reversed the -ED and -ING sides of the action method relationship from what was specified in the mapping tables.

MACHINING_WORKINGSTEP.its_feature
- action_method_relationship.name of "process feature"
  These relationships have changed to clear up confusion between process and final features. Now the its_feature attribute is always the thing machined (the process feature) and must always be present. It may appear that the "process" and "final" action method relationships have switched places, but in the current mapping you only look at the "process" one to machine. In the prior version, you needed to look at both to pick the right one.

MACHINING_WORKINGSTEP.final_features
- action_method_relationship.name of "final feature"
  New, a set of zero or more final part features. The "final" relationship is now only for tracability to the final design. Only the feature pointed to by the "process" relationship is machined.

Version 2.9, issued as wg3n1110 for NWI/CD ballot (2002-04-23)

Incorporated some corrections to the EXPRESS definitions of the rules. In particular, changed the return types for all of the verify_* functions from BOOLEAN to LOGICAL. Incorporated feedback recieved at the TC184/SC4 Spring 2002 meeting in Myrtle Beach. In particular, Turning features are present for compatibility with AP 224, but the restrict_turning_feature_use rule has been added to temporarily restrict their usage until ISO 14649-12 is complete.

Added an index to conform with clause 4.1.3 and 4.3.3 of the supplementary directives and cleaned up some editorial things.

Version 2.8, issued as wg3n1089 (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.

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.

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.