NISTIR 6005

Plant Spatial Configuration Application Protocol Version 1.1

Steven W. Kline
Mark E. Palmer

U.S. Department of Commerce
Technology Administration
National Institute of Standards and Technology
Building and Fire Research Laboratory
Gaithersburg, MD 20899

William Burkett
Diane Craig
Jack A. Skeels

Product Data Integration Technology, Inc.
Long Beach, CA 90802

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Long Beach, CA 90802

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U.S. Department of Commerce
William M. Daley, *Secretary*

Technology Administration
Mary L. Good, *Under Secretary for Technology*

National Institute of Standards and Technology
Robert E. Hebner, *Acting Director*

ABSTRACT

This document specifies the ISO 10303 application protocol (AP) for the exchange of spatial configuration information of process plants. This includes shape characteristics, spatial arrangement characteristics, and design and fabrication information for piping system components, and functional and stream information for piping and HVAC (heating, ventilating, and air conditioning) systems. Also included are shape and spatial arrangement characteristics of other related plant systems that impact the design and layout of piping systems.

This document describes the scope and information requirements for AP 227 and provides the Application Activity Model (AAM), Application Reference Model (ARM), and Application Interpreted Model (AIM) for the AP. The document follows the format and clause numbering scheme prescribed for this type of International Organization for Standardization (ISO) standard.

The *Plant Spatial Configuration Application Protocol*, Version 1.1 has been submitted to ISO TC184/SC4 for international review and balloting as an ISO Draft International Standard document.

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PREFACE

Industry and government require comprehensive and reliable information exchange mechanisms to effectively integrate computer-aided (CAx) systems and evolving information technologies. Subcommittee Four (Industrial data and global manufacturing programming languages) of the International Organization for Standardization (ISO) Technical Committee 184 (Industrial automation systems and integration), ISO TC184/SC4, is preparing ISO 10303, a set of international standards titled *Industrial automation systems and integration - Product data representation and exchange*. The set of proposed standards is informally known as STEP (STandard for the Exchange of Product model data).

ISO 10303 will provide a neutral mechanism for describing product data throughout the life cycle of a product, independent of any particular CAx system. ISO 10303 is suitable for file exchange and for implementing, sharing, and archiving product databases. The development of ISO 10303 is based upon the use of information models, a framework for product data modelling, formal data specification languages, and an architecture that separates information requirements from implementation methods.

A fundamental concept of STEP is the definition of application protocols (APs) as the mechanism for specifying information requirements and for ensuring reliable communication. An **application protocol** is a Part of ISO 10303 that defines the context, scope, and information requirements for designated application(s) and specifies the resource constructs used to satisfy these requirements. The scope of an AP is defined by the type of product, the supported stages in the life cycle of the product, the required types of product data, the uses of the product data, and the disciplines that use the product data. Additionally, an AP enumerates the conformance requirements for conformance testing of implementations of the AP.

Part 227 of ISO 10303, *Plant Spatial Configuration*, specifies an AP for the exchange of spatial configuration information of process plants. This document constitutes the version of the AP that has been submitted to ISO for international review and balloting as a Draft International Standard (DIS).

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The following individuals contributed to the development of this document:

Neal Appel	P.D.I.T., Inc.
Robert Beal	H.B. Zachry Company
Todd Bickel	Black & Veatch
John Cardinal	DuPont Information Systems
Edward Clapp	Autodesk, Inc.
Buddy Cleveland, Jr.	Jacobus Technology, Inc.
Richard Cue	EA Systems, Inc.
Bill Danner	NIST
Pepi Edlinger	Bechtel Corporation
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Keith Hone	CADCentre, Inc.
Ian Howell	Autodesk, Inc.
Bob Jones	Intergraph Corporation
Todd Joyner	H.B. Zachry Company
Susan Jones	Merck & Company, Inc.
Michelle Kieffer	Merck & Company, Inc.
Marcelo Lemos	Dassault Systemes of America
Stephen Lynch	Bechtel Corporation
Dennis Martens	The Pritchard Corporation
Bill Mitchell	John Brown E&C
Clarisse Molad	Black & Veatch
Larry Newland	Black & Veatch
Paul Niebling	Bechtel Corporation
Kent Reed	NIST
Mike Salomone	DuPont & Company, Inc.
Vahid Schricker	EA Systems, Inc.
Mike Scott	Bechtel Corporation
Roland Scott	Computervision
Steven Seelinger	Merck & Company, Inc.
Ed Seufert	Eastman Chemical Company
Nikolay Shulga	Bentley Systems, Inc.
Chet Tabaka	Jacobus Technology, Inc.
Kathy Tan	NIST
Tom Troesch	Dassault Systemes of America
John Voeller	Black & Veatch
Rebecca Ward	Bentley Systems, Inc.
Alan Wilson	Computervision
Yuhwei Yang	P.D.I.T., Inc.

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Foreword

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

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

International Standard ISO 10303-227 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

ISO 10303 consists of the following parts under the general title *Industrial automation systems and integration - Product data representation and exchange*:

- Part 1, Overview and fundamental principles;

- Part 11, Description methods: The EXPRESS language reference manual;

- Part 12, Description method: The EXPRESS-I language reference manual;

- Part 21, Implementation methods: Clear text encoding of the exchange structure;

- Part 22, Implementation method: Standard data access interface specification;

- Part 23, Implementation method: C++ language binding to the standard data access interface;

- Part 24, Implementation method: C language binding to the standard data access interface;

- Part 26, Implementation method: Interface definition language binding to the standard data access;

- Part 31, Conformance testing methodology and framework: General concepts;

- Part 32, Conformance testing methodology and framework: Requirements on testing laboratories and clients;

- Part 33, Conformance testing methodology and framework: Structure and use of abstract test suites;

- Part 34, Conformance testing methodology and framework: Abstract test methods;

- Part 35, Conformance testing methodology and framework: Abstract test methods for SDAI implementations;

- Part 41, Integrated generic resources: Fundamentals of product description and support;
- Part 42, Integrated generic resources: Geometric and topological representation;
- Part 43, Integrated generic resources: Representation structures;
- Part 44, Integrated generic resources: Product structure configuration;
- Part 45, Integrated generic resource: Materials;
- Part 46, Integrated generic resources: Visual presentation;
- Part 47, Integrated generic resource: Shape variation tolerances;
- Part 49, Integrated generic resource: Process structure and properties;
- Part 101, Integrated application resource: Draughting;
- Part 104, Integrated application resource: Finite element analysis;
- Part 105, Integrated application resource: Kinematics;
- Part 106, Integrated application resource: Building construction core model;
- Part 201, Application protocol: Explicit draughting;
- Part 202, Application protocol: Associative draughting;
- Part 203, Application protocol: Configuration controlled design;
- Part 204, Application protocol: Mechanical design using boundary representation;
- Part 205, Application protocol: Mechanical design using surface representation;
- Part 207, Application protocol: Sheet metal die planning and design;
- Part 208, Application protocol: Life cycle management - Change process;
- Part 209, Application protocol: Composite and metallic structural analysis and related design;
- Part 210, Application protocol: Electronic assembly, interconnect, and packaging design;
- Part 212, Application protocol: Electrotechnical design and installation
- Part 213, Application protocol: Numerical control process plans for machined parts;
- Part 214, Application protocol: Core data for automotive design;
- Part 215, Application protocol: Ship arrangement;

- Part 216, Application protocol: Ship moulded forms;

- Part 217, Application protocol: Ship piping;

- Part 218, Application protocol: Ship structures;

- Part 220, Application protocol: Process planning, manufacture, and assembly of layered electronic products;

- Part 221, Application protocol: Functional data and their schematic representation for process plant;

- Part 222, Application protocol: Exchange of product data for composite structures;

- Part 223, Application protocol: Exchange of design and manufacturing product information for casting parts;

- Part 224, Application protocol: Mechanical product definition for process plans using machining features;

- Part 225, Application protocol: Building elements using explicit shape representation;

- Part 226, Application protocol: Ship mechanical systems;

- Part 227, Application protocol: Plant spatial configuration;

- Part 228, Application protocol: Building services: Heating, ventilation, and air conditioning;

- Part 229, Application protocol: Exchange of design and manufacturing product information for forged parts;

- Part 230, Application protocol: Building structural frame: Steelwork;

- Part 231, Application protocol: Process engineering data: Process design and process specification of major equipment;

- Part 232, Application protocol: Technical data packaging core information and exchange;

- Part 301, Abstract test suite: Explicit draughting;

- Part 302, Abstract test suite: Associative draughting;

- Part 303, Abstract test suite: Configuration controlled design;

- Part 304, Abstract test suite: Mechanical design using boundary representation;

- Part 305, Abstract test suite: Mechanical design using surface representation;

- Part 307, Abstract test suite: Sheet metal die planning and design;

- Part 308, Abstract test suite: Life cycle management - Change process;

- Part 309, Abstract test suite: Composite and metallic structural analysis and related design;

- Part 310, Abstract test suite: Electronic assembly, interconnect, and packaging design;

- Part 312, Abstract test suite: Electrotechnical design and installation;

- Part 313, Abstract test suite: Numerical control process plans for machined parts;

- Part 314, Abstract test suite: Core data for automotive mechanical design;

- Part 315, Abstract test suite: Ship arrangement;

- Part 316, Abstract test suite: Ship moulded forms;

- Part 317, Abstract test suite: Ship piping;

- Part 318, Abstract test suite: Ship structures;

- Part 320, Abstract test suite: Process planning, manufacture, and assembly of layered electronic products;

- Part 321, Abstract test suite: Functional data and their schematic representation for process plant;

- Part 322, Abstract test suite: Exchange of product data for composite structures;

- Part 323, Abstract test suite: Exchange of design and manufacturing product information for casting parts;

- Part 324, Abstract test suite: Mechanical product definition for process plans using machining features;

- Part 325, Abstract test suite: Building elements using explicit shape representation;

- Part 326, Abstract test suite: Ship mechanical systems;

- Part 327, Abstract test suite: Plant spatial configuration;

- Part 328, Abstract test suite: Building services: Heating, ventilation, and air conditioning;

- Part 329, Abstract test suite: Exchange of design and manufacturing product information for forged parts;

- Part 330, Abstract test suite: Building structural frame: Steelwork;

- Part 331, Abstract test suite: Process engineering data: Process design and process specification of major equipment;

- Part 332, Abstract test suite: Technical data packaging core information and exchange;
- Part 501, Application interpreted construct: Edge-based wireframe;
- Part 502, Application interpreted construct: Shell-based wireframe;
- Part 503, Application interpreted construct: Geometrically bounded 2D wireframe;
- Part 504, Application interpreted construct: Draughting annotation;
- Part 505, Application interpreted construct: Drawing structure and administration;
- Part 506, Application interpreted construct: Draughting elements;
- Part 507, Application interpreted construct: Geometrically bounded surface;
- Part 508, Application interpreted construct: Non-manifold surface;
- Part 509, Application interpreted construct: Manifold surface;
- Part 510, Application interpreted construct: Geometrically bounded wireframe;
- Part 511, Application interpreted construct: Topologically bounded surface;
- Part 512, Application interpreted construct: Faceted boundary representation;
- Part 513, Application interpreted construct: Elementary boundary representation;
- Part 514, Application interpreted construct: Advanced boundary representation;
- Part 515, Application interpreted construct: Constructive solid geometry;
- Part 517, Application interpreted construct: Mechanical design geometric presentation;
- Part 518, Application interpreted construct: Mechanical design shaded representation.

The structure of this International Standard is described in ISO 10303-1. The numbering of the parts of the International Standard reflects its structure:

- Parts 11 to 12 specify the description methods,
- Parts 21 to 26 specify the implementation methods,
- Parts 31 to 35 specify the conformance testing methodology and framework,
- Parts 41 to 49 specify the integrated generic resources,
- Parts 101 to 106 specify the integrated application resources,
- Parts 201 to 232 specify the application protocols,

- Parts 301 to 332 specify the abstract test suites, and

- Parts 501 to 518 specify the application interpreted constructs.

Should further parts of ISO 10303 be published, they will follow the same numbering pattern.

Annexes A, B, C, D, and E form an integral part of this part of ISO 10303. Annexes F, G, H, J, K, L, M, and N are for information only.

Introduction

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

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

This part of ISO 10303 specifies an application protocol (AP) for the exchange of the spatial configuration information of process plants. This information includes the shape and spatial arrangement characteristics of piping system components as well as the shape and spatial arrangement characteristics of other related plant systems (i.e., electrical, instrumentation and controls, and structural systems) that impact the design and layout of piping systems. In the design and fabrication of a piping system, the piping layout must be evaluated with respect to the spatial characteristics and arrangement of these related plant systems, and the requirements for clearances between systems. The complete specification of these other systems is not needed, but enough spatial information is needed to support the layout of the piping system.

This AP specifies additional requirements for the exchange of information required for the design and fabrication of a piping system. This includes information on the piping material, process stream fluid, and the piping system functional characteristics. A process and system design specifies process requirements for a piping system that includes pipe size, design temperatures and pressures, and insulation class. The physical design uses these process requirements for the design of the piping system.

This AP also identifies and provides a functional specification of the components of the plant piping system. The design information for a piping system may specify a pump capable of maintaining a pressure and flow rate. The design will also specify the shape limitations or requirements and the location of the pump in the system, but not sufficient information for the fabrication of the pump.

The principle focus of the AP is on piping systems and the shape and spatial arrangement of systems including plant items required to ensure the physical integrity of piping systems. Figure 1 contains a data planning model that provides a high level description of the requirements for this application protocol, as well as the relationships between the basic data components. The data planning model illustrates that a plant consists of plant items and that plant items may be connected to one another using connectors on the plant item. The data planning model also illustrates significant concepts found on piping and instrumentation diagrams (P&IDs): the functional view of the piping system (piping system functional characterization) and one kind of plant item: piping components. The shape and spatial arrangement of plant items are represented by the item shape. The shape representation may use constructive solid geometry (CSG), solid boundary representation (B-rep) geometry, wireframe geometry, or combinations of these. The plant item shape may be represented at various levels of abstraction, from an encompassing envelope to a detailed design description. The data planning model further illustrates that the concept of change is a requirement for this application protocol. Change

is applicable to each individual plant item, the relationships between plant items, and to groupings of plant items. It applies to all the concepts noted on the data planning model.

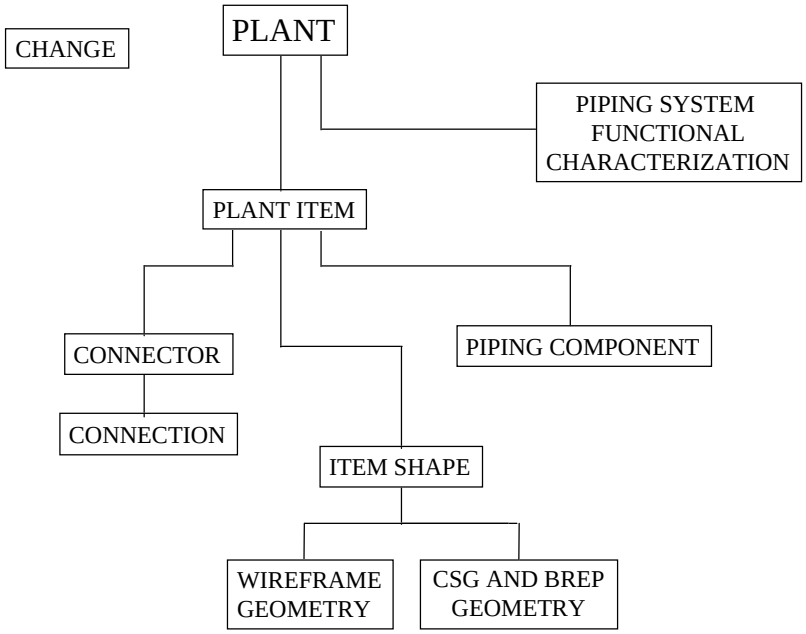

Figure 1 - Data planning model

NOTE - This part of ISO 10303 may be used in conjunction with ISO 13584 [13] to identify catalogue items (Parts Libraries) and classifications, and with ISO 10303-221, annex M [3], to classify plant items, plants, plant systems, and connectors. Refer to annex K for more details.

This application protocol defines the context, scope, and information requirements for the exchange of design and layout information for a plant piping system between different agents over the life cycle of a plant and specifies the integrated resources necessary to satisfy these requirements. The reasons for exchanging this information include:

- Exchange of requirements from a plant owner to an architectural engineering (AE) firm;

- Exchange of process requirements for the plant piping system from a process engineer to a system design engineer;

- Integration of designs created by different engineers;

- Detection of physical interferences of plant piping system components with components of other plant systems;

- Exchange of construction specifications between AE and construction firms.

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. A tiled "wallpaper" version of the application reference model (ARM) is given in annex M.

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 D.

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SUBMITTED FOR BALLOT AS AN ISO DRAFT INTERNATIONAL STANDARD

Industrial automation systems and integration - Product data representation and exchange - Part 227: Application protocol: Plant spatial configuration

1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for the exchange of spatial configuration information of process plants. The spatial configuration information focuses on the shape and spatial arrangement of the components of the plant piping systems. Components of the plant piping system include pipes, fittings, pipe supports, valves, in-line equipment, and in-line instruments. However, shape and spatial configuration information for equipment and non-piping plant systems are also included in this part of ISO 10303. The spatial configuration information principally supports the plant engineering design life-cycle phases, but may be useful in the downstream life-cycle phases of installation and maintenance.

NOTES

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.

2 - Figure 2 illustrates the basic life-cycle stages of a process plant. Physical design life-cycle phases are enclosed in a box labeled AP 227 - Plant Design (solid line). Downstream life-cycle phases that may be useful are enclosed in a box labeled AP 227 (dashed line).

3 - Design of piping systems includes the determination of the requirements of piping components, such as block valves, bypass valves, vents and drains, in-line instrumentation, and instrument taps, and their topological sequences. These piping component requirements and sequences are the starting point of the activities covered by this part of ISO 10303.

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

- The shape and spatial arrangement of plant items in plant systems within the process plant;

- Explicit representation of the 3D shape of plant piping systems;

- Explicit representation of the 3D external shape of plant piping system components and equipment. The representation may include envelope, outline and detailed representations as well as a parametric representation of the external shape.

- The functional configuration of the plant piping system and the relationship of the functional configuration to the planned physical piping system design;

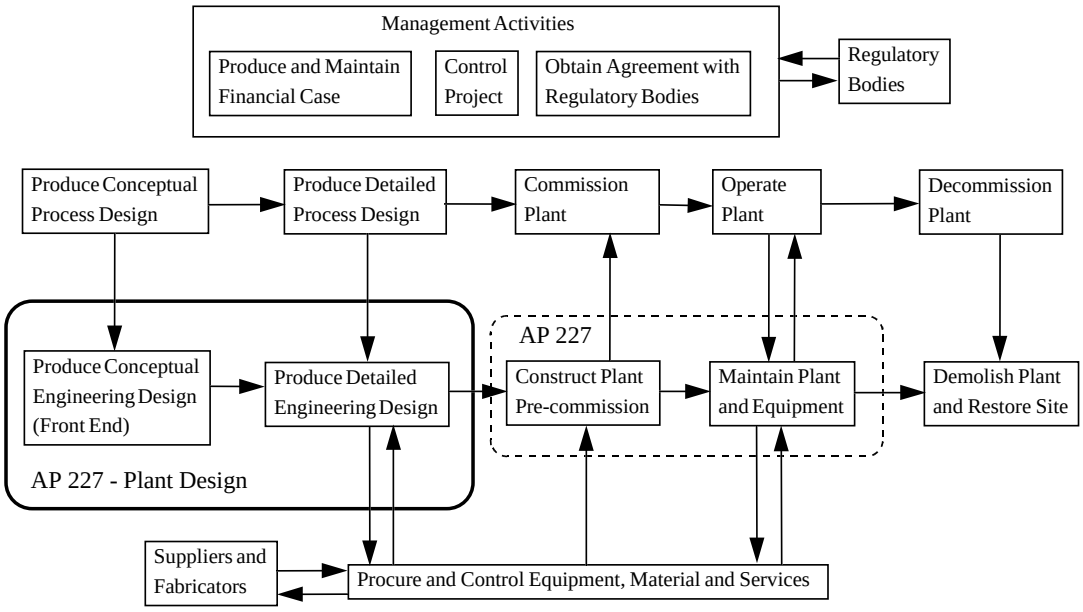

Figure 2 - Life Cycle Activity Coverage

NOTES

4 - The functional configuration overlaps the requirements specified in ISO 10303-221 [3]. Figure 3 illustrates areas of overlap between this part of ISO 10303 and ISO 10303-221 [3] and ISO 10303-231 [12].

5 - The functional configuration entails connectivity, sequencing, pipe size, pipe schedule, and flange class, and may include other information, such as equipment tag numbers and requirements to perform consistency checks between the functional and physical representations of the design.

- Basic engineering data as needed for spatial layout and configuration of the plant piping system;

- References to functional requirements of the plant piping system, such as stream data and operational characteristics;

- References to or designation of functional characteristics of piping components and connected equipment as required for piping design;

- The identification, shape, location, and orientation of reserved areas, volumes, and space-occupying elements of a plant;

- References to specifications, standards, guidelines, or regulations, for the plant piping systems, components, or connected equipment that may specify physical characteristics of the system or component;

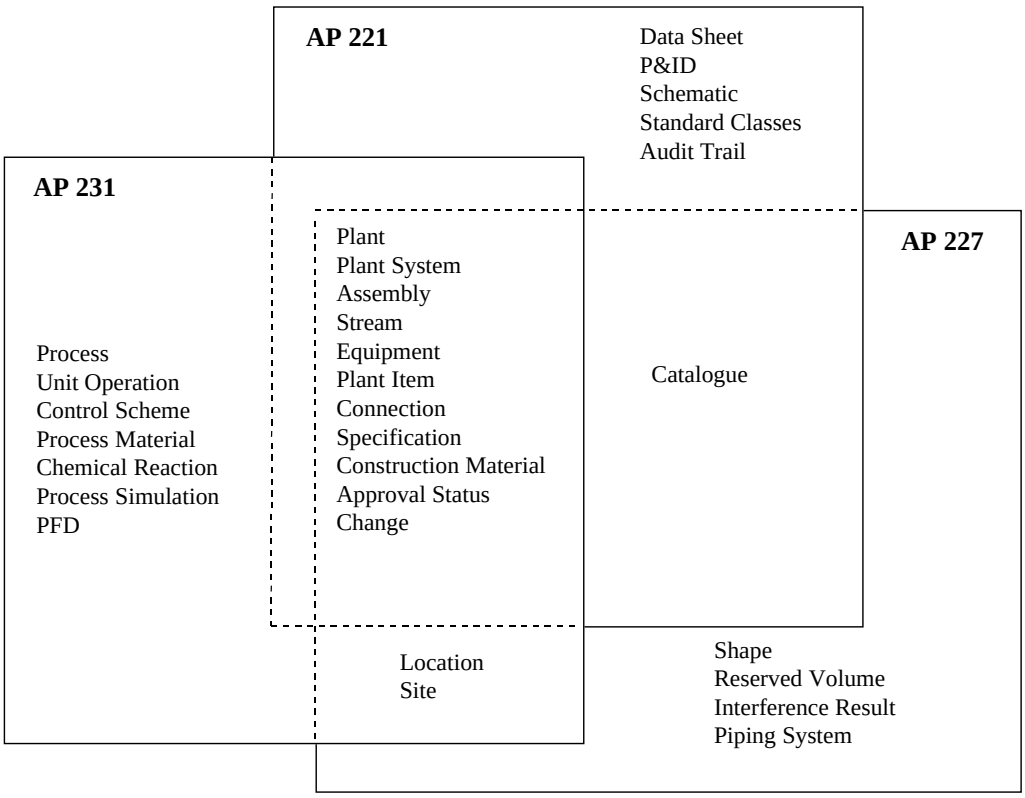

Figure 3 - Process Plant AP Coverage and Overlaps

EXAMPLES

1 - Physical characteristics include material and welding requirements.

2 - References to standards include ISO 10303-221 [3] and ISO 13584 [13].

- The identification of catalogue information associated with a piping component;

- The identification of catalogues that contain piping component definitions;

- Status of piping components and connected equipment and of their spatial arrangement;

NOTE 6 - Status labels are used by project management to monitor and control the execution of the project. Labels such as "preliminary", "in-work", and "released for design" are used to designate the degree of completeness or suitability for further action of the design or layout that the label is applied to.

- Connections and connection requirements for piping components and equipment;

- Definition of piping components in sufficient detail to support the acquisition of the components;

- Change request approval, notification, and verification, tracking of differences between versions of piping system information, and tracking of changes to plant items and attributes of plant items;

NOTE 7 - Only the specific change information described in this part of ISO 10303 is in scope. The change process itself is not in scope.

- Specification of the chemical composition of the streams carried by the plant piping systems in sufficient detail to evaluate the suitability of piping components for the desired process;

- Data exchange.

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

- Schematic representations;

EXAMPLE 3 - Schematic representations include P&IDs and process flow diagrams (PFDs).

- The contents of specifications, standards, guidelines, or regulations;

- Engineering and design of non-piping plant items;

- Preparation of piping specifications;

- Logistics and materials management;

- Detailed information required for the assembly and erection of piping systems except for shape, location, orientation, and connectivity of the components of the system;

- Information required for the assembly and erection of non-piping plant systems or the manufacture of components of these systems;

- Specification of the chemical composition of the streams carried by the plant piping system in sufficient detail for process flow design;

- Process design and conceptual engineering;

EXAMPLE 4 - Process design includes activities such as process material and heat balances, process flow diagram development, and determination of equipment sizes.

- Fabrication and installation information beyond the shape and spatial arrangements of piping components and the definition of piping spools;

- Testing, commissioning, handover, maintenance, and disposal of a plant;

- Plant operating procedures;

- Commercial aspects of procurement and contracting;

EXAMPLE 5 - Commercial aspects include pricing, terms and conditions, and payment schedules.

- Information necessary to manage the evolution and growth of data sets through the life-cycle of a product or project other than indications of changes and approvals;

- History data;

- Internal design and maintenance of equipment.

NOTE 8 - This part of ISO 10303 is not intended to support the detailed design of plant items especially for the manufacture of the plant item. However, some complex plant items may be treated as self-contained plants because they have internal piping, connections, and instrumentation, just like a plant. The detailed design of those plant items is supported by this part of ISO 10303.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10303. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10303 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 8824-1:1995, *Information technology - Open systems interconnection - Abstract syntax notation one (ASN.1): Specification of basic notation.*

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

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

ISO 10303-21:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 21: Implementation methods: Clear text encoding of the exchange structure.*

ISO 10303-31:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 31: Conformance testing methodology and framework: General concepts.*

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

ISO 10303-42:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 42: Integrated generic resources: Geometric and topological representation.*

ISO 10303-43:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 43: Integrated generic resources: Representation structures.*

ISO 10303-44:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 44: Integrated generic resources: Product structure configuration.*

ISO 10303-45:-[1], *Industrial automation systems and integration - Product data representation and exchange - Part 45: Integrated generic resources: Materials.*

ISO 10303-46:1994, *Industrial automation systems and integration - Product data representation and exchange - Part 46: Integrated generic resources: Visual presentation.*

ISO 10303-47:-[1], *Industrial automation systems and integration - Product data representation and exchange - Part 47: Integrated generic resources: Shape variation tolerances.*

ISO 13584-24:1995, *Industrial automation systems and integration - Parts library - Part 24: Logical model of supplier library.*

ISO 13584-42:1995, *Industrial automation systems and integration - Parts library - Part 42: Methodology for structuring part families.*

3 Definitions and abbreviations

3.1 Terms defined in ISO 10303-1

This part of ISO 10303 makes use of the following terms defined in ISO 10303-1:

- abstract test suite (ATS);
- application;
- application activity model (AAM);
- application interpreted model (AIM);
- application protocol (AP);
- application reference model (ARM);
- conformance class;
- implementation method;
- integrated resource;
- product;
- product data;

[1] To be published.

- protocol information and conformance statement (PICS);

- unit of functionality (UoF).

3.2 Terms defined in ISO 10303-31

This part of ISO 10303 makes use of the following terms defined in ISO 10303-31:

- conformance testing;

- implementation under test (IUT).

3.3 Other definitions

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

3.3.1 actual: descriptive adjective that, when applied to an item, indicates that the item exists at some time in the real world. An actual plant item (see 3.3.32) has properties that can be measured or observed.

NOTES

1 - The terms actual, planned (see 3.3.31), and required (see 3.3.41) loosely reflect life-cycle stages of an item.

2 - Within the scope of this part of ISO 10303, being actual can be specified for an item that is:

- a plant item;

- an association between plant items such as a connection;

- an activity or an association between a plant item and an activity;

- a possession of a property by a plant item or activity.

3 - An item cannot be both actual and planned. An actual item can be the realisation of an planned item.

3.3.2 assembly: a set of items that have a relationship to each other apart from being members of the same set.

NOTE - Within the scope of this part of ISO 10303, an assembly can be items that are plant items (see 3.3.32).

3.3.3 basic engineering data: parameters and descriptions that specify design (see 3.3.11) characteristics and boundaries for the plant item (see 3.3.32) that are required to support piping system (see 3.3.30) design.

EXAMPLE 6 - Piping system design parameters and descriptions include design temperature, design pressure, design codes, and weights.

3.3.4 branch: a portion of a piping system (see 3.3.30) that diverges or divides from the main flow path.

NOTE - A branch may have a different identifier from that of the main flow path.

3.3.5 catalogue: a collection (see 3.3.6) of items or an electronic or paper document that contains information about a collection of items.

NOTE - Within the scope of this part of ISO 10303, a catalogue can be a collection of typical or reference plant items (see 3.3.32), that the definition of a specific occurrence of a plant item in the design (see 3.3.11) of a process plant (see 3.3.37) can be selected from.

3.3.6 collection: a set of things that do not have any relationship to each other apart from being members of the same set.

NOTE - Within the scope of this part of ISO 10303, a collection can be items that are plant items (see 3.3.32).

3.3.7 component: an item that may be part of another item.

NOTES

1 - Within the scope of this part of ISO 10303, an item that is a component can be part of a functional (see 3.3.13) or physical (see 3.3.24) plant item (see 3.3.32) or part of a process material (see 3.3.36) that is a mixture.

2 - A component can itself have components.

3.3.8 connection: an association between two items that enables the flow of process material (see 3.3.36), energy, mechanical loads, or signals between them or constrains their relative positions.

NOTES

1 - Within the scope of this part of ISO 10303, a connection can be between either functional (see 3.3.13) or physical (see 3.3.24) plant items (see 3.3.32).

2 - A connection can be the result of a physical joining.

3 - A functional connection can exist between two plant items without a physical joining of the plant items.

3.3.9 connector: a physical (see 3.3.24) or functional (see 3.3.13) property of a plant item (see 3.3.32) that links it to another plant item, or to a compatible connector on another plant item. This linkage enables the flow of energy, mechanical loads, process material (see 3.3.36), or signals through the connected plant items.

NOTES

1 - A connector may be a complete assembly (see 3.3.2) involving multiple physical (see 3.3.24) connectors and plant items (see 3.3.32).

2 - A piping connector may enable several distinct flows of process material (see 3.3.36), e.g., a manifold. An electrical connector may enable several distinct flows of electric current.

3 - The term "port" is often used within the process plant industry in place of the term connector when referring to the functional (see 3.3.13) aspects of the connector.

3.3.10 construction material: the substance or substances that a physical (see 3.3.24) plant item (see 3.3.32) is made from.

3.3.11 design: a representation (see 3.3.40) of a process plant (see 3.3.37), portion of a process plant, or plant item (see 3.3.32), that is created for a specific purpose and uses a consistent syntax and symbology.

NOTE - A PFD is a design that represents the flow and reaction of process materials (see 3.3.36). A P&ID is a design that represents the logical functionality of a piping system (see 3.3.30). A three-dimensional geometric model is a design that represents the physical (see 3.3.24) shape and arrangement of the components (see 3.3.7) of a process plant or plant system (see 3.3.33). The purpose of all these designs is analysis and specification of a process plant, portion of a process plant, or plant item.

3.3.12 equipment: a plant item (see 3.3.32) that carries out an operation on the process material (see 3.3.36) and that is treated as a single item for the purpose of design (see 3.3.11), acquisition, or operation.

NOTE - An equipment has both physical (see 3.3.24) and functional (see 3.3.13) aspects.

3.3.13 functional: descriptive adjective that, when applied to an item, refers to the actions, activities, or capabilities, that the item provides or may provide to fulfill a purpose.

NOTE - In the process plant industry, a plant item (see 3.3.32) that provides functional capability in a process plant (see 3.3.37) is typically denoted by a tag number.

3.3.14 functional characteristics: nomenclature, codes, and named values that describe or specify the performance or behaviour of a plant item (see 3.3.32).

EXAMPLE 7 - Functional characteristics include flow rates, operating pressure, and maximum temperature.

3.3.15 functional requirements: nomenclature, codes, and named values that describe or specify the performance or behaviour to be met by a plant item (see 3.3.32).

3.3.16 instrument: an individually identifiable plant item (see 3.3.32) or combination of plant items, that is part of a system that monitors or controls a process plant (see 3.3.37).

EXAMPLE 8 - Instruments include items such as control valves, sensors, and gauges.

3.3.17 insulation: a quantity of matter or space that provides resistance to the flow of heat, electricity, sound, or mechanical vibration.

3.3.18 line: a logical component (see 3.3.7) of a piping system (see 3.3.30) that is composed of a collection (see 3.3.6) of line segments (see 3.3.19).

NOTE - Further explanation of lines and line segments is provided in K.7.

3.3.19 line segment: an element of a line (see 3.3.18, 4.2.120).

3.3.20 line segment termination: one of two logical end-points of a line segment (see 3.3.19).

NOTE - Lines (see 3.3.18, 4.2.120) are composed of line segments. Line segments are connected through line segment terminations.

3.3.21 line segment termination connection: a logical linkage between two line segments (see 3.3.19) or between a line segment and a plant item (see 3.3.32).

3.3.22 material: a quantity of matter.

3.3.23 material stream: a flow of process material (see 3.3.36) past a defined point along a path.

3.3.24 physical: descriptive adjective that, when applied to an item, refers to a set of characteristics, properties, or traits of the item.

EXAMPLE 9 - Characteristics include weight, size, and location and orientation of the item.

NOTE - In the process plant industry, a physical object that is, or may be, installed as a plant item (see 3.3.32), can be identified by a serial number.

3.3.25 pipe: a plant item (see 3.3.32) that is hollow and approximately cylindrical, that may have a constant cross-section along its extent, and that conveys fluid, vapour, or particulate material (see 3.3.22).

NOTE - Heating, ventilation, and air conditioning (HVAC) duct that has a rectangular cross section is not a pipe.

3.3.26 pipe fitting: a plant item (see 3.3.32) that is used, or is intended to be used, to join or terminate pipes (see 3.3.25, 4.2.153) or other items in a piping system (see 3.3.30) or equipment (see 3.3.12, 4.2.73) connectors (see 3.3.9), or to provide changes of pipe direction or branching within a piping system.

3.3.27 piping and instrumentation diagram: a schematic representation (see 3.3.40) that consists, as a minimum, of the functional (see 3.3.13) connection (see 3.3.8) and assembly (see 3.3.2) of plant items (see 3.3.32), and the identification of principal plant items.

NOTE - The piping and instrumentation diagram can also present the functional and physical (see 3.3.24) aspects of plant items.

3.3.28 piping class: a functional (see 3.3.13) performance envelope defined by a set or range of common physical (see 3.3.24) properties, and an identification of the pipes (see 3.3.25, 4.2.153), pipe fittings (see 3.3.26), and valves that have these properties.

EXAMPLES

10 - Piping classes include stainless steel, cast iron, and carbon steel.

11 - Physical properties of a piping class include diameter, pressure, and temperature.

3.3.29 piping specification: a definition of various aspects of a piping system (see 3.3.30). It is also used to refer to a document or electronic file that contains such a definition.

NOTE - Piping system aspects that may be included in a piping specification include design pressures and temperatures, piping construction materials (see 3.3.10), pipe wall thicknesses or schedules, types of fittings to be used, types of valves and flanges, valve and flange pressure rating requirements, and fabrication, examination, testing, inspection, cleaning, and installation requirements, including the requirements for seismic installations, where applicable.

3.3.30 piping system: a plant system (see 3.3.33) that performs a transport function, and that is composed primarily of pipes (see 3.3.25, 4.2.153), pipe fittings (see 3.3.26), and valves subject to the same set or sets of design (see 3.3.11) conditions.

3.3.31 planned: descriptive adjective that, when applied to an item, indicates that an item that has been designed or predicted.

NOTES

1 - The terms actual (see 3.3.1), planned, and required (see 3.3.41) loosely reflect life-cycle stages of an item.

2 - Within the scope of this part of ISO 10303, being planned can be specified for an item that is:

- a plant item (see 3.3.32);

- an association between plant items such as a connection (see 3.3.8);

- an activity or an association between a plant item and an activity;

- a possession of a property by a plant item or activity.

3 - An item cannot be both actual and planned. An actual item can be the realisation of a planned item.

3.3.32 plant item: a physical (see 3.3.24) object or volume of space that is, or is intended to be, a part of a process plant (see 3.3.37). A plant item can be an assembly (see 3.3.2) of other plant items. A plant item has both physical and functional (see 3.3.13) aspects.

NOTE - If a plant item is a volume of space, it may or may not contain other plant items.

3.3.33 plant system: a part of a process plant (see 3.3.37) that provides or performs, or is intended to provide or perform, a service or function contributing to, or enabling the operation of, a process

plant. A plant system consists of an assembly (see 3.3.2) of one or more plant items (see 3.3.32). A plant system has both physical (see 3.3.24) and functional (see 3.3.13) aspects.

3.3.34 process activity: an activity that transforms or transports process material (see 3.3.36) between its input to a process plant (see 3.3.37) as feed stock and its output from a process plant as a product or waste.

NOTE - The transformation can be a change of physical (see 3.3.24) state, a physical separation or mixing, or a biological or chemical process.

3.3.35 process flow diagram: a schematic representation (see 3.3.40) that consists, as a minimum, of the connection of process activities (see 3.3.34) by material streams (see 3.3.23) and the identification of plant items (see 3.3.32) that perform the process activities.

NOTES

1 - The process activities shown on a process flow diagram can also be called unit operations.

2 - The process flow diagram can also present:

- properties of process activities and material streams for particular cases;
- measurements that are made upon process activities and material streams;
- the flow of signals between sensors, controllers, and actuators;
- the control logic that is implemented by a controller.

3.3.36 process material: the material (see 3.3.22) that is transformed or transported by a process activity (see 3.3.34).

3.3.37 process plant: an assembly (see 3.3.2) of one or more plant systems (see 3.3.33) and plant items (see 3.3.32) that can, or is intended to perform, a chemical, physical (see 3.3.24) or transport process. A process plant is identified as a single unit for the purposes of management and ownership. A process plant has both physical and functional (see 3.3.13) aspects.

3.3.38 range of values: a specification of a value range for a given dimension, parameter, or nominal size, for the purpose of defining a family of plant items (see 3.3.32).

NOTE - This is done by specifying two dimensional values for a given parameter. One dimension has a name with a value of minimum_<parameter name>, such as minimum_flange_inside_diameter. The other dimension has a name with a value of maximum_<parameter name>, such as maximum_flange_-inside_diameter.

3.3.39 range value: an indication of variation of a dimension, parameter, or nominal size on an actual physical (see 3.3.24) plant item (see 3.3.32). A range value is not a toleranced dimension. A range value, like the range of values (see 3.3.38), has a minimum and maximum value. It does not, however, indicate a family of plant items.

NOTE - The attributes that use range values in 4.2 are differentiated from the attributes those that use range of values by a explanatory note that follows the attribute definition.

EXAMPLE 12 - Insulation (see 3.3.17, 4.2.114) may be described as 6 inches thick, but in reality it may be 5-7 inches thick. Range values permit this to be specified.

3.3.40 representation: a description, drawing, or depiction of something.

3.3.41 required: descriptive adjective that, when applied to an item, indicates that an item is essential or necessary, i.e., it has to be provided to satisfy a functional (see 3.3.13) need.

NOTES

1 - The terms actual (see 3.3.1), planned (see 3.3.31), and required loosely reflect life-cycle stages of an item.

2 - Within the scope of this part of ISO 10303, being required can be specified for an item that is:

- a plant item (see 3.3.32);
- an association between plant items such as a connection (see 3.3.8);
- an activity or an association between a plant item and an activity;
- a possession of a property by a plant item or activity.

3.3.42 site: an area of land that one or more process plants (see 3.3.37) is or may be situated on.

3.3.43 spatial configuration: the location, orientation, and relative position of the components (see 3.3.7) of a plant system (see 3.3.33).

3.4 Abbreviations

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

AAM	application activity model
AE	architectural engineering
AEC	architecture, engineering, and construction
AIC	application interpreted construct
AIM	application interpreted model
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
AP	application protocol

ARM	application reference model
ASTM	American Society for Testing and Materials
ATS	abstract test suite
B-rep	boundary representation
BOP	bottom of pipe
CAD	computer-aided design
COP	centre of pipe
CSG	constructive solid geometry
ECN	engineering change notice
EPA	environmental protection agency
FDA	food and drug administration
GIS	geographic information system
HVAC	heating, ventilation, and air conditioning
id	identifier
ICOM	input, control, output, or mechanism
OSHA	occupational safety and health administration
PFD	process flow diagram
P&ID	piping and instrumentation diagram
PICS	protocol information and conformance statement
PIEBASE	process industry executive for achieving business advantage using standards for data exchange
PSI	pounds per square inch
UoF	unit of functionality
UTM	universal transverse mercator

4 Information requirements

This clause specifies the information required for the exchange of plant spatial configuration information between application systems.

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.

NOTES

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

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

3 - The mapping table specified in 5.1 shows how the integrated resources are used to meet the information requirements of this application protocol. The use of the integrated resources introduces additional requirements that are common to application protocols.

4.1 Units of functionality

This subclause specifies the UoFs for the plant spatial configuration application protocol. This part of ISO 10303 specifies the following units of functionality:

- change_information UoF;
- connection UoF;
- connector UoF;
- csg_and_b_rep_geometry UoF;
- piping_component_characterization UoF;
- piping_system_functional_characterization UoF;
- plant_characterization UoF;
- plant_item_characterization UoF;
- shape UoF;
- site_characterization UoF;
- wireframe_geometry UoF.

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 4.2.

4.1.1 change_information UoF

The change_information UoF describes information such as the design change requests and approvals for modifications to Plant objects, Plant_item objects, Plant_system objects, and other components associated with the Plant.

The following application objects are used by the change_information UoF:

- Change;
- Change_approval;
- Change_delta;
- Change_item;
- Change_life_cycle_stage;
- Change_life_cycle_stage_sequence;
- Change_life_cycle_stage_usage;
- Changed_line_assignment;
- Changed_line_branch_connection;
- Changed_line_plant_item_branch_connection;
- Changed_line_plant_item_connection;
- Changed_line_to_line_connection;
- Changed_piping_specification;
- Changed_piping_system_line;
- Changed_piping_system_line_segment;
- Changed_piping_system_line_segment_termination;
- Changed_planned_physical_plant;
- Changed_plant;
- Changed_plant_item;

- Changed_plant_item_collection;

- Changed_plant_item_connection;

- Changed_plant_item_connector;

- Changed_plant_item_location;

- Changed_plant_item_shape;

- Changed_plant_process_capability;

- Changed_plant_system;

- Changed_reference_geometry;

- Changed_required_material_description;

- Changed_site;

- Changed_site_feature;

- Changed_sited_plant;

- Changed_sub_plant_relationship.

4.1.2 connection UoF

The connection UoF describes the physical linkage or connectivity between Plant_item objects. Plant_item objects have connectors. Two connectors of a compatible type are attached to form a connection. The sequence of connections establishes the physical connectivity of items within Plant_-system objects.

The following application objects are used by the connection UoF:

- Connection_definition;

- Electricity_transference;

- Flexible_connection;

- Fluid_transference;

- Functional_connection_definition_satisfaction;

- Functional_connection_occurrence_satisfaction;

- Load_transference;

- Locked_orientation_connection;

- Plant_item_connection;

- Plant_item_connection_occurrence.

4.1.3 connector UoF

The connector UoF is the information about the part of a Plant_item that is intended to interconnect with another Plant_item. This UoF describes the physical features of Plant_item objects that are designed to connect or mate with a similar physical feature on another Plant_item object.

The following application objects are used by the connector UoF:

- Branch_hole;

- Buttweld;

- Catalogue_connector;

- Connector_definition;

- Electrical_connector;

- Female_end;

- Flanged;

- Flanged_end;

- Functional_connector;

- Functional_connector_definition_satisfaction;

- Functional_connector_occurrence_satisfaction;

- Male_end;

- Physical_connector;

- Piping_connector;

- Piping_connector_service_characteristic;

- Plant_item_connector;

- Plant_item_connector_occurrence;

- Pressure_fit;
- Service_operating_case;
- Socket;
- Structural_load_connector;
- Threaded.

4.1.4 csg_and_b_rep_geometry UoF

The csg_and_b_rep_geometry UoF specifies the representation of Plant_item shapes using CSG primitives or B-rep geometry and topology.

The following application objects are used by the csg_and_b_rep_geometry UoF:

- B_rep_element;
- Block;
- Circular_ellipsoid;
- Cone;
- Csg_element;
- Cylinder;
- Eccentric_cone;
- Eccentric_cylinder;
- Eccentric_pyramid;
- Extrusion;
- Hemisphere;
- Pyramid;
- Reducing_torus;
- Solid_of_revolution;
- Sphere;
- Square_to_round;

- Torus;

- Trimmed_block;

- Trimmed_cone;

- Trimmed_cylinder;

- Trimmed_pyramid;

- Trimmed_sphere;

- Trimmed_torus;

- Tube.

4.1.5 piping_component_characterization UoF

The piping_component_characterization UoF describes the individual elements of the Piping_system within a Plant. Piping_component objects include pipes, fittings, valves, in-line equipment, and other elements that regulate, control, or convey Piping_system fluids.

The following application objects are used by the piping_component_characterization UoF:

- Blank;

- Blind_flange;

- Bushing;

- Coupling;

- Cross;

- Eccentric_reducer;

- Eccentric_swage;

- Elbow;

- Expander_flange;

- Family_definition;

- Fitting;

- Flange;

- Gasket;
- Inline_equipment;
- Inline_instrument;
- Insert;
- Inside_and_thickness;
- Lap_joint_flange;
- Lap_joint_stub_end;
- Lateral;
- Mitre_bend_pipe;
- Nipple;
- Olet;
- Orifice_flange;
- Orifice_plate;
- Outside_and_thickness;
- Paddle_blank;
- Paddle_spacer;
- Pipe;
- Pipe_bend;
- Pipe_closure;
- Piping_component;
- Piping_size_description;
- Pressure_class;
- Reducer;
- Reducing_flange;
- Ring_spacer;

- Schedule;
- Slip_on_flange;
- Socket_weld_flange;
- Spacer;
- Specialty_item;
- Spectacle_blind;
- Straight_pipe;
- Swage;
- Swept_bend_pipe;
- Tee;
- Threaded_flange;
- Union;
- Valve;
- Weld_neck_flange;
- Y_type_lateral.

4.1.6 piping_system_functional_characterization UoF

The piping_system_functional_characterization UoF describes the functional connectivity of a Piping_-system and the functional connectivity among Plant_item objects in that system. This UoF provides the information that describes the functional links and properties of a flow stream in a Piping_system. It includes information about the segments in the line and the specifications for these segments, such as design criteria, service conditions, and line identifier.

The following application objects are used by the piping_system_functional_characterization UoF:

- Line_branch_connection;
- Line_branch_termination;
- Line_piping_system_component_assignment;
- Line_plant_item_branch_connection;

- Line_plant_item_branch_connector;

- Line_plant_item_connection;

- Line_plant_item_connector;

- Line_plant_item_termination;

- Line_to_line_connection;

- Line_to_line_termination;

- Piping_specification;

- Piping_system_line;

- Piping_system_line_segment;

- Piping_system_line_segment_termination;

- Segment_insulation;

- Stream_design_case;

- Stream_phase.

4.1.7 plant_characterization UoF

The plant_characterization UoF describes identifiable collections of Plant_item objects that perform specific functions within a plant. The Plant_item objects are functionally dependent on one another for the performance of the system and are interrelated through physical connections. The collection of Plant_system objects as a whole enables the Plant to operate.

The following application objects are used by the plant_characterization UoF:

- Ducting_system;

- Electrical_system;

- External_classification;

- Functional_plant;

- Functional_plant_satisfaction;

- Hvac_system;

- Instrumentation_and_control_system;

- Line_less_piping_system;

- Location_in_plant;

- Manufacturing_line;

- Piping_system;

- Planned_physical_plant;

- Plant;

- Plant_process_capability;

- Plant_system;

- Plant_system_assembly;

- Structural_system;

- Sub_plant_relationship;

- Train;

- Unit.

4.1.8 plant_item_characterization UoF

The plant_item_characterization UoF describes major elements that Plant objects and Plant_system objects are comprised of. These are items within a Plant that occupy space and possess physical, measurable characteristics. This UoF specifies spatial and physical information about Piping_system_-component objects and Equipment, but only spatial characteristics of components of other Plant_-system objects, such as HVAC and instrumentation.

This UoF describes the information and options associated with the specification of the substance or substances that a Plant_item is composed of. It also describes specification and catalogue information concerning piping components.

This UoF describes the spatial shape and position of volumes of space in a Plant.

NOTES

1 - Physical plant_items are things that can be touched.

2 - As used in this part of ISO 10303, material does not refer to the products that flow within plant systems.

The following application objects are used by the plant_item_characterization UoF:

- Cable_support;
- Catalogue_definition;
- Catalogue_item;
- Catalogue_item_substitute;
- Connected_collection;
- Design_project;
- Ducting_component;
- Electrical_component;
- Equipment;
- Equipment_breaching;
- Equipment_trim_piping;
- Functional_design_view;
- Functional_plant_item_satisfaction;
- Hierarchically_organized_collection;
- Hvac_component;
- Hvac_ducting;
- Installed_physical_design_view;
- Instrument;
- Instrumentation_and_control_component;
- Insulation;
- Jacketed_piping;
- Material_specification_selection;
- Material_specification_subset_reference;
- Offline_instrument;

- Physical_design_view;
- Piping_spool;
- Piping_spool_assignment;
- Piping_system_component;
- Planned_physical_plant_item;
- Plant_item;
- Plant_item_collection;
- Plant_item_definition;
- Plant_item_design_view;
- Plant_item_instance;
- Plant_item_location;
- Plant_item_weight;
- Plant_volume;
- Process_ducting;
- Project_design_assignment;
- Relative_item_location;
- Required_material_description;
- Reserved_space;
- Route;
- Spare_plant_item_usage;
- Structural_component;
- Supplied_equipment;
- Supplier;
- Support_component;
- Support_constraints;

- Support_usage;

- Support_usage_connection;

- System_space.

4.1.9 shape UoF

The shape UoF specifies the external shapes of components, assemblies of components, and volumes of a Plant. The external shape of a component can be specified as an envelope of the space occupied by a component, as an outline of the component, or as a detailed definition of the shape of a component.

The following application objects are used by the shape UoF:

- Detail_shape;

- Envelope_shape;

- Interfering_shape_element;

- Outline_shape;

- Plant_item_centreline;

- Plant_item_interference;

- Plant_item_interference_status;

- Plant_item_shape;

- Reference_geometry;

- Shape_interference_zone_usage;

- Shape_parameter;

- Shape_representation;

- Shape_representation_element;

- Shape_representation_element_usage.

4.1.10 site_characterization UoF

The site_characterization UoF describes the significant features of the Site where the Plant is located. It includes information about the site location, infrastructure like roads and sewers, buildings, and other structures located on the Site, and the shape of the terrain where a Building or Site_feature is located.

The following application objects are used by the site_characterization UoF:

- Breakline;
- Building;
- Facet_trigon;
- Faceted_surface_representation;
- Gis_position;
- Location_in_building;
- Location_in_site;
- Point_and_line_representation;
- Site;
- Site_feature;
- Site_shape_representation;
- Sited_plant;
- Survey_point.

4.1.11 wireframe_geometry UoF

The wireframe_geometry UoF specifies the representations of Plant_item shapes using wireframe geometry.

The following application objects are used by the wireframe_geometry UoF:

- Conic;
- Curve;
- Free_form_curve;
- Line;
- Point;
- Polygon;
- Surface;

- Vector;

- Wire_and_surface_element.

4.2 Application objects

This subclause specifies the application objects for the plant spatial configuration 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.

4.2.1 B_rep_element

A B_rep_element is a type of Shape_representation_element (see 4.2.213) that is composed of geometric and topological elements.

NOTE - A B_rep_element need not represent a solid shape.

4.2.2 Blank

A Blank is a type of Fitting (see 4.2.83) that is placed between two Flange (see 4.2.84) objects to block the flow of material between the pipelines on either side of the Blank. Each Blank may be one of the following: a Paddle_blank (see 4.2.149) or a Spectacle_blind (see 4.2.226).

The data associated with Blank are the following:

- outside_diameter;

- thickness.

4.2.2.1 outside_diameter

The outside_diameter specifies the external diameter of the Blank. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.2.2 thickness

The thickness specifies the distance between the two faces of the Blank. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.3 Blind_flange

A Blind_flange is a type of Flange (see 4.2.84) that is used to block material flow at a flanged connection.

4.2.4 Block

A Block is a type of Csg_element (see 4.2.55) that is a 3D right rectangular solid. A Block may be a Trimmed_block (see 4.2.252).

> NOTE - The size and shape of a Block is described by three real values representing the dimensions of the Block.

4.2.5 Branch_hole

A Branch_hole is a type of Piping_connector (see 4.2.157) end type that is a hole cut in a pipe for a branch connection.

> NOTE 1 - A Branch_hole is not typically a design feature of the pipe, but rather is added after the fact to create a branch from the pipe. The hole may be used for stub-in connections, or olets or nipples can be welded or screwed to it.

The data associated with branch_hole are the following:

- diameter.

The diameter specifies the diameter value of the branch_hole. It may be specified as a single value or as a range of values.

> NOTE 2 - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.6 Breakline

A Breakline is a contiguous set of straight line segments that designate a path across a Site_shape_-representation (see 4.2.217).

> NOTE - The path is a constraint on the mathematical interpolation of the surface of the terrain.

4.2.7 Building

A Building is a partially or totally enclosed structure located on a Site (see 4.2.215) that contains Plant_system (see 4.2.187) objects or provides supporting infrastructure within its boundaries.

The data associated with Building are the following:

- building_id;

- location_and_orientation;

- name;

- shape.

4.2.7.1 building_id

The building_id specifies a unique number used to identify the building.

4.2.7.2 location_and_orientation

The location_and_orientation specifies the position of the Building relative to the site coordinate system and the orientation of the Building relative to a specified direction.

> EXAMPLE 13 - E5704.35', N5912.87' are coordinates. They can be used to locate a known point in the Building (e.g., centrelines of column row 1A).

4.2.7.3 name

The name specifies a textual label given to the Building.

4.2.7.4 shape

The shape specifies the outline or characteristic surface configuration or contour of the building.

4.2.8 Bushing

A Bushing is a type of Fitting (see 4.2.83) with one external and one smaller internal end.

> NOTE - Figure 4 depicts a typical threaded hexagon Bushing. It is typically used to connect a smaller Pipe (see 3.3.25, 4.2.153) to a larger Fitting or nozzle.

The data associated with Bushing are the following:

- end_1_connector;

- end_2_connector;

- end_to_end_length.

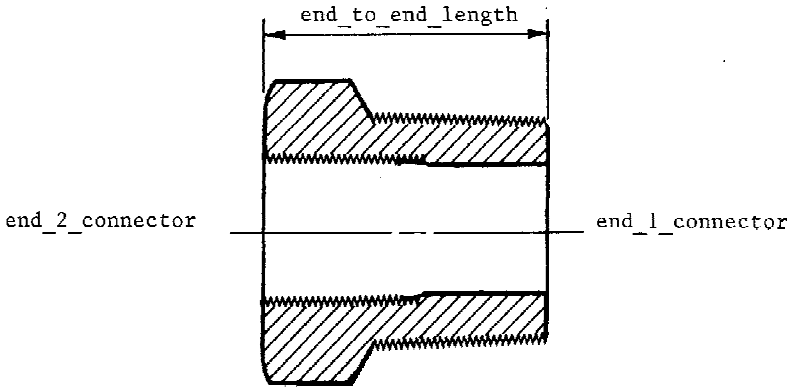

Figure 4 - Bushing

4.2.8.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) Male_end (see 4.2.137).

4.2.8.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) Female_end (see 4.2.82).

4.2.8.3 end_to_end_length

The end_to_end_length specifies the external length of the Bushing from the end-one face to the end-two face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.9 Buttweld

A Buttweld is a type of Piping_connector (see 4.2.157) that consists of the welding of two Piping_-component (see 4.2.156) objects where they are aligned edge to edge.

The data associated with Buttweld are the following:

- end_preparation.

The end_preparation specifies a description of the end of the connector that is necessary to prepare it for welding.

4.2.10 Cable_support

A Cable_support is a type of Support_component (see 4.2.238) that provides support to Electrical_-component (see 4.2.68) objects.

The data associated with Cable_support are the following:

- cable_support_type.

The cable_support_type specifies a description of the category of Cable_support.

4.2.11 Catalogue_connector

A Catalogue_connector is the definition or the reference of a Connector_definition (see 4.2.52). A Connector_definition may appear in a catalogue, or the properties of a Connector_definition may be drawn from a catalogue.

NOTE - A Catalogue_connector is analogous to a Catalogue_item (see 4.2.13) in that both have standardized characteristics.

4.2.12 Catalogue_definition

A Catalogue_definition is the identification of a document that lists Catalogue_item (see 4.2.13) objects.

NOTES

1 - Catalogue_definition may reference either an electronic or printed catalogue.

2 - A Catalogue_definition may be defined by ISO 13584 [13]. ISO 13584 will be considered a normative reference when it has reached the DIS level.

The data associated with Catalogue_definition are the following:

- catalogue_id;

- catalogue_name;

- catalogue_version.

4.2.12.1 catalogue_id

The catalogue_id specifies a unique identifier given to a catalogue.

4.2.12.2 catalogue_name

The catalogue_name specifies a textual label given to the catalogue.

4.2.12.3 catalogue_version

The catalogue_version specifies a particular release of a catalogue within a sequence of catalogue releases.

4.2.13 Catalogue_item

A Catalogue_item is an item whose characteristics are standardized and have been categorized in a library or catalogue.

The data associated with Catalogue_item are the following:

- item_name;

- item_version;

- model_number.

4.2.13.1 item_name

The item_name specifies a textual label that is used by the supplier to refer to the Catalogue_item.

4.2.13.2 item_version

The item_version specifies a particular release of a Catalogue_item within a sequence of Catalogue_-item releases.

NOTE - This attribute accommodates the possibility of revision pages to a supplier catalogue.

4.2.13.3 model_number

The model_number is the identifier assigned by the supplier to one or more Catalogue_item objects.

4.2.14 Catalogue_item_substitute

A Catalogue_item_substitute is an alternate Catalogue_item (see 4.2.13) that can be used instead of the specified Catalogue_item.

4.2.15 Change

A Change is the modification or requested modification of a Plant_item (see 4.2.171).

NOTE - A Change may be a request to make a change or an approved change.

The data associated with Change are the following:

- business_unit;

- change_id;

- change_reason;

- change_summary;

- date;

- project_number;

- revision;

- title.

4.2.15.1 business_unit

The business_unit specifies the organization(s), company(s), or functional group(s) responsible for the Change.

4.2.15.2 change_id

The change_id specifies a unique identifier for the Change.

4.2.15.3 change_reason

The change_reason specifies the rationale for the Change.

4.2.15.4 change_summary

The change_summary specifies a general description of the Change.

4.2.15.5 date

The date specifies the calendar day-month-year and time that the Change was initiated on.

NOTE - A specific ordering of the day, month, and year within the date is not required.

4.2.15.6 project_number

The project_number specifies a designation assigned to identify projects within an organization. More than one project (and therefore more than one project_number) may be associated with a Change.

EXAMPLE 14 - Identification of a project_number is used to allow tracking of items such as costs and job hours associated with a Change.

NOTE - A project_number may or may not be the same as the designation of a Design_project (see 4.2.58).

4.2.15.7 revision

The revision specifies the particular amendment of the Change within a sequence of amendments.

4.2.15.8 title

The title specifies a descriptive label for the Change.

4.2.16 Change_approval

A Change_approval is the endorsement by an authority of the change in status of a specific Change.

The data associated with Change_approval are the following:

- approval_date;

- approver;

- approver_role.

4.2.16.1 approval_date

The approval_date specifies the specific calendar day-month-year and time when the approval authority signed the Change (see 4.2.15) as approved.

NOTE - A specific ordering of the day, month, and year within the date is not required.

4.2.16.2 approver

The approver specifies the name of the individual who endorsed the Change (see 4.2.15).

4.2.16.3 approver_role

The approver_role specifies the purpose or function of the approver that approves a change.

4.2.17 Change_delta

A Change_delta is the relationship between a previous Change_item (see 4.2.18) and the current Change_item.

4.2.18 Change_item

A Change_item is an item that may be modified, for which there is a request to modify, or is the result of a modification to a Change_item. Each Change_item may be one of the following: a Changed_-line_assignment (see 4.2.22), a Changed_line_branch_connection (see 4.2.23), a Changed_line_plant_-item_branch_connection (see 4.2.24), a Changed_line_plant_item_connection (see 4.2.25), a Changed_-line_to_line_connection (see 4.2.26), a Changed_piping_system_line (see 4.2.28), a Changed_piping_-system_line_segment (see 4.2.29), a Changed_piping_system_line_segment_termination (see 4.2.30), a Changed_planned_physical_plant (see 4.2.32), a Changed_plant (see 4.2.32), a Changed_plant_item (see 4.2.33), a Changed_plant_item_collection (see 4.2.34), a Changed_plant_item_connection (see 4.2.35), a Changed_plant_item_connector (see 4.2.36), a Changed_plant_item_design_view (see

4.2.36), a Changed_plant_item_shape (see 4.2.38), a Changed_plant_process_capability (see 4.2.39), a Changed_plant_system (see 4.2.40), a Changed_reference_geometry (see 4.2.41), a Changed_-required_material_description (see 4.2.42), a Changed_sited_plant (see 4.2.45), or a Changed_sub_-plant_relationship (see 4.2.46).

The data associated with Change_item are the following:

- change_item_id;

- creation_date;

- description;

- item_owner;

- supersedence_status.

4.2.18.1 change_item_id

The change_item_id specifies a unique identifier for a Change_item.

4.2.18.2 creation_date

The creation_date specifies the calendar day-month-year and time that the Change_item is created on.

NOTE - A specific ordering of the day, month, and year within the date is not required.

4.2.18.3 description

The description specifies a textual explanation or summary of the item being changed.

4.2.18.4 item_owner

The item_owner specifies the name of the person or organization that owns the item being changed and is responsible for implementing or approving the change.

4.2.18.5 supersedence_status

The status specifies the textual description of the existence condition of a Change_item.

EXAMPLE 15 - Examples of Change_item status include Current, Superseded, and Deleted.

4.2.19 Change_life_cycle_stage

A Change_life_cycle_stage is a state in the life cycle of the change that indicates or classifies the status or disposition of the change.

The data associated with Change_life_cycle_stage are the following:

- name.

The name specifies a textual label given to the stage.

EXAMPLE 16 - Examples of names include requested, pending, and implemented.

4.2.20 Change_life_cycle_stage_sequence

A Change_life_cycle_stage_sequence is the mechanism that specifies the sequence of life-cycle stages.

4.2.21 Change_life_cycle_stage_usage

A Change_life_cycle_stage_usage is the assignment of a Change (see 4.2.15) to a particular Change_-life_cycle_stage (see 4.2.19).

The data associated with Change_life_cycle_stage_usage are the following:

- date_of_activation;

- date_of_completion;

- description.

4.2.21.1 date_of_activation

The date_of_activation specifies the calendar day-month-year and time when the Change was assigned to the Change_life_cycle_stage. A specific ordering of the day, month, and year within the date is not required.

4.2.21.2 date_of_completion

The date_of_activation specifies the calendar day-month-year and time when the Change was released from, or completed, the assigned life_cycle stage.

4.2.21.3 description

The description specifies a textual explanation or summary of the assignment of the Change to a particular stage.

4.2.22 Changed_line_assignment

A Changed_line_assignment is a type of Change_item (see 4.2.18) that identifies a Line_piping_-system_component_assignment (see 4.2.124) that is being changed or is the result of a Change (see 4.2.15).

4.2.23 Changed_line_branch_connection

A Changed_line_branch_connection is a type of Change_item (see 4.2.18) that identifies a Line_-branch_connection (see 4.2.121) that is being changed or is the result of a Change (see 4.2.15).

4.2.24 Changed_line_plant_item_branch_connection

A Changed_line_plant_item_branch_connection is a type of Change_item (see 4.2.18) that identifies a Line_plant_item_branch_connection (see 4.2.125) that is being changed or is the result of a Change (see 4.2.15).

4.2.25 Changed_line_plant_item_connection

A Changed_line_plant_item_connection is a type of Change_item (see 4.2.18) that identifies a Line_-plant_item_connection (see 4.2.127) that is being changed or is the result of a Change (see 4.2.15).

4.2.26 Changed_line_to_line_connection

A Changed_line_to_line_connection is a type of Change_item (see 4.2.18) that identifies a Line_to_-line_connection (see 4.2.130) that is being changed or is the result of a Change (see 4.2.15).

4.2.27 Changed_piping_specification

A Changed_piping_specification is a type of Change_item (see 4.2.18) that identifies a Piping_-specification (see 4.2.160) that is being changed or is the result of a Change (see 4.2.15).

4.2.28 Changed_piping_system_line

A Changed_piping_system_line is a type of Change_item (see 4.2.18) that identifies a Piping_system_-line (see 4.2.165) that is being changed or is the result of a Change (see 4.2.15).

4.2.29 Changed_piping_system_line_segment

A Changed_piping_system_line_segment is a type of Change_item (see 4.2.18) that identifies a Piping_system_line_segment (see 4.2.166) that is being changed or is the result of a Change (see 4.2.15).

4.2.30 Changed_piping_system_line_segment_termination

A Changed_piping_system_line_segment_termination is a type of Change_item (see 4.2.18) that identifies a Piping_system_line_segment_termination (see 4.2.167) that is being changed or is the result of a Change (see 4.2.15).

4.2.31 Changed_planned_physical_plant

A Changed_planned_physical_plant is a type of Change_item (see 4.2.18) that identifies a Planned_-physical_plant (see 4.2.168) that is being changed or is the result of a Change (see 4.2.15).

4.2.32 Changed_plant

A Changed_plant is a type of Change_item (see 4.2.18) that identifies a Plant (see 4.2.170) that is being changed or is the result of a Change (see 4.2.15).

4.2.33 Changed_plant_item

A Changed_plant_item is a type of Change_item (see 4.2.18) that identifies a Plant_item (see 4.2.171) that is being changed or is the result of a Change (see 4.2.15).

4.2.34 Changed_plant_item_collection

A Changed_plant_item_collection is a type of Change_item (see 4.2.18) that identifies a Plant_item_-collection (see 4.2.173) that is being changed or is the result of a Change (see 4.2.15).

4.2.35 Changed_plant_item_connection

A Changed_plant_item_connection is a type of Change_item (see 4.2.18) that identifies a Plant_item_-connection (see 4.2.174) that is being changed or is the result of a Change (see 4.2.15).

4.2.36 Changed_plant_item_connector

A Changed_plant_item_connector is a type of Change_item (see 4.2.18) that identifies a Plant_item_-connector (see 4.2.176) that is being changed or is the result of a Change (see 4.2.15).

4.2.37 Changed_plant_item_location

A Changed_plant_item_location is a type of Change_item (see 4.2.18) that identifies a Plant_item_-location (see 4.2.183) that is being changed or is the result of a Change (see 4.2.15).

4.2.38 Changed_plant_item_shape

A Changed_plant_item_shape is a type of Change_item (see 4.2.18) that identifies a Plant_item_shape (see 4.2.184) that is being changed or is the result of a Change (see 4.2.15).

4.2.39 Changed_plant_process_capability

A Changed_plant_process_capability is a type of Change_item (see 4.2.18) that identifies a Plant_-process_capability (see 4.2.186) that is being changed or is the result of a Change (see 4.2.15).

4.2.40 Changed_plant_system

A Changed_plant_system is a type of Change_item (see 4.2.18) that identifies a Plant_system (see 4.2.187) that is being changed or is the result of a Change (see 4.2.15).

4.2.41 Changed_reference_geometry

A Changed_reference_geometry is a type of Change_item (see 4.2.18) that identifies a Reference_-geometry (see 4.2.201) that is being changed or is the result of a Change (see 4.2.15).

4.2.42 Changed_required_material_description

A Changed_required_material_description is a type of Change_item (see 4.2.18) that identifies a Required_material_description (see 4.2.203) that is being changed or is the result of a Change (see 4.2.15).

4.2.43 Changed_site

A Changed_site is a type of Change_item (see 4.2.18) that identifies a Site (see 4.2.215) that is being changed or is the result of a Change (see 4.2.15).

4.2.44 Changed_site_feature

A Changed_site_feature is a type of Change_item (see 4.2.18) that identifies a Site_feature (see 4.2.216) that is being changed or is the result of a Change (see 4.2.15).

4.2.45 Changed_sited_plant

A Changed_sited_plant is a type of Change_item (see 4.2.18) that identifies a Sited_plant (see 4.2.218) that is being changed or is the result of a Change (see 4.2.15).

4.2.46 Changed_sub_plant_relationship

A Changed_sub_plant_relationship is a type of Change_item (see 4.2.18) that identifies a Sub_plant_-relationship (see 4.2.235) that is being changed or is the result of a Change (see 4.2.15).

4.2.47 Circular_ellipsoid

A Circular_ellipsoid is a type of Csg_element (see 4.2.55) that has the following geometric characteristics: it is axial symmetric; cross sections taken in a plane normal to the axis result are circular; cross sections taken in plane containing the axis are elliptical; it is trimmed with a plane that is normal to an axis.

> NOTE - The shape of a Circular_ellipsoid may be described as a hemisphere that has been compressed along the circular axis.

4.2.48 Cone

A Cone is a type of Csg_element (see 4.2.55) that is a 3D volume with parallel, coaxial, circular cross-sections of radii that varies uniformly from a circular base to an axis normal to and positioned at the centrepoint of the base. A Cone may be an Eccentric_cone (see 4.2.62). A Cone may be a Trimmed_cone (see 4.2.253).

4.2.49 Conic

A Conic is a type of Curve (see 4.2.56) composed of points located at a uniform distance from a point, a pair of points, or a point and a line.

EXAMPLE 17 - Kinds of Conics include circles, ellipses, parabolas, and hyperbolas.

4.2.50 Connected_collection

A Connected_collection is a type of Plant_item_collection (see 4.2.173) where elements of the whole collection must be connected.

NOTE - These connections may be identified explicitly by Plant_item_connection (see 4.2.174) objects.

EXAMPLE 18 - A set of Plant_item objects can be collected for the purpose of defining the items that comprise an assembly. Examples of this assembly include packaged unit and module in a plant.

4.2.51 Connection_definition

A Connection_definition is a type of Plant_item_connection (see 4.2.174) that specifies connection comprised of two or more connectors that is part of a Plant_item_definition (see 4.2.178).

NOTE - A Connection_definition that is part of a Plant_item_definition implies that the Plant_item_-definition is a Connected_collection (see 4.2.50).

4.2.52 Connector_definition

A Connector_definition is a type of Plant_item_connector (see 4.2.176) that identifies the connector where a non-instantiated Plant_item (see 4.2.171) can connect to one or more other Plant_item_-connector (see 4.2.176) objects.

4.2.53 Coupling

A Coupling is a type of Fitting (see 4.2.83) that is used to make a linear connection between two pipes.

NOTE - Figure 5 depicts a typical socket-weld Coupling.

The data associated with Coupling are the following:

- end_1_connector;
- end_2_connector;
- end_to_end_length.

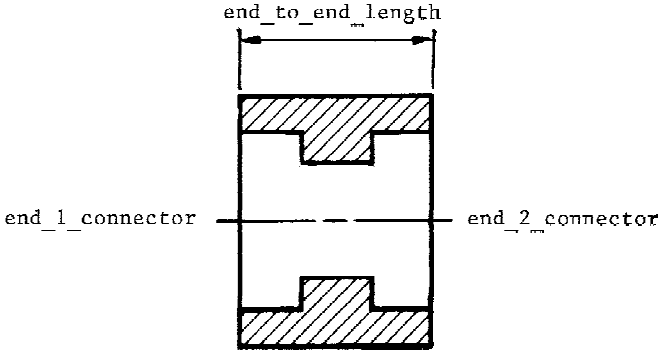

Figure 5 - Coupling

4.2.53.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) designated as end one.

4.2.53.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) designated as end two.

4.2.53.3 end_to_end_length

The end_to_end_length specifies the external distance between the end-one and end-two faces. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.54 Cross

A Cross is a type of Fitting (see 4.2.83) that is a branched outlet consisting of four perpendicular legs to provide straight through and 90 degree flow.

NOTE - Figure 6 depicts a typical butt-weld Cross.

The data associated with Cross are the following:

- centre_to_end_1_length;
- centre_to_end_2_length;
- centre_to_end_3_length;
- centre_to_end_4_length;
- end_1_connector;

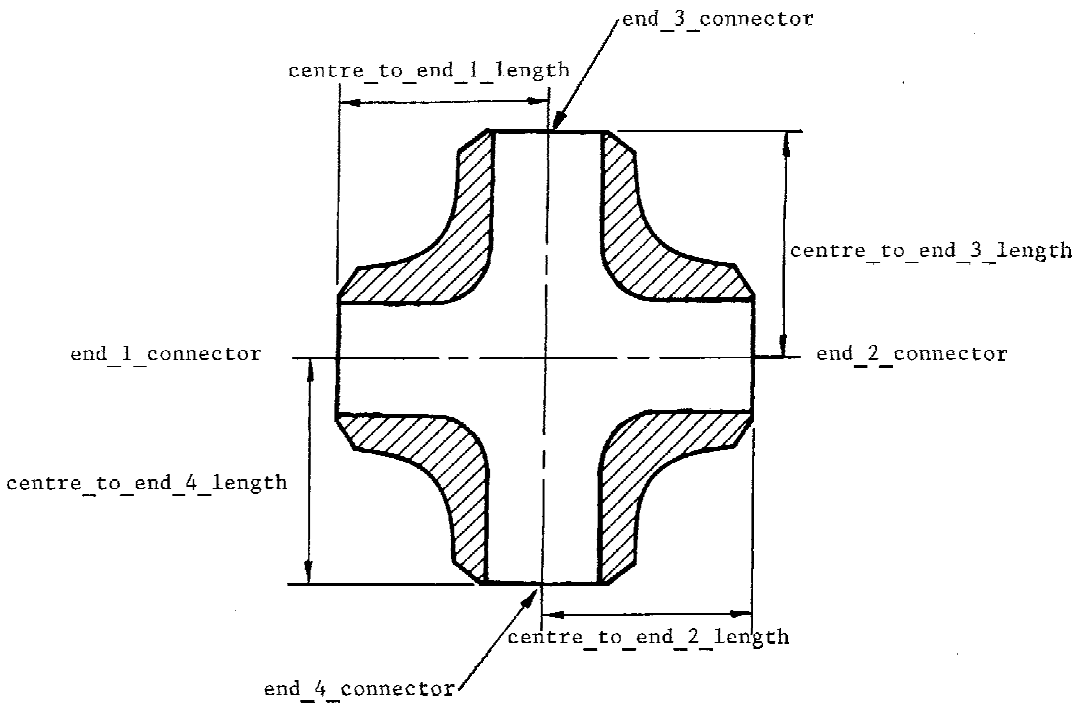

Figure 6 - Cross

- end_2_connector;

- end_3_connector;

- end_4_connector.

4.2.54.1 centre_to_end_1_length

The centre_to_end_1_length specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-one (straight-run) face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.54.2 centre_to_end_2_length

The centre_to_end_2_length specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-two (straight-run) face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.54.3 centre_to_end_3_length

The centre_to_end_3_length specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-three (branch-run) face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.54.4 centre_to_end_4_length

The centre_to_end_4_length specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-four (branch-run) face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.54.5 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) designated as end one.

4.2.54.6 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) designated as end two.

4.2.54.7 end_3_connector

The end_3_connector specifies the Piping_connector (see 4.2.157) designated as end three.

4.2.54.8 end_4_connector

The end_4_connector specifies the Piping_connector (see 4.2.157) designated as end four.

4.2.55 Csg_element

A Csg_element is a type of Shape_representation_element (see 4.2.213) that is a regular, 3D geometric shape that is combined with other regular shapes through boolean operations to create a complex, 3D, solid model. Each Csg_element may be one of the following: a Block (see 4.2.4), a Circular_ellipsoid (see 4.2.47), a Cone (see 4.2.48), a Cylinder (see 4.2.57), an Extrusion (see 4.2.78), a Pyramid (see 4.2.197), a Solid_of_revolution (see 4.2.222), a Sphere (see 4.2.227), a Square_to_round (see 4.2.228), or a Torus (see 4.2.250).

4.2.56 Curve

A Curve is a type of Wire_and_surface_element (see 4.2.264) that is a one-dimensional manifold in a space of dimension two or three. A Curve is either a Conic (see 4.2.49), a Free_form_curve (see 4.2.89), a Line (see 3.3.18, 4.2.120), a Polygon (see 4.2.192), or a Vector (see 4.2.262).

NOTE - Informally, a Curve can be envisioned as the path of a point moving in its coordinate space.

4.2.57 Cylinder

A Cylinder is a type of Csg_element (see 4.2.55) that is a 3D cylindrical solid primitive with end surfaces that are planar and are perpendicular to the axis. The size and shape of a Cylinder is completely described by two real values that represent the radius and length of the cylinder. A Cylinder may be an Eccentric_cylinder (see 4.2.63). A Cylinder may be a Trimmed_cylinder (see 4.2.254). A Cylinder may be a Tube (see 4.2.258).

4.2.58 Design_project

A Design_project is a task with a specifically defined purpose and scope that is used for the administration and management of plant designs.

The data associated with Design_project are the following:

- description;
- design_project_id;
- name;
- owner.

4.2.58.1 description

The description specifies a textual explanation or summary of the Design_project.

4.2.58.2 design_project_id

The design_project_id specifies a unique identifier for the Design_project.

4.2.58.3 name

The name specifies a textual label given to the Design_project.

4.2.58.4 owner

The owner specifies the name of the organization that is responsible for the Design_project.

4.2.59 Detail_shape

A Detail_shape is a type of Plant_item_shape (see 4.2.184) that is the actual or intended external shape of a Plant_item (see 4.2.171). A Detail_shape does not include the description of voids or other internal details of the shape of the Plant_item.

NOTE - Contrast Detail_shape with Outline_shape (see 4.2.147) and Envelope_shape (see 4.2.72). A Detail_shape more closely approximates the actual shape of the plant_item than either Envelope_shape or Outline_shape and is, therefore, likely to be more complex than either Envelope_shape or Outline_-shape.

4.2.60 Ducting_component

A Ducting_component is a type of Plant_item (see 4.2.171) that conveys gaseous matter or airborne, particulate matter. Each Ducting_component may be one of the following: an Equipment_breaching (see 4.2.74), an Hvac_ducting (see 4.2.104), or a Process_ducting (see 4.2.195).

EXAMPLE 19 - A Ducting_component that does not fall within one of the subtype categories may be cable trays, raceways, and other ducting used for routing and support of cables.

4.2.61 Ducting_system

A Ducting_system is a type of Plant_system (see 4.2.187) that controls the temperature, humidity, cleanliness, and circulation of environmental or exhaust air as required in a Plant (see 4.2.170). A Ducting_system may be an Hvac_system (see 4.2.105).

The data associated with Ducting_system are the following:

- type.

The type specifies a designation that classifies a Ducting_system based on the kind of service that it provides.

4.2.62 Eccentric_cone

An Eccentric_cone is a type of Cone (see 4.2.48) with an axis that is not normal to the base.

4.2.63 Eccentric_cylinder

An Eccentric_cylinder is a type of Cylinder (see 4.2.57) with an axis that is not normal to the base.

4.2.64 Eccentric_pyramid

An Eccentric_pyramid is a type of Pyramid (see 4.2.197) with an axis that is not normal to the base.

4.2.65 Eccentric_reducer

An Eccentric_reducer is a type of Reducer (see 4.2.198) where the small end is off-centre from the large end.

NOTE - Figure 7 depicts a typical butt-weld Eccentric_reducer. The end_<number>_connectors correspond to the end_<number>_connector attributes defined in Reducer (see 4.2.198).

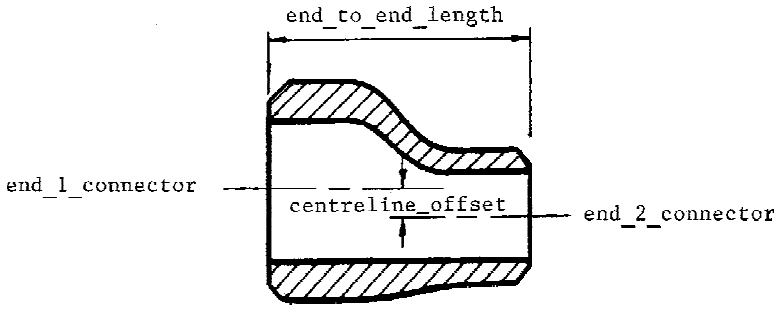

Figure 7 - Eccentric reducer

The data associated with Eccentric_reducer are the following:

- centreline_offset;

- flat_side_orientation.

4.2.65.1 centreline_offset

The centreline_offset specifies the perpendicular distance between the centreline of the large end of the Reducer (see 4.2.198) and the centreline of the smaller end of the Reducer.

4.2.65.2 flat_side_orientation

The flat_side_orientation specifies the direction of the straight side of the Eccentric_reducer.

NOTES

1 - The direction of the straight side is typically specified as up or down.

2 - The straight side of the Eccentric_reducer corresponds to the side where the ends of the Eccentric_-reducer have a common tangent point parallel to the centreline axes of the Eccentric_reducer.

4.2.66 Eccentric_swage

An Eccentric_swage is a type of Swage (see 4.2.244) where the small end is off-centre from the large end.

NOTE - Figure 8 depicts a typical butt-weld Eccentric_swage. The end_<number>_connectors correspond to the end_<number>_connector attributes defined in Swage (see 4.2.244).

The data associated with Eccentric_swage are the following:

- centreline_offset;

- flat_side_orientation.

4.2.66.1 centreline_offset

The centreline_offset specifies the perpendicular distance between the centreline of the large end of the Swage (see 4.2.244) and the centreline of the smaller end of the Swage.

4.2.66.2 flat_side_orientation

A flat_side_orientation specifies the direction of the straight side of the Eccentric_swage.

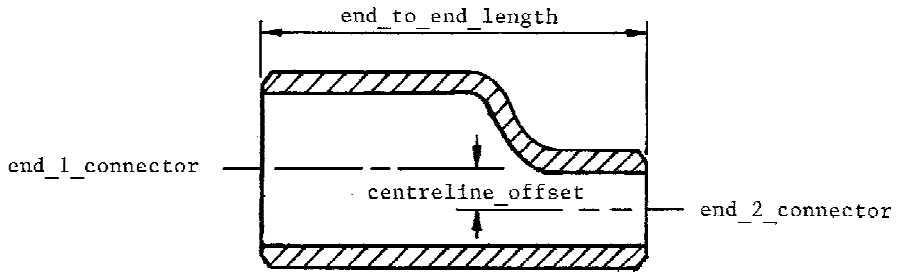

Figure 8 - Eccentric swage

NOTES

1 - The direction of the straight side is typically specified as up or down.

2 - The straight side of the Eccentric_swage corresponds to the side where the ends of the Eccentric_-swage have a common tangent point parallel to the centreline axes of the Eccentric_swage.

4.2.67 Elbow

An Elbow is a type of Fitting (see 4.2.83) that is used to change the direction of piping.

NOTE - Figure 9 depicts a typical socket-weld Elbow.

The data associated with Elbow are the following:

- centre_to_end_1_length;
- centre_to_end_2_length;
- centreline_radius;
- end_1_connector;
- end_2_connector;
- sweep_angle;
- type.

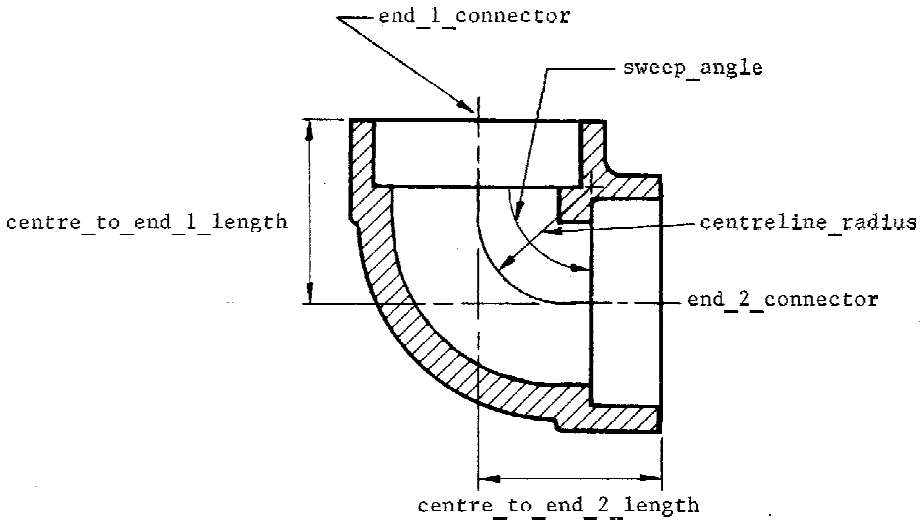

Figure 9 - Elbow

4.2.67.1 centre_to_end_1_length

The centre_to_end_1_length specifies the distance from the centre of the Elbow (i.e., where the centrelines for the two ends intersect) to the end-one face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.67.2 centre_to_end_2_length

The centre_to_end_2_length specifies the distance from the centre of the Elbow (i.e., where the centrelines for the two ends intersect) to the end-two face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.67.3 centreline_radius

The centreline_radius specifies the distance from the centreline of the Elbow to the intersection of the perpendicular projection of the centreline taken at the point where the Elbow centreline ends or where the inlet and outlet ends of the Elbow centreline become straight lines. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.67.4 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) designated as end one.

4.2.67.5 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) designated as end two.

4.2.67.6 sweep_angle

The sweep_angle specifies the included angle formed between two lines that are parallel to the end-one and end-two faces of the Elbow, measured at their point of intersection (the centre of radius of the Elbow). It may be specified as a single value or as a range of values.

> NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.67.7 type

The type specifies a designation that classifies the Elbow.

> EXAMPLE 20 - Examples of elbow designations include long radius, short radius, reducing, and street.

4.2.68 Electrical_component

An Electrical_component is a type of Plant_item (see 4.2.171) that is an individually identifiable and functional part of an Electrical_system (see 4.2.70).

> EXAMPLE 21 - Examples of Electrical_components include cable tray, wireway, conduit, ductbank, cables, switches, relays, motor control centres, and junction boxes.

4.2.69 Electrical_connector

An Electrical_connector is a type of Plant_item_connector (see 4.2.176) that is intended to establish an electrical connection (signal or power) between two Plant_item (see 4.2.171) objects.

The data associated with Electrical_connector are the following:

- type.

The type specifies the designation that describes the functional behaviour of the Electrical_connector.

4.2.70 Electrical_system

An Electrical_system is a type of Plant_system (see 4.2.187) that is a system of wiring, switches, relays, and other equipment associated with receiving and distributing electrical power.

The data associated with Electrical_system are the following:

- system_voltage_designation;

- type.

4.2.70.1 system_voltage_designation

The system_voltage_designation is the rated voltage of the system.

4.2.70.2 type

The type specifies a designation that classifies the Electrical_system based on the kind of service that it provides.

4.2.71 Electricity_transference

An Electricity_transference is a type of Plant_item_connection (see 4.2.174) that identifies the purpose or role of the connection as being the transfer of electrical current or signal.

4.2.72 Envelope_shape

An Envelope_shape is a type of Plant_item_shape (see 4.2.184) that is a 3D spatial volume that completely encloses or bounds a Plant_item (see 4.2.171). An Envelope_shape is a very simple geometric shape, such as a box, that encloses the plant item. An Envelope_shape may, but need not, include clearance or access spaces associated with the plant item.

NOTE - Contrast Envelope_shape with Detail_shape (see 4.2.59) and Outline_shape (see 4.2.147).

4.2.73 Equipment

An Equipment is a type of Plant_item (see 4.2.171) that is treated as a single and self-contained unit that provides a function. Each Equipment may be an Inline_equipment (see 4.2.106).

The data associated with Equipment are the following:

- equipment_characteristics;

- equipment_type;

- heat_tracing_type;

- insulation_specification;

4.2.73.1 equipment_characteristics

The equipment_characteristics specifies functional attributes of the Equipment.

EXAMPLE 22 - Equipment characteristics of a pump may be that it operates at 80% efficiency while pumping 1250 gallons per minute.

4.2.73.2 equipment_type

The equipment_type specifies a classification of an Equipment based on its performance characteristics.

EXAMPLE 23 - Examples of equipment_type classifications include compressor, engine, furnace, gear box, heat exchanger, pressure vessel, pump, silo, tank, and turbine.

4.2.73.3 heat_tracing_type

The heat_tracing_type specifies the means utilized to impart a temperature increase to the Equipment by an external wrapping or coiling.

EXAMPLE 24 - Examples of heat_tracing_types include, but are not limited to, electrical or steam.

4.2.73.4 insulation_specification

The insulation_specification specifies the document that defines the insulation requirements for the Equipment.

4.2.74 Equipment_breaching

An Equipment_breaching is a type of Ducting_component (see 4.2.60) consisting of a type of ductwork connected to a piece of Equipment (see 3.3.12, 4.2.73) for the purpose of exhausting gases.

4.2.75 Equipment_trim_piping

An Equipment_trim_piping is piping connected to a piece of Equipment (see 3.3.12, 4.2.73) that performs a function integral to the Equipment.

NOTE - The piping is normally designed and possibly provided or installed by the Equipment manufacturer. Piping of this nature is normally of nominal size two inches and below.

4.2.76 Expander_flange

An Expander_flange is a type of Flange (see 4.2.84) that provides a transition from a smaller to a larger diameter Pipe (see 3.3.25, 4.2.153) at a flanged connection.

NOTE - Figure 10 depicts a typical Expander_flange.

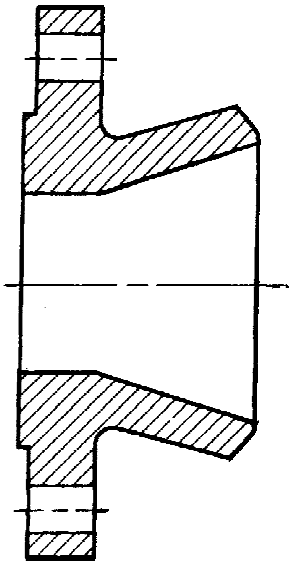

Figure 10 - Expander flange

4.2.77 External_classification

An External_classification is a designation and description that classifies a Plant_item (see 4.2.171), Plant (see 4.2.170), Plant_system (see 4.2.187), or Plant_item_connector (see 4.2.176) based on predefined tables or sources defined externally to this part. The designation is a reference to the predefined table or source.

> EXAMPLE 25 - The table defined in ISO 10303-221, annex M [3], may be used as an external classification in this part. The value of source would be "ISO 10303-221"; the value of name and description will correspond to the name and the description of the table row that classifies the plant item.

The data associated with External_classification are the following:

- description;
- name;
- source.

4.2.77.1 description

The description specifies a textual explanation or summary of the External_classification.

4.2.77.2 name

The name specifies a textual label given to the External_classification.

4.2.77.3 source

The source specifies a designation that identifies a table or document that contains a list of candidate classifications that the name and description are drawn from.

4.2.78 Extrusion

An Extrusion is a type of Csg_element (see 4.2.55) that is a closed, 2D profile swept through a linear distance in space.

4.2.79 Facet_trigon

A Facet_trigon is a planar, polygonal surface with three sides.

> NOTE - In 3D computer models, curved surfaces are sometimes represented by a collection of Facets that approximate the curved surface.

4.2.80 Faceted_surface_representation

A Faceted_surface_representation is a type of Site_shape_representation (see 4.2.217) that consists of a collection of Facet_trigon (see 4.2.79) objects that represent the topography of a Site (see 4.2.215).

4.2.81 Family_definition

A Family_definition is a Plant_item_definition (see 4.2.178) that characterizes a set of Piping_-component (see 4.2.156) objects based on common physical characteristics. Physical characteristics may be specified as a specific value or as a range of values.

> NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.
>
> EXAMPLE 26 - A Piping_specification (see 4.2.160) describes a Family_definition, such as a class of elbows made of stainless steel that are long radius elbows between six inches and twenty four inches in diameter.

The data associated with Family_definition are the following:

- family_classification_description.

The family_classification_description specifies a textual explanation of the principle characteristics that vary within the family.

4.2.82 Female_end

A Female_end is a type of Piping_connector (see 4.2.157) end type that forms a hub of material at the connector to support the insertion of a compatible male connector.

NOTE - Figure 11 depicts a typical Female_end.

The data associated with Female_end are the following:

- depth;
- hub_inside_diameter;
- hub_length;
- hub_outside_diameter.

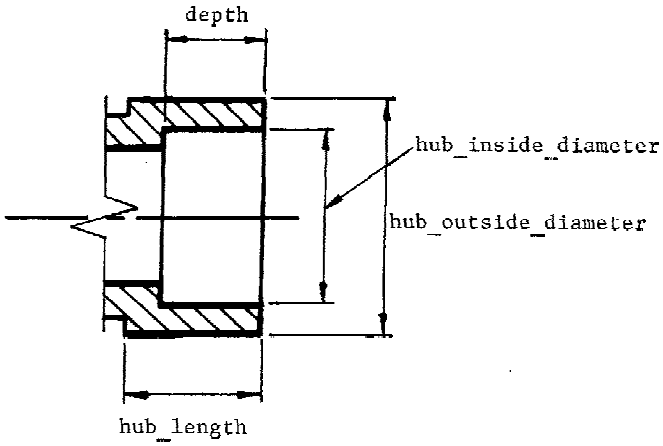

Figure 11 - Female end

4.2.82.1 depth

The depth specifies the distance from the face of the Piping_connector to the depth of relief. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.82.2 hub_inside_diameter

The hub_inside_diameter specifies the diameter of the opening at the hub. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.82.3 hub_length

The hub_length specifies the distance from the face of the Plant_item_connector (see 4.2.176) to the point where the hub size transitions to the body size of the Plant_item (see 4.2.171). It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.82.4 hub_outside_diameter

The hub_outside_diameter specifies the external diameter of the hub. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.83 Fitting

A Fitting is a type of Piping_component (see 4.2.156) used to join or terminate sections of Pipe (see 3.3.25, 4.2.153) or provide changes of direction or branching in a Piping_system (see 4.2.163). Each Fitting may be one of the following: a Blank (see 4.2.2), a Bushing (see 4.2.8), a Coupling (see 4.2.53), a Cross (see 4.2.54), an Elbow (see 4.2.67), a Flange (see 4.2.84), an Insert (see 4.2.108), a Lap_joint_stub_end (see 4.2.118), a Lateral (see 4.2.119), an Olet (see 4.2.144), an Orifice_plate (see 4.2.146), a Pipe_closure (see 4.2.155), a Reducer (see 4.2.198), a Spacer (see 4.2.223), a Swage (see 4.2.244), a Tee (see 4.2.247), a Union (see 4.2.259), or a Y_type_lateral (see 4.2.265).

4.2.84 Flange

A Flange is a type of Fitting (see 4.2.83) that is an annular collar that permits a bolted connection to a similar collar. Each Flange contains two end connectors, one of which shall be a Piping_connector of type Flanged_end. Each Flange may be one of the following: a Blind_flange (see 4.2.3), an Expander_flange (see 4.2.76), an Orifice_flange (see 4.2.145), or a Reducing_flange (see 4.2.199). Each Flange may be one of the following: a Lap_joint_flange (see 4.2.117), a Slip_on_flange (see 4.2.219), a Socket_weld_flange (see 4.2.221), a Threaded_flange (see 4.2.249), or a Weld_neck_flange (see 4.2.263).

NOTE - Figure 12 depicts a typical weld-neck Flange.

The data associated with Flange are the following:

- end_1_connector;
- end_2_connector;
- hub_through_length;
- hub_weld_point_diameter.

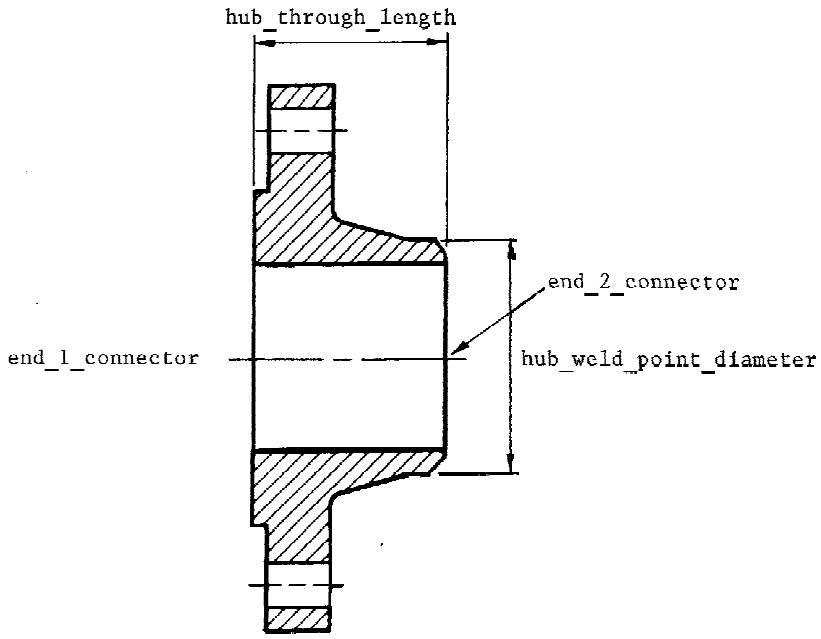

Figure 12 - Flange

4.2.84.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) at the flange face.

4.2.84.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) at the hub face.

4.2.84.3 hub_through_length

The hub_through_length specifies the distance between the flange face and the hub face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.84.4 hub_weld_point_diameter

The hub_weld_point_diameter specifies the outside diameter of the hub at the point of connection between the flange and the pipe. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.85 Flanged

A Flanged is a type of Piping_connector (see 4.2.157) end engagement type consisting of a circular disk of material with holes around the circumference and a facing style.

NOTE - The holes are used to bolt together two connected flanges. The facing is the mating surface that in conjunction with a gasket forms a tight connection by the pressure of the two connected flanged connectors. A flanged connection can be disassembled.

4.2.86 Flanged_end

A Flanged_end is a type of Piping_connector (see 4.2.157) end type that is a circular disk of material that supports the insertion of bolts to mate with a compatible Flanged_end.

NOTE - Figure 13 depicts a typical Flanged_end.

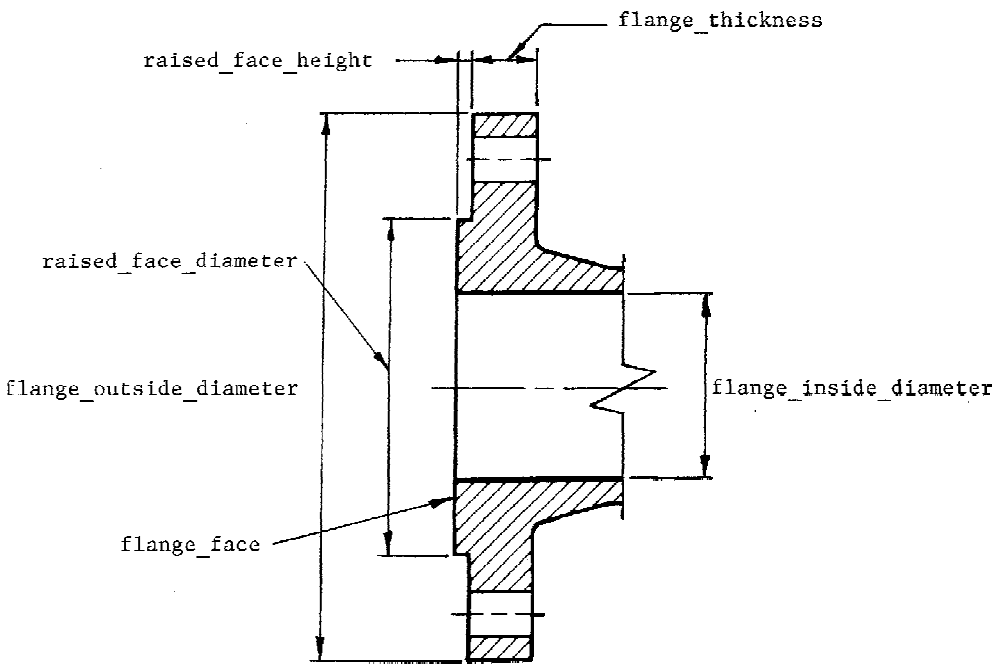

Figure 13 - Flanged end

The data associated with Flanged_end are the following:

- face_finish;
- flange_inside_diameter;
- flange_outside_diameter;
- flange_thickness;

- raised_face_diameter;

- raised_face_height;

- ring_bottom_radius;

- ring_diameter;

- ring_width.

4.2.86.1 face_finish

The face_finish specifies a description of the Flange (see 4.2.84) face surface roughness and groove pattern.

4.2.86.2 flange_inside_diameter

The flange_inside_diameter specifies the interior diameter of the Flange (see 4.2.84) at the working point. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.86.3 flange_outside_diameter

The flange_outside_diameter specifies the external diameter of the Flange (see 4.2.84). It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.86.4 flange_thickness

The flange_thickness specifies the distance between the inside and outside Flange (see 4.2.84) disk surfaces, measured at the disk perimeter. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.86.5 raised_face_diameter

The raised_face_diameter specifies the diameter measured across the elevated portion of the mating surface of a Flange (see 4.2.84). It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.86.6 raised_face_height

The raised_face_height specifies the perpendicular distance measured from the elevated portion of the Flange (see 4.2.84) mating surface to the lower Flange surface. It may be specified as a single value or as a range of values.

> NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.86.7 ring_bottom_radius

The ring_bottom_radius specifies the radial measure of the bottom corners of a ring in raised face. The ring_bottom_radius may not be specified for a particular Flanged_end, but when specified must be accompanied by raised_face_diameter, raised_face_height, ring_diameter, and ring_width.

4.2.86.8 ring_diameter

The ring_diameter specifies the diameter of a ring in the raised-face portion of a Flanged_end. The ring_diameter may not be specified for a particular Flanged_end, but when specified must be accompanied by raised_face_diameter, raised_face_height, ring_bottom_radius, and ring_width.

4.2.86.9 ring_width

The ring_width specifies the width of the groove formed by a ring in the raised-face portion of a Flanged_end. The ring_width may not be specified for a particular Flanged_end, but when specified must be accompanied by raised_face_diameter, raised_face_height, ring_bottom_radius, and ring_-diameter.

4.2.87 Flexible_connection

A Flexible_connection is a type of Plant_item_connection (see 4.2.174) in which two Plant_item_-connector (see 4.2.176) objects are in physical contact, though there is no implication concerning the freedom of motion of the connected Plant_item (see 4.2.171) objects.

> EXAMPLE 27 - The pump driver may be connected to an electrical cable at its terminal using a Flexible_connection; the cable need not rotate when the pump is rotated, but contact must be preserved.

4.2.88 Fluid_transference

A Fluid_transference is a type of Plant_item_connection (see 4.2.174) that identifies the purpose or role of the connection as being the transfer of gas, vapour, liquid or solid material.

4.2.89 Free_form_curve

A Free_form_curve is a type of Curve (see 4.2.56). It is a one-dimensional, contiguous set of points.

4.2.90 Functional_connection_definition_satisfaction

A Functional_connection_definition_satisfaction is the assignment of an actual Connection_definition (see 4.2.51) to a functional Connection_definition for the purpose of satisfying the functional requirements with a physical object.

4.2.91 Functional_connection_occurrence_satisfaction

A Functional_connection_occurrence_satisfaction is the assignment of an actual Plant_item_-connection_occurrence (see 4.2.175) to a functional Plant_item_connection_occurrence for the purpose of satisfying the functional requirements with a physical object.

4.2.92 Functional_connector

A Functional_connector is a type of Plant_item_connector_occurrence (see 4.2.177) that represents the functional or logical aspect of the plant_item_connector_occurrence. Each Functional_connector may be one of the following: a Line_plant_item_branch_connector (see 4.2.126) or a Line_plant_item_-connector (see 4.2.128).

4.2.93 Functional_connector_definition_satisfaction

A Functional_connector_definition_satisfaction is the assignment of an actual Connector_definition (see 4.2.52) to a functional Connector_definition for the purpose of satisfying the functional requirements with a physical object.

4.2.94 Functional_connector_occurrence_satisfaction

A Functional_connector_occurrence_satisfaction is the assignment of an actual Physical_connector (see 4.2.151) to a Functional_connector (see 4.2.92) for the purpose of satisfying the functional requirements with a physical object.

4.2.95 Functional_design_view

A Functional_design_view is a type of Plant_item_design_view (see 4.2.179) that indicates that data associated with the Plant_item (see 4.2.171) are the logical characteristics of a Plant_item rather than the physical.

The data associated with Functional_design_view are the following:

- tag_number.

The tag_number specifies an optional identifier assigned to the Plant_item (see 4.2.171) for purposes of functional identification and eventual physical tracking.

4.2.96 Functional_plant

A Functional_plant is a Plant (see 4.2.170) that is the identification of a view of the Plant that aggregates the functional characteristics of the Plant.

4.2.97 Functional_plant_satisfaction

A Functional_plant_satisfaction is the assignment of an actual Planned_physical_plant (see 4.2.168) to a Functional_plant (see 4.2.96) for the purpose of satisfying the functional requirements with a physical object.

4.2.98 Functional_plant_item_satisfaction

A Functional_plant_item_satisfaction is the assignment of a Physical_design_view (see 4.2.152) to a Functional_design_view (see 4.2.95) for the purpose of satisfying the functional requirements with a physical object.

4.2.99 Gasket

A Gasket is a type of Piping_component (see 4.2.156) that seals a connection between two connectors.

NOTE - Gaskets are primarily used with Flanged (see 4.2.85) Connectors (see 4.2.176).

The data associated with a Gasket are the following:

- compressed_thickness;
- uncompressed_thickness.

4.2.99.1 compressed_thickness

The compressed_thickness specifies the distance between the two parallel surfaces of the Gasket in its compressed state in a connection. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.99.2 uncompressed_thickness

The uncompressed_thickness specifies the as-procured distance between the two parallel surfaces of the Gasket. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.100 Gis_position

A Gis_position is the positioning and orientation information necessary for transforming coordinate values between a local coordinate space and the global coordinate system of earth. Transformation procedures depend upon the geographic information system (GIS) [14] coordinate system. Each Gis_-position object designates the global position and orientation of a Site_shape_representation (see 4.2.217).

The data associated with a Gis_position are the following:

- height;
- scale;
- system;
- x_axis_delta_x;
- x_axis_delta_y;
- x_coordinate;
- y_coordinate;
- zone.

4.2.100.1 height

The height specifies the distance above sea level or reference level in the GIS coordinate system.

4.2.100.2 scale

The scale specifies a transformation factor applied to the conversion of point coordinates between a local coordinate system and a GIS coordinate system. The precise application of the transformation will depend on the GIS system.

4.2.100.3 system

The system specifies the identifier of the GIS system being used.

> EXAMPLE 28 - Gauss-Krueger, Universal Transverse Mercator (UTM), and State Plane are examples of GIS systems used for global positioning.

4.2.100.4 x_axis_delta_x

The x_axis_delta_x specifies the abscissa value of the end point of a vector indicating the positive x axis of GIS coordinate space in the local coordinate system.

4.2.100.5 x_axis_delta_y

The x_axis_delta_y specifies the ordinate value of the end point of a vector indicating the orientation or the positive x axis of GIS coordinate space in the local coordinate system.

> EXAMPLE 29 - The GIS coordinate system XY00 has an origin at the intersection of the equator and the Greenwich meridian. The x_axis of the coordinate system runs East (positive) and West (negative). The y axis runs North (positive) and South (negative). The positive z axis is up (above sea level or the reference level in the GIS coordinate system). The negative z axis is down (below sea level or the reference level in the GIS coordinate system). An x_axis_delta_x of 1.0 and x_axis_delta_y of 1.0 indicates x axis of the GIS coordinate space makes a +45° angle with respect to the x axis of the local coordinate; if the local coordinate space were superimposed on the GIS coordinate space, the positive x axis of the local coordinate system would point in a South-East direction (-45°).

4.2.100.6 x_coordinate

The x_coordinate specifies the distance from the y axis of the coordinate space defined by the GIS system and zone.

4.2.100.7 y_coordinate

The y_coordinate specifies the distance from the x axis of the coordinate space defined by the GIS system and zone.

4.2.100.8 zone

The zone specifies a subdivision of the earth's surface based on the GIS system.

> EXAMPLE 30 - The Gauss-Krueger GIS system subdivides the earth into 120 zones that are 3° in longitudinal width. Each zone is identified as 3°, 6°, 9°, etc., from the Greenwich meridian.

4.2.101 Hemisphere

A Hemisphere is a type of Trimmed_sphere (see 4.2.256) that is formed by cutting the Sphere with a plane that passes through the centrepoint of the Sphere and removing one section.

4.2.102 Hierarchically_organized_collection

A Hierarchically_organized_collection is a type of Plant_item_collection (see 4.2.173) that indicates whether a Plant_item (see 4.2.171) that is a member of an aggregate Plant_item is related to other Plant_items that are also members of the aggregate Plant_item. The members of the aggregate may, but need not, be connected.

4.2.103 Hvac_component

An Hvac_component is a type of Plant_item (see 4.2.171) that is an individually identifiable item or combination of items that is part of an HVAC system.

EXAMPLE 31 - The description attribute inherited from Plant_item is used to describe the HVAC_-component. Examples to descriptions include "air handling unit", "chiller", or "space heater".

4.2.104 Hvac_ducting

An Hvac_ducting is a type of Ducting_component (see 4.2.60) and a type of Hvac_component (see 4.2.103) that is an individually identifiable piece or section of ducting that is part of an HVAC system.

4.2.105 Hvac_system

An Hvac_system is a type of Ducting_system (see 4.2.61) that controls the temperature, humidity, cleanliness, and circulation of environmental air as required in a Building (see 4.2.7).

4.2.106 Inline_equipment

An Inline_equipment is a type of Equipment (see 3.3.12, 4.2.73) and Piping_system_component (see 4.2.164) that is inserted into the flow of a process stream to perform a function. Each Inline_-equipment may be a Jacketed_piping (see 4.2.116).

4.2.107 Inline_instrument

An Inline_instrument is a type of Instrument (see 4.2.111) and Piping_system_component (see 4.2.164) that is inserted into the flow of a process stream to measure some characteristic of the stream.

EXAMPLE 32 - Thermowells, pressure gauges, and flowmeters are examples of Inline_instruments.

4.2.108 Insert

An Insert is a type of Fitting (see 4.2.83) with one external and one smaller internal end.

NOTE - Figure 14 depicts a typical Insert.

The data associated with Insert are the following:

- end_1_connector;
- end_2_connector;
- end_to_end_length.

4.2.108.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) Male_end (see 4.2.137).

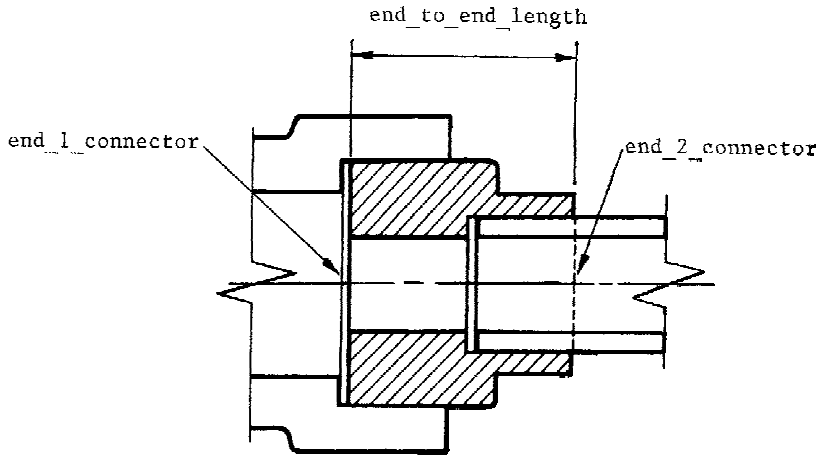

Figure 14 - Insert

4.2.108.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) designated as Female_end (see 4.2.82).

4.2.108.3 end_to_end_length

The end_to_end_length specifies the external length of the Insert from the end-one face to the end-two face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.109 Inside_and_thickness

An Inside_and_thickness is a type of Piping_size_description (see 4.2.159) that describes the size of a Piping_system_component (see 4.2.164) or a Piping_connector (see 4.2.157) using an actual (intended) inside diameter and wall thickness.

The data associated with Inside_and_thickness are the following:

- inside_diameter;

- thickness.

4.2.109.1 inside_diameter

The inside_diameter specifies the actual (intended, not nominal) inside diameter of the Piping_-system_component (see 4.2.164) or Piping_connector (see 4.2.157). It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.109.2 thickness

The thickness specifies the minimum distance between the inside and outside piping wall surfaces required for the Piping_system_component (see 4.2.164) or Piping_connector (see 4.2.157). It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.110 Installed_physical_design_view

An Installed_physical_design_view is an indication that the Plant_item (see 4.2.171) described by a Physical_design_view (see 4.2.152) is physically installed within the Plant (see 4.2.170).

NOTE - Within a usage of this part of ISO 10303, all Plant_items are considered as planned physical design views unless they are related to Installed_physical_design_view. This relationship indicates that the Plant_item is an actual item that currently exists or is installed in the Plant.

The data associated with Installed_physical_design_view are the following:

- serial_number.

The serial_number specifies a designation that uniquely identifies a particular physical Plant_item that is installed in a Plant.

NOTE - The designation is typically assigned and affixed by the manufacturer of the Plant_item.

4.2.111 Instrument

An Instrument is a type of Instrumentation_and_control_component (see 4.2.112) that monitors one or more performance characteristics of a system. Each Instrument may be one of the following: an Inline_instrument (see 4.2.107) or an Offline_instrument (see 4.2.143).

The data associated with Instrument are the following:

- control_loop_id;

- instrument_type;

- sensor_type;

- signal_type;

- stream_interaction_type.

4.2.111.1 control_loop_id

The control_loop_id specifies a unique identifier for the Instrument loop.

4.2.111.2 instrument_type

The instrument_type specifies a classification of an Instrument based on its performance characteristics.

EXAMPLE 33 - Examples of instrument_type classifications include flow control, level control, pressure, or temperature.

4.2.111.3 sensor_type

The sensor_type specifies a classification of an Instrument actuator based on its operational characteristics.

4.2.111.4 signal_type

The signal_type specifies a classification of an Instrument signal based on its physical characteristics.

EXAMPLE 34 - Examples of instrument signal_type classifications include electric and pneumatic.

4.2.111.5 stream_interaction_type

The stream_interaction_type specifies a classification of an Instrument based on how the sensor is positioned to sense the stream.

EXAMPLE 35 - Examples of stream_interaction_types include outside, inserted, and immersed.

4.2.112 Instrumentation_and_control_component

An Instrumentation_and_control_component is a type of Plant_item (see 4.2.171) that is an individually identifiable item or combination of items that is part of the Instrumentation_and_control_-system (see 4.2.113). Each Instrumentation_and_control_component may be an Instrument (see 4.2.111).

EXAMPLE 36 - Examples of Instrumentation_and_control_component objects include wiring, switches, control valves, and gauges.

4.2.113 Instrumentation_and_control_system

An Instrumentation_and_control_system is a type of Plant_system (see 4.2.187) that is a system of wiring, switches, controls, and other equipment associated with monitoring and controlling the performance characteristics of Plant_system objects.

The data associated with Instrumentation_and_control_system are the following:

- type.

The type specifies a designation that classifies the Instrumentation_and_control_system based on the kind of service that it provides.

4.2.114 Insulation

An Insulation is a type of Plant_item (see 4.2.171) that is a material or assembly of materials used to provide resistance to heat flow.

4.2.115 Interfering_shape_element

An Interfering_shape_element is the portion of the Plant_item_shape (see 4.2.184) that is interfered with by a shape element of another Plant_item (see 4.2.171).

NOTE - This application object is intended to support design integration, specifically the need to identify the elements of the designs that physically interfere with one another.

The data associated with Interfering_shape_element are the following:

- interference_colour.

The interference_colour specifies the colour that displays the element.

4.2.116 Jacketed_piping

A Jacketed_piping is a type of Inline_equipment (see 4.2.106) that is a Pipe (see 3.3.25, 4.2.153) surrounded or enclosed by another Pipe.

4.2.117 Lap_joint_flange

A Lap_joint_flange is a type of Flange (see 4.2.84) that has a rounded contour at the intersection of the bore and the Flange face in order to mate to a Lap_joint_stub_end (see 4.2.118).

NOTE - This Flange can be swiveled around a Lap_joint_stub_end in order to align bolt holes.

4.2.118 Lap_joint_stub_end

A Lap_joint_stub_end is a type of Fitting (see 4.2.83) used with a Lap_joint_flange (see 4.2.117), consisting of a cylinder or barrel with an integral flat ring or lap around one end with a rounded contour at the external intersection of the barrel and the lap.

NOTES

1 - Figure 15 depicts a typical Lap_joint_stub_end.

2 - End two is beveled for butt welding to pipe. The lap face normally has a spiral serrated finish. This surface serves as the raised-face gasket surface of the Flange (see 4.2.84) in Lap_joint_flange connections.

The data associated with Lap_joint_stub_end are the following:

- end_1_connector;
- end_2_connector;
- length;
- stub_diameter;
- stub_thickness.

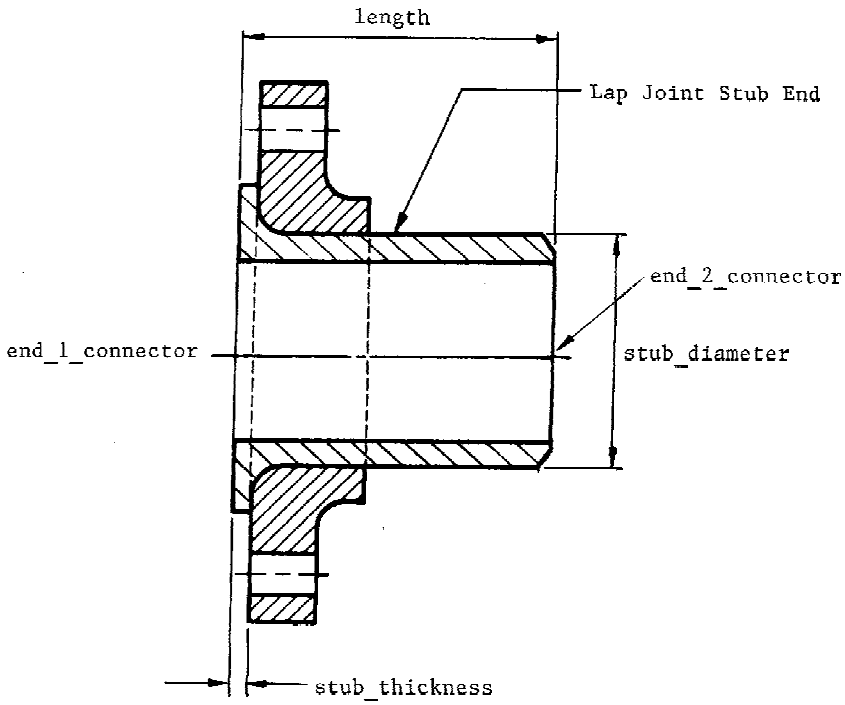

Figure 15 - Lap joint flange and stub end

4.2.118.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) at the stub end face that connects to another Flange (see 4.2.84) or nozzle.

4.2.118.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) at the stub end face that connects to a non-flange Piping_component (see 4.2.156).

4.2.118.3 length

The length specifies the external distance between the lap face and the other stub end face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.118.4 stub_diameter

The stub_diameter specifies the nominal diameter of the Lap_joint_stub_end. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.118.5 stub_thickness

The stub_thickness specifies the distance between the inner and outer surfaces of the flared portion of the stub end. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.119 Lateral

A Lateral is a type of Fitting (see 4.2.83) that is a three-way fitting having two ends opposite each other in a straight run and a branch outlet projecting from the run at an angle.

NOTE - Figure 16 depicts a typical butt-weld Lateral.

The data associated with Lateral are the following:

- branch_angle;
- centre_to_end_1_length;
- centre_to_end_2_length;
- centre_to_end_3_length;
- end_1_connector;
- end_2_connector;
- end_3_connector.

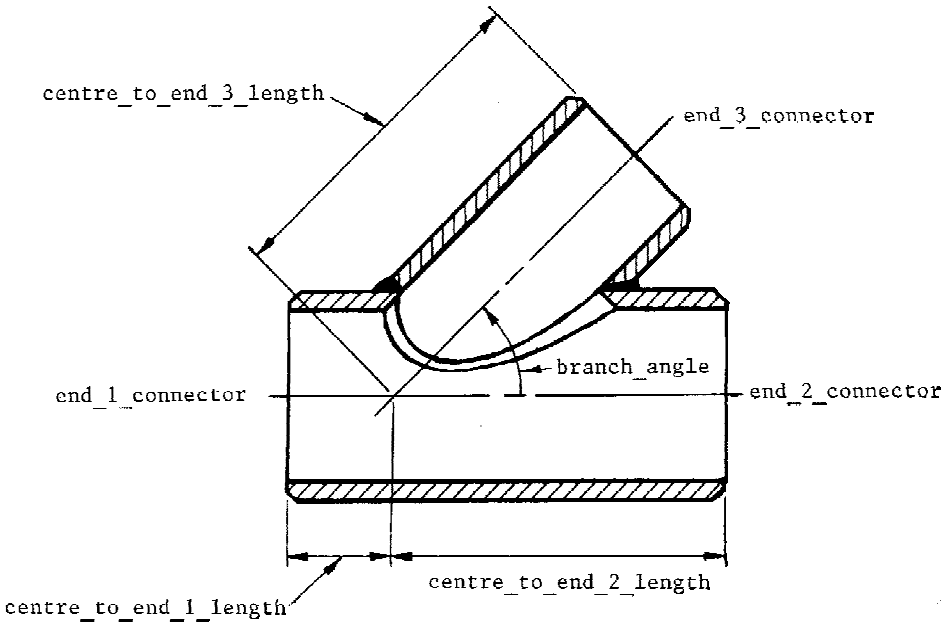

Figure 16 - Lateral

4.2.119.1 branch_angle

The branch_angle specifies the angle that the branch projects from the straight run. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.119.2 centre_to_end_1_length

The centre_to_end_1_length specifies the distance between the point where the branch and straight run centrelines intersect and the straight-run face that is closest to the intersection. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.119.3 centre_to_end_2_length

The centre_to_end_2_length specifies the distance between the point where the branch and straight run centrelines intersect and the straight-run face that is furthest from the intersection. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.119.4 centre_to_end_3_length

The centre_to_end_3_length specifies the distance between the point where the branch and straight run centrelines intersect and the branch face. It may be specified as a single value or as a range of values.

> NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.119.5 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) on the straight run that is closest to the intersection between the centrelines of the branch run and straight run.

4.2.119.6 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) on the straight run that is furthest from the intersection between the centrelines of the branch run and straight run.

4.2.119.7 end_3_connector

The end_3_connector specifies the Piping_connector (see 4.2.157) that connects to the branch line.

4.2.120 Line

A Line is a type of Curve (see 4.2.56) that is a one-dimensional, contiguous set of points that are positioned at a constant distance from a vector or that constitute the shortest distance between two points.

4.2.121 Line_branch_connection

A Line_branch_connection is a connection between the logical termination of one Piping_system_-line_segment (see 4.2.166) and a point on another Piping_system_line_segment other than a termination. The former Piping_system_line_segment branches from the latter Piping_system_line_-segment.

The data associated with Line_branch_connection are the following:

- branch_sequence_id.

The branch_sequence_id specifies an alphanumeric identifier that indicates the order that lines branch off of the main line segment.

> NOTE - All branch_sequence_ids are unique with respect to the branches of a given Piping_system_-line_segment.

4.2.122 Line_branch_termination

A Line_branch_termination is a type of Piping_system_line_segment_termination (see 4.2.167) that connects to a piping_system_line_segment at a point other than a termination.

4.2.123 Line_less_piping_system

A Line_less_piping_system is a type of Piping_system (see 4.2.163) that does not have a line designation as defined in Piping_system_line (see 4.2.165).

4.2.124 Line_piping_system_component_assignment

A Line_piping_system_component_assignment is the relationship between a Piping_system_line (see 4.2.165) and a Piping_system_component (see 4.2.164) that is part of, or satisfies the need specified by, the Piping_system_line.

4.2.125 Line_plant_item_branch_connection

A Line_plant_item_branch_connection is a connection between a Line_plant_item_branch_connector (see 4.2.126) and a point on a Piping_system_line_segment other than a termination. The Line_plant_-item_branch_connector branches from the Piping_system_line_segment.

The data associated with Line_plant_item_branch_connection are the following:

- branch_sequence_id.

The branch_sequence_id specifies an alphanumeric identifier that indicates the order that lines branch off of the main line segment.

> NOTE - All branch_sequence_ids are unique with respect to the branches of a given Piping_system_-line_segment (see 4.2.166) and are ordered from termination_1 and termination_2.

4.2.126 Line_plant_item_branch_connector

A Line_plant_item_branch_connector is a type of Functional_connector (see 4.2.92) that participates in a Line_plant_item_branch_connection (see 4.2.125).

4.2.127 Line_plant_item_connection

A Line_plant_item_connection is a connection between the logical termination of a Piping_system_-line_segment (see 4.2.166) and a Line_plant_item_connector (see 4.2.128).

4.2.128 Line_plant_item_connector

A Line_plant_item_connector is a type of Functional_connector (see 4.2.92) that participates in a Line_plant_item_connection (see 4.2.127).

4.2.129 Line_plant_item_termination

A Line_plant_item_termination is a type of Piping_system_line_segment_termination (see 4.2.167) that connects to Plant_item_connector_occurrence (see 4.2.177).

4.2.130 Line_to_line_connection

A Line_to_line_connection is a connection between the logical terminations of two or more Piping_-system_line_segment (see 4.2.166) objects.

The data associated with a Line_to_line_connection are the following:

- line_to_line_connection_id.

The line_to_line_connection_id specifies a unique identifier for the Line_to_line_connection.

4.2.131 Line_to_line_termination

A Line_to_line_termination is a type of Piping_system_line_segment_termination (see 4.2.167) that connects to other Line_to_line_termination objects.

4.2.132 Load_transference

A Load_transference is a type of Plant_item_connection (see 4.2.174) that identifies the purpose or role of the connection as being the transfer of load or force.

4.2.133 Location_in_building

A Location_in_building is a type of Plant_item_location (see 4.2.183) that is the position of the Plant_item (see 4.2.171) relative to the Building (see 4.2.7).

4.2.134 Location_in_plant

A Location_in_plant is a type of Plant_item_location (see 4.2.183) that is the position of the Plant_-item (see 4.2.171) relative to the Plant (see 4.2.170).

4.2.135 Location_in_site

A Location_in_site is a type of Plant_item_location (see 4.2.183) that is the position of the Plant_item (see 4.2.171) relative to the Site (see 4.2.215).

4.2.136 Locked_orientation_connection

A Locked_orientation_connection is a type of Plant_item_connection (see 4.2.174) in which two Plant_item_connector (see 4.2.176) objects are in physical contact and there is no relative motion of the connected Plant_item (see 4.2.171) objects with respect to each other.

NOTE - A pump housing (containing the impeller and shaft) can be connected to the driver (motor) using a Locked_orientation_connection; this would mean that they move in unison.

4.2.137 Male_end

A Male_end is a type of Piping_connector (see 4.2.157) end type that forms a compatible connection with a Female_end (see 4.2.82).

4.2.138 Manufacturing_line

A Manufacturing_line is a type of Plant (see 4.2.170) that is defined by the type of product(s) it produces.

4.2.139 Material_specification_selection

A Material_specification_selection is the candidate material specifications for piping system design. Each Material_specification_selection may be a Material_specification_subset_reference (see 4.2.140).

The data associated with Material_specification_selection are the following:

- description;
- material_specification_id;
- required_or_optional;
- selection_id;
- type.

EXAMPLE 37 - The material_specification_selection for a piping component would have a of type of "Stainless Steel", a material_specification_id of "ASTM (American Society for Testing and Materials) A403", a selection_id of "SS A316S", a description of "standard material callout", and be required.

4.2.139.1 description

The description specifies a textual explanation or summary of the selected material specification.

4.2.139.2 material_specification_id

The material_specification_id specifies a unique identifier for the material specification selected.

4.2.139.3 required_or_optional

The required_or_optional specifies whether the material specification is required or whether its use is optional.

4.2.139.4 selection_id

The selection_id specifies a unique identifier for the candidate material specification.

4.2.139.5 type

The type specifies a designation that classifies a Material_specification_selection based on selection criteria.

4.2.140 Material_specification_subset_reference

A Material_specification_subset_reference is a type of Material_specification_selection (see 4.2.139) that is the reference parameters required to identify the applicable subset of a Required_material_-description (see 4.2.203).

The data associated with Material_specification_subset_reference are the following:

- subset_id.

The subset_id specifies a unique identifier for the specified subset portion of a Required_material_-description.

NOTE - The subset reference is used when further subdivisions of the material specification selection are provided to allow for a more precise specification of the material.

4.2.141 Mitre_bend_pipe

A Mitre_bend_pipe is a type of Pipe (see 3.3.25, 4.2.153) that is a change in Pipe direction accomplished through the use of two or more straight sections of Pipe that are beveled and joined on a line bisecting the angle of junction.

NOTE - Figure 17 depicts a typical Mitre_bend_pipe.

The data associated with Mitre_bend_pipe are the following:

- number_of_segments;

- radius;

- sweep_angle.

4.2.141.1 number_of_segments

The number_of_segments specifies the number of distinct straight sections of pipe that constitute the mitre_bend_pipe. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

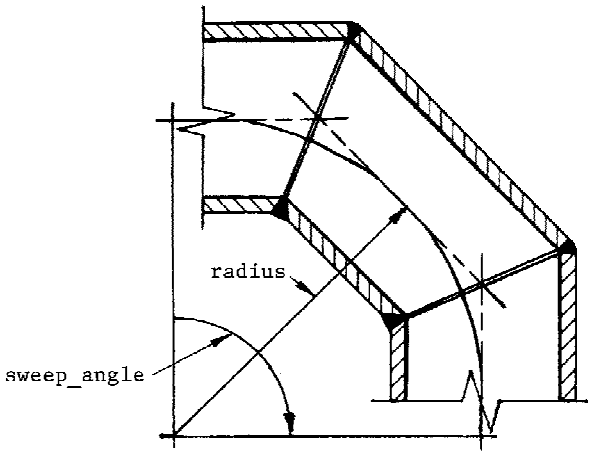

Figure 17 - Mitre bend pipe

4.2.141.2 radius

The radius specifies the measure of the radius of curvature for a mitre_bend_pipe. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.141.3 sweep_angle

The sweep_angle specifies the angular measure at the center of curvature from one end of the mitre_bend_pipe to other. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.142 Nipple

A Nipple is a type of Pipe (see 3.3.25, 4.2.153) that is commonly acquired in prefabricated lengths and end preparations. Nipples are generally small in size in comparison to other pipes in a piping system.

4.2.143 Offline_instrument

An Offline_instrument is a type of Instrument (see 4.2.111) that monitors the conditions of a system but is not an integral element of the system.

EXAMPLE 38 - Local panels, analyzer houses, junction box are examples of Offline_instruments.

4.2.144 Olet

An Olet is a type of Fitting (see 4.2.83) welded onto a hole in the side of a Pipe (see 3.3.25, 4.2.153) or other Fitting.

NOTES

1 - The primary use of an Olet is for making small branch connections or connecting Instrument (see 4.2.111) lines to Piping_component (see 4.2.156) objects.

2 - Figure 18 depicts a typical butt-welded latrolet, a kind of Olet.

EXAMPLE 39 - Other kinds of Olets include weldolets, sweepolets, elbowlets, and sockolets.

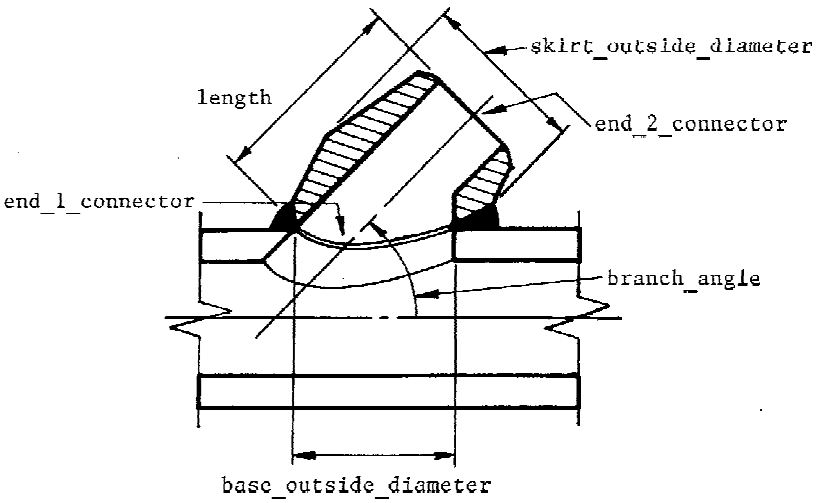

Figure 18 - Olet

The data associated with Olet are the following:

- base_outside_diameter;
- branch_angle;
- end_1_connector;
- end_2_connector;
- length;
- skirt_outside_diameter.

4.2.144.1 base_outside_diameter

The base_outside_diameter specifies the external diameter of the olet at the surface that mates with the straight-run pipe. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.144.2 branch_angle

The branch_angle specifies the angle that the branch projects from the straight run. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.144.3 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) that connects to the main Pipe (see 3.3.25, 4.2.153) or Fitting (see 4.2.83).

4.2.144.4 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) that connects to the branch line.

4.2.144.5 length

The length specifies the distance between the end-one face and the end-two face at the centreline of the Olet. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.144.6 skirt_outside_diameter

The skirt_outside_diameter specifies the maximum external diameter of the Olet (measured perpendicular to the Olet centreline). It may be specified as a single value or as a range of values.

NOTES

1 - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

2 - The sides of an Olet are tapered (not vertical).

4.2.145 Orifice_flange

An Orifice_flange is a type of Flange (see 4.2.84) used to assemble an Inline_instrument (see 4.2.107) to meter the flow of liquids or gases in a Pipe (see 3.3.25, 4.2.153).

NOTES

1 - Orifice_flange objects are used in pairs in conjunction with an Orifice_plate (see 4.2.146).

2 - Figure 19 depicts a typical Orifice_flange and Orifice_plate (see 4.2.146) configuration.

The data associated with Orifice_flange are the following:

- jacking_screw_orientation;

- tap.

4.2.145.1 jacking_screw_orientation

The jacking_screw_orientation specifies the angular position of the threaded bolt holes in an Orifice_-flange.

NOTE - Jacking screws are used to separate the Orifice_flange objects sufficiently to remove or insert the Orifice_plate (see 4.2.146).

4.2.145.2 tap

The tap specifies the Piping_connector (see 4.2.157) designated as the tap.

4.2.146 Orifice_plate

An Orifice_plate is a type of Fitting (see 4.2.83) that is a disk with a calibrated hole that is placed in a Pipe (see 3.3.25, 4.2.153) to measure flow.

NOTE - Figure 19 depicts a typical Orifice_flange (see 4.2.145) and Orifice_plate configuration.

The data associated with Orifice_plate are the following:

- beta_ratio;

- bore_diameter;

- outside_diameter;

- thickness.

4.2.146.1 beta_ratio

The beta_ratio specifies a value that indicates the length of pipe required on either side of the Orifice_-plate to ensure non-turbulent flow past the orifice.

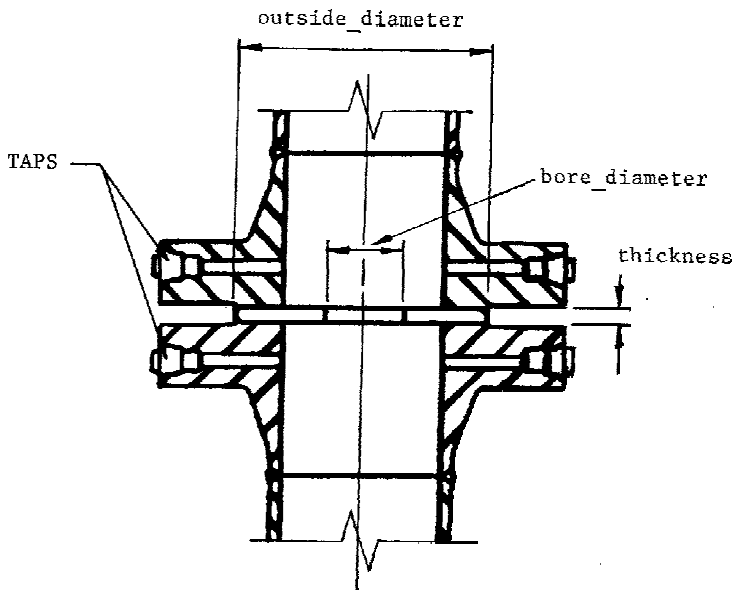

Figure 19 - Orifice flange and orifice plate

4.2.146.2 bore_diameter

The bore_diameter specifies the diameter of the hole in the Orifice_plate. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.146.3 outside_diameter

The outside_diameter specifies the external diameter of the Orifice_plate. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.146.4 thickness

The thickness specifies the perpendicular distance between the two faces of the Orifice_plate. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.147 Outline_shape

An Outline_shape is a type of Plant_item_shape (see 4.2.184) that is a 3D spatial volume that corresponds to the bounding surface features of a Plant_item (see 4.2.171).

NOTE - Contrast with Detail_shape (see 4.2.59) and Envelope_shape (see 4.2.72). An Outline_shape is a simple geometric representation of plant item; this representation may be called a cartoon. The representation is a more accurate representation of the shape of the plant_item than that provided by an Outline_shape, but not nearly as precise as a Detailed_shape.

4.2.148 Outside_and_thickness

An Outside_and_thickness is a type of Piping_size_description (see 4.2.159) that describes the size by providing the outside diameter and thickness values.

The data associated with Outside_and_thickness are the following:

- outside_diameter;

- thickness.

4.2.148.1 outside_diameter

The outside_diameter specifies the external diameter of the Piping_system_component (see 4.2.164) or Piping_connector (see 4.2.157). It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.148.2 thickness

The thickness specifies the minimum distance between the inside and outside piping wall surfaces of the Piping_system_component (see 4.2.164) or Piping_connector (see 4.2.157). It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.149 Paddle_blank

A Paddle_blank is a type of Blank (see 4.2.2) that reserves space between two Flange (see 4.2.84) objects and blocks the flow of material.

NOTES

1 - A Paddle_blank has a handle that permits removal or repositioning of the Paddle_blank. The name is derived from the fact that the Paddle_blank looks like a ping pong paddle.

2 - Figure 20 depicts a typical Paddle_blank.

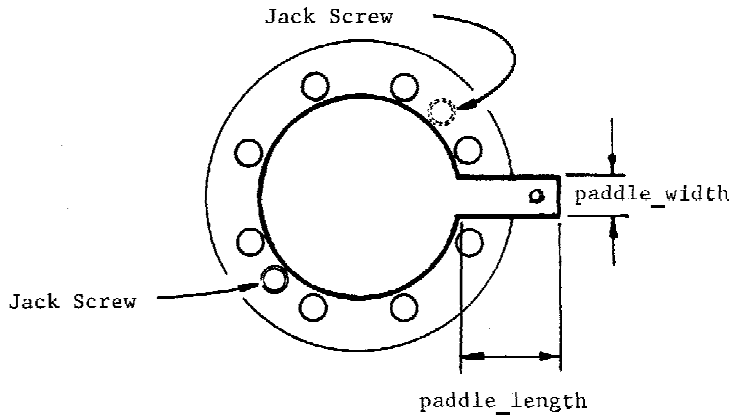

Figure 20 - Paddle blank

The data associated with Paddle_blank are the following:

- paddle_length;

- paddle_width.

4.2.149.1 paddle_length

The paddle_length specifies the length of the handle on the Paddle_blank. It may be specified as a single value or as a range of values.

NOTES

1 - The length is measured from the outside diameter of the Blank (see 4.2.2).

2 - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.149.2 paddle_width

The paddle_width specifies the width of the handle on the Paddle_blank. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.150 Paddle_spacer

A Paddle_spacer is a type of Spacer (see 4.2.223) that reserves space between two Flange (see 4.2.84) objects and permits flow through the Pipe (see 3.3.25, 4.2.153).

NOTES

1 - A Paddle_spacer has a handle that permits its removal or repositioning. The inner diameter of the Paddle_spacer may be less than the diameter of the Pipe, thus altering flow.

2 - Figure 21 depicts a typical Paddle_spacer.

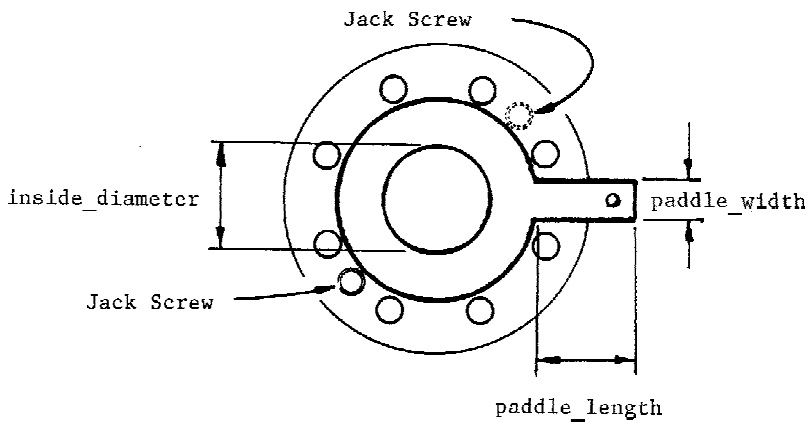

Figure 21 - Paddle spacer

The data associated with Paddle_spacer are the following:

- inside_diameter;
- paddle_length;
- paddle_width.

4.2.150.1 inside_diameter

The inside_diameter specifies the diameter of the bore hole through the Paddle_spacer. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.150.2 paddle_length

The paddle_length specifies the length of the handle of the Paddle_spacer. It may be specified as a single value or as a range of values.

NOTES

1 - The length is measured from the outside diameter of the Blank (see 4.2.2).

2 - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.150.3 paddle_width

The paddle_width specifies the width of the handle of the Paddle_spacer. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.151 Physical_connector

A Physical_connector is a type of Plant_item_connector_occurrence (see 4.2.177) that represents the physical aspects of the plant_item_connector_occurrence.

4.2.152 Physical_design_view

A Physical_design_view is a type of Plant_item_design_view (see 4.2.179) that describes the physical and spatial characteristics of a Plant_item (see 4.2.171).

4.2.153 Pipe

A Pipe is a type of Piping_component (see 4.2.156) that is a hollow cylindrical conveyance, with a constant radius for the cross-sectional circle, for directing fluid, vapour, or particulate flow. Each Pipe may be one of the following: a Mitre_bend_pipe (see 4.2.141), a Nipple (see 4.2.142), a Straight_pipe (see 4.2.229), or a Swept_bend_pipe (see 4.2.245).

NOTES

1 - In most cases, the Pipe will conform to the dimensional requirements for nominal pipe size as tabulated in national standards such as American National Standards Institute (ANSI) B36.10 and ANSI B36.19.

2 - This definition does not exclude tubing and flex hoses from consideration as Pipe.

4.2.154 Pipe_bend

A Pipe_bend is a section of Pipe (see 3.3.25, 4.2.153) that changes the direction of flow along a circular arc. Pipe_bend objects are aggregated into a Swept_bend_pipe (see 4.2.245).

The data associated with Pipe_bend are the following:

- centreline_radius;

- sweep_angle.

4.2.154.1 centreline_radius

The centreline_radius specifies the radius of the Pipe_bend circular arc as measured to the centreline of the Pipe (see 3.3.25, 4.2.153).

4.2.154.2 sweep_angle

The sweep_angle specifies the subtended angle of the Pipe_bend circular arc.

4.2.155 Pipe_closure

A Pipe_closure is a type of Fitting (see 4.2.83) used to close an end of a Piping_component (see 4.2.156).

NOTES

1 - Blind_flange (see 4.2.3) objects also perform the function of closing a Piping_system. However, industry terminology treats them differently and they have been defined as separate objects.

2 - Figure 22 depicts a typical butt-weld Pipe cap, which is a kind of Pipe_closure.

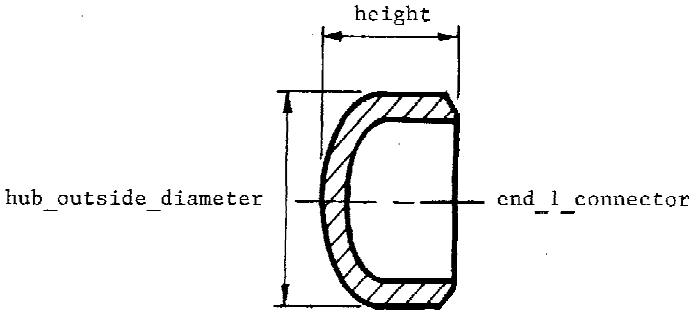

Figure 22 - Pipe cap

The data associated with Pipe_closure are the following:

- cap_or_plug;
- end_1_connector;
- height;
- shape_type.

4.2.155.1 cap_or_plug

The cap_or_plug specifies a designation that identifies the Pipe_closure as a cap or a plug.

4.2.155.2 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) that connects to the Pipe (see 3.3.25, 4.2.153).

4.2.155.3 height

The height specifies the distance between the end-one face and the opposing end of the Pipe_closure. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.155.4 shape_type

The shape_type specifies a designation that classifies a Pipe_closure based on its shape.

EXAMPLE 40 - Examples of the shape_type of a Pipe_closure include square and round.

4.2.156 Piping_component

A Piping_component is a type of Piping_system_component (see 4.2.164) whose primary function is the conveyance or control of fluid flow. Each Piping_component may be one of the following: a Fitting (see 4.2.83), a Pipe (see 3.3.25, 4.2.153), or a Valve (see 4.2.261).

4.2.157 Piping_connector

A Piping_connector is a type of Plant_item_connector (see 4.2.176) that is intended to establish a material flow connection between two Plant_item (see 4.2.171) objects. Each Piping_connector may be one of the following: a Buttweld (see 4.2.9), a Flanged (see 4.2.85), a Socket (see 4.2.220), or a Threaded (see 4.2.248). Each Piping_connector may be one of the following: a Female_end (see 4.2.82), a Flanged_end (see 4.2.86), or a Male_end (see 4.2.137).

The data associated with Piping_connector are the following:

- connector_flow_direction;

- connector_specifications;

- name.

4.2.157.1 connector_flow_direction

The connector_flow_direction specifies an indication of the way process fluid moves past the Plant_-item (see 4.2.171).

4.2.157.2 connector_specifications

The connector_specifications identifies the specifications associated with the Piping_connector.

EXAMPLE 41 - Examples of the identified connector_specifications include insulation specification, end preparation specification, and thread specification.

4.2.157.3 name

The name specifies a textual label given to the Piping_connector.

4.2.158 Piping_connector_service_characteristic

A Piping_connector_service_characteristic is the conditions that the Piping_connector (see 4.2.157) is designed to withstand.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range value.

The data associated with Piping_connector_service_characteristic are the following:

- design_pressure;

- design_temperature.

4.2.158.1 design_pressure

The design_pressure specifies the maximum allowable pressure at the Piping_connector (see 4.2.157). It may be specified as a single value or as a range value.

NOTE - This value is normally created as part of doing 3D analysis of the piping system design.

4.2.158.2 design_temperature

The design_temperature specifies the maximum allowable temperature at the Piping_connector (see 4.2.157). It may be specified as a single value or as a range value.

NOTE - This value is normally created as part of doing 3D analysis of the piping system design.

4.2.159 Piping_size_description

A Piping_size_description is used to explain or summarize the physical size of a Piping_connector (see 4.2.157) or Piping_system_component (see 4.2.164), based on a set of dimensional characteristics, and an optional dimensional standard. Each Piping_size_description is either an Inside_and_thickness (see 4.2.109), an Outside_and_thickness (see 4.2.148), a Pressure_class (see 4.2.193), or a Schedule (see 4.2.207).

NOTE - A Piping_size_description is used to specify the size of a piping component as a whole (where the size is constant over the extant of the component) or to each individual connector of the piping component (where the sizes of each different connector differ.)

The data associated with Piping_size_description are the following:

- dimensional_standard;

- ovality_allowance;

- piping_size_description_id.

4.2.159.1 dimensional_standard

The dimensional_standard specifies a designation for the standard used to dimension the Pipe (see 3.3.25, 4.2.153). The dimensional_standard need not be specified for a particular Piping_size_-description.

EXAMPLE 42 - Examples of dimensional_standard designations include ANSI and DIN.

4.2.159.2 ovality_allowance

The ovality_allowance specifies the acceptable deviation or tolerance allowed in the ‘out-of-roundness’ of the Piping_connector (see 4.2.157) or Piping_system_component (see 4.2.164). In other words, it specifies how much the Piping_connector or Piping_system_component can deviate from a perfect circle. The ovality_allowance need not be specified for a particular Piping_size_description.

4.2.159.3 piping_size_description_id

The piping_size_description_id specifies a unique identifier for the Piping_size_description.

4.2.160 Piping_specification

A Piping_specification is a specification of conditions such as pressure, material, and corrosion allowance that must be met in a Piping_system_line_segment (see 4.2.166) and may include a list of Piping_component (see 4.2.156) objects by size range that meet these conditions.

NOTE - The Piping_specification is used in Spec-driven design, where the user specifies the size and component type, and the Piping_specification is used to look-up the correct component characteristics. The components listed in the Piping_specification may reference component catalogues.

The data associated with a Piping_specification are the following:

- name;

- owner;

- piping_specification_id;

- service_description.

4.2.160.1 name

The name specifies a textual label given to the Piping_specification.

4.2.160.2 owner

The owner specifies the designation given to the person or organization that created and maintains the Piping_specification.

4.2.160.3 piping_specification_id

The piping_specification_id specifies a unique identifier for the Piping_specification.

4.2.160.4 service_description

The service_description specifies a textual explanation or summary of the process stream conditions that are supported by the Plant_item (see 4.2.171) objects described in the Piping_specification.

4.2.161 Piping_spool

A Piping_spool is a collection of piping Plant_item (see 4.2.171) objects.

The data associated with Piping_spool are the following:

- piping_spool_number.

The piping_spool_number specifies an alphanumeric identifier assigned to the Piping_spool.

NOTE - A Piping_spool may be defined to meet transportation, fabrication, or erection requirements.

4.2.162 Piping_spool_assignment

A Piping_spool_assignment is the identification of the Piping_spool (see 4.2.161) that a Piping_-component (see 4.2.156) belongs to.

4.2.163 Piping_system

A Piping_system is a type of Plant_system (see 4.2.187) that is a system of interconnected Plant_item (see 4.2.171) objects that convey fluid, vapour, or particulate flow throughout a plant. Each Piping_-system may be a Line_less_piping_system (see 4.2.123).

EXAMPLE 43 - Methods of flow conveyance through the Piping_system include mechanical, gravitational, and electromagnetic induction.

The data associated with Piping_system are the following:

- code;

- description.

4.2.163.1 code

The code specifies the name of the specification that the Piping_system needs to conform to.

4.2.163.2 description

The description specifies a textual explanation or summary of the Piping_system.

4.2.164 Piping_system_component

A Piping_system_component is a type of Plant_item (see 4.2.171) that is a constituent element of a Piping_system (see 4.2.163). Each Piping_system_component may be one of the following: an Inline_equipment (see 4.2.106), an Inline_instrument (see 4.2.107), a Piping_component (see 4.2.156), a Process_ducting (see 4.2.195), or a Specialty_item (see 4.2.225).

The data associated with Piping_system_component are the following:

- coating_reference;

- corrosion_allowance;

- heat_tracing_type;

- lining.

4.2.164.1 coating_reference

The coating_reference specifies a reference to the specification of the substances used to coat the surfaces of a Piping_system_component. For a given Piping_system_component, the value of this attribute overrides any global specification.

4.2.164.2 corrosion_allowance

The corrosion_allowance specifies the depth that corrosion may encroach below the surface of a piping_system_component before action is required. For a given Piping_system_component, the value of this attribute overrides any global specification. It may be specified as a single value or as a range value.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range value. The depth of the corrosion may vary over the extent of the piping_component.

4.2.164.3 heat_tracing_type

The heat_tracing_type specifies the means utilized to impart a temperature increase to the Piping_-system_component by an external wrapping or coiling. For a given Piping_system_component, the value of this attribute overrides any global specification.

NOTE - Types may include electrical or steam.

4.2.164.4 lining

The lining specifies a description of the substances used to line the internal surfaces of a Piping_-system_component.

4.2.165 Piping_system_line

A Piping_system_line is a logical component of a Piping_system and is composed of a collection of interconnected Piping_system_line_segment (see 4.2.166) objects.

The data associated with Piping_system_line are the following:

- line_number;

- P_and_I_reference;

- piping_system_line_id.

4.2.165.1 line_number

The line_number specifies an alphanumeric identifier assigned to the Piping_system_line and can be used to uniquely define the Piping_system_line.

EXAMPLE 44 - A1A-PX-100-4-150, is a coded number that identifies the Piping_system_line and the main design criteria - specification = A1A, process = PX, line number = 100, line size = 4, and pressure rating = 150.

4.2.165.2 P_and_I_reference

The P_and_I_reference specifies the piping and instrumentation diagram that depicts the Piping_-system_line.

4.2.165.3 piping_system_line_id

The piping_system_line_id specifies a unique identifier for the Piping_system_line.

NOTE - It is normally a subset of the line_number.

4.2.166 Piping_system_line_segment

A Piping_system_line_segment is an element of a Piping_system_line (see 4.2.165). A Piping_-system_line_segment terminates at a functional plant_item_connector (see 4.2.176), a tap into a Piping_system_line (see 4.2.165), a point where the stream diverges or converges, a vent, or a drain.

NOTE - Each piping_system_line_segment is associated with exactly two piping_system_line_segment_-termination objects, termination_1 and termination_2. This provides an artificial direction for the segment that is independent of the stream flow direction.

The data associated with Piping_system_line_segment are the following:

- coating_reference;
- corrosion_allowance;
- design_pressure;
- design_temperature;
- elevation;
- heat_tracing_type;
- line_size;
- segment_id.

4.2.166.1 coating_reference

The coating_reference specifies a reference to the specification that details the coating requirements of the Piping_component (see 4.2.156) objects associated with the Piping_system_line (see 4.2.165).

4.2.166.2 corrosion_allowance

The corrosion_allowance specifies the depth that corrosion may encroach below the surface of components on a piping_system_line_segment before action is required. For a given Piping_-system_component, the value of this attribute overrides any global specification.

4.2.166.3 design_pressure

The design_pressure specifies the requirement for maximum allowable pressure of the Piping_-component (see 4.2.156) objects associated with the Piping_system_line (see 4.2.165).

4.2.166.4 design_temperature

The design_temperature specifies the requirement for maximum allowable temperature of the Piping_-component (see 4.2.156) objects associated with the Piping_system_line (see 4.2.165).

4.2.166.5 elevation

The elevation specifies the distance above sea level that the piping assigned to the line should exist.

4.2.166.6 heat_tracing_type

The heat_tracing_type specifies the heating method used to maintain temperature in the Piping_-system_line (see 4.2.165).

EXAMPLE 45 - Heating method designations include steam tracing and electrical.

4.2.166.7 line_size

The line_size specifies the intended diameter of the piping to be selected to satisfy the Piping_-system_line (see 4.2.165). The line_size need not be specified for a particular Piping_system_line_-segment where the Piping_system_line_segment corresponds to one Piping_system_component (see 4.2.164).

NOTE - When the line_size is not specified, it is either ambiguous due to the nature of the Piping_-system_component such as a Reducer, or derivable from one or more of the connecting Piping_system_-line_segments.

4.2.166.8 segment_id

The segment_id specifies a unique identifier for the Piping_system_line_segment.

4.2.167 Piping_system_line_segment_termination

A Piping_system_line_segment_termination is one of two logical end-points of a Piping_system_line_-segment (see 4.2.166). Each Piping_system_line_segment_termination may be one of the following: a Line_branch_termination (see 4.2.122), a Line_to_line_termination (see 4.2.131), or a Line_plant_-item_termination (see 4.2.129).

NOTES

1 - Piping_system_line objects are composed of individual Piping_system_line_segment objects. Piping_system_line_segment objects are connected through Piping_system_line_segment_termination objects.

The data associated with Piping_system_line_segment_termination are the following:

- flow_direction;

- line_end_location;

- line_start_location;

- termination_id.

2 - Line_end_location and line_start_location are physical anchors for a line and correspond to a particular termination of a line, and therefore a particular termination of a line segment. Most line segments will not have a line_end_location or line_start_location. At most, only one end of the line segment will have a line_end_location or a line_start_location.

4.2.167.1 flow_direction

The flow_direction specifies the direction of material flow at the Piping_system_line_segment_-termination. The value of the flow_direction attribute shall be one of the following:

- both;

- in;

- not_specified;

- out.

4.2.167.1.1 both: material may flow in either direction past the Piping_system_line_segment_-termination.

4.2.167.1.2 in: material flows into the line segment past the Piping_system_line_segment_termination.

4.2.167.1.3 not_specified: the direction of material flow past the Piping_system_line_segment_-termination is not specified.

4.2.167.1.4 out: material flows out of the line segment past the Piping_system_line_segment_-termination.

4.2.167.2 line_end_location

The line_end_location specifies the relative distance in the 'X, Y, Z' directions of the position for the downstream end of the Piping_system_line (see 4.2.165), from a specified reference point and specifies an indicator of the relationship between the point and the Piping_component that will eventually satisfy it. The line_end_location position may also be defined by where it connects to a downstream piece of Equipment (see 3.3.12, 4.2.73) or Piping_system_line.

NOTE - If the indicator is not specified, the assumed value is centre of pipe (COP).

EXAMPLE 46 - The line_end_location is a Cartesian point and an indicator such as bottom of pipe (BOP).

4.2.167.3 line_start_location

The line_start_location specifies the relative distance in the 'X, Y, Z' directions of the position of the upstream end of the Piping_system_line (see 4.2.165), from a specified reference point and specifies an indicator of the relationship between the point and the Piping_component that will eventually satisfy it. The line_start_location position may also be defined by where it connects to an upstream piece of Equipment (see 3.3.12, 4.2.73) or Piping_system_line.

NOTE - If the indicator is not specified, the assumed value is COP.

EXAMPLE 47 - The line_start_location is a Cartesian point and an indicator such as BOP.

4.2.167.4 termination_id

The termination_id specifies a unique identifier for the piping_system_line_segment_termination.

NOTE - All termination_ids are unique and each piping_system_line_segment_termination is owned by a single line segment. Connectivity between line segments can not, therefore, be achieved by two line segments sharing the same termination. Connectivity must be achieved through a connection relationship between two distinct terminations.

4.2.168 Planned_physical_plant

A Planned_physical_plant is the set of physical and spatial characteristics that a Plant (see 4.2.170) can have, including siting, location, and orientation.

NOTE - A Planned_physical_plant can also be the basis for locating other items such as Plant_item (see 4.2.171) objects, Plant_item_location.

4.2.169 Planned_physical_plant_item

A Planned_physical_plant_item is a type of Plant_item_instance (see 4.2.180) that is intended to have physical existence in the real world and that has been used or instanced in a design.

NOTE - Additionally, a Planned_physical_plant_item is always intended to be 'physical' as opposed to purely volumetric. In general, this means that anything that would pose a hard physical impediment to a kick (e.g., a pump) is a physical item, and anything that does not (e.g., an escape route or the water in a cooling pond) is purely volumetric.

The data associated with Planned_physical_plant_item are the following:

- type.

The type specifies a designation that classifies the Plant_item (see 4.2.171).

EXAMPLE 48 - Type designations may include all major categories of Plant_item objects.

4.2.170 Plant

A Plant is a portion of an installation (or the entire installation) required to operate to produce products. Each Plant may be one of the following: a Manufacturing_line (see 4.2.138), a Train (see 4.2.251), or a Unit (see 4.2.260).

> NOTE - Manufacturing_lines, Trains, and Units, may be considered as sub-plants of a plant because they perform all of the same functions as a plant and may be considered as a plant. They are distinct, they produce products based on input resources, and they are (relatively) independent of other plant/sub-plants. Trains, for instance, provide duplicate functionality of one another in case of failure.

The data associated with Plant are the following:

- definition_coordinate_system;
- description;
- name;
- operators;
- owners;
- plant_id.

4.2.170.1 definition_coordinate_system

The definition_coordinate_system is the origin and axes of the Plant that serve as the basis for the location and orientation of Plant_items (see 4.2.171) and subplants in the Plant.

4.2.170.2 description

The description specifies a textual explanation or summary of the Plant. The description need not be specified for a particular Plant. There may be more than one description for a Plant.

4.2.170.3 name

The name specifies a textual label given to the Plant.

4.2.170.4 operators

The operators specifies the name of the organization(s) responsible for the operation of the Plant. For a given plant, the operators need not be specified.

4.2.170.5 owners

The owners specifies the name of the organization(s) that owns the Plant. For a given plant, the owners need not be specified.

4.2.170.6 plant_id

The plant_id specifies a unique identifier for the Plant.

4.2.171 Plant_item

A Plant_item is an identifiable item that has a shape and that may be used as a component of the Plant (see 4.2.170). The Plant_item need not be a physical item, but may be an allocation of space reserved for a purpose. Each Plant_item may be one of the following: a Plant_item_definition (see 4.2.178) or a Plant_item_instance (see 4.2.180). Each Plant_item may be one of the following: a Ducting_-component (see 4.2.60), an Electrical_component (see 4.2.68), an Equipment (see 3.3.12, 4.2.73), an Hvac_component (see 4.2.103), an Instrumentation_and_control_component (see 4.2.112), an Insulation (see 3.3.17, 4.2.114), a Piping_system_component (see 4.2.164), a Structural_component (see 4.2.232), or a Support_component (see 4.2.238).

The data associated with Plant_item are the following:

- description;

- name;

- plant_item_id.

4.2.171.1 description

The description specifies a textual explanation or summary of the Plant_item.

4.2.171.2 name

The name specifies a textual label given to the Plant_item.

4.2.171.3 plant_item_id

The plant_item_id specifies a unique identifier for the Plant_item.

4.2.172 Plant_item_centreline

A Plant_item_centreline is a type of Reference_geometry (see 4.2.201) that is a center of symmetry of an aspect of the shape of the Plant_item (see 4.2.171).

4.2.173 Plant_item_collection

A Plant_item_collection is an association that indicates that a component Plant_item (see 4.2.171) is part of an aggregate Plant_item. Each Plant_item_collection may be a Connected_collection (see 4.2.50). Each Plant_item_collection may be a Hierarchically_organized_collection (see 4.2.102).

EXAMPLE 49 - A Plant_item_collection may be defined for a kit, where the members are not connected, or for an assembly, where the members are connected. Collections that are not hierarchically organized may be physical systems where a single component plays a role in multiple systems, such as a gauge.

The data associated with Plant_item_collection are the following:

- location_and_orientation.

The location_and_orientation specifies the relative position and orientation of the Plant_item (see 4.2.171) within the Plant_item_collection. The location_and_orientation need not be specified for a particular Plant_item_collection.

4.2.174 Plant_item_connection

A Plant_item_connection is a linkage between two or more Plant_item_connector (see 4.2.176) objects. The joining conditions may be specified for the connection. Each Plant_item_connection is either a Connection_definition (see 4.2.51) or a Plant_item_connection_occurrence (see 4.2.175). Each Plant_-item_connection is either a Flexible_connection (see 4.2.87) or a Locked_orientation_connection (see 4.2.136). Each Plant_item_connection may be an Electricity_transference (see 4.2.71). Each Plant_-item_connection may be a Fluid_transference (see 4.2.88). Each Plant_item_connection may be a Load_transference (see 4.2.132). Each Plant_item_connection can have many function types, for the purpose of describing the role that the connection plays in the plant.

NOTES

1 - In most cases, such as piping components, a Plant_item_connection links only two Plant_item_-connector objects.

2 - The term connection does not imply functional continuity beyond the connectors involved in the connection.

The data associated with Plant_item_connection are the following:

- connection_commitment_target;

- connection_id;

- connection_material;

- description.

4.2.174.1 connection_commitment_target

The connection_commitment_target specifies when in the life_cycle phases of the plant system that a connection is actually made.

EXAMPLE 50 - Examples of connection_commitment_targets include fabrication, field-fit, commissioning, or others.

4.2.174.2 connection_id

The connection_id specifies a unique identifier for the Plant_item_connection.

4.2.174.3 connection_material

The connection_material specifies the substances or other Plant_item (see 4.2.171) objects used at the connection of two Plant_item_connector (see 4.2.176) objects. This may be one or more specifications and one or more Plant_item (see 4.2.171) objects.

> EXAMPLE 51 - At a connection of two butt-weld connectors, there is a welding specification that applies to the connection. At a connection of two flanged connectors there are bolts and gaskets that are part of the connection, as well as a specification for the use of these items.

4.2.174.4 description

The description specifies the textual explanation or summary of the function of the Plant_item_-connection.

4.2.175 Plant_item_connection_occurrence

A Plant_item_connection_occurrence is a type of Plant_item_connection (see 4.2.174) that involves a physical linkage between two or more Plant_item_connector_occurrence (see 4.2.177) objects.

4.2.176 Plant_item_connector

A Plant_item_connector is a feature of a Plant_item (see 4.2.171) that is designed to connect to a connector on another Plant_item. Each Plant_item_connector may have specified its design type as one of the following: an Electrical_connector (see 4.2.69), a Piping_connector (see 4.2.157), or a Structural_load_connector (see 4.2.233). Each Plant_item_connector is either a Connector_definition (see 4.2.52) (a definitional type) or a Plant_item_connector_occurrence (4.2.177) (a specified type).

> NOTE - The definitional type is used as the connector definition for a Plant_item_definition (see 4.2.178). A specified type is used for a Plant_item_instance (see 4.2.180).

The data associated with Plant_item_connector are the following:

- connect_point;

- plant_item_connector_id.

4.2.176.1 connect_point

The connect_point specifies a point on or in the connector where the terminal interface with another connector occurs.

4.2.176.2 plant_item_connector_id

The plant_item_connector_id specifies a unique identifier for the Plant_item_connector.

4.2.177 Plant_item_connector_occurrence

A Plant_item_connector_occurrence is a type of Plant_item_connector (see 4.2.176) that is a physical feature of a Plant_item (see 4.2.171) that connects or mates with a like type of connector on another Plant_item. Each Plant_item_connector_occurrence may be one of the following: a Functional_-connector (see 4.2.92) or a Physical_connector (see 4.2.151).

The data associated with Plant_item_connector_occurrence are the following:

- orientation.

The orientation specifies the relative orientation of the Plant_item_connector_occurrence to a defined point on the Plant_item (see 4.2.171).

4.2.178 Plant_item_definition

A Plant_item_definition is a type of Plant_item (see 4.2.171) that has been designed to some level of completeness, but has not been used as the design for physical Plant_item (see 4.2.171) objects.

4.2.179 Plant_item_design_view

A Plant_item_design_view is the collection of information about a Plant_item (see 4.2.171) that is associated with a particular design phase. Each Plant_item_design_view may be one of the following: a Functional_design_view (see 4.2.95) or a Physical_design_view (see 4.2.152).

4.2.180 Plant_item_instance

A Plant_item_instance is a planned type of Plant_item (see 4.2.171), as instanced in a spatial, functional or other design. Each Plant_item_instance is either a Planned_physical_plant_item (see 4.2.169) or a Plant_volume (see 4.2.189).

NOTE - A Plant_item_instance is created through the use or instancing of a Plant_item_definition (see 4.2.178) by placing it in a design.

4.2.181 Plant_item_interference

A Plant_item_interference is where the spatial volume occupied by a Plant_item (see 4.2.171) overlaps the space occupied by one or more Plant_item objects.

The data associated with Plant_item_interference are the following:

- interference_id;

- type.

4.2.181.1 interference_id

The interference_id specifies an identifier for the Plant_item_interference.

4.2.181.2 type

The type specifies the classification assigned to the Plant_item_interference (see 4.2.181) based on the criticality of the clash.

NOTE - The criticality is an assessment of the importance or significance of the clash for a particular project. The values are project dependent.

4.2.182 Plant_item_interference_status

A Plant_item_interference_status is a designation indicating the state of resolution of an identified interference.

The data associated with Plant_item_interference_status are the following:

- assessor;

- status.

4.2.182.1 assessor

The assessor specifies the individual or organization assigned the responsibility for resolving the Plant_item_interference (see 4.2.181).

4.2.182.2 status

The status specifies a designation indicating the state of resolution of an identified Plant_item_-interference (see 4.2.181).

4.2.183 Plant_item_location

A Plant_item_location is the position of the Plant_item (see 4.2.171) within a Plant (see 4.2.170). The position of a Plant_item is specified as the transformation (translation and rotation) of a point and axes on the Plant_item to a point and axes in the destination coordinate system. Each Plant_item_location is either a Location_in_building (see 4.2.133), a Location_in_plant (see 4.2.134), a Location_in_site (see 4.2.135), or a Relative_item_location (see 4.2.202).

The data associated with Plant_item_location are the following:

- location_and_orientation;

- location_id.

4.2.183.1 location_and_orientation

The location_and_orientation specifies the relative position and orientation of the Plant_item (see 4.2.171) within the Plant (see 4.2.170).

4.2.183.2 location_id

The location_id specifies a unique identifier for the Plant_item_location.

4.2.184 Plant_item_shape

A Plant_item_shape is the volumetric representation of a Plant_item (see 4.2.171). Each Plant_item_-shape may be one of the following: a Detail_shape (see 4.2.59), an Envelope_shape (see 4.2.72), or an Outline_shape (see 4.2.147).

The data associated with Plant_item_shape are the following:

- clash_detection_class;

- origin;

- shape_id.

4.2.184.1 clash_detection_class

The clash_detection_class specifies a designation that classifies a Plant_item_shape for the purposes of interference checking. The value of the clash_detection_class attribute shall be one of the following:

- hard;

- ignore;

- soft.

4.2.184.1.1 hard: the Plant_item_shape is used for clash detection and indicates that the shape cannot occupy the same physical space with another hard shape.

4.2.184.1.2 ignore: the Plant_item_shape is not used for clash detection.

4.2.184.1.3 soft: the Plant_item_shape is used for clash detection and indicates that the shape can occupy the same space with another soft shape and, depending on the circumstances, may occupy the same space as a hard object.

> NOTE - See table 1. Table 1 represents a comparison between the clash_detection_class designations for two Plant_item_shapes and indicates whether the resulting interference would be designated as hard clash, soft clash, or no clash. A hard clash refers to an interference between two Plant_item_shapes whose clash_detection_class is hard. A soft clash refers to an interference between two Plant_item_-shapes where at least one of the Plant_item_shapes has a clash_detection_class of soft. A no clash

refers to an interference between two Plant_item_shapes where at least one of the Plant_item_shapes has a clash_detection_class of ignore.

Table 1 - Plant_item_shape interference clash detection

	Hard	Ignore	Soft
Hard	hard clash	no clash	soft clash
Ignore	no clash	no clash	no clash
Soft	soft clash	no clash	soft clash

4.2.184.2 origin

The origin specifies the locating point for the geometric shape of a Plant_item (see 4.2.171).

4.2.184.3 shape_id

The shape_id specifies a unique identifier for the Plant_item_shape.

4.2.185 Plant_item_weight

A Plant_item_weight is an estimate or the measure of the mass of the Plant_item (see 4.2.171).

NOTES

1 - Before the plant_item actually exists, weight is simply an estimate. The actual weight may be provided if the plant_item does exist and has been measured.

2 - Although weight and mass are different, weight is indirectly a measure off the mass of an object on earth. The weight may be specified as either weight or mass, though the former would be much more typical.

The data associated with Plant_item_weight are the following:

- centre_of_gravity;
- weight_state;
- weight_value.

4.2.185.1 centre_of_gravity

The centre_of_gravity specifies the point where the entire weight of a Plant_item (see 4.2.171) may be considered as concentrated so that if supported at this point the Plant_item (see 4.2.171) would remain in equilibrium in any position.

4.2.185.2 weight_state

The weight_state specifies a designation of the condition of the Plant_item (see 4.2.171) that corresponds to the Plant_item_weight.

NOTE - The value of the weight_state may be one of a set of predefined values or may be user supplied.

The value of the weight_state attribute may be one of the following:

- empty;
- full;
- operating;
- shipping;
- test.

4.2.185.2.1 empty: the Plant_item does not contain any process materials.

4.2.185.2.2 full: the Plant_item contains maximum amount of process materials.

4.2.185.2.3 operating: the Plant_item is in normal operating conditions.

4.2.185.2.4 shipping: the Plant_item and its transportation and packing materials are included.

4.2.185.2.5 test: the Plant_item is for purposes of structural load calculations.

4.2.185.3 weight_value

The weight_value specifies a measure of the mass of the Plant_item (see 4.2.171).

4.2.186 Plant_process_capability

A Plant_process_capability is a functional behaviour that can be executed by the Plant (see 4.2.170).

The data associated with Plant_process_capability are the following:

- plant_process_capability_id;
- production_capacity;
- production_type.

EXAMPLE 52 - A plant with a production_type of POWER may produce power at a production_-capacity of 500 million kilowatts per hour. If this process capability is provided by a combination of

a piping system (for steam, for example) and an electrical system, both of these systems can be combined as a subplant; the subplant has the process capability and is part of a plant.

4.2.186.1 plant_process_capability_id

The plant_process_capability_id uniquely identifies a particular plant_process_capability.

4.2.186.2 production_capacity

The production_capacity specifies the rated output of the Plant (see 4.2.170) with respect to a Plant_-process_capability.

4.2.186.3 production_type

The production_type specifies a designation that classifies the Plant (see 4.2.170) based on the products it produces.

4.2.187 Plant_system

A Plant_system is a combination of Plant_item (see 4.2.171) objects that perform a function required for the Plant (see 4.2.170) to operate to produce products. Each Plant_system may be one of the following: an Electrical_system (see 4.2.70), a Ducting_system (see 4.2.61), an Instrumentation_and_-control_system (see 4.2.113), a Piping_system (see 4.2.163), or a Structural_system (see 4.2.234).

NOTE - A Plant_system is one of the types of systems indicated or can have a designation drawn from the classification tables in annex M of ISO 10303-221 [3].

The data associated with Plant_system are the following:

- name;
- plant_system_id;
- service_description.

4.2.187.1 name

The name specifies a textual label given to the Plant_system.

4.2.187.2 plant_system_id

The plant_system_id specifies a unique identifier for the Plant_system.

4.2.187.3 service_description

The service_description specifies a textual or summary label for the system.

> EXAMPLE 53 - Examples of service_description labels include Boiler Feedwater System, Paraxylene System, Pipe Rack K, and 4160V Power System.

4.2.188 Plant_system_assembly

A Plant_system_assembly is a collection of Plant_system (see 4.2.187) objects into a higher-level system to perform a functional capability.

4.2.189 Plant_volume

A Plant_volume is a type of Plant_item_instance (see 4.2.180) that is a specifically defined volume located within a Plant (see 4.2.170) that may, but need not be occupied by physical Plant_item (see 4.2.171) objects. Each Plant_volume may be one of the following: a Reserved_space (see 4.2.204), a Route (see 4.2.206), or a System_space (see 4.2.246).

The data associated with Plant_volume are the following:

- type.

The type specifies a designation that classifies the Plant_volume.

> EXAMPLE 54 - Examples of Plant_volume object type classifications include reserved space, zone-area, area classification zone, equipment pull space, and egress for personnel.

4.2.190 Point

A Point is a type of Wire_and_surface_element (see 4.2.264) that is a dimensionless location in space.

4.2.191 Point_and_line_representation

A Point_and_line_representation is a type of Site_shape_representation (see 4.2.217) represented as a collection of Point (see 4.2.190) objects that define the surface grid of the topography of a Site (see 4.2.215).

4.2.192 Polygon

A Polygon is a type of Curve (see 4.2.56) that is composed of a set of points connected by line segments that form a planar, closed, non-self-intersecting figure.

4.2.193 Pressure_class

A Pressure_class is a type of Piping_size_description (see 4.2.159) based on pressure rating or classification and a nominal size value.

NOTE - This type of piping size description is commonly associated with a dimensional specification, such as the ANSI B16.5 specification for Flange objects.

The data associated with Pressure_class are the following:

- nominal_size;

- pressure_rating.

4.2.193.1 nominal_size

The nominal_size specifies a standard size designation of the Piping_system_component (see 4.2.164) or Piping_connector (see 4.2.157). It may be specified as a single value or as a range of values.

NOTES

1 - The nominal size need not represent an actual dimension.

2 - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.193.2 pressure_rating

The pressure_rating specifies a nominal pressure for the design of the Piping_system_component (see 4.2.164) or Piping_connector (see 4.2.157). It may be specified as a single value or as a range of values.

NOTES

1 - When specified with a dimensional standard, such as ANSI B16.1, its value corresponds to a selection out of a set of available values (e.g., 150 PSI, 300 PSI).

2 - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.194 Pressure_fit

A Pressure_fit is a type of Piping_connector (see 4.2.157) that is a physical feature of a Plant_item (see 4.2.171) that intended to establish a connection with another connector through pressure between the connector rather than by means of threading, welds, or fasteners.

4.2.195 Process_ducting

A Process_ducting is a type of Ducting_component (see 4.2.60) and Piping_system_component (see 4.2.164) that consists of Piping_component (see 4.2.156) objects or ductwork that is used to convey process streams in a Plant (see 4.2.170).

NOTE - Process_ducting is used for venting gaseous portions of the process stream. It is part of the system that handles the process stream, but is ductwork rather than piping.

The data associated with Process_ducting are the following:

- gauge.

The gauge specifies a designation that refers to the thickness of the Process_ducting.

4.2.196 Project_design_assignment

A Project_design_assignment is an assignment of a Plant_item (see 4.2.171) to a Design_project (see 4.2.58).

NOTE - The set of Project_design_assignment instances for a project defines the items and areas that are part of the project.

4.2.197 Pyramid

A Pyramid is a type of Csg_element (see 4.2.55) that is a 3D volume with a rectangular base and four triangular sides that meet at an apex. The axis of a pyramid is the line segment from the centre of the base to the apex. A Pyramid may be an Eccentric_pyramid (see 4.2.64). A Pyramid may be a Trimmed_pyramid (see 4.2.255).

4.2.198 Reducer

A Reducer is a type of Fitting (see 4.2.83) that provides a reduction from one Pipe (see 3.3.25, 4.2.153) size to another. Each Reducer may be an Eccentric_reducer (see 4.2.65).

NOTE - Figure 23 depicts a typical butt-weld Reducer.

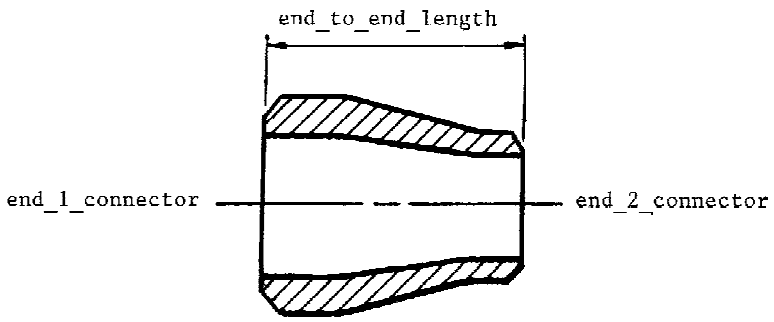

Figure 23 - Reducer

The data associated with Reducer are the following:

- end_1_connector;

- end_2_connector;

- end_to_end_length.

4.2.198.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) that connects to the larger size Pipe (see 3.3.25, 4.2.153).

4.2.198.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) that connects to the smaller size Pipe (see 3.3.25, 4.2.153).

4.2.198.3 end_to_end_length

The end_to_end_length specifies the external distance between the end-one face and the end-two face of the Reducer. It may be specified as a single value or as a range of values.

> NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.199 Reducing_flange

A Reducing_flange is a type of Flange (see 4.2.84) used to make a flanged joint between Pipe (see 3.3.25, 4.2.153) objects of different nominal sizes that has the dimensional characteristics of the larger Pipe and the bore of the smaller Pipe.

> EXAMPLE 55 - Examples of reducing_flange types include weld-neck flange, slip-on flange, socket-weld flange, and threaded flange.

4.2.200 Reducing_torus

A Reducing_torus is a type of Torus (see 4.2.250) that is formed by sweeping a circle that uniformly decreases in size through a circular sweep angle of less that 360 degrees.

4.2.201 Reference_geometry

A Reference_geometry is the identification of one or more Shape_representation_element (see 4.2.213) objects in a model that are not part of a component shape, but provide additional geometric information relative to the shape of the Plant_item (see 4.2.171). Each Reference_geometry may be a Plant_item_centreline (see 4.2.172).

The data associated with Reference_geometry are the following:

- name;

- reference_geometry_id.

4.2.201.1 name

The name specifies a textual label given to the Reference_geometry.

4.2.201.2 reference_geometry_id

The reference_geometry_id specifies a unique identifier assigned to the Reference_geometry.

4.2.202 Relative_item_location

A Relative_item_location is a type of Plant_item_location (see 4.2.183) that is the relative position of the Plant_item (see 4.2.171) with respect to another Plant_item.

4.2.203 Required_material_description

A Required_material_description is a specification of the substances or the requirements of the substances that a component is to be made from.

The data associated with Required_material_description are the following:

- description;

- material_requirement_id.

4.2.203.1 description

The description specifies a textual explanation or summary of the required materials.

4.2.203.2 material_requirement_id

The material_requirement_id specifies a unique identifier for the specification that provides the required material.

NOTE - The identifier is normally a coded value that is company-specific.

4.2.204 Reserved_space

A Reserved_space is a type of Plant_volume (see 4.2.189) that is a region of space that is not to be obstructed by physical objects for reasons related to plant operation.

NOTE - Reserved spaces are normally prescriptive.

EXAMPLE 56 - Reserved_spaces include maintenance volume, operator access, and safety zone.

4.2.205 Ring_spacer

A Ring_spacer is a type of Spacer (see 4.2.223) that fits between Flange (see 4.2.84) objects in a flanged joint to bridge a large gap or fill a slight angle between the Flange objects that cannot be accommodated by standard Flange gaskets.

The data associated with Ring_spacer are the following:

- inside_diameter.

The inside_diameter specifies the diameter of the bore hole through the Ring_spacer. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.206 Route

A Route is a type of Plant_volume (see 4.2.189) that is a 3D path from one location to another.

NOTES

1 - A Route is a conceptual engineered path that reserves space for a piping system. This space need not be occupied by a Plant_item (see 4.2.171) at a future time.

2 - The shape of the reserved volume of a route is a specified Plant_item_shape (see 4.2.184).

EXAMPLE 57 - A cable trench is a kind of route that goes through and runs underneath the surface of a site.

4.2.207 Schedule

A Schedule is a type of Piping_size_description (see 4.2.159) that gives the Pipe (see 3.3.25, 4.2.153) or Piping_component (see 4.2.156) size in terms of nominal size and a sizing schedule.

NOTE - When a Schedule entity is used, the dimensional standard attribute of Piping_size_description (see 4.2.159) must be specified.

The data associated with Schedule are the following:

- nominal_size;

- pipe_schedule.

4.2.207.1 nominal_size

The nominal_size specifies a standard size designation of the Piping_system_component (see 4.2.164) or Piping_connector (see 4.2.157). It may be specified as a single value or as a range of values.

NOTES

1 - The nominal size need not represent an actual dimension.

2 - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.207.2 pipe_schedule

The pipe_schedule specifies a designation of a standard wall thickness and external diameter for a nominal pipe size through a reference to the dimensional standard.

4.2.208 Segment_insulation

A Segment_insulation is a logical connection between a Piping_system_line_segment (see 4.2.166) and the insulation attached to the Pipe (see 3.3.25, 4.2.153) associated with the Piping_system_line_-segment.

The data associated with Segment_insulation are the following:

- boundaries;

- description;

- thickness;

- type.

4.2.208.1 boundaries

The boundaries specifies a description that defines the boundaries for insulation on the Piping_-system_line (see 4.2.165).

EXAMPLE 58 - An example description for the insulation boundaries of a Piping_system_line is personnel protection insulation shall extend to 12 feet above grade or walkway.

4.2.208.2 description

The description specifies a textual explanation or summary of the reasons for providing insulation.

EXAMPLE 59 - Examples of Piping_system_line insulation descriptions include provided for heat conservation and provided for personnel protection.

4.2.208.3 thickness

The thickness specifies the distance between the inside and outside surfaces of the insulation. It may be specified as a single value or as a range value.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range value. The thickness of the insulation may vary over the extent of the insulation.

4.2.208.4 type

The type specifies the insulation material.

4.2.209 Service_operating_case

A Service_operating_case is a stream condition that may exist at a Plant_item_connector (see 4.2.176).

EXAMPLE 60 - Examples of Service_operating_case conditions include normal, upset, and shutdown.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range value.

The data associated with Service_operating_case are the following:

- duration;
- frequency;
- name;
- operating_case_id;
- operating_pressure;
- operating_temperature.

4.2.209.1 duration

The duration specifies the expected time span of the Service_operating_case. It may be specified as a single value or as a range value.

4.2.209.2 frequency

The frequency specifies the expected number of times that the Service_operating_case will occur over a defined period of time. It may be specified as a single value or as a range value.

4.2.209.3 name

The name specifies a textual label given to the condition that the Equipment (see 3.3.12, 4.2.73) operating characteristics are being defined under.

4.2.209.4 operating_case_id

The operating_case_id specifies a unique identifier for the Service_operating_case.

4.2.209.5 operating_pressure

The operating_pressure specifies the force per unit area exerted by the process stream on the Plant_-item (see 4.2.171) under a specific Service_operating_case. It may be specified as a single value or as a range value.

4.2.209.6 operating_temperature

The operating_temperature specifies the temperature of the process stream on the Plant_item (see 4.2.171) under a specific Service_operating_case. It may be specified as a single value or as a range value.

4.2.210 Shape_interference_zone_usage

A Shape_interference_zone_usage is the representational elements that define the shape of a volume that encloses the region of space where the interference of clashing Plant_items (see 4.2.171) occurs.

4.2.211 Shape_parameter

A Shape_parameter is a name-value pair that specifies the dimensional value of some aspect of the Plant_item_shape (see 4.2.184). The meaning of the name-value pair is not specified in this part of ISO 10303.

The data associated with Shape_parameter are the following:

- name;

- value.

4.2.211.1 name

The name specifies a textual label given to a dimension or parameter of a Plant_item_shape (see 4.2.184).

4.2.211.2 value

The value specifies a number that represents the measure of the dimension or parameter of the Plant_-item_shape.

4.2.212 Shape_representation

A Shape_representation is a combination of geometric elements that describe or define the general or specific surface boundaries of a Plant_item (see 4.2.171).

NOTE - Shape representation need not be the exact or specific shape of the item.

4.2.213 Shape_representation_element

A Shape_representation_element is a geometric model that is used to represent the shape or some aspect of the shape of a Plant_item (see 4.2.171). Each Shape_representation_element is either a B_-rep_element (see 4.2.1), a Csg_element (see 4.2.55), or a Wire_and_surface_element (see 4.2.264).

The data associated with Shape_representation_element are the following:

- element_id.

The element_id specifies the unique identifier of the Shape_representation_element.

4.2.214 Shape_representation_element_usage

A Shape_representation_element_usage is an assignment of a Shape_representation_element to a Shape_representation (see 4.2.212) of a Plant_item (see 4.2.171).

NOTE - Shape_representation_element_usage is the mechanism that aggregates the geometric elements that represent the shape of the plant_item. The rules are constraints for what constitutes a valid aggregation are delineated by conformance class.

The data associated with Shape_representation_element_usage are the following:

- element_colour;

- layer.

4.2.214.1 element_colour

The element_colour specifies the colour that displays the element.

4.2.214.2 layer

The layer specifies the collection of displayable items for the purpose of controlling visibility and presentation style.

4.2.215 Site

A Site is a geographical location where the Plant (see 4.2.170) is located.

The data associated with Site are the following:

- address;

- coordinates;

- elevation;
- environmental_references;
- locality;
- name;
- orientation;
- owners;
- site_id.

4.2.215.1 address

The address specifies the street address (including city, state, and zip code as appropriate) of the Site.

4.2.215.2 coordinates

The coordinates specifies the longitude and latitude coordinates of the Site with respect to a known point on the Site.

4.2.215.3 elevation

The elevation specifies the distance that the Site is located above sea level with respect to a known point on the Site.

NOTE - The point referenced here is the same point referenced under coordinates.

4.2.215.4 environmental_references

The environmental_references specifies a reference to a document that provides environmental information relevant to the Site.

EXAMPLE 61 - Environmental_references specify documents that describe the conditions of the environment that a plant operates in that affect the design, such as snow loads, wind loads, and seismic data.

4.2.215.5 locality

The locality specifies the municipality or region where the Site is located.

4.2.215.6 name

The name specifies a textual label given to the Site.

4.2.215.7 orientation

The orientation specifies the relative alignment of the Site with respect to a given compass direction.

4.2.215.8 owners

The owners specify the company or organization that is financially responsible the Site.

4.2.215.9 site_id

The site_id specifies a unique identifier for the Site.

4.2.216 Site_feature

A Site_feature is the composition, proportions, form, or outward appearance of some thing of interest on a Site (see 4.2.215).

> EXAMPLE 62 - A Site_feature may be man-made, such as a building, road, railway, water tower or they may be natural, such as a river, hill, or forest.

The data associated with Site_feature are the following:

- location_and_orientation;
- man_made_or_natural;
- shape;
- site_feature_id;
- type.

4.2.216.1 location_and_orientation

The location_and_orientation specifies the position of the Site_feature relative to the site coordinate system and the orientation of the Site_feature relative to a specified direction.

4.2.216.2 man_made_or_natural

The man_made_or_natural specifies that the Site_feature is either man-made or natural, and provides a short descriptive name or title of the feature.

4.2.216.3 shape

The shape specifies a 3D spatial volume that completely encloses or bounds a feature.

NOTE - The shape of the Site_feature is necessary for the spatial layout of buildings and the piping between buildings.

4.2.216.4 site_feature_id

The site_feature_id specifies a unique identifier for the Site_feature.

4.2.216.5 type

The type specifies a designation that classifies a Site_feature based on its physical and functional characteristics.

4.2.217 Site_shape_representation

A Site_shape_representation is a replica of the topography of a specific area. Each Site_shape_-representation is either a Faceted_surface_representation (see 4.2.80) or a Point_and_line_-representation (see 4.2.191).

The data associated with Site_shape_representation are the following:

- site_shape_representation_id.

The site_shape_representation_id specifies a unique identifier for the Site_shape_representation.

4.2.218 Sited_plant

A Sited_plant is a Planned_physical_plant (see 4.2.168) that a site location has been defined for.

The data associated with Sited_plant are the following:

- plant_site_location;

- plant_site_orientation.

4.2.218.1 plant_site_location

The plant_site_location specifies the geographic position of the plant relative to the Site (see 4.2.215) or a feature of the Site.

4.2.218.2 plant_site_orientation

The plant_site_orientation specifies the directional orientation of the plant with respect to the Site (see 4.2.215).

4.2.219 Slip_on_flange

A Slip_on_flange is a type of Flange (see 4.2.84) that slips over the end of a Pipe (see 3.3.25, 4.2.153) or Fitting (see 4.2.83) and is fillet welded in place.

The data associated with Slip_on_flange are the following:

- stand_off.

The stand_off specifies the measure of the distance between the face of the Slip_on_flange and the end of the pipe that is inserted into the Slip_on_flange. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.220 Socket

A Socket is a type of Piping_connector (see 4.2.157) that is a physical feature of a Plant_item (see 4.2.171) that allows partial insertion of the male end of another Plant_item.

NOTES

1 - The location of the connect point should be based on the dimension from the centreline to the bottom of the socket of a Valve (see 4.2.261) or Fitting (see 4.2.83) plus the root_gap.

2 - Figure 24 depicts a typical Socket.

The data associated with Socket are the following:

- root_gap.

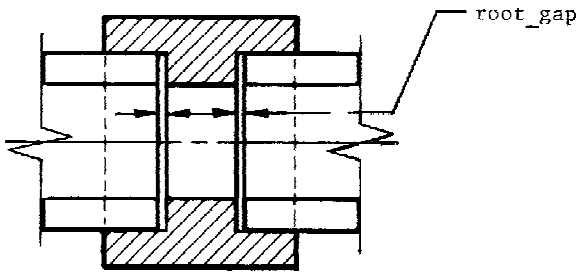

Figure 24 - Socket

The root_gap specifies the distance between the connect point of the Plant_item_connector of the fitting and the base of the Socket.

4.2.221 Socket_weld_flange

A Socket_weld_flange is a type of Flange (see 4.2.84) having a socket configuration that fits the end of a pipe for fillet welding.

4.2.222 Solid_of_revolution

A Solid_of_revolution is a type of Csg_element (see 4.2.55) that is formed by sweeping a 2D shape about an axis. The 2D shape may be closed or open; if open, then the ends of the 2D shape must lie on the sweep axis.

4.2.223 Spacer

A Spacer is a type of Fitting (see 4.2.83) that is placed between two Flange (see 4.2.84) objects to enable the flow of material between the pipelines on either side of the Spacer. Each Spacer may be one of the following: a Paddle_spacer (see 4.2.150), or a Ring_spacer (see 4.2.205).
The data associated with Spacer are the following:

- outside_diameter;

- thickness.

4.2.223.1 outside_diameter

The outside_diameter specifies the external diameter of the Spacer. It may be specified as a single value or as a range of values.

> NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.223.2 thickness

The thickness specifies the distance between the two parallel faces of the Spacer. It may be specified as a single value or as a range of values.

> NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.224 Spare_plant_item_usage

A Spare_plant_item_usage is an association between a primary Plant_item (see 4.2.171) and a Plant_-item used as a spare for the primary Plant_item.

4.2.225 Specialty_item

A Specialty_item is a type of Piping_system_component (see 4.2.164) whose specific dimensional design or configuration is not met by some standard commodity item.

The data associated with Specialty_item are the following:

- type.

The type specifies a category that the item is part of.

EXAMPLE 63 - Examples of Specialty_item types include flange and valve.

4.2.226 Spectacle_blind

A Spectacle_blind is a type of Blank (see 4.2.2) that consists of two paddles connected by an arm. One paddle blocks the flow of material (see Paddle_blank in 4.2.149) and the other is a ring that permits or alters the flow (see Paddle_spacer in 4.2.150). A spectacle either allows or disallows flow in a pipe depending on which end of the spectacle is installed inline. It is often used to isolate a section of the Piping_system (see 4.2.163) or Equipment (see 3.3.12, 4.2.73).

NOTES

1 - The term spectacle refers to shape of the item, that resembles a pair of spectacles (i.e., reading glasses).

2 - Figure 25 depicts a typical Spectacle_blind.

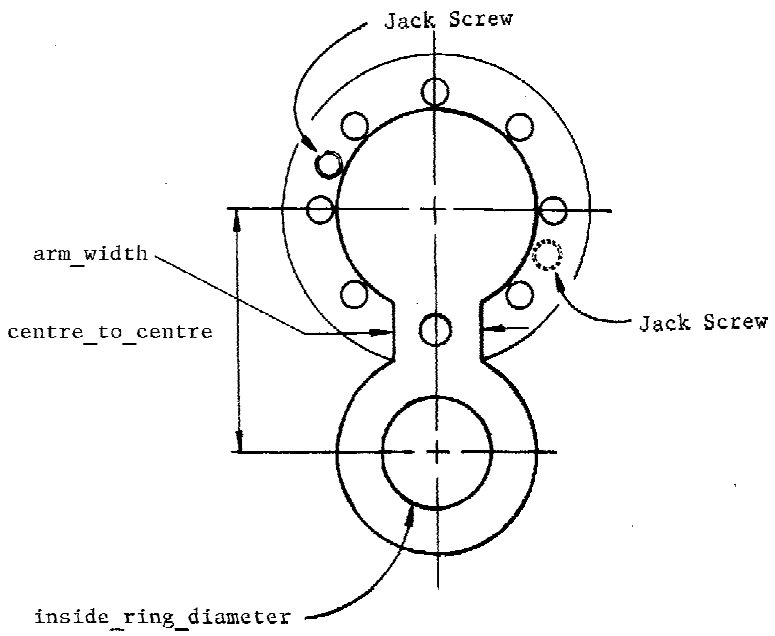

Figure 25 - Spectacle blind

The data associated with Spectacle_blind are the following:

- arm_width;

- centre_to_centre;

- inside_ring_diameter.

4.2.226.1 arm_width

The arm_width specifies the width of the arm connecting the paddles. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.226.2 centre_to_centre

The centre_to_centre specifies the distance between the geometric centres of the paddles. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.226.3 inside_ring_diameter

The inside_ring_diameter specifies the diameter of the bore hole through the ring paddle. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.227 Sphere

A Sphere is a type of Csg_element (see 4.2.55) that is a solid bounded by a surface at a constant radius from a centre point. A Sphere may be a Trimmed_sphere (see 4.2.256).

4.2.228 Square_to_round

A Square_to_round is a type of Csg_element (see 4.2.55) that consists of a planar, rectangular surface, a planar circular surface parallel to the rectangular surface, and an enclosing, transitional surface that connects the boundaries of the rectangular surface and circular surface.

4.2.229 Straight_pipe

A Straight_pipe is a type of Pipe (see 3.3.25, 4.2.153) that does not change the direction of fluid flow.

The data associated with Straight_pipe are the following:

- end_to_end_length.

The end_to_end_length specifies the external length of the Straight_pipe. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.230 Stream_design_case

A Stream_design_case is the set of characteristics of a gas, liquid, vapour, or solid stream under a specific circumstance at the termination of a Piping_system_line_segment (see 4.2.166) or a plant_-item_connector_occurrence (see 4.2.177).

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range value.

The data associated with Stream_design_case are the following:

- description;

- flow_rate;

- pressure;

- stream_case_type;

- stream_data_reference;

- stream_design_id.

4.2.230.1 description

The description specifies a textual explanation or summary of the Stream_design_case.

4.2.230.2 flow_rate

The flow_rate specifies the stream volume, mass, or molar units per unit time. It may be specified as a single value or as a range value.

4.2.230.3 pressure

The pressure specifies the amount of force applied by the stream over a unit area. It may be specified as a single value or as a range value.

4.2.230.4 stream_case_type

The stream_case_type specifies the condition that the stream characteristics are being defined under.

Example 64 - Examples of stream_case_type conditions include normal, upset, and shutdown.

4.2.230.5 stream_data_reference

The stream_data_reference specifies the sources that provide the basis for the stream data.

4.2.230.6 stream_design_id

The stream_design_id specifies a unique identifier for the Stream_design_case.

4.2.231 Stream_phase

A Stream_phase is the set of characteristics of a single gas, liquid, vapour, or solid stream that may be composed into a Stream_design_case (see 4.2.230).

The data associated with Stream_phase are the following:

- constituent_mole_fraction;
- constituents;
- phase_density;
- phase_fraction;
- specific_gravity;
- surface_tension;
- temperature;
- viscosity.

4.2.231.1 constituent_mole_fraction

The constituent_mole_fraction specifies the mass ratio of any given component to the whole for the Stream_phase.

4.2.231.2 constituents

The constituents specifies the various chemicals for the Stream_phase.

4.2.231.3 phase_density

The phase_density specifies the amount of mass per unit volume for the Stream_phase.

4.2.231.4 phase_fraction

The phase_fraction specifies the percentage of the mass of this Stream_phase in the Stream_design_-case (see 4.2.230).

4.2.231.5 specific_gravity

The specific_gravity specifies the ratio of the mass of a liquid to the mass of an equal volume of distilled water at 4 degrees Celsius.

4.2.231.6 surface_tension

The surface_tension specifies the force per unit area of the cohesive forces at or near the surface of a liquid Stream_phase.

4.2.231.7 temperature

The temperature specifies the measure of molecular motion of a stream. It may be specified as a single value or as a range value.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range value.

4.2.231.8 viscosity

The viscosity specifies a measure of the resistance of a stream to deformation when subjected to a shear stress.

4.2.232 Structural_component

A Structural_component is a type of Plant_item (see 4.2.171) that is an individually identifiable item or combination of items that is part of the Plant (see 4.2.170) Structural_system (see 4.2.234).

NOTE - Structural_component objects include structural steel members, load resisting walls, stairs, platforms foundations, supports (excluding pipe supports) for Plant_item (see 4.2.171) objects, and have a primary function to transfer or resist live or dead loads.

The data associated with Structural_component are the following:

- exact_section;

- size_designator;

- type.

4.2.232.1 exact_section

The exact_section specifies the detailed shape of a cross section of the structural element.

4.2.232.2 size_designator

The size_designator specifies the designation given to some types of plant structural elements to define cross-sectional size and general shape based on industry-standard practice.

> EXAMPLE 65 - W30 X 132 is the U.S. American Institute of Steel Construction (AISC) designation for a wide flange beam of nominal 76.20 centimetres (30 inches) depth weighing 194.88 kilograms per metre (132 pounds per foot) of length. Similar designations exist for other plant structural elements such as angles, channels, and structural tee shapes. Also, like designations exist for other structural elements, e.g., reinforcing bar (#8 rebar).

4.2.232.3 type

The type specifies a designation that classifies a structural element based on its function in the Structural_system (see 4.2.234).

> EXAMPLE 66 - Examples of structural element types include beam, column, brace, support, grade beam, and pile.

4.2.233 Structural_load_connector

A Structural_load_connector is a type of Plant_item_connector (see 4.2.176) that connects two Structural_component (see 4.2.232) objects for the purpose of load transfer.

The data associated with Structural_load_connector are the following:

- type.

The type specifies either a shear, moment, or shear and moment type of load at the connector.

4.2.234 Structural_system

A Structural_system is a type of Plant_system (see 4.2.187) that is an assembly of one or more Structural_component (see 4.2.232) objects and Structural_load_connector (see 4.2.233) objects.

The data associated with Structural_system are the following:

- type.

The type specifies a designation that classifies the Structural_system based on the kind of service that it provides.

4.2.235 Sub_plant_relationship

A Sub_plant_relationship is the relationship between Plant (see 4.2.170) objects and sub-plants and defines their relative locations.

EXAMPLE 67 - Sub_plant_relationships include manufacturing line, train, and plant unit.

The data associated with Sub_plant_relationship are the following:

- location_and_orientation.

The location_and_orientation specifies the relative position and orientation of the sub-plant within the Plant (see 4.2.170).

4.2.236 Supplied_equipment

A Supplied_equipment is an Equipment (see 3.3.12, 4.2.73) that is, or is to be, provided by a Supplier (see 4.2.237) for use in a Plant (see 4.2.170).

The data associated with Supplied_equipment are the following:

- delivery_date;

- purchase_order_number;

- requisition_number.

4.2.236.1 delivery_date

The delivery_date specifies the calendar day-month-year and time when the Equipment (see 3.3.12, 4.2.73) was, or is, scheduled to be delivered to the Site (see 4.2.215).

NOTE - A specific ordering of the day, month, and year within the date is not required.

4.2.236.2 purchase_order_number

The purchase_order_number specifies an identifier assigned to the Equipment (see 3.3.12, 4.2.73) purchase order.

4.2.236.3 requisition_number

The requisition_number specifies an identifier assigned to a written request for a piece of Equipment (see 3.3.12, 4.2.73).

4.2.237 Supplier

A Supplier is the organization that produces a piece of Equipment (see 3.3.12, 4.2.73) or publishes a catalogue.

The data associated with Supplier are the following:

- supplier_id;

- vendor_name.

4.2.237.1 supplier_id

The supplier_id specifies a unique identifier for the supplier.

4.2.237.2 vendor_name

The vendor_name specifies a textual label used by the company or organization that is providing the Equipment (see 3.3.12, 4.2.73).

4.2.238 Support_component

A Support_component is a type of Plant_item (see 4.2.171) that is designed to support other Plant_-item objects. This support includes carrying the weight of the Plant_item, including internal fluids and external insulation, permitting thermal expansion and contraction, and dampening any vibrational or seismic forces applied to the Plant_item. Each Support_component may be a Cable_support (see 4.2.10).

> EXAMPLE 68 - If a Support_component is not a Cable_support, it may be a branch reinforcing pad, a hanger, a footer, pipe rack, or anything that supports the weight of a Plant_item.

4.2.239 Support_constraints

A Support_constraints is a limitation on the movement of a Plant_item (see 4.2.171) support, normally in specified directions.

The data associated with Support_constraints are the following:

- gap;

- K;

- restrained;

- support_constraint_id.

4.2.239.1 gap

The gap specifies the allowable space between a Plant_item (see 4.2.171) and a Plant_item support.

4.2.239.2 K

The K specifies the ratio between the force applied to the support and the support deflection produced by that force.

4.2.239.3 restrained

The restrained specifies a boolean indicator that specifies whether the Plant_item (see 4.2.171) support limits movement of the Plant_item in a specified direction.

4.2.239.4 support_constraint_id

The support_constraint_id specifies a unique identifier for the Support_constraints.

4.2.240 Support_usage

A Support_usage is the relationship between a defined load bearing element and the Plant_item (see 4.2.171) that it provides support for. Each Support_usage may be a Support_usage_connection (see 4.2.241).

The data associated with Support_usage are the following:

- detail_sheet_reference;

- function.

4.2.240.1 detail_sheet_reference

The detail_sheet_reference specifies the support detail drawings that define the support.

4.2.240.2 function

The function specifies the role or purpose of using the Plant_item (see 4.2.171) as a support.

EXAMPLE 69 - Examples of function designations include anchor, guide, restraint, and support.

4.2.241 Support_usage_connection

A Support_usage_connection is a type of Support_usage (see 4.2.240) that specifies the actual Plant_-item_connection_occurrence (see 4.2.175) where the support occurs.

4.2.242 Surface

A Surface is a type of Wire_and_surface_element (see 4.2.264) that is a set of connected points in 3D geometric space that is always locally 2D, but need not be a manifold.

NOTE - Surface has many subtypes. Besides being a self-contained object, Surface is used in the definition of other geometric objects such as Point (see 4.2.190) objects and Curve (see 4.2.56) objects. It will not be instantiated as it has no attributes.

4.2.243 Survey_point

A Survey_point is a particular location (position and elevation) on a Site (see 4.2.215) relative to a known geographic location.

NOTE - Survey_point data are established by performing a survey. The collection of Survey_point data can be interpolated to generate a faceted or surface representation of the topography of the Site.

4.2.244 Swage

A Swage is a type of Fitting (see 4.2.83) that provides a reduction from Pipe (see 3.3.25, 4.2.153) size to another. Each Swage may be an Eccentric_swage (see 4.2.66).

NOTES

1 - A Swage will always have at least one male end_type and either a male or butt-weld end.

2 - Figure 26 depicts a typical butt-weld Swage.

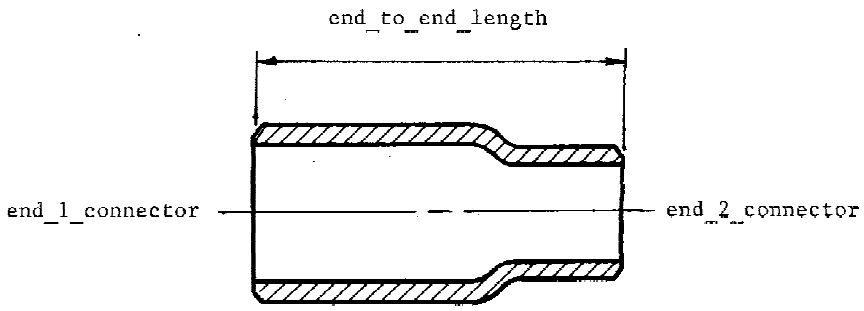

Figure 26 - Swage

The data associated with Swage are the following:

- end_1_connector;
- end_2_connector;
- end_to_end_length.

4.2.244.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) that corresponds to the larger diameter end of the Swage.

4.2.244.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) that corresponds to the smaller diameter end of the Swage.

4.2.244.3 end_to_end_length

The end_to_end_length specifies the external distance between the larger diameter end face and the smaller diameter end face of the swage. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.245 Swept_bend_pipe

A Swept_bend_pipe is a type of Pipe (see 3.3.25, 4.2.153) that is bent to alter the direction of flow of its contents.

NOTE - A Swept_bend_pipe is composed of one or more Pipe_bend (see 4.2.154) objects.

The data associated with Swept_bend_pipe are the following:

- wall_thinning_allowance.

The wall_thinning_allowance specifies the amount of pipe wall material that must be provided to compensate for reduction in wall thickness of the pipe caused by bending.

NOTE - As a pipe is bent, the wall thickness on the outside portion of the bend will reduce as material stretches.

4.2.246 System_space

A System_space is a type of Plant_volume (see 4.2.189) that is used to describe or allocate a volume of space for use by a Plant_system (see 4.2.187).

EXAMPLE 70 - Examples of System_space type designations include electrical chases, HVAC chases, and instrumentation and control chases.

4.2.247 Tee

A Tee is a type of Fitting (see 4.2.83) that is a single branched outlet Fitting consisting of a straight run and a perpendicular branch used to permit straight-through and 90-degree flow.

NOTE - Figure 27 depicts a typical butt-weld Tee.

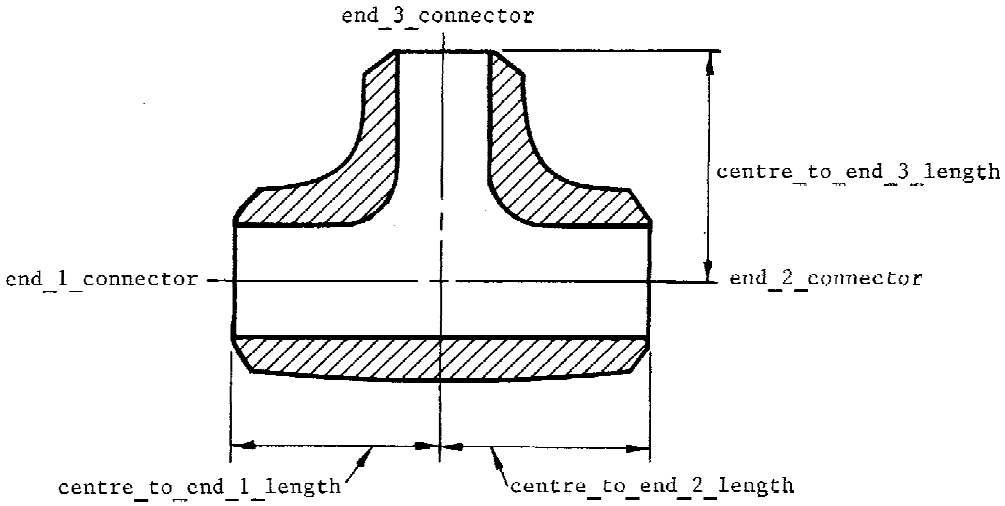

Figure 27 - Tee

The data associated with Tee are the following:

- centre_to_end_1_length;
- centre_to_end_2_length;
- centre_to_end_3_length;
- end_1_connector;
- end_2_connector;
- end_3_connector.

4.2.247.1 centre_to_end_1_length

The centre_to_end_1_length specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-one face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.247.2 centre_to_end_2_length

The centre_to_end_2_length specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-two face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.247.3 centre_to_end_3_length

The centre_to_end_3_length specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-three face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.247.4 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) along the straight-run centreline designated as end one.

4.2.247.5 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) along the straight-run centreline designated as end two.

4.2.247.6 end_3_connector

The end_3_connector specifies the Piping_connector (see 4.2.157) along the branch-run centreline designated as end three.

4.2.248 Threaded

A Threaded is a type of Piping_connector (see 4.2.157) that is a physical feature of a Plant_item (see 4.2.171) that allows partial insertion of a male threaded connector.

NOTE - Figure 28 depicts a typical Threaded end.

The data associated with Threaded are the following:

- thread_engagement_depth.

The thread_engagement_depth specifies the insertion distance of the male threaded connector into a female threaded connector.

4.2.249 Threaded_flange

A Threaded_flange is a type of Flange (see 4.2.84) whose bore is threaded and that is connected to a Pipe (see 3.3.25, 4.2.153) by screwing a threaded Pipe end into the Flange (see 4.2.84).

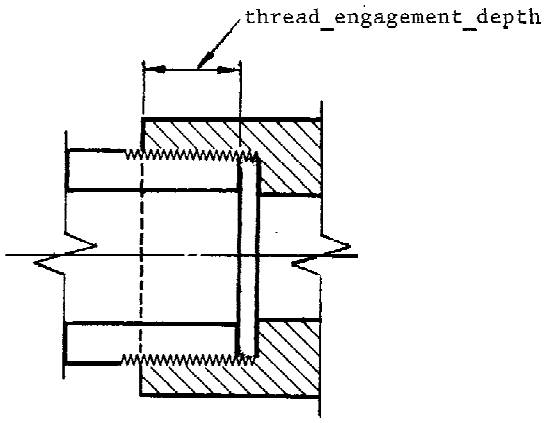

Figure 28 - Threaded

4.2.250 Torus

A Torus is a type of Csg_element (see 4.2.55) that is defined by sweeping the area of a circle (with minor radius) about a larger circle. A Torus may be an Reducing_torus (see 4.2.200). A Torus may be a Trimmed_torus (see 4.2.257).

4.2.251 Train

A Train is a type of Plant (see 4.2.170) that consists of connected Plant_items (see 4.2.171) that perform a distinct function. It is one of two or more distinct but similar portions of a system that perform the same function.

4.2.252 Trimmed_block

A Trimmed_block is a type of Block (see 4.2.4) that is cut with a plane and one of the two sections of the block is removed.

4.2.253 Trimmed_cone

A Trimmed_cone is a type of Cone (see 4.2.48) that is cut with a plane and one of the resulting sections removed.

4.2.254 Trimmed_cylinder

A Trimmed_cylinder is a type of Cylinder (see 4.2.57) that is cut with a plane and one of the resulting sections removed.

4.2.255 Trimmed_pyramid

A Trimmed_pyramid is a type of Pyramid (see 4.2.197) that is cut with a plane and one of the resulting sections removed.

4.2.256 Trimmed_sphere

A Trimmed_sphere is a type of Sphere (see 4.2.227) that is formed by cutting a Sphere with one or more planes and removing some resulting sections. A Trimmed_sphere may be a Hemisphere (see 4.2.101).

4.2.257 Trimmed_torus

A Trimmed_torus is a type of Torus (see 4.2.250) that is defined by cutting a Torus by one or more planes.

4.2.258 Tube

A Tube is a type of Cylinder (see 4.2.57) that a cylindrical, coaxial shape has been removed from, resulting in a circular opening that passed through the cylinder along its axis.

4.2.259 Union

A Union is a type of Fitting (see 4.2.83) composed of multiple pieces that allows the joining or separating of piping without rotating the piping. It consists of two internally threaded ends and a centre piece that draws the two ends together when rotated.

NOTE - Figure 29 depicts a typical socket-weld Union.

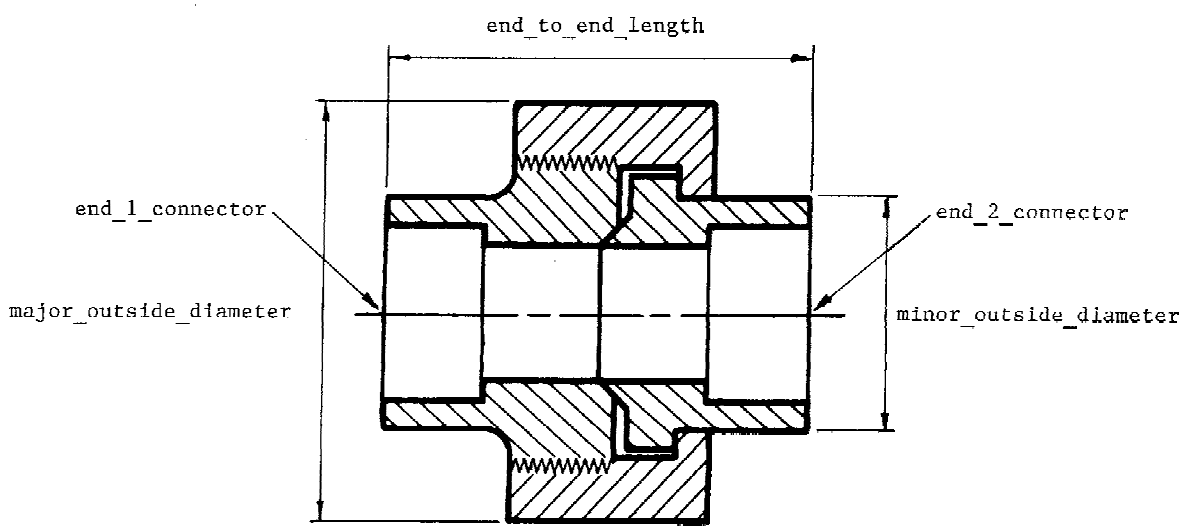

Figure 29 - Union

The data associated with Union are the following:

- end_1_connector;

- end_2_connector;

- end_to_end_length;

- major_outside_diameter;

- minor_outside_diameter.

4.2.259.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) that corresponds to the end with the major_outside_diameter.

4.2.259.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) that corresponds to the end with the minor_outside_diameter.

4.2.259.3 end_to_end_length

The end_to_end_length specifies the external distance between the end-one face and the end-two face. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.259.4 major_outside_diameter

The major_outside_diameter specifies the maximum diameter of the Union along the centreline, normally at the joint between the two internal pieces of the Union. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.259.5 minor_outside_diameter

The minor_outside_diameter specifies the external diameter of the Union at the end-one and end-two connections. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.260 Unit

A Unit is a type of Plant (see 4.2.170) that is the designation (name or number) for a Plant or portion of a Plant that produces the same product by different means.

NOTE - A Unit may perform a unique function for the Plant such as oxygen production, or there may be several units that perform the same function such as multiple units in a power generation installation. The underground or offsite portion of a Plant may be a Unit.

4.2.261 Valve

A Valve is a type of Piping_component (see 4.2.156) that provides isolation or controls fluid direction or flow rate.

The data associated with Valve are the following:

- actuator_type;

- operation_mode;

- type.

4.2.261.1 actuator_type

The actuator_type specifies a descriptive designation of device or mechanism used to open, position, or close a Valve.

4.2.261.2 operation_mode

The operation_mode specifies the failure mode, as in the state of being open or closed when the actuator either has no power or is in the default position.

4.2.261.3 type

The type specifies a designation that classifies a Valve based on its purpose that defines the design of its internals and externals.

EXAMPLE 71 - Examples of Valve type designations include gate, globe, check, and relief.

4.2.262 Vector

A Vector is a type of Curve (see 4.2.56). It is specifies a direction in 3D space.

4.2.263 Weld_neck_flange

A Weld_neck_flange is a type of Flange (see 4.2.84) with a tapered hub bored to match the inside diameter of matching Plant_item (see 4.2.171) and with the hub beveled for butt welding to the Plant_-item.

4.2.264 Wire_and_surface_element

A Wire_and_surface_element is a type of Shape_representation_element (see 4.2.213) that is composed of geometric elements. Each Wire_and_surface_element may be one of the following: a Curve (see 4.2.56), a Point (see 4.2.190), or a Surface (see 4.2.242).

4.2.265 Y_type_lateral

A Y_type_lateral is a type of Fitting (see 4.2.83) that is a three-way fitting whose branches are at equal angles from the straight-run centreline forming a flow passage shaped like the letter "Y".

The data associated with Y_type_lateral are the following:

- angle;
- centre_to_end_1_length;
- centre_to_end_2_length;
- centre_to_end_3_length;
- end_1_connector;
- end_2_connector;
- end_3_connector.

4.2.265.1 angle

The angle specifies the angle of the branch portions of the Y_type_lateral with respect to the straight run. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.265.2 centre_to_end_1_length

The centre_to_end_1_length specifies the distance from the intersection of the Y_type_lateral straight-run centreline and branch-run centreline to the end-one working point. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.265.3 centre_to_end_2_length

The centre_to_end_2_length specifies the distance from the intersection of the Y_type_lateral straight-run centreline and branch-run centreline to the end-two working point. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.265.4 centre_to_end_3_length

The centre_to_end_3_length specifies the distance from the intersection of the Y_type_lateral straight-run centreline and branch-run centreline to the end-three working point. It may be specified as a single value or as a range of values.

NOTE - See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.265.5 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.157) designated as end one.

4.2.265.6 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.157) designated as end two.

4.2.265.7 end_3_connector

The end_3_connector specifies the Piping_connector (see 4.2.157) designated as end three.

4.3 Application assertions

This subclause specifies the application assertions for the plant spatial configuration application protocol. Application assertions specify the relationships among 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.

4.3.1 Breakline to Survey_point

Each Breakline is defined by one or more Survey_point objects. Each Survey_point defines zero, one, or many Breakline objects.

4.3.2 Building to Location_in_building

Each Building is a reference frame for zero, one, or many Location_in_building objects. Each Location_in_building has a reference frame provided by exactly one Building.

4.3.3 Catalogue_connector to Connector_definition

Each Catalogue_connector defines zero, one, or many Connector_definition objects. Each Connector_-definition is defined by zero, one, or many Catalogue_connector objects.

4.3.4 Catalogue_definition to Catalogue_connector

Each Catalogue_definition contains zero, one, or many Catalogue_connector objects. Each Catalogue_-connector is part of exactly one Catalogue_definition.

4.3.5 Catalogue_definition to Catalogue_item

Each Catalogue_definition contains zero, one, or many Catalogue_item objects. Each Catalogue_item is contained by exactly one Catalogue_definition.

4.3.6 Catalogue_item to Catalogue_item_substitute

Each Catalogue_item has zero, one, or many Catalogue_item_substitute objects. Each Catalogue_-item_substitute identifies a substitute for exactly one Catalogue_item.

Each Catalogue_item is a substitute in zero, one, or many Catalogue_item_substitute objects. Each Catalogue_item_substitutes identifies as a substitute exactly one Catalogue_item.

4.3.7 Catalogue_item to Plant_item_definition

Each Catalogue_item is defined by zero, one, or many Plant_item_definition objects. Each Plant_-item_definition defines zero, one, or many Catalogue_item objects.

4.3.8 Change to Change_item

Each Change changes one or more Change_item objects. Each Change_item is changed by zero, one, or many Change objects.

4.3.9 Change to Change_life_cycle_stage_usage

Each Change is assigned by one or more Change_life_cycle_stage_usage objects. Each Change_life_-cycle_stage_usage assigns exactly one Change.

4.3.10 Change_item to Change_delta

Each Change_item is the changed from item in zero, one, or many Change_delta objects. Each Change_delta identifies exactly one Change_item as the item that has been changed.

Each Change_item is the changed to item zero, one, or many Change_delta objects. Each Change_-delta identifies exactly one Change_item as the item that is the result of a change.

4.3.11 Change_life_cycle_stage to Change_life_cycle_stage_sequence

Each Change_life_cycle_stage is the predecessor in zero, one, or many Change_life_cycle_stage_-sequence objects. Each Change_life_cycle_stage_sequence has exactly one Change_life_cycle_stage as the predecessor.

Each Change_life_cycle_stage is the successor in zero, one, or many Change_life_cycle_stage_-sequence objects. Each Change_life_cycle_stage_sequence has exactly one Change_life_cycle_stage as the successor.

4.3.12 Change_life_cycle_stage to Change_life_cycle_stage_usage

Each Change_life_cycle_stage has changes assigned by zero, one, or many Change_life_cycle_stage_-usage objects. Each Change_life_cycle_stage_usage assigns changes for exactly one Change_life_-cycle_stage.

4.3.13 Change_life_cycle_stage_usage to Change_approval

Each Change_life_cycle_stage_usage is approved by zero, one, or many Change_approval objects. Each Change_approval approves exactly one Change_life_cycle_stage_usage.

4.3.14 Connected_collection to Plant_item_connection

Each Connected_collection contains zero, one, or many Plant_item_connection objects. Each Plant_-item_connection participates in zero, one, or many Connected_collection objects.

4.3.15 Connection_definition to Connector_definition

Each Connection_definition connects two or more Connector_definition objects. Each Connector_-definition is connected by zero or one Connection_definition.

4.3.16 Connection_definition to Functional_connection_definition_satisfaction

Each Connection_definition is the functional requirements for zero, one, or many Functional_-connection_definition_satisfaction objects. Each Functional_connection_definition_satisfaction gets the functional requirements from exactly one Connection_definition.

Each Connection_definition satisfies requirements for zero, one, or many Functional_connection_-definition_satisfaction objects. Each Functional_connection_definition_satisfaction has requirements satisfied by exactly one Connection_definition.

4.3.17 Connection_definition to Plant_item_connection_occurrence

Each Connection_definition defines zero, one, or many Plant_item_connection_occurrence objects. Each Plant_item_connection_occurrence is defined by zero or one Connection_definition.

4.3.18 Connector_definition to Catalogue_connector

Each Catalogue_connector is defined by zero, one, or many Connector_definition objects. Each Connector_definition is used as zero, one, or many Catalogue_connector objects.

4.3.19 Connector_definition to Functional_connector_definition_satisfaction

Each Connector_definition is the functional requirements for zero, one, or many Functional_-connector_definition_satisfaction objects. Each Functional_connector_definition_satisfaction gets the functional requirements from exactly one Connector_definition.

Each Connector_definition satisfies requirements for zero, one, or many Functional_connector_-definition_satisfaction objects. Each Functional_connector_definition_satisfaction has requirements satisfied by exactly one Connector_definition.

4.3.20 Connector_definition to Plant_item_connector_occurrence

Each Connector_definition defines zero, one, or many Plant_item_connector_occurrence objects. Each Plant_item_connector_occurrence is defined by zero or one Connector_definition.

4.3.21 Design_project to Project_design_assignment

Each Design_project is performed in one or more Project_design_assignment objects. Each Project_-design_assignment assigns a task to exactly one Design_project.

4.3.22 Ducting_system to Stream_design_case

Each Ducting_system transports material for zero, one, or many Stream_design_case objects. Each Stream_design_case defines potential material for zero, one, or many Ducting_system objects.

4.3.23 Equipment to Equipment_trim_piping

Each Equipment requires zero, one, or many Equipment_trim_piping objects. Each Equipment_trim_-piping is required by exactly one Equipment.

4.3.24 Equipment to Supplied_equipment

Each Equipment is used as zero, one, or many Supplied_equipment objects. Each Supplied_equipment is exactly one Equipment.

4.3.25 Facet_trigon to Survey_point

Each Facet_trigon is defined by exactly three Survey_point objects. Each Survey_point defines zero, one, or many Facet_trigon objects.

4.3.26 Faceted_surface_representation to Facet_trigon

Each Faceted_surface_representation is composed of one or more Facet_trigon objects. Each Facet_trigon is a component of exactly one Faceted_surface_representation.

4.3.27 Functional_connector to Functional_connector_occurrence_satisfaction

Each Functional_connector is the functional requirements for zero, one, or many Functional_connector_occurrence_satisfaction objects. Each Functional_connector_occurrence_satisfaction gets the functional requirements from exactly one Functional_connector.

4.3.28 Functional_plant to Functional_plant_satisfaction

Each Functional_plant is the functional requirements for zero, one, or many Functional_plant_satisfaction. Each Functional_plant_satisfaction gets the functional requirements from exactly one Functional_plant.

4.3.29 Functional_plant to Plant_system

Each Functional_plant is made up of zero, one, or many Plant_system objects. Each Plant_system is part of exactly one Functional_plant.

4.3.30 Functional_design_view to Functional_plant_item_satisfaction

Each Functional_design_view is the functional requirements for zero, one, or many Functional_plant_item_satisfaction. Each Functional_plant_item_satisfaction gets the functional requirements from exactly one Functional_design_view.

4.3.31 Line_branch_connection to Changed_line_branch_connection

Each Line_branch_connection is changed by zero, one, or many Changed_line_branch_connection objects. Each Changed_line_branch_connection changes exactly one Line_branch_connection.

4.3.32 Line_branch_termination to Line_branch_connection

Each Line_branch_termination is branched from exactly one Line_branch_connection. Each Line_branch_connection branches exactly one Line_branch_termination.

4.3.33 Line_less_piping_system to Piping_system_component

Each Line_less_piping_system is composed of zero, one, or many Piping_system_component objects. Each Piping_system_component is a component of zero, one, or many Line_less_piping_system objects.

4.3.34 Line_less_piping_system to Stream_design_case

Each Line_less_piping_system transports material for zero, one, or many Stream_design_case objects. Each Stream_design_case defines potential material for zero, one, or many Line_less_piping_system objects.

4.3.35 Line_piping_system_component_assignment to Changed_line_assignment

Each Line_piping_system_component_assignment is changed by zero, one, or many Changed_line_-assignment objects. Each Changed_line_assignment changes exactly one Line_piping_system_-component_assignment.

4.3.36 Line_plant_item_branch_connection to Changed_line_plant_item_-branch_connection

Each Line_plant_item_branch_connection is changed by zero, one, or many Changed_line_plant_item_-branch_connection objects. Each Changed_line_plant_item_branch_connection changes exactly one Line_plant_item_branch_connection.

4.3.37 Line_plant_item_branch_connector to Line_plant_item_branch_connection

Each Line_plant_item_branch_connector is connected to zero or one Line_plant_item_branch_-connection. Each Line_plant_item_branch_connection connects exactly one Line_plant_item_branch_-connector.

4.3.38 Line_plant_item_connection to Changed_line_plant_item_connection

Each Line_plant_item_connection is changed by zero, one, or many Changed_line_plant_item_-connection objects. Each Changed_line_plant_item_connection changes exactly one Line_plant_item_-connection.

4.3.39 Line_plant_item_connector to Line_plant_item_connection

Each Line_plant_item_connector is connected to zero or one Line_plant_item_connection. Each Line_plant_item_connection connects exactly one Line_plant_item_connector.

4.3.40 Line_plant_item_termination to Line_plant_item_connection

Each Line_plant_item_termination is connected to exactly one Line_plant_item_connection. Each Line_plant_item_connection connects exactly one Line_plant_item_termination.

4.3.41 Line_to_line_connection to Changed_line_to_line_connection

Each Line_to_line_connection is changed by zero, one, or many Changed_line_to_line_connection objects. Each Changed_line_to_line_connection changes exactly one Line_to_line_connection.

4.3.42 Line_to_line_connection to Line_to_line_termination

Each Line_to_line_connection connects two or more Line_to_line_termination objects. Each Line_to_-line_termination is connected by exactly one Line_to_line_connection.

4.3.43 Material_specification_selection to Material_specification_subset_reference

Each Material_specification_selection is used by zero, one, or many Material_specification_subset_reference objects. Each Material_specification_subset_reference uses exactly one Material_specification_selection.

4.3.44 Physical_connector to Functional_connector_occurrence_satisfaction

Each Physical_connector satisfies requirements for zero, one, or many Functional_connector_occurrence_satisfaction objects. Each Functional_connector_occurrence_satisfaction has requirements satisfied by exactly one Physical_connector.

4.3.45 Physical_design_view to Functional_plant_item_satisfaction

Each Physical_design_view satisfies requirements for zero, one, or many Functional_plant_item_satisfaction objects. Each Functional_plant_item_satisfaction has requirements satisfied by exactly one Physical_design_view.

4.3.46 Physical_design_view to Installed_physical_design_view

Each Physical_design_view is used as zero or one Installed_physical_design_view. Each Installed_physical_design_view is exactly one Physical_design_view.

4.3.47 Piping_component to Family_definition

Each Piping_component defines zero or one Family_definition. Each Family_definition is defined by zero or one Piping_component.

4.3.48 Piping_connector to Piping_connector_service_characteristic

Each Piping_connector provides zero or one Piping_connector_service_characteristic. Each Piping_connector_service_characteristic is provided by exactly one Piping_connector.

4.3.49 Piping_connector to Piping_size_description

Each Piping_connector has a size described by zero, one, or many Piping_size_description objects. Each Piping_size_description describes the size of zero, one, or many Piping_connector objects.

4.3.50 Piping_connector_service_characteristic to Service_operating_case

Each Piping_connector_service_characteristic supports zero, one, or many Service_operating_case objects. Each Service_operating_case is supported by exactly one Piping_connector_service_characteristic.

4.3.51 Piping_specification to Changed_piping_specification

Each Piping_specification is changed by zero, one, or many Changed_piping_specification objects. Each Changed_piping_specification changes exactly one Piping_specification.

4.3.52 Piping_specification to Family_definition

Each Piping_specification is composed of one or more Family_definition objects. Each Family_definition is part of exactly one Piping_specification.

4.3.53 Piping_specification to Piping_system_line_segment

Each Piping_specification specifies components for zero, one, or many piping_system_line_segment objects. Each Piping_system_line_segment has components specified by exactly one Piping_-specification.

4.3.54 Piping_spool to Piping_spool_assignment

Each Piping_spool is the spool in zero, one, or many Piping_spool_assignment objects. Each Piping_-spool_assignment has exactly one Piping_spool as the spool.

4.3.55 Piping_system to Piping_system_line

Each Piping_system is made up of zero, one, or many Piping_system_line objects. Each Piping_-system_line is part of exactly one Piping_system.

4.3.56 Piping_system_component to Equipment_trim_piping

Each Piping_system_component is used as zero, one, or many Equipment_trim_piping objects. Each Equipment_trim_piping is exactly one Piping_system_component.

4.3.57 Piping_system_component to Line_piping_system_component_assign-ment

Each Piping_system_component satisfies zero, one, or many Line_piping_system_component_-assignment objects. Each Line_piping_system_component_assignment is satisfied by exactly one Piping_system_component.

4.3.58 Piping_system_component to Piping_size_description

Each Piping_system_component has a size described by zero, one, or many Piping_size_description objects. Each Piping_size_description describes the size of zero, one, or many Piping_system_-component objects.

4.3.59 Piping_system_line to Changed_piping_system_line

Each Piping_system_line is changed by zero, one, or many Changed_piping_system_line objects. Each Changed_piping_system_line changes exactly one Piping_system_line.

4.3.60 Piping_system_line to Piping_system_line_segment

Each Piping_system_line is composed of one or more Piping_system_line_segment objects. Each Piping_system_line_segment is a component of exactly one Piping_system_line.

4.3.61 Piping_system_line_segment to Changed_piping_system_line_segment

Each Piping_system_line_segment is changed by zero, one, or many Changed_piping_system_line_-segment objects. Each Changed_piping_system_line_segment changes exactly one Piping_system_-line_segment.

4.3.62 Piping_system_line_segment to Line_branch_connection

Each Piping_system_line_segment has branches defined by zero, one, or many Line_branch_connection objects. Each Line_branch_connection defines the branches of exactly one Piping_system_line_-segment.

4.3.63 Piping_system_line_segment to Line_plant_item_branch_connection

Each Piping_system_line_segment is connected to zero, one, or many Line_plant_item_branch_-connection objects. Each Line_plant_item_branch_connection defines the branches of exactly one Piping_system_line_segment.

4.3.64 Piping_system_line_segment to Line_piping_system_component_assignment

Each Piping_system_line_segment defines the need for zero, one, or many Line_piping_system_-component_assignment objects. Each Line_piping_system_component_assignment satisfies the need defined by exactly one Piping_system_line_segment.

4.3.65 Piping_system_line_segment to Piping_system_line_segment_termination

Each Piping_system_line_segment is terminated by exactly two Piping_system_line_segment_-termination objects; one is termination_1 and the other is termination_2. Each Piping_system_line_-segment_termination terminates exactly one Piping_system_line_segment.

4.3.66 Piping_system_line_segment to Segment_insulation

Each Piping_system_line_segment requires zero, one, or many Segment_insulation objects. Each Segment_insulation is required by exactly one Piping_system_line_segment.

4.3.67 Piping_system_line_segment to Stream_design_case

Each Piping_system_line_segment defines transport needs for zero, one, or many Stream_design_case objects. Each Stream_design_case defines potential material for zero, one, or many Piping_system_-line_segment objects.

4.3.68 Piping_system_line_segment_termination to Changed_piping_system_line_segment_termination

Each Piping_system_line_segment_termination is changed by zero, one, or many Changed_piping_-system_line_segment_termination objects. Each Changed_piping_system_line_segment_termination changes exactly one Piping_system_line_segment_termination.

4.3.69 Planned_physical_plant to Changed_planned_physical_plant

Each Planned_physical_plant is changed by zero, one, or many Changed_planned_physical_plant objects. Each Changed_planned_physical_plant changes exactly one Planned_physical_plant.

4.3.70 Planned_physical_plant to Functional_plant_satisfaction

Each Planned_physical_plant satisfies requirements for zero, one, or many Functional_plant_-satisfaction objects. Each Functional_plant_satisfaction has requirements satisfied by exactly one Planned_physical_plant.

4.3.71 Planned_physical_plant to Location_in_plant

Each Planned_physical_plant contains zero, one, or many Location_in_plant objects. Each Location_-in_plant is located in zero, one, or many Planned_physical_plant objects.

4.3.72 Planned_physical_plant to Sited_plant

Each Planned_physical_plant is used as zero or one Sited_plant. Each Sited_plant is exactly one Planned_physical_plant.

4.3.73 Planned_physical_plant_item to Plant_item_connector_occurrence

Each Planned_physical_plant_item has zero, one, or many Plant_item_connector_occurrence objects. Each Plant_item_connector_occurrence is part of exactly one Planned_physical_plant_item.

4.3.74 Planned_physical_plant_item to Piping_spool_assignment

Each Planned_physical_plant_item is assigned a spool by zero or one Piping_spool_assignment. Each Piping_spool_assignment assigns a spool to exactly one Planned_physical_plant_item.

4.3.75 Planned_physical_plant_item to Support_usage

Each Planned_physical_plant_item is supported by zero, one, or many Support_usage objects. Each Support_usage identifies exactly one Planned_physical_plant_item that supports another.

Each Planned_physical_plant_item supports zero, one, or many Support_usage objects. Each Support_usage identifies exactly one Planned_physical_plant_item that is supported.

4.3.76 Plant to Changed_plant

Each Plant is changed by zero, one, or many Changed_plant objects. Each Changed_plant changes exactly one Plant.

4.3.77 Plant to External_classification

Each Plant is classified by zero, one, or many External_classification objects. Each External_-classification classifies zero, one, or many Plant objects.

4.3.78 Plant to Functional_plant

Each Plant is used as zero or one Functional_plant. Each Functional_plant is exactly one Plant.

4.3.79 Plant to Planned_physical_plant

Each Plant is realized as zero, one, or many Planned_physical_plant objects. Each Planned_physical_-plant is the realization of exactly one Plant.

4.3.80 Plant to Plant_process_capability

Each Plant produces zero, one, or many Plant_process_capability objects. Each Plant_process_-capability is produced by exactly one Plant.

4.3.81 Plant to Sub_plant_relationship

Each Plant contains zero, one, or many Sub_plant_relationship objects. Each Sub_plant_relationship is contained in exactly one Plant.

Each Plant is used in zero, one, or many Sub_plant_relationship objects. Each Sub-plant_relationship uses exactly one Plant.

4.3.82 Plant_item to Changed_plant_item

Each Plant_item is changed by zero, one, or many Changed_plant_item objects. Each Changed_-plant_item changes exactly one Plant_item.

4.3.83 Plant_item to External_classification

Each Plant_item is classified by zero, one, or many External_classification objects. Each External_-classification classifies zero, one, or many Plant_item objects.

4.3.84 Plant_item to Insulation

Each Plant_item is insulated by zero, one, or many Insulation objects. Each Insulation insulates zero or one Plant_item.

4.3.85 Plant_item to Plant_item_collection

Each Plant_item is an element in zero, one, or many Plant_item_collection objects. Each Plant_item_-collection identifies as an element of a collection exactly one Plant_item.

Each Plant_item is a group of zero, one, or many Plant_item_collection objects. Each Plant_item_-collection identifies as a group exactly one Plant_item.

4.3.86 Plant_item to Plant_item_design_view

Each Plant_item is defined as one or more Plant_item_design_view objects. Each Plant_item_design_-view defines exactly one Plant_item.

4.3.87 Plant_item to Plant_item_shape

Each Plant_item is spatially described by zero, one, or many Plant_item_shape objects. Each Plant_-item_shape spatially describes exactly one Plant_item.

4.3.88 Plant_item to Plant_item_weight

Each Plant_item is measured as having zero, one, or many Plant_item_weight objects. Each Plant_-item_weight is the measured weight of exactly one Plant_item.

4.3.89 Plant_item to Reference_geometry

Each Plant_item references zero, one, or many Reference_geometry objects. Each Reference_geometry is referenced by zero, one, or many Plant_item objects.

4.3.90 Plant_item to Required_material_description

Each Plant_item satisfies zero, one, or many Required_material_description objects. Each Required_-material_description is satisfied by zero, one, or many Plant_item objects.

4.3.91 Plant_item to Spare_plant_item_usage

Each Plant_item is the primary plant item in zero, one, or many Spare_plant_item_usage objects. Each Spare_plant_item_usage has as a primary plant item exactly one Plant_item.

Each Plant_item is the spare plant item in zero, one, or many Spare_plant_item_usage objects. Each Spare_plant_item_usage has as a spare plant item exactly one Plant_item.

4.3.92 Plant_item_collection to Changed_plant_item_collection

Each Plant_item_collection is changed by zero, one, or many Changed_plant_item_collection objects. Each Changed_plant_item_collection changes exactly one Plant_item_collection.

4.3.93 Plant_item_connection to Changed_plant_item_connection

Each Plant_item_connection is changed by zero, one, or many Changed_plant_item_connection objects. Each Changed_plant_item_connection changes exactly one Plant_item_connection.

4.3.94 Plant_item_connection_occurrence to Functional_connection_occurrence_satisfaction

Each Plant_item_connection_occurrence is the functional requirements for zero, one, or many Functional_connection_occurrence_satisfaction objects. Each Functional_connection_occurrence_-satisfaction gets the functional requirements from exactly one Plant_item_connection_occurrence.

Each Plant_item_connection_occurrence satisfies requirements for zero, one, or many Functional_-connection_occurrence_satisfaction objects. Each Functional_connection_occurrence_satisfaction has requirements satisfied by exactly one Plant_item_connection_occurrence.

4.3.95 Plant_item_connection_occurrence to Plant_item_connector_occurrence

Each Plant_item_connection_occurrence connects two or more Plant_item_connector_occurrence objects. Each Plant_item_connector_occurrence is connected by zero or one Plant_item_connection_-occurrence.

4.3.96 Plant_item_connector to Changed_plant_item_connector

Each Plant_item_connector is changed by zero, one, or many Changed_plant_item_connector objects. Each Changed_plant_item_connector changes exactly one Plant_item_connector.

4.3.97 Plant_item_connector to External_classification

Each Plant_item_connector is classified by zero, one, or many External_classification objects. Each External_classification classifies zero, one, or many Plant_item_connector objects.

4.3.98 Plant_item_connector to Required_material_description

Each Plant_item_connector has material requirements defined by zero, one, or many Required_-material_description objects. Each Required_material_description defines material requirements for zero, one, or many Plant_item_connector objects.

4.3.99 Plant_item_connector to Shape_representation

Each Plant_item_connector has shape and orientation defined by zero, one, or many Shape_-representation objects. Each Shape_representation defines the shape and orientation of zero, one, or many Plant_item_connector objects.

4.3.100 Plant_item_definition to Catalogue_item

Each Plant_item_definition is defined as zero, one, or many Catalogue_item objects. Each Catalogue_-item is used as zero, one, or many Plant_item_definition objects.

4.3.101 Plant_item_definition to Connector_definition

Each Plant_item_definition has zero, one, or many Connector_definition objects. Each Connector_-definition is part of exactly one Plant_item_definition.

4.3.102 Plant_item_definition to Planned_physical_plant_item

Each Plant_item_definition defines zero, one, or many Planned_physical_plant_item objects. Each Planned_physical_plant_item is defined by zero or one Plant_item_definition.

4.3.103 Plant_item_instance to Plant_item_interference

Each Plant_item_instance is the first item in zero, one, or many Plant_item_interference objects. Each Plant_item_interference has as its first item exactly one Plant_item_instance.

Each Plant_item_instance is the second item in zero, one, or many Plant_item_interference objects. Each Plant_item_interference has as its second item exactly one Plant_item_instance.

4.3.104 Plant_item_instance to Plant_item_location

Each Plant_item_instance is located by zero, one, or many Plant_item_location objects. Each Plant_-item_location locates exactly one Plant_item_instance. A Plant_item_instance shall be located only once in either a plant, site, or building or multiple times with respect to other Plant_item objects. A Plant_item_instance shall not be located more than once in a plant, site, or building.

4.3.105 Plant_item_instance to Project_design_assignment

Each Plant_item_instance is assigned a project by zero, one, or many Project_design_assignment objects. Each Project_design_assignment assigns a project to exactly one Plant_item_instance.

4.3.106 Plant_item_instance to Relative_item_location

Each Plant_item_instance is the referenced item for zero, one, or many Relative_item_location objects. Each Relative_item_location references exactly one Plant_item_instance.

4.3.107 Plant_item_interference to Interfering_shape_element

Each Plant_item_interference has intersecting geometry of zero, one, or many Interfering_shape_-element objects. Each Interfering_shape_element is the intersecting geometry for exactly one Plant_-item_interference.

4.3.108 Plant_item_interference to Plant_item_interference_status

Each Plant_item_interference has a status of one or more Plant_item_interference_status objects. Each Plant_item_interference_status provides the status for exactly one Plant_item_interference.

4.3.109 Plant_item_interference to Shape_interference_zone_usage

Each Plant_item_interference has a zone of interference defined by zero, one, or many Shape_-interference_zone_usage objects. Each Shape_interference_zone_usage defines the zone of interference for exactly one Plant_item_interference.

4.3.110 Plant_item_location to Changed_plant_item_location

Each Plant_item_location is changed by zero, one, or many Changed_plant_item_location objects. Each Changed_plant_item_location changes exactly one Plant_item_location.

4.3.111 Plant_item_shape to Changed_plant_item_shape

Each Plant_item_shape is changed by zero, one, or many Changed_plant_item_shape objects. Each Changed_plant_item_shape changes exactly one Plant_item_shape.

4.3.112 Plant_item_shape to Shape_representation

Each Plant_item_shape is defined using zero, one, or many Shape_representation objects. Each Shape_representation defines exactly one Plant_item_shape.

4.3.113 Plant_process_capability to Changed_plant_process_capability

Each Plant_process_capability is changed by zero, one, or many Changed_plant_process_capability objects. Each Changed_plant_process_capability changes exactly one Plant_process_capability.

4.3.114 Plant_system to Changed_plant_system

Each Plant_system is changed by zero, one, or many Changed_plant_system objects. Each Changed_-plant_system changes exactly one Plant_system.

4.3.115 Plant_system to External_classification

Each Plant_system is classified by zero, one, or many External_classification objects. Each External_-classification classifies zero, one, or many Plant_system objects.

4.3.116 Plant_system to Plant_item

Each Plant_system is composed of zero, one, or many Plant_item objects. Each Plant_item is part of zero, one, or many Plant_system objects.

4.3.117 Plant_system to Plant_system_assembly

Each Plant_system is the sub-system in zero, one, or many Plant_system_assembly objects. Each Plant_system_assembly has exactly one Plant_system as the sub-system.

Each Plant_system is the super-system in zero, one, or many Plant_system_assembly objects. Each Plant_system_assembly has exactly one Plant_system as the super-system.

4.3.118 Point_and_line_representation to Survey_point

Each Point_and_line_representation is defined by one or more Survey_point objects. Each Survey_-point defines zero, one, or many Point_and_line_representation objects.

4.3.119 Reference_geometry to Changed_reference_geometry

Each Reference_geometry is changed by zero, one, or many Changed_reference_geometry objects. Each Changed_reference_geometry changes exactly one Reference_geometry.

4.3.120 Reference_geometry to Shape_representation_element

Each Reference_geometry is described by zero, one, or many Shape_representation_element objects. Each Shape_representation_element provides description for zero, one, or many Reference_geometry objects.

4.3.121 Required_material_description to Changed_required_material_description

Each Required_material_description is changed by zero, one, or many Changed_required_material_-description objects. Each Changed_required_material_description changes exactly one Required_-material_description.

4.3.122 Required_material_description to Material_specification_selection

Each Required_material_description is satisfied by zero, one, or many Material_specification_selection objects. Each Material_specification_selection satisfies zero, one, or many Required_material_-description objects.

4.3.123 Route to Piping_system_line_segment

Each Route is composed of zero, one, or many Piping_system_line_segment objects. Each Piping_-system_line_segment is a component of zero or one Route.

4.3.124 Shape_representation to Shape_representation_element_usage

Each Shape_representation is defined by one or more Shape_representation_element_usage objects. Each Shape_representation_element_usage defines exactly one Shape_representation.

4.3.125 Shape_representation_element to Shape_interference_zone_usage

Each Shape_representation_element defines a volume for zero or one Shape_interference_zone_usage. Each Shape_interference_zone_usage has a volume defined by exactly one Shape_representation_-element.

4.3.126 Shape_representation_element to Shape_representation_element_-usage

Each Shape_representation_element provides a definition for zero or one Shape_representation_-element_usage. Each Shape_representation_element_usage uses as a definition exactly one Shape_-representation_element.

4.3.127 Shape_representation_element_usage to Interfering_shape_element

Each Shape_representation_element_usage is the intersecting geometry of zero, one, or many Interfering_shape_element objects. Each Interfering_shape_element uses as intersecting geometry exactly one Shape_representation_element_usage.

4.3.128 Site to Building

Each Site has located on it zero, one, or many Building objects. Each Building is located on exactly one Site.

4.3.129 Site to Changed_site

Each Site is changed by zero, one, or many Changed_site objects. Each Changed_site changes exactly one Site.

4.3.130 Site to Location_in_site

Each Site is a reference frame for zero, one, or many Location_in_site objects. Each Location_in_site has a reference frame provided by exactly one Site.

4.3.131 Site to Site_feature

Each Site contains zero, one, or many Site_feature objects. Each Site_feature object is contained in exactly one Site.

4.3.132 Site to Site_shape_representation

Each Site has shape defined by zero, one, or many Site_shape_representation objects. Each Site_-shape_representation defines the shape of exactly one Site.

4.3.133 Site to Sited_plant

Each Site has located on it one or more Sited_plant objects. Each Sited_plant is located on exactly one Site.

4.3.134 Site_feature to Changed_site_feature

Each Site_feature is changed by zero, one, or many Changed_site_feature objects. Each Changed_-site_feature changes exactly one Site_feature.

4.3.135 Site_shape_representation to Breakline

Each Site_shape_representation is constrained by zero, one, or many Breakline objects. Each Breakline constrains zero or one Site_shape_representation.

4.3.136 Site_shape_representation to Gis_position

Each Site_shape_representation has a global position specified by zero or one Gis_position. Each Gis_position specifies the global position for exactly one Site_shape_representation.

4.3.137 Sited_plant to Changed_sited_plant

Each Sited_plant is changed by zero, one, or many Changed_sited_plant objects. Each Changed_-sited_plant changes exactly one Sited_plant.

4.3.138 Stream_design_case to Service_operating_case

Each Stream_design_case defines zero, one, or many Service_operating_case objects. Each Service_-operating_case is defined by exactly one Stream_design_case.

4.3.139 Stream_design_case to Stream_phase

Each Stream_design_case is composed of one or more Stream_phase objects. Each Stream_phase is defined by exactly one Stream_design_case.

4.3.140 Sub_plant_relationship to Changed_sub_plant_relationship

Each Sub_plant_relationship is changed by zero, one, or many Changed_sub_plant_relationship objects. Each Changed_sub_plant_relationship changes exactly one Sub_plant_relationship.

4.3.141 Supplier to Catalogue_definition

Each Supplier publishes zero, one, or many Catalogue_definition objects. Each Catalogue_definition is published by zero or one Supplier.

4.3.142 Supplier to Supplied_equipment

Each Supplier supplies one or more Supplied_equipment objects. Each Supplied_equipment is supplied by exactly one Supplier.

4.3.143 Support_constraints to Support_usage

Each Support_constraints constrains the motion in the negative x-direction of zero, one, or many Support_usage objects. Each Support_usage has motion in the negative x-direction constrained by zero or one Support_constraints object.

Each Support_constraints constrains the motion in the positive x-direction of zero, one, or many Support_usage objects. Each Support_usage has motion in the positive x-direction constrained by zero or one Support_constraints object.

Each Support_constraints constrains the motion in the negative y-direction of zero, one, or many Support_usage objects. Each Support_usage has motion in the negative y-direction constrained by zero or one Support_constraints object.

Each Support_constraints constrains the motion in the positive y-direction of zero, one, or many Support_usage objects. Each Support_usage has motion in the positive y-direction constrained by zero or one Support_constraints object.

Each Support_constraints constrains the motion in the negative z-direction of zero, one, or many Support_usage objects. Each Support_usage has motion in the negative z-direction constrained by zero or one Support_constraints object.

Each Support_constraints constrains the motion in the positive z-direction of zero, one, or many Support_usage objects. Each Support_usage has motion in the positive z-direction constrained by zero or one Support_constraints object.

Each Support_constraints constrains the negative rotation about the x-axis of zero, one, or many Support_usage objects. Each Support_usage has the negative rotation about the x-axis constrained by zero or one Support_constraints object.

Each Support_constraints constrains the positive rotation about the x-axis of zero, one, or many Support_usage objects. Each Support_usage has the positive rotation about the x-axis constrained by zero or one Support_constraints object.

Each Support_constraints constrains the negative rotation about the y-axis of zero, one, or many Support_usage objects. Each Support_usage has the negative rotation about the y-axis constrained by zero or one Support_constraints object.

Each Support_constraints constrains the positive rotation about the y-axis of zero, one, or many Support_usage objects. Each Support_usage has the positive rotation about the y-axis constrained by zero or one Support_constraints object.

Each Support_constraints constrains the negative rotation about the z-axis of zero, one, or many Support_usage objects. Each Support_usage has the negative rotation about the z-axis constrained by zero or one Support_constraints object.

Each Support_constraints constrains the positive rotation about the z-axis of zero, one, or many Support_usage objects. Each Support_usage has the positive rotation about the z-axis constrained by zero or one Support_constraints object.

4.3.144 Support_usage_connection to Plant_item_connection_occurrence

Each Support_usage_connection is detailed by zero, one, or many Plant_item_connection_occurrence objects. Each Plant_item_connection_occurrence gives the details for zero or one Support_usage_-connection.

4.3.145 Swept_bend_pipe to Pipe_bend

Each Swept_bend_pipe contains zero, one, or many Pipe_bend objects. Each Pipe_bend is contained in exactly one Swept_bend_pipe.

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.

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, 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. For those AIM elements that are directly incorporated from an application interpreted protocol (AIC), this is the AIC reference.

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

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

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

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

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

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

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

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

k) \: line continuation for strings that wrap.

Table 2 - Mapping table for change_information UoF

Application element	AIM element	Source	Rules	Reference path
CHANGE	change_action	227	4, 20	change_action <= directed_action
business_unit	organization.name	41		change_action plant_spatial_configuration_organization_item = change_action plant_spatial_configuration_organization_item <- plant_spatial_configuration_organization_assignment.items[i] plant_spatial_configuration_organization_assignment <= organization_assignment organization_assignment.assigned_organization -> organization organization.name
change_id	action.name	41		change_action <= directed_action <= executed_action <= action action.name
change_reason	action_method.purpose	41		change_action <= directed_action <= executed_action <= action action.chosen_method -> action_method action_method.purpose
change_summary	action_method.description	41		change_action <= directed_action <= executed_action <= action action.chosen_method -> action_method action_method.description

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
date	date	41	4	change_action plant_spatial_configuration_dated_item = change_action plant_spatial_configuration_dated_item <- plant_spatial_configuration_date_assignment.items[i] plant_spatial_configuration_date_assignment <= date_assignment date_assignment.assigned_date -> date
project_number	organizational_project.name	41		change_action plant_spatial_configuration_organization_item = change_action plant_spatial_configuration_organization_item <- plant_spatial_configuration_organization_assignment.items[i] plant_spatial_configuration_organization_assignment <= organization_assignment organization_assignment.assigned_organization -> organization <- organizational_project.responsible_organizations[i] organizational_project organizational_project.name
revision	action_relationship	41		change_action <= directed_action <= executed_action <= action <- (action_relationship.relating_action) (action_relationship.related_action) {action_relationship action_relationship.name = ‘change revision’} action_relationship
title	action_method.name	41		change_action <= directed_action <= executed_action <= action action.chosen_method -> action_method action_method.name

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
change to change_item	PATH			change_action <= directed_action <= executed_action <= action <- action_assignment.assigned_action action_assignment => plant_spatial_configuration_change_assignment plant_spatial_configuration_change_assignment.items[i] -> change_item
change to change_life_- cycle_stage_usage	PATH		19	change_action <= directed_action directed_action.directive -> action_directive action_directive.requests[i] -> versioned_action_request
CHANGE_APPROVAL	plant_spatial_configuration_approval_- assignment	227	7	plant_spatial_configuration_approval_assignment <= approval_assignment
approval_date	calendar_date	41	2	plant_spatial_configuration_approval_assignment <= approval_assignment approval_assignment.assigned_approval -> approval <- approval_date_time.dated_approval approval_date_time approval_date_time.date_time -> date_time_select date_time_select = date date => calendar_date

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
approver	person	41	3	plant_spatial_configuration_approval_assignment <= approval_assignment approval_assignment.assigned_approval ->>>>

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CHANGE_DELTA	(product_definition_relationship) (product_definition_formation_- relationship) (property_definition_relationship) (shape_aspect_relationship) (document_relationship) ([change_from_assignment] [change_to_assignment])	41 41 45 41 41 227 227		{product_definition_relationship product_definition_relationship.name = ‘change delta’} {product_definition_formation_relationship product_definition_formation_relationship.name = ‘change delta’} {property_definition_relationship property_definition_relationship.name = ‘change delta’} {shape_aspect_relationship shape_aspect_relationship.name = ‘change delta’} {document_relationship document_relationship.name = ‘change delta’} ([change_from_assignment <= action_assignment] [change_to_assignment <= action_assignment])

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CHANGE_ITEM	change_item	227		{change_item (change_item = change_delta_item change_delta_item (change_delta_item = assembly_component_usage) (change_delta_item = line_branch_connection) (change_delta_item = line_plant_item_branch_connection) (change_delta_item = line_plant_item_connection) (change_delta_item = line_termination_connection) (change_delta_item = plant) (change_delta_item = axis2_placement_2d) (change_delta_item = axis2_placement_3d) (change_delta_item = product) (change_delta_item = product_definition_relationship)) (change_item = reference_geometry) (change_item = electrical_system) (change_item = externally_defined_plant_item_definition) (change_item = ducting_system) (change_item = instrumentation_and_control_system) (change_item = piping_system) (change_item = plant_item_connection) (change_item = plant_item_connector) (change_item = plant_line_definition) (change_item = plant_line_segment_definition) (change_item = plant_line_segment_termination) (change_item = process_capability) (change_item = product_definition) (change_item = product_definition_shape) (change_item = property_definition) (change_item = structural_system) (change_item = document) (change_item = site) (change_item = site_feature)}
change_item_id	change_item_id_assignment	227	6	change_item <- change_item_id_assignment.items[i] change_item_id_assignment <= name_assignment

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
creation_date	date	41	5	change_item plant_spatial_configuration_dated_item = change_item plant_spatial_configuration_dated_item <- plant_spatial_configuration_date_assignment.items[i] plant_spatial_configuration_date_assignment <= date_assignment {date_assignment.role -> date_role date_role.name = ‘creation date’} date_assignment.assigned_date -> date
description	action.description	41		change_item <- plant_spatial_configuration_change_assignment.items[i] plant_spatial_configuration_change_assignment <= action_assignment action_assignment.assigned_action -> action action.description
item_owner	person_and_organization	41		change_item plant_spatial_configuration_person_and_organization_item = change_item plant_spatial_configuration_person_and_organization_item <- plant_spatial_configuration_person_and_organization_assignment.items[i] plant_spatial_configuration_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

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
supersedence_status	action_status.status	41		change_item <- plant_spatial_configuration_change_assignment <= action_assignment action_assignment.assigned_action -> action => executed_action <- action_status.assigned_action action_status action_status.status
change_item to change_-delta (changed from)	PATH			(change_item (change_item = electrical_system electrical_system <=) (change_item = externally_defined_plant_item_definition externally_defined_plant_item_definition <=) (change_item = ducting_system ducting_system <=) (change_item = instrumentation_and_control_system instrumentation_and_control_system <=) (change_item = piping_system piping_system <=) (change_item = plant_line_definition plant_line_definition <= product_definition_with_associated_documents <=) (change_item = plant_line_segment_definition plant_line_segment_definition <=) (change_item = product_definition) (change_item = structural_system structural_system <=) product_definition <- product_definition_relationship.relating_product_definition {product_definition_relationship product_definition_relationship.name = ‘change delta’} product_definition_relationship)

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
change_item to change_-delta (changed from) (continued)				(change_item (change_item = electrical_system electrical_system <=) (change_item = externally_defined_plant_item_definition externally_defined_plant_item_definition <=) (change_item = ducting_system ducting_system <=) (change_item = instrumentation_and_control_system instrumentation_and_control_system <=) (change_item = piping_system piping_system <=) (change_item = plant_line_definition plant_line_definition <= product_definition_with_associated_documents <=) (change_item = plant_line_segment_definition plant_line_segment_definition <=) (change_item = product_definition) (change_item = structural_system structural_system <=) product_definition product_definition.formation -> product_definition_formation <- product_definition_formation_relationship.relating_product_definition_formation {product_definition_formation_relationship product_definition_formation_relationship.name = ‘change delta’} product_definition_relationship)

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
change_item to change_-delta (changed from) (continued)				(change_item (change_item = process_capability process_capability <=) (change_item = product_definition_shape product_definition_shape <=) (change_item = site site <=) (change_item = site_feature site_feature <=) (change_item = property_definition) property_definition <- property_definition_relationship.relating_property_definition {property_definition_relationship property_definition_relationship.name = ‘change delta’} property_definition_relationship) (change_item (change_item = reference_geometry reference_geometry <= derived_shape_aspect <=) (change_item = plant_item_connection plant_item_connection <=) (change_item = plant_item_connector plant_item_connector <=) (change_item = plant_line_segment_termination plant_line_segment_termination <=) shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘change delta’} shape_aspect_relationship)

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
change_item to change_-delta (changed from) (concluded)				(change_item change_item = document document <- document_relationship.relating_document {document_relationship document_relationship.name = ‘change delta’} document) (change_item change_item = change_delta_item change_delta_item <- change_from_assignment.items[i] change_from_assignment)
change_item to change_-delta (changed to)	PATH			(change_item (change_item = electrical_system electrical_system <=) (change_item = externally_defined_plant_item_definition externally_defined_plant_item_definition <=) (change_item = ducting_system ducting_system <=) (change_item = instrumentation_and_control_system instrumentation_and_control_system <=) (change_item = piping_system piping_system <=) (change_item = plant_line_definition plant_line_definition <= product_definition_with_associated_documents <=) (change_item = plant_line_segment_definition plant_line_segment_definition <=) (change_item = product_definition) (change_item = structural_system structural_system <=) product_definition <- product_definition_relationship.related_product_definition {product_definition_relationship product_definition_relationship.name = ‘change delta’} product_definition_relationship)

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
change_item to change_-delta (changed to) (continued)				(change_item (change_item = electrical_system electrical_system <=) (change_item = externally_defined_plant_item_definition externally_defined_plant_item_definition <=) (change_item = ducting_system ducting_system <=) (change_item = instrumentation_and_control_system instrumentation_and_control_system <=) (change_item = piping_system piping_system <=) (change_item = plant_line_definition plant_line_definition <= product_definition_with_associated_documents <=) (change_item = plant_line_segment_definition plant_line_segment_definition <=) (change_item = product_definition) (change_item = structural_system structural_system <=) product_definition product_definition.formation -> product_definition_formation <- product_definition_formation_relationship.related_product_definition_formation {product_definition_formation_relationship product_definition_formation_relationship.name = ‘change delta’} product_definition_formation_relationship)

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
change_item to change_-delta (changed to) (continued)				(change_item (change_item = process_capability process_capability <=) (change_item = product_definition_shape product_definition_shape <=) (change_item = site site <=) (change_item = site_feature site_feature <=) (change_item = property_definition) property_definition <- property_definition_relationship.related_property_definition {property_definition_relationship property_definition_relationship.name = ‘change delta’} property_definition_relationship) (change_item (change_item = reference_geometry reference_geometry <= derived_shape_aspect <=) (change_item = plant_item_connection plant_item_connection <=) (change_item = plant_item_connector plant_item_connector <=) (change_item = plant_line_segment_termination plant_line_segment_termination <=) shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘change delta’} shape_aspect_relationship)

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
change_item to change_-delta (changed to) (concluded)				(change_item change_item = document document <- document_relationship.related_document {document_relationship document_relationship.name = ‘change delta’} document) (change_item change_item = change_delta_item change_delta_item <- change_to_assignment.items[i] change_to_assignment)
CHANGE_LIFE_-CYCLE_STAGE	action_request_status	41	8	
name	action_request_status.status	41		
change_life_cycle_stage to change_life_cycle_-stage_sequence (as predecessor)	PATH			action_request_status action_request_status.assigned_request -> versioned_action_request <- action_request_solution.request action_request_solution action_request_solution.method -> action_method <- action_method_relationship.relating_method action_method_relationship {action_method_relationship action_method_relationship.name = ‘change life cycle stage sequence’}

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
change_life_cycle_stage to change_life_cycle_-stage_sequence (as successor)	PATH			action_request_status action_request_status.assigned_request -> versioned_action_request <- action_request_solution.request action_request_solution action_request_solution.method -> action_method <- action_method_relationship.related_method action_method_relationship {action_method_relationship action_method_relationship.name = ‘change life cycle stage sequence’}
change_life_cycle_stage to change_life_cycle_-stage_usage	PATH		8	action_request_status action_request_status.assigned_request -> versioned_action_request
CHANGE_LIFE_-CYCLE_STAGE_-SEQUENCE	action_method_relationship	41		{action_method_relationship action_method_relationship.name = ‘change life cycle stage sequence’}
CHANGE_LIFE_-CYCLE_STAGE_USAGE	versioned_action_request	41		
date_of_activation	date	41		versioned_action_request <- action_directive.requests[i] action_directive plant_spatial_configuration_dated_item = action_directive plant_spatial_configuration_dated_item <- plant_spatial_configuration_date_assignment.items[i] plant_spatial_configuration_date_assignment <= {date_assignment date_assignment.role -> date_role date_role.name = ‘activation date’} date_assignment date_assignment.assigned_date -> date

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
date_of_completion	date	41		versioned_action_request <- action_directive.requests[i] action_directive plant_spatial_configuration_dated_item = action_directive plant_spatial_configuration_dated_item <- plant_spatial_configuration_date_assignment.items[i] plant_spatial_configuration_date_assignment <= {date_assignment date_assignment.role -> date_role date_role.name = ‘completion date’} date_assignment date_assignment.assigned_date -> date
description	versioned_action_request.description	41		
change_life_cycle_- stage_usage to change_- approval	PATH		7	versioned_action_request <- action_directive.requests[i] action_directive <- directed_action.directive directed_action => change_action approval_item = change_action approval_item <- plant_spatial_configuration_approval_assignment.items[i] plant_spatial_configuration_approval_assignment
CHANGED_LINE_- ASSIGNMENT	product_definition_relationship	41		{product_definition_relationship change_delta_item = product_definition_relationship change_delta_item change_item = change_delta_item}
CHANGED_LINE_- BRANCH_CONNECTION	line_branch_connection	227		line_branch_connection <= shape_aspect_relationship {line_branch_connection change_delta_item = line_branch_connection change_delta_item change_item = change_delta_item}

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CHANGED_LINE_- PLANT_ITEM_- BRANCH_CONNECTION	line_plant_item_branch_connection	227		line_plant_item_branch_connection <= shape_aspect_relationship {line_plant_item_branch_connection change_delta_item = line_plant_item_branch_connection change_delta_item change_item = change_delta_item}
CHANGED_LINE_- PLANT_ITEM_- CONNECTION	line_plant_item_connection	227		line_plant_item_connection <= shape_aspect_relationship {line_plant_item_connection change_delta_item = line_plant_item_connection change_delta_item change_item = change_delta_item}
CHANGED_LINE_TO_- LINE_CONNECTION	line_termination_connection	227		line_termination_connection <= shape_aspect_relationship {line_termination_connection change_delta_item = line_termination_connection change_delta_item change_item = change_delta_item}
CHANGED_PIPING_- SPECIFICATION	document	41		{document [document.kind -> document_type document_type.product_data_type = ‘piping specification’] [change_item = document]}
CHANGED_PIPING_- SYSTEM_LINE	plant_line_definition	227		plant_line_definition <= product_definition_with_associated_documents {plant_line_definition change_item = plant_line_definition}
CHANGED_PIPING_- SYSTEM_LINE_- SEGMENT	plant_line_segment_definition	227		plant_line_segment_definition <= product_definition {plant_line_segment_definition change_item = plant_line_segment_definition}

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CHANGED_PIPING_- SYSTEM_LINE_- SEGMENT_- TERMINATION	plant_line_segment_termination	227		plant_line_segment_termination <= shape_aspect {plant_line_segment_termination change_item = plant_line_segment_termination}
CHANGED_PLANNED_- PHYSICAL_PLANT	product_definition	41	1, 9, 11, 13, 14	{product_definition [product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product => plant] [product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’] [change_item = product_definition]}
CHANGED_PLANT	plant	227		plant <= product {plant change_delta_item = plant change_delta_item change_item = change_delta_item}
CHANGED_PLANT_- ITEM	(product_definition) (externally_defined_plant_item_- definition) (product)	41 227 41	17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {(product_definition change_item = product_definition) (externally_defined_plant_item_definition change_item = externally_defined_plant_item_definition) (product change_delta_item = product change_delta_item change_item = change_delta_item)}

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CHANGED_PLANT_- ITEM_COLLECTION	assembly_component_usage	44		{assembly_component_usage change_delta_item = assembly_component_usage change_delta_item change_item = change_delta_item}
CHANGED_PLANT_- ITEM_CONNECTION	plant_item_connection	227		plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {plant_item_connection change_item = plant_item_connection}
CHANGED_PLANT_- ITEM_CONNECTOR	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector change_item = plant_item_connector}
CHANGED_PLANT_- ITEM_LOCATION	(axis2_placement_2d) (axis2_placement_3d)	42 42		{(axis2_placement_2d change_delta_item = axis2_placement_2d) (axis2_placement_3d change_delta_item = axis2_placement_3d) change_delta_item change_item = change_delta_item}
CHANGED_PLANT_- ITEM_SHAPE	product_definition_shape	41		{product_definition_shape change_item = product_definition_shape}
CHANGED_PLANT_- PROCESS_CAPABILITY	process_capability	227		process_capability <= property_definition {process_capability change_item = process_capability}

Table 2 - Mapping table for change_information UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CHANGED_PLANT_- SYSTEM	(electrical_system) (ducting_system) (instrumentation_and_control_system) (piping_system) (structural_system)	227 227 227 227 227		(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition {(electrical_system change_item = electrical_system) (ducting_system change_item = ducting_system) (instrumentation_and_control_system change_item = instrumentation_and_control_system) (piping_system change_item = piping_system) (structural_system change_item = structural_system)}
CHANGED_- REFERENCE_- GEOMETRY	reference_geometry	227		reference_geometry <= derived_shape_aspect {reference_geometry change_item = reference_geometry}
CHANGED_REQUIRED_- MATERIAL_- DESCRIPTION	product_definition	41		{product_definition change_item = product_definition}
CHANGED_SITE	site	227	15	site <= [characterized_object] [property_definition] {site change_item = site}
CHANGED_SITE_- FEATURE	site_feature	227		site_feature <= property_definition {site_feature change_item = site_feature}

Table 2 - Mapping table for change_information UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
CHANGED_SITED_- PLANT	property_definition.definition	41		{property_definition.definition property_definition change_item = property_definition}
CHANGED_SUB_- PLANT_RELATIONSHIP	product_definition_relationship	41		{product_definition_relationship change_delta_item = product_definition_relationship change_delta_item change_item = change_delta_item}

Table 3 - Mapping table for connection UoF

Application element	AIM element	Source	Rules	Reference path
CONNECTION_-DEFINITION	plant_item_connection	227	1, 9, 11, 13, 14	plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional definition’) (application_context_element.name = ‘physical definition’)}
connection_definition to connector_definition	PATH			plant_item_connection <= shape_aspect_relationship [shape_aspect_relationship.relating_shape_aspect ->] [shape_aspect_relationship.related_shape_aspect ->] shape_aspect => plant_item_connector

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connection_definition to functional_connection_-definition_satisfaction (as functional requirements)	PATH			plant_item_connection <= {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional definition’} shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship {shape_aspect_relationship shape_aspect_relationship.name = ‘connection definition satisfaction’}

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connection_definition to functional_connection_-definition_satisfaction (as requirements satisfaction)	PATH			plant_item_connection <= {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical definition’} shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship {shape_aspect_relationship shape_aspect_relationship.name = ‘connection definition satisfaction’}

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connection_definition to plant_item_connection_-occurrence	PATH			plant_item_connection <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship {shape_aspect_relationship shape_aspect_relationship.name = ‘usage’} shape_aspect_relationship.related_shape_aspect ->{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 product_definition.frame_of_reference ->product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)} shape_aspect => plant_item_connection

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ELECTRICITY_- TRANSFERENCE	plant_item_connection	227		plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {plant_item_connection classification_item = plant_item_connection classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connection_functional_classification] [group group.name = ‘electricity transference’]}
FLEXIBLE_- CONNECTION	plant_item_connection	227		plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {plant_item_connection classification_item = plant_item_connection classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connection_motion_classification] [group group.name = ‘flexible’]}

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FLUID_TRANSFERENCE	plant_item_connection	227		plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {plant_item_connection classification_item = plant_item_connection classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connection_functional_classification] [group group.name = ‘fluid transference’]}

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FUNCTIONAL_- CONNECTION_- DEFINITION_- SATISFACTION	shape_aspect_relationship	41	1, 9, 11, 13, 14	{shape_aspect_relationship shape_aspect_relationship.name = ‘connection definition satisfaction’} {shape_aspect_relationship [shape_aspect_relationship.relating_shape_aspect ->] [shape_aspect_relationship.related_shape_aspect ->] {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional definition’) (application_context_element.name = ‘physical definition’)} shape_aspect => plant_item_connection

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FUNCTIONAL_- CONNECTION_- OCCURRENCE_- SATISFACTION	shape_aspect_relationship	41	1, 9, 11, 13, 14	{shape_aspect_relationship shape_aspect_relationship.name = ‘connection occurrence satisfaction’} {shape_aspect_relationship [shape_aspect_relationship.relating_shape_aspect ->] [shape_aspect_relationship.related_shape_aspect ->] {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)} shape_aspect => plant_item_connection

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LOAD_TRANSFERENCE	plant_item_connection	227		plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {plant_item_connection classification_item = plant_item_connection classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connection_functional_classification] [group group.name = ‘load transference’]}
LOCKED_- ORIENTATION_- CONNECTION	plant_item_connection	227		plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {plant_item_connection classification_item = plant_item_connection classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connection_motion_classification] [group group.name = ‘locked orientation’]}

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PLANT_ITEM_- CONNECTION	plant_item_connection	227	1, 9, 11, 13, 14	plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {plant_item_connection classification_item = plant_item_connection classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connection_motion_classification] [group (group.name = ‘flexible’) (group.name = ‘locked orientation’)]} {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional definition’) (application_context_element.name = ‘physical definition’) (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)}
connection_- commitment_target	shape_aspect.description	41		plant_item_connection <= shape_aspect shape_aspect.description

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connection_id	shape_aspect.name	41		plant_item_connection <= shape_aspect shape_aspect.name
connection_material	material_designation	45		plant_item_connection <= shape_aspect_relationship shape_definition = shape_aspect_relationship shape_definition characterized_definition = shape_definition characterized_definition <- material_designation.definitions[i] material_designation
description	shape_aspect_relationship.description	41		plant_item_connection <= shape_aspect_relationship shape_aspect_relationship.description
plant_item_connection to changed_plant_item_-connection	IDENTICAL MAPPING			
PLANT_ITEM_-CONNECTION_-OCCURRENCE	plant_item_connection	227	1, 9, 11, 13, 14	plant_item_connection <= [shape_aspect_relationship] [shape_aspect] {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)}

Table 3 - Mapping table for connection UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_connection_-occurrence to functional_connection_-occurrence_satisfaction (as functional requirements)	PATH			plant_item_connection <= {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional occurrence’} shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship {shape_aspect_relationship shape_aspect_relationship.name = ‘connection occurrence satisfaction’}

Table 3 - Mapping table for connection UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
plant_item_connection_-occurrence to functional_connection_-occurrence_satisfaction (as requirements satisfaction)	PATH			plant_item_connection <= {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’} shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship {shape_aspect_relationship shape_aspect_relationship.name = ‘connection occurrence satisfaction’}
plant_item_connection_-occurrence to plant_-item_connector_-occurrence	PATH			plant_item_connection <= shape_aspect_relationship [shape_aspect_relationship.relating_shape_aspect ->] [shape_aspect_relationship.related_shape_aspect ->] shape_aspect => plant_item_connector

Table 4 - Mapping table for connector UoF

Application element	AIM element	Source	Rules	Reference path
BRANCH_HOLE	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connector_end_type_classification] [group group.name = ‘branch hole’]}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
diameter #1: The diameter is for the individual connector. #2: The diameter is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- dimensional_size.applies_to 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 = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘diameter’}) #2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
diameter (concluded)				representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum diameter’) (representation_item.name = ‘minimum diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
BUTTWELD	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => piping_connector_classification] [group group.name = ‘buttweld’]}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_preparation	descriptive_representation_item.-description	45		plant_item_connector <= 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.items[i] -> {representation_item representation_item.name = ‘end preparation’} representation_item => descriptive_representation_item descriptive_representation_item.description
CATALOGUE_-CONNECTOR	catalogue_connector	227	15, 17	catalogue_connector <= [externally_defined_item] [shape_aspect {shape_aspect shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object}]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
catalogue_connector to connector_definition (is defined by)	PATH			catalogue_connector <= shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘definition usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => plant_item_connector
CONNECTOR_-DEFINITION	plant_item_connector	227	1, 9, 11, 13, 14	plant_item_connector <= shape_aspect {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional definition’) (application_context_element.name = ‘physical definition’)}
connector_definition to catalogue_connector (is defined as)	PATH			plant_item_connector <= shape_aspect <- shape_aspect_relationship.related_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘catalogue usage’} shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect => catalogue_connector

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connector_definition to functional_connector_-definition_satisfaction (as functional requirements for)	PATH			plant_item_connector <= shape_aspect {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional definition’} shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector definition satisfaction’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connector_definition to functional_connector_-definition_satisfaction (as satisfies requirements for)	PATH			plant_item_connector <= {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical definition’} shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector definition satisfaction’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connector_definition to plant_item_connector_-occurrence	PATH		1, 9, 11, 13	plant_item_connector <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship {shape_aspect_relationship shape_aspect_relationship.name = ‘usage’} shape_aspect_relationship.related_shape_aspect ->{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 product_definition.frame_of_reference ->product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)} shape_aspect => plant_item_connector
ELECTRICAL_-CONNECTOR	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->group => electrical_connector_classification}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
type	group.name	41		plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->{group => electrical_connector_classification} group group.name
FEMALE_END	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group => connector_end_type_classification] [group group.name = ‘female end’]}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
depth #1: The depth is for the individual connector. #2: The depth is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘depth’})

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
depth (concluded)				#2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum depth’) (representation_item.name = ‘minimum depth’)}) ([representation.items[i] -> representation_item representation_item.name = ‘maximum depth’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum depth’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_inside_diameter #1: The diameter is for the individual connector. #2: The diameter is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- dimensional_size.applies_to 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 = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘hub inside diameter’}) #2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_inside_diameter (concluded)				representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum hub inside diameter’) (representation_item.name = ‘minimum hub inside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum hub inside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum hub inside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_length #1: The length is for the individual connector. #2: The length is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘hub length’})

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_length (concluded)				#2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum hub length’) (representation_item.name = ‘minimum hub length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum hub length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum hub length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_outside_diameter #1: The diameter is for the individual connector. #2: The diameter is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- dimensional_size.applies_to 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 = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘hub outside diameter’}) #2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_outside_diameter (concluded)				representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum hub outside diameter’) (representation_item.name = ‘minimum hub outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum hub outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum hub outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
FLANGED	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => piping_connector_classification] [group group.name = ‘flanged’]}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FLANGED_END	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connector_end_type_classification] [group group.name = ‘flanged end’]}
face_finish	descriptive_representation_item.- description	45		plant_item_connector <= 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.items[i] -> {representation_item representation_item.name = ‘face finish’} representation_item => descriptive_representation_item descriptive_representation_item.description

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flange_inside_diameter #1: The diameter is for the individual connector. #2: The diameter is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- dimensional_size.applies_to 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 = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘flange inside diameter’}) #2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flange_inside_diameter (concluded)				representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum flange inside diameter’) (representation_item.name = ‘minimum flange inside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum flange inside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum flange inside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flange_outside_diameter #1: The diameter is for the individual connector. #2: The diameter is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- dimensional_size.applies_to 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 = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘flange outside diameter’}) #2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flange_outside_diameter (concluded)				representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum flange outside diameter’) (representation_item.name = ‘minimum flange outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum flange outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum flange outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flange_thickness #1: The thickness is for the individual connector. #2: The thickness is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘flange thickness’})

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flange_thickness (concluded)				#2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum flange thickness’) (representation_item.name = ‘minimum flange thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum flange thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum flange thickness’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
raised_face_diameter #1: The diameter is for the individual connector. #2: The diameter is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- dimensional_size.applies_to 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 = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘raised face diameter’}) #2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
raised_face_diameter (concluded)				representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum raised face diameter’) (representation_item.name = ‘minimum raised face diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum raised face diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum raised face diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
raised_face_height #1: The height is for the individual connector. #2: The height is for the definition of a family of piping components.	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	plant_item_connector <= #1: (shape_aspect <- [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘raised face height’})

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
raised_face_height (concluded)				#2: (shape_aspect [shape_aspect.of_shape -> product_definition_shape <= property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class] [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 = ‘piping connector class dimension’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum raised face height’) (representation_item.name = ‘minimum raised face height’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum raised face height’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum raised face height’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ring_bottom_radius	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	plant_item_connector <= shape_aspect <- dimensional_size.applies_to 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 = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘ring bottom radius’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ring_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	plant_item_connector <= shape_aspect <- dimensional_size.applies_to 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 = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘ring diameter’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ring_width	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	plant_item_connector <= shape_aspect <- [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘ring width’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FUNCTIONAL_-CONNECTOR	plant_item_connector	227	1, 9, 11, 13	plant_item_connector <= shape_aspect {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional occurrence’}
functional_connector to functional_connector_-occurrence_satisfaction	PATH			plant_item_connector <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector occurrence satisfaction’}
FUNCTIONAL_-CONNECTOR_-DEFINITION_-SATISFACTION	shape_aspect_relationship	41		{shape_aspect_relationship shape_aspect_relationship.name = ‘connector definition satisfaction’}
FUNCTIONAL_-CONNECTOR_-OCCURRENCE_-SATISFACTION	shape_aspect_relationship	41		{shape_aspect_relationship shape_aspect_relationship.name = ‘connector occurrence satisfaction’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
MALE_END	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => connector_end_type_classification] [group group.name = ‘male end’]}
PHYSICAL_-CONNECTOR	plant_item_connector	227	1, 9, 11, 13, 14	plant_item_connector <= shape_aspect {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’}
physical_connector to functional_connector_-occurrence_satisfaction	PATH			plant_item_connector <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector occurrence satisfaction’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PIPING_CONNECTOR	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group => piping_connector_classification} {(plant_item_connector) (plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group => connector_end_type_classification)}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connector_flow_direction	descriptive_representation_item.-description	45		plant_item_connector <= 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.items[i] -> {representation_item representation_item.name = ‘flow direction’} representation_item => descriptive_representation_item descriptive_representation_item.description
connector_specifications	document_usage_constraint.-subject_element_value	41		plant_item_connector plant_spatial_configuration_document_item = plant_item_connector plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> {document document.kind -> document_type document_type.product_data_type = ‘connector specification’} document <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element_value
name	shape_aspect.description	41		plant_item_connector <= shape_aspect shape_aspect.description

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
piping_connector to piping_connector_-service_characteristic	PATH			plant_item_connector <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition property_definition {property_definition.name = ‘service characteristics’}
piping_connector to piping_size_description	PATH			plant_item_connector <= shape_aspect <- dimensional_size.applies_to dimensional_size dimensional_characteristic = dimensional_size dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation
PIPING_CONNECTOR_-SERVICE_-CHARACTERISTIC	property_definition	41		{property_definition property_definition.name = ‘service characteristics’}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
design_pressure	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘design service characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘pressure’) (representation_item.name = ‘maximum pressure’) (representation_item.name = ‘minimum pressure’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum pressure’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum pressure’}]) representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
design_temperature	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘design service characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘temperature’) (representation_item.name = ‘maximum temperature’) (representation_item.name = ‘minimum temperature’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum temperature’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum temperature’}]) representation_item => measure_representation_item <= {measure_with_unit => thermodynamic_temperature_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
piping_connector_-service_characteristic to service_operating_case	PATH			property_definition <- property_definition_relationship.related_property_definition property_definition_relationship
PLANT_ITEM_-CONNECTOR	plant_item_connector	227		plant_item_connector <= shape_aspect {shape_aspect shape_aspect.product_definitional = TRUE}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connect_point	cartesian_point	42		plant_item_connector <= 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.items[i] -> {representation_item representation_item.name = ‘connect point’} representation_item => geometric_representation_item => point => cartesian_point
plant_item_connector_id	shape_aspect.name	41		plant_item_connector <= shape_aspect shape_aspect.name
plant_item_connector to changed_plant_item_-connector	IDENTICAL MAPPING			
plant_item_connector to external_classification	PATH			plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group => externally_defined_classification

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_connector to required_material_-description	PATH			plant_item_connector <= shape_aspect shape_definition = shape_aspect shape_definition characterized_definition = shape_definition characterized_definition <- property_definition.definition {property_definition => material_property => required_material_property} property_definition <- property_definition_relationship.related_property_definition {property_definition_relationship property_definition_relationship.name = ‘requirement allocation’} property_definition_relationship property_definition_relationship.relating_property_definition ->{property_definition => material_property} property_definition property_definition.definition ->characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition product_definition

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_connector to shape_representation	PATH		16	plant_item_connector <= 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 => (advanced_csg_shape_representation) (piping_design_csg_shape_representation) (hybrid_shape_representation)
PLANT_ITEM_- CONNECTOR_- OCCURRENCE	plant_item_connector	227	1, 9, 11, 13, 14	plant_item_connector <= shape_aspect {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
orientation	(axis2_placement_2d) (axis2_placement_3d)	42 42		plant_item_connector <= 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.items[i] -> {representation_item representation_item.name = ‘connector orientation’} representation_item => geometric_representation_item => {placement placement.location -> cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘connect point’} placement => (axis2_placement_2d) (axis2_placement_3d)

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PRESSURE_FIT	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => piping_connector_classification] [group group.name = ‘pressure fit’]}
SERVICE_OPERATING_-CASE	property_definition_relationship	45		{property_definition_relationship [property_definition_relationship.relating_property_definition -> property_definition => stream_design_case] [property_definition_relationship.related_property_definition -> property_definition property_definition.name = ‘service characteristics’]}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
duration	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		property_definition_relationship property_definition_relationship.related_property_definition -> property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘service operating characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘duration’) (representation_item.name = ‘maximum duration’) (representation_item.name = ‘minimum duration’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum duration’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum duration’}]) representation_item => measure_representation_item <= {measure_with_unit => time_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
frequency	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		property_definition_relationship property_definition_relationship.related_property_definition ->
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = ‘service operating characteristics’}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = ‘frequency’)
(representation_item.name = ‘maximum frequency’)
(representation_item.name = ‘minimum frequency’)})
([representation.items[i] ->
{representation_item
representation_item.name = ‘maximum frequency’}]
[representation.items[i] ->
{representation_item
representation_item.name = ‘minimum frequency’}])
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]
name	property_definition_relationship.-description	45		
operating_case_id	property_definition_relationship.name	45		

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
operating_pressure	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		property_definition_relationship property_definition_relationship.related_property_definition -> property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘service operating characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘pressure’) (representation_item.name = ‘maximum pressure’) (representation_item.name = ‘minimum pressure’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum pressure’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum pressure’}]) representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
operating_temperature	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		property_definition_relationship property_definition_relationship.related_property_definition -> property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> {representation representation.name = ‘service operating characteristics’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘temperature’) (representation_item.name = ‘maximum temperature’) (representation_item.name = ‘minimum temperature’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum temperature’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum duration’}]) representation_item => measure_representation_item <= {measure_with_unit => thermodynamic_temperature_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SOCKET	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group => piping_connector_classification] [group group.name = ‘socket’]}

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
root_gap	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	plant_item_connector <= shape_aspect <- [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘root gap’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component]

Table 4 - Mapping table for connector UoF (continued)

Application element	AIM element	Source	Rules	Reference path
STRUCTURAL_LOAD_-CONNECTOR	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group => structural_load_connector_classification}
type	group.name	41		plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group {group => structural_load_connector_classification} group.name
THREADED	plant_item_connector	227		plant_item_connector <= shape_aspect {plant_item_connector classification_item = plant_item_connector classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => piping_connector_classification] [group group.name = ‘threaded’]}

Table 4 - Mapping table for connector UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
thread_engagement_- depth	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	plant_item_connector <= shape_aspect <- [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect_relationship.relating_shape_aspect {shape_aspect_relationship shape_aspect_relationship.name = ‘connector dimensional aspect’} shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘piping connector dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘thread engagement depth’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component]

Table 5 - Mapping table for csg_and_b_rep_geometry UoF

Application element	AIM element	Source	Rules	Reference path
B_REP_ELEMENT	manifold_solid_brep	42		
BLOCK	block	42		
CIRCULAR_ELLIPSOID	revolved_area_solid	42		
CONE	right_circular_cone	42		
CSG_ELEMENT	(csg_primitive) (boolean_result)	42 42		
CYLINDER	right_circular_cylinder	42		
ECCENTRIC_CONE	(manifold_solid_brep) (shell_based_wireframe_model)	42 42	16	{shell_based_wireframe_model <= geometric_representation_item <= representation_item <- representation.items[i] representation => shape_representation => hybrid_shape_representation}
ECCENTRIC_CYLINDER	(manifold_solid_brep) (shell_based_wireframe_model)	42 42	16	{shell_based_wireframe_model <= geometric_representation_item <= representation_item <- representation.items[i] representation => shape_representation => hybrid_shape_representation}
ECCENTRIC_PYRAMID	boolean_result	42		

Table 5 - Mapping table for csg_and_b_rep_geometry UoF (continued)

Application element	AIM element	Source	Rules	Reference path
EXTRUSION	extruded_area_solid	42		{extruded_area_solid <= swept_area_solid swept_area_solid.swept_area -> curve_bounded_surface [curve_bounded_surface.basis_surface -> surface => elementary_surface => plane] [curve_bounded_surface.boundaries[i] -> boundary_curve <= composite_curve_on_surface <= composite_curve composite_curve.segments[i] -> composite_curve_segment composite_curve_segment.parent_curve -> curve => bounded_curve => trimmed_curve trimmed_curve.basis_curve -> curve => (line) (conic)]}
HEMISPHERE	boolean_result	42		{boolean_result boolean_result.first_operand -> boolean_operand boolean_operand = csg_primitive csg_primitive csg_primitive = sphere}
PYRAMID	boolean_result	42		

Table 5 - Mapping table for csg_and_b_rep_geometry UoF (continued)

Application element	AIM element	Source	Rules	Reference path
REDUCING_TORUS	(manifold_solid_brep) (shell_based_wireframe_model)	42 42	16	{shell_based_wireframe_model <= geometric_representation_item <= representation_item <- representation.items[i] representation => shape_representation => hybrid_shape_representation}
SOLID_OF_- REVOLUTION	revolved_area_solid	42		{revolved_area_solid <= swept_area_solid swept_area_solid.swept_area -> curve_bounded_surface curve_bounded_surface.boundaries[i] -> boundary_curve <= composite_curve_on_surface <= composite_curve composite_curve.segments[i] -> composite_curve_segment composite_curve_segment.parent_curve -> curve => bounded_curve => trimmed_curve trimmed_curve.basis_curve -> curve => (line) (conic)}
SPHERE	sphere	42		
SQUARE_TO_ROUND	(manifold_solid_brep) (shell_based_wireframe_model)	42 42	16	{shell_based_wireframe_model <= geometric_representation_item <= representation_item <- representation.items[i] representation => shape_representation => hybrid_shape_representation}
TORUS	torus	42		

Table 5 - Mapping table for csg_and_b_rep_geometry UoF (continued)

Application element	AIM element	Source	Rules	Reference path
TRIMMED_BLOCK	boolean_result	42		{boolean_result boolean_result.first_operand ->boolean_operand boolean_operand = csg_primitive csg_primitive csg_primitive = block}
TRIMMED_CONE	boolean_result	42		{boolean_result boolean_result.first_operand ->boolean_operand boolean_operand = csg_primitive csg_primitive csg_primitive = right_circular_cone}
TRIMMED_CYLINDER	boolean_result	42		{boolean_result boolean_result.first_operand ->boolean_operand boolean_operand = csg_primitive csg_primitive csg_primitive = right_circular_cylinder}
TRIMMED_PYRAMID	truncated_pyramid	227		truncated_pyramid <= boolean_result
TRIMMED_SPHERE	boolean_result	42		{boolean_result boolean_result.first_operand ->boolean_operand boolean_operand = csg_primitive csg_primitive csg_primitive = sphere}
TRIMMED_TORUS	revolved_area_solid	42		

Table 5 - Mapping table for csg_and_b_rep_geometry UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
TUBE	boolean_result	42		{boolean_result [[boolean_result.first_operand ->] [boolean_result.second_operand ->] boolean_operand boolean_operand = csg_primitive csg_primitive csg_primitive = right_circular_cylinder right_circular_cylinder] [boolean_result.operator = DIFFERENCE]}

Table 6 - Mapping table for piping_component_characterization UoF

Application element	AIM element	Source	Rules	Reference path
BLANK #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘blank’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘blank fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘outside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘blank fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum outside diameter’) (representation_item.name = ‘minimum outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘blank fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘thickness’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness (concluded)				{representation representation.name = ‘blank fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum thickness’) (representation_item.name = ‘minimum thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum thickness’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
BLIND_FLANGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_classification] [group group.name = ‘blind flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
BUSHING #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘bushing’}) #2: (piping_component_class <= [characterized_object] [product_category])
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘bushing fitting dimensional shape’} representation representation.items[i] -> {representation_item

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘bushing fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum end to end length’) (representation_item.name = ‘minimum end to end length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum end to end length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum end to end length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
COUPLING #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘coupling’}) #2: (piping_component_class <= [characterized_object] [product_category])
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘coupling fitting dimensional shape’} representation representation.items[i] -> {representation_item

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘coupling fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum end to end length’) (representation_item.name = ‘minimum end to end length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum end to end length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum end to end length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CROSS #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘cross’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘cross fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 1 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘cross fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 1 length’) (representation_item.name = ‘minimum centre to end 1 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 1 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 1 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘cross fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 2 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘cross fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 2 length’) (representation_item.name = ‘minimum centre to end 2 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 2 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 2 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_3_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 3’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘cross fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_3_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 3 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘cross fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 3 length’) (representation_item.name = ‘minimum centre to end 3 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 3 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 3 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_4_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 4’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘cross fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_4_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 4 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘cross fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 4 length’) (representation_item.name = ‘minimum centre to end 4 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 4 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 4 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_3_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 3’} shape_aspect => plant_item_connector
end_4_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 4’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ECCENTRIC_REDUCER	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => reducer_fitting_classification] [group group.name = ‘eccentric reducer’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘reducer’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centreline_offset	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {shape_aspect => derived_shape_aspect => centre_of_symmetry} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘reducer fitting dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘centreline offset’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flat_side_orientation	shape_aspect.description	41		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.name = ‘flat side’} shape_aspect shape_aspect.description

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ECCENTRIC_SWAGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => swage_fitting_classification] [group group.name = ‘eccentric swage’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘swage’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centreline_offset	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {shape_aspect => derived_shape_aspect => centre_of_symmetry} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘swage fitting dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘centreline offset’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flat_side_orientation	shape_aspect.description	41		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.name = ‘flat side’} shape_aspect shape_aspect.description
ELBOW #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘elbow’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘elbow fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 1 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘elbow fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 1 length’) (representation_item.name = ‘minimum centre to end 1 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 1 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 1 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘elbow fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 2 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘elbow fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 2 length’) (representation_item.name = ‘minimum centre to end 2 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 2 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 2 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centreline_radius	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {shape_aspect => derived_shape_aspect} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {shape_aspect => derived_shape_aspect => centre_of_symmetry} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘elbow fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘centreline radius’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centreline_radius (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘elbow fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum centreline radius’) (representation_item.name = ‘minimum centreline radius’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum centreline radius’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum centreline radius’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
sweep_angle	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => {dimensional_location => angular_location} dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘elbow fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘sweep angle’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
sweep_angle (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘elbow fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum sweep angle’) (representation_item.name = ‘minimum sweep angle’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum sweep angle’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum sweep angle’}])) representation_item => measure_representation_item <= {measure_with_unit => plane_angle_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
type	group.name	41		piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->{group => elbow_fitting_classification} group group.name

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
EXPANDER_FLANGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_classification] [group group.name = ‘expander flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}
FAMILY_DEFINITION	piping_component_class	227	15	piping_component_class <= [product_category] [characterized_object]
family_classification_- description	product_category.description	41		piping_component_class <= product_category product_category.description

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FITTING	(piping_component_definition) (piping_component_class)	227 227	15	(piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘fitting’}) (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FLANGE #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}) #2: (piping_component_class <= [characterized_object] [product_category])
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_through_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘flange fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘hub through length’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_through_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘flange fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum hub through length’) (representation_item.name = ‘minimum hub through length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum hub through length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum hub through length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_weld_point_- diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘flange fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘hub weld point diameter’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
hub_weld_point_- diameter (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘flange fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum hub weld point diameter’) (representation_item.name = ‘minimum hub weld point diameter’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum hub weld point diameter’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum hub weld point diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
GASKET #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘gasket’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
compressed_thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘gasket fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘thickness’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
compressed_thickness (concluded)				{representation representation.name = ‘gasket fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum thickness’) (representation_item.name = ‘minimum thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum thickness’}])) representation_item => {qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = type_qualifier type_qualifier type_qualifier.name = ‘compressed’} measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
uncompressed_thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘gasket fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘thickness’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
uncompressed_thickness (concluded)				{representation representation.name = ‘gasket fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum thickness’) (representation_item.name = ‘minimum thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum thickness’}])) representation_item => {qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = type_qualifier type_qualifier type_qualifier.name = ‘uncompressed’} measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
INLINE_EQUIPMENT	inline_equipment	227		inline_equipment <= piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘equipment’}
INLINE_INSTRUMENT	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘instrument’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
INSERT #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘insert’}) #2: (piping_component_class <= [characterized_object] [product_category])
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘insert fitting dimensional shape’} representation representation.items[i] -> {representation_item

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘insert fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum end to end length’) (representation_item.name = ‘minimum end to end length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum end to end length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum end to end length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
INSIDE_AND_- THICKNESS #1: The attributes are for an individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (shape_dimension_representation) #2: (representation)	47 43	15, 16	#1: ({shape_dimension_representation <= shape_representation <= [representation representation.name = ‘piping component dimensions’] [representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> ({property_definition => 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 => piping_component_definition) (property_definition property_definition.definition -> characterized_definition characterized_definition = shape_definition shape_definition shape_definition = shape_aspect shape_aspect => plant_item_connector)]}) #2: ({[representation representation.name = ‘piping component class size’] [representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	#1: (shape_dimension_representation <= shape_representation <= representation representation.items[i] -> {representation_item representation_item.name = ‘inside diameter’}) #2: (representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum inside diameter’) (representation_item.name = ‘minimum inside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum inside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum inside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	#1: (shape_dimension_representation <= shape_representation <= representation representation.items[i] -> {representation_item representation_item.name = ‘thickness’}) #2: (representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum thickness’) (representation_item.name = ‘minimum thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum thickness’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LAP_JOINT_FLANGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_neck_type_classification] [group group.name = ‘lap joint flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LAP_JOINT_STUB_END #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘lap joint stub end’}) #2: (piping_component_class <= [characterized_object] [product_category])
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘lap joint stub end fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘length’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘lap joint stub end fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum length’) (representation_item.name = ‘minimum length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stub_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘lap joint stub end fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘stub diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘lap joint stub end fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stub_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum stub diameter’) (representation_item.name = ‘minimum stub diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum stub diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum stub diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stub_thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘lap joint stub end fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘stub thickness’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stub_thickness (concluded)				{representation representation.name = ‘lap joint stub end fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum stub thickness’) (representation_item.name = ‘minimum stub thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum stub thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum stub thickness’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LATERAL #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘lateral’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
branch_angle	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => {dimensional_location => angular_location} dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘lateral fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘branch angle’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
branch_angle (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘lateral fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum branch angle’) (representation_item.name = ‘minimum branch angle’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum branch angle’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum branch angle’}])) representation_item => measure_representation_item <= {measure_with_unit => plane_angle_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘lateral fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 1 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘lateral fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 1 length’) (representation_item.name = ‘minimum centre to end 1 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 1 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 1 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘lateral fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 2 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘lateral fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 2 length’) (representation_item.name = ‘minimum centre to end 2 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 2 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 2 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_3_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 3’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘lateral fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_3_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 3 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘lateral fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 3 length’) (representation_item.name = ‘minimum centre to end 3 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 3 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 3 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_3_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 3’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
MITRE_BEND_PIPE #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => pipe_classification] [group group.name = ‘mitre bend pipe’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘pipe’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
number_of_segments	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15	#1: (piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘pipe characteristics’} representation {representation_item representation_item.name = ‘number of segments’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘pipe class characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum number of segments’) (representation_item.name = ‘minimum number of segments’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum number of segments’}] [representation.items[i] ->{representation_item

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
number_of_segments (concluded)				representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component {measure_with_unit.value_component -> measure_value measure_value = count_measure}] [measure_with_unit.unit_component]
radius	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘pipe dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘radius’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
radius (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘pipe class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum radius’) (representation_item.name = ‘minimum radius’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum radius’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum radius’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
sweep_angle	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => {dimensional_location => angular_location} dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘pipe dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘sweep angle’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
sweep_angle (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘pipe class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum sweep angle’) (representation_item.name = ‘minimum sweep angle’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum sweep angle’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum sweep angle’}])) representation_item => measure_representation_item <= {measure_with_unit => plane_angle_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
NIPPLE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => pipe_classification] [group group.name = ‘nipple’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘pipe’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
OLET #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘olet’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
base_outside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘olet fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘base outside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘olet fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
base_outside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum base outside diameter’) (representation_item.name = ‘minimum base outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum base outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum base outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
branch_angle	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => {dimensional_location => angular_location} dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘olet fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘branch angle’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
branch_angle (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘lateral fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum branch angle’) (representation_item.name = ‘minimum branch angle’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum branch angle’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum branch angle’}])) representation_item => measure_representation_item <= {measure_with_unit => plane_angle_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘olet fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘length’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘olet fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum length’) (representation_item.name = ‘minimum length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
skirt_outside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘olet fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘skirt outside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘olet fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
skirt_outside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum skirt outside diameter’) (representation_item.name = ‘minimum skirt outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum skirt outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum skirt outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ORIFICE_FLANGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_classification] [group group.name = ‘orifice flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
jacking_screw_- orientation	shape_aspect.description	41		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.name = ‘jacking screw’} shape_aspect shape_aspect.description
tap	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘tap’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ORIFICE_PLATE #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘orifice plate’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
beta_ratio	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_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 representation_item.name = ‘beta ratio’} representation_item => measure_representation_item <= {measure_with_unit => ratio_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
bore_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘orifice plate fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘bore diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘orifice plate fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
bore_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum bore diameter’) (representation_item.name = ‘minimum bore diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum bore diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum bore diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘orifice plate fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘outside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘orifice plate fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum outside diameter’) (representation_item.name = ‘minimum outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘orifice plate fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘thickness’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness (concluded)				{representation representation.name = ‘orifice plate fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum thickness’) (representation_item.name = ‘minimum thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum thickness’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
OUTSIDE_AND_- THICKNESS #1: The attributes are for an individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (shape_dimension_representation) #2: (representation)	47 43	15, 16	#1: ({shape_dimension_representation <= shape_representation <= {representation representation.name = ‘piping component dimensions’}) representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> ({property_definition => 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 => piping_component_definition) (property_definition property_definition.definition -> characterized_definition characterized_definition = shape_definition shape_definition shape_definition = shape_aspect shape_aspect => plant_item_connector)]}) #2: ({[representation representation.name = ‘piping component class size’] [representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	#1: (shape_dimension_representation <= shape_representation <= representation representation.items[i] ->{representation_item representation_item.name = ‘outside diameter’}) #2: (representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum outside diameter’) (representation_item.name = ‘minimum outside diameter’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum outside diameter’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	#1: (shape_dimension_representation <= shape_representation <= representation representation.items[i] -> {representation_item representation_item.name = ‘thickness’}) #2: (representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum thickness’) (representation_item.name = ‘minimum thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum thickness’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PADDLE_BLANK #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => blank_fitting_classification] [group group.name = ‘paddle blank’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘blank’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
paddle_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘blank fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘paddle length’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
paddle_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘blank fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum paddle length’) (representation_item.name = ‘minimum paddle length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum paddle length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum paddle length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
paddle_width	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘blank fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘paddle width’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
paddle_width (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘blank fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum paddle width’) (representation_item.name = ‘minimum paddle width’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum paddle width’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum paddle width’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PADDLE_SPACER #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => spacer_fitting_classification] [group group.name = ‘paddle spacer’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘spacer’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘spacer fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘inside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘spacer fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum inside diameter’) (representation_item.name = ‘minimum inside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum inside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum inside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
paddle_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘spacer fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘paddle length’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
paddle_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘spacer fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum paddle length’) (representation_item.name = ‘minimum paddle length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum paddle length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum paddle length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
paddle_width	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘spacer fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘paddle width’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
paddle_width (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘spacer fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum paddle width’) (representation_item.name = ‘minimum paddle width’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum paddle width’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum paddle width’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PIPE	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	(piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘pipe’}) (piping_component_class <= [characterized_object] [product_category])
PIPE_BEND	shape_aspect	41		{shape_aspect [shape_aspect.name = ‘pipe bend’] [shape_aspect.product_definitional = TRUE] [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 => piping_component_definition]}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centreline_radius	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	shape_aspect <- [shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect ->{[shape_aspect => derived_shape_aspect] [shape_aspect shape_aspect.description = ‘sweep angle centre point’]} shape_aspect <- shape_aspect_relationship.relating_shape_aspect]] [shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect ->{[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘pipe centreline’]} shape_aspect <- shape_aspect_relationship.related_shape_aspect]] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation ->shape_dimension_representation <= shape_representation <= {representation representation.name = ‘pipe bend dimensional shape’} representation representation.items[i] ->{representation_item representation_item.name = ‘centreline radius’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centreline_radius (concluded)				representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
sweep_angle	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	shape_aspect <- [shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect ->{shape_aspect shape_aspect.description = ‘pipe bend start’} shape_aspect <- shape_aspect_relationship.relating_shape_aspect]] [shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect ->{shape_aspect shape_aspect.description = ‘pipe bend end’} shape_aspect <- shape_aspect_relationship.related_shape_aspect]] shape_aspect_relationship => {dimensional_location => angular_location} dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation ->shape_dimension_representation <= shape_representation <=

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
sweep_angle (concluded)				{representation representation.name = ‘pipe bend dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘sweep angle’} representation_item => measure_representation_item <= {measure_with_unit => plane_angle_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
PIPE_CLOSURE #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘pipe closure’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
cap_or_plug	group.name	41		piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->{group => pipe_closure_fitting_classification} group group.name {(group.name = ‘cap’) (group.name = ‘plug’)}
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
height	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘pipe closure fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘height’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
height (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘pipe closure fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum height’) (representation_item.name = ‘minimum height’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum height’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum height’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
shape_type	group.description	41		piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->{group => pipe_closure_fitting_classification} group group.description {(group.description = ‘square’) (group.description = ‘round’)}
PIPING_COMPONENT	(piping_component_definition) (piping_component_class)	227 227	15	(piping_component_definition <= product_definition) (piping_component_class <= [characterized_object] [product_category])
piping_component to family_definition	IDENTICAL MAPPING			

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PIPING_SIZE_- DESCRIPTION #1: The attributes are for an individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (shape_dimension_representation) #2: (representation)	47 43	15, 16	{(shape_dimension_representation <= shape_representation <= representation) (representation) plant_spatial_configuration_document_item = representation plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document document.kind -> document_type document_type.product_data_type = ‘dimensional standard’} #1: ({(shape_dimension_representation <= shape_representation <= {representation representation.name = ‘piping component dimensions’}) ({representation representation.name = ‘piping component size’}) representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> ({property_definition => 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 => piping_component_definition)

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PIPING_SIZE_- DESCRIPTION (concluded)				(property_definition property_definition.definition ->
characterized_definition characterized_definition = shape_definition shape_definition shape_definition = shape_aspect shape_aspect => plant_item_connector)}) #2: ({[representation representation.name = ‘piping component class size’] [representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition ->
property_definition property_definition.definition ->
characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class]})
dimensional_standard	document	41	16	#1: (shape_dimension_representation <= shape_representation <= representation) #2: (representation) plant_spatial_configuration_document_item = representation plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document ->
document {document.kind ->
document_type document_type.product_data_type = ‘dimensional standard’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ovality_allowance	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	#1: (shape_dimension_representation <= shape_representation <= representation) #2: (representation) representation.items[i] ->{representation_item (representation_item.name = ‘ovality upper limit’) (representation_item.name = ‘ovality lower limit’)} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
piping_size_description_-id	property_definition_representation	41	16	#1: (shape_dimension_representation <= shape_representation representation <-) #2: (representation <-) property_definition_representation.used_representation property_definition_representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PRESSURE_CLASS #1: The attributes are for an individual piping component. #2: The attributes are for the definition of a family of piping components.	representation	43	15	#1: ({[representation representation.name = ‘piping component size’] [representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition (characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition product_definition => piping_component_definition) (characterized_definition = shape_definition shape_definition shape_definition = shape_aspect shape_aspect => plant_item_connector)]}) #2: ({[representation representation.name = ‘piping component class size’] [representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class]})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
nominal_size	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation #1: ({representation representation.name = ‘piping component size’} representation.items[i] -> {representation_item representation_item.name = ‘nominal size’}) #2: ({representation representation.name = ‘piping component class size’} (representation.items[i] -> {representation_item (representation_item.name = ‘maximum nominal size’) (representation_item.name = ‘minimum nominal size’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum nominal size’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum nominal size’}]) representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
pressure_rating	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation #1: ({representation representation.name = ‘piping component size’} representation.items[i] -> {representation_item representation_item.name = ‘pressure rating’}) #2: ({representation representation.name = ‘piping component class size’} (representation.items[i] -> {representation_item (representation_item.name = ‘maximum pressure rating’) (representation_item.name = ‘minimum pressure rating’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum pressure rating’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum pressure rating’}]) representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
REDUCER #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘reducer’}) #2: (piping_component_class <= [characterized_object] [product_category])
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘reducer fitting dimensional shape’} representation representation.items[i] -> {representation_item

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘reducer fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum end to end length’) (representation_item.name = ‘minimum end to end length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum end to end length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum end to end length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
REDUCING_FLANGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_classification] [group group.name = ‘reducing flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
RING_SPACER #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => spacer_fitting_classification] [group group.name = ‘ring spacer’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘spacer’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘spacer fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘inside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘spacer fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum inside diameter’) (representation_item.name = ‘minimum inside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum inside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum inside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SCHEDULE #1: The attributes are for an individual piping component. #2: The attributes are for the definition of a family of piping components.	representation	43	15	{representation plant_spatial_configuration_document_item = representation plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference <- document_usage_constraint.source document_usage_constraint (document_usage_constraint.subject_element = ‘pipe schedule’) (document_usage_constraint.subject_element = ‘connector schedule’)} #1: ({[representation representation.name = ‘piping component size’] [representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition (characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition product_definition => piping_component_definition) (characterized_definition = shape_definition shape_definition shape_definition = shape_aspect shape_aspect => plant_item_connector)]})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SCHEDULE (concluded)				#2: ({[representation representation.name = ‘piping component class size’] [representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => piping_component_class]})
nominal_size	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation #1: ({representation representation.name = ‘piping component size’} representation.items[i] -> {representation_item representation_item.name = ‘nominal size’}) #2: ({representation representation.name = ‘piping component class size’} (representation.items[i] -> {representation_item (representation_item.name = ‘maximum nominal size’) (representation_item.name = ‘minimum nominal size’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum nominal size’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum nominal size’}]) representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
pipe_schedule	document_usage_constraint.- subject_element_value	41		representation plant_spatial_configuration_document_item = representation plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element_value

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SLIP_ON_FLANGE #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_neck_type_classification] [group group.name = ‘slip on flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stand_off	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {shape_aspect shape_aspect.name = ‘flange face’} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {shape_aspect shape_aspect.name = ‘pipe end’} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘slip on flange fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘stand off’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stand_off (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘slip on flange fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum stand off’) (representation_item.name = ‘minimum stand off’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum stand off’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum stand off’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SOCKET_WELD_- FLANGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_neck_type_classification] [group group.name = ‘socket weld flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SPACER #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘spacer’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘spacer fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘outside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘spacer fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
outside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum outside diameter’) (representation_item.name = ‘minimum outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘spacer fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘thickness’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness (concluded)				{representation representation.name = ‘spacer fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum thickness’) (representation_item.name = ‘minimum thickness’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum thickness’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum thickness’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
SPECIALTY_ITEM	piping_component_definition	227		piping_component_definition <= product_definition
type	group.name	41		piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> {group => specialty_item_classification} group group.name

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SPECTACLE_BLIND #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => blank_fitting_classification] [group group.name = ‘spectacle blind’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘blank’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
arm_width	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘blank fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘arm width’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
arm_width (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘blank fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum arm width’) (representation_item.name = ‘minimum arm width’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum arm width’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum arm width’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_centre	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘blank fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_centre (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to centre’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘blank fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to centre’) (representation_item.name = ‘minimum centre to centre’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to centre’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to centre’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inside_ring_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘blank fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘inside ring diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘blank fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
inside_ring_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum inside ring diameter’) (representation_item.name = ‘minimum inside ring diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum inside ring diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum inside ring diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
STRAIGHT_PIPE #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => pipe_classification] [group group.name = ‘straight pipe’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘pipe’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length #1a: The length is given as a numeric value. #1b: The length is as required.	#1a: ([measure_with_unit.-value_component] [measure_with_unit.unit_component]) #1b: (descriptive_representation_item.-description) #2: ([measure_with_unit.-value_component] [measure_with_unit.unit_component])	41 41 45 41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] #1a: (shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘pipe dimensional shape’} representation representation.items[i] -> {representation_item

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length (continued)				representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]) #1b: (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 representation_item.name = ‘end to end length’} representation_item => descriptive_representation_item descriptive_representation_item.description {descriptive_representation_item.description = ‘as required’}))

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘pipe class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum end to end length’) (representation_item.name = ‘minimum end to end length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum end to end length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum end to end length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SWAGE #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘swage’}) #2: (piping_component_class <= [characterized_object] [product_category])
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘swage fitting dimensional shape’} representation representation.items[i] -> {representation_item

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘swage fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum end to end length’) (representation_item.name = ‘minimum end to end length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum end to end length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum end to end length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SWEPT_BEND_PIPE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => pipe_classification] [group group.name = ‘swept bend pipe’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘pipe’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
wall_thinning_allowance	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= representation {representation.name = ‘swept bend pipe dimensional shape’} representation.items[i] -> {representation_item representation_item.name = ‘wall thinning allowance’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
swept_bend_pipe to pipe_bend	PATH			piping_component_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 <- shape_aspect.of_shape shape_aspect {shape_aspect shape_aspect.name = ‘pipe bend’}
TEE #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘tee’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘tee fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 1 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘tee fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 1 length’) (representation_item.name = ‘minimum centre to end 1 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 1 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 1 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘tee fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 2 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘tee fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 2 length’) (representation_item.name = ‘minimum centre to end 2 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 2 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 2 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_3_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 3’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘tee fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_3_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 3 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘tee fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 3 length’) (representation_item.name = ‘minimum centre to end 3 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 3 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 3 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_3_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 3’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
THREADED_FLANGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_neck_type_classification] [group group.name = ‘threaded flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
UNION #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘union’}) #2: (piping_component_class <= [characterized_object] [product_category])
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘union fitting dimensional shape’} representation representation.items[i] -> {representation_item

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_to_end_length (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘union fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum end to end length’) (representation_item.name = ‘minimum end to end length’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum end to end length’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum end to end length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
major_outside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘union fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘major outside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘union fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
major_outside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum major outside diameter’) (representation_item.name = ‘minimum major outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum major outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum major outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
minor_outside_diameter	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape shape_aspect <- dimensional_size.applies_to 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 = ‘union fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘minor outside diameter’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘union fitting class dimensions’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
minor_outside_diameter (concluded)				(representation.items[i] -> {representation_item (representation_item.name = ‘maximum minor outside diameter’) (representation_item.name = ‘minimum minor outside diameter’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum minor outside diameter’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum minor outside diameter’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
VALVE	piping_component_definition	227		piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘valve’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
actuator_type	descriptive_representation_item.-description	45		piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_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 representation_item.name = ‘actuator type’} representation_item => descriptive_representation_item descriptive_representation_item.description
operation_mode	descriptive_representation_item.-description	45		piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_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 representation_item.name = ‘operation mode’} representation_item => descriptive_representation_item descriptive_representation_item.description

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
type	group.name	41		piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->{group => valve_classification} group group.name

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
WELD_NECK_FLANGE	piping_component_definition	227		piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group => flange_fitting_neck_type_classification] [group group.name = ‘weld neck flange’]} {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘flange’}

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
Y_TYPE_LATERAL #1: The attributes are for the individual piping component. #2: The attributes are for the definition of a family of piping components.	#1: (piping_component_definition) #2: (piping_component_class)	227 227	15	#1: (piping_component_definition <= product_definition {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 <- product_category_relationship.sub_category product_category_relationship product_category_relationship.category -> product_category) product_category.name = ‘Y type lateral’}) #2: (piping_component_class <= [characterized_object] [product_category])

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
angle	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => {dimensional_location => angular_location} dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘y type lateral fitting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘angle’})

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
angle (concluded)				#2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation ->{representation representation.name = ‘y type lateral fitting class dimensions’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘maximum angle’) (representation_item.name = ‘minimum angle’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum angle’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum angle’}])) representation_item => measure_representation_item <= {measure_with_unit => plane_angle_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 1’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘y type lateral fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_1_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 1 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘y type lateral fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 1 length’) (representation_item.name = ‘minimum centre to end 1 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 1 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 1 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 2’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘y type lateral fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_2_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 2 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘y type lateral fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 2 length’) (representation_item.name = ‘minimum centre to end 2 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 2 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 2 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_3_length	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	15, 16	#1: (piping_component_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 <- shape_aspect.of_shape [shape_aspect <- {[shape_aspect => derived_shape_aspect => centre_of_symmetry] [shape_aspect shape_aspect.description = ‘centre’]} shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- {[shape_aspect => plant_item_connector] [shape_aspect shape_aspect.description = ‘end 3’]} shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘y type lateral fitting dimensional shape’} representation

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_to_end_3_length (concluded)				representation.items[i] -> {representation_item representation_item.name = ‘centre to end 3 length’}) #2: (piping_component_class <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation.used_representation -> {representation representation.name = ‘y type lateral fitting class dimensions’} representation (representation.items[i] -> {representation_item (representation_item.name = ‘maximum centre to end 3 length’) (representation_item.name = ‘minimum centre to end 3 length’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum centre to end 3 length’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum centre to end 3 length’}])) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 6 - Mapping table for piping_component_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
end_1_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 1’} shape_aspect => plant_item_connector
end_2_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 2’} shape_aspect => plant_item_connector

Table 6 - Mapping table for piping_component_characterization UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
end_3_connector	plant_item_connector	227		piping_component_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 <- shape_aspect.of_shape {shape_aspect shape_aspect.description = ‘end 3’} shape_aspect => plant_item_connector

Table 7 - Mapping table for piping_system_functional_characterization UoF

Application element	AIM element	Source	Rules	Reference path
LINE_BRANCH_- CONNECTION	line_branch_connection	227		line_branch_connection <= shape_aspect_relationship {shape_aspect_relationship [shape_aspect_relationship.description = ‘branch location’] [shape_aspect_relationship.relating_shape_aspect -> 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 => plant_line_segment_definition] [shape_aspect_relationship.related_shape_aspect -> shape_aspect => plant_line_segment_termination]}
branch_sequence_id	shape_aspect_relationship.name	41		line_branch_connection <= {shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect shape_aspect.of_shape -> product_definition_shape <- [shape_aspect.of_shape shape_aspect shape_aspect.description = ‘termination 1’] [shape_aspect.of_shape shape_aspect shape_aspect.description = ‘termination 2’]} shape_aspect_relationship shape_aspect_relationship.name

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
line_branch_connection to changed_line_-branch_connection	IDENTICAL MAPPING			
LINE_BRANCH_-TERMINATION	plant_line_segment_termination	227		plant_line_segment_termination <= shape_aspect
line_branch_termination to line_branch_-connection	PATH			plant_line_segment_termination <= shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship
LINE_PIPING_SYSTEM_-COMPONENT_-ASSIGNMENT	product_definition_relationship	41	1, 9, 11, 13, 14	{product_definition_relationship [product_definition_relationship.name = ‘realization’] [product_definition_relationship.relating_product_definition -> {product_definition => plant_line_segment_definition} product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional definition’] [product_definition_relationship.related_product_definition -> {product_definition => piping_component_definition} product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)]}
line_piping_system_-component_assignment to changed_line_-assignment	IDENTICAL MAPPING			

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LINE_PLANT_ITEM_- BRANCH_CONNECTION	line_plant_item_branch_connection	227		line_plant_item_branch_connection <= shape_aspect_relationship {shape_aspect_relationship [shape_aspect_relationship.relating_shape_aspect -> 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 => plant_line_segment_definition] [shape_aspect_relationship.related_shape_aspect -> shape_aspect => plant_item_connector]}
branch_sequence_id	shape_aspect_relationship.name	41		line_plant_item_branch_connection <= {shape_aspect_relationship shape_aspect_relationship.relating_shape_aspect -> shape_aspect shape_aspect.of_shape -> product_definition_shape <- [shape_aspect.of_shape shape_aspect shape_aspect.description = ‘termination 1’] [shape_aspect.of_shape shape_aspect shape_aspect.description = ‘termination 2’]} shape_aspect_relationship shape_aspect_relationship.name

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
line_plant_item_branch_-connection to changed_-line_plant_item_branch_-connection	IDENTICAL MAPPING			
LINE_PLANT_ITEM_-BRANCH_CONNECTOR	plant_item_connector	227	1, 9, 11, 13	plant_item_connector <= shape_aspect {shape_aspect [shape_aspect.description = ‘line plant item connector’] [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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional occurrence’]}
line_plant_item_branch_-connector to line_plant_-item_branch_connection	PATH			plant_item_connector <= shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship => line_plant_item_branch_connection

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LINE_PLANT_ITEM_-CONNECTION	line_plant_item_connection	227		line_plant_item_connection <= shape_aspect_relationship {[shape_aspect_relationship.relating_shape_aspect -> shape_aspect => plant_line_segment_termination] [shape_aspect_relationship.related_shape_aspect -> shape_aspect {shape_aspect <= plant_item_connector} 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) (product_definition => externally_defined_plant_item_definition)]}
line_plant_item_-connection to changed_-line_plant_item_-connection	IDENTICAL MAPPING			

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LINE_PLANT_ITEM_-CONNECTOR	plant_item_connector	227	1, 9, 11, 13	plant_item_connector <= shape_aspect {shape_aspect [shape_aspect.description = ‘line plant item connector’] [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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional occurrence’}
line_plant_item_-connector to line_plant_-item_connection	PATH			plant_item_connector <= shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship => line_plant_item_connection
LINE_PLANT_ITEM_-TERMINATION	plant_line_segment_termination	227		plant_line_segment_termination <= shape_aspect
line_plant_item_-termination to line_-plant_item_connection	PATH			plant_line_segment_termination <= shape_aspect <- shape_aspect_relationship.related_shape_aspect shape_aspect_relationship => line_plant_item_connection
LINE_TO_LINE_-CONNECTION	line_termination_connection	227		line_termination_connection <= shape_aspect_relationship
line_to_line_-connection_id	shape_aspect_relationship.name	41		line_termination_connection <= shape_aspect_relationship shape_aspect_relationship.name

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
line_to_line_connection to changed_line_to_-line_connection	IDENTICAL MAPPING			
line_to_line_connection to line_to_line_-termination	PATH			line_termination_connection <= shape_aspect_relationship [shape_aspect_relationship.relating_shape_aspect -> shape_aspect => (connection_node) (plant_line_segment_termination)] [shape_aspect_relationship.related_shape_aspect -> shape_aspect => plant_line_segment_termination]
LINE_TO_LINE_-TERMINATION	plant_line_segment_termination	227		plant_line_segment_termination <= shape_aspect
PIPING_SPECIFICATION	document	41		{document document.kind -> document_type document_type.product_data_type = ‘piping specification’}
name	document.name	41		

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
owner	(organization.name) ([person.first_name] person.last_name])	41 41 41		document (plant_spatial_configuration_organization_item = document plant_spatial_configuration_organization_item <- plant_spatial_configuration_organization_assignment.items[i] plant_spatial_configuration_organization_assignment <= organization_assignment {organization_assignment organization_assignment.role -> organization_role organization_role.name = ‘owner’} organization_assignment.assigned_organization -> organization organization.name) (plant_spatial_configuration_person_item = document plant_spatial_configuration_person_item <- plant_spatial_configuration_person_assignment.items[i] plant_spatial_configuration_person_assignment <= person_assignment {person_assignment person_assignment.role -> person_role person_role.name = ‘owner’} person_assignment.assigned_person -> person [person.first_name] [person.last_name])
piping_specification_id	document.id	41		
service_description	document_usage_constraint	41		document <- document_usage_constraint.source document_usage_constraint {document_usage_constraint document_usage_constraint.subject_element = ‘service description’}
piping_specification to changed_piping_-specification	IDENTICAL MAPPING			

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
piping_specification to family_definition	PATH			document <- document_reference.assigned_document document_reference => plant_spatial_configuration_document_reference plant_spatial_configuration_document_reference.items[i] ->
plant_spatial_configuration_document_item plant_spatial_configuration_document_item = piping_component_class piping_component_class
piping_specification to piping_system_line_-segment	PATH			document <- document_reference.assigned_document document_reference => plant_spatial_configuration_document_reference plant_spatial_configuration_document_reference.items[i] ->
plant_spatial_configuration_document_item plant_spatial_configuration_document_item = plant_line_segment_definition plant_line_segment_definition
PIPING_SYSTEM_LINE	plant_line_definition	227	1, 9, 11, 13	plant_line_definition <= product_definition_with_associated_documents {product_definition_with_associated_documents <= product_definition product_definition.frame_of_reference ->
product_definition_context <= application_context_element application_context_element.name = ‘functional definition’}
line_number	product_definition.description	41		plant_line_definition <= product_definition_with_associated_documents <= product_definition product_definition.description
P_and_I_reference	document	41		plant_line_definition <= product_definition_with_associated_documents product_definition_with_associated_documents.documentation_ids[i] ->
document

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
piping_system_line_id	product_definition.id	41		plant_line_definition <= product_definition_with_associated_documents <= product_definition product_definition.id
piping_system_line to changed_piping_-system_line	IDENTICAL MAPPING			
piping_system_line to piping_system_line_-segment	PATH			plant_line_definition <= product_definition_with_associated_documents <= product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship product_definition_relationship.related_product_definition -> product_definition => plant_line_segment_definition
PIPING_SYSTEM_LINE_-SEGMENT	plant_line_segment_definition	227	1, 9, 11, 13	plant_line_segment_definition <= product_definition {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional definition’}
coating_reference	document_usage_constraint	41		plant_line_segment_definition plant_spatial_configuration_document_item = plant_line_segment_definition plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document <- document_usage_constraint {document_usage_constraint.subject_element = ‘coating reference’}

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
corrosion_allowance	([measure_with_unit.value_component] [measure_with_unit.unit_component]) ([measure_with_unit.value_component] [measure_with_unit.unit_component] [document_usage_constraint.- subject_element_value])	41 41 41 41 41		plant_line_segment_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘line segment characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘corrosion allowance’} (representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]) ([representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]] [representation_item plant_spatial_configuration_document_item = representation_item plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document ->document <- document_usage_constraint

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
design_pressure	([measure_with_unit.value_component] [measure_with_unit.unit_component]) ([measure_with_unit.value_component] [measure_with_unit.unit_component] [document_usage_constraint.- subject_element_value])	41 41 41 41 41		plant_line_segment_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘line segment characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘design pressure’} (representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]) ([representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]] [representation_item plant_spatial_configuration_document_item = representation_item plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document ->document <- document_usage_constraint

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
design_temperature	([measure_with_unit.value_component] [measure_with_unit.unit_component]) ([measure_with_unit.value_component] [measure_with_unit.unit_component] [document_usage_constraint.- subject_element_value])	41 41 41 41 41		plant_line_segment_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘line segment characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘design temperature’} (representation_item => measure_representation_item <= {measure_with_unit => thermodynamic_temperature_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component])

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
design_temperature (concluded)				([representation_item => measure_representation_item <= {measure_with_unit => thermodynamic_temperature_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]] [representation_item plant_spatial_configuration_document_item = representation_item plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document <- document_usage_constraint document_usage_constraint.subject_element_value])

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
elevation	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		plant_line_segment_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘line segment characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘elevation’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
heat_tracing_type	(heat_tracing_representation) ([heat_tracing_representation] [document_usage_constraint.- subject_element_value])	227 227 41		plant_line_segment_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_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 => descriptive_representation_item} representation => (heat_tracing_representation) ([heat_tracing_representation] [heat_tracing_representation plant_spatial_configuration_document_item = heat_tracing_representation plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document ->document <- document_usage_constraint document_usage_constraint.subject_element_value])

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
line_size	shape_dimension_representation	47	16	plant_line_segment_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_representation.definition property_definition_representation {=> shape_definition_representation} property_definition_representation.used_representation ->{representation representation.items[i] -> representation_item representation_item.name = ‘line size’} representation => shape_representation => shape_dimension_representation
segment_id	product_definition.id	41		plant_line_segment_definition <= product_definition product_definition.id
piping_system_line_-segment to changed_-piping_system_line_-segment	IDENTICAL MAPPING			

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
piping_system_line_-segment to line_branch_-connection	PATH			plant_line_segment_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 <- shape_aspect.of_shape shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship => line_branch_connection
piping_system_line_-segment to line_plant_-item_branch_connection	PATH			plant_line_segment_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 <- shape_aspect.of_shape shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship => line_plant_item_branch_connection
piping_system_line_-segment to line_piping_-system_component_-assignment	PATH			plant_line_segment_definition <= product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
piping_system_line_-segment to piping_-system_line_segment_-termination	PATH			plant_line_segment_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 <- shape_aspect.of_shape shape_aspect => plant_line_segment_termination
piping_system_line_-segment to segment_-insulation	PATH			plant_line_segment_definition <= product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘segment insulation’}
piping_system_line_-segment to stream_-design_case	PATH			plant_line_segment_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition => stream_design_case

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PIPING_SYSTEM_LINE_- SEGMENT_- TERMINATION	plant_line_segment_termination	227	1, 9, 11, 13	plant_line_segment_termination <= shape_aspect {[shape_aspect <- (shape_aspect_relationship.relating_shape_aspect) (shape_aspect_relationship.related_shape_aspect) shape_aspect_relationship => (line_branch_connection) (line_plant_item_connection) (line_termination_connection)] [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 {product_definition => plant_line_segment_definition} product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional definition’]}

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flow_direction	descriptive_representation_item.-description	45		plant_line_segment_termination <= 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.items[i] -> {representation_item representation_item.name = ‘flow direction’} representation_item => descriptive_representation_item descriptive_representation_item.description {(descriptive_representation_item.description = ‘both’) (descriptive_representation_item.description = ‘in’) (descriptive_representation_item.description = ‘not specified’) (descriptive_representation_item.description = ‘out’)}

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
line_end_location	(point) (shape_aspect)	42 41		plant_line_segment_termination <= (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.items[i] -> {representation_item representation_item.name = ‘line end point’} representation_item => geometric_representation_item => point) (shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> {shape_aspect shape_aspect.name = ‘line end location’} shape_aspect)

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
line_start_location	(point) (shape_aspect)	42 41		plant_line_segment_termination <= (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.items[i] -> {representation_item representation_item.name = ‘line start point’} representation_item => geometric_representation_item => point) (shape_aspect <- shape_aspect_relationship.relating_shape_aspect shape_aspect_relationship shape_aspect_relationship.related_shape_aspect -> {shape_aspect shape_aspect.name = ‘line end location’} shape_aspect)
termination_id	shape_aspect.name	41		plant_line_segment_termination <= shape_aspect shape_aspect.name
piping_system_line_- segment_termination to changed_piping_- system_line_segment_- termination	IDENTICAL MAPPING			

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SEGMENT_INSULATION	product_definition_relationship	41		{product_definition_relationship [product_definition_relationship.name = ‘segment insulation’] [product_definition_relationship.relating_product_definition -> product_definition => plant_line_segment_definition]}
boundaries	descriptive_representation_item.- description	45		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} property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘segment insulation characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘segment insulation boundary’} representation_item <= descriptive_representation_item descriptive_representation_item.description
description	product_definition_relationship.- description	41		

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
thickness	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		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} property_definition <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘segment insulation characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘thickness’) (representation_item.name = ‘maximum thickness’) (representation_item.name = ‘minimum thickness’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum thickness’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum thickness’}]) representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
type	product.name	41		product_definition_relationship product_definition_relationship.related_product_definition ->
product_definition product_definition.formation ->
product_definition_formation product_definition_formation.of_product ->
product product.name
STREAM_DESIGN_CASE	stream_design_case	227	15	stream_design_case <= [characterized_object] [property_definition]
description	characterized_object.description	41	15	stream_design_case <= characterized_object characterized_object.description

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
flow_rate	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_design_case <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream flow characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘flow rate’) (representation_item.name = ‘maximum flow rate’) (representation_item.name = ‘minimum flow rate’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum flow rate’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum flow rate’}]) representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
pressure	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_design_case <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream flow characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘pressure’) (representation_item.name = ‘maximum pressure’) (representation_item.name = ‘minimum pressure’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum pressure’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum pressure’}]) representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
stream_case_type	property_definition.name	41		stream_design_case <= property_definition property_definition.name

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stream_data_reference	(descriptive_representation_item.-description) ([descriptive_representation_item.-description] [document_usage_constraint.subject_-element_value])	45 45 41		stream_design_case <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream flow characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘stream data reference’} (representation_item => descriptive_representation_item descriptive_representation_item.description) ([representation_item => descriptive_representation_item descriptive_representation_item.description] [representation_item plant_spatial_configuration_document_item = representation_item plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document ->document <- document_usage_constraint document_usage_constraint.subject_element_value])
stream_design_id	characterized_object.name	41	15	stream_design_case <= characterized_object characterized_object.name
stream_design_case to service_operating_case	PATH			stream_design_case <= property_definition <- property_definition_relationship.relating_property_definition property_definition_relationship

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stream_design_case to stream_phase	PATH		15	stream_design_case <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => stream_phase
STREAM_PHASE	stream_phase	227		stream_phase <= property_definition
constituent_mole_-fraction	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_phase <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream phase characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘constituent mole fraction’} representation_item => measure_representation_item <= {measure_with_unit => ratio_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
constituents	descriptive_representation_item.-description	45		stream_phase <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream phase characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘constituents’} representation_item => descriptive_representation_item descriptive_representation_item.description
phase_density	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_phase <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream phase characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘phase density’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
phase_fraction	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_phase <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream phase characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘phase fraction’} representation_item => measure_representation_item <= {measure_with_unit => ratio_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
specific_gravity	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_phase <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream phase characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘specific gravity’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
surface_tension	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_phase <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream phase characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘surface tension’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 7 - Mapping table for piping_system_functional_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
temperature	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_phase <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream phase characteristics’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘temperature’) (representation_item.name = ‘maximum temperature’) (representation_item.name = ‘minimum temperature’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum temperature’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum temperature’}]) representation_item => measure_representation_item <= {measure_with_unit => thermodynamic_temperature_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 7 - Mapping table for piping_system_functional_characterization UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
viscosity	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		stream_phase <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘stream phase characteristics’} representation representation.items[i] ->{representation_item representation_item.name = ‘viscosity’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 8 - Mapping table for plant_characterization UoF

Application element	AIM element	Source	Rules	Reference path
DUCTING_SYSTEM	ducting_system	227		ducting_system <= product_definition
type	group.name	41		ducting_system classification_item = ducting_system classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->{group => system_classification} group group.name
ducting_system to stream_design_case	PATH			ducting_system <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition => stream_design_case
ELECTRICAL_SYSTEM	electrical_system	227		electrical_system <= product_definition

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
system_voltage_- designation	representation	43		electrical_system <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation [representation.name = ‘system voltage designation’] [representation.items[i] -> representation_item => measure_representation_item <= measure_with_unit => electric_current_measure_with_unit]}
type	group.name	41		electrical_system classification_item = electrical_system classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> {group => system_classification} group group.name
EXTERNAL_- CLASSIFICATION	externally_defined_classification	227	17, 18	externally_defined_classification <= [group] [externally_defined_item]

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
description	group.description	41		externally_defined_classification <= group group.description
name	group.name	41		externally_defined_classification <= group group.name
source	external_source.source_id	41		externally_defined_classification <= externally_defined_item externally_defined_item.source -> (external_source) (external_source => known_source) external_source.source_id
FUNCTIONAL_PLANT	product_definition	41	1, 9, 11, 13	{product_definition [product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product => plant] [product_definition.frame_of_reference -> [product_definition_context <= application_context_element application_context_element.name = ‘functional occurrence’] [product_definition_context product_definition_context.life_cycle_stage = ‘functional design’]]}
functional_plant to functional_plant_-satisfaction	PATH			product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘plant satisfaction’}

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
functional_plant to plant_system	PATH			product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship product_definition_relationship.related_product_definition ->product_definition => (electrical_system) (ducting_system) (instrumentation_and_control_system) (piping_system) (structural_system)
FUNCTIONAL_PLANT_-SATISFACTION	product_definition_relationship	41		{product_definition_relationship product_definition_relationship.name = ‘plant satisfaction’}
HVAC_SYSTEM	ducting_system	227		ducting_system <= product_definition {ducting_system classification_item = ducting_system classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group => system_classification] [group group.name = ‘hvac’]}
INSTRUMENTATION_-AND_CONTROL_-SYSTEM	instrumentation_and_control_system	227		instrumentation_and_control_system <= product_definition

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
type	group.name	41		instrumentation_and_control_system classification_item = instrumentation_and_control_system classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->{group => system_classification} group group.name
LINE_LESS_PIPING_-SYSTEM	line_less_piping_system	227		line_less_piping_system <= product_definition
line_less_piping_system to piping_system_-component	PATH			line_less_piping_system <= product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship {product_definition_relationship => product_definition_usage => assembly_component_usage} product_definition_relationship.related_product_definition ->product_definition => piping_component_definition
line_less_piping_system to stream_design_case	PATH			line_less_piping_system <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition => stream_design_case

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LOCATION_IN_PLANT	(axis2_placement_2d) (axis2_placement_3d)	42 42	1, 9, 11, 13, 14, 16	{(axis2_placement_2d <=) (axis2_placement_3d <=) placement <= geometric_representation_item <= representation_item <- representation.items[i] {representation => shape_representation} representation <- property_definition_representation.used_representation {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.definition -> property_definition => 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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’]} product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product => plant]}

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
MANUFACTURING_-LINE	plant	227	1, 9, 10, 12	plant <= product {product product.frame_of_reference[i] -> product_context <= application_context_element application_context_element.name = ‘manufacturing line’}
PIPING_SYSTEM	piping_system	227		piping_system <= product_definition
code	document_usage_constraint.-subject_element_value	41		piping_system plant_spatial_configuration_document_item = piping_system plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element_value {document_usage_constraint.subject_element_value = ‘piping system code’}
description	product_definition_formation.description	41		piping_system <= product_definition product_definition.formation -> product_definition_formation product_definition_formation.description
piping_system to piping_system_line	PATH			piping_system <= product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship product_definition_relationship.related_product_definition -> product_definition => product_definition_with_associated_documents => plant_line_definition

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PLANNED_PHYSICAL_-PLANT	product_definition	41	1, 9, 11, 13, 14	{product_definition [product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product => plant] [product_definition.frame_of_reference -> [product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’] [product_definition_context product_definition_context.life_cycle_stage = ‘physical design’]]}
planned_physical_plant to changed_planned_-physical_plant	IDENTICAL MAPPING			
planned_physical_plant to functional_plant_-satisfaction	PATH			product_definition <- product_definition_relationship.related_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘plant satisfaction’}

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
planned_physical_plant to location_in_plant	PATH		16	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 <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation ->{representation => shape_representation} representation representation.items[i] ->representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)
planned_physical_plant to sited_plant	PATH			product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PLANT	plant	227	1, 9, 11, 13	plant <= product {product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition product_definition.frame_of_reference -> product_definition_context (product_definition_context.life_cycle_stage = ‘physical design’) (product_definition_context.life_cycle_stage = ‘functional design’)}

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
definition_coordinate_-system	representation_context.context_identifier	43		plant <= product <- product_definition_formation.of_product 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 <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.items[i] ->[representation_item representation_item.name = ‘plant placement reference’] [representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)]} representation representation.context_of_items ->{representation_context => geometric_representation_context} representation_context representation_context.context_identifier
description	product.description	41		plant <= product product.description
name	product.name	41		plant <= product product.name

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
operators	(organization) (person_and_organization)	41 41		plant (plant_spatial_configuration_organization_item = plant plant_spatial_configuration_organization_item <- plant_spatial_configuration_organization_assignment.items[i] plant_spatial_configuration_organization_assignment <= organization_assignment {organization_assignment.role -> organization_role organization_role.name = ‘plant operator’} organization_assignment.assigned_organization -> organization) (plant_spatial_configuration_person_and_organization_item = plant plant_spatial_configuration_person_and_organization_item <- plant_spatial_configuration_person_and_organization_assignment.items[i] plant_spatial_configuration_person_and_organization_assignment <= person_and_organization_assignment {person_and_organization_assignment.role -> person_and_organization_role person_and_organization_role.name = ‘plant operator’} person_and_organization_assignment.assigned_person_and_organization -> person_and_organization)

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
owners	(person) (organization) (person_and_organization)	41 41 41		plant (plant_spatial_configuration_person_item = plant plant_spatial_configuration_person_item <- plant_spatial_configuration_person_assignment.items[i] plant_spatial_configuration_person_assignment <= person_assignment {person_assignment.role -> person_role person_role.name = ‘plant owner’} person_assignment.assigned_person -> person) (plant_spatial_configuration_organization_item = plant plant_spatial_configuration_organization_item <- plant_spatial_configuration_organization_assignment.items[i] plant_spatial_configuration_organization_assignment <= organization_assignment {organization_assignment.role -> organization_role organization_role.name = ‘plant owner’} organization_assignment.assigned_organization -> organization) (plant_spatial_configuration_person_and_organization_item = plant plant_spatial_configuration_person_and_organization_item <- plant_spatial_configuration_person_and_organization_assignment.items[i] plant_spatial_configuration_person_and_organization_assignment <= person_and_organization_assignment {person_and_organization_assignment.role -> person_and_organization_role person_and_organization_role.name = ‘plant owner’} person_and_organization_assignment.assigned_person_and_organization -> person_and_organization)
plant_id	product.id	41		plant <= product product.id
plant to changed_plant	IDENTICAL MAPPING			

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant to external_-classification	PATH			plant <= product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group => externally_defined_classification
plant to functional_plant	PATH		1, 9, 11, 13	plant <= product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional occurrence’}
plant to planned_-physical_plant	PATH		1, 9, 11, 13, 14	plant <= product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’}

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant to plant_process_-capability	PATH			plant <= product <- product_definition_formation.of_product 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 => process_capability
plant to sub_plant_-relationship (contains)	PATH			plant <= product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘sub plant’}
plant to sub_plant_-relationship (used in)	PATH			plant <= product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <- product_definition_relationship.related_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘sub plant’}
PLANT_PROCESS_-CAPABILITY	process_capability	227		process_capability <= property_definition

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_process_- capability_id	property_definition.name	41		process_capability <= property_definition property_definition.name
production_capacity	representation	43		process_capability <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation representation.name = ‘production capacity’}
production_type	descriptive_representation_item.- description	45		process_capability <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> {representation representation.name = ‘production capacity’} representation representation.items[i] -> {representation_item representation_item.name = ‘production type’} representation_item => descriptive_representation_item descriptive_representation_item.description
plant_process_capability to changed_plant_- process_capability	IDENTICAL MAPPING			
PLANT_SYSTEM	(electrical_system) (ducting_system) (instrumentation_and_control_system) (piping_system) (structural_system)	227 227 227 227 227		(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
name	product_definition.description	41		(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition product_definition.description
plant_system_id	product_definition.id	41		(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition product_definition.id
service_description	property_definition.name	41		(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition property_definition.name
plant_system to changed_plant_system	IDENTICAL MAPPING			

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_system to external_classification	PATH			(electrical_system classification_item = electrical_system) (ducting_system classification_item = ducting_system) (instrumentation_and_control_system classification_item = instrumentation_and_control_system) (piping_system classification_item = piping_system) (structural_system classification_item = structural_system) classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group => externally_defined_classification
plant_system to plant_-item	PATH			(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship product_definition_relationship.related_product_definition -> (product_definition) (product_definition => externally_defined_plant_item_definition) (product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product)

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_system to plant_-system_assembly (sub-system)	PATH			(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition <- product_definition_relationship.related_product_definition product_definition_relationship product_definition_relationship.relating_product_definition -> product_definition (electrical_system) (ducting_system) (instrumentation_and_control_system) (piping_system) (structural_system)
plant_system to plant_-system_assembly (super-system)	PATH			(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship product_definition_relationship.related_product_definition -> product_definition (electrical_system) (ducting_system) (instrumentation_and_control_system) (piping_system) (structural_system)

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PLANT_SYSTEM_- ASSEMBLY	(electrical_system) (ducting_system) (instrumentation_and_control_system) (piping_system) (structural_system)	227 227 227 227 227		(electrical_system <=) (ducting_system <=) (instrumentation_and_control_system <=) (piping_system <=) (structural_system <=) product_definition
STRUCTURAL_SYSTEM	structural_system	227		structural_system <= product_definition
type	group.name	41		structural_system classification_item = structural_system classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->{group => system_classification} group group.name
SUB_PLANT_- RELATIONSHIP	product_definition_relationship	41		{product_definition_relationship product_definition_relationship.name = ‘sub plant’}

Table 8 - Mapping table for plant_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
location_and_orientation	(axis2_placement_2d) (axis2_placement_3d)	42 42	16	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} property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> {representation => shape_representation} representation representation.items[i] -> representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)
sub_plant_relationship to changed_sub_plant_-relationship	IDENTICAL MAPPING			
TRAIN	plant	227	1, 9, 10, 12	plant <= product {product product.frame_of_reference[i] -> product_context <= application_context_element application_context_element.name = ‘train’}

Table 8 - Mapping table for plant_characterization UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
UNIT	plant	227	1, 9, 10, 12	plant <= product {product product.frame_of_reference[i] -> product_context <= application_context_element application_context_element.name = ‘unit’}

Table 9 - Mapping table for plant_item_characterization UoF

Application element	AIM element	Source	Rules	Reference path
CABLE_SUPPORT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group group.name = ‘cable support’] [group <- group_relationship.related_group {group_relationship group_relationship.name = ‘usage classification’} group_relationship.relating_group ->group group.name = ‘support component’]}
cable_support_type	group.name	41		product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->group.name
CATALOGUE_-DEFINITION	catalogue	227		catalogue <= (external_source) (external_source => known_source) [document]
catalogue_id	document.id	41		catalogue <= document document.id

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
catalogue_name	document.name	41		catalogue <= document document.name
catalogue_version	document.description	41		catalogue <= document document.description
catalogue_definition to catalogue_connector	PATH		17	catalogue <= (external_source) (external_source => known_source) <- externally_defined_item.source externally_defined_item => catalogue_connector
catalogue_definition to catalogue_item	PATH		17	catalogue <= (external_source) (external_source => known_source) <- externally_defined_item.source externally_defined_item => externally_defined_plant_item_definition => catalogue_item

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
CATALOGUE_ITEM	catalogue_item	227	1, 9, 11, 13, 17	catalogue_item <= externally_defined_plant_item_definition <= [product_definition {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘catalogue definition’}] [externally_defined_item {externally_defined_item externally_defined_item.source -> (external_source) (external_source => known_source) => catalogue}]
item_name	product.name	41		catalogue_item <= externally_defined_plant_item_definition <= product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product product.name
item_version	product_definition_formation.id	41		catalogue_item <= externally_defined_plant_item_definition <= product_definition product_definition.formation -> product_definition_formation product_definition_formation.id

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
model_number	product.id	41		catalogue_item <= externally_defined_plant_item_definition <= product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product product.id
catalogue_item to catalogue_item_substitute (has as substitute)	PATH			catalogue_item <= externally_defined_plant_item_definition <= product_definition <- product_definition_relationship.related_product_definition product_definition_relationship <- product_definition_substitute.context_relationship product_definition_substitute
catalogue_item to catalogue_item_substitute (is substitute)	PATH			catalogue_item <= externally_defined_plant_item_definition <= product_definition <- product_definition_substitute.substitute_definition product_definition_substitute
catalogue_item to plant_-item_definition (is defined by)	PATH			catalogue_item <= externally_defined_plant_item_definition
CATALOGUE_ITEM_-SUBSTITUTE	product_definition_substitute	41		
CONNECTED_-COLLECTION	assembly_component_usage	44		{assembly_component_usage <= product_definition_usage <= product_definition_relationship (product_definition_relationship.name = ‘connected collection’) (product_definition_relationship.name = ‘connected hierarchical collection’)}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
connected_collection to plant_item_connection	PATH			assembly_component_usage <= product_definition_usage <= product_definition_relationship product_definition_relationship.relating_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 <- shape_aspect.of_shape shape_aspect => plant_item_connection
DESIGN_PROJECT	design_project	227		design_project <= organization
description	organization.description	41		design_project <= organization organization.description
design_project_id	organization.id	41		design_project <= organization organization.id
name	organization.name	41		design_project <= organization organization.name

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
owner	organization.name	41		design_project plant_spatial_configuration_organization_item = design_project plant_spatial_configuration_organization_item <- plant_spatial_configuration_organization_assignment.items[i] plant_spatial_configuration_organization_assignment <= organization_assignment {organization_assignment.role -> organization_role organization_role.name = ‘project owner’} organization_assignment.assigned_organization -> organization organization.name
design_project to project_design_-assignment	PATH			design_project <= organization <- organization_assignment.assigned_organization organization_assignment => design_project_assignment
DUCTING_COMPONENT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘ducting component’}
ELECTRICAL_-COMPONENT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group group.name = ‘electrical component’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
EQUIPMENT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘equipment’}
equipment_characteristics	([representation_item.name] [(descriptive_representation_item.- description) ([measure_with_unit.value_component] [measure_with_unit.unit_component])]) ([representation_item.name] [(descriptive_representation_item.- description) ([measure_with_unit.value_component] [measure_with_unit.unit_component])] [document_usage_constraint.- subject_element_value])	43 45 41 41 43 45 41 41 41		product <- product_definition_formation.of_product 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 property_definition.name = ‘general characteristics’} property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> [representation_item representation_item.name] [representation_item => (descriptive_representation_item descriptive_representation_item.description) (measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component])]

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
equipment_characteristics (concluded)				[(representation_item) (representation_item plant_spatial_configuration_document_item = representation_item plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element_value)]
equipment_type	product_category.name	41		product <- product_related_product_category.products[i] product_related_product_category <= product_category product_category.name

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
heat_tracing_type	(heat_tracing_representation) ([heat_tracing_representation] [document_usage_constraint.subject_- element_value])	227 227 41		product <- product_definition_formation.of_product 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 <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation => (heat_tracing_representation) ([heat_tracing_representation] [heat_tracing_representation plant_spatial_configuration_document_item = heat_tracing_representation plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element_value])

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
insulation_specification	document_usage_constraint.- subject_element_value	41		product plant_spatial_configuration_document_item = product plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element_value
equipment to equipment_trim_piping	PATH			product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘trim piping’}
equipment to supplied_- equipment	IDENTICAL MAPPING			

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
EQUIPMENT_- BREACHING	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group group.name = ‘equipment breaching’] [group <- group_relationship.related_group {group_relationship group_relationship.name = ‘usage classification’} group_relationship.relating_group ->group group.name = ‘ducting component’]}
EQUIPMENT_TRIM_- PIPING	product_definition_relationship	41		{product_definition_relationship [product_definition_relationship.relating_product_definition ->product_definition product_definition.formation ->product_definition_formation product_definition_formation.of_product ->product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->group group.name = ‘equipment’] [product_definition_relationship.related_product_definition ->product_definition => piping_component_definition] [product_definition_relationship.name = ‘trim piping’]}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
FUNCTIONAL_- DESIGN_VIEW	(product_definition) (externally_defined_plant_item_- definition)	41 227	1, 9, 11, 13, 17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {product_definition product_definition.frame_of_reference -> [product_definition_context <= application_context_element (application_context_element.name = ‘functional definition’) (application_context_element.name = ‘functional occurrence’)] [product_definition_context product_definition_context.life_cycle_stage = ‘functional design’]}
tag_number	product_definition.id	41		(product_definition) (externally_defined_plant_item_definition <= product_definition) {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional occurrence’} product_definition.id
functional_design_view to functional_plant_- item_satisfaction	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.relating_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘plant item satisfaction’}
FUNCTIONAL_PLANT_- ITEM_SATISFACTION	product_definition_relationship	41		{product_definition_relationship product_definition_relationship.name = ‘plant item satisfaction’}
HIERARCHICALLY_- ORGANIZED_- COLLECTION	assembly_component_usage	44		{assembly_component_usage <= product_definition_usage <= product_definition_relationship (product_definition_relationship.name = ‘hierarchical collection’) (product_definition_relationship.name = ‘connected hierarchical collection’)}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
HVAC_COMPONENT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group group.name = ‘hvac component’}
HVAC_DUCTING	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group group.name = ‘hvac ducting’] [group <- group_relationship.related_group {group_relationship group_relationship.name = ‘usage classification’} group_relationship.relating_group ->group group.name = ‘ducting component’] [group <- group_relationship.related_group {group_relationship group_relationship.name = ‘usage_classification’} group_relationship.relating_group ->group group.name = ‘hvac component’]}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
INSTALLED_- PHYSICAL_DESIGN_- VIEW	(product_definition) (externally_defined_plant_item_- definition)	41 227	1, 9, 11, 13, 14, 17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {product_definition [product_definition.description = ‘installed’] [product_definition.frame_of_reference -> [product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’] [product_definition_context product_definition_context.life_cycle_stage = ‘physical design’]]}
serial_number	product_definition.id	41		(product_definition) (externally_defined_plant_item_definition <= product_definition) product_definition.id

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
INSTRUMENT	product	41		{[product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group group.name = ‘instrument’] [group <- group_relationship.related_group {group_relationship group_relationship.name = ‘usage classification’} group_relationship.relating_group ->group group.name = ‘instrumentation and control component’]] [product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <- product_definition_relationship.related_product_definition {product_definition_relationship product_definition_relationship.name = ‘control loop element’} product_definition_relationship product_definition_relationship.relating_product_definition ->product_definition product_definition.formation ->product_definition_formation product_definition_formation.of_product ->product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
control_loop_id	product.id	41		product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <- product_definition_relationship.related_product_definition {product_definition_relationship product_definition_relationship.name = ‘control loop element’} product_definition_relationship product_definition_relationship.relating_product_definition -> product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product product.id
instrument_type	product_category.name	41		product <- product_related_product_category.products[i] product_related_product_category <= product_category product_category.name

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
sensor_type	descriptive_representation_item.-description	45		product <- product_definition_formation.of_product 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 <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> {representation_item representation_item.name = ‘sensor type’} representation_item => descriptive_representation_item descriptive_representation_item.description

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
signal_type	descriptive_representation_item.-description	45		product <- product_definition_formation.of_product 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 <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->representation representation.items[i] ->{representation_item representation_item.name = ‘signal type’} representation_item => descriptive_representation_item descriptive_representation_item.description

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
stream_interaction_type	descriptive_representation_item.-description	45		product <- product_definition_formation.of_product 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 <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> {representation_item representation_item.name = ‘stream interaction type’} representation_item => descriptive_representation_item descriptive_representation_item.description
INSTRUMENTATION_-AND_CONTROL_-COMPONENT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group group.name = ‘instrumentation and control component’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
INSULATION	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->group group.name = ‘insulation’}
JACKETED_PIPING	inline_equipment	227		inline_equipment <= piping_component_definition <= {product_definition product_definition.description = ‘jacketed piping’} product_definition
MATERIAL_- SPECIFICATION_- SELECTION	[material_property] [document]	45 41		{document document.kind ->document_type document_type.product_data_type = ‘material specification’}
description	property_definition.description	41		material_property <= property_definition property_definition.description
material_specification_id	document.id	41		

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
required_or_optional	group.name	41		document <- document_reference.assigned_document document_reference => plant_spatial_configuration_document_reference classification_item = plant_spatial_configuration_document_reference classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group {(group.name = ‘required’) (group.name = ‘optional’)}
selection_id	document_usage_constraint.- subject_element	41		document <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element
type	document_usage_constraint.- subject_element_value	41		document <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element_value
material_specification_- selection to material_- specification_subset_- reference	PATH			document <- document_relationship.relating_document {document_relationship document_relationship.description = ‘subset’}
MATERIAL_- SPECIFICATION_- SUBSET_REFERENCE	document_relationship	41		{document_relationship document_relationship.description = ‘subset’}
subset_id	document_relationship.name	41		

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
OFFLINE_INSTRUMENT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group ->[group group.name = ‘offline instrument’] [group <- group_relationship.related_group {group_relationship group_relationship.name = ‘usage classification’} group_relationship.relating_group ->group group.name = ‘instrument’]}
PHYSICAL_DESIGN_-VIEW	(product_definition) (externally_defined_plant_item_-definition)	41 227	1, 9, 11, 13, 14, 17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {product_definition product_definition.frame_of_reference ->[product_definition_context <= application_context_element (application_context_element.name = ‘physical definition’) (application_context_element.name = ‘physical occurrence’)] [product_definition_context product_definition_context.life_cycle_stage = ‘physical design’]}
physical_design_view to functional_plant_item_-satisfaction	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.related_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘plant item satisfaction’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
physical_design_view to installed_physical_-design_view	IDENTICAL MAPPING			
PIPING_SPOOL	product_definition	41	1, 9, 11, 13	{product_definition product_definition.frame_of_reference ->
product_definition_context <= application_context_element application_context_element.name = ‘fabrication assembly’}
piping_spool_number	product_definition.id	41		
piping_spool to piping_-spool_assignment	PATH			product_definition <- product_definition_relationship.relating_product_definition product_definition_relationship => product_definition_usage
PIPING_SPOOL_-ASSIGNMENT	product_definition_usage	44	1, 9, 11, 13, 14	{product_definition_usage <= product_definition_relationship [product_definition_relationship.relating_product_definition ->
product_definition product_definition.frame_of_reference ->
product_definition_context <= application_context_element application_context_element.name = ‘fabrication assembly’] [product_definition_relationship.related_product_definition ->
{(product_definition) (product_definition => externally_defined_plant_item_definition} product_definition product_definition.frame_of_reference ->
product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)]}
PIPING_SYSTEM_-COMPONENT	piping_component_definition	227	1, 9, 11, 13, 14	piping_component_definition <= product_definition

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
coating_reference	descriptive_representation_item.-description	45		piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘system coating and lining’} representation representation.items[i] ->{representation_item representation_item.name = ‘coating’} representation_item => descriptive_representation_item descriptive_representation_item.description

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
corrosion_allowance	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘system coating and lining’} representation (representation.items[i] ->{representation_item (representation_item.name = ‘corrosion allowance’) (representation_item.name = ‘maximum corrosion allowance’) (representation_item.name = ‘minimum corrosion allowance’)}) ([representation.items[i] ->{representation_item representation_item.name = ‘maximum corrosion allowance’}] [representation.items[i] ->{representation_item representation_item.name = ‘minimum corrosion allowance’}]) representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
heat_tracing_type	(heat_tracing_representation) ([heat_tracing_representation] [document_usage_constraint.subject_- element_value])	227 227 41		piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation => (heat_tracing_representation) ([heat_tracing_representation] [heat_tracing_representation plant_spatial_configuration_document_item = heat_tracing_representation plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document <- document_usage_constraint.source document_usage_constraint document_usage_constraint.subject_element_value])

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
lining	descriptive_representation_item.-description	45		piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation representation.name = ‘system coating and lining’} representation representation.items[i] ->{representation_item representation_item.name = ‘lining’} representation_item => descriptive_representation_item descriptive_representation_item.description
piping_system_-component to equipment_trim_piping	PATH			piping_component_definition <= product_definition <- product_definition_relationship.related_product_definition {product_definition_relationship product_definition_relationship.name = ‘trim piping’} product_definition_relationship
piping_system_-component to line_-piping_system_-component_assignment	PATH			piping_component_definition <= product_definition <- product_definition_relationship.related_product_definition {product_definition_relationship product_definition_relationship.name = ‘realization’} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
piping_system_- component to piping_- size_description	PATH		16	piping_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation => shape_representation => shape_dimension_representation
PLANNED_PHYSICAL_- PLANT_ITEM	(product_definition) (externally_defined_plant_item_- definition)	41 227	1, 9, 11, 13, 14, 17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)}
type	product_category.name	41		(product_definition) (externally_defined_plant_item_definition <= 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

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
planned_physical_plant_-item to plant_item_-connector_occurrence	PATH			(product_definition) (externally_defined_plant_item_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 <- shape_aspect.of_shape shape_aspect => plant_item_connector
planned_physical_plant_-item to piping_spool_-assignment	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.related_product_definition product_definition_relationship => product_definition_usage
planned_physical_plant_-item to support_usage (supported by)	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.related_product_definition {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship
planned_physical_plant_-item to support_usage (supports)	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.relating_product_definition {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PLANT_ITEM	(product_definition) (externally_defined_plant_item_- definition) (product)	41 227 41	1, 9, 10, 11, 12, 13, 17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {(product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product) (product) product.frame_of_reference[i] -> product_context product_context.discipline_type = ‘process plant’} {(product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition) (product_definition) product_definition.frame_of_reference -> product_definition_context (product_definition_context.life_cycle_stage = ‘physical design’) (product_definition_context.life_cycle_stage = ‘functional design’)}
description	product.description	41		(product_definition) (externally_defined_plant_item_definition <= product_definition) product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product product.description

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
name	product.name	41		(product_definition) (externally_defined_plant_item_definition <= product_definition) product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product product.name
plant_item_id	product.id	41		(product_definition) (externally_defined_plant_item_definition <= product_definition) product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product product.id
plant_item to changed_- plant_item	IDENTICAL MAPPING			
plant_item to external_- classification	PATH			(product_definition) (externally_defined_plant_item_definition <= product_definition) classification_item = product_definition classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group => externally_defined_classification

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item to insulation	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) (product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <-) product_definition_relationship.relating_product_definition {product_definition_relationship product_definition_relationship.name = ‘item insulation’} product_definition_relationship product_definition_relationship.related_product_definition -> product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product {product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘insulation’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item to plant_-item_collection (element)	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) (product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <-) product_definition_relationship.related_product_definition product_definition_relationship <= product_definition_usage <= assembly_component_usage
plant_item to plant_-item_collection (group)	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) (product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <-) product_definition_relationship.relating_product_definition product_definition_relationship <= product_definition_usage <= assembly_component_usage
plant_item to plant_-item_design_view	(IDENTICAL MAPPING) (PATH)			product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation (product_definition) (product_definition => externally_defined_plant_item_definition)

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item to plant_- item_shape	PATH			(product_definition) (externally_defined_plant_item_definition <= product_definition) (product <- product_definition_formation.of_product 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
plant_item to plant_- item_weight	PATH			(product_definition) (externally_defined_plant_item_definition <= product_definition) (product <- product_definition_formation.of_product 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 <- property_definition_representation.definition property_definition_representation => plant_item_weight_representation

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item to reference_-geometry	PATH			(product_definition) (externally_defined_plant_item_definition <= product_definition) (product <- product_definition_formation.of_product 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 <- shape_aspect.of_shape shape_aspect => derived_shape_aspect => reference_geometry
plant_item to required_-material_description #1: The quantity is not known or not yet specified. #2: The quantity is known.	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) (product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <-) product_definition_relationship.relating_product_definition {product_definition_relationship => #1: (product_definition_usage) #2: (product_definition_usage => make_from_usage_option)} product_definition_relationship product_definition_relationship.related_product_definition ->product_definition

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item to spare_- plant_item_usage (as primary)	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) (product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <-) product_definition_relationship.related_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘spare plant item usage’}
plant_item to spare_- plant_item_usage (as spare)	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) (product <- product_definition_formation.of_product product_definition_formation <- product_definition.formation product_definition <-) product_definition_relationship.related_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘spare plant item usage’}
PLANT_ITEM_- COLLECTION	assembly_component_usage	44		{assembly_component_usage <= product_definition_usage <= product_definition_relationship [product_definition_relationship.relating_product_definition ->] [product_definition_relationship.related_product_definition ->] (product_definition) (product_definition => externally_defined_plant_item_definition)}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
location_and_orientation	(axis2_placement_2d) (axis2_placement_3d)	42 42		{assembly_component_usage <= product_definition_usage <= product_definition_relationship characterized_product_definition = product_definition_relationship characterized_product_definition characterized_definition = characterized_product_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 => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)
plant_item_collection to changed_plant_item_-collection	IDENTICAL MAPPING			
PLANT_ITEM_-DEFINITION	(product_definition) (externally_defined_plant_item_-definition)	41 227	1, 9, 11, 13, 14, 17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional definition’) (application_context_element.name = ‘physical definition’)}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_definition to catalogue_item (is defined as) #1: Instances of the definition use the same catalogue item. #2: Instances of the definition use different catalogue items.	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) #1: (product_definition_relationship.related_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘catalogue usage’} product_definition_relationship.relating_product_definition ->) #2: (product_definition_relationship.relating_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘definition usage’} product_definition_relationship.related_product_definition ->{product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘physical occurrence’) (application_context_element.name = ‘functional occurrence’)} (product_definition <-) ({product_definition => externally_defined_plant_item_definition} product_definition <-) product_definition_relationship.related_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘catalogue usage’} product_definition_relationship.relating_product_definition ->) product_definition => externally_defined_plant_item_definition => catalogue_item

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_definition to connector_definition	PATH			(product_definition) (externally_defined_plant_item_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 <- shape_aspect.of_shape shape_aspect => plant_item_connector
plant_item_definition to planned_physical_plant_-item #1: The definition is physical. #2: The definition is functional.	PATH		1, 9, 11, 13, 14	#1: ((product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical definition’} product_definition_relationship.relating_product_definition {product_definition_relationship product_definition_relationship.name = ‘definition usage’} product_definition_relationship product_definition_relationship.related_product_definition ->{product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’} (product_definition) (product_definition => externally_defined_plant_item_definition))

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_definition to planned_physical_plant_-item (concluded)				#2: ((product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional definition’} product_definition_relationship.relating_product_definition product_definition_relationship {product_definition_relationship product_definition_relationship.name = ‘definition usage’} product_definition_relationship.related_product_definition ->{product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘functional occurrence’} (product_definition) (product_definition => externally_defined_plant_item_definition))
PLANT_ITEM_DESIGN_-VIEW	(product_definition) (externally_defined_plant_item_-definition)	41 227	1, 9, 11, 13, 14, 17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {product_definition product_definition.frame_of_reference -> [product_definition_context <= application_context_element (application_context_element.name = ‘functional definition’) (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical definition’) (application_context_element.name = ‘physical occurrence’)] [product_definition_context (product_definition_context.life_cycle_stage = ‘physical design’) (product_definition_context.life_cycle_stage = ‘functional design’)]}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PLANT_ITEM_- INSTANCE	(product_definition) (externally_defined_plant_item_- definition)	41 227	1, 9, 11, 13, 14, 17, 18	externally_defined_plant_item_definition <= [product_definition] [externally_defined_item] {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)}
plant_item_instance to plant_item_interference (first item)	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.relating_product_definition product_definition_relationship => plant_item_interference
plant_item_instance to plant_item_interference (second item)	PATH			(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.related_product_definition product_definition_relationship => plant_item_interference

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_instance to plant_item_location #1: The plant item is placed relative to another plant item. #2a: The plant item is placed in a building, plant, or site. #2b: The plant item is defined in the coordinate space of a building, plant, or site.	PATH		16	(product_definition) (externally_defined_plant_item_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 <- property_definition_representation.definition {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.used_representation ->{representation => shape_representation} #1: (representation <- representation_map.mapped_representation representation_map <- mapped_item.mapping_source mapped_item {mapped_item <= representation_item representation_item.name = ‘relative item location’}) #2a: ({representation representation.name = ‘placed shape’} representation representation.items[i] ->representation_item => mapped_item mapped_item.mapping_target ->representation_item => geometric_representation_item => placement =>

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_instance to plant_item_location (concluded)				#2a: ({representation representation.name = ‘in-situ shape’} representation representation.items[i] -> representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d))
plant_item_instance to project_design_-assignment	PATH			(product_definition) (externally_defined_plant_item_definition <= product_definition) design_project_item = product_definition design_project_item <- design_project_assignment.items[i] design_project_assignment

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_instance to relative_item_location	PATH			(product_definition) (externally_defined_plant_item_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 <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> {representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)} representation_item <- mapped_item.mapping_target mapped_item {mapped_item <= representation_item representation_item.name = ‘relative item location’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PLANT_ITEM_- LOCATION #1: The plant item is placed relative to another plant item. #2: The plant item is placed in a building, plant, or site.	#1: (mapped_item) #2: ((axis2_placement_2d) (axis2_placement_3d))	43 42 42		
location_and_orientation	[(axis2_placement_2d) (axis2_placement_3d)] [cartesian_point]	42 42 42		#1: (mapped_item mapped_item.mapping_target -> representation_item => geometric_representation_item => [placement => (axis2_placement_2d) (axis2_placement_3d)] [placement placement.location -> cartesian_point]) #2: ([(axis2_placement_2d) (axis2_placement_3d)] [(axis2_placement_2d <=) (axis2_placement_3d <=) placement placement.location -> cartesian_point])

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
location_id	representation_item.name	43		#1: (mapped_item mapped_item.mapping_target ->{representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)}) #2: ((axis2_placement_2d <=) (axis2_placement_3d <=) placement <= geometric_representation_item <=) representation_item representation_item.name
plant_item_location to changed_plant_item_-location	#1: (PATH) #2: (IDENTICAL MAPPING)			#1: mapped_item mapped_item.mapping_target ->representation_item => geometric_representation_item => placement => (axis2_placement_2d {axis2_placement_2d change_delta_item = axis2_placement_2d change_delta_item change_item = change_delta_item}) (axis2_placement_3d {axis2_placement_3d change_delta_item = axis2_placement_3d change_delta_item change_item = change_delta_item})
PLANT_ITEM_WEIGHT	plant_item_weight_representation	227		plant_item_weight_representation <= property_definition_representation {property_definition_representation.used_representation ->representation representation.name = ‘item weight’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
centre_of_gravity	geometric_representation_item	42		plant_item_weight_representation <= property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> {representation_item representation_item.name = ‘centre of gravity’} representation_item => geometric_representation_item

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
weight_state	type_qualifier.name	45		plant_item_weight_representation <= property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> ({[representation_item (representation_item.name = ‘weight value’) (representation_item.name = ‘mass value’)] [representation_item => measure_representation_item]} representation_item => qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = type_qualifier type_qualifier {(type_qualifier.name = ‘empty’) (type_qualifier.name = ‘full’) (type_qualifier.name = ‘operating’) (type_qualifier.name = ‘shipping’) (type_qualifier.name = ‘test’)}) ({[representation_item (representation_item.name = ‘maximum weight value’) (representation_item.name = ‘minimum weight value’) (representation_item.name = ‘maximum mass value’) (representation_item.name = ‘minimum mass value’)] [representation_item => measure_representation_item]} representation_item => qualified_representation_item qualified_representation_item.qualifiers[i] -> value_qualifier value_qualifier = type_qualifier type_qualifier type_qualifier.name = ‘operating’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
weight_value	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		plant_item_weight_representation <= property_definition_representation property_definition_representation.used_representation ->
representation (representation.items[i] -> {representation_item (representation_item.name = ‘weight value’) (representation_item.name = ‘mass value’) (representation_item.name = ‘maximum weight value’) (representation_item.name = ‘minimum weight value’) (representation_item.name = ‘maximum mass value’) (representation_item.name = ‘minimum mass value’)}) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum weight value’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum weight value’}]) ([representation.items[i] -> {representation_item representation_item.name = ‘maximum mass value’}] [representation.items[i] -> {representation_item representation_item.name = ‘minimum mass value’}]) {representation_item => qualified_representation_item} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PLANT_VOLUME	(plant_item_route) (reserved_space) (system_space) (product_definition_shape) (shape_aspect)	227 227 227 41 41		(plant_item_route <= product_definition_shape) (reserved_space <= shape_aspect) (system_space <= product_definition_shape)
type	(property_definition.name) (shape_aspect.name)	41 41		((plant_item_route <= product_definition_shape <=) (system_space <= product_definition_shape <=) (product_definition_shape <=) property_definition property_definition.name) ((reserved_space <= shape_aspect) (shape_aspect) shape_aspect.name)

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PROCESS_DUCTING	piping_component_definition	227		piping_component_definition <= product_definition {product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> [group group.name = ‘process ducting’] [group <- group_relationship.related_group {group_relationship group_relationship.name = ‘usage classification’} group_relationship.relating_group -> group group.name = ‘ducting component’]}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
gauge	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41	16	piping_component_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 <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relating_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <= shape_representation <= {representation representation.name = ‘process ducting dimensional shape’} representation representation.items[i] -> {representation_item representation_item.name = ‘gauge’} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
PROJECT_DESIGN_- ASSIGNMENT	design_project_assignment	227		design_project_assignment <= organization_assignment {organization_assignment.assigned_organization -> organization => design_project}
RELATIVE_ITEM_- LOCATION	mapped_item	43	1, 9, 11, 13, 14	{[mapped_item <= representation_item representation_item.name = ‘relative item location’] [mapped_item mapped_item.mapping_target -> [representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)] [representation_item <- representation.items[i] representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)]]}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
REQUIRED_- MATERIAL_- DESCRIPTION	product_definition	41		
description	property_definition.description	41		product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition {property_definition => material_property} property_definition <- property_definition_relationship.relating_property_definition {property_definition_relationship property_definition_relationship.name = ‘requirement allocation’} property_definition_relationship property_definition_relationship.related_property_definition ->{property_definition => material_property => required_material_property} property_definition property_definition.description
material_requirement_id	product.id	41		product_definition product_definition.formation ->product_definition_formation product_definition_formation.of_product ->product product.id
required_material_- description to changed_- required_material_- description	IDENTICAL MAPPING			

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
required_material_- description to material_- specification_selection	PATH			product_definition [characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition => material_property] [plant_spatial_configuration_document_item = product_definition plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document]
RESERVED_SPACE	reserved_space	227	1, 9, 11, 13, 14	reserved_space <= shape_aspect {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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
ROUTE	plant_item_route	227	1, 9, 11, 13, 14	plant_item_route <= product_definition_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 product_definition.frame_of_reference -> product_definition_context <= application_context_element application_context_element.name = ‘physical occurrence’}
route to piping_system_-line_segment	PATH		14	plant_item_route <= 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 <- product_definition_relationship.related_product_definition product_definition_relationship product_definition_relationship.relating_product_definition product_definition => plant_line_segment_definition
SPARE_PLANT_ITEM_-USAGE	product_definition_relationship	41		{product_definition_relationship product_definition_relationship.name = ‘spare plant item usage’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
STRUCTURAL_- COMPONENT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘structural component’}
exact_section	shape_aspect	41		product <- product_definition_formation.of_product 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 <- shape_aspect.of_shape shape_aspect

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
size_designator	descriptive_representation_item.-description	45		product <- product_definition_formation.of_product 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 <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> {representation plant_spatial_configuration_document_item = representation plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document} representation representation.items[i] -> {representation_item representation_item.name = ‘size designator’} representation_item => descriptive_representation_item descriptive_representation_item.description
type	product_category.name	41		product <- product_related_product_category.products[i] product_related_product_category <= product_category product_category.name

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SUPPLIED_EQUIPMENT	product	41		{[product <- product_definition_formation.of_product product_definition_formation => product_definition_formation_with_specified_source product_definition_formation_with_specified_source.make_or_buy = ‘BUY’] [product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘equipment’]}
delivery_date	(date_assignment.role) (date_and_time_assignment.role)	41 41		product (plant_spatial_configuration_dated_item = product plant_spatial_configuration_dated_item <- plant_spatial_configuration_date_assignment.items[i] plant_spatial_configuration_date_assignment <= date_assignment date_assignment.role) (plant_spatial_configuration_date_and_time_item = product plant_spatial_configuration_date_and_time_item <- plant_spatial_configuration_date_and_time_assignment.items[i] plant_spatial_configuration_date_and_time_assignment <= date_and_time_assignment date_and_time_assignment.role)

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
purchase_order_number	action_directive.name	41		product purchase_item = product purchase_item <- purchase_assignment.items[i] purchase_assignment <= action_assignment action_assignment.assigned_action -> action => executed_action => directed_action directed_action.directive -> action_directive action_directive.name
requisition_number #1: Prior to purchase order being issue. #2: A purchase order exists.	versioned_action_request.id	41		product #1: (plant_spatial_configuration_action_request_item = product plant_spatial_configuration_action_request_item <- plant_spatial_configuration_action_request_assignment.items[i] plant_spatial_configuration_action_request_assignment <= action_request_assignment action_request_assignment.assigned_action_request ->) #2: (purchase_item = product purchase_item <- purchase_assignment.items[i] purchase_assignment <= action_assignment action_assignment.assigned_action -> action => executed_action => directed_action directed_action.directive -> action_directive action_directive.requests[i] ->) versioned_action_request versioned_action_request.id
SUPPLIER	organization	41		

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
supplier_id	organization.id	41		
vendor_name	organization.name	41		
supplier to catalogue_-definition	PATH			organization <- organization_assignment.assigned_organization {organization_assignment organization_assignment.role -> organization_role organization_role.name = ‘publisher’} organization_assignment => plant_spatial_configuration_organization_assignment plant_spatial_configuration_organization_assignment.items[i] -> plant_spatial_configuration_organization_item plant_spatial_configuration_organization_item = catalogue catalogue

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
supplier to supplied_-equipment	PATH			organization <- organization_assignment.assigned_organization {organization_assignment organization_assignment.role -> organization_role organization_role.name = ‘supplier’} organization_assignment => plant_spatial_configuration_organization_assignment plant_spatial_configuration_organization_assignment.items[i] -> plant_spatial_configuration_organization_item plant_spatial_configuration_organization_item = product_definition_formation {product_definition_formation => product_definition_formation_with_specified_source} product_definition_formation product_definition_formation.of_product -> product {product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘equipment’}
SUPPORT_COMPONENT	product	41		{product classification_item = product classification_item <- classification_assignment.items[i] classification_assignment <= group_assignment group_assignment.assigned_group -> group group.name = ‘support component’}

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SUPPORT_- CONSTRAINTS	support_constraint_representation	227		support_constraint_representation <= representation
gap	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		support_constraint_representation <= representation representation.items[i] ->{representation_item (representation_item.name = ‘negative x’) (representation_item.name = ‘positive x’) (representation_item.name = ‘negative y’) (representation_item.name = ‘positive y’) (representation_item.name = ‘negative z’) (representation_item.name = ‘positive z’) (representation_item.name = ‘negative x rotation’) (representation_item.name = ‘positive x rotation’) (representation_item.name = ‘negative y rotation’) (representation_item.name = ‘positive y rotation’) (representation_item.name = ‘negative z rotation’) (representation_item.name = ‘positive z rotation’)} representation_item => measure_representation_item <= {measure_with_unit => length_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
k	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		support_constraint_representation <= representation representation.items[i] ->representation_item => measure_representation_item <= {measure_with_unit => ratio_measure_with_unit} measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
restrained	descriptive_representation_item.-description	45		support_constraint_representation <= representation representation.items[i] -> representation_item => descriptive_representation_item descriptive_representation_item.description
support_constraint_id	representation.name	43		support_constraint_representation <= representation representation.name
support_constraints to support_usage (negative x-direction)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘negative x’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (positive x-direction)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘positive x’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (negative y-direction)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘negative y’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (positive y-direction)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘positive y’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (negative z-direction)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘negative z’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (positive z-direction)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘positive z’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (negative rotation x-axis)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘negative x rotation’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (positive rotation x-axis)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘positive x rotation’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (negative rotation y-axis)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘negative y rotation’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (positive rotation y-axis)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘positive y rotation’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (negative rotation z-axis)	PATH			{representation representation.items[i] -> representation_item representation_item.name = ‘negative z rotation’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
support_constraints to support_usage (positive rotation z-axis)	PATH			support_constraint_representation <= {representation representation.items[i] -> representation_item representation_item.name = ‘positive z rotation’} representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_product_definition characterized_product_definition characterized_product_definition = product_definition_relationship {product_definition_relationship (product_definition_relationship.name = ‘support usage’) (product_definition_relationship.name = ‘support usage connection’)} product_definition_relationship
SUPPORT_USAGE	product_definition_relationship	41		{product_definition_relationship product_definition_relationship.name = ‘support usage’}
detail_sheet_reference	document	41		product_definition_relationship plant_spatial_configuration_document_item = product_definition_relationship plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> {document document.kind -> document_type document_type.product_data_type = ‘drawing’} document
function	product_definition_relationship.-description	41		

Table 9 - Mapping table for plant_item_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SUPPORT_USAGE_-CONNECTION	product_definition_relationship	41		{product_definition_relationship product_definition_relationship.name = ‘support usage connection’}
support_usage_-connection to plant_-item_connection_-occurrence	PATH		1, 9, 11, 13, 14	product_definition_relationship [product_definition_relationship.relating_product_definition ->] [product_definition_relationship.related_product_definition ->] {product_definition product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘functional occurrence’) (application_context_element.name = ‘physical occurrence’)} 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 <- shape_aspect.of_shape shape_aspect => plant_item_connection

Table 9 - Mapping table for plant_item_characterization UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
SYSTEM_SPACE	system_space	227		system_space <= product_definition_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 => (electrical_system) (ducting_system) (instrumentation_and_control_system) (piping_system) (structural_system)

Table 10 - Mapping table for shape UoF

Application element	AIM element	Source	Rules	Reference path
DETAIL_SHAPE	representation.name	43		{representation.name = ‘detail’}
ENVELOPE_SHAPE	representation.name	43		{representation.name = ‘envelope’}
INTERFERING_SHAPE_-ELEMENT	interfering_shape_element	227		interfering_shape_element <= [shape_aspect_relationship] [shape_aspect]
interference_colour	descriptive_colour	227		interfering_shape_element <= 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.items[i] -> {representation_item representation_item.name = ‘interference colour’} representation_item => descriptive_representation_item => {descriptive_colour <= colour} descriptive_colour
OUTLINE_SHAPE	representation.name	43		{representation.name = ‘outline’}
PLANT_ITEM_-CENTRELINE	centre_of_symmetry	47		
PLANT_ITEM_-INTERFERENCE	plant_item_interference	227		plant_item_interference <= product_definition_relationship

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
interference_id	product_definition_relationship.name	41		plant_item_interference <= product_definition_relationship product_definition_relationship.name
type	product_definition_relationship.-description	41		plant_item_interference <= product_definition_relationship product_definition_relationship.description
plant_item_interference to interfering_shape_-element	PATH			plant_item_interference <= product_definition_relationship product_definition_relationship.relating_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 <- shape_aspect.of_shape shape_aspect => interfering_shape_element

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_interference to plant_item_-interference_status	PATH			plant_item_interference <= product_definition_relationship (plant_spatial_configuration_organization_item = product_definition_relationship plant_spatial_configuration_organization_item <- plant_spatial_configuration_organization_assignment.items[i] plant_spatial_configuration_organization_assignment) (plant_spatial_configuration_person_item = product_definition_relationship plant_spatial_configuration_person_item <- plant_spatial_configuration_person_assignment.items[i] plant_spatial_configuration_person_assignment) (characterized_product_definition = product_definition_relationship characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->representation)

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_item_interference to shape_interference_-zone_usage	PATH		16	plant_item_interference <= product_definition_relationship characterized_product_definition = product_definition_relationship characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->{representation => shape_representation} representation representation.items[i] ->representation_item => mapped_item
PLANT_ITEM_-INTERFERENCE_-STATUS	(plant_spatial_configuration_-organization_assignment) (plant_spatial_configuration_person_-assignment) (representation)	227 227 43		(plant_spatial_configuration_organization_assignment <= organization_assignment) (plant_spatial_configuration_person_assignment <= person_assignment)
assessor	(organization.name) ([person.first_name] [person.last_name])	41 41 41		(plant_spatial_configuration_organization_assignment <= organization_assignment organization_assignment.assigned_organization ->organization organization.name) (plant_spatial_configuration_person_assignment <= person_assignment person_assignment.assigned_person ->person [person.first_name] [person.last_name])

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
status	descriptive_representation_item.-description	45		representation representation.items[i] ->{representation_item representation_item.name = ‘interference status’} representation_item => descriptive_representation_item descriptive_representation_item.description
PLANT_ITEM_SHAPE	product_definition_shape	41	1, 9, 11, 13, 14	{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 product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = ‘physical definition’) (application_context_element.name = ‘physical occurrence’)}
clash_detection_class	property_definition.description	41		product_definition_shape <= property_definition {property_definition (property_definition.description = ‘hard’) (property_definition.description = ‘ignore’) (property_definition.description = ‘soft’)} property_definition.description

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
origin	(axis2_placement_2d) (axis2_placement_3d)	42 42		product_definition_shape <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->representation representation.items[i] ->{representation_item representation_item.name = ‘plant item orientation’} representation_item => geometric_representation_item => {placement placement.location ->cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘plant item location’} placement => (axis2_placement_2d) (axis2_placement_3d)
shape_id	property_definition.name	41		product_definition_shape <= property_definition property_definition.name
plant_item_shape to changed_plant_item_-shape	IDENTICAL MAPPING			
plant_item_shape to shape_representation	PATH			product_definition_shape <= property_definition <- property_definition_representation.definition property_definition_representation
REFERENCE_-GEOMETRY	reference_geometry	227		reference_geometry <= derived_shape_aspect

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
name	shape_aspect.name	41		reference_geometry <= derived_shape_aspect <= shape_aspect shape_aspect.name
reference_geometry_id	representation_item.name	43		reference_geometry <= derived_shape_aspect <= 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.items[i] -> representation_item representation_item.name
reference_geometry to changed_reference_-geometry	IDENTICAL MAPPING			

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
reference_geometry to shape_representation_-element	PATH			reference_geometry <= derived_shape_aspect <= 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.items[i] -> representation_item
SHAPE_-INTERFERENCE_-ZONE_USAGE	mapped_item	43		
SHAPE_PARAMETER	measure_representation_item	45		{representation_item <- representation.items[i] representation representation.name = ‘parametric shape representation’}
name	representation_item.name	43		measure_representation_item <= representation_item representation_item.name
value	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
SHAPE_-REPRESENTATION	property_definition_representation	41		

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
shape_representation to shape_representation_-element_usage	PATH		16	property_definition_representation property_definition_representation.used_representation ->(representation => shape_representation => (advanced_csg_shape_representation) (piping_design_csg_shape_representation) (hybrid_shape_representation)) (representation {representation representation.name = ‘parametric shape representation’})
SHAPE_-REPRESENTATION_-ELEMENT	representation_item	43		
element_id	representation_item.name	43		
shape_representation_-element to shape_-interference_zone_usage	PATH			representation_item <- representation_map.mapping_origin representation_map <- mapped_item.mapping_source mapped_item
shape_representation_-element to shape_-representation_element_-usage	PATH		16	representation_item <- representation.items[i] (representation => shape_representation => (advanced_csg_shape_representation) (piping_design_csg_shape_representation) (hybrid_shape_representation)) (representation {representation representation.name = ‘parametric shape representation’})

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
SHAPE_- REPRESENTATION_- ELEMENT_USAGE	(advanced_csg_shape_representation) (piping_design_csg_shape_- representation) (hybrid_shape_representation) (representation)	227 227 227 43	16	((advanced_csg_shape_representation <=) (piping_design_csg_shape_representation <=) (hybrid_shape_representation <=) shape_representation) ({representation representation.name = ‘parametric shape representation’})
element_colour	descriptive_colour	227	16	(advanced_csg_shape_representation <= shape_representation <= representation) (piping_design_csg_shape_representation <= shape_representation <= representation) (hybrid_shape_representation <= shape_representation <= representation) (representation) representation.items[i] -> {representation_item representation_item.name = ‘element colour’} representation_item => descriptive_representation_item => {descriptive_colour <= colour} descriptive_colour

Table 10 - Mapping table for shape UoF (continued)

Application element	AIM element	Source	Rules	Reference path
layer	presentation_layer_assignment	46	16	(advanced_csg_shape_representation <= shape_representation <= representation) (piping_design_csg_shape_representation <= shape_representation <= representation) (hybrid_shape_representation <= shape_representation <= representation) (representation) representation.items[i] -> representation_item layered_item = representation_item layered_item <- presentation_layer_assignment.assigned_items[i] presentation_layer_assignment

Table 10 - Mapping table for shape UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
shape_representation_-element_usage to interfering_shape_-element	PATH		16	(advanced_csg_shape_representation <= shape_representation <= representation <-) (piping_design_csg_shape_representation <= shape_representation <= representation <-) (hybrid_shape_representation <= shape_representation <= representation <-) (representation <-) property_definition_representation.used_representation property_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 => interfering_shape_element

Table 11 - Mapping table for site_characterization UoF

Application element	AIM element	Source	Rules	Reference path
BREAKLINE	polyline	42		
breakline to survey_point	PATH			polyline polyline.points[i] -> cartesian_point {cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘survey point’}
BUILDING	site_building	227		site_building <= property_definition
building_id	representation	43		site_building <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation [representation.name = ‘building number’] [representation.items[i] -> representation_item => descriptive_representation_item]}

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
location_and_orientation	[(axis2_placement_2d) (axis2_placement_3d)] [cartesian_point]	42 42 42		site_building <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> {representation_item representation_item.name = ‘building orientation’} representation_item => geometric_representation_item => [placement => (axis2_placement_2d) (axis2_placement_3d)] [placement placement.location -> cartesian_point {cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘building location’}]
name	property_definition.name	41		site_building <= property_definition property_definition.name
shape	shape_representation	41	16	site_building <= {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

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
building to location_in_-building	PATH			site_building <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->representation representation.items[i] ->representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)
FACET_TRIGON	poly_loop	42		
facet_trigon to survey_-point	PATH			poly_loop poly_loop.polygon[i] ->cartesian_point {cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘survey point’}
FACETED_SURFACE_-REPRESENTATION	site_representation	227	16	site_representation <= shape_representation

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
faceted_surface_- representation to facet_- trigon	PATH		16	site_representation <= shape_representation <= representation representation.items[i] -> representation_item => topological_representation_item => connected_face_set connected_face_set.cfs_faces[i] -> {face => face_surface} face face.bounds[i] -> face_bound face_bound.bound -> loop => poly_loop
GIS_POSITION	representation	43		{representation representation.name = ‘gis position’}
height	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation representation.items[i] -> {representation_item representation_item.name = ‘height’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
scale	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation representation.items[i] ->{representation_item representation_item.name = ‘scale’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
system	representation_context.context_type	43		representation representation.context_of_items ->representation_context representation_context.context_type
x_axis_delta_x	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation representation.items[i] ->{representation_item representation_item.name = ‘x-axis delta x’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
x_axis_delta_y	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation representation.items[i] ->{representation_item representation_item.name = ‘x-axis delta y’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
x_coordinate	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation representation.items[i] -> {representation_item representation_item.name = ‘x coordinate’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
y_coordinate	[measure_with_unit.value_component] [measure_with_unit.unit_component]	41 41		representation representation.items[i] -> {representation_item representation_item.name = ‘y coordinate’} representation_item => measure_representation_item <= measure_with_unit [measure_with_unit.value_component] [measure_with_unit.unit_component]
zone	descriptive_representation_item.- description	45		representation representation.items[i] -> {representation_item representation_item.name = ‘zone’} representation_item => descriptive_representation_item descriptive_representation_item.description

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
LOCATION_IN_- BUILDING	(axis2_placement_2d) (axis2_placement_3d)	42 42		{(axis2_placement_2d <=) (axis2_placement_3d <=) placement <= geometric_representation_item <= representation_item <- representation.items[i] representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition -> property_definition => site_building}
LOCATION_IN_SITE	(axis2_placement_2d) (axis2_placement_3d)	42 42	15	{(axis2_placement_2d <=) (axis2_placement_3d <=) placement <= geometric_representation_item <= representation_item <- representation.items[i] representation <- property_definition_representation.used_representation {property_definition_representation => shape_definition_representation} property_definition_representation property_definition_representation.definition -> {property_definition => product_definition_shape} property_definition property_definition.definition -> characterized_definition characterized_definition = characterized_object characterized_object => site}
POINT_AND_LINE_- REPRESENTATION	site_representation	227	16	site_representation <= shape_representation

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
point_and_line_- representation to survey_point	PATH		16	site_representation <= shape_representation <= representation representation.items[i] -> representation_item => geometric_representation_item => {geometric_set => geometric_curve_set} geometric_set geometric_set.elements[i] -> geometric_set_select geometric_set_select = point point => cartesian_point {cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘survey point’}
SITE	site	227	15	site <= [characterized_object] [property_definition]
address	representation	43	15	site <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation.name = ‘site address’}

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
coordinates	representation	43	15	site <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation.name = ‘site coordinates’}
elevation	representation	43	15	site <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation.name = ‘site elevation’}
environmental_references	document.id	41		site plant_spatial_configuration_document_item = site plant_spatial_configuration_document_item <- plant_spatial_configuration_document_reference.items[i] plant_spatial_configuration_document_reference <= document_reference document_reference.assigned_document -> document document.id

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
locality	representation	43	15	site <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation {representation.name = ‘site locality’}
name	characterized_object.description	41	15	site <= characterized_object characterized_object.description

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
orientation	(axis2_placement_2d) (axis2_placement_3d)	42 42	15	site <= characterized_object characterized_definition = characterized_object 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 representation_item.name = ‘site orientation’} representation_item => geometric_representation_item => {placement placement.location -> cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘site location’} placement => (axis2_placement_2d) (axis2_placement_3d)

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
owners	(person) (organization) (person_and_organization)	41 41 41		site (plant_spatial_configuration_person_item = site plant_spatial_configuration_person_item <- plant_spatial_configuration_person_assignment.items[i] plant_spatial_configuration_person_assignment <= person_assignment {person_assignment person_assignment.role -> person_role person_role.name = ‘owner’} person_assignment.assigned_person -> person) (plant_spatial_configuration_organization_item = site plant_spatial_configuration_organization_item <- plant_spatial_configuration_organization_assignment.items[i] plant_spatial_configuration_organization_assignment <= organization_assignment {organization_assignment organization_assignment.role -> organization_role organization_role.name = ‘owner’} organization_assignment.assigned_organization -> organization) (plant_spatial_configuration_person_and_organization_item = site plant_spatial_configuration_person_and_organization_item <- plant_spatial_configuration_person_and_organization_assignment.items[i] plant_spatial_configuration_person_and_organization_assignment <= 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)

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
site_id	characterized_object.name	41	15	site <= characterized_object characterized_object.name
site to building	PATH		15	site <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => site_building
site to changed_site	IDENTICAL MAPPING			
site to location_in_site	PATH		15	site <= characterized_object characterized_definition = characterized_object 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 => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)
site to site_feature	PATH		15	site <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition property_definition => site_feature

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
site to site_shape_-representation	PATH		15, 16	site <= characterized_object characterized_definition = characterized_object characterized_definition <- property_definition.definition {property_definition => product_definition_shape} property_definition property_definition.used_representation -> representation => shape_representation => site_representation
site to sited_plant	PATH			site <= property_definition property_definition.definition
SITE_FEATURE	site_feature	227		site_feature <= property_definition

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
location_and_orientation	[(axis2_placement_2d) (axis2_placement_3d)] [cartesian_point]	42 42 42		site_feature <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> {representation_item representation_item.name = ‘feature orientation’} representation_item => geometric_representation_item => [placement => (axis2_placement_2d) (axis2_placement_3d)] [placement placement.location -> cartesian_point {cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘feature location’}]
man_made_or_natural	descriptive_representation_item.- description	45		site_feature <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> {representation_item representation_item.name = ‘origin type’} representation_item => descriptive_representation_item descriptive_representation_item.description {(descriptive_representation_item.description = ‘man made’) (descriptive_representation_item.description = ‘natural’)}

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
shape	shape_representation	41	16	site_feature <= {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
site_feature_id	property_definition.name	41		site_feature <= property_definition property_definition.name
type	descriptive_representation_item.-description	45		site_feature <= property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation representation.items[i] -> {representation_item representation_item.name = ‘site feature type’} representation_item => descriptive_representation_item descriptive_representation_item.description
site_feature to changed_-site_feature	IDENTICAL MAPPING			
SITE_SHAPE_-REPRESENTATION	site_representation	227	16	site_representation <= shape_representation
site_shape_-representation_id	representation.name	43	16	site_representation <= shape_representation <= representation representation.name

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
site_shape_representation to breakline	PATH		16	site_representation <= shape_representation <= representation representation.items[i] -> representation_item => geometric_representation_item => {geometric_set => geometric_curve_set} geometric_set geometric_set.elements[i] -> geometric_set_select geometric_set_select = curve curve => bounded_curve => polyline
site_shape_representation to gis_position	PATH		16	site_representation <= shape_representation <= representation <- representation_map.mapped_representation representation_map <- mapped_item.mapping_source mapped_item <= representation_item <- representation.items[i] representation {representation representation.name = ‘gis position’}
SITED_PLANT	property_definition.definition	41		

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_site_location	cartesian_point	42	15	property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->representation representation.items[i] ->{[representation_item <- mapped_item.mapping_target mapped_item <= representation_item <- representation.items[i] representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition ->property_definition property_definition.definition ->characterized_definition characterized_definition = characterized_object characterized_object =>site] representation_item representation_item.name = ‘plant orientation’]} representation_item => geometric_representation_item => {placement => (axis2_placement_2d) (axis2_placement_3d)} placement placement.location ->cartesian_point {cartesian_point <= point <= geometric_representation_item <= representation_item

Table 11 - Mapping table for site_characterization UoF (continued)

Application element	AIM element	Source	Rules	Reference path
plant_site_orientation	(axis2_placement_2d) (axis2_placement_3d)	42 42	15	property_definition.definition property_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation ->representation representation.items[i] ->{[representation_item <- mapped_item.mapping_target mapped_item <= representation_item <- representation.items[i] representation <- property_definition_representation.used_representation property_definition_representation property_definition_representation.definition ->property_definition property_definition ->characterized_definition characterized_definition = characterized_object characterized_object =>site] [representation_item representation_item.name = ‘plant orientation’]} representation_item => geometric_representation_item => placement => (axis2_placement_2d) (axis2_placement_3d)
sited_plant to changed_-sited_plant	IDENTICAL MAPPING			

Table 11 - Mapping table for site_characterization UoF (concluded)

Application element	AIM element	Source	Rules	Reference path
SURVEY_POINT	cartesian_point	42		{cartesian_point <= point <= geometric_representation_item <= representation_item representation_item.name = ‘survey point’}

Table 12 - Mapping table for wireframe_geometry UoF

Application element	AIM element	Source	Rules	Reference path
CONIC	conic	42		
CURVE	curve	42		
FREE_FORM_CURVE	b_spline_curve	42		
LINE	line	42		
POINT	point	42		
POLYGON	polyline	42		
SURFACE	surface	42		
VECTOR	vector	42		
WIRE_AND_SURFACE_-ELEMENT	geometric_representation_item	42		

The following rules are referenced in the preceding tables:

1) application_context_requires_ap_definition
2) approval_requires_approval_date_time
3) approval_requires_approval_person_organization
4) change_action_requires_date
5) change_item_requires_creation_date
6) change_item_requires_id
7) change_life_cycle_stage_usage_requires_approval
8) change_life_cycle_stage_usage_requires_stage
9) dependent_instantiable_application_context
10) dependent_instantiable_product_context
11) dependent_instantiable_product_definition_context
12) product_context_discipline_type_constraint
13) product_definition_context_name_constraint
14) product_definition_usage_constraint
15) subtype_exclusive_characterized_object
16) subtype_exclusive_shape_representation
17) subtype_mandatory_externally_defined_item
18) subtype_mandatory_pre_defined_item
19) versioned_action_request_requires_change_action

5.2 AIM EXPRESS short listing

This clause specifies the EXPRESS schema that uses elements from the integrated resources 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. 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 such items and subtypes apply exclusively to those items which are imported into the AIM.

EXPRESS specification:

```
*)
SCHEMA plant_spatial_configuration;

USE FROM action_schema
  (action_directive,
   action_method_relationship,
   action_relationship,
   action_request_solution,
   action_request_status,
   action_status,
   directed_action,
   versioned_action_request);

USE FROM application_context_schema
  (application_context,
   application_protocol_definition,
   product_context,
   product_definition_context);
```

```
USE FROM approval_schema
  (approval,
   approval_date_time,
   approval_person_organization);

USE FROM date_time_schema
  (calendar_date,
   date_and_time);

USE FROM document_schema
  (document,
   document_relationship,
   document_usage_constraint);

USE FROM external_reference_schema
  (external_source,
   externally_defined_item,
   pre_defined_item);

USE FROM geometric_model_schema
  (block,
   boolean_operator,
   boolean_operand,
   boolean_result,
   brep_with_voids,
   csg_solid,
   extruded_area_solid,
   extruded_face_solid,
   faceted_brep,
   geometric_curve_set,
   geometric_set,
   geometric_set_replica,
   manifold_solid_brep,
   revolved_area_solid,
   revolved_face_solid,
   right_circular_cone,
   right_circular_cylinder,
   shell_based_wireframe_model,
   solid_model,
   sphere,
   swept_face_solid,
   swept_area_solid,
   torus);

USE FROM geometry_schema
  (axis2_placement_2d,
   axis2_placement_3d,
   b_spline_curve,
   b_spline_curve_with_knots,
   b_spline_surface,
   b_spline_surface_with_knots,
   bezier_curve,
   bezier_surface,
   boundary_curve,
   bounded_curve,
   bounded_pcurve,
   bounded_surface,
   bounded_surface_curve,
   cartesian_point,
   circle,
   composite_curve,
   composite_curve_on_surface,
   composite_curve_segment,
   conic,
```

```
   conical_surface,
   curve_bounded_surface,
   curve_replica,
   cylindrical_surface,
   degenerate_pcurve,
   degenerate_toroidal_surface,
   direction,
   elementary_surface,
   ellipse,
   evaluated_degenerate_pcurve,
   geometric_representation_context,
   geometric_representation_item,
   hyperbola,
   intersection_curve,
   line,
   offset_curve_2d,
   offset_curve_3d,
   offset_surface,
   parabola,
   pcurve,
   plane,
   point,
   point_on_curve,
   point_on_surface,
   point_replica,
   polyline,
   quasi_uniform_curve,
   quasi_uniform_surface,
   rational_b_spline_curve,
   rational_b_spline_surface,
   reparametrised_composite_curve_segment,
   rectangular_composite_surface,
   rectangular_trimmed_surface,
   seam_curve,
   spherical_surface,
   surface_curve,
   surface_of_linear_extrusion,
   surface_of_revolution,
   surface_patch,
   surface_replica,
   swept_surface,
   toroidal_surface,
   trimmed_curve,
   uniform_curve,
   uniform_surface);

USE FROM group_schema
  (group);

USE FROM management_resources_schema
  (action_assignment,
   action_request_assignment,
   approval_assignment,
   date_and_time_assignment,
   date_assignment,
   document_reference,
   group_assignment,
   name_assignment,
   organization_assignment,
   person_and_organization_assignment,
   person_assignment);

USE FROM material_property_definition_schema
  (characterized_material_property,
```

```
   material_designation,
   material_designation_characterization,
   material_property,
   product_material_composition_relationship,
   property_definition_relationship);

USE FROM material_property_representation_schema
  (material_property_representation);

USE FROM measure_schema
  (amount_of_substance_measure,
   amount_of_substance_measure_with_unit,
   amount_of_substance_unit,
   area_measure,
   area_measure_with_unit,
   area_unit,
   context_dependent_measure,
   context_dependent_unit,
   conversion_based_unit,
   count_measure,
   derived_unit,
   electric_current_measure_with_unit,
   electric_current_unit,
   global_unit_assigned_context,
   length_measure,
   length_measure_with_unit,
   length_unit,
   mass_measure,
   mass_measure_with_unit,
   mass_unit,
   named_unit,
   numeric_measure,
   parameter_value,
   plane_angle_measure_with_unit,
   plane_angle_unit,
   positive_length_measure,
   positive_plane_angle_measure,
   positive_ratio_measure,
   ratio_measure,
   ratio_measure_with_unit,
   ratio_unit,
   si_unit,
   solid_angle_measure,
   solid_angle_measure_with_unit,
   solid_angle_unit,
   thermodynamic_temperature_measure,
   thermodynamic_temperature_measure_with_unit,
   thermodynamic_temperature_unit,
   time_measure,
   time_measure_with_unit,
   time_unit,
   volume_measure,
   volume_measure_with_unit,
   volume_unit);

USE FROM qualified_measure_schema
  (descriptive_representation_item,
   measure_representation_item,
   qualified_representation_item,
   type_qualifier);

USE FROM person_organization_schema
  (organization,
   organizational_project);
```

```
USE FROM presentation_organization_schema
  (presentation_layer_assignment);

USE FROM presentation_resource_schema
  (colour,
   colour_rgb);

USE FROM product_definition_schema
  (product,
   product_category,
   product_category_relationship,
   product_definition,
   product_definition_formation,
   product_definition_formation_relationship,
   product_definition_formation_with_specified_source,
   product_definition_relationship,
   product_definition_substitute,
   product_definition_with_associated_documents,
   product_related_product_category);

USE FROM product_property_definition_schema
  (characterized_object,
   product_definition_shape,
   property_definition,
   shape_aspect,
   shape_aspect_relationship);

USE FROM product_property_representation_schema
  (property_definition_representation,
   shape_definition_representation,
   shape_representation);

USE FROM product_structure_schema
  (assembly_component_usage,
   make_from_usage_option,
   product_definition_usage);

USE FROM representation_schema
  (mapped_item,
   representation,
   representation_context,
   representation_item);

USE FROM shape_aspect_definition_schema
  (centre_of_symmetry,
   derived_shape_aspect);

USE FROM shape_dimension_schema
  (angular_location,
   dimensional_characteristic_representation,
   dimensional_location,
   dimensional_size,
   shape_dimension_representation);

USE FROM topology_schema
  (connected_face_set,
   edge,
   edge_curve,
   edge_loop,
   face,
   face_bound,
   face_surface,
   loop,
   oriented_closed_shell,
```

```
   oriented_edge,
   oriented_open_shell,
   path,
   poly_loop,
   topological_representation_item);
(*
```

Note – The schemas referenced above can be found in the following parts of ISO 10303:

action_schema	ISO 10303-41
application_context_schema	ISO 10303-41
approval_schema	ISO 10303-41
date_time_schema	ISO 10303-41
document_schema	ISO 10303-41
external_reference_schema	ISO 10303-41
geometric_model_schema	ISO 10303-42
geometry_schema	ISO 10303-42
group_schema	ISO 10303-41
management_resources_schema	ISO 10303-41
material_property_definition_schema	ISO 10303-45
measure_schema	ISO 10303-41
person_organization_schema	ISO 10303-41
presentation_organization_schema	ISO 10303-46
presentation_resource_schema	ISO 10303-46
product_definition_schema	ISO 10303-41
product_property_definition_schema	ISO 10303-41
product_property_representation_schema	ISO 10303-41
product_structure_schema	ISO 10303-44
qualified_measure_schema	ISO 10303-45
representation_schema	ISO 10303-43
shape_aspect_definition_schema	ISO 10303-47
shape_dimension_schema	ISO 10303-47
topology_schema	ISO 10303-42

5.2.1 Fundamental concepts and assumptions

For a given item, non-shape properties are handled through a **property_definition**. All non-shape properties are grouped together and evaluated by a function for consistency. Shape properties are dealt with as a subtype and evaluated separately using **shape_definition**.

Any identifier is used to differentiate between instances of an entity with respect to a scope of use or implementation of the identifier. If used in data exchange, the value of the identifier shall be unique within the exchange file and, additionally, may be unique between the partners in the exchange.

EXAMPLE 72 - **Representation_context.context_identifier** may be any user-defined identifier that is used to differentiate contexts. REPCXT1, for example, may identify a **representation_context**.

Any type is used to specify the intent of the instance.

EXAMPLE 73 - **Representation_context.context_type** may be ‘parametric’ if the geometry of a part is represented parametrically.

Units for a particular dimension specified in this part of ISO 10303 must be either globally specified or individually specified for each dimensional value. Different kinds dimensions (e.g., length versus weight), however, may be either specified global or locally.

Connectors are **shape_aspect**s of the plant items that they belong to because they cannot exist independently. Connections are, therefore, a **shape_aspect_relationship**. Connections are also a **shape_aspect** of the assembly that contains the connection, so connections are also **shape_aspect**s.

5.2.2 Plant spatial configuration type definitions

5.2.2.1 approval_item

An **approval_item** identifies a **change_action** or **versioned_action_request** that is assigned an approval status.

EXPRESS specification:

```
*)
TYPE approval_item = SELECT
  (change_action,
   versioned_action_request);
END_TYPE;
(*
```

5.2.2.2 change_delta_item

A **change_delta_item** identifies the **assembly_component_usage**, **axis2_placement_2d**, **axis2_-placement_3d**, **line_branch_connection**, **line_plant_item_branch_connection**, **line_plant_item_-connection**, **line_termination_connection**, **plant**, **product,** or **product_definition_relationship** that is the association between two **change_item**s.

EXPRESS specification:

```
*)
TYPE change_delta_item = SELECT
  (assembly_component_usage,
   axis2_placement_2d,
   axis2_placement_3d,
   line_branch_connection,
   line_plant_item_branch_connection,
   line_plant_item_connection,
   line_termination_connection,
   plant,
   product,
   product_definition_relationship);
END_TYPE;
(*
```

5.2.2.3 change_item

A **change_item** identifies the **change_delta_item**, **document**, **ducting_system**, **electrical_system**, **externally_defined_plant_item_definition**, **instrumentation_and_control_system**, **piping_system**, **plant_item_connection**, **plant_item_connector**, **plant_line_definition**, **plant_line_segment_-**

definition, **plant_line_segment_termination**, **process_capability**, **product_definition**, **product_-definition_shape**, **property_definition**, **reference_geometry**, **site**, **site_feature**, or **structural_system** that can be modified, for which there is a request to modify, or that is the result of a change.

EXPRESS specification:

```
*)
TYPE change_item = SELECT
  (change_delta_item,
   document,
   ducting_system,
   electrical_system,
   externally_defined_plant_item_definition,
   instrumentation_and_control_system,
   piping_system,
   plant_item_connection,
   plant_item_connector,
   plant_line_definition,
   plant_line_segment_definition,
   plant_line_segment_termination,
   process_capability,
   product_definition,
   product_definition_shape,
   property_definition,
   reference_geometry,
   site,
   site_feature,
   structural_system);
END_TYPE;
(*
```

5.2.2.4 classification_item

A **classification_item** identifies the **ducting_system**, **electrical_system**, **instrumentation_and_-control_system**, **piping_component_definition**, **piping_system**, **plant_item_connection**, **plant_-item_connector**, **plant_spatial_configuration_document_reference**, **product**, **product_definition**, or **structural_system** that is classified.

EXPRESS specification:

```
*)
TYPE classification_item = SELECT
   (ducting_system,
   electrical_system,
   instrumentation_and_control_system,
   piping_component_definition,
   piping_system,
   plant_item_connection,
   plant_item_connector,
   plant_spatial_configuration_document_reference,
   product,
   product_definition,
   structural_system);
END_TYPE;
(*
```

5.2.2.5 design_project_item

A **design_project_item** identifies the **product_definition** that is assigned to a **design_project**.

EXPRESS specification:

```
*)
TYPE design_project_item = SELECT
  (product_definition);
END_TYPE;
(*
```

5.2.2.6 plant_spatial_configuration_action_request_item

A **plant_spatial_configuration_action_request_item** identifies the **product** that is assigned to an **action_request**, indicating a request for purchase.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_action_request_item = SELECT
  (product);
END_TYPE;
(*
```

5.2.2.7 plant_spatial_configuration_date_and_time_item

A **plant_spatial_configuration_date_and_time_item** identifies the **product** that a **date_and_time** is assigned to.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_date_and_time_item = SELECT
  (product);
END_TYPE;
(*
```

5.2.2.8 plant_spatial_configuration_dated_item

A **plant_spatial_configuration_dated_item** identifies the **action_directive**, **change_action**, **change_-item**, or **product** that a **date** is assigned to.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_dated_item = SELECT
  (action_directive,
   change_action,
   change_item,
   product);
END_TYPE;
(*
```

5.2.2.9 plant_spatial_configuration_document_item

A **plant_spatial_configuration_document_item** identifies the **heat_tracing_representation**, **piping_-component_class**, **piping_system**, **plant_item_connector**, **plant_line_segment_definition**, **product**, **product_definition**, **product_definition_relationship**, **property_definition**, **representation**, **representation_item**, or **site** that is associated with a **document**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_document_item = SELECT
  (heat_tracing_representation,
   piping_component_class,
   piping_system,
   plant_item_connector,
   plant_line_segment_definition,
   product,
   product_definition,
   product_definition_relationship,
   property_definition,
   representation,
   representation_item,
   site);
END_TYPE;
(*
```

5.2.2.10 plant_spatial_configuration_organization_item

A **plant_spatial_configuration_organization_item** identifies the **catalogue**, **change_action**, **design_-project**, **document**, **plant**, **product_definition_formation**, **product_definition_relationship** or **site** that is associated with an **organization**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_organization_item = SELECT
  (catalogue,
   change_action,
   design_project,
   document,
   plant,
   product_definition_formation,
   product_definition_relationship,
   site);
END_TYPE;
(*
```

5.2.2.11 plant_spatial_configuration_person_item

A **plant_spatial_configuration_person_item** identifies the **document**, **plant**, **product_definition_-relationship**, or **site** that is associated with a **person**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_person_item = SELECT
```

```
  (document,
   plant,
   product_definition_relationship,
   site);
END_TYPE;
(*
```

5.2.2.12 plant_spatial_configuration_person_and_organization_item

A **plant_spatial_configuration_person_and_organization_item** identifies the **change_item**, **plant**, or **site** that is associated with a **person_and_organization**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_person_and_organization_item = SELECT
  (change_item,
   plant,
   site);
END_TYPE;
(*
```

5.2.2.13 purchase_item

A **purchase_item** identifies a **product** that is purchased.

EXPRESS specification:

```
*)
TYPE purchase_item = SELECT
  (product);
END_TYPE;
(*
```

5.2.3 Plant spatial configuration entities

5.2.3.1 Plant spatial configuration entity definitions

5.2.3.1.1 advanced_csg_shape_representation

An **advanced_csg_shape_representation** is a **shape_representation** that is composed of CSG primitives and boolean operators.

EXPRESS specification:

```
*)
ENTITY advanced_csg_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (item <* SELF.items |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF (item)) = 1)))
```

```
      = 0;
  WR2: SIZEOF (QUERY (item <* SELF.items |
       SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF (item))
       = 1)) >= 1;
  WR3: SIZEOF (QUERY (item <* SELF.items |
       ('PLANT_SPATIAL_CONFIGURATION.CSG_SOLID' IN TYPEOF (item)) AND
       (NOT (valid_advanced_csg_tree
               (item\csg_solid.tree_root_expression))))) = 0;
  WR4: SIZEOF (QUERY (mi <* QUERY (item <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF (item)) |
       NOT ('PLANT_SPATIAL_CONFIGURATION.' +
       'ADVANCED_CSG_SHAPE_REPRESENTATION' IN
       TYPEOF (mi\mapped_item.mapping_source.mapped_representation)))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: Each item of an **advanced_csg_shape_representation** shall be a **csg_solid**, **extruded_area_solid**, **revolved_area_solid**, **axis2_placement_3d**, or **mapped_item**.

WR2: An **advanced_csg_shape_representation** shall have at least one **representation_item** instance in its set of **items** that is of type **csg_solid**, **extruded_area_solid**, **revolved_area_solid**, or **mapped_item**.

WR3: An **advanced_csg_shape_representation** shall be comprised of the proper CSG tree elements.

WR4: For each **mapped_item** in an **advanced_csg_shape_representation**, the source of the **mapped_item** shall be an **advanced_csg_shape_representation**.

5.2.3.1.2 blank_fitting_classification

A **blank_fitting_classification** is a type of **group** that classifies the items that are assigned to it as blank fittings.

EXPRESS specification:

```
*)
ENTITY blank_fitting_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
```

```
        TYPEOF (it)) |
        NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
        category_in_tree (prpc, 'blank'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **blank_fitting_classification** shall classify items of type **piping_component_definition**.

WR2: A **blank_fitting_classification** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'blank'.

5.2.3.1.3 catalogue

A **catalogue** is a **document** defined as an **external_source** that records items whose characteristics are standardized.

NOTE - Whether the catalogue is a paper-based or digitally-based catalogue is indicated by the value of the attribute **document_type.product_data_type**. **document_type** is referenced the attribute **kind** inherited from **document**, a supertype of **catalogue**.

EXPRESS specification:

```
*)
ENTITY catalogue
  SUBTYPE OF (document, external_source);
END_ENTITY;
(*
```

5.2.3.1.4 catalogue_connector

A **catalogue_connector** is a **shape_aspect** that is externally defined and identifies a connector whose characteristics are standardised in a library or catalogue.

EXPRESS specification:

```
*)
ENTITY catalogue_connector
  SUBTYPE OF (shape_aspect, externally_defined_item);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_OBJECT' IN
       TYPEOF (SELF.of_shape);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF (SELF.source);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **catalogue_connector** shall be an aspect of the shape of a **characterized_object**.

WR2: The **catalogue_connector** shall have a **catalogue** as its source.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **catalogue_connector** entity:

- subtype_mandatory_externally_defined_item (see 5.2.4.17).

5.2.3.1.5 catalogue_item

A **catalogue_item** is an **externally_defined_plant_item_definition** that identifies an item whose characteristics are standardized and have been recorded in a library or catalogue.

EXPRESS specification:

```
*)
ENTITY catalogue_item
  SUBTYPE OF (externally_defined_plant_item_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF (SELF.source);
  WR2: SELF.frame_of_reference.name = 'catalogue definition';
END_ENTITY;
(*
```

Formal propositions:

WR1: A **catalogue_item** shall have a **catalogue** as the **external_source**.

WR2: A **catalogue_item** shall have a **frame_of_reference name** of 'catalogue definition'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **catalogue_item** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13);

- subtype_mandatory_externally_defined_item (see 5.2.4.17).

5.2.3.1.6 change_action

A **change_action** is a type of **directed_action** that identifies a change, or a request for a change.

EXPRESS specification:

```
*)
ENTITY change_action
  SUBTYPE OF (directed_action);
WHERE
```

```
  WR1: SIZEOF (QUERY (ca <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'ACTION_ASSIGNMENT.ASSIGNED_ACTION') |
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT' IN
       TYPEOF (ca))) >= 1;
  WR2: SIZEOF (QUERY (ar <* SELF\directed_action.directive.requests |
       NOT (SIZEOF (USEDIN (ar, 'PLANT_SPATIAL_CONFIGURATION.' +
       'ACTION_REQUEST_SOLUTION.SOLUTION')) = 1))) = 0;
  WR3: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.ACTION_STATUS.' +
       'ASSIGNED_ACTION')) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **change_action** shall be assigned by at least one **plant_spatial_configuration_change_-assignment**.

WR2: Each **versioned_action_request** that is referenced by a **change_action** shall have exactly one **action_request_solution**.

WR3: Each **change_action** shall be assigned exactly one **action_status**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **change_action** entity:

- change_action_requires_date (see 5.2.4.4);

- versioned_action_request_requires_change_action (see 5.2.4.19).

5.2.3.1.7 change_from_assignment

A **change_from_assignment** assigns a **change_action** to a set of one or more **change_delta_item**s.

EXPRESS specification:

```
*)
ENTITY change_from_assignment
  SUBTYPE OF (action_assignment);
  items : SET [1:?] OF change_delta_item;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CHANGE_ACTION'
       IN TYPEOF (SELF.assigned_action);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **change_delta_item**s that an action is assigned to.

Formal propositions:

WR1: The assigned action shall be a **change_action**.

5.2.3.1.8 change_item_id_assignment

A **change_item_id_assignment** assigns a name to a set of one or more **change_item**s.

EXPRESS specification:

```
*)
ENTITY change_item_id_assignment
  SUBTYPE OF (name_assignment);
  items : SET [1:?] OF change_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **change_item**s that a name is assigned to.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **change_item_id_-assignment** entity:

- change_item_requires_id (see 5.2.4.6).

5.2.3.1.9 change_to_assignment

A **change_to_assignment** assigns a **change_action** to a set of one or more **change_delta_item**s.

EXPRESS specification:

```
*)
ENTITY change_to_assignment
  SUBTYPE OF (action_assignment);
  items : SET [1:?] OF change_delta_item;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CHANGE_ACTION'
       IN TYPEOF (SELF.assigned_action);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **change_delta_item**s that an action is assigned to.

Formal propositions:

WR1: The assigned action shall be a **change_action**.

5.2.3.1.10 classification_assignment

A **classification_assignment** assigns a classification to a **ducting_system**, **electrical_system**, **instrumentation_and_control_system**, **piping_component_definition**, **piping_system**, **plant_item_-connection**, **plant_item_connector**, **plant_spatial_configuration_document_reference**, **product**, **product_definition**, or **structural_system**.

EXPRESS specification:

```
*)
ENTITY classification_assignment
  SUBTYPE OF (group_assignment);
  items : SET [1:?] OF classification_item;
WHERE
  WR1: (NOT (SIZEOF (QUERY (item <* SELF.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
       TYPEOF(item)))) = 0)) OR
       (SIZEOF (TYPEOF (SELF.assigned_group) *
       ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_FUNCTIONAL_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.CONNECTION_MOTION_CLASSIFICATION'])
       >= 1);
  WR2: (NOT (SIZEOF (QUERY (item <* SELF.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
       TYPEOF(item)))) = 0)) OR
       (SIZEOF (TYPEOF (SELF.assigned_group) *
       ['PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_CONNECTOR_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'STRUCTURAL_LOAD_CONNECTOR_CLASSIFICATION']) >= 1);
  WR3: (NOT (SIZEOF (QUERY (item <* SELF.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF(item)))) = 0)) OR
       (SIZEOF (TYPEOF (SELF.assigned_group) *
       ['PLANT_SPATIAL_CONFIGURATION.BLANK_FITTING_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.ELBOW_FITTING_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.FLANGE_FITTING_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'FLANGE_FITTING_NECK_TYPE_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.PIPE_CLOSURE_FITTING_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.PIPE_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.REDUCER_FITTING_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.SPACER_FITTING_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.SPECIALTY_ITEM_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.SWAGE_FITTING_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.VALVE_CLASSIFICATION']) >= 1);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **ducting_system**, **electrical_system**, **instrumentation_and_control_system**, **piping_-component_definition**, **piping_system**, **plant_item_connection**, **plant_item_connector**, **plant_spatial_configuration_document_reference**, **product**, **product_definition**, or **structural_-system** that are assigned to a **group**.

Formal propositions:

WR1: A **plant_item_connection** shall be assigned either a **connection_functional_classification**, a **connection_motion_classification**, or a combination of these.

WR2: A **plant_item_connector** shall be assigned either a **connector_end_type_classification, electrical_connector_classification**, **piping_connector_classification**, **structural_load_connector_-classification**, or a combination of these.

WR3: A **piping_component_definition** shall be assigned either a **blank_fitting_classification**, **elbow_fitting_classification**, **flange_fitting_classification**, **flange_fitting_neck_type_classification**, **pipe_closure_fitting_classification**, **pipe_classification**, **reducer_fitting_classification**, **spacer_-fitting_classification**, **specialty_item_classification**, **swage_fitting_classification**, **valve_classification**, or a combination of these.

5.2.3.1.11 connection_functional_classification

A **connection_functional_classification** is a **group** that classifies items that are assigned to it as belonging to a common functional classification of connections.

EXPRESS specification:

```
*)
ENTITY connection_functional_classification
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.12 connection_motion_classification

A **connection_motion_classification** is a type of **group** that classifies the connection motion of the items that are assigned to it.

EXPRESS specification:

```
*)
ENTITY connection_motion_classification
  SUBTYPE OF (group);
WHERE
  WR1: SELF.name IN ['flexible', 'locked orientation'];
END_ENTITY;
(*
```

Formal propositions:

WR1: The name of the **connection_motion_classification** shall be ‘flexible’ or ‘locked orientation’.

5.2.3.1.13 connection_node

A **connection_node** is a type of **shape_aspect** that is part of the definition of a piping system, and connects more than one **line_termination_connection**s.

EXPRESS specification:

```
*)
ENTITY connection_node
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM'
       IN TYPEOF (SELF.of_shape.definition);
  WR2: SIZEOF (QUERY (sar <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT_RELATIONSHIP.' +
       'RELATING_SHAPE_ASPECT') |
       'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION' IN
       TYPEOF (sar))) >= 2;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **connection_node** shall be an aspect of the definition of the shape of a **piping_system**.

WR2: A **connection_node** shall be the **relating_shape_aspect** for at least two **line_termination_-connection**s.

5.2.3.1.14 connector_end_type_classification

A **connector_end_type_classification** is a type of **group** that classifies the end type of the connectors that are assigned to it.

EXPRESS specification:

```
*)
ENTITY connector_end_type_classification
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.15 descriptive_colour

A **descriptive_colour** is a type of **descriptive_representation_item** that identifies a colour.

EXPRESS specification:

```
*)
ENTITY descriptive_colour
  SUBTYPE OF (colour, descriptive_representation_item);
END_ENTITY;
(*
```

5.2.3.1.16 design_project

A **design_project** is a type of **organization** that identifies a task with a defined scope and purpose.

EXPRESS specification:

```
*)
ENTITY design_project
  SUBTYPE OF (organization);
WHERE
  WR1: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'ORGANIZATION_ASSIGNMENT.ASSIGNED_ORGANIZATION')) >= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: Each **design_project** shall be assigned to product data by at least one **organization_-assignment**.

5.2.3.1.17 design_project_assignment

A **design_project_assignment** assigns a **product_definition** to a **design_project**.

EXPRESS specification:

```
*)
ENTITY design_project_assignment
  SUBTYPE OF (organization_assignment);
  items : SET [1:?] OF design_project_item;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT' IN
       TYPEOF (SELF.assigned_organization);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **product_definition**s that are assigned to a **design_project**.

Formal propositions:

WR1: The **organization** that is assigned by a **design_project_assignment** shall be a **design_project**.

5.2.3.1.18 ducting_system

A **ducting_system** is a type of **product_definition** that identifies a system that controls the temperature, humidity, cleanliness, and circulation of environmental air.

EXPRESS specification:

```
*)
ENTITY ducting_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
```

```
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **ducting_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of 'functional occurrence'.

5.2.3.1.19 elbow_fitting_classification

An **elbow_fitting_classification** is a type of **group** that classifies the items that are assigned to it as elbow fittings. The **name** of the **elbow_fitting_classification** further classifies the assigned items.

EXPRESS specification:

```
*)
ENTITY elbow_fitting_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
       category_in_tree (prpc, 'elbow'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: An **elbow_fitting_classification** shall classify items of type **piping_component_definition**.

WR2: An **elbow_fitting_classification** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'elbow'.

5.2.3.1.20 electrical_connector_classification

An **electrical_connector_classification** is a type of **group** that classifies the items that are assigned to it as being electrical connectors. The **name** of the **electrical_connector_classification** further classifies the assigned items.

EXPRESS specification:

```
*)
ENTITY electrical_connector_classification
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.21 electrical_system

An **electrical_system** is a type of **product_definition** that identifies a system of wiring, switches, relays and other equipment associated with receiving and distributing electrical power.

EXPRESS specification:

```
*)
ENTITY electrical_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **electrical_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of 'functional occurrence'.

5.2.3.1.22 externally_defined_classification

An **externally_defined_classification** is a **group** that classifies an item and is defined by reference to an external source.

> NOTE - An external source may be a ISO 13584 classification table [13]. This standard would be specified as a **known_source** (see 5.2.3.1.31) and referenced with **externally_defined_item.source**.

EXPRESS specification:

```
*)
ENTITY externally_defined_classification
  SUBTYPE OF (group, externally_defined_item);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ((SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM',
```

```
        'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
        'PLANT_SPATIAL_CONFIGURATION.PLANT',
        'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
        'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION',
        'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1) OR
        (('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' |
        IN TYPEOF (it)) AND
        (SIZEOF (QUERY (pc <*
        it.formation.of_product.frame_of_reference |
        pc.discipline_type = 'process plant')) = 1))))) = 0))) = 0;
END_ENTITY;
(*
```

Formal proposition:

WR1: An **externally_defined_classification** shall classify either an **electrical_system**, **ducting_-system**, **instrumentation_and_control_system**, **piping_system, plant**, **plant_item_connector**, **piping_component_definition**, **structural_system**, or **product_definition** that is the definition of a plant item.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **externally_defined_-classification** entity:

- subtype_mandatory_externally_defined_item (see 5.2.4.17);

- subtype_mandatory_pre_defined_item (see 5.2.4.18).

5.2.3.1.23 externally_defined_plant_item_definition

An **externally_defined_plant_item_definition** is a **product_definition** that identifies an item or piece of equipment that may be used as a component of a plant and is defined by reference to an external source.

NOTE - An external source may be a ISO 13584 library [13]. This standard would be specifed as a **known_source** (see 5.2.3.1.31) and referenced with **externally_defined_item.source**.

EXPRESS specification:

```
*)
ENTITY externally_defined_plant_item_definition
  SUBTYPE OF (product_definition, externally_defined_item);
END_ENTITY;
(*
```

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **externally_defined_plant_-item_definition** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_context (see 5.2.4.10);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_context_discipline_type_constraint (see 5.2.4.12);

- product_definition_context_name_constraint (see 5.2.4.13);

- subtype_mandatory_externally_defined_item (see 5.2.4.17);

- subtype_mandatory_pre_defined_item (see 5.2.4.18).

5.2.3.1.24 flange_fitting_classification

A **flange_fitting_classification** is a type of **group** that classifies the items that are assigned to it as flange fittings.

EXPRESS specification:

```
*)
ENTITY flange_fitting_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
       category_in_tree (prpc, 'flange'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **flange_fitting_classification** shall classify items of type **piping_component_definition**.

WR2: A **flange_fitting_classification** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'flange'.

5.2.3.1.25 flange_fitting_neck_type_classification

A **flange_fitting_neck_type_classification** is a type of **group** that classifies the neck type of the flange fittings items that are assigned to it.

EXPRESS specification:

```
*)
ENTITY flange_fitting_neck_type_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
       category_in_tree (prpc, 'flange'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **flange_fitting_neck_type_classification** shall classify items of type **piping_component_-definition**.

WR2: A **flange_fitting_neck_type_classification** shall classify items of type **piping_component_-definition** that are a definition of a **product** that is categorized as a 'flange'.

5.2.3.1.26 heat_tracing_representation

A **heat_tracing_representation** is a **representation** that represents the means utilized to impart a temperature increase by an external wrapping or coiling.

EXPRESS specification:

```
*)
ENTITY heat_tracing_representation
  SUBTYPE OF (representation);
END_ENTITY;
(*
```

5.2.3.1.27 hybrid_shape_representation

A **hybrid_shape_representation** is a type of **shape_representation** that is composed of CSG primitives, boolean operators, manifold solid boundary representation solids, shell based wireframe models, and curves.

EXPRESS specification:

```
*)
ENTITY hybrid_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
WR1: SIZEOF (QUERY (i <* SELF\representation.items |
     NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT',
     'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
     'PLANT_SPATIAL_CONFIGURATION.TRUNCATED_PYRAMID',
     'PLANT_SPATIAL_CONFIGURATION.BLOCK',
     'PLANT_SPATIAL_CONFIGURATION.TORUS',
     'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
     'PLANT_SPATIAL_CONFIGURATION.SPHERE',
     'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
     'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
     'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
     'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
     'PLANT_SPATIAL_CONFIGURATION.MANIFOLD_SOLID_BREP',
     'PLANT_SPATIAL_CONFIGURATION.SHELL_BASED_WIREFRAME_MODEL',
     'PLANT_SPATIAL_CONFIGURATION.CONIC',
     'PLANT_SPATIAL_CONFIGURATION.CURVE',
     'PLANT_SPATIAL_CONFIGURATION.B_SPLINE_CURVE',
     'PLANT_SPATIAL_CONFIGURATION.LINE',
     'PLANT_SPATIAL_CONFIGURATION.POINT',
     'PLANT_SPATIAL_CONFIGURATION.POLYLINE',
     'PLANT_SPATIAL_CONFIGURATION.SURFACE',
     'PLANT_SPATIAL_CONFIGURATION.VECTOR',
     'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
     'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] *
      TYPEOF(i)) = 1))) = 0;
  WR2: SIZEOF (QUERY (mi <* QUERY (item <* SELF\representation.items |
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF(item)) |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.' +
       'ADVANCED_CSG_SHAPE_REPRESENTATION',
       'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION'] *
       TYPEOF(mi\mapped_item.mapping_source.mapped_representation))
       = 1))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **hybrid_shape_representation** shall contain **representation_item**s that are of type **boolean_-result**, **csg_solid**, **truncated_pyramid**, **block**, **torus**, **right_circular_cylinder**, **sphere**, **right_-**

circular_cone, **extruded_area_solid**, **revolved_area_solid**, **shell_based_wireframe_model**, **manifold_solid_brep**, **conic**, **curve**, **b_spline_curve**, **line**, **point**, **polyline**, **surface**, **vector**, **axis2_-placement_3d**, **measure_representation_item**, or **mapped_item**.

WR2: If there is a **mapped_item** in a **hybrid_shape_representation**, the source of the **mapped_item** shall be an **advanced_csg_shape_representation** or a **hybrid_shape_representation**.

5.2.3.1.28 inline_equipment

An **inline_equipment** is a type of **piping_component_definition** that identifies an item that is inserted into the flow of a process stream.

EXPRESS specification:

```
*)
ENTITY inline_equipment
  SUBTYPE OF (piping_component_definition);
END_ENTITY;
(*
```

5.2.3.1.29 instrumentation_and_control_system

An **instrumentation_and_control_system** is a type of **product_definition** that identifies a system of wiring, switches, controls, and other equipment associated with monitoring and controlling performance characteristics.

EXPRESS specification:

```
*)
ENTITY instrumentation_and_control_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **instrumentation_and_control_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of 'functional occurrence'.

5.2.3.1.30 interfering_shape_element

An **interfering_shape_element** identifies a portion of the shape of an item that interferes with the shape of another item.

EXPRESS specification:

```
*)
ENTITY interfering_shape_element
  SUBTYPE OF (shape_aspect, shape_aspect_relationship);
END_ENTITY;
(*
```

5.2.3.1.31 known_source

A **known_source** is a type of **external_source** whose identification is standardized for all implementations of this part of ISO 10303. The purpose of the **known_source** entity data type is to identify particular sources of data that are used within the scope of this part of ISO 10303, and to associate specific data formats with such identification. The following known sources of data are identified in this part of ISO 10303:

- ISO 13584 Dictionaries, conforming to the requirements of ISO 13584-42. In this Part of ISO 10303, such Dictionaries are used to hold values of **name**s for **externally_defined_-classification**s;

- ISO 13584 Parts Libraries, conforming to the requirements of ISO 13584-24. In this Part of ISO 10303, such Parts Libraries are used to hold collections of **catalogue_connector** and **externally_defined_plant_item_definition**;

EXPRESS specification:

```
*)
ENTITY known_source
SUBTYPE OF (external_source, pre_defined_item);
WHERE
  WR1: SELF\pre_defined_item.name IN
       ['ISO 13584 Dictionary','ISO 13584 Parts Library'];
END_ENTITY;
(*
```

Formal propositions:

WR1: The **name** of the **known_source** inherited from the **pre_defined_item** shall be 'ISO 13584 Dictionary', or 'ISO 13584 Parts Library'.

Attribute value definitions:

The **known_source** shall be used as follows, based on the standard values of the name attribute.

ISO 13584 Dictionary: the **known_source** shall be a dictionary as defined in ISO 13584-42. The string value given as the **item_id** of an **externally_defined_item** that references this **known_source** shall
conform to the requirements for a Class_BSU as defined in ISO 13584-42.

ISO 13584 Parts Library: the **known_source** shall be a parts library as defined in ISO 13584-42. The string value given as the **item_id** of an **externally_defined_item** that references this **known_-source** shall conform to the requirements for a BSU as defined in ISO 13584-42.

5.2.3.1.32 line_branch_connection

A **line_branch_connection** is a type of **shape_aspect_relationship** that identifies the connection between a line and a branch.

EXPRESS specification:

```
*)
ENTITY line_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SELF.description = 'branch location';
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
       IN TYPEOF (SELF.relating_shape_aspect.of_shape.definition);
  WR3: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
(*
```

Formal propositions:

WR1: The value of **line_branch_connection.description** shall be 'branch location'.

WR2: The **product_definition** that the **relating_shape_aspect** of a **line_branch_connection** is related to shall be a **plant_line_segment_definition**.

WR3: The **related_shape_aspect** of a **line_branch_connection** shall be a **plant_line_segment_-termination**.

5.2.3.1.33 line_less_piping_system

A **line_less_piping_system** is a type of **product_definition** that identifies a piping system that is not part of a line.

EXPRESS specification:

```
*)
ENTITY line_less_piping_system
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.34 line_plant_item_branch_connection

A **line_plant_item_branch_connection** is a **shape_aspect_relationship** that identifies the connection between a line and a plant item connector that branches from the line.

EXPRESS specification:

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

5.2.3.1.35 line_plant_item_connection

A **line_plant_item_ connection** is a **shape_aspect_relationship** that identifies the connection between a line segment and a plant item connector.

EXPRESS specification:

```
*)
ENTITY line_plant_item_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.relating_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR'
       IN TYPEOF (SELF.related_shape_aspect);
  WR3: SELF\shape_aspect_relationship.related_shape_aspect.
       of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.
       name = 'physical occurrence';
END_ENTITY;
(*
```

Formal propositions:

WR1: The **relating_shape_aspect** of a **line_plant_item_connection** shall be a **plant_line_segment_-termination**.

WR2: The **related_shape_aspect** of a **line_plant_item_connection** shall be a **plant_item_connector**.

WR3: The **product_definition** that the **related_shape_aspect** of a **line_plant_item_connection** is related to shall have a context with the name 'physical occurrence'.

5.2.3.1.36 line_termination_connection

A **line_termination_connection** is a type of **shape_aspect_relationship** that identifies a connection between two line segment terminations, or between a line segment termination and a connection node.

EXPRESS specification:

```
*)
ENTITY line_termination_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SIZEOF (TYPEOF (SELF.relating_shape_aspect) *
       ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_NODE',
       'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION']
       ) >= 1;
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
       IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
(*
```

Formal propositions:

WR1: The **relating_shape_aspect** of a **line_termination_connection** shall be a **connection_node** or a **plant_line_segment_termination**.

WR2: The **related_shape_aspect** of a **line_termination_connection** shall be a **plant_line_segment_-termination**.

5.2.3.1.37 pipe_classification

A **pipe_classification** is a type of **group** that classifies the items are assigned to it as pipes. The name of the **pipe_classification** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY pipe_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
       category_in_tree (prpc, 'pipe'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **pipe_classification** shall classify items of type **piping_component_definition**.

WR2: A **pipe_classification** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'pipe'.

5.2.3.1.38 pipe_closure_fitting_classification

A **pipe_closure_fitting_classification** is a type of **group** that classifies the items that are assigned to it as pipe closure fittings. The name of the **pipe_closure_fitting_classification** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY pipe_closure_fitting_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
       category_in_tree (prpc, 'pipe closure'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **pipe_closure_fitting_classification** shall classify items of type **piping_component_-definition**.

WR2: A **pipe_closure_fitting_classification** shall classify items of type **piping_component_-definition** that are a definition of a **product** that is categorized as a 'pipe closure'.

5.2.3.1.39 piping_component_class

A **piping_component_class** is a type of **product_category** that is a **characterized_object** representing a family of piping components defined by parameter range values.

EXPRESS specification:

```
*)
ENTITY piping_component_class
  SUBTYPE OF (product_category, characterized_object);
END_ENTITY;
(*
```

5.2.3.1.40 piping_component_definition

A **piping_component_definition** is a type of **product_definition** that defines a piping component.

EXPRESS specification:

```
*)
ENTITY piping_component_definition
```

```
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

5.2.3.1.41 piping_connector_classification

A **piping_connector_classification** is a type of **group** that classifies the items that are assigned to it as being piping connectors.

EXPRESS specification:

```
*)
ENTITY piping_connector_classification
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.42 piping_design_csg_shape_representation

A **piping_design_csg_shape_representation** is a type of **shape_representation** that is composed of CSG primitives and boolean operators and is used to represent the shape of the piping design.

EXPRESS specification:

```
*)
ENTITY piping_design_csg_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (i <* SELF\representation.items |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT',
       'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
       'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] *
       TYPEOF(i)) = 1))) = 0;
  WR2: SIZEOF (QUERY (mi <* QUERY (item <* SELF\representation.items |
       'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF(item)) |
       NOT ('PLANT_SPATIAL_CONFIGURATION.' +
       'PIPING_DESIGN_CSG_SHAPE_REPRESENTATION' IN
       TYPEOF (mi\mapped_item.mapping_source.mapped_representation)))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **piping_design_csg_shape_representation** shall consist only of **representation_item**s that are **boolean_result**, **csg_solid**, **axis2_placement_3d**, or **mapped_item**.

WR2: If there is a **mapped_item** in a **piping_design_csg_shape_representation**, the source of the **mapped_item** shall be a **piping_design_csg_shape_representation**.

5.2.3.1.43 piping_system

A **piping_system** is a type of **product_definition** that identifies a system of interconnected objects that convey fluid, vapour, or particulate flow.

EXPRESS specification:

```
*)
ENTITY piping_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **piping_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of 'functional occurrence'.

5.2.3.1.44 plant

A **plant** is a type of **product** that identifies a process plant facility.

EXPRESS specification:

```
*)
ENTITY plant
  SUBTYPE OF (product);
WHERE
  WR1: SIZEOF (QUERY (pscoa <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.'+
       'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')  |
       pscoa.role.name =
       'plant operator')) +
       SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.'+
       'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
       'ITEMS') |
       pscpaoa.role.name =
       'plant operator')) <= 1;
  WR2: SIZEOF (QUERY (pscoa <* USEDIN(SELF,
       'PLANT_SPATIAL_CONFIGURATION.'+
       'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS') |
       pscoa.role.name = 'plant owner')) +
       SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.'+
       'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
       'ITEMS') |
       pscpaoa.role.name =
       'plant owner')) +
       SIZEOF (QUERY (pscpa <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.'+
       'PLANT_SPATIAL_CONFIGURATION_PERSON_ASSIGNMENT.ITEMS') |
       pscpa.role.name = 'plant owner')) >= 1;
  WR3: SIZEOF (QUERY (pscoa <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.'+
       'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')  |
       pscoa\organization_assignment.role.name =
       'plant project owner')) +
```

```
        SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.'+
        'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
        'ITEMS') |
        pscpaoa\person_and_organization_assignment.role.name =
        'plant project owner')) >= 1;
  WR4:  SIZEOF (QUERY (pdf <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') |
        NOT (SIZEOF (QUERY (pd <* USEDIN (pdf,
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION.FORMATION') |
        pd.frame_of_reference.name = 'functional occurrence')) <= 1))) = 0;
  WR5: SIZEOF (QUERY (pdf <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') |
       NOT (SIZEOF (QUERY (prod_def <* USEDIN (pdf,
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION.FORMATION') |
       SIZEOF (QUERY (pd <* USEDIN (prod_def,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       SIZEOF (QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (it <* pdr.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_2D',
       'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D']) = 1) AND
       (it.name =
       'plant placement reference'))) >= 1)) >= 1)) >= 1)) = 1))) = 0;

END_ENTITY;
(*
```

Formal propositions:

WR1: A **plant** is associated with zero or one **person_and_organization** or **organization** in the role of plant operator.

WR2: A **plant** is associated with at least one **organization**, **person_and_organization**, or **person** in the role of plant owner.

WR3: A **plant** is associated with at least one **person_and_organization** or **organization** in the role of plant project owner.

WR4: A **plant** shall be related to at most one **product_definition** that has a context of 'functional occurrence'.

WR5: A **plant** shall have definitions that have at least one representation with at least one item that is either an **axis2_placement_2d** or an **axis2_placement_3d** with the name of 'plant placement reference'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_context (see 5.2.4.10);

- product_context_discipline_type_constraint (see 5.2.4.12).

5.2.3.1.45 plant_item_connection

A **plant_item_connection** is a type of **shape_aspect** and **shape_aspect_relationship** that identifies a connection between plant items.

NOTE - A connection is a **shape_aspect** of the physical assembly where the two plant items are connected.

EXPRESS specification:

```
*)
ENTITY plant_item_connection
  SUBTYPE OF(shape_aspect, shape_aspect_relationship);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
       TYPEOF (SELF\shape_aspect_relationship.relating_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
       TYPEOF (SELF\shape_aspect_relationship.related_shape_aspect);
  WR3: SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name IN
       ['functional occurrence', 'physical occurrence',
       'functional definition', 'physical definition'];
  WR4: (SELF\shape_aspect_relationship.relating_shape_aspect.
       of_shape\property_definition.definition\product_definition.
       frame_of_reference\application_context_element.name =
       SELF\shape_aspect_relationship.related_shape_aspect.
       of_shape\property_definition.definition\product_definition.
       frame_of_reference\application_context_element.name);
  WR5: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'CLASSIFICATION_ASSIGNMENT.ITEMS')) > 0;
  WR6: SIZEOF (QUERY (pscca <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
       NOT (SIZEOF (
       ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_FUNCTIONAL_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.CONNECTION_MOTION_CLASSIFICATION'] *
       TYPEOF (pscca.assigned_group)) >= 1))) = 0;
  WR7: SIZEOF (QUERY (pdr <* USEDIN (SELF.of_shape.definition,
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.' +
       'RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'support usage connection')) <= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **relating_shape_aspect** of a **plant_item_connection** shall be a **plant_item_connector**.

WR2: The **related_shape_aspect** of a **plant_item_connection** shall be a **plant_item_connector**.

WR3: The **application_context_element** that applies to a **plant_item_connection** shall have the name 'functional occurrence', 'physical occurrence', 'functional definition', or 'physical definition'.

WR4: The **application_context_element**s that apply to the **relating_shape_aspect** and the **related_-shape_aspect** of a **plant_item_connection** shall have the same name.

WR5: A **plant_item_connection** shall be classified at least once.

WR6: A **plant_item_connection** shall be classified as a **connection_functional_classification**, as a **connection_motion_classification**, or as both.

WR7: The **product_definition** of the **plant_item_connection** shall be the related **product_definition** in at most one **product_definition_relationship** with a name of 'support usage connection'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_item_connection** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13);

- product_definition_usage_constraint (see 5.2.4.14).

5.2.3.1.46 plant_item_connector

A **plant_item_connector** is a type of **shape_aspect** that identifies a feature of a plant item that is designed to connect to another connector.

EXPRESS specification:

```
*)
ENTITY plant_item_connector
  SUBTYPE OF(shape_aspect);
WHERE
  WR1: SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name IN
       ['functional definition', 'physical definition',
       'functional occurrence', 'physical occurrence'];
  WR2: SIZEOF (QUERY (pic <*
       (bag_to_set (USEDIN (SELF,'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) +
       bag_to_set (USEDIN (SELF,'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT'))) |
       'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
       TYPEOF (pic))) <= 1;
  WR3: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
       SIZEOF (TYPEOF (ga.assigned_group) *
       ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
       'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
```

```
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name =
     'design service characteristics')) = 1))) = 0));
WR4: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
     (SIZEOF (TYPEOF (ga.assigned_group) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
     = 1) )) >= 1)) OR
     (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     (pd.name = 'service characteristics') )) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     (pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     (pdr.used_representation.name = 'design service characteristics') |
     SIZEOF (dsc.used_representation.items) >= 2) )) = 1)) )) = 0);
WR5: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
     SIZEOF (TYPEOF (ga.assigned_group) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name = 'design service characteristics') |
     {1 <= SIZEOF (QUERY (it <* dsc.used_representation.items |
     ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
     TYPEOF (it)) AND
     (it.name IN ['pressure', 'minimum pressure',
     'maximum pressure']))) <= 2})) = 1))) = 0));
WR6: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
     SIZEOF (TYPEOF (ga.assigned_group) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
```

```
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name = 'design service characteristics') |
     SIZEOF (QUERY (it <* dsc.used_representation.items |
     ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
     TYPEOF (it)) AND
     (it.name = 'pressure'))) <= 1)) = 1))) = 0));
WR7: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
     SIZEOF (TYPEOF (ga.assigned_group) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name = 'design service characteristics') |
     SIZEOF (QUERY (it <* dsc.used_representation.items |
     ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
     TYPEOF (it)) AND
     (it.name = 'minimum pressure'))) <= 1)) = 1))) = 0));
WR8: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
     SIZEOF (TYPEOF (ga.assigned_group) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name = 'design service characteristics') |
     SIZEOF (QUERY (it <* dsc.used_representation.items |
     ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
     TYPEOF (it)) AND
     (it.name = 'maximum pressure'))) <= 1)) = 1))) = 0));
WR9: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
     SIZEOF (TYPEOF (ga.assigned_group) *
     ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
     'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
     = 1)) >= 1)) OR
     ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics')) >= 1)) OR
     (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
     'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
     pd.name = 'service characteristics') |
     NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
     'PLANT_SPATIAL_CONFIGURATION.' +
     'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
     pdr.used_representation.name = 'design service characteristics') |
     {1 <= SIZEOF (QUERY (it <* dsc.used_representation.items |
     (SIZEOF (TYPEOF (it) *
```

```
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['temperature', 'minimum temperature',
      'maximum temperature']))) <= 2})) = 1))) = 0));
WR10: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
      SIZEOF (TYPEOF (ga.assigned_group) *
      ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
      'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
      = 1)) >= 1)) OR
      ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'temperature'))) <= 1)) = 1))) = 0));
WR11: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
      SIZEOF (TYPEOF (ga.assigned_group) *
      ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
      'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
      = 1)) >= 1)) OR
      ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'design service characteristics') |
      SIZEOF (QUERY (it <* dsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'minimum temperature'))) <= 1)) = 1))) = 0));
WR12: (NOT (SIZEOF (QUERY (ga <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.ITEMS') |
      SIZEOF (TYPEOF (ga.assigned_group) *
      ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASSIFICATION',
      'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASSIFICATION'])
      = 1)) >= 1)) OR
      ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      pd.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
```

```
        pdr.used_representation.name = 'design service characteristics') |
        SIZEOF (QUERY (it <* dsc.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.' +
        'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'maximum temperature'))) <= 1)) = 1))) = 0));
END_ENTITY;
(*
```

Formal propositions:

WR1: The **application_context_element** that applies to a **plant_item_connector** (as its **product_-definition_context**) shall have the name 'functional definition', 'physical definition' 'functional occurrence', or 'physical occurrence'.

WR2: The **plant_item_connector** shall be the connector in at most one **plant_item_connection**.

WR3: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of 'service characteristics', the **property_definition** shall have exactly one **representation** with the **name** of 'design service characteristics'.

WR4: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of 'service characteristics', the **property_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at least two **representation_item**s.

WR5: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of 'service characteristics', the **property_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has one or two **representation_item**s of type **measure_representation_item** with a **name** of 'pressure', 'minimum pressure', or 'maximum pressure'.

WR6: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of 'service characteristics', the **property_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation_item** of type **measure_representation_item** with a **name** of 'pressure'.

WR7: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of 'service characteristics', the **property_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation_item** of type **measure_representation_item** with a **name** of 'minimum pressure'.

WR8: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of 'service characteristics', the **property_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation_item** of type **measure_representation_item** with a **name** of 'maximum pressure'.

WR9: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of 'service characteristics', the **property_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has one or two **representation_item**s of type **measure_representation_item** and **thermodynamic_temperature_-**

measure_with_unit with a **name** of ‘temperature’, ‘minimum temperature’, or ‘maximum temperature’.

WR10: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a **name** of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_-measure_with_unit** with a **name** of ‘temperature’.

WR11: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a **name** of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_-measure_with_unit** with a **name** of ‘minimum temperature’.

WR12: If the **plant_item_connector** is classified as either a piping connector or a connector end type and has a **property_definition** with a **name** of ‘service characteristics’, the **property_definition** shall have exactly one **representation** with a **name** of ‘design service characteristics’ that has at most one **representation_item** of type **measure_representation_item** and **thermodynamic_temperature_-measure_with_unit** with a **name** of ‘maximum temperature’.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_item_connector** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13);

- product_definition_usage_constraint (see 5.2.4.14).

5.2.3.1.47 plant_item_interference

A **plant_item_interference** is a type of **product_definition_relationship** that identifies interference between plant items.

EXPRESS specification:

```
*)
ENTITY plant_item_interference
  SUBTYPE OF (product_definition_relationship);
END_ENTITY;
(*
```

5.2.3.1.48 plant_item_route

A **plant_item_route** is a type of **product_definition_shape** that identifies the 3D path of a **plant_-line_definition** or a **plant_line_segment_definition**.

EXPRESS specification:

```
*)
ENTITY plant_item_route
  SUBTYPE OF (product_definition_shape);
WHERE
  WR1: SELF\property_definition.definition\product_definition.
       frame_of_reference\application_context_element.name =
       'physical occurrence';
  WR2: SIZEOF (TYPEOF (SELF\property_definition.definition) *
       ['PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION',
       'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION']) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **name** of the **product_definition_context** that a **plant_item_route** is related to shall be 'physical occurrence'.

WR2: A **plant_item_route** shall be the definition of the shape of a **plant_line_definition** or a **plant_-line_segment_definition**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_item_route** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13);

- product_definition_usage_constraint (see 5.2.4.14).

5.2.3.1.49 plant_item_weight_representation

A **plant_item_weight_representation** is a type of **property_definition_representation** that specifies the weight of plant items.

EXPRESS specification:

```
*)
ENTITY plant_item_weight_representation
  SUBTYPE OF (property_definition_representation);
WHERE
```

```
  WR1: SELF.used_representation.name = 'item weight';
  WR2: SIZEOF (SELF.used_representation.items) >= 2;
  WR3: SIZEOF (QUERY (it <* SELF.used_representation.items |
       (it.name IN ['weight value', 'mass value',
       'maximum weight value', 'minimum weight value',
       'maximum mass value', 'minimum mass value']) AND
       (NOT (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.QUALIFIED_REPRESENTATION_ITEM']) =
       2)))) = 0;
  WR4: SIZEOF (QUERY (it <* SELF.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_REPRESENTATION_ITEM'
       IN TYPEOF (it)) AND
       (it.name = 'centre of gravity'))) = 1;
  WR5: {1 <= SIZEOF (QUERY (it <* SELF.used_representation.items |
       it.name IN ['weight value', 'mass value',
       'maximum weight value', 'minimum weight value',
       'maximum mass value', 'minimum mass value'])) <= 2};
  WR6: SIZEOF (QUERY (it <* SELF\property_definition_representation.
       used_representation.items |
       (it.name IN ['maximum weight value', 'minimum weight value',
       'maximum mass value', 'minimum mass value']) AND
       (NOT (SIZEOF (QUERY (tq <* QUERY (qual <*
       it\qualified_representation_item.qualifiers |
       'PLANT_SPATIAL_CONFIGURATION.TYPE_QUALIFIER' IN TYPEOF (qual)) |
       tq.name = 'operating')) = 1)))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **name** of the **plant_item_weight_representation** shall be 'item weight'.

WR2: The **plant_item_weight_representation** shall contain at least two items.

WR3: If the **plant_item_weight_representation** contains a **representation_item** with a **name** of 'weight value', 'mass value', 'maximum weight value', 'minimum weight value', 'maximum mass value', or 'minimum mass value', the **representation_item** shall be a **measure_representation_item** and a **qualified_representation_item**.

WR4: The **plant_item_weight_representation** shall contain exactly one **representation_item** that is a **geometric_representation_item** with a **name** of 'centre of gravity'.

WR5: The **plant_item_weight_representation** shall have between 1 and 2 **representation_items** with a **name** of 'weight value','mass value, 'maximum weight value', 'minimum weight value', 'maximum mass value', or 'minimum mass value'.

WR6: If the **plant_item_weight_representation** has a **representation_item** with a **name** of 'maximum weight value', 'minimum weight value', 'maximum mass value', or 'minimum mass value', the **representation_item** shall have a **type_qualifier** with a **name** of 'operating'.

5.2.3.1.50 plant_line_definition

A **plant_line_definition** is a type of **product_definition_with_associated_documents** that identifies a piping system line.

EXPRESS specification:

```
*)
ENTITY plant_line_definition
  SUBTYPE OF (product_definition_with_associated_documents);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM' IN
       TYPEOF (pdr.relating_product_definition)))) = 1;
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION' IN
       TYPEOF (pdr.related_product_definition))) >= 1;
  WR3: (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       SIZEOF (USEDIN (pd, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1)) = 0))  OR
       (SIZEOF (QUERY (pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (rep <*
       USEDIN (pdr.used_representation.context_of_items,
       'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.CONTEXT_OF_ITEMS') |
       SIZEOF (QUERY (prop_def_rep <* USEDIN (rep,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.SITE',
       'PLANT_SPATIAL_CONFIGURATION.SITE_BUILDING'] *
       TYPEOF (prop_def_rep.definition)) = 1) OR
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN
       TYPEOF (prop_def_rep.definition.definition.formation.of_product))))
       >= 1)) >= 1)) >= 1))) = 0);
  WR4: SELF.frame_of_reference.name =
       'functional definition';
END_ENTITY;
(*
```

Formal propositions:

WR1: A **plant_line_definition** shall be related to exactly one **piping_system**.

WR2: A **plant_line_definition** shall be related to at least one **plant_line_segment_definition**.

WR3: If a **plant_line_definition** has a **representation**, that **representation** shall be in the context of a **site_building**, a **site**, or a **plant**.

WR4: A **plant_line_definition** shall have an **application_context_element.name** of 'functional definition'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_line_definition** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13).

5.2.3.1.51 plant_line_segment_definition

A **plant_line_segment_definition** is a type of **product_definition** that identifies a line segment.

EXPRESS specification:

```
*)
ENTITY plant_line_segment_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION'
       IN TYPEOF (pdr.relating_product_definition))) >= 1;
  WR2: SIZEOF (QUERY( pd <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN
       TYPEOF (pd))) >= 1;
  WR3: SELF.frame_of_reference\application_context_element.name =
       'functional definition';
  WR4: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'line segment characteristics')) = 1;
  WR5: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'line segment characteristics') |
       NOT (SIZEOF (lsc.used_representation.items) >= 2))) = 0;
  WR6: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'line segment characteristics') |
       NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'design pressure'))) = 1))) = 0;
  WR7: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'line segment characteristics') |
       NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'design temperature'))) = 1))) = 0;
```

```
 WR8: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'line segment characteristics') |
      NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'elevation'))) <= 1))) = 0;
 WR9: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'line segment characteristics') |
      NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'corrosion allowance'))) <= 1))) = 0;
WR10: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name =
      'segment insulation characteristics')) = 1))) = 0))) = 0);
WR11: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
      TYPEOF (pdr)) |
      pds.used_representation.name = |
      'segment insulation characteristics') |
      SIZEOF (sic.used_representation.items) >= 1)) = 1))) = 0))) = 0);
WR12: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation')) >= 1)) OR
      (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
      pdr.name = 'segment insulation') |
      NOT (SIZEOF (QUERY (pd <* USEDIN (si,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
      NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
      'PLANT_SPATIAL_CONFIGURATION.' +
```

```
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
       TYPEOF (pdr)) |
       pds.used_representation.name = |
       'segment insulation characteristics') |
       {1 <= SIZEOF (QUERY (it <* sic.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
       (it.name IN ['thickness', 'minimum thickness',
       'maximum thickness']))) <= 2})) = 1))) = 0))) = 0);
WR13: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'segment insulation')) >= 1)) OR
       (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'segment insulation') |
       NOT (SIZEOF (QUERY (pd <* USEDIN (si,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
       TYPEOF (pdr)) |
       pds.used_representation.name = |
       'segment insulation characteristics') |
       SIZEOF (QUERY (it <* sic.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'thickness'))) <= 1)) = 1))) = 0))) = 0);
WR14: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'segment insulation')) >= 1)) OR
       (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'segment insulation') |
       NOT (SIZEOF (QUERY (pd <* USEDIN (si,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
       NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
       TYPEOF (pdr)) |
       pds.used_representation.name = |
       'segment insulation characteristics') |
       SIZEOF (QUERY (it <* sic.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'minimum thickness'))) <= 1)) = 1))) = 0))) = 0);
WR15: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'segment insulation')) >= 1)) OR
       (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       pdr.name = 'segment insulation') |
       NOT (SIZEOF (QUERY (pd <* USEDIN (si,
```

```
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
        TYPEOF (pdr)) |
        pds.used_representation.name = |
        'segment insulation characteristics') |
        SIZEOF (QUERY (it <* sic.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'maximum thickness'))) <= 1)) = 1))) = 0))) = 0);
 WR16: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
        pdr.name = 'segment insulation')) >= 1)) OR
        (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
        pdr.name = 'segment insulation') |
        NOT (SIZEOF (QUERY (pd <* USEDIN (si,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
        TYPEOF (pdr)) |
        pds.used_representation.name = |
        'segment insulation characteristics') |
        SIZEOF (QUERY (it <* sic.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
        TYPEOF (it)) AND
        (it.name = 'boundaries'))) <= 1)) = 1))) = 0))) = 0);
END_ENTITY;
(*
```

Formal propositions:

WR1: A **plant_line_segment_definition** shall be the **related_product_definition** in a **product_-definition_relationship** that has a **relating_product_definition** that is a **plant_line_definition**.

WR2: A **plant_line_segment_definition** shall be referenced by a **shape_definition**.

WR3: A **plant_line_segment_definition** shall have a **frame_of_reference name** of 'functional definition'.

WR4: A **plant_line_segment_definition** shall have exactly one representation with the name of 'line segment characteristics'.

WR5: The representation of the **plant_line_segment_definition** with the name of 'line segment characteristics' shall have at least two **representation_item**s.

WR6: The representation of the **plant_line_segment_definition** with the name of 'line segment characteristics' shall have exactly one **representation_item** that is of type **measure_representation_-item** with a name of 'design pressure'.

WR7: The representation of the **plant_line_segment_definition** with the name of ‘line segment characteristics’ shall have exactly one **representation_item** that is of type **measure_representation_-item** and **thermodynamic_temperature_measure_with_unit** with a name of ‘design temperature’.

WR8: The representation of the **plant_line_segment_definition** with the name of ‘line segment characteristics’ shall have at most one **representation_item** that is of type **measure_representation_-item** and **length_measure_with_unit** with a name of ‘elevation’.

WR9: The representation of the **plant_line_segment_definition** with the name of ‘line segment characteristics’ shall have at most one **representation_item** that is of type **measure_representation_-item** with a name of ‘corrosion allowance’.

WR10: If the **plant_line_segment_definition** is related to a **product_definition** as a ’segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’.

WR11: If the **plant_line_segment_definition** is related to a **product_definition** as a ’segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at least one **representation_item**.

WR12: If the **plant_line_segment_definition** is related to a **product_definition** as a ’segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has one or two **representation_item**s of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘thickness’, ‘minimum thickness’, or ‘maximum thickness’.

WR13: If the **plant_line_segment_definition** is related to a **product_definition** as a ’segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘thickness’.

WR14: If the **plant_line_segment_definition** is related to a **product_definition** as a ’segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘minimum thickness’.

WR15: If the **plant_line_segment_definition** is related to a **product_definition** as a ’segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation_item** items of type **measure_representation_item** and **length_measure_with_unit** with a **name** of ‘maximum thickness’.

WR16: If the **plant_line_segment_definition** is related to a **product_definition** as a ’segment insulation’, the **product_definition** shall have a **product_definition_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation_item** items of type **descriptive_representation_item** with a **name** of ‘boundaries’.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_line_segment_-definition** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13).

5.2.3.1.52 plant_line_segment_termination

A **plant_line_segment_termination** is a type of **shape_aspect** that identifies the termination of a line segment.

EXPRESS specification:

```
*)
ENTITY plant_line_segment_termination
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
       IN TYPEOF (SELF.of_shape.definition);
  WR2: SIZEOF (QUERY (sar <*
       USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') +
       USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
       NOT (SIZEOF (TYPEOF (sar) *
       ['PLANT_SPATIAL_CONFIGURATION.LINE_BRANCH_CONNECTION',
       'PLANT_SPATIAL_CONFIGURATION.LINE_PLANT_ITEM_CONNECTION',
       'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION'])
       = 1))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **plant_line_segment_termination** is an aspect of the shape of a **plant_line_segment_-definition**.

WR2: A **plant_line_segment_termination** is the **relating_shape_aspect** or the **related_shape_aspect** in at least one **shape_aspect_relationship** that is a **line_branch_connection**, **line_plant_item_-connection**, or **line_termination_connection**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_line_segment_-termination** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13).

5.2.3.1.53 plant_spatial_configuration_action_request_assignment

A **plant_spatial_configuration_action_request_assignment** assigns an **action_request** to a set of one or more **product**s.

```
*)
ENTITY plant_spatial_configuration_action_request_assignment
  SUBTYPE OF (action_request_assignment);
  items : SET [1:?] OF plant_spatial_configuration_action_request_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **product**s that an **action_request** is assigned to.

5.2.3.1.54 plant_spatial_configuration_approval_assignment

A **plant_spatial_configuration_approval_assignment** assigns an **approval** to a set of one or more **change_action**s.

EXPRESS specification:

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

Attribute definitions:

items: the set of **change_action**s and **versioned_action_request**s that an **approval** is assigned to.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **plant_spatial_-configuration_approval_assignment** entity:

- change_life_cycle_stage_usage_requires_approval (see 5.2.4.7).

5.2.3.1.55 plant_spatial_configuration_change_assignment

A **plant_spatial_configuration_change_assignment** assigns a **change_action** to a set of one or more **change_item**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_change_assignment
  SUBTYPE OF (action_assignment);
  items : SET [1:?] OF change_item;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CHANGE_ACTION'
       IN TYPEOF (SELF.assigned_action);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **change_item**s that an action is assigned to.

Formal propositions:

WR1: The assigned action shall be a **change_action**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_spatial_-configuration_change_assignment** entity:

- change_item_requires_creation_date (see 5.2.4.5);

- change_item_requires_id (see 5.2.4.6).

5.2.3.1.56 plant_spatial_configuration_date_and_time_assignment

A **plant_spatial_configuration_date_and_time_assignment** assigns a **date_and_time** to a set of one or more **product**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_date_and_time_assignment
  SUBTYPE OF (date_and_time_assignment);
  items : SET [1:?] OF plant_spatial_configuration_date_and_time_item;
```

```
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **product**s that a **date_and_time** is assigned to.

5.2.3.1.57 plant_spatial_configuration_date_assignment

A **plant_spatial_configuration_date_assignment** assigns a **date** to a set of one or more **action_-directive**s, **change_action**s, **change_item**s, and **product**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_date_assignment
  SUBTYPE OF (date_assignment);
  items : SET [1:?] OF plant_spatial_configuration_dated_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **action_directive**s, **change_action**s, **change_item**s, and **product**s that a **date** is assigned to.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant_spatial_-configuration_date_assignment** entity:

- change_action_requires_date (see 5.2.4.4);

- change_item_requires_creation_date (see 5.2.4.5).

5.2.3.1.58 plant_spatial_configuration_document_reference

A **plant_spatial_configuration_document_reference** assigns a **document** to a set of one or more **heat_tracing_representation**s, **piping_component_class**es, **piping_system**s, **plant_item_connector**s, **plant_line_segment_definition**s, **product**s, **product_definition**s, **product_definition_relationship**s, **property_definition**s, **representation**s, **representation_item**s, and **site**s.

EXPRESS specification:

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

Attribute definitions:

items: the set of **heat_tracing_representation**s, **piping_component_class**es, **piping_system**s, **plant_-item_connector**s, **plant_line_segment_definition**s, **product**s, **product_definition**s, **product_-definition_relationship**s, **property_definition**s, **representation**s, **representation_item**s, and **site**s that is associated with a **document**.

5.2.3.1.59 plant_spatial_configuration_organization_assignment

A **plant_spatial_configuration_organization_assignment** assigns an **organization** to a set of one or more **catalogue**s, **change_action**s, **design_project**s, **document**s, **plant**s, **product_definition_-formation**s, **product_definition_relationship**s, and **site**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_organization_assignment
  SUBTYPE OF (organization_assignment);
  items : SET [1:?] OF plant_spatial_configuration_organization_item;
WHERE
  WR1: plant_spatial_configuration_organization_correlation (SELF);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **catalogue**s, **change_action**s, **design_project**s, **document**s, **plant**s, **product_-definition_formation**s, **product_definition_relationship**s, and **site**s that an **organization** is assigned to.

Formal propositions:

WR1: The **plant_spatial_configuration_organization_correlation** function that correlates roles of organizations to elements of product data shall be satisfied.

5.2.3.1.60 plant_spatial_configuration_person_and_organization_assignment

A **plant_spatial_configuration_person_and_organization_assignment** assigns a **person_and_-organization** to a set of one or more **change_item**s, **plant**s, and **site**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_person_and_organization_assignment
  SUBTYPE OF (person_and_organization_assignment);
  items : SET [1:?] OF
          plant_spatial_configuration_person_and_organization_item;
WHERE
  WR1: plant_spatial_configuration_person_and_organization_correlation
       (SELF);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **change_item**s, **plant**s, and **site**s that a **person_and_organization** is assigned to.

Formal propositions:

WR1: The **plant_spatial_configuration_person_and_organization_correlation** function that correlates roles of persons and organizations to elements of product data shall be satisfied.

5.2.3.1.61 plant_spatial_configuration_person_assignment

A **plant_spatial_configuration_person_assignment** assigns a **person** to a set of one or more **document**s, **plant**s, **product_definition_relationship**s, and **site**s.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_person_assignment
  SUBTYPE OF (person_assignment);
  items : SET [1:?] OF plant_spatial_configuration_person_item;
WHERE
  WR1: plant_spatial_configuration_person_correlation (SELF);
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **document**s, **plant**s, **product_definition_relationship**s, and **site**s that a **person** is assigned to.

Formal propositions:

WR1: The **plant_spatial_configuration_person_correlation** function that correlates roles of persons to elements of product data shall be satisfied.

5.2.3.1.62 process_capability

A **process_capability** is a type of **property_definition** that identifies the physical or chemical process that is, or is intended to be, carried out by a **plant**.

EXPRESS specification:

```
*)
ENTITY process_capability
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT' IN
       TYPEOF(SELF.definition\product_definition.formation.of_product);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION_REPRESENTATION.' +
       'DEFINITION') |
       (pdr.used_representation.name = 'production capacity') AND
       (NOT (SIZEOF (QUERY (it <* pdr.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM'
```

```
       IN TYPEOF (it)) AND
       (it.name = 'production type'))) = 1)))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **process_capability** is a property of a **plant**.

WR2: The **representation** instances associated with a **process_capability** shall have a name of 'production capacity' and shall contain exactly one **descriptive_representation_item** with a name of 'production type'.

5.2.3.1.63 purchase_assignment

A **purchase_assignment** assigns a set of one or more **product**s to an **action** to identify that the **product** is purchased.

EXPRESS specification:

```
*)
ENTITY purchase_assignment
  SUBTYPE OF (action_assignment);
  items : SET [1:?] OF purchase_item;
END_ENTITY;
(*
```

Attribute definitions:

items: the set of **product**s that are purchased.

5.2.3.1.64 reducer_fitting_classification

A **reducer_fitting_classification** is a type of **group** that classifies the items that are assigned to it as reducer fittings.

EXPRESS specification:

```
*)
ENTITY reducer_fitting_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
```

```
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
       category_in_tree (prpc, 'reducer'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **reducer_fitting_classification** shall classify items of type **piping_component_definition**.

WR2: A **reducer_fitting_classification** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'reducer'.

5.2.3.1.65 reference_geometry

A **reference_geometry** is a type of **derived_shape_aspect** that is a geometric element that is not part of the definition of the shape of **plant_item**, but is provided as supplementary geometric information. A **reference_geometry** has a relationship to the shape definition geometry and may be derivable from shape geometry.

EXAMPLE 74 - Centrelines of symmetric elements and origin points are considered **reference_-geometry**.

EXPRESS specification:

```
*)
ENTITY reference_geometry
  SUBTYPE OF (derived_shape_aspect);
WHERE
  WR1: SIZEOF (QUERY (pd <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION.DEFINITION') |
       NOT (SIZEOF (USEDIN (pd, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: Each **reference_geometry** shall have at least one **representation**s.

5.2.3.1.66 required_material_property

A **required_material_property** is a type of **material_property** that specifies the material or the requirements for the material that a plant item should be made from.

```
*)
ENTITY required_material_property
  SUBTYPE OF (material_property);
WHERE
  WR1: (SIZEOF (TYPEOF (SELF\property_definition.definition) *
       ['PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'EXTERNALLY_DEFINED_PLANT_ITEM']) = 1) OR
       (('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN
```

```
       TYPEOF (SELF.definition)) AND
       (SIZEOF (QUERY (pc <* SELF\property_definition.
       definition\product_definition.formation.of_product.
       frame_of_reference |
       pc.discipline_type = 'process plant')) = 1));
  WR2: SIZEOF (QUERY (ra <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATED_PROPERTY_DEFINITION') |
       pdr.name = 'requirement allocation') |
       'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY' IN
       TYPEOF (ra.relating_property_definition))) >= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **required_material_property** shall be a property of a **plant_item_connector**, **externally_-defined_plant_item**, or a **product_definition** that defines a plant item.

WR2: A **required_material_property** shall be related to at least one **material_property** as the 'requirement allocation'.

5.2.3.1.67 reserved_space

A **reserved_space** is a type of **shape_aspect** that identifies a space that is reserved for a plant item.

```
*)
ENTITY reserved_space
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: SELF\shape_aspect.of_shape\property_definition.
       definition\product_definition.
       frame_of_reference\application_context_element.name =
       'physical occurrence';
END_ENTITY;
(*
```

Formal propositions:

WR1: A **reserved_space** shall be an aspect of the definition of the shape of a **product_definition** with a context with the name 'physical occurrence'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **reserved_space** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9);

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13);

- product_definition_usage_constraint (see 5.2.4.14).

5.2.3.1.68 site

A **site** is a type of **characterized_object** and **property_definition** that identifies the geographic and topographic characteristics of the location of a plant.

EXPRESS specification:

```
*)
ENTITY site
  SUBTYPE OF (characterized_object, property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT' IN
       TYPEOF (SELF\property_definition.definition\product_definition.
       formation.of_product);
END_ENTITY;
(*
```

Formal propositions:

WR1: Each **site** shall be a property of a **plant**.

5.2.3.1.69 site_building

A **site_building** is a type of **property_definition** that identifies a partially or totally enclosed structure located on a site.

EXPRESS specification:

```
*)
ENTITY site_building
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.SITE' IN
       TYPEOF (SELF.definition);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       (pdr.used_representation.name = 'building number') AND
       (SIZEOF (QUERY (it <* pdr.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
       TYPEOF (it)))) = 1))) = 1;
  WR3: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (it <* pdr.used_representation.items |
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.AXIS_PLACEMENT_2D',
       'PLANT_SPATIAL_CONFIGURATION.AXIS_PLACEMENT_3D'] *
       TYPEOF (it)) = 1) AND
       (it.name = 'building orientation') AND
       (it.location.name = 'building location'))) = 1)) <= 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **site_building** shall be a property of a site.

WR2: The **site_building** shall have exactly one **representation** with a name of 'building number' that contains exactly one **representation_item** that is a **descriptive_representation_item**.

WR3: The **site_building** shall have at most one **representation** that contains exactly one **axis2_-placement_2d** or **axis2_placement_3d** with a **name** of 'building orientation' and a **location** that has a **name** of 'building location'.

5.2.3.1.70 site_feature

A **site_feature** is a type of **property_definition** that identifies the composition, proportions, form or outward appearance of part of a site.

EXPRESS specification:

```
*)
ENTITY site_feature
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.SITE' IN
       TYPEOF(SELF.definition);
  WR2: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 3;
  WR3: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (it <* pdr.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'site feature type'))) = 1)) = 1;
  WR4: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (it <* pdr.used_representation.items |
       (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.AXIS_PLACEMENT_2D',
       'PLANT_SPATIAL_CONFIGURATION.AXIS_PLACEMENT_3D'] *
       TYPEOF (it)) = 1) AND
       (it.name = 'feature orientation') AND
       (it.location.name = 'feature location'))) = 1)) = 1;
  WR5: SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       SIZEOF (QUERY (it <* pdr.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
       TYPEOF (pdr.used_representation)) AND
       (it.name = 'origin type') AND
       (it.description IN ['man made', 'natural']))) = 1)) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **site_feature** is a property of a **site**.

WR2: A **site_feature** is referenced by exactly three **property_definition_representation** instances.

WR3: A **site_feature** shall have exactly one **representation** contains exactly one item of type **descriptive_representation_item** with the name of 'site feature type'.

WR4: The **site_feature** shall have at exactly one **representation** that contains exactly one **axis2_-placement_2d** or **axis2_placement_3d** with a **name** of 'feature orientation' and a **location** that has a **name** of 'feature location'.

WR5: The **site_feature** shall have exactly one **representation** that contains exactly one **representation_item** that is a **descriptive_representation_item** with the name of 'origin type' and a **description** of either 'man made' or 'natural'.

5.2.3.1.71 site_representation

A **site_representation** is a type of **shape_representation** that represents the shape properties of a **site**.

EXPRESS specification:

```
*)
ENTITY site_representation
  SUBTYPE OF(shape_representation);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF,'PLANT_SPATIAL_CONFIGURATION.'+
       'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
       NOT('PLANT_SPATIAL_CONFIGURATION.SITE' IN
       TYPEOF (pdr.definition.definition)))) = 0;
  WR2: SIZEOF (QUERY (item <* SELF.items |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET',
       'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'] *
       TYPEOF (item)) = 1))) = 1;
  WR3: SIZEOF (QUERY (cfs <* QUERY (item <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF (item)) |
       NOT (SIZEOF (QUERY (fcs <* cfs\connected_face_set.cfs_faces |
       NOT (SIZEOF (QUERY (bnds <* fcs.bounds |
       NOT ('PLANT_SPATIAL_CONFIGURATION.POLY_LOOP' |
       IN TYPEOF (bnds.bound))))
       = 0))) = 0))) = 0;
  WR4: SIZEOF (QUERY (cfs <* QUERY (item <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF (item)) |
       NOT (SIZEOF (QUERY (fcs <* cfs\connected_face_set.cfs_faces |
       NOT (SIZEOF (QUERY (bnds <* fcs.bounds |
       NOT (SIZEOF (bnds.bound\poly_loop.polygon) = 3)))
       = 0))) = 0))) = 0;
  WR5: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' |
       IN TYPEOF (item)) |
       NOT (SIZEOF (QUERY (el <* gcs\geometric_set.elements |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT',
       'PLANT_SPATIAL_CONFIGURATION.POLYLINE'] * TYPEOF (el))
       = 1))) = 0))) = 0;
  WR6: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' |
       IN TYPEOF (item)) |
       NOT (SIZEOF (QUERY (el <* gcs\geometric_set.elements |
       'PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT' IN TYPEOF (el)))
       >= 1))) = 0;
  WR7: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
```

```
        'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' |
        IN TYPEOF (item)) |
        NOT (SIZEOF (QUERY (pline <* QUERY (el <* |
        gcs\geometric_set.elements |
        'PLANT_SPATIAL_CONFIGURATION.POLYLINE' IN TYPEOF (el)) |
        NOT (SIZEOF (QUERY (pline_pt <* pline\polyline.points |
        NOT (pline_pt IN gcs\geometric_set.elements))) = 0))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **site_representation** shall be used to represent a **site**.

WR2: A **site_representation** shall have in its set of items exactly one **connected_face_set** or **geometric_curve_set**.

WR3: If the **representation_item** is a **connected_face_set**, it shall contain faces that are bounded by **poly_loop**s.

WR4: If the **representation_item** is a **connected_face_set**, all of its **face** instances shall be bounded by **poly_loop**s with topology defined by three **cartesian_point**s.

WR5: If the **representation_item** is a **geometric_curve_set**, its **elements** set shall consist of **cartesian_point** or **polyline**.

WR6: If the **representation_item** is a **geometric_curve_set**, its **elements** shall consist of at least one **cartesian_point**.

WR7: If the **representation_item** is a **geometric_curve_set**, its **elements** that are of type **polyline** shall reference only points that are in the **elements** set.

5.2.3.1.72 spacer_fitting_classification

A **spacer_fitting_classification** is a type of **group** that classifies the items that are assigned to it as spacer fittings.

EXPRESS specification:

```
*)
ENTITY spacer_fitting_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
```

```
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
       category_in_tree (prpc, 'spacer'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **spacer_fitting_classification** shall classify items of type **piping_component_definition**.

WR2: A **spacer_fitting_classification** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'spacer'.

5.2.3.1.73 specialty_item_classification

A **specialty_item_classification** is a type of **group** that classifies the items are assigned to it as specialty items. The name of the **specialty_item_classification** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY specialty_item_classification
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.74 stream_design_case

A **stream_design_case** is a type of **property_definition** and **characterized_object** that identifies the characteristics of a gas, liquid, vapour, or particulate stream.

EXPRESS specification:

```
*)
ENTITY stream_design_case
  SUBTYPE OF (property_definition, characterized_object);
WHERE
  WR1: SIZEOF (QUERY (pd <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION.DEFINITION') |
       'PLANT_SPATIAL_CONFIGURATION.STREAM_PHASE' IN
       TYPEOF (pd))) >= 1;
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream flow characteristics')) = 1;
  WR3: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream flow characteristics') |
       NOT (SIZEOF (sfc.used_representation.items) >= 2))) = 0;
  WR4: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream flow characteristics') |
```

```
      NOT ({1 <= SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name IN ['flow rate', 'minimum flow rate',
      'maximum flow rate']))) <= 2}))) = 0;
 WR5: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'flow rate'))) <= 1))) = 0;
 WR6: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'minimum flow rate'))) <= 1))) = 0;
 WR7: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'maximum flow rate'))) <= 1))) = 0;
 WR8: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT ({1 <= SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name IN ['pressure', 'minimum pressure',
      'maximum pressure']))) <= 2}))) = 0;
 WR9: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'pressure'))) <= 1))) = 0;
WR10: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'minimum pressure'))) <= 1))) = 0;
WR11: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'maximum pressure'))) <= 1))) = 0;
WR12: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
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      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = 'stream flow characteristics') |
      NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'stream data reference'))) <= 1))) = 0;
WR13: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (pdr <* USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name =
      'service operating characteristics')) = 1))) = 0);
WR14: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = |
      'service operating characteristics') |
      NOT (SIZEOF (soc.used_representation.items) >= 3))) = 0))) = 0);
WR15: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = |
      'service operating characteristics') |
      {1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['temperature', 'minimum temperature',
      'maximum temperature']))) <= 2})) = 1))) = 0);
WR16: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
```

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       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = |
       'service operating characteristics') |
       SIZEOF (QUERY (it <* soc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'temperature'))) <= 1)) = 1))) = 0);
WR17: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = |
       'service operating characteristics') |
       SIZEOF (QUERY (it <* soc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'minimum temperature'))) <= 1)) = 1))) = 0);
WR18: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = |
       'service operating characteristics') |
       SIZEOF (QUERY (it <* soc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'maximum temperature'))) <= 1)) = 1))) = 0);
WR19: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
```

```
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = |
       'service operating characteristics') |
       {1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name IN ['pressure', 'minimum pressure',
       'maximum pressure']))) <= 2})) = 1))) = 0);
WR20: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = |
       'service operating characteristics') |
       SIZEOF (QUERY (it <* soc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'pressure'))) <= 1)) = 1))) = 0);
WR21: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = |
       'service operating characteristics') |
       SIZEOF (QUERY (it <* soc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'minimum pressure'))) <= 1)) = 1))) = 0);
WR22: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
```

```
      pdr.used_representation.name = |
      'service operating characteristics') |
      SIZEOF (QUERY (it <* soc.used_representation.items |
      ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
      TYPEOF (it)) AND
      (it.name = 'maximum pressure'))) <= 1)) = 1))) = 0);
WR23: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = |
      'service operating characteristics') |
      {1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
      (it.name IN ['duration', 'minimum duration',
      'maximum duration']))) <= 2})) = 1))) = 0);
WR24: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = |
      'service operating characteristics') |
      SIZEOF (QUERY (it <* soc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
      ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
      (it.name = 'duration'))) <= 1)) = 1))) = 0);
WR25: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name =
      'service characteristics')) >= 1)) OR
      (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
      pdr.related_property_definition.name = 'service characteristics') |
      NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
      USEDIN (sc.related_property_definition,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
      pdr.used_representation.name = |
      'service operating characteristics') |
      SIZEOF (QUERY (it <* soc.used_representation.items |
      (SIZEOF (TYPEOF (it) *
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```
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'minimum duration'))) <= 1)) = 1))) = 0);
 WR26: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
       USEDIN (sc.related_property_definition,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = |
       'service operating characteristics') |
       SIZEOF (QUERY (it <* soc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'maximum duration'))) <= 1)) = 1))) = 0);
 WR27: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name =
       'service characteristics')) >= 1)) OR
       (SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
       pdr.related_property_definition.name = 'service characteristics') |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
       TYPEOF (sc.related_property_definition.definition)))) = 0);
END_ENTITY;
(*
```

Formal propositions:

WR1: A **stream_design_case** shall have at least one **stream_phase**.

WR2: A **stream_design_case** shall have exactly one representation with the **name** of 'stream flow characteristics'.

WR3: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at least two **representation_item**s.

WR4: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have between one and two **representation_item**s that are of type **measure_representation_item** with a name of 'flow rate', 'maximum flow rate', or 'minimum flow rate'.

WR5: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'flow rate'.

WR6: The representation of the **stream_design_case** with the **name** of 'stream flow characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'minimum flow rate'.

WR7: The representation of the **stream_design_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation_item** that is of type **measure_representation_item** with a name of ‘maximum flow rate’.

WR8: The representation of the **stream_design_case** with the **name** of ‘stream flow characteristics’ shall have between one and two **representation_item**s that are of type **measure_representation_item** with a name of ‘pressure’, ‘maximum pressure’, or ‘minimum pressure’.

WR9: The representation of the **stream_design_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation_item** that is of type **measure_representation_item** with a name of ‘pressure’.

WR10: The representation of the **stream_design_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation_item** that is of type **measure_representation_item** with a name of ‘minimum pressure’.

WR11: The representation of the **stream_design_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation_item** that is of type **measure_representation_item** with a name of ‘maximum pressure’.

WR12: The representation of the **stream_design_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation_item** that is of type **descriptive_representation_item** with a name of ‘stream reference data’.

WR13: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **property_definition** that is related with a **name** of ‘service characteristics’ shall have exactly one **representation** with the **name** of ‘stream operating characteristics’.

WR14: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at least three **representation_item**s.

WR15: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have one or two **representation_item**s of type **measure_representation_-item** and **thermodynamic_temperature_measure_with_unit** with a **name** of ‘temperature’, ‘minimum temperature’, or ‘maximum temperature’.

WR16: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘services characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at most one **representation_item** of type **measure_representation_-item** and **thermodynamic_temperature_measure_with_unit** with a **name** of ‘temperature’.

WR17: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at most one **representation_item** of type **measure_representation_-item** and **thermodynamic_temperature_measure_with_unit** with a **name** of ‘minimum temperature’.

WR18: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that

property_definition shall have at most one **representation_item** of type **measure_representation_-item** and **thermodynamic_temperature_measure_with_unit** with a **name** of ‘maximum temperature’.

WR19: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have one or two **representation_item**s of type **measure_representation_-item** with a **name** of ‘pressure’, ‘minimum pressure’, or ‘maximum pressure’.

WR20: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at most one **representation_item** of type **measure_representation_-item** with a **name** of ‘pressure’.

WR21: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at most one **representation_item** of type **measure_representation_-item** with a **name** of ‘minimum pressure’.

WR22: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at most one **representation_item** of type **measure_representation_-item** with a **name** of ‘maximum pressure’.

WR23: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have one or two **representation_item**s of type **measure_representation_-item** and **time_measure_with_unit** with a **name** of ‘duration’, ‘minimum duration’, or ‘maximum duration’.

WR24: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at most one **representation_item** of type **measure_representation_-item** and **time_measure_with_unit** with a **name** of ‘duration’.

WR25: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at most one **representation_item** of type **measure_representation_-item** and **time_measure_with_unit** with a **name** of ‘minimum duration’.

WR26: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property_definition** shall have at most one **representation_item** of type **measure_representation_-item** and **time_measure_with_unit** with a **name** of ‘maximum duration’.

WR27: If the **stream_design_case** relates to a **property_definition** with a **name** of ‘service characteristics’, that **property_definition** shall be a property of a **plant_item_connector**.

5.2.3.1.75 stream_phase

A **stream_phase** is a type of **property_definition** that identifies the characteristics of a gas, liquid, vapour, or particulate phase.

EXPRESS specification:

```
*)
ENTITY stream_phase
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE' IN
       TYPEOF (SELF.DEFINITION);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics')) = 1;
  WR3: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (spc.used_representation.items) >= 5))) = 0;
  WR4: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'constituent mole fraction'))) = 1))) = 0;
  WR5: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'constituents'))) = 1))) = 0;
  WR6: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
       TYPEOF (it)) AND
       (it.name = 'phase density'))) = 1))) = 0;
  WR7: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
       'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT']) = 2) AND
       (it.name = 'phase fraction'))) = 1))) = 0;
  WR8: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
       pdr.used_representation.name = 'stream phase characteristics') |
       NOT ({1 <= SIZEOF (QUERY (it <* spc.used_representation.items |
       (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
```

```
        'PLANT_SPATIAL_CONFIGURATION.' +
        'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
        (it.name IN ['temperature', 'minimum temperature',
        'maximum temperature']))) <= 2}))) = 0;
  WR9: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.' +
        'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'temperature'))) <= 1))) = 0;
 WR10: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.' +
        'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'minimum temperature'))) <= 1))) = 0;
 WR11: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.' +
        'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'maximum temperature'))) <= 1))) = 0;
 WR12: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
        TYPEOF (it)) AND
        (it.name = 'specific gravity'))) <= 1))) = 0;
 WR13: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
        TYPEOF (it)) AND
        (it.name = 'surface tension'))) <= 1))) = 0;
 WR14: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
        TYPEOF (it)) AND
        (it.name = 'viscosity'))) <= 1))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **stream_phase** shall define a property of a **stream_design_case**.

WR2: A **stream_phase** shall have exactly one **representation** with the name of 'stream phase characteristics'.

WR3: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at least five **representation_item**s.

WR4: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have exactly one **representation_item** that is of type **measure_representation_item** and **ratio_-measure_with_unit** with a name of 'constituent mole fraction'.

WR5: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have exactly one **representation_item** that is of type **descriptive_representation_item** with a name of 'constituents'.

WR6: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have exactly one **representation_item** that is of type **measure_representation_item** with a name of 'phase density'.

WR7: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have exactly one **representation_item** that is of type **measure_representation_item** and **ratio_-measure_with_unit** with a name of 'phase fraction'.

WR8: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have one or two **representation_item**s of type **measure_representation_item** and **thermodynamic_-temperature_measure_with_unit** with a **name** of 'temperature', 'minimum temperature', or 'maximum temperature'.

WR9: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_-temperature_measure_with_unit** with a **name** of 'temperature'.

WR10: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_-temperature_measure_with_unit** with a **name** of 'minimum temperature'.

WR11: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** of type **measure_representation_item** and **thermodynamic_-temperature_measure_with_unit** with a **name** of 'maximum temperature'.

WR12: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'specific gravity'.

WR13: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'surface tension'.

WR14: The representation of the **stream_phase** with the name of 'stream phase characteristics' shall have at most one **representation_item** that is of type **measure_representation_item** with a name of 'viscosity'.

5.2.3.1.76 structural_load_connector_classification

A **structural_load_connector_classification** is a type of **group** that classifies the items that are assigned to it as being structural load connectors. The **name** of the **structural_connector_-classification** further classifies the assigned items.

EXPRESS specification:

```
*)
ENTITY structural_load_connector_classification
  SUBTYPE OF (group);
END_ENTITY;
(*
```

5.2.3.1.77 structural_system

A **structural_system** is a type of **product_definition** that identifies a system or assembly of structural components.

EXPRESS specification:

```
*)
ENTITY structural_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
       ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
       (pdr.relating_product_definition.formation.of_product)) AND
       (pdr.relating_product_definition.frame_of_reference.name =
       'functional occurrence'))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **structural_system** shall be related to exactly one **product_definition** that is the definition of a plant and has a context of 'functional occurrence'.

5.2.3.1.78 support_constraint_representation

A **support_constraint_representation** is a type of **representation** that identifies limitations on the movement of a plant item.

EXPRESS specification:

```
*)
ENTITY support_constraint_representation
  SUBTYPE OF (representation);
WHERE
```

```
  WR1: SIZEOF (SELF.items) >= 3;
  WR2: SIZEOF (QUERY (it <* SELF.items |
       ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
       IN TYPEOF (it)) AND
       (it.name IN ['negative x', 'positive x', 'negative y',
       'positive y', 'negative z', 'positive z',
       'negative x rotation', 'positive x rotation',
       'negative y rotation', 'positive y rotation',
       'negative z rotation', 'positive z rotation'] ))) = 1;
  WR3: SIZEOF (QUERY (it <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT'
       IN TYPEOF (it))) = 1;
  WR4: SIZEOF (QUERY (it <* SELF.items |
       'PLANT_SPATIAL_CONFIGURATION.DESCRIPTIVE_REPRESENTATION_ITEM'
       IN TYPEOF (it))) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: The **support_constraint_representation** shall contain at least three items.

WR2: The **support_constraint_representation** shall contain **measure_representation_item**s that have a name of 'negative x', 'positive x', 'negative y', 'positive y', 'negative z', 'positive z', 'negative x rotation', 'positive x rotation', 'negative y rotation', 'positive y rotation', 'negative z rotation', or 'positive z rotation'.

WR3: The **support_constraint_representation** shall contain exactly one **ratio_measure_with_unit**.

WR4: The **support_constraint_representation** shall contain exactly one **descriptive_-representation_item**.

5.2.3.1.79 swage_fitting_classification

A **swage_fitting_classification** is a type of **group** that classifies the items that are assigned to it as swage fittings.

EXPRESS specification:

```
*)
ENTITY swage_fitting_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
```

```
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
       category_in_tree (prpc, 'swage'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **swage_fitting_classification** shall classify items of type **piping_component_definition**.

WR2: A **swage_fitting_classification** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'swage'.

5.2.3.1.80 system_classification

A **system_classification** is a type of **group** that classifies items that are assigned to it as systems. The name of the system classification may further classify the assigned item.

EXPRESS specification:

```
*)
ENTITY system_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT (SIZEOF (TYPEOF (it) *
       ['PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1)
       )) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **system_classification** shall classify items of type **ducting_system**, **electrical_system**, **instrumentation_and_control_system**, **piping_system**, and **structural_system**.

5.2.3.1.81 system_space

A **system_space** is a type of **product_definition_shape** that identifies the shape of the space allocated for an **electrical_system**, **ducting_system**, **instrumentation_and_control_system**, **piping_system**, or **structural_system**.

EXPRESS specification:

```
*)
ENTITY system_space
```

```
  SUBTYPE OF (product_definition_shape);
WHERE
  WR1: SIZEOF (TYPEOF (SELF.definition) *
       ['PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'INSTRUMENTATION_AND_CONTROL_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
       'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **system_space** shall define the shape of the space allocation for an **electrical_system**, **ducting_system**, **instrumentation_and_control_system**, **piping_system**, or **structural_system**.

5.2.3.1.82 truncated_pyramid

A **truncated_pyramid** is a type of **boolean_result** that is a solid primitive with a square bottom face, a square top face of smaller size than the bottom face, and four trapezoidal faces that connect the top and bottom face.

EXPRESS specification:

```
*)
ENTITY truncated_pyramid
  SUBTYPE OF (boolean_result);
END_ENTITY;
(*
```

5.2.3.1.83 valve_classification

A **valve_classification** is a type of **group** that classifies the items are assigned to it as valves. The name of the **valve_classification** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY valve_classification
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (it <* ca.items |
       NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (ca <* QUERY (ga <* USEDIN (SELF,
       'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP') |
       'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT' IN
       TYPEOF (ga)) |
       NOT (SIZEOF (QUERY (pcd <* QUERY (it <* ca.items |
       'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
       TYPEOF (it)) |
       NOT (SIZEOF (QUERY (prpc <* USEDIN (pcd.formation.of_product,
```

```
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
        category_in_tree (prpc, 'valve'))) = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

WR1: A **valve_classification** shall classify items of type **piping_component_definition**.

WR2: A **valve_classification** shall classify items of type **piping_component_definition** that are a definition of a **product** that is categorized as a 'valve'.

5.2.3.2 Plant spatial configuration imported entity modifications

5.2.3.2.1 action_request_status

The base definition of the **action_request_status** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **action_request_status** entity:

- change_life_cycle_stage_usage_requires_stage (see 5.2.4.8).

5.2.3.2.2 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 rules defined in this part of ISO 10303 apply to the **application_context** entity:

- application_context_requires_ap_definition (see 5.2.4.1);

- dependent_instantiable_application_context (see 5.2.4.9).

5.2.3.2.3 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 rule:

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).

5.2.3.2.4 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 rules defined in this part of ISO 10303 apply to the **approval** entity:

- approval_requires_approval_date_time (see 5.2.4.2);

- approval_requires_approval_person_organization (see 5.2.4.3).

5.2.3.2.5 approval_date_time

The base definition of the **approval_date_time** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **approval_date_time** entity:

- approval_requires_approval_date_time (see 5.2.4.2).

5.2.3.2.6 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 rule:

The following global rule defined in this part of ISO 10303 applies to the **approval_person_-organization** entity:

- approval_requires_approval_person_organization (see 5.2.4.3).

5.2.3.2.7 externally_defined_item

The base definition of the **externally_defined_item** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **externally_defined_item** entity:

- subtype_mandatory_externally_defined_item (see 5.2.4.17).

5.2.3.2.8 pre_defined_item

The base definition of the **pre_defined_item** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **pre_defined_item** entity:

- subtype_mandatory_defined_item (see 5.2.4.18).

5.2.3.2.9 product_context

The base definition of the **product_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **product_context** entity:

- dependent_instantiable_product_context (see 5.2.4.10);

- product_context_discipline_type_constraint (see 5.2.4.12).

5.2.3.2.10 product_definition

The base definition of the **product_definition** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **product_definition** entity:

- product_definition_usage_constraint (see 5.2.4.14).

5.2.3.2.11 product_definition_context

The base definition of the **product_definition_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **product_definition_context** entity:

- dependent_instantiable_product_definition_context (see 5.2.4.11);

- product_definition_context_name_constraint (see 5.2.4.13).

5.2.3.2.12 versioned_action_request

The base definition of the **versioned_action_request** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **versioned_action_request** entity:

- change_life_cycle_stage_usage_requires_approval (see 5.2.4.7);

- change_life_cycle_stage_usage_requires_stage (see 5.2.4.8);

- versioned_action_request_requires_change_action (see 5.2.4.19).

5.2.4 Plant spatial configuration 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: SIZEOF (QUERY (ac <* application_context |
       NOT (SIZEOF (QUERY (apd <* application_protocol_definition |
       (ac :=: apd.application)
       AND
       (apd.application_interpreted_model_schema_name =
       'plant_spatial_configuration'))) = 1 ))) = 0;
END_RULE;
(*
```

Argument definitions:

application_context: the set of all instances of **application_context** entities.

application_protocol_definition: the set of all instances of **application_protocol_definition** entities.

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 'plant_spatial_configuration' as its **application_interpreted_model_schema_name**.

5.2.4.2 approval_requires_approval_date_time

Every **approval** shall have exactly one **approval_date_time**.

EXPRESS specification:

```
*)
RULE approval_requires_approval_date_time FOR
  (approval_date_time,
   approval);
WHERE
  WR1: SIZEOF (QUERY (app <* approval |
       NOT (SIZEOF (QUERY (adt <* approval_date_time |
       (app :=: adt.dated_approval))) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **approval** there shall be exactly one **approval_date_time** that has the **approval** as its **dated_approval**.

5.2.4.3 approval_requires_approval_person_organization

Every **approval** shall have exactly one **approval_person_organization**.

EXPRESS specification:

```
*)
RULE approval_requires_approval_person_organization FOR
  (approval_person_organization,
   approval);
WHERE
  WR1: SIZEOF (QUERY (app <* approval |
       NOT (SIZEOF (QUERY (apo <* approval_person_organization |
       (app :=: apo.authorized_approval))) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **approval** there shall be exactly one **approval_person_organization** that has the **approval** as its **authorized_approval**.

5.2.4.4 change_action_requires_date

Every **change_action** shall have a date assigned to it.

EXPRESS specification:

```
*)
RULE change_action_requires_date FOR
  (change_action,
   plant_spatial_configuration_date_assignment);
WHERE
  WR1: SIZEOF (QUERY (ca <* change_action |
       NOT (SIZEOF (QUERY (pscda <*
       plant_spatial_configuration_date_assignment |
       (ca IN pscda.items))) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **change_action** there shall be exactly one **plant_spatial_configuration_date_-assignment** that contains the **change_action** in its set of **items**.

5.2.4.5 change_item_requires_creation_date

Every item of a **plant_spatial_configuration_change_assignment** shall have a date assigned to it with the role of 'creation date'.

EXPRESS specification:

```
*)
RULE change_item_requires_creation_date FOR
  (plant_spatial_configuration_change_assignment,
   plant_spatial_configuration_date_assignment);
WHERE
  WR1: SIZEOF (QUERY (pscca <*
           plant_spatial_configuration_change_assignment |
       NOT (SIZEOF (QUERY (ch_it <* pscca.items |
       NOT (SIZEOF (QUERY (pscda <*
           plant_spatial_configuration_date_assignment |
       (NOT (ch_it IN pscda.items) OR
       (pscda.role.name = 'creation date')))) = 1))) = 0))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each item of a **plant_spatial_configuration_change_assignment** there shall be exactly one **plant_spatial_configuration_date_assignment** with a role of 'creation date' that assigns a date to the item.

5.2.4.6 change_item_requires_id

Every item of a **plant_spatial_configuration_change_assignment** shall have an identification assigned to it.

EXPRESS specification:

```
*)
RULE change_item_requires_id FOR
  (plant_spatial_configuration_change_assignment,
   change_item_id_assignment);
WHERE
  WR1: SIZEOF (QUERY (pscca <*
           plant_spatial_configuration_change_assignment |
       NOT (SIZEOF (QUERY (ch_it <* pscca.items |
       NOT (SIZEOF (QUERY (ciia <* change_item_id_assignment |
       (ch_it IN ciia.items))) = 1))) = 0))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each item of a **plant_spatial_configuration_change_assignment** there shall be exactly one **change_item_id_assignment** that assigns an identification to the item.

5.2.4.7 change_life_cycle_stage_usage_requires_approval

Every **versioned_action_request** shall have an approval assigned to it.

EXPRESS specification:

```
*)
RULE change_life_cycle_stage_usage_requires_approval FOR
  (versioned_action_request,
   plant_spatial_configuration_approval_assignment);
WHERE
  WR1: SIZEOF (QUERY (vareq <* versioned_action_request |
       NOT (SIZEOF (QUERY (pscaa <*
       plant_spatial_configuration_approval_assignment |
       vareq IN pscaa.items)) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **versioned_action_request** there shall be exactly one **plant_spatial_configuration_-approval_assignment** that contains the **versioned_action_request** in its set of **items**.

5.2.4.8 change_life_cycle_stage_usage_requires_stage

Every **versioned_action_request** shall have a status assigned to it.

EXPRESS specification:

```
*)
RULE change_life_cycle_stage_usage_requires_stage FOR
  (versioned_action_request,
   action_request_status);
WHERE
  WR1: SIZEOF (QUERY (vareq <* versioned_action_request |
       NOT (SIZEOF (QUERY (ars <* action_request_status |
       vareq :=: ars.assigned_request)) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **versioned_action_request** there shall be exactly one **action_request_status** that has the **versioned_action_request** as its **assigned_request**.

5.2.4.9 dependent_instantiable_application_context

The **dependent_instantiable_application_context** rule specifies that all instances of **application_-context** are dependent on their usage to define another entity.

EXPRESS specification:

```
*)
RULE dependent_instantiable_application_context FOR (application_context);
WHERE
  WR1: SIZEOF (QUERY (ac <* application_context |
       NOT (SIZEOF (USEDIN (ac, '')) >= 1))) = 0;
END_RULE;
(*
```

Argument definition:

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

Formal proposition:

WR1: For each instance of **application_context**, there shall be a reference to the **application_context** instance from an attribute of another entity.

5.2.4.10 dependent_instantiable_product_context

The **dependent_instantiable_product_context** rule specifies that all instances of **product_context** are dependent on their usage to define another entity.

EXPRESS specification:

```
*)
RULE dependent_instantiable_product_context FOR (product_context);
WHERE
  WR1: SIZEOF (QUERY (pc <* product_context |
       NOT (SIZEOF (USEDIN (pc, '')) >= 1))) = 0;
```

```
END_RULE;
(*
```

Argument definition:

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

Formal proposition:

WR1: For each instance of **product_context**, there shall be a reference to the **product_context** instance from an attribute of another entity.

5.2.4.11 dependent_instantiable_product_definition_context

The **dependent_instantiable_product_definition_context** rule specifies that all instances of **product_-definition_context** are dependent on their usage to define another entity.

EXPRESS specification:

```
*)
RULE dependent_instantiable_product_definition_context FOR
  (product_definition_context);
WHERE
  WR1: SIZEOF (QUERY (pdc <* product_definition_context |
       NOT (SIZEOF (USEDIN (pdc, '')) >= 1))) = 0;
END_RULE;
(*
```

Argument definition:

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

Formal proposition:

WR1: For each instance of **product_definition_context**, there shall be a reference to the **product_-definition_context** instance from an attribute of another entity.

5.2.4.12 product_context_discipline_type_constraint

Every **product_context** shall have a **discipline_type** of ‘process plant’.

EXPRESS specification:

```
*)
RULE product_context_discipline_type_constraint FOR
  (product_context);
WHERE
  WR1: SIZEOF (QUERY (pc <* product_context |
       NOT (pc.name = 'process plant'))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **product_context**, the **name** shall be ‘process plant’.

5.2.4.13 product_definition_context_name_constraint

Every **product_definition_context** shall have a name of ‘functional definition’, ‘physical definition’, ‘functional occurrence’, ‘physical occurrence’, ‘catalogue definition’, or ‘fabrication assembly’.

EXPRESS specification:

```
*)
RULE product_definition_context_name_constraint FOR
  (product_definition_context);
WHERE
  WR1: SIZEOF (QUERY (pdc <* product_definition_context |
       NOT (pdc.name IN
       ['functional definition', 'physical definition',
        'functional occurrence', 'physical occurrence',
        'catalogue definition', 'fabrication assembly']))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **product_definition_context**, the **name** shall be ‘functional definition’, ‘physical definition’, ‘functional occurrence’, ‘physical occurrence’, ‘catalogue definition’, or ‘fabrication assembly’.

5.2.4.14 product_definition_usage_constraint

Every **product_definition** that identifies an item that may be used as a component of a plant shall have restricted participation in relationships with other **product_definition**s.

EXPRESS specification:

```
*)
RULE product_definition_usage_constraint FOR (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pd <* product_definition |
       ((pd.frame_of_reference.name = 'physical occurrence') AND
       (NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.' +
       'RELATED_PRODUCT_DEFINITION') |
       SIZEOF (TYPEOF (pdr) *
       ['PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_USAGE',
       'PLANT_SPATIAL_CONFIGURATION.MAKE_FROM_USAGE_OPTION',
       'PLANT_SPATIAL_CONFIGURATION.ASSEMBLY_COMPONENT_USAGE'])
       = 1)) <= 1))))) = 0;
  WR2: SIZEOF (QUERY (pd <* product_definition |
       ((pd.frame_of_reference.name = 'physical definition') AND
       (NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
       'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.' +
       'RELATING_PRODUCT_DEFINITION') |
       pdr.related_product_definition.frame_of_reference.name =
       'physical occurrence')) <= 1))))) = 0;
```

```
END_RULE;
(*
```

Formal propositions:

WR1: For each **product_definition** that has a **product_definition_context** where the name is ‘physical occurrence’, the **product_definition** shall be the related **product_definition** in at most one **product_definition_usage**, **make_from_usage_option**, or **assembly_component_usage**.

WR2: For each **product_definition** that has a **product_definition_context** where the name is ‘physical definition’, the **product_definition** shall be related to at most one **product_definition** that has a **product_definition_context** where the name is ‘physical occurrence’.

5.2.4.15 subtype_exclusive_characterized_object

All instances of **characterized_object** shall be an instance of at most one of **piping_component_class**, **site**, or **stream_design_case**.

EXPRESS specification:

```
*)
RULE subtype_exclusive_characterized_object FOR
  (characterized_object);
WHERE
  WR1: SIZEOF (QUERY (co <*characterized_object |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_CLASS',
       'PLANT_SPATIAL_CONFIGURATION.SITE',
       'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE']
       * TYPEOF (co)) <= 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every instance of **characterized_object** shall also be an instance of at most one of **piping_component_class**, **site**, or **stream_design_case**.

5.2.4.16 subtype_exclusive_shape_representation

All instances of **shape_representation** shall be instances of at most one of **advanced_csg_shape_-representation**, **hybrid_shape_representation**, or **piping_design_csg_shape_representation**.

EXPRESS specification:

```
*)
RULE subtype_exclusive_shape_representation FOR
  (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (sr <*shape_representation|
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.' +
       'ADVANCED_CSG_SHAPE_REPRESENTATION',
       'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION',
       'PLANT_SPATIAL_CONFIGURATION.' +
       'PIPING_DESIGN_CSG_SHAPE_REPRESENTATION']
```

```
       * TYPEOF (sr)) <= 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every instance of **shape_representation** shall be an instance of at most one of **advanced_csg_-shape_representation**, **hybrid_shape_representation**, or **piping_design_csg_shape_representation**.

5.2.4.17 subtype_mandatory_externally_defined_item

All instances of **externally_defined_item** shall be instances of **known_source**.

EXPRESS specification:

```
*)
RULE subtype_mandatory_externally_defined_item FOR
  (externally_defined_item);
WHERE
  WR1: SIZEOF (QUERY (edi <* externally_defined_item |
       NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.CATALOGUE_CONNECTOR',
       'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_CLASSIFICATION',

'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION']
       * TYPEOF (edi)) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every instance of **externally_defined_item** shall also be an instance of one of **catalogue_-connector**, **externally_defined_classification** or **externally_defined_plant_item_definition**.

5.2.4.18 subtype_mandatory_pre_defined_item

All instances of **pre_defined_item** shall be instances of **known_source**.

EXPRESS specification:

```
*)
RULE subtype_mandatory_pre_defined_item FOR
  (pre_defined_item);
WHERE
  WR1: SIZEOF (QUERY (pdi <* pre_defined_item |
       NOT ('PLANT_SPATIAL_CONFIGURATION.KNOWN_SOURCE' IN
       TYPEOF (pdi)))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: Every instance of **pre_defined_item** shall also be an instance of **known_source**.

5.2.4.19 versioned_action_request_requires_change_action

Every **versioned_action_request** shall be the request for exactly one **change_action**.

EXPRESS specification:

```
*)
RULE versioned_action_request_requires_change_action FOR
  (change_action,
   versioned_action_request);
WHERE
  WR1: SIZEOF (QUERY (vareq <* versioned_action_request |
       NOT (SIZEOF (QUERY (ca <* change_action |
       (vareq IN ca.directive.requests))) = 1))) = 0;
END_RULE;
(*
```

Formal propositions:

WR1: For each **versioned_action_request** there shall be exactly one **change_action** whose directive contains the **versioned_action_request** in its set of **requests**.

5.2.5 Plant spatial configuration function definitions

5.2.5.1 bag_to_set

The **bag_to_set** function converts BAGs into SETs.

> EXAMPLE 75 - It can be used to convert the BAGs returned by the USEDIN function into SETs that can be properly assigned to variables that are SETs.

EXPRESS specification:

```
*)
FUNCTION bag_to_set (the_bag: BAG OF GENERIC:intype) :
    SET OF GENERIC:intype;

  LOCAL
    the_set : SET OF GENERIC:intype := [];
    i       : INTEGER;
  END_LOCAL;
  IF SIZEOF(the_bag) > 0 THEN
    REPEAT i := 1 TO HIINDEX(the_bag) BY 1;
      the_set := the_set + the_bag[i];
    END_REPEAT;
  END_IF;
  RETURN(the_set);
END_FUNCTION;
(*
```

Argument definitions:

the_bag: the BAG that is to be converted into a SET.

5.2.5.2 category_in_tree

The **category_in_tree** function is a boolean function that returns true if the specified **product_-category** has the **name** specified by the **val** parameter, or if the specified **product_category** has a **super_category** with the **name** specified by the **val** parameter.

EXPRESS specification:

```
*)
FUNCTION category_in_tree (cat : product_category; val : STRING) : BOOLEAN;
  IF cat.name = val THEN RETURN (TRUE);
  ELSE
    RETURN (SIZEOF (QUERY (pc <* USEDIN (cat,
'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_CATEGORY_RELATIONSHIP.SUB_CATEGORY') |
    category_in_tree (pc, val))) = 1);
  END_IF;
  RETURN (FALSE);
END_FUNCTION;
(*
```

Argument definitions:

cat: the **product_category** the **name** that the specified value is required for.

val: the **value** that is required for the **product_category**.

5.2.5.3 plant_spatial_configuration_organization_correlation

The **plant_spatial_configuration_organization_correlation** boolean function returns TRUE if the **name** attribute of the **organization_role** entity is coordinated with the type of entity selected in the **items** of a **plant_spatial_configuration_organization_assignment**.

> EXAMPLE 76 - If the role for an **organization** is ‘vendor’, then all of the **items** in the set must be either **product** or **document**.

EXPRESS specification:

```
*)
FUNCTION plant_spatial_configuration_organization_correlation
  (e : plant_spatial_configuration_organization_assignment ) : BOOLEAN;
  LOCAL
    o_role : STRING;
  END_LOCAL;
    o_role := e\organization_assignment.role.name;
  CASE o_role OF
    'vendor'            : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          SIZEOF(['PLANT_SPATIAL_CONFIGURATION.PRODUCT',
                                  'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
                          TYPEOF (x)) = 1))
                          THEN RETURN(FALSE);
                          END_IF;
    'owner'             : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
```

```
                                 'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
                            TYPEOF (x)) = 1))
                            THEN RETURN(FALSE);
                            END_IF;
    'plant operator'    : IF SIZEOF (e.items) <>
                            SIZEOF (QUERY (x <* e.items |
                            'PLANT_SPATIAL_CONFIGURATION.PLANT'
                            IN TYPEOF (x)))
                            THEN RETURN(FALSE);
                            END_IF;
    'plant owner'       : IF SIZEOF (e.items) <>
                            SIZEOF (QUERY (x <* e.items |
                            'PLANT_SPATIAL_CONFIGURATION.PLANT'
                            IN TYPEOF (x)))
                            THEN RETURN(FALSE);
                            END_IF;
    'project owner'     : IF SIZEOF (e.items) <>
                            SIZEOF (QUERY (x <* e.items |
                            'PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT'
                            IN TYPEOF (x)))
                            THEN RETURN(FALSE);
                            END_IF;
    'assessor'          : IF SIZEOF (e.items) <>
                            SIZEOF (QUERY (x <* e.items |
                            'PLANT_SPATIAL_CONFIGURATION.' +
                            'PRODUCT_DEFINITION_RELATIONSHIP'
                            IN TYPEOF (x)))
                            THEN RETURN(FALSE);
                            END_IF;
    OTHERWISE : RETURN(TRUE);
  END_CASE;
  RETURN (TRUE);
END_FUNCTION;
(*
```

Argument definitions:

e: the input **plant_spatial_configuration_organization_assignment** to be checked.

5.2.5.4 plant_spatial_configuration_person_and_organization_correlation

The **plant_spatial_configuration_person_and_organization_correlation** boolean function returns TRUE if the **name** attribute of the **person_organization_role** entity is coordinated with the type of entity selected in the **items** of a **plant_spatial_configuration_person_and_organization_assignment**.

EXAMPLE 77 - If the role for a **person_and_organization** is 'owner', then all of the **items** in the set must be either **site** or **change_item**.

EXPRESS specification:

```
*)
FUNCTION plant_spatial_configuration_person_and_organization_correlation
  (e : plant_spatial_configuration_person_and_organization_assignment )
  : BOOLEAN;
  LOCAL
    po_role : STRING;
  END_LOCAL;
    po_role := e\person_and_organization_assignment.role.name;
  CASE po_role OF
```

```
    'owner'             : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
                                  'PLANT_SPATIAL_CONFIGURATION.' +
                                  'CHANGE_ITEM'] *
                          TYPEOF (x)) = 1))
                          THEN RETURN(FALSE);
                          END_IF;
    'plant owner'       : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.PLANT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'plant operator'    : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.PLANT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    OTHERWISE : RETURN(TRUE);
  END_CASE;
  RETURN (TRUE);
END_FUNCTION;
(*
```

Argument definitions:

e: the input **plant_spatial_configuration_person_and_organization_assignment** to be checked.

5.2.5.5 plant_spatial_configuration_person_correlation

The **plant_spatial_configuration_person_correlation** boolean function returns TRUE if the **name** attribute of the **person_role** entity is coordinated with the type of entity selected in the **items** of a **plant_spatial_configuration_person_assignment**.

EXAMPLE 78 - If the role for a **person** is 'owner', then all of the **items** in the set must be either **site** or **document**.

EXPRESS specification:

```
*)
FUNCTION plant_spatial_configuration_person_correlation
  (e : plant_spatial_configuration_person_assignment ) : BOOLEAN;
  LOCAL
    p_role : STRING;
  END_LOCAL;
    p_role := e\person_assignment.role.name;
  CASE p_role OF
    'vendor'            : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'owner'             : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
                                  'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
```

```
                          TYPEOF (x)) = 1))
                          THEN RETURN(FALSE);
                          END_IF;
    'plant owner'       : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.PLANT'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    'assessor'          : IF SIZEOF (e.items) <>
                          SIZEOF (QUERY (x <* e.items |
                          'PLANT_SPATIAL_CONFIGURATION.' +
                          'PRODUCT_DEFINITION_RELATIONSHIP'
                          IN TYPEOF (x)))
                          THEN RETURN(FALSE);
                          END_IF;
    OTHERWISE : RETURN(TRUE);
  END_CASE;
  RETURN (TRUE);
END_FUNCTION;
(*
```

Argument definitions:

e: the input **plant_spatial_configuration_person_assignment** to be checked.

5.2.5.6 valid_advanced_csg_tree

The **valid_advanced_csg_tree** function returns true if the elements that comprise the CSG tree passed in as a parameter satisfy the requirements defined for advanced CSG trees.

```
*)
FUNCTION valid_advanced_csg_tree (tree_element : boolean_operand) :
BOOLEAN;

  -- return true if the tree_element is a valid primitive

  IF SIZEOF (TYPEOF (tree_element) *
    ['PLANT_SPATIAL_CONFIGURATION.BLOCK',|
    'PLANT_SPATIAL_CONFIGURATION.TORUS',
    'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
    'PLANT_SPATIAL_CONFIGURATION.SPHERE',
    'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'ADVANCED_FACE_WITH_THICKNESS_SHAPE_REPRESENTATION',
    'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID']) = 1 |
    THEN RETURN (TRUE);
    ELSE

    -- if the tree_element is a boolean_result check its operations and
    -- operands

    IF 'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT' |
    IN TYPEOF (tree_element)
      THEN

      -- addition and subtraction are the only valid operations

      IF NOT (tree_element\boolean_result.operator
```

```
        IN [boolean_operator.union, boolean_operator.difference])
        THEN RETURN (FALSE);
      END_IF;

      -- if the operand is a half_space_solid, check for advanced surface
      -- otherwise return false and recursively check second operand

      IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
        TYPEOF (tree_element\boolean_result.first_operand) THEN
        IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
          TYPEOF (tree_element\boolean_result.
                  first_operand\half_space_solid.base_surface) THEN
          IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
            TYPEOF (tree_element\boolean_result.second_operand) THEN
            IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
              TYPEOF (tree_element\boolean_result.
                      second_operand\half_space_solid.base_surface) THEN
              RETURN (TRUE);
              ELSE RETURN (FALSE);
            END_IF;
            ELSE RETURN (valid_advanced_csg_tree
            (tree_element\boolean_result.second_operand));
          END_IF;
          ELSE RETURN (FALSE);
        END_IF;
        ELSE
          IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
            TYPEOF (tree_element\boolean_result.second_operand) THEN
            IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN TYPEOF
              (tree_element\boolean_result.second_operand\half_space_solid.
               base_surface) THEN
              RETURN (valid_advanced_csg_tree
                        (tree_element\boolean_result.first_operand));
              ELSE
              RETURN (FALSE);
            END_IF;
            ELSE
            RETURN (valid_advanced_csg_tree
                      (tree_element\boolean_result.first_operand) AND
                    valid_advanced_csg_tree
                      (tree_element\boolean_result.second_operand));
          END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN (FALSE);
END_FUNCTION;
(*
```

Argument definitions:

tree_element: (input) the **boolean_operand** to be evaluated.

```
*)
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 Information 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:

- Class 1 - Provides piping system functional information;

- Class 2 - Provides equipment and component spatial information;

- Class 3 - Provides plant layout and piping design information;

- Class 4 - Provides piping fabrication and installation information

Support for a particular conformance class requires support of all the options specified in this class. All four conformance classes include information concerning plant item characterization, piping component characterization, connectors, connections, and change information.

Table 13 defines the units of functionality included within each conformance class.

Conformance to a particular class requires that all AIM elements defined as part of that class be supported. Table 14 defines the classes that each AIM element belongs to.

NOTE - ISO 10303-327:-[2)] defines the abstract test suite (ATS) to be used in the assessment of conformance. ISO 10303-32:-[2)] describes the conformance assessment process.

6.1 Class 1

This conformance class provides piping system functional information. This conformance class contains functional information of the piping system and catalogue reference information, but no shape or spatial information. This conformance class enables the following activity:

- exchange of functional information on plant piping systems.

[2)] To be published.

NOTES

1 - The purpose of this conformance class is to provide an interface with ISO 10303-221[2)] [3] and piping functional design and schematics software.

2 - This conformance class is related to the following data flows between AAM activities:

- Piping and Instrumentation Diagrams (Preliminary) A222 to A223, A224, and A225;

- Piping and Instrumentation Diagrams (AFD) A222 to A232 and A235;

- Piping and Instrumentation Diagrams (Design) A232 to A241;

- Piping and Instrumentation Diagrams A241 to A242, A243, A244, A245, and O4.

6.2 Class 2

This conformance class provides equipment and component spatial information. This conformance class contains basic equipment performance characteristics, connector location and orientation information, material specifications, version information, explicit shape, and catalogue reference information. This conformance class enables the exchange of minimal vendor equipment and component information.

NOTE - This conformance class is related to the following data flows between AAM activities:

- Equipment List C3 to A32;

- Equipment Characteristics C3 to A32;

- Material Requirements C3 to A32;

- Specifications and Standards C3 to A32 and A33;

- Plant Items A35 to A43.

6.3 Class 3

This conformance class provides plant layout and piping design information. This conformance class contains design, layout, and spatial information for the plant, and catalogue reference information. This conformance class enables the exchange of plant layout and piping design information and supports the following activities:

- area classification;

- space analysis;

- plant arrangement (placement of space occupying elements);

- spatial design of piping systems including pipe routing and component placement and placement of pipe supports;

- operation and maintenance analysis;

- constructability reviews;

- interference checking;

- development of equipment list and line list;

- development of equipment takeoffs;

- development of material takeoffs for piping and piping components;

- connectivity and topology checks;

- material and connection compatibility checks;

- provision of spatial design information to support fabrication and construction;

- spool and weld identification;

- plant startup;

- plant commissioning;

- plant operation;

- configuration management of plant items and piping system information.

NOTES

1 - Although not explicitly cited above, this conformance class also supports the activities listed for the other conformance classes.

2 - This conformance class is related to the following data flows between AAM activities:

- Corporate Standards to A22 and A24;

- Societal Requirements to A22 and A24;

- Site Information (Existing) I3 to A222 and A224;

- Site Information (Existing) I1 to A242;

- Process Flow Diagrams C2 to A222, A223, A224, and A225;

- Process Flow Diagrams C4 to A241;

- Equipment List A223 to A222, A232, A233, and A241;

- Equipment List A241 to A242, A245, and A32;

- Equipment List C3 to A32;
- Equipment Characteristics (Required) C1 to A222 and A223;
- Equipment Characteristics (Functional) A222 to A223;
- Equipment Characteristics (Performance) A223 to A222, A232, A233, and A241;
- Equipment Characteristics (Performance) A241 to A242, A245, and A32;
- Equipment Characteristics (Process) C1 to A241;
- Equipment Characteristics C3 to A32;
- Piping and Instrumentation Diagrams (Preliminary) A222 to A223, A224, and A225;
- Piping and Instrumentation Diagrams (AFD) A222 to A232, A234, and A235;
- Piping and Instrumentation Diagrams (Design) C2 to A241;
- System Layout (Preliminary) A224 to A222, A232, A234, A235, and A242;
- System Design (Preliminary) A222 to A224, A232, A234, A235, and A242;
- System Layout and Design A242 to A243, A244, A245, and A41;
- Change Request (Design) A222, A223, A224, and A225 to A21;
- Change Request (Design) A241, A242, and A245 to A23;
- Supplier Documentation I3 to A241 and A242;
- Specifications and Standards C9 to A241, A242, A243, and A244;
- Specifications and Standards C3 to A32 and A33;
- Material Requirements A241 to A242, A245, and A32;
- Material Requirements C3 to A32;
- Project-specific Documents A241, A242, A243 to A32, A33, A34, and A35;
- Plant Items A35 to A43.

6.4 Class 4

This conformance class provides piping fabrication and installation information. This conformance class contains system, plant item, and line identification, piping information, plant item characteristics and shape, and catalogue reference information. This conformance class enables the exchange of piping fabrication and installation information.

NOTE - This conformance class is related to the following data flows between AAM activities:

- Plant Items I1 to A43;
- Change Request A43 to A2;
- Specifications and Standards to A43;
- Company Requirements to A43;
- Project-specific Documents to A43;
- Supplier Documentation C1 to A43.

Table 13 - Conformance classes

Unit of functionality	Conformance class			
	1	2	3	4
plant_characterization	X	-	X	-
site_characterization	-	-	X	-
piping_system_functional_characterization	X	-	X	X
plant_item_characterization	X	X	X	X
piping_component_characterization	X	X	X	X
connector	X	X	X	X
connection	X	X	X	X
change_information	X	X	X	X
shape	-	X	X	X
csg_and_b_rep_geometry	-	X	X	-
wireframe_geometry	-	-	X	X

Table 14 - Conformance class elements

AIM element	Conformance class			
	1	2	3	4
action	X	X	X	X
action_assignment	X	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
action_directive	X	X	X	X
action_method	X	X	X	X
action_method_relationship	X	X	X	X
action_relationship	X	X	X	X
action_request_assignment	X	X	X	X
action_request_solution	X	X	X	X
action_request_status	X	X	X	X
action_status	X	X	X	X
advanced_csg_shape_representation	-	X	X	-
amount_of_substance_measure_with_unit	X	-	X	-
amount_of_substance_unit	X	-	X	-
angular_location	-	X	X	X
application_context	X	X	X	X
application_context_element	X	X	X	X
application_protocol_definition	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_role	X	X	X	X
approval_status	X	X	X	X
area_measure_with_unit	X	X	X	-
area_unit	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

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
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
bezier_curve	-	X	X	X
bezier_surface	-	X	X	X
blank_fitting_classification	X	X	X	X
block	-	X	X	-
boolean_result	-	X	X	-
boundary_curve	-	X	X	-
bounded_curve	-	X	X	X
bounded_pcurve	-	X	X	X
bounded_surface	-	X	X	X
bounded_surface_curve	-	X	X	X
brep_with_voids	-	X	X	-
calendar_date	X	X	X	X
cartesian_point	X	X	X	X
cartesian_transformation_operator	-	X	X	X
cartesian_transformation_operator_3d	-	X	X	X
catalogue	X	X	X	X
catalogue_connector	X	X	X	X
catalogue_item	X	X	X	X
centre_of_symmetry	-	X	X	X
change_action	X	X	X	X
change_from_assignment	X	X	X	X
change_item_id_assignment	X	X	X	X
change_to_assignment	X	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
characterized_object	X	X	X	X
circle	-	X	X	X
classification_assignment	X	X	X	X
closed_shell	-	X	X	-
colour	-	X	X	X
colour_rgb	-	X	X	X
colour_specification	-	X	X	X
composite_curve	-	X	X	X
composite_curve_on_surface	-	X	X	X
composite_curve_segment	-	X	X	X
conic	-	X	X	X
conical_surface	-	X	X	X
connected_face_set	-	X	X	-
connection_functional_classification	X	X	X	X
connection_motion_classification	-	X	X	X
connection_node	X	X	X	X
connector_end_type_classification	X	X	X	X
context_dependent_unit	X	X	X	X
conversion_based_unit	X	X	X	X
coordinated_universal_time_offset	X	X	X	X
csg_solid	-	X	X	-
curve	-	X	X	X
curve_bounded_surface	-	X	X	X
curve_replica	-	X	X	X
cylindrical_surface	-	X	X	X
data_environment	-	X	X	X
date	X	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
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
definitional_representation	-	X	X	-
degenerate_pcurve	-	X	X	X
degenerate_toroidal_surface	-	X	X	X
derived_shape_aspect	-	X	X	X
derived_unit	X	X	X	X
derived_unit_element	X	X	X	X
descriptive_colour	-	X	X	X
descriptive_representation_item	X	X	X	X
design_project	X	X	X	X
design_project_assignment	X	X	X	X
dimensional_characteristic_representation	-	X	X	X
dimensional_exponents	X	X	X	X
dimensional_location	-	X	X	X
dimensional_size	-	X	X	X
directed_action	X	X	X	X
direction	X	X	X	X
document	X	X	X	X
document_reference	X	X	X	X
document_relationship	X	X	X	X
document_type	X	X	X	X
document_usage_constraint	X	X	X	X
ducting_system	X	-	X	-

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
edge	-	X	X	-
edge_curve	-	X	X	-
edge_loop	-	X	X	-
elbow_fitting_classification	X	X	X	X
electric_current_measure_with_unit	X	-	X	-
electric_current_unit	X	-	X	-
electrical_connector_classification	X	X	X	X
electrical_system	X	-	X	-
elementary_surface	-	X	X	X
ellipse	-	X	X	X
evaluated_degenerate_pcurve	-	X	X	X
executed_action	X	X	X	X
external_source	X	X	X	X
externally_defined_classification	X	X	X	X
externally_defined_item	X	X	X	X
externally_defined_plant_item_definition	X	X	X	X
extruded_area_solid	-	X	X	-
extruded_face_solid	-	X	X	-
face	-	X	X	-
face_bound	-	X	X	-
face_surface	-	X	X	-
faceted_brep	-	X	X	-
flange_fitting_classification	X	X	X	X
flange_fitting_neck_type_classification	X	X	X	X
functionally_defined_transformation	-	X	X	X
geometric_curve_set	-	X	X	X
geometric_representation_context	-	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
geometric_representation_item	-	X	X	X
geometric_set	-	X	X	X
geometric_set_replica	-	X	X	X
global_unit_assigned_context	X	X	X	X
group	X	X	X	X
group_assignment	X	X	X	X
half_space_solid	-	X	X	-
heat_tracing_representation	X	X	X	X
hybrid_shape_representation	-	X	X	-
hyperbola	-	X	X	X
inline_equipment	-	X	X	X
instrumentation_and_control_system	X	-	X	-
interfering_shape_element	-	X	X	X
intersection_curve	-	X	X	X
known_source	X	X	X	X
length_measure_with_unit	X	X	X	X
length_unit	X	X	X	X
line	X	X	X	X
line_branch_connection	X	-	X	X
line_less_piping_system	X	-	X	X
line_plant_item_branch_connection	X	-	X	X
line_plant_item_connection	X	-	X	X
line_termination_connection	X	-	X	X
local_time	X	X	X	X
loop	-	X	X	-
make_from_usage_option	-	X	X	X
manifold_solid_brep	-	X	X	-

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
mapped_item	-	X	X	X
mass_measure_with_unit	X	X	X	X
mass_unit	X	X	X	X
material_designation	-	X	X	X
material_designation_characterization	-	X	X	X
material_property	-	X	X	X
material_property_representation	-	X	X	X
measure_representation_item	X	X	X	X
measure_with_unit	X	X	X	X
name_assignment	X	X	X	X
named_unit	X	X	X	X
offset_curve_2d	-	X	X	X
offset_curve_3d	-	X	X	X
offset_surface	-	X	X	X
open_shell	-	X	X	-
organization	X	X	X	X
organization_assignment	X	X	X	X
organization_role	X	X	X	X
organizational_project	X	X	X	X
oriented_closed_shell	-	X	X	-
oriented_edge	-	X	X	-
oriented_face	-	X	X	-
oriented_open_shell	-	X	X	-
oriented_path	-	X	X	-
parabola	-	X	X	X
path	-	X	X	-
pcurve	-	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
person	X	X	X	X
person_and_organization	X	X	X	X
person_and_organization_assignment	X	X	X	X
person_and_organization_role	X	X	X	X
person_assignment	X	X	X	X
person_role	X	X	X	X
pipe_classification	X	X	X	X
pipe_closure_fitting_classification	X	X	X	X
piping_component_class	X	X	X	X
piping_component_definition	X	X	X	X
piping_connector_classification	X	X	X	X
piping_design_csg_shape_representation	-	X	X	-
piping_system	X	X	X	X
placement	X	X	X	X
plane	-	X	X	X
plane_angle_measure_with_unit	-	X	X	X
plane_angle_unit	-	X	X	X
plant	X	X	X	X
plant_item_connection	X	X	X	X
plant_item_connector	X	X	X	X
plant_item_interference	-	X	X	X
plant_item_route	-	X	X	X
plant_item_weight_representation	-	X	X	X
plant_line_definition	X	-	X	X
plant_line_segment_definition	X	-	X	X
plant_line_segment_termination	X	-	X	X
plant_spatial_configuration_action_request_assignment	X	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
plant_spatial_configuration_approval_assignment	X	X	X	X
plant_spatial_configuration_change_assignment	X	X	X	X
plant_spatial_configuration_date_and_time_assignment	X	X	X	X
plant_spatial_configuration_date_assignment	X	X	X	X
plant_spatial_configuration_document_reference	X	X	X	X
plant_spatial_configuration_organization_assignment	X	X	X	X
plant_spatial_configuration_person_and_organization_assignment	X	X	X	X
plant_spatial_configuration_person_assignment	X	X	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	-
polyline	-	X	X	X
pre_defined_item	X	X	X	X
presentation_layer_assignment	-	X	X	X
process_capability	X	X	X	X
product	X	X	X	X
product_category	X	X	X	X
product_category_relationship	X	X	X	X
product_context	X	X	X	X
product_definition	X	X	X	X
product_definition_context	X	X	X	X
product_definition_formation	X	X	X	X
product_definition_formation_relationship	X	X	X	X
product_definition_formation_with_specified_source	X	X	X	X
product_definition_relationship	X	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
product_definition_shape	X	X	X	X
product_definition_substitute	X	X	X	X
product_definition_usage	X	X	X	X
product_definition_with_associated_documents	X	X	X	X
product_material_composition_relationship	-	X	X	X
product_related_product_category	X	X	X	X
property_definition	X	X	X	X
property_definition_relationship	X	X	X	X
property_definition_representation	X	X	X	X
purchase_assignment	-	X	X	X
qualified_representation_item	-	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
rectangular_composite_surface	-	X	X	X
rectangular_trimmed_surface	-	X	X	X
reducer_fitting_classification	X	X	X	X
reference_geometry	-	X	X	X
reparametrised_composite_curve_segment	-	X	X	X
representation	X	X	X	X
representation_context	X	X	X	X
representation_item	X	X	X	X
representation_map	-	X	X	X
required_material_property	-	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
reserved_space	-	X	X	X
revolved_area_solid	-	X	X	-
revolved_face_solid	-	X	X	-
right_circular_cone	-	X	X	X
right_circular_cylinder	-	X	X	X
seam_curve	-	X	X	X
shape_aspect	X	X	X	X
shape_aspect_deriving_relationship	-	X	X	X
shape_aspect_relationship	X	X	X	X
shape_definition_representation	-	X	X	X
shape_dimension_representation	-	X	X	X
shape_representation	-	X	X	X
si_unit	X	X	X	X
site	-	-	X	-
site_building	-	-	X	-
site_feature	-	-	X	-
site_representation	-	-	X	-
solid_angle_measure_with_unit	-	X	X	X
solid_angle_unit	-	X	X	X
solid_model	-	X	X	-
spacer_fitting_classification	X	X	X	X
specialty_item_classification	X	X	X	X
sphere	-	X	X	-
spherical_surface	-	X	X	X
stream_design_case	X	-	X	-
stream_phase	X	-	X	-
structural_load_connector_classification	X	X	X	X

Table 14 - Conformance class elements (continued)

AIM element	Conformance class			
	1	2	3	4
structural_system	X	-	X	-
support_constraint_representation	-	X	X	X
surface	-	X	X	X
surface_curve	-	X	X	X
surface_of_linear_extrusion	-	X	X	X
surface_of_revolution	-	X	X	X
surface_patch	-	X	X	X
surface_replica	-	X	X	X
swage_fitting_classification	X	X	X	X
swept_area_solid	-	X	X	-
swept_face_solid	-	X	X	-
swept_surface	-	X	X	X
system_classification	X	-	X	-
system_space	-	X	X	X
thermodynamic_temperature_measure_with_unit	X	X	X	X
thermodynamic_temperature_unit	X	X	X	X
time_measure_with_unit	X	X	X	X
time_unit	X	X	X	X
topological_representation_item	-	X	X	-
toroidal_surface	-	X	X	X
torus	-	X	X	-
trimmed_curve	-	X	X	X
truncated_pyramid	-	X	X	-
type_qualifier	X	X	X	X
uniform_curve	-	X	X	X
uniform_surface	-	X	X	X
valve_classification	X	X	X	X

Table 14 - Conformance class elements (concluded)

AIM element	Conformance class			
	1	2	3	4
vector	X	X	X	X
versioned_action_request	X	X	X	X
vertex	-	X	X	-
volume_measure_with_unit	X	X	X	X
volume_unit	X	X	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 plant_spatial_configuration;

  TYPE ahead_or_behind = ENUMERATION OF
    (ahead,
     behind);
  END_TYPE; -- ahead_or_behind

  TYPE amount_of_substance_measure = REAL;
  END_TYPE; -- amount_of_substance_measure

  TYPE angle_relator = ENUMERATION OF
    (equal,
     large,
     small);
  END_TYPE; -- angle_relator

  TYPE approval_item = SELECT
    (change_action,
     versioned_action_request);
  END_TYPE; -- approval_item

  TYPE area_measure = REAL;
  END_TYPE; -- area_measure

  TYPE axis2_placement = SELECT
    (axis2_placement_2d,
     axis2_placement_3d);
  END_TYPE; -- axis2_placement

  TYPE b_spline_curve_form = ENUMERATION OF
    (polyline_form,
     circular_arc,
     elliptic_arc,
     parabolic_arc,
     hyperbolic_arc,
     unspecified);
  END_TYPE; -- b_spline_curve_form

  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; -- b_spline_surface_form

TYPE boolean_operand = SELECT
  (solid_model,
   half_space_solid,
   csg_primitive,
   boolean_result);
END_TYPE; -- boolean_operand

TYPE boolean_operator = ENUMERATION OF
  (union,
   intersection,
   difference);
END_TYPE; -- boolean_operator

TYPE change_delta_item = SELECT
  (assembly_component_usage,
   axis2_placement_2d,
   axis2_placement_3d,
   line_branch_connection,
   line_plant_item_branch_connection,
   line_plant_item_connection,
   line_termination_connection,
   plant,
   product,
   product_definition_relationship);
END_TYPE; -- change_delta_item

TYPE change_item = SELECT
  (change_delta_item,
   document,
   ducting_system,
   electrical_system,
   externally_defined_plant_item_definition,
   instrumentation_and_control_system,
   piping_system,
   plant_item_connection,
   plant_item_connector,
   plant_line_definition,
   plant_line_segment_definition,
   plant_line_segment_termination,
   process_capability,
   product_definition,
   product_definition_shape,
   property_definition,
   reference_geometry,
   site,
   site_feature,
   structural_system);
END_TYPE; -- change_item

TYPE characterized_definition = SELECT
  (characterized_object,
   characterized_product_definition,
   shape_definition);
END_TYPE; -- characterized_definition

TYPE characterized_material_property = SELECT
  (material_property_representation,
   product_material_composition_relationship);
END_TYPE; -- characterized_material_property

TYPE characterized_product_definition = SELECT
  (product_definition,
```

```
   product_definition_relationship);
END_TYPE; -- characterized_product_definition

TYPE classification_item = SELECT
  (ducting_system,
   electrical_system,
   instrumentation_and_control_system,
   piping_component_definition,
   piping_system,
   plant_item_connection,
   plant_item_connector,
   plant_spatial_configuration_document_reference,
   product,
   product_definition,
   structural_system);
END_TYPE; -- classification_item

TYPE context_dependent_measure = REAL;
END_TYPE; -- context_dependent_measure

TYPE count_measure = NUMBER;
END_TYPE; -- count_measure

TYPE csg_primitive = SELECT
  (sphere,
   block,
   torus,
   right_circular_cone,
   right_circular_cylinder);
END_TYPE; -- csg_primitive

TYPE csg_select = SELECT
  (boolean_result,
   csg_primitive);
END_TYPE; -- csg_select

TYPE curve_on_surface = SELECT
  (pcurve,
   surface_curve,
   composite_curve_on_surface);
END_TYPE; -- curve_on_surface

TYPE date_time_select = SELECT
  (date,
   local_time,
   date_and_time);
END_TYPE; -- date_time_select

TYPE day_in_month_number = INTEGER;
END_TYPE; -- day_in_month_number

TYPE design_project_item = SELECT
  (product_definition);
END_TYPE; -- design_project_item

TYPE dimension_count = INTEGER;
WHERE
  wr1: SELF > 0;
END_TYPE; -- dimension_count

TYPE dimensional_characteristic = SELECT
  (dimensional_location,
   dimensional_size);
```

```
END_TYPE; -- dimensional_characteristic

TYPE geometric_set_select = SELECT
  (point,
   curve,
   surface);
END_TYPE; -- geometric_set_select

TYPE hour_in_day = INTEGER;
WHERE
  wr1: (0 <= SELF) AND (SELF < 24);
END_TYPE; -- hour_in_day

TYPE identifier = STRING;
END_TYPE; -- identifier

TYPE knot_type = ENUMERATION OF
  (uniform_knots,
   unspecified,
   quasi_uniform_knots,
   piecewise_bezier_knots);
END_TYPE; -- knot_type

TYPE label = STRING;
END_TYPE; -- label

TYPE layered_item = SELECT
  (representation_item);
END_TYPE; -- layered_item

TYPE length_measure = REAL;
END_TYPE; -- length_measure

TYPE list_of_reversible_topology_item = LIST [0:?] OF
            reversible_topology_item;
END_TYPE; -- list_of_reversible_topology_item

TYPE mass_measure = REAL;
END_TYPE; -- mass_measure

TYPE measure_value = SELECT
  (length_measure,
   mass_measure,
   time_measure,
   thermodynamic_temperature_measure,
   amount_of_substance_measure,
   plane_angle_measure,
   solid_angle_measure,
   area_measure,
   volume_measure,
   ratio_measure,
   parameter_value,
   numeric_measure,
   context_dependent_measure,
   positive_length_measure,
   positive_plane_angle_measure,
   positive_ratio_measure,
   count_measure);
END_TYPE; -- measure_value

TYPE minute_in_hour = INTEGER;
WHERE
  wr1: (0 <= SELF) AND (SELF <= 59);
END_TYPE; -- minute_in_hour
```

```
TYPE month_in_year_number = INTEGER;
WHERE
  wr1: (1 <= SELF) AND (SELF <= 12);
END_TYPE; -- month_in_year_number

TYPE numeric_measure = NUMBER;
END_TYPE; -- numeric_measure

TYPE parameter_value = REAL;
END_TYPE; -- parameter_value

TYPE pcurve_or_surface = SELECT
  (pcurve,
   surface);
END_TYPE; -- pcurve_or_surface

TYPE person_organization_select = SELECT
  (person,
   organization,
   person_and_organization);
END_TYPE; -- person_organization_select

TYPE plane_angle_measure = REAL;
END_TYPE; -- plane_angle_measure

TYPE plant_spatial_configuration_action_request_item = SELECT
  (product);
END_TYPE; -- plant_spatial_configuration_action_request_item

TYPE plant_spatial_configuration_date_and_time_item = SELECT
  (product);
END_TYPE; -- plant_spatial_configuration_date_and_time_item

TYPE plant_spatial_configuration_dated_item = SELECT
  (action_directive,
   change_action,
   change_item,
   product);
END_TYPE; -- plant_spatial_configuration_dated_item

TYPE plant_spatial_configuration_document_item = SELECT
  (heat_tracing_representation,
   piping_component_class,
   piping_system,
   plant_item_connector,
   plant_line_segment_definition,
   product,
   product_definition,
   product_definition_relationship,
   property_definition,
   representation,
   representation_item,
   site);
END_TYPE; -- plant_spatial_configuration_document_item

TYPE plant_spatial_configuration_organization_item = SELECT
  (catalogue,
   change_action,
   design_project,
   document,
   plant,
   product_definition_formation,
   product_definition_relationship,
```

```
   site);
END_TYPE; -- plant_spatial_configuration_organization_item

TYPE plant_spatial_configuration_person_and_organization_item = SELECT
  (change_item,
   plant,
   site);
END_TYPE; -- plant_spatial_configuration_person_and_organization_item

TYPE plant_spatial_configuration_person_item = SELECT
  (document,
   plant,
   product_definition_relationship,
   site);
END_TYPE; -- plant_spatial_configuration_person_item

TYPE positive_length_measure = length_measure;
WHERE
  wr1: SELF > 0;
END_TYPE; -- positive_length_measure

TYPE positive_plane_angle_measure = plane_angle_measure;
WHERE
  wr1: SELF > 0;
END_TYPE; -- positive_plane_angle_measure

TYPE positive_ratio_measure = ratio_measure;
WHERE
  wr1: SELF > 0;
END_TYPE; -- positive_ratio_measure

TYPE preferred_surface_curve_representation = ENUMERATION OF
  (curve_3d,
   pcurve_s1,
   pcurve_s2);
END_TYPE; -- preferred_surface_curve_representation

TYPE purchase_item = SELECT
  (product);
END_TYPE; -- purchase_item

TYPE ratio_measure = REAL;
END_TYPE; -- ratio_measure

TYPE reversible_topology = SELECT
  (reversible_topology_item,
   list_of_reversible_topology_item,
   set_of_reversible_topology_item);
END_TYPE; -- reversible_topology

TYPE reversible_topology_item = SELECT
  (edge,
   path,
   face,
   face_bound,
   closed_shell,
   open_shell);
END_TYPE; -- reversible_topology_item

TYPE second_in_minute = REAL;
WHERE
  wr1: (0 <= SELF) AND (SELF < 60);
END_TYPE; -- second_in_minute
```

```
TYPE set_of_reversible_topology_item = SET [0:?] OF
            reversible_topology_item;
END_TYPE; -- set_of_reversible_topology_item

TYPE shape_definition = SELECT
  (product_definition_shape,
   shape_aspect,
   shape_aspect_relationship);
END_TYPE; -- shape_definition

TYPE shell = SELECT
  (open_shell,
   closed_shell);
END_TYPE; -- shell

TYPE si_prefix = ENUMERATION OF
  (exa,
   peta,
   tera,
   giga,
   mega,
   kilo,
   hecto,
   deca,
   deci,
   centi,
   milli,
   micro,
   nano,
   pico,
   femto,
   atto);
END_TYPE; -- si_prefix

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; -- si_unit_name

TYPE solid_angle_measure = REAL;
END_TYPE; -- solid_angle_measure

TYPE source = ENUMERATION OF
  (made,
   bought,
   not_known);
END_TYPE; -- source

TYPE source_item = SELECT
  (identifier);
END_TYPE; -- source_item

TYPE text = STRING;
END_TYPE; -- text

TYPE thermodynamic_temperature_measure = REAL;
END_TYPE; -- thermodynamic_temperature_measure

TYPE time_measure = REAL;
END_TYPE; -- time_measure

TYPE transition_code = ENUMERATION OF
  (discontinuous,
   continuous,
   cont_same_gradient,
   cont_same_gradient_same_curvature);
END_TYPE; -- transition_code

TYPE trimming_preference = ENUMERATION OF
  (cartesian,
   parameter,
   unspecified);
END_TYPE; -- trimming_preference

TYPE trimming_select = SELECT
  (cartesian_point,
   parameter_value);
END_TYPE; -- trimming_select

TYPE unit = SELECT
  (named_unit,
   derived_unit);
END_TYPE; -- unit

TYPE value_qualifier = SELECT
  (type_qualifier);
END_TYPE; -- value_qualifier

TYPE vector_or_direction = SELECT
  (vector,
   direction);
END_TYPE; -- vector_or_direction

TYPE volume_measure = REAL;
END_TYPE; -- volume_measure

TYPE year_number = INTEGER;
END_TYPE; -- year_number

ENTITY action;
    name          : label;
```

```
    description   : text;
    chosen_method : action_method;
END_ENTITY; -- action

ENTITY action_assignment
  ABSTRACT SUPERTYPE;
    assigned_action : action;
END_ENTITY; -- action_assignment

ENTITY action_directive;
    name        : label;
    description : text;
    analysis    : text;
    comment     : text;
    requests    : SET [1:?] OF versioned_action_request;
END_ENTITY; -- action_directive

ENTITY action_method;
    name        : label;
    description : text;
    consequence : text;
    purpose     : text;
END_ENTITY; -- action_method

ENTITY action_method_relationship;
    name            : label;
    description     : text;
    relating_method : action_method;
    related_method  : action_method;
END_ENTITY; -- action_method_relationship

ENTITY action_relationship;
    name            : label;
    description     : text;
    relating_action : action;
    related_action  : action;
END_ENTITY; -- action_relationship

ENTITY action_request_assignment
  ABSTRACT SUPERTYPE;
    assigned_action_request : versioned_action_request;
END_ENTITY; -- action_request_assignment

ENTITY action_request_solution;
    method  : action_method;
    request : versioned_action_request;
END_ENTITY; -- action_request_solution

ENTITY action_request_status;
    status           : label;
    assigned_request : versioned_action_request;
END_ENTITY; -- action_request_status

ENTITY action_status;
    status          : label;
    assigned_action : executed_action;
END_ENTITY; -- action_status

ENTITY advanced_csg_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: SIZEOF(QUERY ( item <* SELF.items | (NOT (SIZEOF([
             'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
```

```
              'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
              'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF(item)) =
               1)) )) = 0;
    wr2: SIZEOF(QUERY ( item <* SELF.items | (SIZEOF([
              'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF(item)) =
               1) )) >= 1;
    wr3: SIZEOF(QUERY ( item <* SELF.items | ((
              'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID' IN TYPEOF(item)) AND
               (NOT valid_advanced_csg_tree(item\csg_solid.
              tree_root_expression))) )) = 0;
    wr4: SIZEOF(QUERY ( mi <* QUERY ( item <* SELF.items | (
              'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF(item)) )
               | (NOT ('PLANT_SPATIAL_CONFIGURATION.' +
               'ADVANCED_CSG_SHAPE_REPRESENTATION'
              IN TYPEOF(mi\mapped_item.mapping_source.
              mapped_representation))) )) = 0;
END_ENTITY; -- advanced_csg_shape_representation

ENTITY amount_of_substance_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.AMOUNT_OF_SUBSTANCE_UNIT' IN
              TYPEOF(SELF\measure_with_unit.unit_component);
END_ENTITY; -- amount_of_substance_measure_with_unit

ENTITY amount_of_substance_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
              named_unit.dimensions.mass_exponent = 0) AND (SELF\
              named_unit.dimensions.time_exponent = 0) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0) AND (
              SELF\named_unit.dimensions.
              thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
              .dimensions.amount_of_substance_exponent = 1) AND (SELF\
              named_unit.dimensions.luminous_intensity_exponent = 0);
END_ENTITY; -- amount_of_substance_unit

ENTITY angular_location
  SUBTYPE OF (dimensional_location);
    angle_selection : angle_relator;
END_ENTITY; -- angular_location

ENTITY application_context;
    application : text;
  INVERSE
    context_elements : SET [1:?] OF application_context_element FOR
                           frame_of_reference;
END_ENTITY; -- application_context

ENTITY application_context_element
  SUPERTYPE OF (ONEOF (product_context,product_definition_context));
    name                : label;
    frame_of_reference : application_context;
END_ENTITY; -- application_context_element

ENTITY application_protocol_definition;
    status                                  : label;
    application_interpreted_model_schema_name : label;
```

```
    application_protocol_year                 : year_number;
    application                               : application_context;
END_ENTITY; -- application_protocol_definition

ENTITY approval;
    status : approval_status;
    level  : label;
END_ENTITY; -- approval

ENTITY approval_assignment
  ABSTRACT SUPERTYPE;
    assigned_approval : approval;
END_ENTITY; -- approval_assignment

ENTITY approval_date_time;
    date_time      : date_time_select;
    dated_approval : approval;
END_ENTITY; -- approval_date_time

ENTITY approval_person_organization;
    person_organization : person_organization_select;
    authorized_approval : approval;
    role                : approval_role;
END_ENTITY; -- approval_person_organization

ENTITY approval_role;
    role : label;
END_ENTITY; -- approval_role

ENTITY approval_status;
    name : label;
END_ENTITY; -- approval_status

ENTITY area_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.AREA_UNIT' IN TYPEOF(SELF\
            measure_with_unit.unit_component);
END_ENTITY; -- area_measure_with_unit

ENTITY area_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 2) AND (SELF\
              named_unit.dimensions.mass_exponent = 0) AND (SELF\
              named_unit.dimensions.time_exponent = 0) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0) AND (
              SELF\named_unit.dimensions.
              thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
              .dimensions.amount_of_substance_exponent = 0) AND (SELF\
              named_unit.dimensions.luminous_intensity_exponent = 0);
END_ENTITY; -- area_unit

ENTITY assembly_component_usage
  SUBTYPE OF (product_definition_usage);
    reference_designator : OPTIONAL identifier;
END_ENTITY; -- assembly_component_usage

ENTITY axis1_placement
  SUBTYPE OF (placement);
    axis : OPTIONAL direction;
  DERIVE
    z : direction := NVL(normalise(axis),direction([0,0,1]));
```

```
  WHERE
    wr1: SELF\geometric_representation_item.dim = 3;
END_ENTITY; -- axis1_placement

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; -- axis2_placement_2d

ENTITY axis2_placement_3d
  SUBTYPE OF (placement);
    axis          : OPTIONAL direction;
    ref_direction : OPTIONAL direction;
  DERIVE
    p : LIST [3:3] OF direction := build_axes(axis,ref_direction);
  WHERE
    wr1: SELF\placement.location.dim = 3;
    wr2: (NOT EXISTS(axis)) OR (axis.dim = 3);
    wr3: (NOT EXISTS(ref_direction)) OR (ref_direction.dim = 3);
    wr4: (NOT EXISTS(axis)) OR (NOT EXISTS(ref_direction)) OR (
             cross_product(axis,ref_direction).magnitude > 0);
END_ENTITY; -- axis2_placement_3d

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: ('PLANT_SPATIAL_CONFIGURATION.UNIFORM_CURVE' IN TYPEOF(SELF))
             OR ('PLANT_SPATIAL_CONFIGURATION.QUASI_UNIFORM_CURVE' IN
             TYPEOF(SELF)) OR ('PLANT_SPATIAL_CONFIGURATION.BEZIER_CURVE'

             IN TYPEOF(SELF)) OR (
             'PLANT_SPATIAL_CONFIGURATION.B_SPLINE_CURVE_WITH_KNOTS' IN
             TYPEOF(SELF));
END_ENTITY; -- b_spline_curve

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; -- b_spline_curve_with_knots

  ENTITY b_spline_surface
    SUPERTYPE OF (ONEOF (b_spline_surface_with_knots,uniform_surface,
        quasi_uniform_surface,bezier_surface) ANDOR
        rational_b_spline_surface)
    SUBTYPE OF (bounded_surface);
      u_degree            : INTEGER;
      v_degree            : INTEGER;
      control_points_list : LIST [2:?] OF LIST [2:?] OF cartesian_point;
      surface_form        : b_spline_surface_form;
      u_closed            : LOGICAL;
      v_closed            : LOGICAL;
      self_intersect      : LOGICAL;
    DERIVE
      u_upper        : INTEGER := SIZEOF(control_points_list) - 1;
      v_upper        : INTEGER := SIZEOF(control_points_list[1]) - 1;
      control_points : ARRAY [0:u_upper] OF ARRAY [0:v_upper] OF
                           cartesian_point := make_array_of_array(
                          control_points_list,0,u_upper,0,v_upper);
    WHERE
      wr1: ('PLANT_SPATIAL_CONFIGURATION.UNIFORM_SURFACE' IN TYPEOF(SELF))
               OR ('PLANT_SPATIAL_CONFIGURATION.QUASI_UNIFORM_SURFACE' IN
               TYPEOF(SELF)) OR (
               'PLANT_SPATIAL_CONFIGURATION.BEZIER_SURFACE' IN
TYPEOF(SELF))
               OR (
               'PLANT_SPATIAL_CONFIGURATION.B_SPLINE_SURFACE_WITH_KNOTS' IN
                TYPEOF(SELF));
  END_ENTITY; -- b_spline_surface

  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; -- b_spline_surface_with_knots

  ENTITY bezier_curve
    SUBTYPE OF (b_spline_curve);
  END_ENTITY; -- bezier_curve

  ENTITY bezier_surface
    SUBTYPE OF (b_spline_surface);
  END_ENTITY; -- bezier_surface

  ENTITY blank_fitting_classification
    SUBTYPE OF (group);
```

```
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +
               'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
              NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
              QUERY ( it <* ca.items | (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
              formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
              category_in_tree(prpc,'blank') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- blank_fitting_classification

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; -- block

ENTITY boolean_result
  SUBTYPE OF (geometric_representation_item);
    operator       : boolean_operator;
    first_operand  : boolean_operand;
    second_operand : boolean_operand;
END_ENTITY; -- boolean_result

ENTITY boundary_curve
  SUBTYPE OF (composite_curve_on_surface);
  WHERE
    wr1: SELF\composite_curve.closed_curve;
END_ENTITY; -- boundary_curve

ENTITY bounded_curve
  SUPERTYPE OF (ONEOF (polyline,b_spline_curve,trimmed_curve,
      bounded_pcurve,bounded_surface_curve,composite_curve))
  SUBTYPE OF (curve);
END_ENTITY; -- bounded_curve

ENTITY bounded_pcurve
  SUBTYPE OF (pcurve, bounded_curve);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.BOUNDED_CURVE' IN TYPEOF(SELF\
              pcurve.reference_to_curve.items[1]);
END_ENTITY; -- bounded_pcurve

ENTITY bounded_surface
  SUPERTYPE OF (ONEOF (b_spline_surface,rectangular_trimmed_surface,
      curve_bounded_surface,rectangular_composite_surface))
  SUBTYPE OF (surface);
END_ENTITY; -- bounded_surface

ENTITY bounded_surface_curve
  SUBTYPE OF (surface_curve, bounded_curve);
```

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  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.BOUNDED_CURVE' IN TYPEOF(SELF\
             surface_curve.curve_3d);
END_ENTITY; -- bounded_surface_curve

ENTITY brep_with_voids
  SUBTYPE OF (manifold_solid_brep);
    voids : SET [1:?] OF oriented_closed_shell;
END_ENTITY; -- brep_with_voids

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; -- calendar_date

ENTITY cartesian_point
  SUBTYPE OF (point);
    coordinates : LIST [1:3] OF length_measure;
END_ENTITY; -- cartesian_point

ENTITY cartesian_transformation_operator
  SUPERTYPE OF (cartesian_transformation_operator_3d)
  SUBTYPE OF (geometric_representation_item,
      functionally_defined_transformation);
    axis1        : OPTIONAL direction;
    axis2        : OPTIONAL direction;
    local_origin : cartesian_point;
    scale        : OPTIONAL REAL;
  DERIVE
    scl : REAL := NVL(scale,1);
  WHERE
    wr1: scl > 0;
END_ENTITY; -- cartesian_transformation_operator

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\cartesian_transformation_operator.dim = 3;
END_ENTITY; -- cartesian_transformation_operator_3d

ENTITY catalogue
  SUBTYPE OF (document, external_source);
END_ENTITY; -- catalogue

ENTITY catalogue_connector
  SUBTYPE OF (shape_aspect, externally_defined_item);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_OBJECT' IN TYPEOF(
             SELF.of_shape);
    wr2: 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF(SELF.source);
END_ENTITY; -- catalogue_connector

ENTITY catalogue_item
  SUBTYPE OF (externally_defined_plant_item_definition);
  WHERE
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    wr1: 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF(SELF.source);
    wr2: SELF.frame_of_reference.name = 'catalogue definition';
END_ENTITY; -- catalogue_item

ENTITY centre_of_symmetry
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: SIZEOF(QUERY ( sadr <* deriving_relationships | (NOT (
             'PLANT_SPATIAL_CONFIGURATION.SYMMETRIC_SHAPE_ASPECT' IN
             TYPEOF(sadr.related_shape_aspect))) )) = 0;
END_ENTITY; -- centre_of_symmetry

ENTITY change_action
  SUBTYPE OF (directed_action);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.'
             + 'ACTION_ASSIGNMENT.ASSIGNED_ACTION') | ((
             'PLANT_SPATIAL_CONFIGURATION.' +
             'PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT') IN TYPEOF(
             ca)) )) >= 1;
    wr2: SIZEOF(QUERY ( ar <* SELF\directed_action.directive.requests |
             (NOT (SIZEOF(USEDIN(ar,'PLANT_SPATIAL_CONFIGURATION.' +
             'ACTION_REQUEST_SOLUTION.SOLUTION')) = 1)) )) = 0;
    wr3: SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.ACTION_STATUS.'
             + 'ASSIGNED_ACTION')) = 1;
END_ENTITY; -- change_action

ENTITY change_from_assignment
  SUBTYPE OF (action_assignment);
    items : SET [1:?] OF change_delta_item;
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.CHANGE_ACTION' IN TYPEOF(SELF.
             assigned_action);
END_ENTITY; -- change_from_assignment

ENTITY change_item_id_assignment
  SUBTYPE OF (name_assignment);
    items : SET [1:?] OF change_item;
END_ENTITY; -- change_item_id_assignment

ENTITY change_to_assignment
  SUBTYPE OF (action_assignment);
    items : SET [1:?] OF change_delta_item;
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.CHANGE_ACTION' IN TYPEOF(SELF.
             assigned_action);
END_ENTITY; -- change_to_assignment

ENTITY characterized_object;
    name        : label;
    description : text;
END_ENTITY; -- characterized_object

ENTITY circle
  SUBTYPE OF (conic);
    radius : positive_length_measure;
END_ENTITY; -- circle

ENTITY classification_assignment
  SUBTYPE OF (group_assignment);
    items : SET [1:?] OF classification_item;
  WHERE
    wr1: (NOT (SIZEOF(QUERY ( item <* SELF.items | (NOT (
             'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
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              TYPEOF(item))) )) = 0)) OR (SIZEOF(TYPEOF(SELF.
              assigned_group) * ['PLANT_SPATIAL_CONFIGURATION.' +
              'CONNECTION_FUNCTIONAL_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.' +
              'CONNECTION_MOTION_CLASSIFICATION'])
              >= 1);
    wr2: (NOT (SIZEOF(QUERY ( item <* SELF.items | (NOT (
              'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
              TYPEOF(item))) )) = 0)) OR (SIZEOF(TYPEOF(SELF.
              assigned_group) *
              ['PLANT_SPATIAL_CONFIGURATION.' +
               'CONNECTOR_END_TYPE_CLASSIFICATION',
               'PLANT_SPATIAL_CONFIGURATION.' +
               'ELECTRICAL_CONNECTOR_CLASSIFICATION',
               'PLANT_SPATIAL_CONFIGURATION.' +
               'PIPING_CONNECTOR_CLASSIFICATION',
               'PLANT_SPATIAL_CONFIGURATION.' +
               'EXTERNALLY_DEFINED_CLASSIFICATION',
               'PLANT_SPATIAL_CONFIGURATION.' +
               'STRUCTURAL_LOAD_CONNECTOR_CLASSIFICATION']) >= 1);
    wr3: (NOT (SIZEOF(QUERY ( item <* SELF.items | (NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(item))) )) = 0)) OR (SIZEOF(TYPEOF(SELF.
              assigned_group) * [
              'PLANT_SPATIAL_CONFIGURATION.BLANK_FITTING_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.ELBOW_FITTING_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.FLANGE_FITTING_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.' +
              'FLANGE_FITTING_NECK_TYPE_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PIPE_CLOSURE_FITTING_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.PIPE_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.' +
              'REDUCER_FITTING_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.SPACER_FITTING_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.SPECIALTY_ITEM_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.SWAGE_FITTING_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.VALVE_CLASSIFICATION']) >= 1);
END_ENTITY; -- classification_assignment

ENTITY closed_shell
  SUBTYPE OF (connected_face_set);
END_ENTITY; -- closed_shell

ENTITY colour;
END_ENTITY; -- colour

ENTITY colour_rgb
  SUBTYPE OF (colour_specification);
    red   : REAL;
    green : REAL;
    blue  : REAL;
  WHERE
    wr1: (0 <= red) AND (red <= 1);
    wr2: (0 <= green) AND (green <= 1);
    wr3: (0 <= blue) AND (blue <= 1);
END_ENTITY; -- colour_rgb

ENTITY colour_specification
  SUBTYPE OF (colour);
    name : label;
END_ENTITY; -- colour_specification
```

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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; -- composite_curve

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; -- composite_curve_on_surface

ENTITY composite_curve_segment;
    transition   : transition_code;
    same_sense   : BOOLEAN;
    parent_curve : curve;
  INVERSE
    using_curves : BAG [1:?] OF composite_curve FOR segments;
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.BOUNDED_CURVE' IN TYPEOF(
              parent_curve);
END_ENTITY; -- composite_curve_segment

ENTITY conic
  SUPERTYPE OF (ONEOF (circle,ellipse,hyperbola,parabola))
  SUBTYPE OF (curve);
    position : axis2_placement;
END_ENTITY; -- conic

ENTITY conical_surface
  SUBTYPE OF (elementary_surface);
    radius     : length_measure;
    semi_angle : plane_angle_measure;
  WHERE
    wr1: radius >= 0;
END_ENTITY; -- conical_surface

ENTITY connected_face_set
  SUPERTYPE OF (ONEOF (closed_shell,open_shell))
  SUBTYPE OF (topological_representation_item);
    cfs_faces : SET [1:?] OF face;
END_ENTITY; -- connected_face_set

ENTITY connection_functional_classification
  SUBTYPE OF (group);
END_ENTITY; -- connection_functional_classification

ENTITY connection_motion_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SELF.name IN ['flexible','locked orientation'];
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END_ENTITY; -- connection_motion_classification

ENTITY connection_node
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM' IN TYPEOF(SELF.
             of_shape.definition);
    wr2: SIZEOF(QUERY ( sar <* USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT_RELATIONSHIP.' +
             'RELATING_SHAPE_ASPECT') | (
             'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION' IN
              TYPEOF(sar)) )) >= 3;
END_ENTITY; -- connection_node

ENTITY connector_end_type_classification
  SUBTYPE OF (group);
END_ENTITY; -- connector_end_type_classification

ENTITY context_dependent_unit
  SUBTYPE OF (named_unit);
    name : label;
END_ENTITY; -- context_dependent_unit

ENTITY conversion_based_unit
  SUBTYPE OF (named_unit);
    name              : label;
    conversion_factor : measure_with_unit;
END_ENTITY; -- conversion_based_unit

ENTITY coordinated_universal_time_offset;
    hour_offset   : hour_in_day;
    minute_offset : OPTIONAL minute_in_hour;
    sense         : ahead_or_behind;
END_ENTITY; -- coordinated_universal_time_offset

ENTITY csg_solid
  SUBTYPE OF (solid_model);
    tree_root_expression : csg_select;
END_ENTITY; -- csg_solid

ENTITY curve
  SUPERTYPE OF (ONEOF (line,conic,pcurve,surface_curve,offset_curve_2d,
      offset_curve_3d,curve_replica))
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- curve

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 AND (
             'PLANT_SPATIAL_CONFIGURATION.OUTER_BOUNDARY_CURVE' IN
             TYPEOF(boundaries)));
    wr2: (NOT implicit_outer) OR (
             'PLANT_SPATIAL_CONFIGURATION.BOUNDED_SURFACE' IN TYPEOF(
             basis_surface));
    wr3: SIZEOF(QUERY ( temp <* boundaries | (
             'PLANT_SPATIAL_CONFIGURATION.OUTER_BOUNDARY_CURVE' IN
             TYPEOF(temp)) )) <= 1;
    wr4: SIZEOF(QUERY ( temp <* boundaries | (temp\
             composite_curve_on_surface.basis_surface[1] :<>: SELF.
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             basis_surface) )) = 0;
END_ENTITY; -- curve_bounded_surface

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; -- curve_replica

ENTITY cylindrical_surface
  SUBTYPE OF (elementary_surface);
    radius : positive_length_measure;
END_ENTITY; -- cylindrical_surface

ENTITY data_environment;
    name        : label;
    description : text;
    elements    : SET [1:?] OF property_definition_representation;
END_ENTITY; -- data_environment

ENTITY date
  SUPERTYPE OF (calendar_date);
    year_component : year_number;
END_ENTITY; -- date

ENTITY date_and_time;
    date_component : date;
    time_component : local_time;
END_ENTITY; -- date_and_time

ENTITY date_and_time_assignment
  ABSTRACT SUPERTYPE;
    assigned_date_and_time : date_and_time;
    role                   : date_time_role;
END_ENTITY; -- date_and_time_assignment

ENTITY date_assignment
  ABSTRACT SUPERTYPE;
    assigned_date : date;
    role          : date_role;
END_ENTITY; -- date_assignment

ENTITY date_role;
    name : label;
END_ENTITY; -- date_role

ENTITY date_time_role;
    name : label;
END_ENTITY; -- date_time_role

ENTITY definitional_representation
  SUBTYPE OF (representation);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PARAMETRIC_REPRESENTATION_CONTEXT'
             IN TYPEOF(SELF\representation.context_of_items);
END_ENTITY; -- definitional_representation

ENTITY degenerate_pcurve
  SUBTYPE OF (point);
    basis_surface      : surface;
    reference_to_curve : definitional_representation;
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  WHERE
    wr1: SIZEOF(reference_to_curve\representation.items) = 1;
    wr2: 'PLANT_SPATIAL_CONFIGURATION.CURVE' IN TYPEOF(
             reference_to_curve\representation.items[1]);
    wr3: reference_to_curve\representation.items[1]\
             geometric_representation_item.dim = 2;
END_ENTITY; -- degenerate_pcurve

ENTITY degenerate_toroidal_surface
  SUBTYPE OF (toroidal_surface);
    select_outer : BOOLEAN;
  WHERE
    wr1: major_radius < minor_radius;
END_ENTITY; -- degenerate_toroidal_surface

ENTITY derived_shape_aspect
  SUPERTYPE OF (centre_of_symmetry)
  SUBTYPE OF (shape_aspect);
  INVERSE
    deriving_relationships : SET [1:?] OF
                                 shape_aspect_deriving_relationship FOR
                               relating_shape_aspect;
END_ENTITY; -- derived_shape_aspect

ENTITY derived_unit;
    elements : SET [1:?] OF derived_unit_element;
  WHERE
    wr1: (SIZEOF(elements) > 1) OR ((SIZEOF(elements) = 1) AND (elements
             [1].exponent <> 1));
END_ENTITY; -- derived_unit

ENTITY derived_unit_element;
    unit     : named_unit;
    exponent : REAL;
END_ENTITY; -- derived_unit_element

ENTITY descriptive_colour
  SUBTYPE OF (colour, descriptive_representation_item);
END_ENTITY; -- descriptive_colour

ENTITY descriptive_representation_item
  SUBTYPE OF (representation_item);
    description : text;
END_ENTITY; -- descriptive_representation_item

ENTITY design_project
  SUBTYPE OF (organization);
  WHERE
    wr1: SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
             'ORGANIZATION_ASSIGNMENT.ASSIGNED_ORGANIZATION')) >= 1;
END_ENTITY; -- design_project

ENTITY design_project_assignment
  SUBTYPE OF (organization_assignment);
    items : SET [1:?] OF design_project_item;
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT' IN TYPEOF(SELF.
             assigned_organization);
END_ENTITY; -- design_project_assignment

ENTITY dimensional_characteristic_representation;
    dimension      : dimensional_characteristic;
    representation : shape_dimension_representation;
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END_ENTITY; -- dimensional_characteristic_representation

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; -- dimensional_exponents

ENTITY dimensional_location
  SUPERTYPE OF (angular_location)
  SUBTYPE OF (shape_aspect_relationship);
END_ENTITY; -- dimensional_location

ENTITY dimensional_size;
    applies_to : shape_aspect;
    name       : label;
  WHERE
    wr1: applies_to.product_definitional = TRUE;
END_ENTITY; -- dimensional_size

ENTITY directed_action
  SUBTYPE OF (executed_action);
    directive : action_directive;
END_ENTITY; -- directed_action

ENTITY direction
  SUBTYPE OF (geometric_representation_item);
    direction_ratios : LIST [2:3] OF REAL;
  WHERE
    wr1: SIZEOF(QUERY ( tmp <* direction_ratios | (tmp <> 0) )) > 0;
END_ENTITY; -- direction

ENTITY document;
    id          : identifier;
    name        : label;
    description : text;
    kind        : document_type;
  UNIQUE
    ur1 : id;
END_ENTITY; -- document

ENTITY document_reference
  ABSTRACT SUPERTYPE;
    assigned_document : document;
    source            : label;
END_ENTITY; -- document_reference

ENTITY document_relationship;
    name              : label;
    description       : text;
    relating_document : document;
    related_document  : document;
END_ENTITY; -- document_relationship

ENTITY document_type;
    product_data_type : label;
END_ENTITY; -- document_type

ENTITY document_usage_constraint;
    source                : document;
```

```
    subject_element       : label;
    subject_element_value : text;
END_ENTITY; -- document_usage_constraint

ENTITY ducting_system
  SUBTYPE OF (product_definition);
  WHERE
    wr1: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_DEFINITION_RELATIONSHIP.' +
              'RELATED_PRODUCT_DEFINITION')
               | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
              relating_product_definition.formation.of_product)) AND (pdr.
              relating_product_definition.frame_of_reference.name =
              'functional occurrence')) )) = 1;
END_ENTITY; -- ducting_system

ENTITY edge
  SUPERTYPE OF (ONEOF (edge_curve,oriented_edge))
  SUBTYPE OF (topological_representation_item);
    edge_start : vertex;
    edge_end   : vertex;
END_ENTITY; -- edge

ENTITY edge_curve
  SUBTYPE OF (edge, geometric_representation_item);
    edge_geometry : curve;
    same_sense    : BOOLEAN;
END_ENTITY; -- edge_curve

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; -- edge_loop

ENTITY elbow_fitting_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
              NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
              QUERY ( it <* ca.items | (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
              formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
              category_in_tree(prpc,'elbow') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- elbow_fitting_classification
```

```
ENTITY electric_current_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.ELECTRIC_CURRENT_UNIT' IN TYPEOF(
             SELF\measure_with_unit.unit_component);
END_ENTITY; -- electric_current_measure_with_unit

ENTITY electric_current_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
             named_unit.dimensions.mass_exponent = 0) AND (SELF\
             named_unit.dimensions.time_exponent = 0) AND (SELF\
             named_unit.dimensions.electric_current_exponent = 1) AND (
             SELF\named_unit.dimensions.
             thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
             .dimensions.amount_of_substance_exponent = 0) AND (SELF\
             named_unit.dimensions.luminous_intensity_exponent = 0);
END_ENTITY; -- electric_current_unit

ENTITY electrical_connector_classification
  SUBTYPE OF (group);
END_ENTITY; -- electrical_connector_classification

ENTITY electrical_system
  SUBTYPE OF (product_definition);
  WHERE
    wr1: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.' +
             'PRODUCT_DEFINITION_RELATIONSHIP.' +
             'RELATED_PRODUCT_DEFINITION')
              | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
             relating_product_definition.formation.of_product)) AND (pdr.
             relating_product_definition.frame_of_reference.name =
             'functional occurrence')) )) = 1;
END_ENTITY; -- electrical_system

ENTITY elementary_surface
  SUPERTYPE OF (ONEOF (plane,cylindrical_surface,conical_surface,
      spherical_surface,toroidal_surface))
  SUBTYPE OF (surface);
    position : axis2_placement_3d;
END_ENTITY; -- elementary_surface

ENTITY ellipse
  SUBTYPE OF (conic);
    semi_axis_1 : positive_length_measure;
    semi_axis_2 : positive_length_measure;
END_ENTITY; -- ellipse

ENTITY evaluated_degenerate_pcurve
  SUBTYPE OF (degenerate_pcurve);
    equivalent_point : cartesian_point;
END_ENTITY; -- evaluated_degenerate_pcurve

ENTITY executed_action
  SUBTYPE OF (action);
END_ENTITY; -- executed_action

ENTITY external_source;
    source_id : source_item;
END_ENTITY; -- external_source

ENTITY externally_defined_classification
```

```
  SUBTYPE OF (group, externally_defined_item);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
              NOT ((SIZEOF(TYPEOF(it) * [
              'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
              'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
              'PLANT_SPATIAL_CONFIGURATION.' +
              'INSTRUMENTATION_AND_CONTROL_SYSTEM',
              'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
              'PLANT_SPATIAL_CONFIGURATION.PLANT',
              'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION',
              'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1) OR ((
              'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF(
              it)) AND (SIZEOF(QUERY ( pc <* it.formation.of_product.
              frame_of_reference |
              (pc.discipline_type = 'process plant') ))
              = 1)))) )) = 0)) )) = 0;
END_ENTITY; -- externally_defined_classification

ENTITY externally_defined_item;
    item_id : source_item;
    source  : external_source;
END_ENTITY; -- externally_defined_item

ENTITY externally_defined_plant_item_definition
  SUBTYPE OF (product_definition, externally_defined_item);
END_ENTITY; -- externally_defined_plant_item_definition

ENTITY extruded_area_solid
  SUBTYPE OF (swept_area_solid);
    extruded_direction : direction;
    depth              : positive_length_measure;
  WHERE
    wr1: dot_product(SELF\swept_area_solid.swept_area.basis_surface\
              elementary_surface.position.p[3],extruded_direction) <> 0;
END_ENTITY; -- extruded_area_solid

ENTITY extruded_face_solid
  SUBTYPE OF (swept_face_solid);
    extruded_direction : direction;
    depth              : positive_length_measure;
  WHERE
    wr1: dot_product(SELF\swept_face_solid.swept_face.face_geometry\
              elementary_surface.position.p[3],extruded_direction) <> 0;
END_ENTITY; -- extruded_face_solid

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 | (
              'PLANT_SPATIAL_CONFIGURATION.FACE_OUTER_BOUND' IN TYPEOF(
              temp)) )) <= 1;
END_ENTITY; -- face

ENTITY face_bound
```

```
  SUBTYPE OF (topological_representation_item);
    bound       : loop;
    orientation : BOOLEAN;
END_ENTITY; -- face_bound

ENTITY face_surface
  SUBTYPE OF (face, geometric_representation_item);
    face_geometry : surface;
    same_sense    : BOOLEAN;
END_ENTITY; -- face_surface

ENTITY faceted_brep
  SUBTYPE OF (manifold_solid_brep);
END_ENTITY; -- faceted_brep

ENTITY flange_fitting_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
              NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
              QUERY ( it <* ca.items | (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
              formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
              category_in_tree(prpc,'flange') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- flange_fitting_classification

ENTITY flange_fitting_neck_type_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
              NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
              QUERY ( it <* ca.items | (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
              formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
              category_in_tree(prpc,'flange') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- flange_fitting_neck_type_classification

ENTITY functionally_defined_transformation;
```

```
    name        : label;
    description : text;
END_ENTITY; -- functionally_defined_transformation

ENTITY geometric_curve_set
  SUBTYPE OF (geometric_set);
  WHERE
    wr1: SIZEOF(QUERY ( temp <* SELF\geometric_set.elements | (
             'PLANT_SPATIAL_CONFIGURATION.SURFACE' IN TYPEOF(temp)) )) =
             0;
END_ENTITY; -- geometric_curve_set

ENTITY geometric_representation_context
  SUBTYPE OF (representation_context);
    coordinate_space_dimension : dimension_count;
END_ENTITY; -- geometric_representation_context

ENTITY geometric_representation_item
  SUPERTYPE OF (ONEOF (point,direction,vector,placement,
      cartesian_transformation_operator,curve,surface,edge_curve,
      face_surface,poly_loop,solid_model,boolean_result,sphere,
      right_circular_cone,right_circular_cylinder,torus,block,
      half_space_solid,shell_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
             ('PLANT_SPATIAL_CONFIGURATION.' +
             'GEOMETRIC_REPRESENTATION_CONTEXT'
             IN TYPEOF(using_rep.context_of_items))) )) = 0;
END_ENTITY; -- geometric_representation_item

ENTITY geometric_set
  SUPERTYPE OF (ONEOF (geometric_curve_set,geometric_set_replica))
  SUBTYPE OF (geometric_representation_item);
    elements : SET [1:?] OF geometric_set_select;
END_ENTITY; -- geometric_set

ENTITY geometric_set_replica
  SUBTYPE OF (geometric_set);
    parent_set     : geometric_set;
    transformation : cartesian_transformation_operator;
  DERIVE
    SELF\geometric_set.elements : SET [1:?] OF geometric_set_select :=
                                   build_transformed_set(transformation,
                                   parent_set);
  WHERE
    wr1: acyclic_set_replica(SELF,parent_set);
END_ENTITY; -- geometric_set_replica

ENTITY global_unit_assigned_context
  SUBTYPE OF (representation_context);
    units : SET [1:?] OF unit;
END_ENTITY; -- global_unit_assigned_context

ENTITY group;
    name        : label;
    description : text;
END_ENTITY; -- group

ENTITY group_assignment
  ABSTRACT SUPERTYPE;
```

```
    assigned_group : group;
END_ENTITY; -- group_assignment

ENTITY half_space_solid
  SUBTYPE OF (geometric_representation_item);
    base_surface   : surface;
    agreement_flag : BOOLEAN;
END_ENTITY; -- half_space_solid

ENTITY heat_tracing_representation
  SUBTYPE OF (representation);
END_ENTITY; -- heat_tracing_representation

ENTITY hybrid_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: SIZEOF(QUERY ( i <* SELF\representation.items | (NOT (SIZEOF([
              'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT',
              'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.TRUNCATED_PYRAMID',
              'PLANT_SPATIAL_CONFIGURATION.BLOCK',
              'PLANT_SPATIAL_CONFIGURATION.TORUS',
              'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
              'PLANT_SPATIAL_CONFIGURATION.SPHERE',
              'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
              'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
              'PLANT_SPATIAL_CONFIGURATION.MANIFOLD_SOLID_BREP',
              'PLANT_SPATIAL_CONFIGURATION.SHELL_BASED_WIREFRAME_MODEL',
              'PLANT_SPATIAL_CONFIGURATION.CONIC',
              'PLANT_SPATIAL_CONFIGURATION.CURVE',
              'PLANT_SPATIAL_CONFIGURATION.B_SPLINE_CURVE',
              'PLANT_SPATIAL_CONFIGURATION.LINE',
              'PLANT_SPATIAL_CONFIGURATION.POINT',
              'PLANT_SPATIAL_CONFIGURATION.POLYLINE',
              'PLANT_SPATIAL_CONFIGURATION.SURFACE',
              'PLANT_SPATIAL_CONFIGURATION.VECTOR',
              'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
              'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] *
              TYPEOF(i)) = 1)) )) = 0;
    wr2: SIZEOF(QUERY ( mi <* QUERY ( item <* SELF\representation.items
               | ('PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN
               TYPEOF(item)))
               | (NOT (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.' +
              'ADVANCED_CSG_SHAPE_REPRESENTATION',
              'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION'] *
               TYPEOF(mi\mapped_item.mapping_source.
               mapped_representation))
              = 1)) )) = 0;
END_ENTITY; -- hybrid_shape_representation

ENTITY hyperbola
  SUBTYPE OF (conic);
    semi_axis      : positive_length_measure;
    semi_imag_axis : positive_length_measure;
END_ENTITY; -- hyperbola

ENTITY inline_equipment
  SUBTYPE OF (piping_component_definition);
END_ENTITY; -- inline_equipment

ENTITY instrumentation_and_control_system
  SUBTYPE OF (product_definition);
```

```
  WHERE
    wr1: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_DEFINITION_RELATIONSHIP.' +
              'RELATED_PRODUCT_DEFINITION')
               | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
              relating_product_definition.formation.of_product)) AND (pdr.
              relating_product_definition.frame_of_reference.name =
              'functional occurrence')) )) = 1;
END_ENTITY; -- instrumentation_and_control_system

ENTITY interfering_shape_element
  SUBTYPE OF (shape_aspect, shape_aspect_relationship);
END_ENTITY; -- interfering_shape_element

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; -- intersection_curve

ENTITY known_source
  SUBTYPE OF (external_source, pre_defined_item);
  WHERE
    wr1: SELF\pre_defined_item.name IN ['ISO 13584 Dictionary',
              'ISO 13584 Parts Library'];
END_ENTITY; -- known_source

ENTITY length_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.LENGTH_UNIT' IN TYPEOF(SELF\
              measure_with_unit.unit_component);
END_ENTITY; -- length_measure_with_unit

ENTITY length_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 1) AND (SELF\
              named_unit.dimensions.mass_exponent = 0) AND (SELF\
              named_unit.dimensions.time_exponent = 0) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0) AND (
              SELF\named_unit.dimensions.
              thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
              .dimensions.amount_of_substance_exponent = 0) AND (SELF\
              named_unit.dimensions.luminous_intensity_exponent = 0);
END_ENTITY; -- length_unit

ENTITY line
  SUBTYPE OF (curve);
    pnt : cartesian_point;
    dir : vector;
  WHERE
    wr1: dir.dim = pnt.dim;
END_ENTITY; -- line

ENTITY line_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1: SELF.description = 'branch location';
```

```
    wr2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION' IN
             TYPEOF(SELF.relating_shape_aspect.of_shape.definition);
    wr3: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION' IN
              TYPEOF(SELF.related_shape_aspect);
END_ENTITY; -- line_branch_connection

ENTITY line_less_piping_system
  SUBTYPE OF (product_definition);
END_ENTITY; -- line_less_piping_system

ENTITY line_plant_item_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
END_ENTITY; -- line_plant_item_branch_connection

ENTITY line_plant_item_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION' IN
             TYPEOF(SELF.relating_shape_aspect);
    wr2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN TYPEOF(
             SELF.related_shape_aspect);
    wr3: SELF\shape_aspect_relationship.related_shape_aspect.
             of_shape\property_definition.
             definition\product_definition.
             frame_of_reference\application_context_element.
             name = 'physical occurrence';
END_ENTITY; -- line_plant_item_connection

ENTITY line_termination_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1: SIZEOF(TYPEOF(SELF.relating_shape_aspect) * [
             'PLANT_SPATIAL_CONFIGURATION.CONNECTION_NODE',
             'PLANT_SPATIAL_CONFIGURATION.' +
             'PLANT_LINE_SEGMENT_TERMINATION'])
             >= 1;
    wr2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION' IN
              TYPEOF(SELF.related_shape_aspect);
END_ENTITY; -- line_termination_connection

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; -- local_time

ENTITY loop
  SUPERTYPE OF (ONEOF (edge_loop,poly_loop))
  SUBTYPE OF (topological_representation_item);
END_ENTITY; -- loop

ENTITY make_from_usage_option
  SUBTYPE OF (product_definition_usage);
    ranking           : INTEGER;
    ranking_rationale : text;
    quantity          : measure_with_unit;
  WHERE
    wr1: ranking > 0;
END_ENTITY; -- make_from_usage_option

ENTITY manifold_solid_brep
```

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  SUBTYPE OF (solid_model);
    outer : closed_shell;
END_ENTITY; -- manifold_solid_brep

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; -- mapped_item

ENTITY mass_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.MASS_UNIT' IN TYPEOF(SELF\
             measure_with_unit.unit_component);
END_ENTITY; -- mass_measure_with_unit

ENTITY mass_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
             named_unit.dimensions.mass_exponent = 1) AND (SELF\
             named_unit.dimensions.time_exponent = 0) AND (SELF\
             named_unit.dimensions.electric_current_exponent = 0) AND (
             SELF\named_unit.dimensions.
             thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
             .dimensions.amount_of_substance_exponent = 0) AND (SELF\
             named_unit.dimensions.luminous_intensity_exponent = 0);
END_ENTITY; -- mass_unit

ENTITY material_designation;
    name        : label;
    definitions : SET [1:?] OF characterized_definition;
END_ENTITY; -- material_designation

ENTITY material_designation_characterization;
    name        : label;
    description : text;
    designation : material_designation;
    property    : characterized_material_property;
END_ENTITY; -- material_designation_characterization

ENTITY material_property
  SUBTYPE OF (property_definition);
  UNIQUE
    ur1 : name, definition;
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_OBJECT' IN (TYPEOF(
             SELF\property_definition.definition) OR SIZEOF(bag_to_set(
             USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) -
             QUERY ( temp <* bag_to_set(USEDIN(SELF,
             'PRODUCT_PROPERTY_REPRESENTATION_SCHEMA.' +
             'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) | ((
             'MATERIAL_PROPERTY_REPRESENTATION_SCHEMA.' +
             'MATERIAL_PROPERTY_REPRESENTATION') IN TYPEOF(temp)) )))) =
             0;
END_ENTITY; -- material_property

ENTITY material_property_representation
```

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  SUBTYPE OF (property_definition_representation);
    dependent_environment : data_environment;
END_ENTITY; -- material_property_representation

ENTITY measure_representation_item
  SUBTYPE OF (representation_item, measure_with_unit);
END_ENTITY; -- measure_representation_item

ENTITY measure_with_unit
  SUPERTYPE OF (ONEOF (length_measure_with_unit,mass_measure_with_unit,
      time_measure_with_unit,electric_current_measure_with_unit,
      thermodynamic_temperature_measure_with_unit,
      amount_of_substance_measure_with_unit,
      plane_angle_measure_with_unit,
      solid_angle_measure_with_unit,area_measure_with_unit,
      volume_measure_with_unit,ratio_measure_with_unit));
    value_component : measure_value;
    unit_component  : unit;
  WHERE
    wr1: valid_units(SELF);
END_ENTITY; -- measure_with_unit

ENTITY name_assignment
  ABSTRACT SUPERTYPE;
    assigned_name : label;
END_ENTITY; -- name_assignment

ENTITY named_unit
  SUPERTYPE OF (ONEOF (si_unit,conversion_based_unit,
      context_dependent_unit) ANDOR ONEOF (length_unit,mass_unit,
      time_unit,electric_current_unit,thermodynamic_temperature_unit,
      amount_of_substance_unit,plane_angle_unit,solid_angle_unit,
      area_unit,volume_unit,ratio_unit));
    dimensions : dimensional_exponents;
END_ENTITY; -- named_unit

ENTITY offset_curve_2d
  SUBTYPE OF (curve);
    basis_curve    : curve;
    distance       : length_measure;
    self_intersect : LOGICAL;
  WHERE
    wr1: basis_curve.dim = 2;
END_ENTITY; -- offset_curve_2d

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; -- offset_curve_3d

ENTITY offset_surface
  SUBTYPE OF (surface);
    basis_surface  : surface;
    distance       : length_measure;
    self_intersect : LOGICAL;
END_ENTITY; -- offset_surface

ENTITY open_shell
  SUBTYPE OF (connected_face_set);
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END_ENTITY; -- open_shell

ENTITY organization;
    id          : OPTIONAL identifier;
    name        : label;
    description : text;
END_ENTITY; -- organization

ENTITY organization_assignment
  ABSTRACT SUPERTYPE;
    assigned_organization : organization;
    role                  : organization_role;
END_ENTITY; -- organization_assignment

ENTITY organization_role;
    name : label;
END_ENTITY; -- organization_role

ENTITY organizational_project;
    name                       : label;
    description                : text;
    responsible_organizations : SET [1:?] OF organization;
END_ENTITY; -- organizational_project

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 ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_CLOSED_SHELL' IN
             TYPEOF(SELF.closed_shell_element));
END_ENTITY; -- oriented_closed_shell

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 ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_EDGE' IN TYPEOF(SELF
             .edge_element));
END_ENTITY; -- oriented_edge

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 ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_FACE' IN TYPEOF(SELF
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             .face_element));
END_ENTITY; -- oriented_face

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 ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_OPEN_SHELL' IN
             TYPEOF(SELF.open_shell_element));
END_ENTITY; -- oriented_open_shell

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 ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_PATH' IN TYPEOF(SELF
             .path_element));
END_ENTITY; -- oriented_path

ENTITY parabola
  SUBTYPE OF (conic);
    focal_dist : length_measure;
  WHERE
    wr1: focal_dist <> 0;
END_ENTITY; -- parabola

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; -- path

ENTITY pcurve
  SUBTYPE OF (curve);
    basis_surface      : surface;
    reference_to_curve : definitional_representation;
  WHERE
    wr1: SIZEOF(reference_to_curve\representation.items) = 1;
    wr2: 'PLANT_SPATIAL_CONFIGURATION.CURVE' IN TYPEOF(
             reference_to_curve\representation.items[1]);
    wr3: reference_to_curve\representation.items[1]\
             geometric_representation_item.dim = 2;
END_ENTITY; -- pcurve

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;
```

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  UNIQUE
    ur1 : id;
  WHERE
    wr1: EXISTS(last_name) OR EXISTS(first_name);
END_ENTITY; -- person

ENTITY person_and_organization;
    the_person       : person;
    the_organization : organization;
END_ENTITY; -- person_and_organization

ENTITY person_and_organization_assignment
  ABSTRACT SUPERTYPE;
    assigned_person_and_organization : person_and_organization;
    role                             : person_and_organization_role;
END_ENTITY; -- person_and_organization_assignment

ENTITY person_and_organization_role;
    name : label;
END_ENTITY; -- person_and_organization_role

ENTITY person_assignment
  ABSTRACT SUPERTYPE;
    assigned_person : person;
    role            : person_role;
END_ENTITY; -- person_assignment

ENTITY person_role;
    name : label;
END_ENTITY; -- person_role

ENTITY pipe_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
              NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
              QUERY ( it <* ca.items | (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
              formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
              category_in_tree(prpc,'pipe') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- pipe_classification

ENTITY pipe_closure_fitting_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
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              NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
              QUERY ( it <* ca.items | (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
              formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
              category_in_tree(prpc,'pipe closure') )) = 1)) )) = 0)) )) =
               0;
END_ENTITY; -- pipe_closure_fitting_classification

ENTITY piping_component_class
  SUBTYPE OF (product_category, characterized_object);
END_ENTITY; -- piping_component_class

ENTITY piping_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY; -- piping_component_definition

ENTITY piping_connector_classification
  SUBTYPE OF (group);
END_ENTITY; -- piping_connector_classification

ENTITY piping_design_csg_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: SIZEOF(QUERY ( i <* SELF\representation.items | (NOT (SIZEOF([
              'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT',
              'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
              'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
              'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF(i))
              = 1)) )) = 0;
    wr2: SIZEOF(QUERY ( mi <* QUERY ( item <* SELF\representation.items
               | ('PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN
               TYPEOF(item)))
               | (NOT (('PLANT_SPATIAL_CONFIGURATION.' +
              'PIPING_DESIGN_CSG_SHAPE_REPRESENTATION') IN TYPEOF(mi\
              mapped_item.mapping_source.mapped_representation))) )) = 0;
END_ENTITY; -- piping_design_csg_shape_representation

ENTITY piping_system
  SUBTYPE OF (product_definition);
  WHERE
    wr1: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_DEFINITION_RELATIONSHIP.' +
              'RELATED_PRODUCT_DEFINITION')
               | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
              relating_product_definition.formation.of_product)) AND (pdr.
              relating_product_definition.frame_of_reference.name =
              'functional occurrence')) )) = 1;
END_ENTITY; -- piping_system

ENTITY placement
  SUPERTYPE OF (ONEOF (axis1_placement,axis2_placement_2d,
      axis2_placement_3d))
  SUBTYPE OF (geometric_representation_item);
    location : cartesian_point;
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  END_ENTITY; -- placement

  ENTITY plane
    SUBTYPE OF (elementary_surface);
  END_ENTITY; -- plane

  ENTITY plane_angle_measure_with_unit
    SUBTYPE OF (measure_with_unit);
    WHERE
      wr1: 'PLANT_SPATIAL_CONFIGURATION.PLANE_ANGLE_UNIT' IN TYPEOF(SELF\
               measure_with_unit.unit_component);
  END_ENTITY; -- plane_angle_measure_with_unit

  ENTITY plane_angle_unit
    SUBTYPE OF (named_unit);
    WHERE
      wr1: (SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
               named_unit.dimensions.mass_exponent = 0) AND (SELF\
               named_unit.dimensions.time_exponent = 0) AND (SELF\
               named_unit.dimensions.electric_current_exponent = 0) AND (
               SELF\named_unit.dimensions.
               thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
               .dimensions.amount_of_substance_exponent = 0) AND (SELF\
               named_unit.dimensions.luminous_intensity_exponent = 0);
  END_ENTITY; -- plane_angle_unit

  ENTITY plant
    SUBTYPE OF (product);
    WHERE
      wr1: (SIZEOF(QUERY ( pscoa <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +
               'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')
                | (pscoa.role.name = 'plant operator') )) + SIZEOF(
               QUERY ( pscpaoa <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +

'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.'
               + 'ITEMS')
               | (pscpaoa.role.name = 'plant operator') ))) <= 1;
      wr2: (SIZEOF(QUERY ( pscoa <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +
               'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')
                | (pscoa.role.name = 'plant owner') )) + SIZEOF(
               QUERY ( pscpaoa <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +
'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.'
               + 'ITEMS') | (pscpaoa.role.name = 'plant owner') )) +
               SIZEOF(QUERY ( pscpa <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +
               'PLANT_SPATIAL_CONFIGURATION_PERSON_ASSIGNMENT.ITEMS') | (
               pscpa.role.name = 'plant owner') ))) >= 1;
      wr3: (SIZEOF(QUERY ( pscoa <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +
               'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')
                | (pscoa\organization_assignment.role.name =
               'plant project owner') )) + SIZEOF(QUERY ( pscpaoa <*
               USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.'
               + 'ITEMS') | (pscpaoa\person_and_organization_assignment.
               role.name = 'plant project owner') ))) >= 1;
      wr4: SIZEOF(QUERY ( pdf <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +
               'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | (NOT (SIZEOF(
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              QUERY ( pd <* USEDIN(pdf,
              'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION.FORMATION')
               | (pd.frame_of_reference.name = 'functional occurrence')
               )) <= 1)) )) = 0;
    wr5: SIZEOF(QUERY ( pdf <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | (NOT (SIZEOF(
              QUERY ( prod_def <* USEDIN(pdf,
              'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION.FORMATION')
               | (SIZEOF(QUERY ( pd <* USEDIN(prod_def,
              'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
              'DEFINITION') | (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
              QUERY ( it <* pdr.used_representation.items | ((SIZEOF(
              TYPEOF(it) * [
              'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_2D',
              'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D']) = 1) AND
              (it.name = 'plant placement reference')) )) >= 1) )) >=
              1) )) >= 1) )) = 1)) )) = 0;
END_ENTITY; -- plant

ENTITY plant_item_connection
  SUBTYPE OF (shape_aspect, shape_aspect_relationship);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN TYPEOF(
              SELF\shape_aspect_relationship.relating_shape_aspect);
    wr2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN TYPEOF(
              SELF\shape_aspect_relationship.related_shape_aspect);
    wr3: SELF\shape_aspect.of_shape\property_definition.
              definition\product_definition.
              frame_of_reference\application_context_element.name IN [
              'functional occurrence','physical occurrence',
              'functional_definition','physical definition'];
    wr4: SELF\shape_aspect_relationship.relating_shape_aspect.
              of_shape\property_definition.
              definition\product_definition.
              frame_of_reference\application_context_element.
              name = SELF\shape_aspect_relationship.related_shape_aspect.
              of_shape\property_definition.
              definition\product_definition.
              frame_of_reference\application_context_element.name;
    wr5: SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
              'CLASSIFICATION_ASSIGNMENT.ITEMS')) > 0;
    wr6: SIZEOF(QUERY ( pscca <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
              'ITEMS')
              | (NOT (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.' +
              'CONNECTION_FUNCTIONAL_CLASSIFICATION',
              'PLANT_SPATIAL_CONFIGURATION.' +
              'CONNECTION_MOTION_CLASSIFICATION']
              * TYPEOF(pscca.assigned_group)) >= 1)) )) = 0;
    wr7: SIZEOF(QUERY ( pdr <* USEDIN(SELF.of_shape.definition,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_DEFINITION_RELATIONSHIP.'
              + 'RELATED_PRODUCT_DEFINITION') | (pdr.name =
              'support usage connection') )) <= 1;
END_ENTITY; -- plant_item_connection

ENTITY plant_item_connector
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : SELF\shape_aspect.of_shape\property_definition.
               definition\product_definition.
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          frame_of_reference\application_context_element.name IN [
          'functional definition','physical definition',
          'functional occurrence','physical occurrence'];
wr2 : SIZEOF(QUERY ( pic <* (bag_to_set(USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) +
          bag_to_set(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
          'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT'))) | (
          'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
          TYPEOF(pic)) )) <= 1;
wr3 : (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
          'ITEMS')
           | (SIZEOF(TYPEOF(ga.assigned_group) *
          ['PLANT_SPATIAL_CONFIGURATION.' +
          'PIPING_CONNECTOR_CLASSIFICATION',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'CONNECTOR_END_TYPE_CLASSIFICATION'])
          = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (pd.name = 'service characteristics') )) >= 1)) OR (
          SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
          QUERY ( pdr <* USEDIN(sc,'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'design service characteristics')))
          = 1)) )) = 0);
wr4 : (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
          'ITEMS') | (SIZEOF(TYPEOF(ga.assigned_group) *
          ['PLANT_SPATIAL_CONFIGURATION.' +
          'PIPING_CONNECTOR_CLASSIFICATION',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'CONNECTOR_END_TYPE_CLASSIFICATION'])
          = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (pd.name = 'service characteristics') )) >= 1)) OR (
          SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
          QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'design service characteristics') )
           | (SIZEOF(dsc.used_representation.items) >= 2) )) = 1))
          )) = 0);
wr5 : (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
          'ITEMS')
           | (SIZEOF(TYPEOF(ga.assigned_group) *
          ['PLANT_SPATIAL_CONFIGURATION.' +
          'PIPING_CONNECTOR_CLASSIFICATION',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'CONNECTOR_END_TYPE_CLASSIFICATION'])
          = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
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            'DEFINITION')
             | (pd.name = 'service characteristics') )) >= 1)) OR (
            SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
            'DEFINITION')
             | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
            QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
            'PLANT_SPATIAL_CONFIGURATION.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
            used_representation.
            name = 'design service characteristics') )
             | ((1 <= SIZEOF(QUERY ( it <* dsc.used_representation.
            items | ((
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND (it.name IN ['pressure',
            'minimum pressure','maximum pressure'])) ))) AND (SIZEOF(
            QUERY ( it <* dsc.used_representation.items | ((
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND (it.name IN ['pressure',
            'minimum pressure','maximum pressure'])) )) <= 2)) ))
            = 1)) )) = 0);
wr6 : (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
            'ITEMS')
             | (SIZEOF(TYPEOF(ga.assigned_group) *
            ['PLANT_SPATIAL_CONFIGURATION.' +
            'PIPING_CONNECTOR_CLASSIFICATION',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'CONNECTOR_END_TYPE_CLASSIFICATION'])
            = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
            'DEFINITION')
             | (pd.name = 'service characteristics') )) >= 1)) OR (
            SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
            'DEFINITION')
             | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
            QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
            'PLANT_SPATIAL_CONFIGURATION.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
            used_representation.
            name = 'design service characteristics') )
             | (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND (it.name = 'pressure')) )) <= 1) ))
            = 1)) )) = 0);
wr7 : (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
            'ITEMS')
             | (SIZEOF(TYPEOF(ga.assigned_group) *
            ['PLANT_SPATIAL_CONFIGURATION.' +
            'PIPING_CONNECTOR_CLASSIFICATION',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'CONNECTOR_END_TYPE_CLASSIFICATION'])
            = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
            'DEFINITION')
             | (pd.name = 'service characteristics') )) >= 1)) OR (
            SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
            'DEFINITION')
             | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
            QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
            'PLANT_SPATIAL_CONFIGURATION.' +
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            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
            used_representation.
            name = 'design service characteristics') )
             | (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND (it.name = 'minimum pressure')) ))
            <= 1) )) = 1)) )) = 0);
wr8 : (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
            'ITEMS')
             | (SIZEOF(TYPEOF(ga.assigned_group) *
            ['PLANT_SPATIAL_CONFIGURATION.' +
            'PIPING_CONNECTOR_CLASSIFICATION',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'CONNECTOR_END_TYPE_CLASSIFICATION'])
            = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
            'DEFINITION')
             | (pd.name = 'service characteristics') )) >= 1)) OR (
            SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
            'DEFINITION')
             | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
            QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
            'PLANT_SPATIAL_CONFIGURATION.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
            used_representation.
            name = 'design service characteristics') )
             | (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND (it.name = 'maximum pressure')) ))
            <= 1) )) = 1)) )) = 0);
wr9 : (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
            'ITEMS')
             | (SIZEOF(TYPEOF(ga.assigned_group) *
            ['PLANT_SPATIAL_CONFIGURATION.' +
            'PIPING_CONNECTOR_CLASSIFICATION',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'CONNECTOR_END_TYPE_CLASSIFICATION'])
            = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
            'DEFINITION')
             | (pd.name = 'service characteristics') )) >= 1)) OR (
            SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
           'DEFINITION')
             | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
            QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
            'PLANT_SPATIAL_CONFIGURATION.' +
            'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
            used_representation.
            name = 'design service characteristics') )
             | ((1 <= SIZEOF(QUERY ( it <* dsc.used_representation.
            items | ((SIZEOF(TYPEOF(it) * [
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
            it.name IN ['temperature','minimum temperature',
            'maximum temperature'])) ))) AND (SIZEOF(QUERY ( it <* dsc.
            used_representation.items | ((SIZEOF(TYPEOF(it) * [
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
            'PLANT_SPATIAL_CONFIGURATION.' +
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          'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
          it.name IN ['temperature','minimum temperature',
          'maximum temperature'])) )) <= 2)) )) = 1)) )) = 0);
wr10: (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
          'ITEMS')
           | (SIZEOF(TYPEOF(ga.assigned_group) *
          ['PLANT_SPATIAL_CONFIGURATION.' +
          'PIPING_CONNECTOR_CLASSIFICATION',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'CONNECTOR_END_TYPE_CLASSIFICATION'])
          = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (pd.name = 'service characteristics') )) >= 1)) OR (
          SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
          QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'design service characteristics') )
           | (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
          SIZEOF(TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
          it.name = 'temperature')) )) <= 1) )) = 1)) )) = 0);
wr11: (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
          'ITEMS')
           | (SIZEOF(TYPEOF(ga.assigned_group) *
          ['PLANT_SPATIAL_CONFIGURATION.' +
          'PIPING_CONNECTOR_CLASSIFICATION',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'CONNECTOR_END_TYPE_CLASSIFICATION'])
          = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (pd.name = 'service characteristics') )) >= 1)) OR (
          SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
          QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'design service characteristics') )
           | (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
          SIZEOF(TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
          it.name = 'minimum temperature')) )) <= 1) )) = 1)) ))
          = 0);
wr12: (NOT (SIZEOF(QUERY ( ga <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
          'ITEMS')
           | (SIZEOF(TYPEOF(ga.assigned_group) *
          ['PLANT_SPATIAL_CONFIGURATION.' +
          'PIPING_CONNECTOR_CLASSIFICATION',
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                'PLANT_SPATIAL_CONFIGURATION.' +
                'CONNECTOR_END_TYPE_CLASSIFICATION'])
                = 1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
                'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
                'DEFINITION')
                 | (pd.name = 'service characteristics') )) >= 1)) OR (
                SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
                'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
                'DEFINITION')
                 | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
                QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
                used_representation.
                name = 'design service characteristics') )
                 | (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
                SIZEOF(TYPEOF(it) * [
                'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
                'PLANT_SPATIAL_CONFIGURATION.' +
                'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
                it.name = 'maximum temperature')) )) <= 1) )) = 1)) ))
                = 0);
END_ENTITY; -- plant_item_connector

ENTITY plant_item_interference
  SUBTYPE OF (product_definition_relationship);
END_ENTITY; -- plant_item_interference

ENTITY plant_item_route
  SUBTYPE OF (product_definition_shape);
  WHERE
    wr1: SELF\property_definition.definition\product_definition.
             frame_of_reference\application_context_element.name =
             'physical occurrence';
    wr2: SIZEOF(TYPEOF(SELF\property_definition.definition) * [
             'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION',
             'PLANT_SPATIAL_CONFIGURATION.' +
             'PLANT_LINE_SEGMENT_DEFINITION'])
             = 1;
END_ENTITY; -- plant_item_route

ENTITY plant_item_weight_representation
  SUBTYPE OF (property_definition_representation);
  WHERE
    wr1: SELF.used_representation.name = 'item weight';
    wr2: SIZEOF(SELF.used_representation.items) >= 2;
    wr3: SIZEOF(QUERY ( it <* SELF.used_representation.items | ((it.name
             IN ['weight value','mass value','maximum weight value',
             'minimum weight value','maximum mass value',
             'minimum mass value']) AND (NOT (SIZEOF(TYPEOF(it) * [
             'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
             'PLANT_SPATIAL_CONFIGURATION.' +
             'QUALIFIED_REPRESENTATION_ITEM'])
             = 2))) )) = 0;
    wr4: SIZEOF(QUERY ( it <* SELF.used_representation.items | ((
             'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_REPRESENTATION_ITEM'
             IN TYPEOF(it)) AND (it.name = 'centre of gravity')) )) = 1;
    wr5: (1 <= SIZEOF(QUERY ( it <* SELF.used_representation.items | (it
             .name IN ['weight value','mass value',
             'maximum weight value',
             'minimum weight value','maximum mass value',
             'minimum mass value']) ))) AND (SIZEOF(QUERY ( it <* SELF.
             used_representation.items | (it.name IN ['weight value',
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              'mass value','maximum weight value','minimum weight value',
              'maximum mass value','minimum mass value']) )) <= 2);
    wr6: SIZEOF(QUERY ( it <* SELF\property_definition_representation.
              used_representation.items | ((it.name
              IN ['maximum weight value','minimum weight value',
              'maximum mass value','minimum mass value']) AND (NOT (
              SIZEOF(QUERY ( tq <* QUERY ( qual <*
              it\qualified_representation_item.qualifiers | (
              'PLANT_SPATIAL_CONFIGURATION.TYPE_QUALIFIER'
              IN TYPEOF(qual)) )
               | (tq.name = 'operating') )) = 1))) )) = 0;
END_ENTITY; -- plant_item_weight_representation

ENTITY plant_line_definition
  SUBTYPE OF (product_definition_with_associated_documents);
  WHERE
    wr1: SIZEOF(QUERY ( pdr <* USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.'
              + 'PRODUCT_DEFINITION_RELATIONSHIP.' +
              'RELATED_PRODUCT_DEFINITION')
               | ('PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM' IN TYPEOF(
              pdr.relating_product_definition)) )) = 1;
    wr2: SIZEOF(QUERY ( pdr <* USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.'
              + 'PRODUCT_DEFINITION_RELATIONSHIP.' +
              'RELATING_PRODUCT_DEFINITION')
               | (
              'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
              IN TYPEOF(pdr.related_product_definition)) )) >= 1;
    wr3: (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
              'DEFINITION')
               | (SIZEOF(USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1) )) =
               0)) OR (SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
              'DEFINITION')
               | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
              QUERY ( rep <* USEDIN(pdr.used_representation.
              context_of_items,
              'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.' +
              'CONTEXT_OF_ITEMS')
               | (SIZEOF(QUERY ( prop_def_rep <* USEDIN(rep,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
              ((SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
              'PLANT_SPATIAL_CONFIGURATION.SITE_BUILDING'] * TYPEOF(
              prop_def_rep.definition)) = 1) OR (
              'PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(prop_def_rep.
              definition.definition.formation.of_product))) )) >= 1) )) >=
               1) )) >= 1)) )) = 0);
    wr4: SELF.frame_of_reference.name = 'functional definition';
END_ENTITY; -- plant_line_definition

ENTITY plant_line_segment_definition
  SUBTYPE OF (product_definition);
  WHERE
    wr1 : SIZEOF(QUERY ( pdr <* USEDIN(SELF,
               'PLANT_SPATIAL_CONFIGURATION.' +
               'PRODUCT_DEFINITION_RELATIONSHIP.' +
               'RELATED_PRODUCT_DEFINITION')
                | ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION' IN
               TYPEOF(pdr.relating_product_definition)) )) >= 1;
    wr2 : SIZEOF(QUERY ( pd <* USEDIN(SELF,
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          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | ('PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN
          TYPEOF(pd)) )) >= 1;
wr3 : SELF.frame_of_reference\application_context_element.name =
          'functional definition';
wr4 : SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'line segment characteristics') )) = 1;
wr5 : SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'line segment characteristics') )
           | (NOT (SIZEOF(lsc.used_representation.items) >= 2)) )) =
          0;
wr6 : SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'line segment characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* lsc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'design pressure')) )) = 1))
          )) = 0;
wr7 : SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'line segment characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* lsc.used_representation.items
           | ((SIZEOF(TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
          it.name = 'design temperature')) )) = 1)) )) = 0;
wr8 : SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'line segment characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* lsc.used_representation.items
           | ((SIZEOF(TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
          2) AND (it.name = 'elevation')) )) <= 1)) )) = 0;
wr9 : SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'line segment characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* lsc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'corrosion allowance')) )) <=
           1)) )) = 0;
wr10: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_DEFINITION_RELATIONSHIP.' +
          'RELATED_PRODUCT_DEFINITION')
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            | (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
           QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PRODUCT_DEFINITION_RELATIONSHIP.' +
           'RELATED_PRODUCT_DEFINITION')
            | (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
           QUERY ( pd <* USEDIN(si,
           'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
           'DEFINITION')
            | (NOT (SIZEOF(QUERY ( pds <* QUERY ( pdr <* USEDIN(pd,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
           'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
           TYPEOF(pdr)) ) | (pds.used_representation.name =
           'segment insulation characteristics') )) = 1)) )) = 0)) ))
           = 0);
wr11: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PRODUCT_DEFINITION_RELATIONSHIP.' +
           'RELATED_PRODUCT_DEFINITION')
            | (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
           QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PRODUCT_DEFINITION_RELATIONSHIP.' +
           'RELATED_PRODUCT_DEFINITION')
            | (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
           QUERY ( pd <* USEDIN(si,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION.DEFINITION')
            | (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
           QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
           'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
           TYPEOF(pdr)) ) | (pds.used_representation.name =
           'segment insulation characteristics') ) | (SIZEOF(sic.
           used_representation.items) >= 1) )) = 1)) )) = 0)) )) = 0);
wr12: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PRODUCT_DEFINITION_RELATIONSHIP.' +
           'RELATED_PRODUCT_DEFINITION')
            | (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
           QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PRODUCT_DEFINITION_RELATIONSHIP.' +
           'RELATED_PRODUCT_DEFINITION')
            | (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
           QUERY ( pd <* USEDIN(si,
           'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
           'DEFINITION')
            | (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
           QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
           'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
           TYPEOF(pdr)) ) | (pds.used_representation.name =
           'segment insulation characteristics') ) | ((1 <= SIZEOF(
           QUERY ( it <* sic.used_representation.items | ((SIZEOF(
           TYPEOF(it) * [
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
           'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
           2) AND (it.name IN ['thickness','minimum thickness',
           'maximum thickness'])) ))) AND (SIZEOF(QUERY ( it <* sic.
           used_representation.items | ((SIZEOF(TYPEOF(it) * [
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
           'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
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          2) AND (it.name IN ['thickness','minimum thickness',
          'maximum thickness'])) )) <= 2)) )) = 1)) )) = 0)) )) = 0);
wr13: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_DEFINITION_RELATIONSHIP.' +
         'RELATED_PRODUCT_DEFINITION')
           | (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
          QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_DEFINITION_RELATIONSHIP.' +
         'RELATED_PRODUCT_DEFINITION')
           | (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
          QUERY ( pd <* USEDIN(si,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
          QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
          'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
          TYPEOF(pdr)) ) | (pds.used_representation.name =
          'segment insulation characteristics') ) | (SIZEOF(
          QUERY ( it <* sic.used_representation.items | ((SIZEOF(
          TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
          2) AND (it.name = 'thickness')) )) <= 1) )) = 1)) ))
          = 0)) )) = 0);
wr14: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_DEFINITION_RELATIONSHIP.' +
          'RELATED_PRODUCT_DEFINITION')
           | (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
          QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_DEFINITION_RELATIONSHIP.' +
          'RELATED_PRODUCT_DEFINITION')
           | (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
          QUERY ( pd <* USEDIN(si,
          'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
          'DEFINITION')
           | (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
          QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
          'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
          TYPEOF(pdr)) ) | (pds.used_representation.name =
          'segment insulation characteristics') ) | (SIZEOF(
          QUERY ( it <* sic.used_representation.items | ((SIZEOF(
          TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
          2) AND (it.name = 'minimum thickness')) )) <= 1) ))
          = 1)) )) = 0)) )) = 0);
wr15: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_DEFINITION_RELATIONSHIP.' +
          'RELATED_PRODUCT_DEFINITION')
           | (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
          QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_DEFINITION_RELATIONSHIP.' +
          'RELATED_PRODUCT_DEFINITION')
           | (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
          QUERY ( pd <* USEDIN(si,
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              'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
              'DEFINITION')
               | (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
              QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
              'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
              TYPEOF(pdr)) ) | (pds.used_representation.name =
              'segment insulation characteristics') ) | (SIZEOF(
              QUERY ( it <* sic.used_representation.items | ((SIZEOF(
              TYPEOF(it) * [
              'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
              'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
              2) AND (it.name = 'maximum thickness')) )) <= 1) ))
              = 1)) )) = 0)) )) = 0);
    wr16: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_DEFINITION_RELATIONSHIP.' +
              'RELATED_PRODUCT_DEFINITION')
               | (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
              QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_DEFINITION_RELATIONSHIP.' +
              'RELATED_PRODUCT_DEFINITION')
               | (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
              QUERY ( pd <* USEDIN(si,
              'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.' +
              'DEFINITION')
               | (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
              QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
              'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
              TYPEOF(pdr)) ) | (pds.used_representation.name =
              'segment insulation characteristics') ) | (SIZEOF(
              QUERY ( it <* sic.used_representation.items |
              (('PLANT_SPATIAL_CONFIGURATION.' +
              'DESCRIPTIVE_REPRESENTATION_ITEM'
              IN TYPEOF(it)) AND (it.name = 'boundaries')) )) <= 1) )) =
              1)) )) = 0)) )) = 0);
END_ENTITY; -- plant_line_segment_definition

ENTITY plant_line_segment_termination
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION' IN
             TYPEOF(SELF.of_shape.definition);
    wr2: SIZEOF(QUERY ( sar <* (USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.' +
             'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') + USEDIN(
             SELF,'PLANT_SPATIAL_CONFIGURATION.' +
             'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) | (NOT (
             SIZEOF(TYPEOF(sar) * [
             'PLANT_SPATIAL_CONFIGURATION.LINE_BRANCH_CONNECTION',
             'PLANT_SPATIAL_CONFIGURATION.LINE_PLANT_ITEM_CONNECTION',
             'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION'])
             = 1)) )) = 0;
END_ENTITY; -- plant_line_segment_termination

ENTITY plant_spatial_configuration_action_request_assignment
  SUBTYPE OF (action_request_assignment);
    items : SET [1:?] OF plant_spatial_configuration_action_request_item;
END_ENTITY; -- plant_spatial_configuration_action_request_assignment

ENTITY plant_spatial_configuration_approval_assignment
  SUBTYPE OF (approval_assignment);
```

```
      items : SET [1:?] OF approval_item;
  END_ENTITY; -- plant_spatial_configuration_approval_assignment

  ENTITY plant_spatial_configuration_change_assignment
    SUBTYPE OF (action_assignment);
      items : SET [1:?] OF change_item;
    WHERE
      wr1: 'PLANT_SPATIAL_CONFIGURATION.CHANGE_ACTION' IN TYPEOF(SELF.
                assigned_action);
  END_ENTITY; -- plant_spatial_configuration_change_assignment

  ENTITY plant_spatial_configuration_date_and_time_assignment
    SUBTYPE OF (date_and_time_assignment);
      items : SET [1:?] OF plant_spatial_configuration_date_and_time_item;
  END_ENTITY; -- plant_spatial_configuration_date_and_time_assignment

  ENTITY plant_spatial_configuration_date_assignment
    SUBTYPE OF (date_assignment);
      items : SET [1:?] OF plant_spatial_configuration_dated_item;
  END_ENTITY; -- plant_spatial_configuration_date_assignment

  ENTITY plant_spatial_configuration_document_reference
    SUBTYPE OF (document_reference);
      items : SET [1:?] OF plant_spatial_configuration_document_item;
  END_ENTITY; -- plant_spatial_configuration_document_reference

  ENTITY plant_spatial_configuration_organization_assignment
    SUBTYPE OF (organization_assignment);
      items : SET [1:?] OF plant_spatial_configuration_organization_item;
    WHERE
      wr1: plant_spatial_configuration_organization_correlation(SELF);
  END_ENTITY; -- plant_spatial_configuration_organization_assignment

  ENTITY plant_spatial_configuration_person_and_organization_assignment
    SUBTYPE OF (person_and_organization_assignment);
      items : SET [1:?] OF
                  plant_spatial_configuration_person_and_organization_item;
    WHERE
      wr1: plant_spatial_configuration_person_and_organization_correlation(
                SELF);
  END_ENTITY; --
plant_spatial_configuration_person_and_organization_assignment

  ENTITY plant_spatial_configuration_person_assignment
    SUBTYPE OF (person_assignment);
      items : SET [1:?] OF plant_spatial_configuration_person_item;
    WHERE
      wr1: plant_spatial_configuration_person_correlation(SELF);
  END_ENTITY; -- plant_spatial_configuration_person_assignment

  ENTITY point
    SUPERTYPE OF (ONEOF (cartesian_point,point_on_curve,point_on_surface,
        point_replica,degenerate_pcurve))
    SUBTYPE OF (geometric_representation_item);
  END_ENTITY; -- point

  ENTITY point_on_curve
    SUBTYPE OF (point);
      basis_curve     : curve;
      point_parameter : parameter_value;
  END_ENTITY; -- point_on_curve

  ENTITY point_on_surface
```

```
  SUBTYPE OF (point);
    basis_surface     : surface;
    point_parameter_u : parameter_value;
    point_parameter_v : parameter_value;
END_ENTITY; -- point_on_surface

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; -- point_replica

ENTITY poly_loop
  SUBTYPE OF (loop, geometric_representation_item);
    polygon : LIST [3:?] OF UNIQUE cartesian_point;
END_ENTITY; -- poly_loop

ENTITY polyline
  SUBTYPE OF (bounded_curve);
    points : LIST [2:?] OF cartesian_point;
END_ENTITY; -- polyline

ENTITY pre_defined_item;
    name : label;
END_ENTITY; -- pre_defined_item

ENTITY presentation_layer_assignment;
    name           : label;
    description    : text;
    assigned_items : SET [1:?] OF layered_item;
END_ENTITY; -- presentation_layer_assignment

ENTITY process_capability
  SUBTYPE OF (property_definition);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(SELF.definition\
             product_definition.formation.of_product);
    wr2: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.' +
             'PROPERTY_DEFINITION_REPRESENTATION.'
             + 'DEFINITION') | ((pdr.used_representation.name =
             'production capacity') AND (NOT (SIZEOF(QUERY ( it <* pdr.
             used_representation.items | (('PLANT_SPATIAL_CONFIGURATION.'
             + 'DESCRIPTIVE_REPRESENTATION_ITEM'
             IN TYPEOF(it)) AND (it.name = 'production type')) ))
             = 1))) )) = 0;
END_ENTITY; -- process_capability

ENTITY product;
    id                 : identifier;
    name               : label;
    description        : text;
    frame_of_reference : SET [1:?] OF product_context;
  UNIQUE
    ur1 : id;
END_ENTITY; -- product

ENTITY product_category;
    name        : label;
    description : OPTIONAL text;
END_ENTITY; -- product_category
```

```
ENTITY product_category_relationship;
    name         : label;
    description  : text;
    category     : product_category;
    sub_category : product_category;
  WHERE
    wr1: acyclic_product_category_relationship(SELF,[SELF.sub_category]);
END_ENTITY; -- product_category_relationship

ENTITY product_context
  SUBTYPE OF (application_context_element);
    discipline_type : label;
END_ENTITY; -- product_context

ENTITY product_definition;
    id                 : identifier;
    description        : text;
    formation          : product_definition_formation;
    frame_of_reference : product_definition_context;
END_ENTITY; -- product_definition

ENTITY product_definition_context
  SUBTYPE OF (application_context_element);
    life_cycle_stage : label;
END_ENTITY; -- product_definition_context

ENTITY product_definition_formation;
    id          : identifier;
    description : text;
    of_product  : product;
  UNIQUE
    ur1 : id, of_product;
END_ENTITY; -- product_definition_formation

ENTITY product_definition_formation_relationship;
    id                                    : identifier;
    name                                  : label;
    description                           : text;
    relating_product_definition_formation : product_definition_formation;
    related_product_definition_formation  : product_definition_formation;
END_ENTITY; -- product_definition_formation_relationship

ENTITY product_definition_formation_with_specified_source
  SUBTYPE OF (product_definition_formation);
    make_or_buy : source;
END_ENTITY; -- product_definition_formation_with_specified_source

ENTITY product_definition_relationship;
    id                          : identifier;
    name                        : label;
    description                 : text;
    relating_product_definition : product_definition;
    related_product_definition  : product_definition;
END_ENTITY; -- product_definition_relationship

ENTITY product_definition_shape
  SUBTYPE OF (property_definition);
  UNIQUE
    ur1 : definition;
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_PRODUCT_DEFINITION'
             IN TYPEOF(SELF\property_definition.definition);
END_ENTITY; -- product_definition_shape
```

```
ENTITY product_definition_substitute;
    description           : text;
    context_relationship  : product_definition_relationship;
    substitute_definition : product_definition;
  WHERE
    wr1: context_relationship.related_product_definition :<>:
             substitute_definition;
END_ENTITY; -- product_definition_substitute

ENTITY product_definition_usage
  SUPERTYPE OF (ONEOF (make_from_usage_option,assembly_component_usage))
  SUBTYPE OF (product_definition_relationship);
  UNIQUE
    ur1 : id, relating_product_definition, related_product_definition;
  WHERE
    wr1: acyclic_product_definition_relationship(SELF,[SELF\
             product_definition_relationship.related_product_definition],
             'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_USAGE.' +
             'RELATED_PRODUCT_DEFINITION');
END_ENTITY; -- product_definition_usage

ENTITY product_definition_with_associated_documents
  SUBTYPE OF (product_definition);
    documentation_ids : SET [1:?] OF document;
END_ENTITY; -- product_definition_with_associated_documents

ENTITY product_material_composition_relationship
  SUBTYPE OF (product_definition_relationship);
    class                : label;
    constituent_amount   : SET [1:?] OF measure_with_unit;
    composition_basis    : label;
    determination_method : text;
END_ENTITY; -- product_material_composition_relationship

ENTITY product_related_product_category
  SUBTYPE OF (product_category);
    products : SET [1:?] OF product;
END_ENTITY; -- product_related_product_category

ENTITY property_definition;
    name        : label;
    description : text;
    definition  : characterized_definition;
END_ENTITY; -- property_definition

ENTITY property_definition_relationship;
    name                        : label;
    description                 : text;
    relating_property_definition : property_definition;
    related_property_definition  : property_definition;
END_ENTITY; -- property_definition_relationship

ENTITY property_definition_representation;
    definition          : property_definition;
    used_representation : representation;
END_ENTITY; -- property_definition_representation

ENTITY purchase_assignment
  SUBTYPE OF (action_assignment);
    items : SET [1:?] OF purchase_item;
END_ENTITY; -- purchase_assignment

ENTITY qualified_representation_item
  SUBTYPE OF (representation_item);
```

```
    qualifiers : SET [1:?] OF value_qualifier;
  WHERE
    wr1: SIZEOF(QUERY ( temp <* qualifiers | (
             'PLANT_SPATIAL_CONFIGURATION.PRECISION_QUALIFIER' IN TYPEOF(
             temp)) )) < 2;
END_ENTITY; -- qualified_representation_item

ENTITY quasi_uniform_curve
  SUBTYPE OF (b_spline_curve);
END_ENTITY; -- quasi_uniform_curve

ENTITY quasi_uniform_surface
  SUBTYPE OF (b_spline_surface);
END_ENTITY; -- quasi_uniform_surface

ENTITY ratio_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.RATIO_UNIT' IN TYPEOF(SELF\
             measure_with_unit.unit_component);
END_ENTITY; -- ratio_measure_with_unit

ENTITY ratio_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
             named_unit.dimensions.mass_exponent = 0) AND (SELF\
             named_unit.dimensions.time_exponent = 0) AND (SELF\
             named_unit.dimensions.electric_current_exponent = 0) AND (
             SELF\named_unit.dimensions.
             thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
             .dimensions.amount_of_substance_exponent = 0) AND (SELF\
             named_unit.dimensions.luminous_intensity_exponent = 0);
END_ENTITY; -- ratio_unit

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; -- rational_b_spline_curve

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; -- rational_b_spline_surface

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: [] = QUERY ( s <* segments | (n_v <> SIZEOF(s)) );
    wr2: constraints_rectangular_composite_surface(SELF);
END_ENTITY; -- rectangular_composite_surface

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: (('PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN TYPEOF(
             basis_surface)) AND (NOT (
             'PLANT_SPATIAL_CONFIGURATION.PLANE'
             IN TYPEOF(basis_surface))))
             OR ('PLANT_SPATIAL_CONFIGURATION.SURFACE_OF_REVOLUTION' IN
             TYPEOF(basis_surface)) OR (usense = (u2 > u1));
    wr4: ('PLANT_SPATIAL_CONFIGURATION.SPHERICAL_SURFACE' IN TYPEOF(
             basis_surface)) OR (
             'PLANT_SPATIAL_CONFIGURATION.TOROIDAL_SURFACE' IN TYPEOF(
             basis_surface)) OR (vsense = (v2 > v1));
END_ENTITY; -- rectangular_trimmed_surface

ENTITY reducer_fitting_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.' +
             'ASSIGNED_GROUP')
              | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
             IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
             NOT (
             'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
              TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.' +
             'ASSIGNED_GROUP')
              | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
             IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
             QUERY ( it <* ca.items | (
             'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
              TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
             formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
             category_in_tree(prpc,'reducer') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- reducer_fitting_classification

ENTITY reference_geometry
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: SIZEOF(QUERY ( pd <* USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.'
             + 'PROPERTY_DEFINITION.DEFINITION')
             | (NOT (SIZEOF(USEDIN(pd,
             'PLANT_SPATIAL_CONFIGURATION.' +
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              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1)) ))
              = 0;
END_ENTITY; -- reference_geometry

ENTITY reparametrised_composite_curve_segment
  SUBTYPE OF (composite_curve_segment);
    param_length : parameter_value;
  WHERE
    wr1: param_length > 0;
END_ENTITY; -- reparametrised_composite_curve_segment

ENTITY representation;
    name             : label;
    items            : SET [1:?] OF representation_item;
    context_of_items : representation_context;
END_ENTITY; -- representation

ENTITY representation_context;
    context_identifier : identifier;
    context_type       : text;
  INVERSE
    representations_in_context : SET [1:?] OF representation FOR
                                    context_of_items;
END_ENTITY; -- representation_context

ENTITY representation_item;
    name : label;
  WHERE
    wr1: SIZEOF(using_representations(SELF)) > 0;
END_ENTITY; -- representation_item

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; -- representation_map

ENTITY required_material_property
  SUBTYPE OF (material_property);
  WHERE
    wr1: (SIZEOF(TYPEOF(SELF\property_definition.definition) * [
              'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
              'PLANT_SPATIAL_CONFIGURATION.' +
              'EXTERNALLY_DEFINED_PLANT_ITEM'])
              = 1) OR (('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION'
              IN TYPEOF(SELF.definition)) AND (SIZEOF(QUERY ( pc <*
              SELF\property_definition.
              definition\product_definition.formation.of_product.
              frame_of_reference |
              (pc.discipline_type = 'process plant') )) = 1));
    wr2: SIZEOF(QUERY ( ra <* QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_RELATIONSHIP.' +
              'RELATED_PROPERTY_DEFINITION')
               | (pdr.name = 'requirement allocation') ) | (
              'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY' IN TYPEOF(ra
              .relating_property_definition)) )) >= 1;
END_ENTITY; -- required_material_property
```

```
ENTITY reserved_space
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: SELF\shape_aspect.of_shape\property_definition.
             definition\product_definition.
             frame_of_reference\application_context_element.name =
             'physical occurrence';
END_ENTITY; -- reserved_space

ENTITY revolved_area_solid
  SUBTYPE OF (swept_area_solid);
    axis  : axis1_placement;
    angle : plane_angle_measure;
  DERIVE
    axis_line : line := line(axis.location,vector(axis.z,1));
END_ENTITY; -- revolved_area_solid

ENTITY revolved_face_solid
  SUBTYPE OF (swept_face_solid);
    axis  : axis1_placement;
    angle : plane_angle_measure;
  DERIVE
    axis_line : line := line(axis.location,vector(axis.z,1));
END_ENTITY; -- revolved_face_solid

ENTITY right_circular_cone
  SUBTYPE OF (geometric_representation_item);
    position   : axis1_placement;
    height     : positive_length_measure;
    radius     : length_measure;
    semi_angle : plane_angle_measure;
  WHERE
    wr1: radius >= 0;
END_ENTITY; -- right_circular_cone

ENTITY right_circular_cylinder
  SUBTYPE OF (geometric_representation_item);
    position : axis1_placement;
    height   : positive_length_measure;
    radius   : positive_length_measure;
END_ENTITY; -- right_circular_cylinder

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: 'PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(SELF\
             surface_curve.associated_geometry[1]);
    wr4: 'PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(SELF\
             surface_curve.associated_geometry[2]);
END_ENTITY; -- seam_curve

ENTITY shape_aspect;
    name                 : label;
    description          : text;
    of_shape             : product_definition_shape;
    product_definitional : LOGICAL;
END_ENTITY; -- shape_aspect

ENTITY shape_aspect_deriving_relationship
  SUBTYPE OF (shape_aspect_relationship);
```

```
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.DERIVED_SHAPE_ASPECT' IN TYPEOF(
             SELF\shape_aspect_relationship.relating_shape_aspect);
END_ENTITY; -- shape_aspect_deriving_relationship

ENTITY shape_aspect_relationship;
    name                  : label;
    description           : text;
    relating_shape_aspect : shape_aspect;
    related_shape_aspect  : shape_aspect;
END_ENTITY; -- shape_aspect_relationship

ENTITY shape_definition_representation
  SUBTYPE OF (property_definition_representation);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN TYPEOF(SELF.
             definition.definition)) OR (
             'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
             TYPEOF(SELF.definition));
    wr2: 'PLANT_SPATIAL_CONFIGURATION.SHAPE_REPRESENTATION' IN TYPEOF(
             SELF.used_representation);
END_ENTITY; -- shape_definition_representation

ENTITY shape_dimension_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: SIZEOF(QUERY ( temp <* SELF.items | (NOT (
             'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
              TYPEOF(temp))) )) = 0;
    wr2: SIZEOF(SELF.items) <= 2;
    wr3: SIZEOF(QUERY ( pos_mri <* QUERY ( real_mri <* SELF.items | (
             'REAL' IN TYPEOF(real_mri\measure_with_unit.
              value_component)) )
              | (NOT (pos_mri\measure_with_unit.value_component > 0)) ))
             = 0;
END_ENTITY; -- shape_dimension_representation

ENTITY shape_representation
  SUBTYPE OF (representation);
END_ENTITY; -- shape_representation

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; -- shell_based_wireframe_model

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(SELF.name);
END_ENTITY; -- si_unit

ENTITY site
  SUBTYPE OF (characterized_object, property_definition);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(SELF\
             property_definition.definition\product_definition.formation.
             of_product);
```

```
END_ENTITY; -- site

ENTITY site_building
  SUBTYPE OF (property_definition);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.SITE' IN TYPEOF(SELF.definition);
    wr2: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((pdr.
              used_representation.name = 'building number') AND (SIZEOF(
              QUERY ( it <* pdr.used_representation.items |
              ('PLANT_SPATIAL_CONFIGURATION.' +
              'DESCRIPTIVE_REPRESENTATION_ITEM'
              IN TYPEOF(it)) )) = 1)) )) = 1;
    wr3: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
              QUERY ( it <* pdr.used_representation.items | ((SIZEOF([
              'PLANT_SPATIAL_CONFIGURATION.AXIS_PLACEMENT_2D',
              'PLANT_SPATIAL_CONFIGURATION.AXIS_PLACEMENT_3D']
              * TYPEOF(it))
              = 1) AND (it.name = 'building orientation') AND (it.location
              .name = 'building location')) )) = 1) )) <= 1;
END_ENTITY; -- site_building

ENTITY site_feature
  SUBTYPE OF (property_definition);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.SITE' IN TYPEOF(SELF.definition);
    wr2: SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 3;
    wr3: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
              QUERY ( it <* pdr.used_representation.items |
              (('PLANT_SPATIAL_CONFIGURATION.' +
              'DESCRIPTIVE_REPRESENTATION_ITEM'
              IN TYPEOF(it)) AND (it.
              name = 'site feature type')) )) = 1) )) = 1;
    wr4: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
              QUERY ( it <* pdr.used_representation.items | ((SIZEOF([
              'PLANT_SPATIAL_CONFIGURATION.AXIS_PLACEMENT_2D',
              'PLANT_SPATIAL_CONFIGURATION.AXIS_PLACEMENT_3D']
              * TYPEOF(it))
              = 1) AND (it.name = 'feature orientation') AND (it.location.
              name = 'feature location')) )) = 1) )) = 1;
    wr5: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
              QUERY ( it <* pdr.used_representation.items |
              (('PLANT_SPATIAL_CONFIGURATION.' +
              'DESCRIPTIVE_REPRESENTATION_ITEM'
              IN TYPEOF(pdr.used_representation)) AND (it.name =
              'origin type') AND (it.description IN ['man made',
              'natural'])) )) = 1) )) = 1;
END_ENTITY; -- site_feature

ENTITY site_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
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              'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
              (NOT ('PLANT_SPATIAL_CONFIGURATION.SITE' IN TYPEOF(pdr.
              definition.definition))) )) = 0;
     wr2: SIZEOF(QUERY ( item <* SELF.items | (NOT (SIZEOF([
              'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET',
              'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'] * TYPEOF(
              item)) = 1)) )) = 1;
     wr3: SIZEOF(QUERY ( cfs <* QUERY ( item <* SELF.items | (
              'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF(
              item)) ) | (NOT (SIZEOF(QUERY ( fcs <* cfs\
              connected_face_set.cfs_faces | (NOT (SIZEOF(QUERY ( bnds <*
              fcs.bounds | (NOT ('PLANT_SPATIAL_CONFIGURATION.POLY_LOOP'
              IN TYPEOF(bnds.bound))) )) = 0)) )) = 0)) )) = 0;
     wr4: SIZEOF(QUERY ( cfs <* QUERY ( item <* SELF.items | (
              'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF(
              item)) ) | (NOT (SIZEOF(QUERY ( fcs <* cfs\
              connected_face_set.cfs_faces | (NOT (SIZEOF(QUERY ( bnds <*
              fcs.bounds | (NOT (SIZEOF(bnds.bound\poly_loop.polygon)
              <= 4)) )) = 0)) )) = 0)) )) = 0;
     wr5: SIZEOF(QUERY ( gcs <* QUERY ( item <* SELF.items | (
              'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' IN TYPEOF(
              item)) ) | (NOT (SIZEOF(QUERY ( el <* gcs\geometric_set.
              elements | (NOT (SIZEOF([
              'PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT',
              'PLANT_SPATIAL_CONFIGURATION.POLYLINE'] * TYPEOF(el))
              = 1)) )) = 0)) )) = 0;
     wr6: SIZEOF(QUERY ( gcs <* QUERY ( item <* SELF.items | (
              'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' IN TYPEOF(
              item)) ) | (NOT (SIZEOF(QUERY ( el <* gcs\geometric_set.
              elements | ('PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT' IN
               TYPEOF(el)) )) >= 1)) )) = 0;
     wr7: SIZEOF(QUERY ( gcs <* QUERY ( item <* SELF.items | (
              'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' IN TYPEOF(
              item)) ) | (NOT (SIZEOF(QUERY ( pline <* QUERY ( el <* gcs\
              geometric_set.elements | (
              'PLANT_SPATIAL_CONFIGURATION.POLYLINE' IN TYPEOF(el)) ) | (
              NOT (SIZEOF(QUERY ( pline_pt <* pline\polyline.points | (
              NOT (pline_pt IN gcs\geometric_set.elements)) )) = 0)) )) =
              0)) )) = 0;
END_ENTITY; -- site_representation

ENTITY solid_angle_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.SOLID_ANGLE_UNIT' IN TYPEOF(SELF\
              measure_with_unit.unit_component);
END_ENTITY; -- solid_angle_measure_with_unit

ENTITY solid_angle_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
              named_unit.dimensions.mass_exponent = 0) AND (SELF\
              named_unit.dimensions.time_exponent = 0) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0) AND (
              SELF\named_unit.dimensions.
              thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
              .dimensions.amount_of_substance_exponent = 0) AND (SELF\
              named_unit.dimensions.luminous_intensity_exponent = 0);
END_ENTITY; -- solid_angle_unit

ENTITY solid_model
  SUPERTYPE OF (ONEOF (csg_solid,manifold_solid_brep,swept_face_solid,
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      swept_area_solid))
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- solid_model

ENTITY spacer_fitting_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.' +
             'ASSIGNED_GROUP')
              | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
             IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
             NOT (
             'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
              TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.' +
             'ASSIGNED_GROUP')
              | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
             IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
             QUERY ( it <* ca.items | (
             'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
              TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
             formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
             'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
             category_in_tree(prpc,'spacer') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- spacer_fitting_classification

ENTITY specialty_item_classification
  SUBTYPE OF (group);
END_ENTITY; -- specialty_item_classification

ENTITY sphere
  SUBTYPE OF (geometric_representation_item);
    radius : positive_length_measure;
    centre : point;
END_ENTITY; -- sphere

ENTITY spherical_surface
  SUBTYPE OF (elementary_surface);
    radius : positive_length_measure;
END_ENTITY; -- spherical_surface

ENTITY stream_design_case
  SUBTYPE OF (property_definition, characterized_object);
  WHERE
    wr1 : SIZEOF(QUERY ( pd <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION.DEFINITION') | (
              'PLANT_SPATIAL_CONFIGURATION.STREAM_PHASE'
              IN TYPEOF(pd)) )) >= 1;
    wr2 : SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
              used_representation.
              name = 'stream flow characteristics') )) = 1;
    wr3 : SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
              used_representation.name = 'stream flow characteristics') )
               | (NOT (SIZEOF(sfc.used_representation.items) >= 2)) )) =
              0;
    wr4 : SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
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          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT ((1 <= SIZEOF(QUERY ( it <* sfc.used_representation
          .items | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name IN ['flow rate',
          'minimum flow rate','maximum flow rate'])) ))) AND (SIZEOF(
          QUERY ( it <* sfc.used_representation.items | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name IN ['flow rate',
          'minimum flow rate','maximum flow rate'])) )) <= 2))) )) =
          0;
wr5 : SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'flow rate')) )) <= 1)) )) =
          0;
wr6 : SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.
          name = 'minimum flow rate')) )) <= 1)) )) = 0;
wr7 : SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.
          name = 'maximum flow rate')) )) <= 1)) )) = 0;
wr8 : SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT ((1 <= SIZEOF(QUERY ( it <* sfc.used_representation
          .items | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name IN ['pressure',
          'minimum pressure','maximum pressure'])) ))) AND (SIZEOF(
          QUERY ( it <* sfc.used_representation.items | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name IN ['pressure',
          'minimum pressure','maximum pressure'])) )) <= 2))) )) = 0;
wr9 : SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.
          name = 'pressure')) )) <= 1)) )) = 0;
wr10: SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
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          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.
          name = 'minimum pressure')) )) <= 1)) )) = 0;
wr11: SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'maximum pressure')) ))
          <= 1)) )) = 0;
wr12: SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name = 'stream flow characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
           | (('PLANT_SPATIAL_CONFIGURATION.' +
          'DESCRIPTIVE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'stream data reference')) ))
          <= 1)) )) = 0;
wr13: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
           | (pdr.related_property_definition.name =
          'service characteristics') )) >= 1)) OR (SIZEOF(
          QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
           | (pdr.related_property_definition.name =
          'service characteristics') ) | (NOT (SIZEOF(QUERY ( pdr <*
          USEDIN(sc.related_property_definition,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name =
          'service operating characteristics') )) = 1)) )) = 0);
wr14: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
           | (pdr.related_property_definition.name =
          'service characteristics') )) >= 1)) OR (SIZEOF(
          QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
           | (pdr.related_property_definition.name =
          'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
          QUERY ( pdr <* USEDIN(sc.related_property_definition,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name =
          'service operating characteristics') ) | (NOT (SIZEOF(soc.
          used_representation.items) >= 3)) )) = 0)) )) = 0);
wr15: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
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            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
           used_representation.name =
           'service operating characteristics') ) | ((1 <= SIZEOF(
           QUERY ( it <* soc.used_representation.items | ((SIZEOF(
           TYPEOF(it) * [
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
           'PLANT_SPATIAL_CONFIGURATION.' +
           'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
           it.name IN ['temperature','minimum temperature',
           'maximum temperature'])) ))) AND (SIZEOF(QUERY ( it <* soc.
           used_representation.items | ((SIZEOF(TYPEOF(it) * [
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
           'PLANT_SPATIAL_CONFIGURATION.' +
           'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
           it.name IN ['temperature','minimum temperature',
           'maximum temperature'])) )) <= 2)) )) = 1)) )) = 0);
wr16: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
           used_representation.name =
           'service operating characteristics') ) | (SIZEOF(
           QUERY ( it <* soc.used_representation.items | ((SIZEOF(
           TYPEOF(it) * [
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
           'PLANT_SPATIAL_CONFIGURATION.' +
           'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
           it.name = 'temperature')) )) <= 1) )) = 1)) )) = 0);
wr17: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
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          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name =
          'service operating characteristics') ) | (SIZEOF(
          QUERY ( it <* soc.used_representation.items | ((SIZEOF(
          TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
          it.name = 'minimum temperature')) )) <= 1) )) = 1)) ))
          = 0);
wr18: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
           | (pdr.related_property_definition.name =
          'service characteristics') )) >= 1)) OR (SIZEOF(
          QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
           | (pdr.related_property_definition.name =
          'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
          QUERY ( pdr <* USEDIN(sc.related_property_definition,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name =
          'service operating characteristics') ) | (SIZEOF(
          QUERY ( it <* soc.used_representation.items | ((SIZEOF(
          TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
          it.name = 'maximum temperature')) )) <= 1) )) = 1)) ))
          = 0);
wr19: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
           | (pdr.related_property_definition.name =
          'service characteristics') )) >= 1)) OR (SIZEOF(
          QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
           | (pdr.related_property_definition.name =
          'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
          QUERY ( pdr <* USEDIN(sc.related_property_definition,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.name =
          'service operating characteristics') ) | ((1 <= SIZEOF(
          QUERY ( it <* soc.used_representation.items | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name IN ['pressure',
          'minimum pressure','maximum pressure'])) )) AND (SIZEOF(
          QUERY ( it <* soc.used_representation.items | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name IN ['pressure',
          'minimum pressure','maximum pressure'])) )) <= 2)) ))
          = 1)) )) = 0);
wr20: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_RELATIONSHIP.' +
          'RELATING_PROPERTY_DEFINITION')
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            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
           used_representation.name =
           'service operating characteristics') ) | (SIZEOF(
           QUERY ( it <* soc.used_representation.items | ((
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
           IN TYPEOF(it)) AND (it.name = 'pressure')) )) <= 1) ))
           = 1)) )) = 0);
wr21: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
           used_representation.name =
           'service operating characteristics') ) | (SIZEOF(
           QUERY ( it <* soc.used_representation.items | ((
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
           IN TYPEOF(it)) AND (it.name = 'minimum pressure')) ))
           <= 1) )) = 1)) )) = 0);
wr22: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
           used_representation.name =
           'service operating characteristics') ) | (SIZEOF(
           QUERY ( it <* soc.used_representation.items | ((
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
           IN TYPEOF(it)) AND (it.name = 'maximum pressure')) ))
           <= 1) )) = 1)) )) = 0);
wr23: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
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            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
           used_representation.name =
           'service operating characteristics') ) | ((1 <= SIZEOF(
           QUERY ( it <* soc.used_representation.items | ((SIZEOF(
           TYPEOF(it) * [
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
           'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2)

           AND (it.name IN ['duration','minimum duration',
           'maximum duration'])) ))) AND (SIZEOF(QUERY ( it <* soc.
           used_representation.items | ((SIZEOF(TYPEOF(it) * [
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
           'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT'])
           = 2) AND (it.name IN ['duration','minimum duration',
           'maximum duration'])) )) <= 2)) )) = 1)) )) = 0);
wr24: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
           used_representation.name =
           'service operating characteristics') ) | (SIZEOF(
           QUERY ( it <* soc.used_representation.items | ((SIZEOF(
           TYPEOF(it) * [
           'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
           'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT'])
           = 2) AND (it.name = 'duration')) )) <= 1) )) = 1)) )) = 0);
wr25: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') )) >= 1)) OR (SIZEOF(
           QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_RELATIONSHIP.' +
           'RELATING_PROPERTY_DEFINITION')
            | (pdr.related_property_definition.name =
           'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
           QUERY ( pdr <* USEDIN(sc.related_property_definition,
           'PLANT_SPATIAL_CONFIGURATION.' +
           'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
           used_representation.name =
           'service operating characteristics') ) | (SIZEOF(
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                QUERY ( it <* soc.used_representation.items | ((SIZEOF(
                TYPEOF(it) * [
                'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
                'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT'])
                = 2) AND (it.name = 'minimum duration')) )) <= 1) ))
                = 1)) )) = 0);
      wr26: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PROPERTY_DEFINITION_RELATIONSHIP.' +
                'RELATING_PROPERTY_DEFINITION')
                 | (pdr.related_property_definition.name =
                'service characteristics') )) >= 1)) OR (SIZEOF(
                QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PROPERTY_DEFINITION_RELATIONSHIP.' +
                'RELATING_PROPERTY_DEFINITION')
                 | (pdr.related_property_definition.name =
                'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
                QUERY ( pdr <* USEDIN(sc.related_property_definition,
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
                used_representation.name =
                'service operating characteristics') ) | (SIZEOF(
                QUERY ( it <* soc.used_representation.items | ((SIZEOF(
                TYPEOF(it) * [
                'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
                'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT'])
                = 2) AND (it.name = 'maximum duration')) )) <= 1) ))
                = 1)) )) = 0);
      wr27: (NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PROPERTY_DEFINITION_RELATIONSHIP.' +
                'RELATING_PROPERTY_DEFINITION')
                 | (pdr.related_property_definition.name =
                'service characteristics') )) >= 1)) OR (SIZEOF(
                QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PROPERTY_DEFINITION_RELATIONSHIP.' +
                'RELATING_PROPERTY_DEFINITION')
                 | (pdr.related_property_definition.name =
                'service characteristics') ) | (NOT (
                'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
                TYPEOF(sc.related_property_definition.definition))) ))
                = 0);
  END_ENTITY; -- stream_design_case

  ENTITY stream_phase
    SUBTYPE OF (property_definition);
    WHERE
      wr1 : 'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE' IN TYPEOF(
                SELF.definition);
      wr2 : SIZEOF(QUERY ( pdr <* USEDIN(SELF,
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
                used_representation.
                name = 'stream phase characteristics') )) = 1;
      wr3 : SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
                used_representation.
                name = 'stream phase characteristics') )
                 | (NOT (SIZEOF(spc.used_representation.items) >= 5)) )) =
                0;
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wr4 : SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'stream phase characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
           | ((SIZEOF(TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT'])
          = 2) AND (it.name = 'constituent mole fraction')) ))
          = 1)) )) = 0;
wr5 : SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'stream phase characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
           | (('PLANT_SPATIAL_CONFIGURATION.' +
          'DESCRIPTIVE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'constituents')) )) = 1)) ))
          = 0;
wr6 : SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'stream phase characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
           | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'phase density')) ))
          = 1)) )) = 0;
wr7 : SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'stream phase characteristics') )
           | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
           | ((SIZEOF(TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT'])
          = 2) AND (it.name = 'phase fraction')) )) = 1)) )) = 0;
wr8 : SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'stream phase characteristics') )
           | (NOT ((1 <= SIZEOF(QUERY ( it <* spc.used_representation
          .items | ((SIZEOF(TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
          it.name IN ['temperature','minimum temperature',
          'maximum temperature'])) ))) AND (SIZEOF(QUERY ( it <* spc.
          used_representation.items | ((SIZEOF(TYPEOF(it) * [
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.' +
          'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
          it.name IN ['temperature','minimum temperature',
          'maximum temperature'])) )) <= 2))) )) = 0;
wr9 : SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
          used_representation.
          name = 'stream phase characteristics') )
```

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                 | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
                 | ((SIZEOF(TYPEOF(it) * [
                ’PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM’,
                ’PLANT_SPATIAL_CONFIGURATION.’ +
                ’THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT’]) = 2) AND (
                it.name = ’temperature’)) )) <= 1)) )) = 0;
     wr10: SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
                ’PLANT_SPATIAL_CONFIGURATION.’ +
                ’PROPERTY_DEFINITION_REPRESENTATION.DEFINITION’) | (pdr.
                used_representation.
                name = ’stream phase characteristics’) )
                 | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
                 | ((SIZEOF(TYPEOF(it) * [
                ’PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM’,
                ’PLANT_SPATIAL_CONFIGURATION.’ +
                ’THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT’]) = 2) AND (
                it.name = ’minimum temperature’)) )) <= 1)) )) = 0;
     wr11: SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
                ’PLANT_SPATIAL_CONFIGURATION.’ +
                ’PROPERTY_DEFINITION_REPRESENTATION.DEFINITION’) | (pdr.
                used_representation.
                name = ’stream phase characteristics’) )
                 | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
                 | ((SIZEOF(TYPEOF(it) * [
                ’PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM’,
                ’PLANT_SPATIAL_CONFIGURATION.’ +
                ’THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT’]) = 2) AND (
                it.name = ’maximum temperature’)) )) <= 1)) )) = 0;
     wr12: SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
                ’PLANT_SPATIAL_CONFIGURATION.’ +
                ’PROPERTY_DEFINITION_REPRESENTATION.DEFINITION’) | (pdr.
                used_representation.
                name = ’stream phase characteristics’) )
                 | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
                 | ((
                ’PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM’
                IN TYPEOF(it)) AND (it.name = ’specific gravity’)) ))
                <= 1)) )) = 0;
     wr13: SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
                ’PLANT_SPATIAL_CONFIGURATION.’ +
                ’PROPERTY_DEFINITION_REPRESENTATION.DEFINITION’) | (pdr.
                used_representation.
                name = ’stream phase characteristics’) )
                 | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
                 | ((
                ’PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM’
                IN TYPEOF(it)) AND (it.name = ’surface tension’)) ))
                <= 1)) )) = 0;
     wr14: SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
                ’PLANT_SPATIAL_CONFIGURATION.’ +
                ’PROPERTY_DEFINITION_REPRESENTATION.DEFINITION’) | (pdr.
                used_representation.
                name = ’stream phase characteristics’) )
                 | (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
                 | ((
                ’PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM’
                IN TYPEOF(it)) AND (it.name = ’viscosity’)) )) <= 1)) )) =
                0;
  END_ENTITY; -- stream_phase

  ENTITY structural_load_connector_classification
    SUBTYPE OF (group);
  END_ENTITY; -- structural_load_connector_classification
```

```
ENTITY structural_system
  SUBTYPE OF (product_definition);
  WHERE
    wr1: SIZEOF(QUERY ( pdr <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_DEFINITION_RELATIONSHIP.' +
              'RELATED_PRODUCT_DEFINITION')
               | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
              relating_product_definition.formation.of_product)) AND (pdr.
              relating_product_definition.frame_of_reference.name =
              'functional occurrence')) )) = 1;
END_ENTITY; -- structural_system

ENTITY support_constraint_representation
  SUBTYPE OF (representation);
  WHERE
    wr1: SIZEOF(SELF.items) >= 3;
    wr2: SIZEOF(QUERY ( it <* SELF.items | ((
              'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
               TYPEOF(it)) AND (it.name IN ['negative x','positive x',
              'negative y','positive y','negative z','positive z',
              'negative x rotation','positive x rotation',
              'negative y rotation','positive y rotation',
              'negative z rotation','positive z rotation'])) )) = 1;
    wr3: SIZEOF(QUERY ( it <* SELF.items | (
              'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT' IN
              TYPEOF(it)) )) = 1;
    wr4: SIZEOF(QUERY ( it <* SELF.items |
              ('PLANT_SPATIAL_CONFIGURATION.' +
              'DESCRIPTIVE_REPRESENTATION_ITEM'
              IN TYPEOF(it)) )) = 1;
END_ENTITY; -- support_constraint_representation

ENTITY surface
  SUPERTYPE OF (ONEOF (elementary_surface,swept_surface,bounded_surface,
      offset_surface,surface_replica))
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- surface

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: ('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(
              associated_geometry[1])) OR (master_representation <>
              pcurve_s1);
    wr3: ('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(
              associated_geometry[2])) OR (master_representation <>
              pcurve_s2);
    wr4: NOT ('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(curve_3d));
END_ENTITY; -- surface_curve

ENTITY surface_of_linear_extrusion
  SUBTYPE OF (swept_surface);
    extrusion_axis : vector;
END_ENTITY; -- surface_of_linear_extrusion
```

```
ENTITY surface_of_revolution
  SUBTYPE OF (swept_surface);
    axis_position : axis1_placement;
  DERIVE
    axis_line : line := line(axis_position.location,vector(axis_position
                    .z,1));
END_ENTITY; -- surface_of_revolution

ENTITY surface_patch;
    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 ('PLANT_SPATIAL_CONFIGURATION.CURVE_BOUNDED_SURFACE' IN
              TYPEOF(parent_surface));
END_ENTITY; -- surface_patch

ENTITY surface_replica
  SUBTYPE OF (surface);
    parent_surface : surface;
    transformation : cartesian_transformation_operator_3d;
  WHERE
    wr1: acyclic_surface_replica(SELF,parent_surface);
END_ENTITY; -- surface_replica

ENTITY swage_fitting_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.' +
              'ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
              NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.' +
              'ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
              QUERY ( it <* ca.items | (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
              formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
              category_in_tree(prpc,'swage') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- swage_fitting_classification

ENTITY swept_area_solid
  SUPERTYPE OF (ONEOF (revolved_area_solid,extruded_area_solid))
  SUBTYPE OF (solid_model);
    swept_area : curve_bounded_surface;
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PLANE' IN TYPEOF(swept_area.
              basis_surface);
END_ENTITY; -- swept_area_solid
```

```
ENTITY swept_face_solid
  SUPERTYPE OF (ONEOF (extruded_face_solid,revolved_face_solid))
  SUBTYPE OF (solid_model);
    swept_face : face_surface;
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.PLANE' IN TYPEOF(swept_face.
             face_geometry);
END_ENTITY; -- swept_face_solid

ENTITY swept_surface
  SUPERTYPE OF (ONEOF (surface_of_linear_extrusion,
    surface_of_revolution))
  SUBTYPE OF (surface);
    swept_curve : curve;
END_ENTITY; -- swept_surface

ENTITY system_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
             'PLANT_SPATIAL_CONFIGURATION.' +
             'GROUP_ASSIGNMENT.ASSIGNED_GROUP')
              | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
             IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
             NOT (SIZEOF(TYPEOF(it) * [
             'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
             'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
             'PLANT_SPATIAL_CONFIGURATION.' +
             'INSTRUMENTATION_AND_CONTROL_SYSTEM',
             'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
             'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1)) )) =
              0)) )) = 0;
END_ENTITY; -- system_classification

ENTITY system_space
  SUBTYPE OF (product_definition_shape);
  WHERE
    wr1: SIZEOF(TYPEOF(SELF.definition) * [
             'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
             'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
             'PLANT_SPATIAL_CONFIGURATION.' +
             'INSTRUMENTATION_AND_CONTROL_SYSTEM',
             'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
             'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1;
END_ENTITY; -- system_space

ENTITY thermodynamic_temperature_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.THERMODYNAMIC_TEMPERATURE_UNIT' IN
              TYPEOF(SELF\measure_with_unit.unit_component);
END_ENTITY; -- thermodynamic_temperature_measure_with_unit

ENTITY thermodynamic_temperature_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
             named_unit.dimensions.mass_exponent = 0) AND (SELF\
             named_unit.dimensions.time_exponent = 0) AND (SELF\
             named_unit.dimensions.electric_current_exponent = 0) AND (
             SELF\named_unit.dimensions.
             thermodynamic_temperature_exponent = 1) AND (SELF\named_unit
             .dimensions.amount_of_substance_exponent = 0) AND (SELF\
             named_unit.dimensions.luminous_intensity_exponent = 0);
```

```
  END_ENTITY; -- thermodynamic_temperature_unit

  ENTITY time_measure_with_unit
    SUBTYPE OF (measure_with_unit);
    WHERE
      wr1: 'PLANT_SPATIAL_CONFIGURATION.TIME_UNIT' IN TYPEOF(SELF\
                measure_with_unit.unit_component);
  END_ENTITY; -- time_measure_with_unit

  ENTITY time_unit
    SUBTYPE OF (named_unit);
    WHERE
      wr1: (SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
                named_unit.dimensions.mass_exponent = 0) AND (SELF\
                named_unit.dimensions.time_exponent = 1) AND (SELF\
                named_unit.dimensions.electric_current_exponent = 0) AND (
                SELF\named_unit.dimensions.
                thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
                .dimensions.amount_of_substance_exponent = 0) AND (SELF\
                named_unit.dimensions.luminous_intensity_exponent = 0);
  END_ENTITY; -- time_unit

  ENTITY topological_representation_item
    SUPERTYPE OF (ONEOF (vertex,edge,face_bound,face,connected_face_set,
        loop ANDOR path))
    SUBTYPE OF (representation_item);
  END_ENTITY; -- topological_representation_item

  ENTITY toroidal_surface
    SUBTYPE OF (elementary_surface);
      major_radius : positive_length_measure;
      minor_radius : positive_length_measure;
  END_ENTITY; -- toroidal_surface

  ENTITY torus
    SUBTYPE OF (geometric_representation_item);
      position     : axis1_placement;
      major_radius : positive_length_measure;
      minor_radius : positive_length_measure;
    WHERE
      wr1: major_radius > minor_radius;
  END_ENTITY; -- torus

  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) XOR (TYPEOF(trim_1[1]) <>
TYPEOF(trim_1[2]));
      wr2: (HIINDEX(trim_2) = 1) XOR (TYPEOF(trim_2[1]) <>
TYPEOF(trim_2[2]));
  END_ENTITY; -- trimmed_curve

  ENTITY truncated_pyramid
    SUBTYPE OF (boolean_result);
  END_ENTITY; -- truncated_pyramid

  ENTITY type_qualifier;
      name : label;
```

```
END_ENTITY; -- type_qualifier

ENTITY uniform_curve
  SUBTYPE OF (b_spline_curve);
END_ENTITY; -- uniform_curve

ENTITY uniform_surface
  SUBTYPE OF (b_spline_surface);
END_ENTITY; -- uniform_surface

ENTITY valve_classification
  SUBTYPE OF (group);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.' +
              'ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
              NOT (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it))) )) = 0)) )) = 0;
    wr2: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
              'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.' +
              'ASSIGNED_GROUP')
               | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
              IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( pcd <*
              QUERY ( it <* ca.items | (
              'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
               TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( prpc <* USEDIN(pcd.
              formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
              'PRODUCT_RELATED_PRODUCT_CATEGORY.PRODUCTS') |
              category_in_tree(prpc,'valve') )) = 1)) )) = 0)) )) = 0;
END_ENTITY; -- valve_classification

ENTITY vector
  SUBTYPE OF (geometric_representation_item);
    orientation : direction;
    magnitude   : length_measure;
  WHERE
    wr1: magnitude >= 0;
END_ENTITY; -- vector

ENTITY versioned_action_request;
    id          : identifier;
    version     : label;
    purpose     : text;
    description : text;
END_ENTITY; -- versioned_action_request

ENTITY vertex
  SUBTYPE OF (topological_representation_item);
END_ENTITY; -- vertex

ENTITY volume_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: 'PLANT_SPATIAL_CONFIGURATION.VOLUME_UNIT' IN TYPEOF(SELF\
              measure_with_unit.unit_component);
END_ENTITY; -- volume_measure_with_unit

ENTITY volume_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: (SELF\named_unit.dimensions.length_exponent = 3) AND (SELF\
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              named_unit.dimensions.mass_exponent = 0) AND (SELF\
              named_unit.dimensions.time_exponent = 0) AND (SELF\
              named_unit.dimensions.electric_current_exponent = 0) AND (
              SELF\named_unit.dimensions.
              thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
              .dimensions.amount_of_substance_exponent = 0) AND (SELF\
              named_unit.dimensions.luminous_intensity_exponent = 0);
END_ENTITY; -- volume_unit

RULE application_context_requires_ap_definition FOR (application_context,

              application_protocol_definition);

WHERE
  wr1: SIZEOF(QUERY ( ac <* application_context | (NOT (SIZEOF(
            QUERY ( apd <* application_protocol_definition | ((ac :=: apd.
            application) AND (apd.
            application_interpreted_model_schema_name =
            'plant_spatial_configuration')) )) = 1)) )) = 0;

END_RULE; -- application_context_requires_ap_definition

RULE approval_requires_approval_date_time FOR (approval_date_time,
            approval);

WHERE
  wr1: SIZEOF(QUERY ( app <* approval | (NOT (SIZEOF(QUERY ( adt <*
            approval_date_time | (app :=: adt.dated_approval) )) = 1)) ))
            = 0;

END_RULE; -- approval_requires_approval_date_time

RULE approval_requires_approval_person_organization FOR (
            approval_person_organization, approval);

WHERE
  wr1: SIZEOF(QUERY ( app <* approval | (NOT (SIZEOF(QUERY ( apo <*
            approval_person_organization | (app :=: apo.
            authorized_approval) )) = 1)) )) = 0;

END_RULE; -- approval_requires_approval_person_organization

RULE change_action_requires_date FOR (change_action,
            plant_spatial_configuration_date_assignment);

WHERE
  wr1: SIZEOF(QUERY ( ca <* change_action | (NOT (SIZEOF(
            QUERY ( pscda <* plant_spatial_configuration_date_assignment
             | (ca IN pscda.items) )) = 1)) )) = 0;

END_RULE; -- change_action_requires_date

RULE change_item_requires_creation_date FOR (
            plant_spatial_configuration_change_assignment,
            plant_spatial_configuration_date_assignment);

WHERE
  wr1: SIZEOF(QUERY ( pscca <*
            plant_spatial_configuration_change_assignment | (NOT (SIZEOF(
            QUERY ( ch_it <* pscca.items | (NOT (SIZEOF(QUERY ( pscda <*
            plant_spatial_configuration_date_assignment | ((NOT (ch_it IN
            pscda.items)) OR (pscda.role.name = 'creation date')) ))
            = 1)) )) = 0)) )) = 0;
```

```
END_RULE; -- change_item_requires_creation_date

RULE change_item_requires_id FOR (
           plant_spatial_configuration_change_assignment,
           change_item_id_assignment);

WHERE
  wr1: SIZEOF(QUERY ( pscca <*
           plant_spatial_configuration_change_assignment | (NOT (SIZEOF(
           QUERY ( ch_it <* pscca.items | (NOT (SIZEOF(QUERY ( ciia <*
           change_item_id_assignment | (ch_it IN ciia.items) )) = 1)) ))
           = 0)) )) = 0;

END_RULE; -- change_item_requires_id

RULE change_life_cycle_stage_usage_requires_approval FOR (
           versioned_action_request,
           plant_spatial_configuration_approval_assignment);

WHERE
  wr1: SIZEOF(QUERY ( vareq <* versioned_action_request | (NOT (SIZEOF(
           QUERY ( pscaa <*
           plant_spatial_configuration_approval_assignment | (vareq IN
           pscaa.items) )) = 1)) )) = 0;

END_RULE; -- change_life_cycle_stage_usage_requires_approval

RULE change_life_cycle_stage_usage_requires_stage FOR (
           versioned_action_request, action_request_status);

WHERE
  wr1: SIZEOF(QUERY ( vareq <* versioned_action_request | (NOT (SIZEOF(
           QUERY ( ars <* action_request_status | (vareq :=: ars.
           assigned_request) )) = 1)) )) = 0;

END_RULE; -- change_life_cycle_stage_usage_requires_stage

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; -- compatible_dimension

RULE dependent_instantiable_application_context FOR (
           application_context);

WHERE
  wr1: SIZEOF(QUERY ( ac <* application_context | (NOT (SIZEOF(USEDIN(ac,
           '')) >= 1)) )) = 0;

END_RULE; -- dependent_instantiable_application_context

RULE dependent_instantiable_product_context FOR (product_context);

WHERE
```

```
  wr1: SIZEOF(QUERY ( pc <* product_context | (NOT (SIZEOF(USEDIN(pc,’’))

           >= 1)) )) = 0;

END_RULE; -- dependent_instantiable_product_context

RULE dependent_instantiable_product_definition_context FOR (
           product_definition_context);

WHERE
  wr1: SIZEOF(QUERY ( pdc <* product_definition_context | (NOT (SIZEOF(
           USEDIN(pdc,’’)) >= 1)) )) = 0;

END_RULE; -- dependent_instantiable_product_definition_context

RULE product_context_discipline_type_constraint FOR (product_context);

WHERE
  wr1: SIZEOF(QUERY ( pc <* product_context | (NOT (pc.name =
           ’process plant’)) )) = 0;

END_RULE; -- product_context_discipline_type_constraint

RULE product_definition_context_name_constraint FOR (
           product_definition_context);

WHERE
  wr1: SIZEOF(QUERY ( pdc <* product_definition_context | (NOT (pdc.name
           IN [’functional definition’,’physical definition’,
           ’functional occurrence’,’physical occurrence’,
           ’catalogue definition’,’fabrication assembly’])) )) = 0;

END_RULE; -- product_definition_context_name_constraint

RULE product_definition_usage_constraint FOR (product_definition);

WHERE
  wr1: SIZEOF(QUERY ( pd <* product_definition | ((pd.frame_of_reference
           .name = ’physical occurrence’) AND (NOT (SIZEOF(
           QUERY ( pdr <* USEDIN(pd,
           ’PLANT_SPATIAL_CONFIGURATION.’ +
           ’PRODUCT_DEFINITION_RELATIONSHIP.’ +
           ’RELATED_PRODUCT_DEFINITION’) | (SIZEOF(TYPEOF(pdr) * [
           ’PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_USAGE’,
           ’PLANT_SPATIAL_CONFIGURATION.MAKE_FROM_USAGE_OPTION’,
           ’PLANT_SPATIAL_CONFIGURATION.ASSEMBLY_COMPONENT_USAGE’])
           = 1) )) <= 1))) )) = 0;
  wr2: SIZEOF(QUERY ( pd <* product_definition | ((pd.frame_of_reference
           .name = ’physical definition’) AND (NOT (SIZEOF(
           QUERY ( pdr <* USEDIN(pd,
           ’PLANT_SPATIAL_CONFIGURATION.’ +
           ’PRODUCT_DEFINITION_RELATIONSHIP.’
           + ’RELATING_PRODUCT_DEFINITION’) | (pdr.
           related_product_definition.frame_of_reference.name =
           ’physical occurrence’) )) <= 1))) )) = 0;

END_RULE; -- product_definition_usage_constraint

RULE subtype_exclusive_characterized_object FOR (characterized_object);

WHERE
  wr1: SIZEOF (QUERY (co <*characterized_object |
           NOT (SIZEOF (’PLANT_SPATIAL_CONFIGURATION.’ +
```

```
            'PIPING_COMPONENT_CLASS',
            'PLANT_SPATIAL_CONFIGURATION.SITE',
            'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE']
            * TYPEOF (co)) <= 1))) = 0;

END_RULE; -- subtype_exclusive_characterized_object

RULE subtype_exclusive_shape_representation FOR (shape_representation);

WHERE
  wr1: SIZEOF (QUERY (sr <*shape_representation|
            NOT (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.' +
            'ADVANCED_CSG_SHAPE_REPRESENTATION',
            'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'PIPING_DESIGN_CSG_SHAPE_REPRESENTATION']
            * TYPEOF (sr)) <= 1))) = 0;

END_RULE; -- subtype_exclusive_shape_representation

RULE subtype_mandatory_externally_defined_item FOR (
            externally_defined_item);

WHERE
  wr1: SIZEOF(QUERY ( edi <* externally_defined_item | (NOT (SIZEOF([
            'PLANT_SPATIAL_CONFIGURATION.CATALOGUE_CONNECTOR',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'EXTERNALLY_DEFINED_CLASSIFICATION',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION']
            * TYPEOF(edi)) = 1)) )) = 0;

END_RULE; -- subtype_mandatory_externally_defined_item

RULE subtype_mandatory_pre_defined_item FOR (pre_defined_item);

WHERE
  wr1: SIZEOF(QUERY ( pdi <* pre_defined_item | (NOT (
            'PLANT_SPATIAL_CONFIGURATION.KNOWN_SOURCE'
            IN TYPEOF(pdi))) )) = 0;

END_RULE; -- subtype_mandatory_pre_defined_item

RULE versioned_action_request_requires_change_action FOR (change_action,
            versioned_action_request);

WHERE
  wr1: SIZEOF(QUERY ( vareq <* versioned_action_request | (NOT (SIZEOF(
            QUERY ( ca <* change_action | (vareq IN ca.directive.
            requests) )) = 1)) )) = 0;

END_RULE; -- versioned_action_request_requires_change_action

FUNCTION acyclic_curve_replica(
              rep: curve_replica;
              parent: curve
    ): BOOLEAN;
  IF NOT ('PLANT_SPATIAL_CONFIGURATION.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; -- acyclic_curve_replica

FUNCTION acyclic_mapped_representation(
             parent_set: SET OF representation;
             children_set: SET OF representation_item
    ): BOOLEAN;

  LOCAL
    i : INTEGER;
    x : SET OF representation_item;
    y : SET OF representation_item;
  END_LOCAL;
  x := QUERY ( z <* children_set | (
      'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF(z)) );
  IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
      IF x[i]\mapped_item.mapping_source.mapped_representation IN
          parent_set THEN
        RETURN(FALSE);
      END_IF;
      IF NOT acyclic_mapped_representation(parent_set + x[i]\mapped_item
          .mapping_source.mapped_representation,x[i]\mapped_item.
          mapping_source.mapped_representation.items) THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_IF;
  x := children_set - x;
  IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
      y := QUERY ( z <* bag_to_set(USEDIN(x[i],'')) | (
          'PLANT_SPATIAL_CONFIGURATION.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; -- acyclic_mapped_representation

FUNCTION acyclic_point_replica(
             rep: point_replica;
             parent: point
    ): BOOLEAN;
  IF NOT ('PLANT_SPATIAL_CONFIGURATION.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; -- acyclic_point_replica

FUNCTION acyclic_product_category_relationship(
             relation: product_category_relationship;
```

```
              children: SET OF product_category
    ): LOGICAL;

  LOCAL
    i              : INTEGER;
    x              : SET OF product_category_relationship;
    local_children : SET OF product_category;
  END_LOCAL;
  REPEAT i := 1 TO HIINDEX(children) BY 1;
    IF relation.category :=: children[i] THEN
      RETURN(FALSE);
    END_IF;
  END_REPEAT;
  x := bag_to_set(USEDIN(relation.category,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_CATEGORY_RELATIONSHIP.SUB_CATEGORY'));
  local_children := children + relation.category;
  IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
      IF NOT acyclic_product_category_relationship(x[i],local_children)
           THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_IF;
  RETURN(TRUE);

END_FUNCTION; -- acyclic_product_category_relationship

FUNCTION acyclic_product_definition_relationship(
              relation: product_definition_relationship;
              relatives: SET OF product_definition;
              specific_relation: STRING
    ): LOGICAL;

  LOCAL
    i               : INTEGER;
    x               : SET OF product_definition_relationship;
    local_relatives : SET OF product_definition;
  END_LOCAL;
  REPEAT i := 1 TO HIINDEX(relatives) BY 1;
    IF relation.relating_product_definition :=: relatives[i] THEN
      RETURN(FALSE);
    END_IF;
  END_REPEAT;
  x := bag_to_set(USEDIN(relation.relating_product_definition,
      specific_relation));
  local_relatives := relatives + relation.relating_product_definition;
  IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
      IF NOT acyclic_product_definition_relationship(x[i],
          local_relatives,specific_relation) THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_IF;
  RETURN(TRUE);

END_FUNCTION; -- acyclic_product_definition_relationship

FUNCTION acyclic_set_replica(
              rep: geometric_set_replica;
              parent: geometric_set
    ): BOOLEAN;
```

```
    IF NOT ('PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_SET_REPLICA' IN TYPEOF(
        parent)) THEN
      RETURN(TRUE);
    END_IF;
    IF parent :=: rep THEN
      RETURN(FALSE);
    ELSE
      RETURN(acyclic_set_replica(rep,parent\geometric_set_replica.
          parent_set));
    END_IF;

  END_FUNCTION; -- acyclic_set_replica

  FUNCTION acyclic_surface_replica(
               rep: surface_replica;
               parent: surface
      ): BOOLEAN;
    IF NOT ('PLANT_SPATIAL_CONFIGURATION.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; -- acyclic_surface_replica

  FUNCTION associated_surface(
               arg: pcurve_or_surface
      ): surface;

    LOCAL
      surf : surface;
    END_LOCAL;
    IF 'PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(arg) THEN
      surf := arg\pcurve.basis_surface;
    ELSE
      surf := arg;
    END_IF;
    RETURN(surf);

  END_FUNCTION; -- associated_surface

  FUNCTION bag_to_set(
               the_bag: BAG OF GENERIC:intype
      ): SET OF GENERIC:intype;

    LOCAL
      i       : INTEGER;
      the_set : SET OF GENERIC:intype := [];
    END_LOCAL;
    IF SIZEOF(the_bag) > 0 THEN
      REPEAT i := 1 TO HIINDEX(the_bag) BY 1;
        the_set := the_set + the_bag[i];
      END_REPEAT;
    END_IF;
    RETURN(the_set);

  END_FUNCTION; -- bag_to_set
```

```
FUNCTION base_axis(
             dim: INTEGER;
             axis1, axis2, axis3: direction
    ): LIST [2:3] OF direction;

  LOCAL
    u      : LIST [2:3] OF direction;
    vec    : direction;
    factor : REAL;
  END_LOCAL;
  IF dim = 3 THEN
    u[3] := NVL(normalise(axis3),direction([0,0,1]));
    u[1] := first_proj_axis(u[3],axis1);
    u[2] := second_proj_axis(u[3],u[1],axis2);
  ELSE
    u[3] := ?;
    IF EXISTS(axis1) THEN
      u[1] := normalise(axis1);
      u[2] := orthogonal_complement(u[1]);
      IF EXISTS(axis2) THEN
        factor := dot_product(axis2,u[2]);
        IF factor < 0 THEN
          u[2].direction_ratios[1] := -u[2].direction_ratios[1];
          u[2].direction_ratios[2] := -u[2].direction_ratios[2];
        END_IF;
      END_IF;
    ELSE
      IF EXISTS(axis2) THEN
        u[2] := normalise(axis2);
        u[1] := orthogonal_complement(u[2]);
        u[1].direction_ratios[1] := -u[1].direction_ratios[1];
        u[1].direction_ratios[2] := -u[1].direction_ratios[2];
      ELSE
        u[1].direction_ratios[1] := 1;
        u[1].direction_ratios[2] := 0;
        u[2].direction_ratios[1] := 0;
        u[2].direction_ratios[2] := 1;
      END_IF;
    END_IF;
  END_IF;
  RETURN(u);

END_FUNCTION; -- base_axis

FUNCTION boolean_choose(
             b: BOOLEAN;
             choice1, choice2: GENERIC:item
    ): GENERIC:item;
  IF b THEN
    RETURN(choice1);
  ELSE
    RETURN(choice2);
  END_IF;

END_FUNCTION; -- boolean_choose

FUNCTION build_2axes(
             ref_direction: direction
    ): LIST [2:2] OF direction;

  LOCAL
    u : LIST [2:2] OF direction;
  END_LOCAL;
  u[1] := NVL(normalise(ref_direction),direction([1,0]));
```

```
    u[2] := orthogonal_complement(u[1]);
    RETURN(u);

  END_FUNCTION; -- build_2axes

  FUNCTION build_axes(
                axis, ref_direction: direction
      ): LIST [3:3] OF direction;

    LOCAL
      u : LIST [3:3] OF direction;
    END_LOCAL;
    u[3] := NVL(normalise(axis),direction([0,0,1]));
    u[1] := first_proj_axis(u[3],ref_direction);
    u[2] := normalise(cross_product(u[3],u[1]))\vector.orientation;
    RETURN(u);

  END_FUNCTION; -- build_axes

  FUNCTION build_transformed_set(
                tr: cartesian_transformation_operator;
                gset: geometric_set
      ): SET [0:?] OF geometric_set_select;

    LOCAL
      trcurve : curve;
      s       : SET [1:?] OF geometric_set_select := gset.elements;
      trpoint : point;
      trset   : SET [0:?] OF geometric_set_select := [];
      trsurf  : surface;
    END_LOCAL;
    REPEAT j := 1 TO SIZEOF(s) BY 1;
      IF 'PLANT_SPATIAL_CONFIGURATION.CURVE' IN TYPEOF(s[j]) THEN
        trset := trset + curve_replica(s[j],tr);
      ELSE
        IF 'PLANT_SPATIAL_CONFIGURATION.POINT' IN TYPEOF(s[j]) THEN
          trset := trset + point_replica(s[j],tr);
        ELSE
          IF 'PLANT_SPATIAL_CONFIGURATION.SURFACE' IN TYPEOF(s[j]) THEN
            trset := trset + surface_replica(s[j],tr ||
                cartesian_transformation_operator_3d(?));
          END_IF;
        END_IF;
      END_IF;
    END_REPEAT;
    RETURN(trset);

  END_FUNCTION; -- build_transformed_set

  FUNCTION category_in_tree(
                cat: product_category;
                val: STRING
      ): BOOLEAN;
    IF cat.name = val THEN
      RETURN(TRUE);
    ELSE
      RETURN(SIZEOF(QUERY ( pc <* USEDIN(cat,
          'PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_CATEGORY_RELATIONSHIP.SUB_CATEGORY') | category_in_tree(
          pc,val) )) = 1);
    END_IF;
    RETURN(FALSE);
```

```
END_FUNCTION; -- category_in_tree

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; -- conditional_reverse

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 BY 1;
    IF (NOT ('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(c\
        composite_curve.segments[k].parent_curve))) AND (NOT (
        'PLANT_SPATIAL_CONFIGURATION.SURFACE_CURVE' IN TYPEOF(c\
        composite_curve.segments[k].parent_curve))) AND (NOT (
        'PLANT_SPATIAL_CONFIGURATION.COMPOSITE_CURVE_ON_SURFACE' IN
        TYPEOF(c\composite_curve.segments[k].parent_curve))) THEN
      RETURN(FALSE);
    END_IF;
  END_REPEAT;
  RETURN(TRUE);

END_FUNCTION; -- constraints_composite_curve_on_surface

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) BY 1;
    IF (NOT ('PLANT_SPATIAL_CONFIGURATION.WIRE_SHELL' IN TYPEOF(m.
        sbwm_boundary[j]))) AND (NOT (
        'PLANT_SPATIAL_CONFIGURATION.VERTEX_SHELL' IN TYPEOF(m.
        sbwm_boundary[j]))) THEN
      result := FALSE;
      RETURN(result);
    END_IF;
  END_REPEAT;
  RETURN(result);

END_FUNCTION; -- constraints_geometry_shell_based_wireframe_model

FUNCTION constraints_param_b_spline(
             degree, up_knots, up_cp: INTEGER;
             knot_mult: LIST OF INTEGER;
             knots: LIST OF parameter_value
    ): BOOLEAN;

  LOCAL
    k      : INTEGER;
    l      : INTEGER;
```

```
    sum    : INTEGER;
    result : BOOLEAN := TRUE;
  END_LOCAL;
  sum := knot_mult[1];
  REPEAT i := 2 TO up_knots BY 1;
    sum := sum + knot_mult[i];
  END_REPEAT;
  IF (degree < 1) OR (up_knots < 2) OR (up_cp < degree) OR (sum <> (
      degree + up_cp + 2)) THEN
    result := FALSE;
    RETURN(result);
  END_IF;
  k := knot_mult[1];
  IF (k < 1) OR (k > (degree + 1)) THEN
    result := FALSE;
    RETURN(result);
  END_IF;
  REPEAT i := 2 TO up_knots BY 1;
    IF (knot_mult[i] < 1) OR (knots[i] <= knots[i - 1]) THEN
      result := FALSE;
      RETURN(result);
    END_IF;
    k := knot_mult[i];
    IF (i < up_knots) AND (k > degree) THEN
      result := FALSE;
      RETURN(result);
    END_IF;
    IF (i = up_knots) AND (k > (degree + 1)) THEN
      result := FALSE;
      RETURN(result);
    END_IF;
  END_REPEAT;
  RETURN(result);

END_FUNCTION; -- constraints_param_b_spline

FUNCTION constraints_rectangular_composite_surface(
             s: rectangular_composite_surface
    ): BOOLEAN;
  REPEAT i := 1 TO s.n_u BY 1;
    REPEAT j := 1 TO s.n_v BY 1;
      IF NOT (('PLANT_SPATIAL_CONFIGURATION.B_SPLINE_SURFACE' IN TYPEOF(
          s.segments[i][j].parent_surface)) OR (
          'PLANT_SPATIAL_CONFIGURATION.RECTANGULAR_TRIMMED_SURFACE' IN
          TYPEOF(s.segments[i][j].parent_surface))) THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  REPEAT i := 1 TO s.n_u - 1 BY 1;
    REPEAT j := 1 TO s.n_v BY 1;
      IF s.segments[i][j].u_transition = discontinuous THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  REPEAT i := 1 TO s.n_u BY 1;
    REPEAT j := 1 TO s.n_v - 1 BY 1;
      IF s.segments[i][j].v_transition = discontinuous THEN
        RETURN(FALSE);
      END_IF;
    END_REPEAT;
  END_REPEAT;
```

```
  RETURN(TRUE);

END_FUNCTION; -- constraints_rectangular_composite_surface

FUNCTION cross_product(
             arg1, arg2: direction
    ): vector;

  LOCAL
    v2     : LIST [3:3] OF REAL;
    v1     : LIST [3:3] OF REAL;
    mag    : REAL;
    res    : direction;
    result : vector;
  END_LOCAL;
  IF (NOT EXISTS(arg1)) OR (arg1.dim = 2) OR (NOT EXISTS(arg2)) OR (arg2
      .dim = 2) THEN
    RETURN(?);
  ELSE
    BEGIN
      v1 := normalise(arg1)\direction.direction_ratios;
      v2 := normalise(arg2)\direction.direction_ratios;
      res.direction_ratios[1] := (v1[2] * v2[3]) - (v1[3] * v2[2]);
      res.direction_ratios[2] := (v1[3] * v2[1]) - (v1[1] * v2[3]);
      res.direction_ratios[3] := (v1[1] * v2[2]) - (v1[2] * v2[1]);
      mag := 0;
      REPEAT i := 1 TO 3 BY 1;
        mag := mag + (res.direction_ratios[i] * res.direction_ratios[i]);
      END_REPEAT;
      IF mag > 0 THEN
        result.orientation := res;
        result.magnitude := SQRT(mag);
      ELSE
        result.orientation := arg1;
        result.magnitude := 0;
      END_IF;
      RETURN(result);
    END;
  END_IF;

END_FUNCTION; -- cross_product

FUNCTION curve_weights_positive(
             b: rational_b_spline_curve
    ): BOOLEAN;

  LOCAL
    result : BOOLEAN := TRUE;
  END_LOCAL;
  REPEAT i := 0 TO b.upper_index_on_control_points BY 1;
    IF b.weights[i] <= 0 THEN
      result := FALSE;
      RETURN(result);
    END_IF;
  END_REPEAT;
  RETURN(result);

END_FUNCTION; -- curve_weights_positive

FUNCTION derive_dimensional_exponents(
             x: unit
    ): dimensional_exponents;

  LOCAL
```

```
    i      : INTEGER;
    result : dimensional_exponents := dimensional_exponents(0,0,0,0,0,0,
               0);
  END_LOCAL;
  IF 'PLANT_SPATIAL_CONFIGURATION.DERIVED_UNIT' IN TYPEOF(x) THEN
    REPEAT i := LOINDEX(x.elements) TO HIINDEX(x.elements) BY 1;
      result.length_exponent := result.length_exponent + (x.elements[i].
          exponent * x.elements[i].unit.dimensions.length_exponent);
      result.mass_exponent := result.mass_exponent + (x.elements[i].
          exponent * x.elements[i].unit.dimensions.mass_exponent);
      result.time_exponent := result.time_exponent + (x.elements[i].
          exponent * x.elements[i].unit.dimensions.time_exponent);
      result.electric_current_exponent := result.
          electric_current_exponent + (x.elements[i].exponent * x.
          elements[i].unit.dimensions.electric_current_exponent);
      result.thermodynamic_temperature_exponent := result.
          thermodynamic_temperature_exponent + (x.elements[i].exponent *
          x.elements[i].unit.dimensions.
          thermodynamic_temperature_exponent);
      result.amount_of_substance_exponent := result.
          amount_of_substance_exponent + (x.elements[i].exponent * x.
          elements[i].unit.dimensions.amount_of_substance_exponent);
      result.luminous_intensity_exponent := result.
          luminous_intensity_exponent + (x.elements[i].exponent * x.
          elements[i].unit.dimensions.luminous_intensity_exponent);
    END_REPEAT;
  ELSE
    result := x.dimensions;
  END_IF;
  RETURN(result);

END_FUNCTION; -- derive_dimensional_exponents

FUNCTION dimension_of(
             item: geometric_representation_item
    ): dimension_count;

  LOCAL
    x : SET OF representation;
    y : representation_context;
  END_LOCAL;
  x := using_representations(item);
  y := x[1].context_of_items;
  RETURN(y\geometric_representation_context.coordinate_space_dimension);

END_FUNCTION; -- dimension_of

FUNCTION dimensions_for_si_unit(
             n: si_unit_name
    ): dimensional_exponents;
  CASE n OF
    metre         :       RETURN(dimensional_exponents(1,0,0,0,0,0,0));
    gram          :       RETURN(dimensional_exponents(0,1,0,0,0,0,0));
    second        :       RETURN(dimensional_exponents(0,0,1,0,0,0,0));
    ampere        :       RETURN(dimensional_exponents(0,0,0,1,0,0,0));
    kelvin        :       RETURN(dimensional_exponents(0,0,0,0,1,0,0));
    mole          :       RETURN(dimensional_exponents(0,0,0,0,0,1,0));
    candela       :       RETURN(dimensional_exponents(0,0,0,0,0,0,1));
    radian        :       RETURN(dimensional_exponents(0,0,0,0,0,0,0));
    steradian     :       RETURN(dimensional_exponents(0,0,0,0,0,0,0));
    hertz         :       RETURN(dimensional_exponents(0,0,-1,0,0,0,0));
    newton        :       RETURN(dimensional_exponents(1,1,-2,0,0,0,0));
    pascal        :       RETURN(dimensional_exponents(-1,1,-2,0,0,0,0));
```

```
    joule         :       RETURN(dimensional_exponents(2,1,-2,0,0,0,0));
    watt          :       RETURN(dimensional_exponents(2,1,-3,0,0,0,0));
    coulomb       :       RETURN(dimensional_exponents(0,0,1,1,0,0,0));
    volt          :       RETURN(dimensional_exponents(2,1,-3,-1,0,0,0));
    farad         :       RETURN(dimensional_exponents(-2,-1,4,1,0,0,0));
    ohm           :       RETURN(dimensional_exponents(2,1,-3,-2,0,0,0));
    siemens       :       RETURN(dimensional_exponents(-2,-1,3,2,0,0,0));
    weber         :       RETURN(dimensional_exponents(2,1,-2,-1,0,0,0));
    tesla         :       RETURN(dimensional_exponents(0,1,-2,-1,0,0,0));
    henry         :       RETURN(dimensional_exponents(2,1,-2,-2,0,0,0));
    degree_celsius  :     RETURN(dimensional_exponents(0,0,0,0,1,0,0));
    lumen         :       RETURN(dimensional_exponents(0,0,0,0,0,0,1));
    lux           :       RETURN(dimensional_exponents(-2,0,0,0,0,0,1));
    becquerel     :       RETURN(dimensional_exponents(0,0,-1,0,0,0,0));
    gray          :       RETURN(dimensional_exponents(2,0,-2,0,0,0,0));
    sievert       :       RETURN(dimensional_exponents(2,0,-2,0,0,0,0));
    END_CASE;

END_FUNCTION; -- dimensions_for_si_unit

FUNCTION dot_product(
             arg1, arg2: direction
    ): REAL;

  LOCAL
    ndim   : INTEGER;
    scalar : REAL;
    vec1   : direction;
    vec2   : direction;
  END_LOCAL;
  IF (NOT EXISTS(arg1)) OR (NOT EXISTS(arg2)) THEN
    scalar := ?;
  ELSE
    IF arg1.dim <> arg2.dim THEN
      scalar := ?;
    ELSE
      BEGIN
        vec1 := normalise(arg1);
        vec2 := normalise(arg2);
        ndim := arg1.dim;
        scalar := 0;
        REPEAT i := 1 TO ndim BY 1;
          scalar := scalar + (vec1.direction_ratios[i] * vec2.
              direction_ratios[i]);
        END_REPEAT;
      END;
    END_IF;
  END_IF;
  RETURN(scalar);

END_FUNCTION; -- dot_product

FUNCTION edge_reversed(
             an_edge: edge
    ): edge;

  LOCAL
    the_reverse : edge;
  END_LOCAL;
  IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_EDGE' IN TYPEOF(an_edge)
       THEN
    the_reverse := oriented_edge(an_edge\oriented_edge.edge_element,NOT
        an_edge\oriented_edge.orientation);
  ELSE
```

```
    the_reverse := oriented_edge(an_edge,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- edge_reversed

FUNCTION face_bound_reversed(
              a_face_bound: face_bound
    ): face_bound;

  LOCAL
    the_reverse : face_bound;
  END_LOCAL;
  IF 'PLANT_SPATIAL_CONFIGURATION.FACE_OUTER_BOUND' IN TYPEOF(
      a_face_bound) THEN
    the_reverse := face_bound(a_face_bound\face_bound.bound,NOT
        a_face_bound\face_bound.orientation);
  ELSE
    the_reverse := face_bound(a_face_bound.bound,NOT a_face_bound.
        orientation);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- face_bound_reversed

FUNCTION face_reversed(
              a_face: face
    ): face;

  LOCAL
    the_reverse : face;
  END_LOCAL;
  IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_FACE' IN TYPEOF(a_face) THEN
    the_reverse := oriented_face(a_face\oriented_face.face_element,NOT
        a_face\oriented_face.orientation);
  ELSE
    the_reverse := oriented_face(a_face,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- face_reversed

FUNCTION first_proj_axis(
              z_axis, arg: direction
    ): direction;

  LOCAL
    x_vec  : vector;
    v      : direction;
    z      : direction;
    x_axis : direction;
  END_LOCAL;
  IF (NOT EXISTS(z_axis)) OR (NOT EXISTS(arg)) OR (arg.dim <> 3) THEN
    x_axis := ?;
  ELSE
    z_axis := normalise(z_axis);
    IF NOT EXISTS(arg) THEN
      IF z_axis <> direction([1,0,0]) THEN
        v := direction([1,0,0]);
      ELSE
        v := direction([0,1,0]);
      END_IF;
    ELSE
```

```
      IF cross_product(arg,z).magnitude = 0 THEN
        RETURN(?);
      ELSE
        v := normalise(arg);
      END_IF;
    END_IF;
    x_vec := scalar_times_vector(dot_product(v,z),z_axis);
    x_axis := vector_difference(v,x_vec).orientation;
    x_axis := normalise(x_axis);
  END_IF;
  RETURN(x_axis);

END_FUNCTION; -- first_proj_axis

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 'PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(c) THEN
    surfs := [c\pcurve.basis_surface];
  ELSE
    IF 'PLANT_SPATIAL_CONFIGURATION.SURFACE_CURVE' IN TYPEOF(c) THEN
      n := SIZEOF(c\surface_curve.associated_geometry);
      REPEAT i := 1 TO n BY 1;
        surfs := surfs + associated_surface(c\surface_curve.
            associated_geometry[i]);
      END_REPEAT;
    END_IF;
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.COMPOSITE_CURVE_ON_SURFACE' IN TYPEOF(
      c) THEN
    n := SIZEOF(c\composite_curve_on_surface.segments);
    surfs := get_basis_surface(c\composite_curve_on_surface.segments[1].
        parent_curve);
    IF n > 1 THEN
      REPEAT i := 2 TO n BY 1;
        surfs := surfs * get_basis_surface(c\composite_curve_on_surface.
            segments[i].parent_curve);
      END_REPEAT;
    END_IF;
  END_IF;
  RETURN(surfs);

END_FUNCTION; -- get_basis_surface

FUNCTION item_in_context(
             item: representation_item;
             cntxt: representation_context
    ): BOOLEAN;

  LOCAL
    i : INTEGER;
    y : BAG OF representation_item;
  END_LOCAL;
  IF SIZEOF(USEDIN(item,
      'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.ITEMS') * cntxt.
      representations_in_context) > 0 THEN
    RETURN(TRUE);
  ELSE
```

```
    y := QUERY ( z <* USEDIN(item,'') | (
        'PLANT_SPATIAL_CONFIGURATION.' +
        'REPRESENTATION_ITEM' IN TYPEOF(z)) );
    IF SIZEOF(y) > 0 THEN
      REPEAT i := 1 TO HIINDEX(y) BY 1;
        IF item_in_context(y[i],cntxt) THEN
          RETURN(TRUE);
        END_IF;
      END_REPEAT;
    END_IF;
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- item_in_context

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; -- leap_year

FUNCTION list_face_loops(
             f: face
    ): LIST [0:?] OF loop;

  LOCAL
    loops : LIST [0:?] OF loop := [];
  END_LOCAL;
  REPEAT i := 1 TO SIZEOF(f.bounds) BY 1;
    loops := loops + f.bounds[i].bound;
  END_REPEAT;
  RETURN(loops);

END_FUNCTION; -- list_face_loops

FUNCTION list_of_topology_reversed(
             a_list: list_of_reversible_topology_item
    ): list_of_reversible_topology_item;

  LOCAL
    the_reverse : list_of_reversible_topology_item;
  END_LOCAL;
  the_reverse := [];
  REPEAT i := 1 TO SIZEOF(a_list) BY 1;
    the_reverse := topology_reversed(a_list[i]) + the_reverse;
  END_REPEAT;
  RETURN(the_reverse);

END_FUNCTION; -- list_of_topology_reversed

FUNCTION list_to_array(
             lis: LIST [0:?] OF GENERIC:t;
             low, 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
    REPEAT i := 1 TO n BY 1;
      res[(low + i) - 1] := lis[i];
    END_REPEAT;
    RETURN(res);
  END_IF;

END_FUNCTION; -- list_to_array

FUNCTION list_to_set(
              l: LIST [0:?] OF GENERIC:t
    ): SET OF GENERIC:t;

  LOCAL
    s : SET OF GENERIC:t := [];
  END_LOCAL;
  REPEAT i := 1 TO SIZEOF(l) BY 1;
    s := s + l[i];
  END_REPEAT;
  RETURN(s);

END_FUNCTION; -- list_to_set

FUNCTION make_array_of_array(
              lis: LIST [1:?] OF LIST [1:?] OF GENERIC:t;
              low1, u1, low2, u2: INTEGER
    ): ARRAY [low1:u1] OF ARRAY [low2:u2] OF GENERIC:t;

  LOCAL
    n2   : INTEGER;
    n1   : INTEGER;
    res  : ARRAY [low1:u1] OF ARRAY [low2:u2] OF GENERIC:t;
    resl : LIST [1:?] OF ARRAY [low2:u2] OF GENERIC:t;
  END_LOCAL;
  n1 := SIZEOF(lis);
  n2 := SIZEOF(lis[1]);
  IF (n1 <> ((u1 - low1) + 1)) AND (n2 <> ((u2 - low2) + 1)) THEN
    RETURN(?);
  END_IF;
  REPEAT i := 1 TO n1 BY 1;
    IF SIZEOF(lis[i]) <> n2 THEN
      RETURN(?);
    END_IF;
  END_REPEAT;
  REPEAT i := 1 TO n1 BY 1;
    resl[i] := list_to_array(lis[i],low2,u2);
  END_REPEAT;
  res := list_to_array(resl,low1,u1);
  RETURN(res);

END_FUNCTION; -- make_array_of_array

FUNCTION mixed_loop_type_set(
              l: SET [0:?] OF loop
    ): LOGICAL;

  LOCAL
    i              : INTEGER;
    poly_loop_type : LOGICAL;
```

```
    END_LOCAL;
    IF SIZEOF(l) <= 1 THEN
      RETURN(FALSE);
    END_IF;
    poly_loop_type := 'PLANT_SPATIAL_CONFIGURATION.POLY_LOOP' IN TYPEOF(l[
        1]);
    REPEAT i := 2 TO SIZEOF(l) BY 1;
      IF ('PLANT_SPATIAL_CONFIGURATION.POLY_LOOP' IN TYPEOF(l[i])) <>
          poly_loop_type THEN
        RETURN(TRUE);
      END_IF;
    END_REPEAT;
    RETURN(FALSE);

  END_FUNCTION; -- mixed_loop_type_set

  FUNCTION normalise(
               arg: vector_or_direction
      ): vector_or_direction;

    LOCAL
      ndim   : INTEGER;
      v      : direction;
      vec    : vector;
      mag    : REAL;
      result : vector_or_direction;
    END_LOCAL;
    IF NOT EXISTS(arg) THEN
      result := ?;
    ELSE
      ndim := arg.dim;
      IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(arg) THEN
        BEGIN
          vec := arg;
          v := arg\vector.orientation;
          IF arg\vector.magnitude = 0 THEN
            RETURN(?);
          ELSE
            vec.magnitude := 1;
          END_IF;
        END;
      ELSE
        v := arg;
      END_IF;
      mag := 0;
      REPEAT i := 1 TO ndim BY 1;
        mag := mag + (v.direction_ratios[i] * v.direction_ratios[i]);
      END_REPEAT;
      IF mag > 0 THEN
        mag := SQRT(mag);
        REPEAT i := 1 TO ndim BY 1;
          v.direction_ratios[i] := v.direction_ratios[i] / mag;
        END_REPEAT;
        IF 'PLANT_SPATIAL_CONFIGURATION.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; -- normalise

FUNCTION orthogonal_complement(
             vec: direction
    ): direction;

  LOCAL
    result : direction;
  END_LOCAL;
  IF (vec.dim <> 2) OR (NOT EXISTS(vec)) THEN
    RETURN(?);
  ELSE
    result.direction_ratios[1] := -vec.direction_ratios[2];
    result.direction_ratios[2] := vec.direction_ratios[1];
    RETURN(result);
  END_IF;

END_FUNCTION; -- orthogonal_complement

FUNCTION path_head_to_tail(
             a_path: path
    ): LOGICAL;

  LOCAL
    n : INTEGER;
    p : BOOLEAN := TRUE;
  END_LOCAL;
  n := SIZEOF(a_path.edge_list);
  REPEAT i := 2 TO n BY 1;
    p := p AND (a_path.edge_list[i - 1].edge_end :=: a_path.edge_list[i]
        .edge_start);
  END_REPEAT;
  RETURN(p);

END_FUNCTION; -- path_head_to_tail

FUNCTION path_reversed(
             a_path: path
    ): path;

  LOCAL
    the_reverse : path;
  END_LOCAL;
  IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_PATH' IN TYPEOF(a_path) THEN
    the_reverse := oriented_path(a_path\oriented_path.path_element,NOT
        a_path\oriented_path.orientation);
  ELSE
    the_reverse := oriented_path(a_path,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- path_reversed

FUNCTION plant_spatial_configuration_organization_correlation(
             e: plant_spatial_configuration_organization_assignment
    ): BOOLEAN;

  LOCAL
    o_role : STRING;
  END_LOCAL;
  o_role := e\organization_assignment.role.name;
  CASE o_role OF
```

```
    'vendor'        :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <*
          e.items | (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.PRODUCT',
          'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] * TYPEOF(x)) = 1) ))
           THEN
        RETURN(FALSE);
      END_IF;
    'owner'         :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <*
          e.items | (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
          'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] * TYPEOF(x)) = 1) ))
           THEN
        RETURN(FALSE);
      END_IF;
    'plant operator'  :         IF SIZEOF(e.items) <> SIZEOF(
          QUERY ( x <* e.items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN
          TYPEOF(x)) )) THEN
        RETURN(FALSE);
      END_IF;
    'plant owner'   :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <*
          e.items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(x)) ))
           THEN
        RETURN(FALSE);
      END_IF;
    'project owner' :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <*
          e.items | ('PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT' IN
          TYPEOF(x)) )) THEN
        RETURN(FALSE);
      END_IF;
    'assessor'      :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <*
          e.items | (('PLANT_SPATIAL_CONFIGURATION.' +
          'PRODUCT_DEFINITION_RELATIONSHIP') IN TYPEOF(x)) )) THEN
        RETURN(FALSE);
      END_IF;
    OTHERWISE       :         RETURN(TRUE);
    END_CASE;
  RETURN(TRUE);

END_FUNCTION; -- plant_spatial_configuration_organization_correlation

FUNCTION plant_spatial_configuration_person_and_organization_correlation(
        e: plant_spatial_configuration_person_and_organization_assignment
    ): BOOLEAN;

  LOCAL
    po_role : STRING;
  END_LOCAL;
  po_role := e\person_and_organization_assignment.role.name;
  CASE po_role OF
    'owner'         :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <*
          e.items | (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
          'PLANT_SPATIAL_CONFIGURATION.' + 'CHANGE_ITEM'] * TYPEOF(x)) =
          1) )) THEN
        RETURN(FALSE);
      END_IF;
    'plant owner'   :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <*
          e.items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(x)) ))
           THEN
        RETURN(FALSE);
      END_IF;
    'plant operator'  :         IF SIZEOF(e.items) <> SIZEOF(
          QUERY ( x <* e.items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN
          TYPEOF(x)) )) THEN
        RETURN(FALSE);
      END_IF;
```

```
      OTHERWISE       :         RETURN(TRUE);
      END_CASE;
    RETURN(TRUE);

  END_FUNCTION; --
plant_spatial_configuration_person_and_organization_correlation

  FUNCTION plant_spatial_configuration_person_correlation(
              e: plant_spatial_configuration_person_assignment
      ): BOOLEAN;

    LOCAL
      p_role : STRING;
    END_LOCAL;
    p_role := e\person_assignment.role.name;
    CASE p_role OF
      'vendor'     :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <* e.
            items | ('PLANT_SPATIAL_CONFIGURATION.' +
             'DOCUMENT' IN TYPEOF(x)) ))
             THEN
          RETURN(FALSE);
        END_IF;
      'owner'      :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <* e.
            items | (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
            'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] * TYPEOF(x)) = 1) ))
             THEN
          RETURN(FALSE);
        END_IF;
      'plant owner'  :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <* e
            .items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(x)) ))
             THEN
          RETURN(FALSE);
        END_IF;
      'assessor'   :         IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <* e.
            items | (('PLANT_SPATIAL_CONFIGURATION.' +
            'PRODUCT_DEFINITION_RELATIONSHIP') IN TYPEOF(x)) )) THEN
          RETURN(FALSE);
        END_IF;
      OTHERWISE    :         RETURN(TRUE);
      END_CASE;
    RETURN(TRUE);

  END_FUNCTION; -- plant_spatial_configuration_person_correlation

  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
      result := ?;
    ELSE
      IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(vec) THEN
        v := vec\vector.orientation;
        mag := scalar * vec\vector.magnitude;
      ELSE
        v := vec;
        mag := scalar;
      END_IF;
```

```
    IF mag < 0 THEN
      REPEAT i := 1 TO SIZEOF(v.direction_ratios) BY 1;
        v.direction_ratios[i] := -v.direction_ratios[i];
      END_REPEAT;
      mag := -mag;
    END_IF;
    result.orientation := normalise(v);
    result.magnitude := mag;
  END_IF;
  RETURN(result);

END_FUNCTION; -- scalar_times_vector

FUNCTION second_proj_axis(
             z_axis, x_axis, arg: direction
    ): direction;

  LOCAL
    temp   : vector;
    v      : direction;
    y_axis : vector;
  END_LOCAL;
  IF NOT EXISTS(arg) THEN
    v := direction([0,1,0]);
  ELSE
    v := arg;
  END_IF;
  temp := scalar_times_vector(dot_product(v,z_axis),z_axis);
  y_axis := vector_difference(v,temp);
  temp := scalar_times_vector(dot_product(v,x_axis),x_axis);
  y_axis := vector_difference(y_axis,temp);
  y_axis := normalise(y_axis);
  RETURN(y_axis.orientation);

END_FUNCTION; -- second_proj_axis

FUNCTION set_of_topology_reversed(
             a_set: set_of_reversible_topology_item
    ): set_of_reversible_topology_item;

  LOCAL
    the_reverse : set_of_reversible_topology_item;
  END_LOCAL;
  the_reverse := [];
  REPEAT i := 1 TO SIZEOF(a_set) BY 1;
    the_reverse := the_reverse + topology_reversed(a_set[i]);
  END_REPEAT;
  RETURN(the_reverse);

END_FUNCTION; -- set_of_topology_reversed

FUNCTION shell_reversed(
             a_shell: shell
    ): shell;

  LOCAL
    the_reverse : shell;
  END_LOCAL;
  IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_OPEN_SHELL' IN TYPEOF(a_shell)
       THEN
    the_reverse := oriented_open_shell(a_shell\oriented_open_shell.
        open_shell_element,NOT a_shell\oriented_open_shell.orientation);
  ELSE
```

```
    IF 'PLANT_SPATIAL_CONFIGURATION.OPEN_SHELL' IN TYPEOF(a_shell) THEN
      the_reverse := oriented_open_shell(a_shell,FALSE);
    ELSE
      IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_CLOSED_SHELL' IN TYPEOF(
          a_shell) THEN
        the_reverse := oriented_closed_shell(a_shell\
            oriented_closed_shell.closed_shell_element,NOT a_shell\
            oriented_closed_shell.orientation);
      ELSE
        IF 'PLANT_SPATIAL_CONFIGURATION.CLOSED_SHELL' IN TYPEOF(a_shell)
             THEN
          the_reverse := oriented_closed_shell(a_shell,FALSE);
        ELSE
          the_reverse := ?;
        END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- shell_reversed

FUNCTION surface_weights_positive(
             b: rational_b_spline_surface
    ): BOOLEAN;

  LOCAL
    result : BOOLEAN := TRUE;
  END_LOCAL;
  REPEAT i := 0 TO b.u_upper BY 1;
    REPEAT j := 0 TO b.v_upper BY 1;
      IF b.weights[i][j] <= 0 THEN
        result := FALSE;
        RETURN(result);
      END_IF;
    END_REPEAT;
  END_REPEAT;
  RETURN(result);

END_FUNCTION; -- surface_weights_positive

FUNCTION topology_reversed(
             an_item: reversible_topology
    ): reversible_topology;
  IF 'PLANT_SPATIAL_CONFIGURATION.EDGE' IN TYPEOF(an_item) THEN
    RETURN(edge_reversed(an_item));
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.PATH' IN TYPEOF(an_item) THEN
    RETURN(path_reversed(an_item));
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.FACE_BOUND' IN TYPEOF(an_item) THEN
    RETURN(face_bound_reversed(an_item));
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.FACE' IN TYPEOF(an_item) THEN
    RETURN(face_reversed(an_item));
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.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; -- topology_reversed

FUNCTION using_representations(
             item: representation_item
    ): SET OF representation;

  LOCAL
    results            : SET OF representation;
    i                  : INTEGER;
    intermediate_items : SET OF representation_item;
    result_bag         : BAG OF representation;
  END_LOCAL;
  result_bag := USEDIN(item,
      'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.ITEMS');
  IF SIZEOF(result_bag) > 0 THEN
    REPEAT i := 1 TO HIINDEX(result_bag) BY 1;
      results := results + result_bag[i];
    END_REPEAT;
  END_IF;
  intermediate_items := QUERY ( z <* bag_to_set(USEDIN(item,'')) | (
      'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION_ITEM' IN TYPEOF(z)) );
  IF SIZEOF(intermediate_items) > 0 THEN
    REPEAT i := 1 TO HIINDEX(intermediate_items) BY 1;
      results := results + using_representations(intermediate_items[i]);
    END_REPEAT;
  END_IF;
  RETURN(results);

END_FUNCTION; -- using_representations

FUNCTION valid_advanced_csg_tree(
             tree_element: boolean_operand
    ): BOOLEAN;
  IF SIZEOF(TYPEOF(tree_element) * ['PLANT_SPATIAL_CONFIGURATION.BLOCK',
      'PLANT_SPATIAL_CONFIGURATION.TORUS',
      'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
      'PLANT_SPATIAL_CONFIGURATION.SPHERE',
      'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'ADVANCED_FACE_WITH_THICKNESS_SHAPE_REPRESENTATION',
      'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID']) = 1 THEN
    RETURN(TRUE);
  ELSE
    IF 'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT' IN TYPEOF(
        tree_element) THEN
      IF NOT (tree_element\boolean_result.operator IN [boolean_operator.
          union,boolean_operator.difference]) THEN
        RETURN(FALSE);
      END_IF;
      IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN TYPEOF(
          tree_element\boolean_result.first_operand) THEN
        IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN TYPEOF(
            tree_element\boolean_result.first_operand\half_space_solid.
            base_surface) THEN
          IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN TYPEOF(
              tree_element\boolean_result.second_operand) THEN
            IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
                TYPEOF(tree_element\boolean_result.second_operand\
```

```
                half_space_solid.base_surface) THEN
              RETURN(TRUE);
            ELSE
              RETURN(FALSE);
            END_IF;
          ELSE
            RETURN(valid_advanced_csg_tree(tree_element\boolean_result.
                second_operand));
          END_IF;
        ELSE
          RETURN(FALSE);
        END_IF;
      ELSE
        IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN TYPEOF(
            tree_element\boolean_result.second_operand) THEN
          IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN TYPEOF(
              tree_element\boolean_result.second_operand\half_space_solid
              .base_surface) THEN
            RETURN(valid_advanced_csg_tree(tree_element\boolean_result.
                first_operand));
          ELSE
            RETURN(FALSE);
          END_IF;
        ELSE
          RETURN(valid_advanced_csg_tree(tree_element\boolean_result.
              first_operand) AND valid_advanced_csg_tree(tree_element\
              boolean_result.second_operand));
        END_IF;
      END_IF;
    END_IF;
  END_IF;
  RETURN(FALSE);

END_FUNCTION; -- valid_advanced_csg_tree

FUNCTION valid_calendar_date(
             date: calendar_date
    ): LOGICAL;
  IF NOT ((1 <= date.day_component) AND (date.day_component <= 31))
       THEN
    RETURN(FALSE);
  END_IF;
  CASE date.month_component OF
    4        :         RETURN((1 <= date.day_component) AND (date.
          day_component <= 30));
    6        :         RETURN((1 <= date.day_component) AND (date.
          day_component <= 30));
    9        :         RETURN((1 <= date.day_component) AND (date.
          day_component <= 30));
    11       :         RETURN((1 <= date.day_component) AND (date.
          day_component <= 30));
    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;
    OTHERWISE  :         RETURN(TRUE);
    END_CASE;

END_FUNCTION; -- valid_calendar_date
```

```
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; -- valid_time

FUNCTION valid_units(
             m: measure_with_unit
    ): BOOLEAN;
  IF 'PLANT_SPATIAL_CONFIGURATION.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 'PLANT_SPATIAL_CONFIGURATION.MASS_MEASURE' IN TYPEOF(m.
      value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,1,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.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 'PLANT_SPATIAL_CONFIGURATION.ELECTRIC_CURRENT_MEASURE' IN TYPEOF(m.
      value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,1,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.THERMODYNAMIC_TEMPERATURE_MEASURE' IN
      TYPEOF(m.value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,1,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.AMOUNT_OF_SUBSTANCE_MEASURE' IN
      TYPEOF(m.value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,1,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.LUMINOUS_INTENSITY_MEASURE' IN TYPEOF(
      m.value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,1) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
```

```
  IF 'PLANT_SPATIAL_CONFIGURATION.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 'PLANT_SPATIAL_CONFIGURATION.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 'PLANT_SPATIAL_CONFIGURATION.AREA_MEASURE' IN TYPEOF(m.
      value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(2,0,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.VOLUME_MEASURE' IN TYPEOF(m.
      value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(3,0,0,0,0,0,0) THEN
      RETURN(FALSE);
    END_IF;
  END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.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 'PLANT_SPATIAL_CONFIGURATION.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 'PLANT_SPATIAL_CONFIGURATION.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; -- valid_units

FUNCTION vector_difference(
             arg1, arg2: vector_or_direction
    ): vector;

  LOCAL
    ndim   : INTEGER;
    mag2   : REAL;
    mag1   : REAL;
    mag    : REAL;
    res    : direction;
    vec1   : direction;
```

```
      vec2   : direction;
      result : vector;
    END_LOCAL;
    IF (NOT EXISTS(arg1)) OR (NOT EXISTS(arg2)) OR (arg1.dim <> arg2.dim)
         THEN
      result := ?;
    ELSE
      BEGIN
        IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(arg1) THEN
          mag1 := arg1\vector.magnitude;
          vec1 := arg1\vector.orientation;
        ELSE
          mag1 := 1;
          vec1 := arg1;
        END_IF;
        IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(arg2) THEN
          mag2 := arg2\vector.magnitude;
          vec2 := arg2\vector.orientation;
        ELSE
          mag2 := 1;
          vec2 := arg2;
        END_IF;
        vec1 := normalise(vec1);
        vec2 := normalise(vec2);
        ndim := SIZEOF(vec1.direction_ratios);
        mag := 0;
        REPEAT i := 1 TO ndim BY 1;
          res.direction_ratios[i] := (mag1 * vec1.direction_ratios[i]) - (
              mag2 * vec2.direction_ratios[i]);
          mag := mag + (res.direction_ratios[i] * res.direction_ratios[i]);
        END_REPEAT;
        IF mag > 0 THEN
          result.magnitude := SQRT(mag);
          result.orientation := res;
        ELSE
          result.magnitude := 0;
          result.orientation := vec1;
        END_IF;
      END;
    END_IF;
    RETURN(result);

  END_FUNCTION; -- vector_difference

END_SCHEMA; -- plant_spatial_configuration
```

Annex B
(normative)

AIM short names of entities

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 - Short names of entities

Entity names	Short names
ACTION	ACTION
ACTION_ASSIGNMENT	ACTASS
ACTION_DIRECTIVE	ACTDRC
ACTION_METHOD	ACTMTH
ACTION_METHOD_RELATIONSHIP	ACMTRL
ACTION_RELATIONSHIP	ACTRLT
ACTION_REQUEST_ASSIGNMENT	ACRQAS
ACTION_REQUEST_SOLUTION	ACRQSL
ACTION_REQUEST_STATUS	ACRQST
ACTION_STATUS	ACTSTT
ADVANCED_CSG_SHAPE_REPRESENTATION	ACSR
AMOUNT_OF_SUBSTANCE_MEASURE_WITH_UNIT	AOSMWU
AMOUNT_OF_SUBSTANCE_UNIT	AOSU
ANGULAR_LOCATION	ANGLCT
APPLICATION_CONTEXT	APPCNT
APPLICATION_CONTEXT_ELEMENT	APCNEL
APPLICATION_PROTOCOL_DEFINITION	APPRDF
APPROVAL	APPRVL
APPROVAL_ASSIGNMENT	APPASS
APPROVAL_DATE_TIME	APDTTM
APPROVAL_PERSON_ORGANIZATION	APPROR
APPROVAL_ROLE	APPRL

Table B.1 - Short names of entities (continued)

Entity names	Short names
APPROVAL_STATUS	APPSTT
AREA_MEASURE_WITH_UNIT	AMWU
AREA_UNIT	ARUNT
ASSEMBLY_COMPONENT_USAGE	ASCMUS
AXIS1_PLACEMENT	AX1PLC
AXIS2_PLACEMENT_2D	A2PL2D
AXIS2_PLACEMENT_3D	A2PL3D
BEZIER_CURVE	BZRCRV
BEZIER_SURFACE	BZRSRF
BLANK_FITTING_CLASSIFICATION	BLFTCL
BLOCK	BLOCK
BOOLEAN_RESULT	BLNRSL
BOUNDARY_CURVE	BNDCR
BOUNDED_CURVE	BNDCRV
BOUNDED_PCURVE	BNDPCR
BOUNDED_SURFACE	BNDSRF
BOUNDED_SURFACE_CURVE	BNSRCR
BREP_WITH_VOIDS	BRWTVD
B_SPLINE_CURVE	BSPCR
B_SPLINE_CURVE_WITH_KNOTS	BSCWK
B_SPLINE_SURFACE	BSPSR
B_SPLINE_SURFACE_WITH_KNOTS	BSSWK
CALENDAR_DATE	CLNDT
CARTESIAN_POINT	CRTPNT
CARTESIAN_TRANSFORMATION_OPERATOR	CRTROP
CARTESIAN_TRANSFORMATION_OPERATOR_3D	CTO3
CATALOGUE	CTLG
CATALOGUE_CONNECTOR	CTLCNN

Table B.1 - Short names of entities (continued)

Entity names	Short names
CATALOGUE_ITEM	CTLITM
CENTRE_OF_SYMMETRY	CNOFSY
CHANGE_ACTION	CHNACT
CHANGE_FROM_ASSIGNMENT	CHFRAS
CHANGE_ITEM_ID_ASSIGNMENT	CIIA
CHANGE_TO_ASSIGNMENT	CHTAS
CHARACTERIZED_OBJECT	CHROBJ
CIRCLE	CIRCLE
CLASSIFICATION_ASSIGNMENT	CLSASS
CLOSED_SHELL	CLSSHL
COLOUR	COLOUR
COLOUR_RGB	CLRRGB
COLOUR_SPECIFICATION	CLRSPC
COMPOSITE_CURVE	CMPCRV
COMPOSITE_CURVE_ON_SURFACE	CCOS
COMPOSITE_CURVE_SEGMENT	CMCRSG
CONIC	CONIC
CONICAL_SURFACE	CNCSRF
CONNECTED_FACE_SET	CNFCST
CONNECTION_FUNCTIONAL_CLASSIFICATION	CNFNCL
CONNECTION_MOTION_CLASSIFICATION	CNMTCL
CONNECTION_NODE	CNNND
CONNECTOR_END_TYPE_CLASSIFICATION	CETC
CONTEXT_DEPENDENT_UNIT	CNDPUN
CONVERSION_BASED_UNIT	CNBSUN
COORDINATED_UNIVERSAL_TIME_OFFSET	CUTO
CSG_SOLID	CSGSLD
CURVE	CURVE

Table B.1 - Short names of entities (continued)

Entity names	Short names
CURVE_BOUNDED_SURFACE	CRBNSR
CURVE_REPLICA	CRVRPL
CYLINDRICAL_SURFACE	CYLSRF
DATA_ENVIRONMENT	DTENV
DATE	DATE
DATE_AND_TIME	DTANTM
DATE_AND_TIME_ASSIGNMENT	DATA
DATE_ASSIGNMENT	DTASS
DATE_ROLE	DTRL
DATE_TIME_ROLE	DTTMRL
DEFINITIONAL_REPRESENTATION	DFNRPR
DEGENERATE_PCURVE	DGNPCR
DEGENERATE_TOROIDAL_SURFACE	DGTRSR
DERIVED_SHAPE_ASPECT	DRSHAS
DERIVED_UNIT	DRVUNT
DERIVED_UNIT_ELEMENT	DRUNEL
DESCRIPTIVE_COLOUR	DSCCLR
DESCRIPTIVE_REPRESENTATION_ITEM	DSRPIT
DESIGN_PROJECT	DSGPRJ
DESIGN_PROJECT_ASSIGNMENT	DSPRAS
DIMENSIONAL_CHARACTERISTIC_REPRESENTATION	DMCHRP
DIMENSIONAL_EXPONENTS	DMNEXP
DIMENSIONAL_LOCATION	DMNLCT
DIMENSIONAL_SIZE	DMNSZ
DIRECTED_ACTION	DRCACT
DIRECTION	DRCTN
DOCUMENT	DCMNT
DOCUMENT_REFERENCE	DCMRFR

Table B.1 - Short names of entities (continued)

Entity names	Short names
DOCUMENT_RELATIONSHIP	DCMRLT
DOCUMENT_TYPE	DCMTYP
DOCUMENT_USAGE_CONSTRAINT	DCUSCN
DUCTING_SYSTEM	DCTSYS
EDGE	EDGE
EDGE_CURVE	EDGCRV
EDGE_LOOP	EDGLP
ELBOW_FITTING_CLASSIFICATION	ELFTCL
ELECTRICAL_CONNECTOR_CLASSIFICATION	ELCNCL
ELECTRICAL_SYSTEM	ELCSYS
ELECTRIC_CURRENT_MEASURE_WITH_UNIT	ECMWU
ELECTRIC_CURRENT_UNIT	ELCRUN
ELEMENTARY_SURFACE	ELMSRF
ELLIPSE	ELLPS
EVALUATED_DEGENERATE_PCURVE	EVDGPC
EXECUTED_ACTION	EXCACT
EXTERNALLY_DEFINED_CLASSIFICATION	EXDFCL
EXTERNALLY_DEFINED_ITEM	EXDFIT
EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION	EDPID
EXTERNAL_SOURCE	EXTSRC
EXTRUDED_AREA_SOLID	EXARSL
EXTRUDED_FACE_SOLID	EXFCSL
FACE	FACE
FACETED_BREP	FCTBR
FACE_BOUND	FCBND
FACE_SURFACE	FCSRF
FLANGE_FITTING_CLASSIFICATION	FLFTCL
FLANGE_FITTING_NECK_TYPE_CLASSIFICATION	FFNTC

Table B.1 - Short names of entities (continued)

Entity names	Short names
FUNCTIONALLY_DEFINED_TRANSFORMATION	FNDFTR
GEOMETRIC_CURVE_SET	GMCRST
GEOMETRIC_REPRESENTATION_CONTEXT	GMRPCN
GEOMETRIC_REPRESENTATION_ITEM	GMRPIT
GEOMETRIC_SET	GMTST
GEOMETRIC_SET_REPLICA	GMSTRP
GLOBAL_UNIT_ASSIGNED_CONTEXT	GUAC
GROUP	GROUP
GROUP_ASSIGNMENT	GRPASS
HALF_SPACE_SOLID	HLSPSL
HEAT_TRACING_REPRESENTATION	HTTRRP
HYBRID_SHAPE_REPRESENTATION	HYSHRP
HYPERBOLA	HYPRBL
INLINE_EQUIPMENT	INLEQP
INSTRUMENTATION_AND_CONTROL_SYSTEM	IACS
INTERFERING_SHAPE_ELEMENT	INSHEL
INTERSECTION_CURVE	INTCRV
KNOWN_SOURCE	KNWSRC
LENGTH_MEASURE_WITH_UNIT	LMWU
LENGTH_UNIT	LNGUNT
LINE	LINE
LINE_BRANCH_CONNECTION	LNBRCN
LINE_LESS_PIPING_SYSTEM	LLPS
LINE_PLANT_ITEM_BRANCH_CONNECTION	LPIBC
LINE_PLANT_ITEM_CONNECTION	LPIC
LINE_TERMINATION_CONNECTION	LNTRCN
LOCAL_TIME	LCLTM
LOOP	LOOP

Table B.1 - Short names of entities (continued)

Entity names	Short names
MAKE_FROM_USAGE_OPTION	MFUO
MANIFOLD_SOLID_BREP	MNSLBR
MAPPED_ITEM	MPPITM
MASS_MEASURE_WITH_UNIT	MMWU
MASS_UNIT	MSSUNT
MATERIAL_DESIGNATION	MTRDSG
MATERIAL_DESIGNATION_CHARACTERIZATION	MTDSCH
MATERIAL_PROPERTY	MTRPRP
MATERIAL_PROPERTY_REPRESENTATION	MTPRRP
MEASURE_REPRESENTATION_ITEM	MSRPIT
MEASURE_WITH_UNIT	MSWTUN
NAMED_UNIT	NMDUNT
NAME_ASSIGNMENT	NMASS
OFFSET_CURVE_2D	OFCR2D
OFFSET_CURVE_3D	OFCR3D
OFFSET_SURFACE	OFFSRF
OPEN_SHELL	OPNSHL
ORGANIZATION	ORGNZT
ORGANIZATIONAL_PROJECT	ORGPRJ
ORGANIZATION_ASSIGNMENT	ORGASS
ORGANIZATION_ROLE	ORGRL
ORIENTED_CLOSED_SHELL	ORCLSH
ORIENTED_EDGE	ORNEDG
ORIENTED_FACE	ORNFC
ORIENTED_OPEN_SHELL	OROPSH
ORIENTED_PATH	ORNPTH
PARABOLA	PRBL
PATH	PATH

Table B.1 - Short names of entities (continued)

Entity names	Short names
PCURVE	PCURVE
PERSON	PERSON
PERSON_AND_ORGANIZATION	PRANOR
PERSON_AND_ORGANIZATION_ASSIGNMENT	PAOA
PERSON_AND_ORGANIZATION_ROLE	PAOR
PERSON_ASSIGNMENT	PRSASS
PERSON_ROLE	PRSRL
PIPE_CLASSIFICATION	PPCLS
PIPE_CLOSURE_FITTING_CLASSIFICATION	PCFC
PIPING_COMPONENT_CLASS	PPCMCL
PIPING_COMPONENT_DEFINITION	PPCMDF
PIPING_CONNECTOR_CLASSIFICATION	PPCNCL
PIPING_DESIGN_CSG_SHAPE_REPRESENTATION	PDCSR
PIPING_SYSTEM	PPNSYS
PLACEMENT	PLCMNT
PLANE	PLANE
PLANE_ANGLE_MEASURE_WITH_UNIT	PAMWU
PLANE_ANGLE_UNIT	PLANUN
PLANT	PLANT
PLANT_ITEM_CONNECTION	PLITCN
PLANT_ITEM_CONNECTOR	PLI0
PLANT_ITEM_INTERFERENCE	PLITIN
PLANT_ITEM_ROUTE	PLITRT
PLANT_ITEM_WEIGHT_REPRESENTATION	PIWR
PLANT_LINE_DEFINITION	PLLNDF
PLANT_LINE_SEGMENT_DEFINITION	PLSD
PLANT_LINE_SEGMENT_TERMINATION	PLST
PLANT_SPATIAL_CONFIGURATION_ACTION_REQUEST_ASSIGNMENT	PSCARA

Table B.1 - Short names of entities (continued)

Entity names	Short names
PLANT_SPATIAL_CONFIGURATION_APPROVAL_ASSIGNMENT	PSCAA
PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT	PSCCA
PLANT_SPATIAL_CONFIGURATION_DATE_AND_TIME_ASSIGNMENT	PSCDAT
PLANT_SPATIAL_CONFIGURATION_DATE_ASSIGNMENT	PSCDA
PLANT_SPATIAL_CONFIGURATION_DOCUMENT_REFERENCE	PSCDR
PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT	PSCOA
PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_-ASSIGNMENT	PSCPAO
PLANT_SPATIAL_CONFIGURATION_PERSON_ASSIGNMENT	PSCPA
POINT	POINT
POINT_ON_CURVE	PNONCR
POINT_ON_SURFACE	PNONSR
POINT_REPLICA	PNTRPL
POLYLINE	PLYLN
POLY_LOOP	PLYLP
PRESENTATION_LAYER_ASSIGNMENT	PRLYAS
PRE_DEFINED_ITEM	PRDFIT
PROCESS_CAPABILITY	PRCCPB
PRODUCT	PRDCT
PRODUCT_CATEGORY	PRDCTG
PRODUCT_CATEGORY_RELATIONSHIP	PRCTRL
PRODUCT_CONTEXT	PRDCNT
PRODUCT_DEFINITION	PRDDFN
PRODUCT_DEFINITION_CONTEXT	PRDFCN
PRODUCT_DEFINITION_FORMATION	PRDFFR
PRODUCT_DEFINITION_FORMATION_RELATIONSHIP	PDFR
PRODUCT_DEFINITION_FORMATION_WITH_SPECIFIED_SOURCE	PDFWSS
PRODUCT_DEFINITION_RELATIONSHIP	PRDFRL

Table B.1 - Short names of entities (continued)

Entity names	Short names
PRODUCT_DEFINITION_SHAPE	PRDFSH
PRODUCT_DEFINITION_SUBSTITUTE	PRDFSB
PRODUCT_DEFINITION_USAGE	PRDFUS
PRODUCT_DEFINITION_WITH_ASSOCIATED_DOCUMENTS	PDWAD
PRODUCT_MATERIAL_COMPOSITION_RELATIONSHIP	PMCR
PRODUCT_RELATED_PRODUCT_CATEGORY	PRPC
PROPERTY_DEFINITION	PRPDFN
PROPERTY_DEFINITION_RELATIONSHIP	PRDFR
PROPERTY_DEFINITION_REPRESENTATION	PRDFRP
PURCHASE_ASSIGNMENT	PRCASS
QUALIFIED_REPRESENTATION_ITEM	QLRPIT
QUASI_UNIFORM_CURVE	QSUNCR
QUASI_UNIFORM_SURFACE	QSUNSR
RATIONAL_B_SPLINE_CURVE	RBSC
RATIONAL_B_SPLINE_SURFACE	RBSS
RATIO_MEASURE_WITH_UNIT	RMWU
RATIO_UNIT	RTUNT
RECTANGULAR_COMPOSITE_SURFACE	RCCMSR
RECTANGULAR_TRIMMED_SURFACE	RCTRSR
REDUCER_FITTING_CLASSIFICATION	RDFTCL
REFERENCE_GEOMETRY	RFRGMT
REPARAMETRISED_COMPOSITE_CURVE_SEGMENT	RCCS
REPRESENTATION	RPRSNT
REPRESENTATION_CONTEXT	RPRCNT
REPRESENTATION_ITEM	RPRITM
REPRESENTATION_MAP	RPRMP
REQUIRED_MATERIAL_PROPERTY	RQMTPR
RESERVED_SPACE	RSRSPC

Table B.1 - Short names of entities (continued)

Entity names	Short names
REVOLVED_AREA_SOLID	RVARSL
REVOLVED_FACE_SOLID	RVFCSL
RIGHT_CIRCULAR_CONE	RGCRCN
RIGHT_CIRCULAR_CYLINDER	RGCRCY
SEAM_CURVE	SMCRV
SHAPE_ASPECT	SHPASP
SHAPE_ASPECT_DERIVING_RELATIONSHIP	SADR
SHAPE_ASPECT_RELATIONSHIP	SHASRL
SHAPE_DEFINITION_REPRESENTATION	SHDFRP
SHAPE_DIMENSION_REPRESENTATION	SHDMRP
SHAPE_REPRESENTATION	SHPRPR
SHELL_BASED_WIREFRAME_MODEL	SBWM
SITE	SITE
SITE_BUILDING	STBLD
SITE_FEATURE	STFTR
SITE_REPRESENTATION	STRPR
SI_UNIT	SUNT
SOLID_ANGLE_MEASURE_WITH_UNIT	SAMWU
SOLID_ANGLE_UNIT	SLANUN
SOLID_MODEL	SLDMDL
SPACER_FITTING_CLASSIFICATION	SPFTCL
SPECIALTY_ITEM_CLASSIFICATION	SPITCL
SPHERE	SPHERE
SPHERICAL_SURFACE	SPHSRF
STREAM_DESIGN_CASE	STDSCS
STREAM_PHASE	STRPHS
STRUCTURAL_LOAD_CONNECTOR_CLASSIFICATION	SLCC
STRUCTURAL_SYSTEM	STRSYS

Table B.1 - Short names of entities (continued)

Entity names	Short names
SUPPORT_CONSTRAINT_REPRESENTATION	SPCNRP
SURFACE	SRFC
SURFACE_CURVE	SRFCRV
SURFACE_OF_LINEAR_EXTRUSION	SL
SURFACE_OF_REVOLUTION	SROFRV
SURFACE_PATCH	SRFPTC
SURFACE_REPLICA	SRFRPL
SWAGE_FITTING_CLASSIFICATION	SWFTCL
SWEPT_AREA_SOLID	SWARSL
SWEPT_FACE_SOLID	SWFCSL
SWEPT_SURFACE	SWPSRF
SYSTEM_CLASSIFICATION	SYSCLS
SYSTEM_SPACE	SYSSPC
THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT	TTMWU
THERMODYNAMIC_TEMPERATURE_UNIT	THTMUN
TIME_MEASURE_WITH_UNIT	TMWU
TIME_UNIT	TMUNT
TOPOLOGICAL_REPRESENTATION_ITEM	TPRPIT
TOROIDAL_SURFACE	TRDSRF
TORUS	TORUS
TRIMMED_CURVE	TRMCRV
TRUNCATED_PYRAMID	TRNPYR
TYPE_QUALIFIER	TYPQLF
UNIFORM_CURVE	UNFCRV
UNIFORM_SURFACE	UNFSRF
VALVE_CLASSIFICATION	VLVCLS
VECTOR	VECTOR
VERSIONED_ACTION_REQUEST	VRACRQ

Table B.1 - Short names of entities (concluded)

Entity names	Short names
VERTEX	VERTEX
VOLUME_MEASURE_WITH_UNIT	VMWU
VOLUME_UNIT	VLMUNT

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 the AIM defined in annex A of this part of ISO 10303. The header of the exchange structure shall identify the use of this part of ISO 10303 by the schema name ‘plant_spatial_-configuration’.

Annex D
(normative)

Protocol Information Conformance Statement proforma

This clause lists the optional elements of this part of ISO 10303. An implementation may chose to support any combination of this optional elements. However, certain combinations of options are likely to be implemented together. These combinations are called conformance classes and are described in the subclauses of this annex.

This annex is in the form of a questionnaire. This questionnaire is intended to be filled out by the implementor and may be used in preparation for conformance testing by a testing laboratory. The completed PICS proforma is referred to as a PICS.

Four conformance classes are identified in this part of ISO 10303. A conforming implementation shall support at least one conformance class. Each class specifies a subset of the AIM constructs in this part of ISO 10303. These classes are detailed in clause 6 of this part of ISO 10303.

Questions:

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. Please indicate the classes for which conformance is claimed:

   - Class 1:_____

   - Class 2:_____

   - Class 3:_____

   - Class 4:_____

Annex E
(normative)

Information object registration

E.1 Document identification

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

{ iso standard 10303 part(227) version(0) }

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

E.2 Schema identification

To provide for unambiguous identification of the schema specifications given in this application protocol plant_spatial_configuration in an open information system, object identifiers are assigned as follows:

{ iso standard 10303 part(227) version(0) object(1) plant-spatial-configuration(1) }

is assigned to the **plant_spatial_configuration** expanded schema (see annex A).

{ iso standard 10303 part(227) version(0) object(1) plant-spatial-configuration-schema(2) }

is assigned to the **plant_spatial_configuration** short form schema (see 5.2).

The meaning of these values 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 model is presented as a set of activity figures that contain the activity diagrams and a set of definitions of the activities and their data.

F.1 Application activity model

F.1.1 Application activity model definitions and abbreviations

The following terms are used in the application activity model. Terms marked with an asterisk are outside the scope of this application protocol.

The definitions given in this annex do not supersede the definitions given in the main body of the text.

The viewpoint of the AAM is the users of plant spatial configuration information, including owner, architect, engineer, and builder.

F.1.1.1 analyze final plant design (AAM A245): examine all aspects of final design for compliance to performance criteria and generate any necessary changes required to meet these criteria.

F.1.1.2 as-built documents*: site plans, detailed equipment descriptions, electrical instrumentation diagrams, and P&IDs that record the actual condition of a plant at a specific point in time.

> NOTE - These documents aid in meeting government documentation and safety requirements. Frequently, they are simply corrections or modifications to existing design documents delivered to construction.

F.1.1.3 authorization plan*: high level plan, justification, and forecast for design and construction of a plant. The authorization plan describes how funds, people, and resources are to be allocated for the plant project.

> NOTE - It is a document used internally and is sometimes called a white paper.

F.1.1.4 automation tools*: the collection of software and hardware tools used to assist the activities involved in the life cycle of a process plant.

F.1.1.5 basic laws*: those elements of natural and human laws affecting any activity in the life cycle of a process plant.

> EXAMPLE 79 - These laws include operating rules and guidelines as established by U.S. federal regulatory agencies such as the Occupational Safety and Health Administration (OSHA), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA).

F.1.1.6 bids*: commercial proposal by supplier for provision of equipment, supplies, or services.

F.1.1.7 calculate heat and mass balance* (A212): calculations performed based on design basis, unit operations, fuel or materials in the process, along with associated chemical properties to optimize plant and operational cost.

F.1.1.8 capital appropriation*: authorization of funding for capital project or expenditure.

F.1.1.9 change request: a request made by an user of data to revise the original or current version of something due to errors, omissions, or other reasons, such as new requirements.

NOTES

1 - A request is followed by review, analysis, and approval. Change requests are tracked in terms of cost and schedule (a kind of mini-project within project).

2 - Change requests may be made against a supplier list, process, plant, procedure, and design basis.

3 - Change request originators include construction and operations.

F.1.1.10 change request (design): a request made by an user of data to revise the original or current version of the design of something due to errors, omissions, or other reasons.

F.1.1.11 change request (plant): a request made by an user of data to revise the original or current version of the design of the plant due to errors, omissions, or other reasons.

F.1.1.12 change request (procedure): a request made by an user of data to revise the original or current version of a procedure due to errors, omissions, or other reasons.

F.1.1.13 change request (supplier list): a request made by an user of data to revise the original or current version of the supplier's list due to errors, omissions, or other reasons.

F.1.1.14 chemical properties*: chemical data needed by the process engineer during design.

NOTE - This data includes, but is not limited to:

- Boiling Point;
- Critical Pressure;
- Critical Temperature;
- Density;
- Enthalpy;
- Entropy;
- Flash Point;
- Heat of Vapourization;
- Melting Point;

- Molecular Weight;

- Specific Heat;

- Thermal Conductivity;

- Viscosity.

F.1.1.15 codes: widely recognized, accepted, and sometimes legally mandated rules that apply during the life-cycle of the plant. These rules govern life-cycle activities such as design, fabrication, and operation, and characteristics such as safety. Codes are consensus documents and specifications and are sometimes a subset of regulatory requirements.

EXAMPLE 80 - The ANSI 31.x series of codes.

NOTE - The design basis data specified will guide the code application, i.e., how the code is applied. (ANSI 31.3 allows overpressurizing for short periods of times to accommodate specific design basis scenarios.)

F.1.1.16 commission plant* (AAM A46): test the functionality of the completed plant prior to operation, develop final operating and maintenance procedures, and obtain final regulatory approval to operate the plant.

F.1.1.17 commissioned plant*: a plant that has been proven to be operational through commissioning procedures.

F.1.1.18 commissioning procedures*: step-by-step explanation of start-up actions required to commission the plant.

F.1.1.19 company requirements: those managerial decisions that place constraints on the operations of the company, that give direction or emphasis on areas for development, or that dictate decisions outside the local decision making paths. The embodiment of policies and regulations that govern the operations of a company.

F.1.1.20 confirm safety and regulatory compliance (AAM A244): establish that the final design of the plant meets specified safety and regulatory criteria.

F.1.1.21 construct and commission plant* (AAM A4): the process of building or retrofitting a physical plant, using plans and building materials. The layout drawings and material requirements are used to establish the physical arrangement and to procure the materials required. A plan for erecting the plant is determined from material schedules, heavy equipment schedules, labor schedules, and environmental conditions (such as weather). Temporary erection material (such as scaffolding) is procured as needed. Regulatory requirements and client requirements are used to plan and erect the plant, and for the final testing and certification for operation. The result is a completed plant that meets the testing procedures defined in the project control and approval documentation.

F.1.1.22 construction design specification*: a contractual document that gives the criteria and standards to be used in the construction of the plant.

EXAMPLE 81 - The specification contents include detailed construction drawings, plant layout, equipment lists, isometric models, piping and instrumentation diagrams, specifications for the construction phase of the project, and pre-commissioning, acceptance and approval, and testing procedures.

F.1.1.23 construction documentation*: all information related to the construction of the process plant.

EXAMPLE 82 - Documentation includes as-built reports, equipment certification, nameplate information of installed equipment, operating manuals, testing procedures, field changes, and photographs of as-built units, modules, and plant.

F.1.1.24 construction plan*: a description of the method(s) to be used for building or fabricating a plant or plant item.

F.1.1.25 construction services*: constructor activities and abilities to be used to construct the plant.

F.1.1.26 control and approve activities* (AAM A11): prepare plans, check conformance to plans, and arrange for any corrective actions.

F.1.1.27 control requirements*: requirements and criteria specified in operating procedures and safety requirements imposed on the mechanisms and systems that monitor and control plant operation.

F.1.1.28 corporate standards: procedures, instructions, or specifications that may be used in the execution of a plant project and are standardized within an organization. Corporate standards are not project specific, but may be used (and possibly customized) by a variety of projects. Corporate standards are developed over a long period of time as standard, recommended, or best practice.

EXAMPLE 83 - Kinds of standards include safety, design, and maintenance.

F.1.1.29 decommission and dispose of plant* (AAM A6): the activities during which the plant is decommissioned, disassembled, and the site either prepared for a new plant or returned to a state specified by the regulatory agencies. Records of the disposal of toxic and hazardous waste together with the location of any holes and the methodology used to plug them are produced and stored in accordance with approved procedures and guidelines.

F.1.1.30 decommission plant* (AAM A61): plan and complete the activities required to decommission the plant.

F.1.1.31 define plant operating philosophy* (AAM A231): ascertain and confirm those plant operating characteristics and activities necessary to achieve the plant owner's operational goals such as methods of production, technology, plant safety, or plant availability. This activity includes selecting types and sequences of unit operations and processing steps so that the plant production objectives can be achieved and specifying alternate or abnormal operating conditions, and procedures such as startup and shutdown.

F.1.1.32 define procedures, standards, guidelines, specifications, and codes* (AAM A13): specify the engineering policies to be used and determine appropriate procedures, codes, standards, guidelines, and specifications that may apply.

F.1.1.33 delivery dates*: scheduled date for delivery of procured items to meet or support construction.

F.1.1.34 deploy component or service* (AAM A35): the process whereby the part or service is delivered and the acquisition agreement is fulfilled.

F.1.1.35 design basis: a document provided by the plant owner or developed by the architecture, engineering, and construction (AEC) contractors that establishes or defines the information and data that Plant engineering is to be based upon. It consists of guidelines and requirements, corporate standards, codes, references to regulatory agreements, form of deliverables, and plant or production capacity.

EXAMPLE 84 - The design basis includes:

- Design safety philosophy;
- Environmental requirements;
- Plant inputs (e.g., fuel, feedstock);
- Plant license and permit requirements;
- Plant operating requirements;
- Plant process requirements;
- Plant product or output (type and capacity);
- Site parameters (geographical, meteorological, soils, hydrological);
- Type of plant.

It also addresses performance objectives for the plant such as:

- Capacity;
- Engineering quality;
- Environmental;
- Investment and project economics;
- Safety and health;
- Schedule;
- Product and plant quality;
- Product and raw material storage;
- Project execution;
- Technology.

NOTES

1 - Performance objectives usually take the form of a written document owned and maintained by the project team (consisting of members from the business, engineering, construction, and plant site).

2 - The definition for design basis is from an owner's perspective.

F.1.1.36 design and engineer plant (AAM A2): the activities required to develop an appropriations request and generate a construction design specification for some modification to an existing process plant or the construction of a new process plant.

NOTE - The appropriation request is submitted to company management for approval. Upon approval, the construction design specification is generated.

F.1.1.37 design strategy*: a description of major steps required to complete enough design to obtain a budget estimate for business calculations as well as to begin the identification of process unknowns that may or may not require piloting. It encompasses building technology, mechanical technology, utility technology, automation technology, schedules, scope, standards and regulations, process definition, control philosophies, costs, benefits and timings, and project approach (e.g., architectural engineering, construction management, internal).

F.1.1.38 disassembled plant*: all equipment items remaining after the disposal of a process plant.

F.1.1.39 disposal documentation*: all information related to the disposal of the process plant including acceptance and approval procedures used in disposing all hazardous materials, residues, insulation, wiring, piping, vessels, rotating equipment, site cleanup and restoration reports, and photographs.

F.1.1.40 dispose of plant* (AAM A62): plan and complete the activities required to dispose of the plant.

F.1.1.41 energy*: all utilities required in the production of useful products through the operation of a process plant.

F.1.1.42 engineer and design equipment (AAM A223): preliminary sizing of all major pieces of required equipment is made at this time with enough detail to obtain budget quotes.

EXAMPLE 85 - This includes equipment such as refrigeration machines, purchase power substations, secondary substations, switch gear, compressors, and boilers, as well as the major process equipment specific to the plant.

F.1.1.43 engineer and design plant systems (AAM A222): at the conceptual level, this is a preliminary scoping of all major modifications or additions to major plant distribution systems such as steam, compressed air, electrical power, refrigeration, water, firewater, and sewers (storm, process, sanitary). Impact on distribution pipe lines and feeder systems quantity and size are also included. A consideration of system operation in terms of reliability, uptime, planned maintenance, and winter and summer operations are vital to proper planning.

F.1.1.44 engineering design, construction, and operation changes: changes to the design of the plant arising from errors, omissions, new requirements, or other reasons during plant design, construction, or operation.

F.1.1.45 environmental impact assessment*: evaluation of project's or plant's affect on the environment.

NOTE - A report is usually required by an environmental regulatory agency before construction can begin.

F.1.1.46 equipment characteristics (functional): describe or specify the functional requirements for the equipment: what it is supposed to do. They are items of information that describe: the service provided to the process by the equipment.

EXAMPLE 86 - For a pump, such information might include a descriptive name or title, such as 1502-B Condensate Return Pump B.

F.1.1.47 equipment characteristics (performance): describe or specify the performance requirements for the equipment: how much it is supposed to do it. They are items of information that describe the effect that equipment has on the process or other operational information.

EXAMPLE 87 - For a pump, such information might include flow rate, total developed head, and efficiency.

F.1.1.48 equipment characteristics (process): a subset of equipment functional data that describe the contribution to the process desired from equipment. Such data is specified prior to the actual selection of specific equipment to fulfill the purpose.

F.1.1.49 equipment characteristics (required): needed functional, performance, physical, or process attributes of an item that have a name and measurable value.

F.1.1.50 equipment id: an identifier assigned to a piece of equipment.

F.1.1.51 equipment list: a list of equipment in the process plant.

EXAMPLE 88 - An equipment list is comprised of, but not limited to:

- contract numbers (e.g., purchase, install);
- drawing references (e.g., P&IDs, plant arrangements);
- electrical load and type;
- identifier (e.g., tag);
- location (e.g., building, elevation, area, column row);
- name;

- service requirements (e.g., air, water, structural base, electrical power, control circuitry);

- spare requirements.

NOTE - The equipment list may not include all equipment. It does not include miscellaneous equipment and devices (e.g., y-pattern strainers, inline flow meters, instruments) or valves.

F.1.1.52 erect plant* (AAM A43): utilizing plans, materials, services and labor, build a physical plant that conforms to the detailed design.

NOTE - This process begins with the site preparation; grading and primary foundations poured, and temporary roads and rails created. Utility services are provided and temporary warehouses are built. Major equipment is moved, often in pieces, and installed on foundations with supporting steel. Site permanent buildings are built, as are pipe racks and other permanent steel. Pipe runs and pipe spools are put in place with valves and miscellaneous equipment and welded or joined. Other items such as ducting, electrical, instrumentation are installed.

F.1.1.53 establish initial process control logic* (AAM A214): document philosophical and operational requirements between instrumentation, equipment and process.

F.1.1.54 establish plant design basis* (AAM A16): the activity of collecting a complete and consistent set of constraints, requirements, and guidelines for subsequent engineering activities.

NOTE - This activity results in the development of the design basis documents. See Design Basis.

F.1.1.55 evaluate bids and negotiate purchase* (AAM A33): the process whereby bid packages are evaluated, a supplier is selected, and an agreement is entered into for the acquisition of the plant item(s).

F.1.1.56 finalize layout, arrangement, and spatial design (AAM A242): develop the spatial design of the plant to its final approved-for-construction state utilizing the finalized system design as the primary input.

F.1.1.57 finalize system design (AAM A241): develop the system design, expressed by flow and control information and equipment performance data, to its final state.

NOTE - The resulting design serves as a basis for detailed plant design.

F.1.1.58 guidelines and requirements: specifications, instructions, and mandates specified by management that shall be followed in the plant project. These guidelines and requirements may be project specific. Guidelines are more generally applicable than requirements, which tend to be specific in terms of what must be done.

NOTE - Originators and users of guidelines and requirements are:

- Architectural and engineering;

- Construction management;

- Constructor;

- Contractor (basic practices);

- Engineering and construction;

- Engineering, procurement, and construction;

- Owner.

These categories are not mutually exclusive.

F.1.1.59 heat and mass calculations*: calculations performed based on design basis, unit operations, fuel or materials in the process, along with associated chemical properties to optimize plant and operational cost.

F.1.1.60 identify and analyze safety requirements and hazards* (AAM A215): review design basis, unit operations, heat and mass balances, materials, identified equipment, control logic and process flow diagrams against federal, state and local regulations, codes and standards to determine compliance and produce an analysis of results.

F.1.1.61 identify and define unit operations* (AAM 211): incorporate the design basis and owner requirements to define and document the basis for conceptual process design and estimated time and cost expenditures. If the design activity is related to an existing plant, then existing operations are incorporated into the conceptual process design.

F.1.1.62 identify and size equipment* (AAM A213): identify equipment requirements based on the design basis and unit operations. Sizing of the equipment is based on the heat and mass balance calculations and unit operations.

F.1.1.63 identify plant performance requirements and establish design strategy (AAM A221): define a quantitative description of the quantity and quality of a product to be produced by the plant in a yearly time period and describe the major steps required to complete enough design to obtain a budget estimate for business calculations as well as to begin the identification of process unknowns.

NOTE - Performance requirements are usually stated as units of product per unit time.

EXAMPLE 89 - Additional qualifications are typically made regarding the quality of the plant. Examples include time between major shutdowns for continuous processes, percent uptime required, and expected yield.

F.1.1.64 information databases: those elements of information collections comprising literature references, physical and transport properties, symbology sets, equipment specifications, and equipment costs that assist in the conception, design, construction, operation, and disposal of a process plant.

F.1.1.65 initial information: any knowledge available at the start of the process to build or modify a process plant.

EXAMPLE 90 - This includes information about the site, regulatory agreements, owner requirements, and approved suppliers.

F.1.1.66 innovation: new ideas and concepts generated internally or through the public domain to solve problems or to enhance the quality of work.

NOTE - Some ideas and concepts may become goods, services, and systems that there is a societal requirement for. To some degree, innovation is fundamental to all activities involved with the process, however, particular emphasis is placed on activities that require generation of new ideas and concepts from abstract entities as inputs.

F.1.1.67 inspection plan*: the description of anticipated activities necessary for surveillance of suppliers, fabricators, and assemblers to verify compliance to contractual specifications, codes, and good practice.

NOTE - The plan usually lists the items to be inspected, the place where the inspections are expected to occur, anticipated frequency of inspection and type of activity to be undertaken at each inspection. The reporting procedure for the surveillance results is usually included in the developed inspection plan.

F.1.1.68 inspection requirements*: requirements imposed by a regulatory agency related to the inspection of the plant during the decommissioning process.

F.1.1.69 inspection results*: reports that result from inspection and supplier surveillance activities.

F.1.1.70 layout plant (AAM A224): a general arrangement of the plant in plan view, showing all the major components of the distribution systems affected by the plant and the location of the plant. A general arrangement of all major equipment within the battery limits of the plant is also included.

F.1.1.71 licensed technologies: patented or proprietary processes or design information purchased or licensed from an outside source, such as a process processor, supplier, or fabricator.

NOTE - This technology may range from laboratory synthesis data through unit operation process data to complete, detailed plant designs or equipment items and modules.

F.1.1.72 line schedule and list: a subset of information presented on the P&ID, and possibly the heat and mass balance, that describes the characteristics of pipelines required for a given process.

NOTE - This information is used by the piping designer during the detail design. It is analogous to the equipment list.

F.1.1.73 maintain plant* (AAM A53): conduct and monitor the activities required to maintain the plant.

F.1.1.74 maintain suppliers list* (AAM A31): the process whereby a list of accepted or approved suppliers is kept up to date.

F.1.1.75 manage and plan project* (AAM A1): managing the project requires that sufficient resources be provided to execute the project and check that the execution is done in accordance with the plans and regulations. Planning the project is the activity that establishes a detailed technical plan and a financial plan that are consistent with the engineering, construction, and commissioning activities required to fulfill the project objectives.

F.1.1.76 manage plant* (AAM A51): direct and administrate the operations, maintenance, and disposal of the plant.

F.1.1.77 manage, operate, and maintain plant* (AAM A5): the activities required to manage, operate, and maintain the plant safely, efficiently, and according to operating procedures and regulations.

F.1.1.78 management authorizations and controls*: management authorization, imperatives, directives, and procedures for initiating and executing plant management activities.

F.1.1.79 obtain agreements with regulatory bodies* (AAM A15): the activity of confirming that the intended design, construction, commissioning, operation, and decommissioning of the proposed project will comply with requirements of the regulatory body. This confirmation is recorded by formal documentation such as written agreements and safety compliance reports.

F.1.1.80 obtain construction services* (AAM A42): use the construction plan as a requirements list for outside services needed and their schedule. Negotiate contracts and agreements with sub-contractors, equipment suppliers, and labour unions as needed for the erection of the plant. Adjust the schedule of the construction plan to allow for the availability of sub-contractors, equipment and labour.

F.1.1.81 operate plant* (AAM A52): conduct and monitor the activities required to operate the plant.

F.1.1.82 operating philosophy*: the plant owner's operational goals.

> EXAMPLE 91 - Operational goals include methods of production, technology, plant safety, and plant availability.

F.1.1.83 operating procedures*: documentation that covers many different phases and aspects of plant operation that is necessary to run the plant safely.

F.1.1.84 optimize for environment* (AAM A236): evaluate the plant design against the applicable environmental regulations (Federal, State, and local) and modify the design where required.

> NOTE - These regulations influence many of the activities in plant and process design such as operating procedures, plant and process control strategies, specification and design of piping, instrumentation, and equipment, as well as site selection. Broad regulatory interpretations often mean that conservative measures are incorporated in plant design.

F.1.1.85 owner requirements: an initial statement of plant requirements provided by the owner.

> NOTE - Owner requirements are an aggregation of items such as design requirements and client general specifications. The owner requirements may be provided at any level of abstraction from very general to very specific.

F.1.1.86 perform process plant life-cycle activities (AAM A0): the completion of all tasks involved in the life cycle of a process plant from conception through final disposal.

NOTES

1 - These tasks include:

- conception;
- research;
- design;
- construction;
- operation;
- maintenance;
- retrofit;
- disposal.

2 - Major outputs from the life-cycle activities are contractual documents, regulatory compliance information, data retained beyond the life time of the plant, useful products generated by the operation of the plant, and residual materials remaining in the environment upon completion of the plant life cycle. These residual materials include waste products generated while producing the product(s) and the disassembled plant.

F.1.1.87 personnel*: the individuals responsible for performing the life-cycle activities of the process plant.

EXAMPLE 92 - These individuals include discipline experts, skilled workers, and labourers.

F.1.1.88 piping and instrumentation diagram (P&ID): a schematic diagram that shows engineering details of the equipment, instruments, pipes, valves, and their connectivity and sequence.

F.1.1.89 piping and instrumentation diagram (AFD): the process definition is firm. Instrumentation needs to be added.

F.1.1.90 piping and instrumentation diagram (design): instrumentation details are included. All lines and valves have been sized. All valving, vents and drains are included. Instrumentation and loops are indicated, but final instrumentation may not have been selected.

F.1.1.91 piping and instrumentation diagram (final): the complete P&ID has been approved for release by engineering for construction and has been stamped by a registered professional engineer. It is a last version of the design P&ID. It contains all changes that were incorporated during the physical design of the systems. It reflects the plant as it was, or will be, constructed.

F.1.1.92 piping and instrumentation diagram (preliminary): conveys the flow of the fluids from equipment to equipment in the system. It shows the valves that are used to control the flow. The major fluid containing lines have been sized.

F.1.1.93 plan and analyze project finances* (AAM A14): the activity of anticipating and estimating the financial resource requirements for a project. This activity establishes the expected financial performance for the project and the project financial plan.

F.1.1.94 plant: a portion of an installation (or the entire installation) required to operate to produce products.

EXAMPLE 93 - Products produced include chemicals, pharmaceuticals, electrical power, petroleum, and similar products.

F.1.1.95 plant design documentation: all documents related to the process of designing the process plant.

NOTE - Plant design documents include the approved design methodologies, basic data describing physical properties and their correlations used in the design, kinetic data and kinetic models used in the design, corrosion data and methodology used in selecting materials of construction, supplier performance data, capital and operating cost estimates, and appropriations requests.

F.1.1.96 plant items: an item or piece of equipment that may be used as a component of the plant.

F.1.1.97 plant life-cycle documentation: the collection of all project management, design, contractual, regulatory, and disposal documents produced during the life cycle of a process plant.

NOTE - This includes all data retained past the end of the plant life cycle.

F.1.1.98 plant operation and maintenance documentation*: the collection of documents relating to the operation and maintenance of process plant.

NOTE - These documents include operating records and plant data, safety and accident reports, maintenance reports, disposal records for all residual materials generated during the operation of the plant, and economic information related to product sales.

F.1.1.99 plant performance requirements: a quantitative description of the quantity and quality of a product to be produced by the plant in a yearly time period.

NOTE - Performance requirements are usually stated as units of product per unit time. Additional qualifications are made regarding the quality of the Plant, such as time between major shutdowns for continuous processes, percent uptime required, and expected yield.

F.1.1.100 plant records*: the documentation of information related to plant disposal, restoration, turnover, and regulatory approvals.

F.1.1.101 pre-commission plant* (AAM A45): resolve any differences between the detailed design and the as-built plant, perform all testing required by regulatory agencies and the client, resolve any problems that were discovered during testing, and obtain regulatory permission to start-up the plant for functional testing.

F.1.1.102 pre-commissioned plant*: a plant that is completed and ready for check out. Mechanical systems are complete, transfer of ownership and operation remain.

F.1.1.103 prepare bid packages and solicit bids* (AAM A32): the process whereby the technical and commercial requirements for a plant item are compiled and sent out for pricing by multiple suppliers.

F.1.1.104 process control logic*: prose or diagrammatic explanation of mechanisms or systems that monitor and control a process.

F.1.1.105 process control logic (preliminary)*: initial prose or diagrammatic explanation of mechanisms or systems that monitor and control a process developed during conceptual process design.

F.1.1.106 process flow diagram (PFD): a schematic document describing the equipment units and their interconnections, major process control functions, and major stream characteristics including physical and transport properties, material flows, and energy flows.

F.1.1.107 procure goods and services* (AAM A3): the process whereby needed plant items, equipment, or services are purchased or acquired.

F.1.1.108 procured item*: plant item that has been obtained from a supplier for incorporation into the plant.

NOTE - States or status of procured items include:

- In_fabrication;
- Accepted;
- Shipped;
- Delivered_to_site.

F.1.1.109 produce as-built surveys* (AAM A44): the completed plant is given a physical inspection to determine whether the plant conforms to the detailed design. The detail design drawings and other documents are updated to reflect the changes to the plant discovered during the inspection.

F.1.1.110 produce conceptual plant design (AAM A22): the activity of extending the conceptual process design into a preliminary plant spatial configuration.

F.1.1.111 produce conceptual process design* (AAM A21): the activity of defining the basic parameters of a plant flow scheme.

F.1.1.112 produce conceptual safety engineering designs (AAM A225): create designs that specifically address how the major hazards associated with the new plant are to be dealt with to ensure the safety of all personnel working in the plant as well as the general site and surrounding neighborhood population.

NOTE - These hazards will have been identified during the preliminary screening reviews to identify chemical, fire and health hazards associated with the specific chemical or mechanical characteristics of the process.

F.1.1.113 produce construction plans* (AAM A41): using site drawings, layout drawings, and other documents, determine the desired sequence for building the plant that will meet contract budget and schedule. Determine those services that will be needed from sub-contractors for the site preparation, erection, and testing of the plant. Develop detailed erection drawings and schedules for each section of the plant and for temporary structures.

F.1.1.114 produce final plant design (AAM A24): the activities required to generate a construction design specification from the process plant requirements.

NOTE - The activities include designing the mechanical, electrical, and civil engineering systems of the process, designing the detailed instrumentation systems, producing piping and instrumentation diagrams and detailed equipment layout through isometric drawings or three-dimensional computer-aided design (CAD) models.

F.1.1.115 produce final process design* (AAM A23): integration of conceptual process and plant designs to fully define parameters of a plant flow scheme.

F.1.1.116 produce process flow diagrams* (AAM A216): production of a schematic showing basic process flow developed from the cumulative results of unit operations, equipment sizing, initial logic and safety requirements along with related chemical properties.

NOTE - If a design activity is related to a modification or addition to an existing plant, then the existing plant information is reflected in the developed process flow diagram.

F.1.1.117 project authorizations and controls*: management authorization, imperatives, directives, and procedures for initiating and executing project activities.

F.1.1.118 project control and approval documentation: a set of documents that define the standard procedures, standard software modules, or standard forms adopted to ensure that all activities in the project comply with organizational constraints. The documents indicate how all activities are to be implemented and approved and identify all constraints that must be met.

NOTE - The constraints include financial limitations, accounting, legal and regulatory restrictions, socio-economic factors, and business practices throughout the plant life cycle.

F.1.1.119 project financial plan*: document that states how much the plant will cost to construct, how it is to be paid for, and when payments are to be made. It is a general financing and cash flow document.

F.1.1.120 project-specific documents: procedures, standards, guidelines, specifications, and codes created specifically for the plant project. These documents may call out, add to, modify, or tailor a standard. Portions of these documents are derived from the design basis.

NOTE - Project-specific documents evolve through stages like P&IDs and other design documentation.

F.1.1.121 provide resources* (AAM A12): acquire and deploy personnel, tools, and funding to perform the project activities.

F.1.1.122 purchase agreement*: contract between two parties to provide a service or item for a designated payment.

F.1.1.123 qualified construction firms*: list of construction firms that are capable and acceptable to construct the plant.

F.1.1.124 receive, inspect, and disposition components* (AAM A34): the process of receiving equipment and materials from various suppliers at the process plant, inspecting the equipment and material for compliance to the purchase specification, and either placing the equipment or material in stock, delivering it to construction or maintenance, or returning it to the supplier.

F.1.1.125 regulatory agreements*: mutual agreement between the owner or operators and regulatory agencies.

F.1.1.126 regulatory authorizations*: approval from regulatory agencies to initiate activities.

F.1.1.127 regulatory requirements: federal, state, or local laws, codes, or standards that impact various activities related to the process plant.

NOTE - Regulatory requirements may apply to, but are not limited to, permitting, engineering, construction, operations and decommissioning.

F.1.1.128 request for management approval: a document submitted to management requesting either approval to continue a particular activity of the project or requesting the procedure to use to solve a particular problem.

NOTE - Approval requests may, at times, include a request that the company appropriate monies for a particular activity.

F.1.1.129 residual materials*: all chemicals and equipment, excluding useful products, remaining in the environment at the end of the plant life cycle.

F.1.1.130 resources*: the technology, people, and tools used to carry out the plant life-cycle activities.

F.1.1.131 resources (existing)*: currently available technology, people, and tools used to carry out the plant life-cycle activities.

F.1.1.132 safety and hazardous operations analysis*: the results of the evaluation of the plant design with respect to safety and hazardous operations. Identifies possible causes of faults and their consequences, and recommends remedies.

F.1.1.133 safety and hazardous operations analysis (preliminary)*: the initial results of the evaluation of the plant design with respect to safety and hazardous operations.

F.1.1.134 safety compliance reports*: documentation of analyses and evaluations of the plant performed with respect to safety considerations.

F.1.1.135 safety system specification: job specific document related to plant safety.

NOTE - This specification may be developed from applying the design safety philosophy to plant design.

F.1.1.136 satisfy safety requirements* (AAM A235): perform a formal plant process design, operation, and control review to assess the whether all safety requirements are met.

NOTE - Plant safety requirements involve issues such as source terms for spill scenarios, vapour dispersion for combustible and toxic releases, reliability of metallurgy and other materials, component failure rates, operator response and error, fail-safe instrumentation, equipment spacing, number and size of equipment trains, radiation from fires, relief system design philosophies, deflagration test results, thermal runaways and associated vent sizing, detonations and resulting shock waves.

F.1.1.137 schedules*: a time-based list of project tasks that describes:

- What is supposed to happen;
- When it is supposed to happen;
- Task sequence and dependencies;
- Restraints and constraints;
- Float;
- Critical path.

F.1.1.138 schematic diagrams*: a physically non-dimensional, 2D graphical representation of the functional design of a system that does not (necessarily) encompass physical information.

EXAMPLE 94 - Types of schematic diagrams include:

- PFD;
- P&ID;
- Electrical single line;
- Motor control;
- Control loops;
- HVAC;
- Plumbing;
- Input output.

NOTE - Schematic diagrams evolve through stages like P&IDs and other design documentation.

F.1.1.139 schematic diagrams (preliminary)*: an initial physically non-dimensional, 2D graphical representation of the functional design of a system that does not (necessarily) encompass physical information developed during conceptual plant design.

F.1.1.140 site information (existing): information about the physical location where the plant will be constructed and the conditions of any plant on the site (if one exists).

EXAMPLES

95 - Site information includes:

- Geological data, such as before and after terrain contours, and subterranean structure, and seismic activity;

- Meteorological data such as seasonal wind profile, precipitation, snowfall, and ambient temperature;

- Road data;

- Cadastre (property lines) zones;

- Utilities.

96 - A kind of site information included in the scope of this part of ISO 10303 is verified field dimensions. They are parameters that specify the physical and spatial characteristics of an existing item or component in a plant that have been verified by measurements taken by a second, independent agency. For example, field dimensions provided by the Plant owner for piping tie-in locations (coordinate locations and sizes) are considered as "verified" when duplicated by the AEC representative. If discrepancies are discovered during verification of the field dimensions, the initial and verification measurement processes must be repeated to assure verified dimensions.

NOTE - Existing plant conditions are the characteristics of the existing plant(s) relevant to the revamp, retrofit, or expansion Plant project.

F.1.1.141 societal requirements*: the expressed need or demand by society, on either a local, national, or global scale, for products, services, or processes.

NOTE - In some instances, a market study may project the expected demand or price of a product or service required by some element of society.

F.1.1.142 specifications and standards: consensus or mandated technical descriptions of plant hardware or systems that control the design or construction of a plant.

F.1.1.143 specify building and plant services (AAM A243): establish utility and other service needs for the building(s) and plant(s) based on owner requirements, final system design, and final spatial design.

F.1.1.144 specify control requirements* (AAM A234): define instrumentation and control system characteristics required to fulfill requirements for plant operation using the operating procedures and safety requirements.

NOTE - Control systems are used to help maintain plant safety, ensure product quality, and to safeguard equipment. These systems are used to control areas such as process reactions, flows, temperatures, pressures, and levels. They operate automatically, or provide indications to plant personnel. Control requirements are generally defined in the operating procedures and specified on the P&ID and in the instrument list.

F.1.1.145 specify equipment functional characteristics* (AAM A233): define the functional characteristics of each major item of equipment based on confirmed plant operating requirements, process technologies, and process optimization.

EXAMPLE 97 - Functional characteristics include equipment type, process stream inputs, outputs, capacities, and conditions, equipment metallurgy, piping and instrumentation, power requirements, and auxiliary systems.

F.1.1.146 specify piping and instrumentation* (AAM A232): define piping and instrumentation required by the process plant based on the functional requirements for the plant.

NOTE - Piping and instrumentation functional requirements are developed based on plant production capacities, process type or technology, control methodology, chemical content of process streams, and equipment layout. Also considered are alternative operating conditions, maintenance requirements, and plant operating and personal safety are issues. The results of this activity are detailed on P&IDs, line lists, equipment lists, and instrument lists.

F.1.1.147 starting materials*: all necessary equipment components or consumable goods necessary to construct and operate the process plant for the production of useful products.

F.1.1.148 status: a report of the current state of a task, design, action, or schedule. It is a quality assurance feedback mechanism.

F.1.1.149 stream data: chemical composition, physical state, and mass quantities of process flows.

F.1.1.150 supplier documentation: drawings, manuals, calculations, etc. received from a company concerning items procured from the company, that provides information concerning design details or performance of the procured items.

NOTE - Statuses assigned to supplier documentation include:

- Preliminary (in-process design information);

- Certified (information from the supplier is warranted to correctly describe the as-delivered functional or physical data);

- Released for fabrication or construction.

F.1.1.151 suppliers list*: a list of companies that provide commodities or services to an organization.

NOTE - Kinds or statuses of supplier lists include:

- Approved;

- Recommended;

- Partnered.

F.1.1.152 system design (preliminary): at the conceptual level, this is an initial definition and representation of the physical components or items of the system.

F.1.1.153 system layout (preliminary): at the conceptual level, this is an initial definition and representation of the spatial configuration or arrangement of the system, showing all the major components of the system.

F.1.1.154 system layout and design: the definition and representation of the physical components or items and spatial configuration of the system in sufficient detail to support construction.

NOTES

1 - This definition results from the use of the system design basis, P&IDs, specifications, and other documentation or information.

2 - The definition of the term "system" is broader than common usage, e.g., it encompasses structural systems.

3 - System layout and designs can be viewed or categorized according to the following breakdowns:

- Evolutionary Phase

  a) Initial;

  b) Design;

  c) Final.

- System Type

  a) Piping;

  b) HVAC;

  c) Electrical;

  d) Instrumentation and Control;

  e) Structural and Civil;

  f) Architecture;

  g) Safety.

- Functional Views

  a) Conceptual arrangement;

  b) Spatial information;

  c) Schematic diagram;

  d) Piping and instrumentation diagram (includes piping connectivity and sequencing).

EXAMPLE 98 - The final HVAC spatial information system design and layout will specify the definition, physical dimensions, location coordinates, and characteristics for all HVAC components that

occupy space in the Plant. Only those physical dimensions, location coordinates, and characteristics required to specify the spatial instance of each component are included in this definition.

F.1.1.155 system layout and design (preliminary): the initial definition and representation of the physical components or items and spatial configuration of the system.

F.1.1.156 time and cost estimate*: projected or forecasted cost and length of time to design, produce, or procure a plant item, obtain a service, or achieve some goal.

F.1.1.157 unit operations*: design basis and owner requirements that define the basis for conceptual process design.

F.1.1.158 useful products*: the materials or energy generated through the operation of the process plant that are sold to customers for a profit.

F.1.2 Application activity model diagrams

The application activity model diagrams are given in figures F.9 through F.20. The graphical form of the application activity model is presented in the IDEF0 activity modelling format. Activities and data flows that are out of scope are marked with asterisks.

Figure F.1 describes the basic notation used in IDEF0 modelling. Each activity may be decomposed to provide more detail. If an activity has been decomposed, a separate diagram is included.

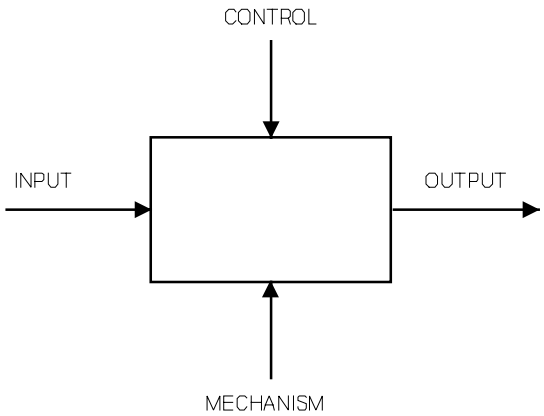
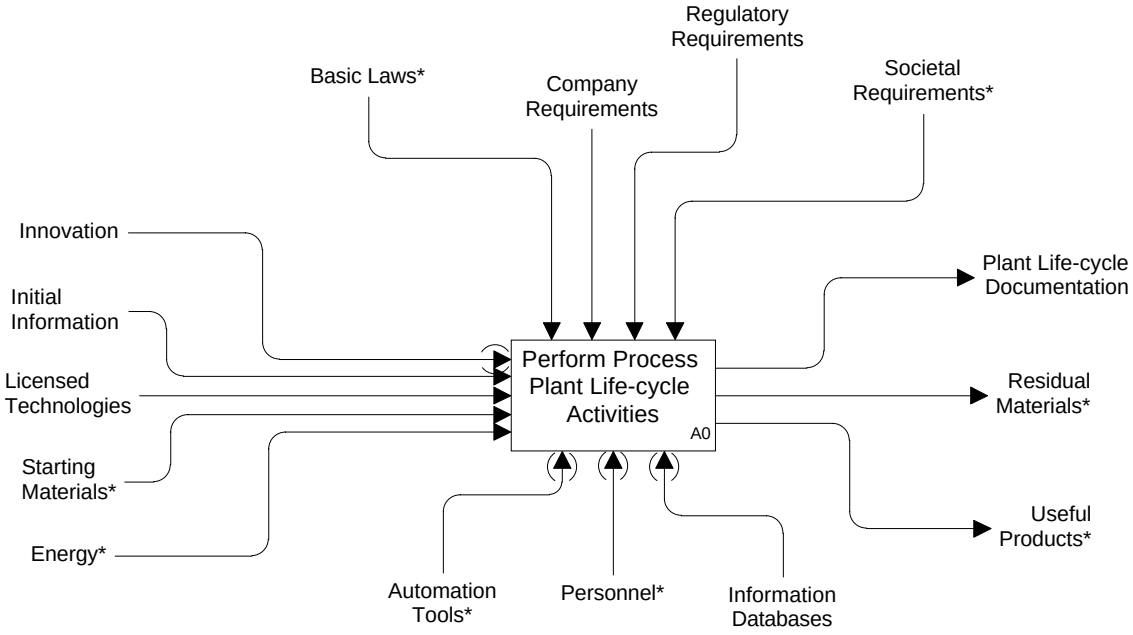


Figure F.1 - IDEF0 basic notation

As with any IDEF0 model, the AAM is dependent on a particular viewpoint and purpose. The purpose of the AAM is to describe the exchange of process plant spatial configuration information and design, fabrication, and maintenance information for process plant piping systems.



PURPOSE: To describe the exchange of process plant spatial configuration information and design, fabrication,and maintenance information for process plant piping systems.

VIEWPOINT: The user(s) of plant spatial configuration information, including architect, engineer, and builder.

Figure F.2 - A-0: Process Plants

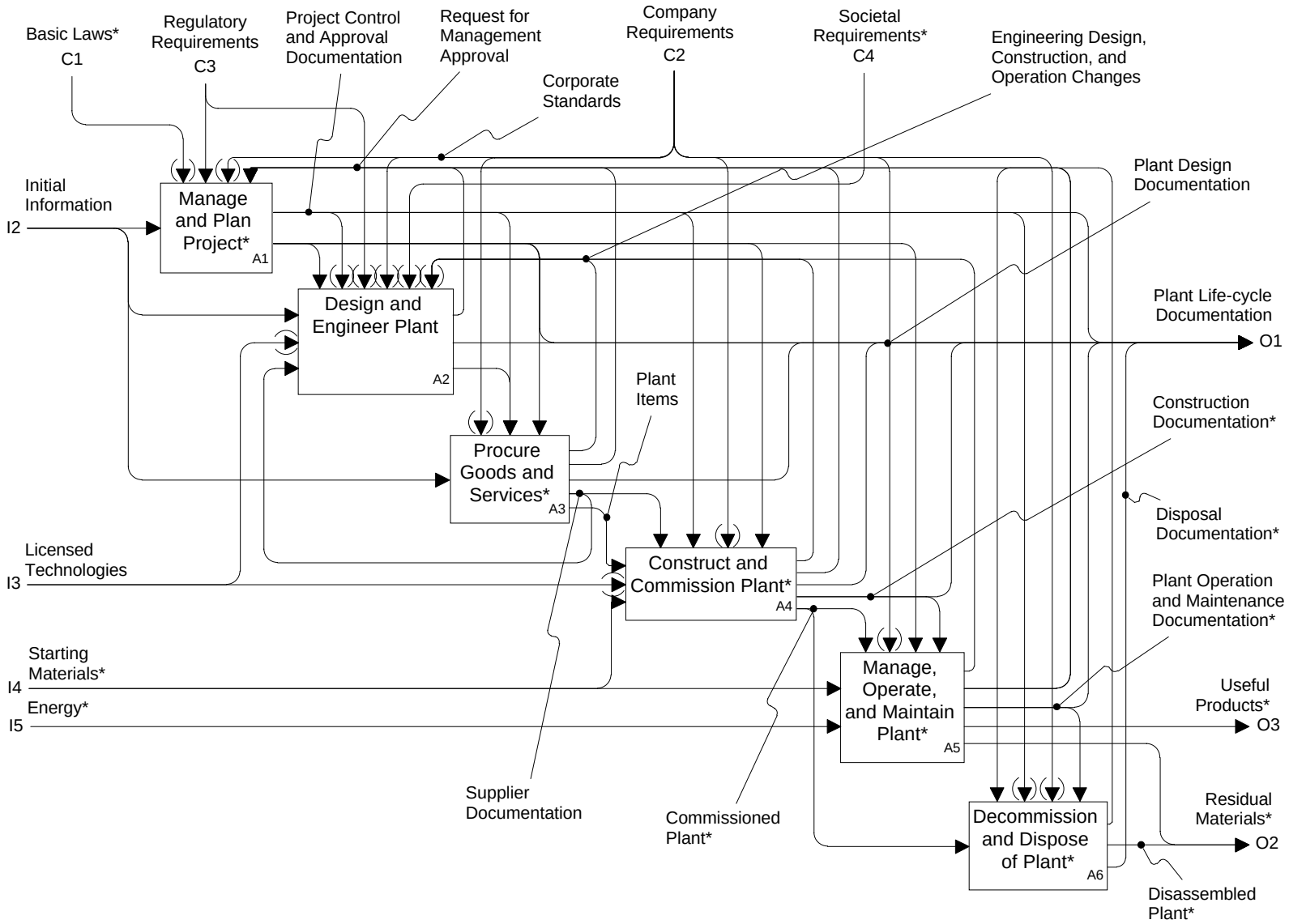


Figure F.3 - A0: Perform Process Plant Life-cycle Activities

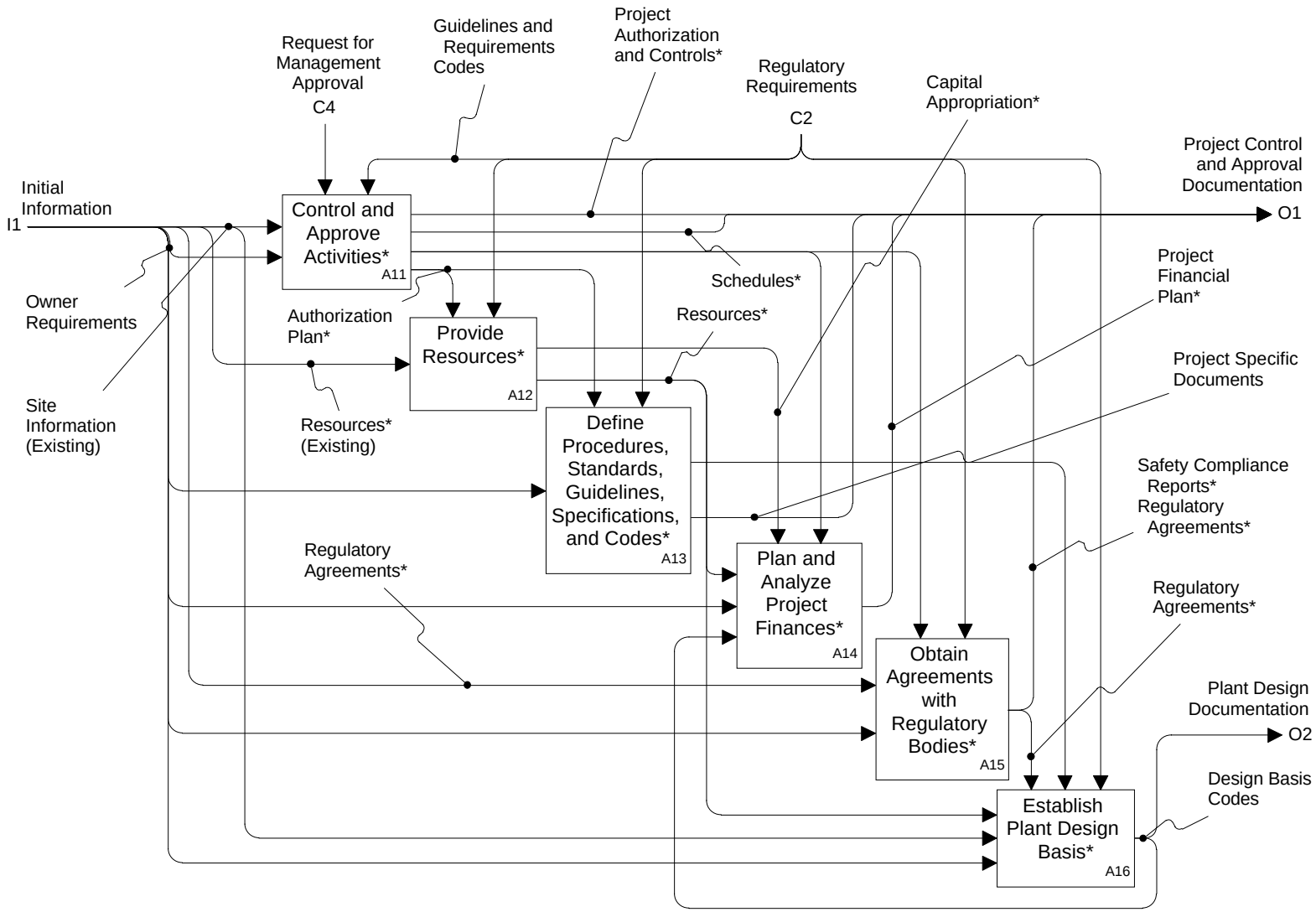


Figure F.4 - A1: Manage and Plan Project

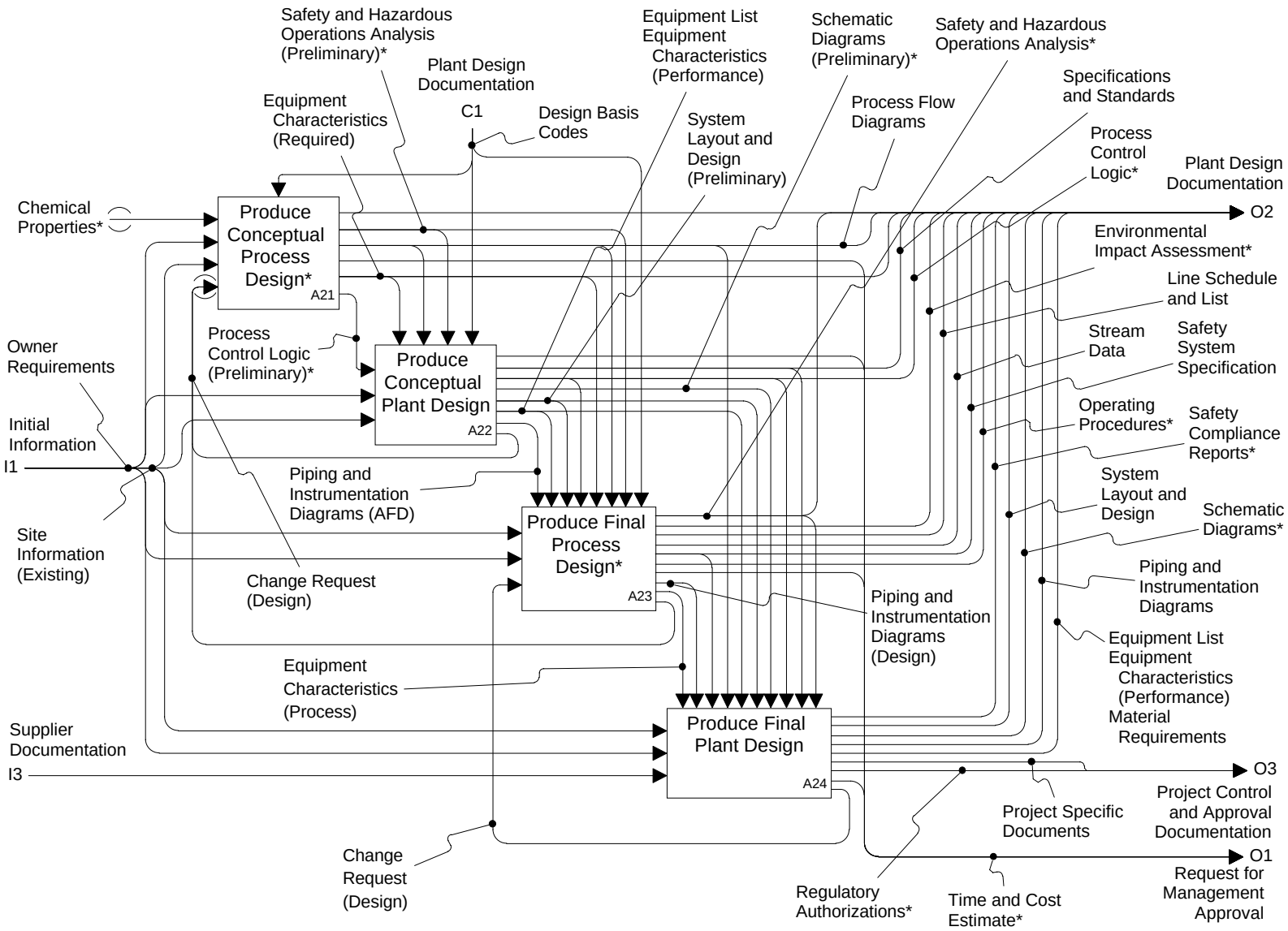


Figure F.5 - A2: Design and Engineer Plant

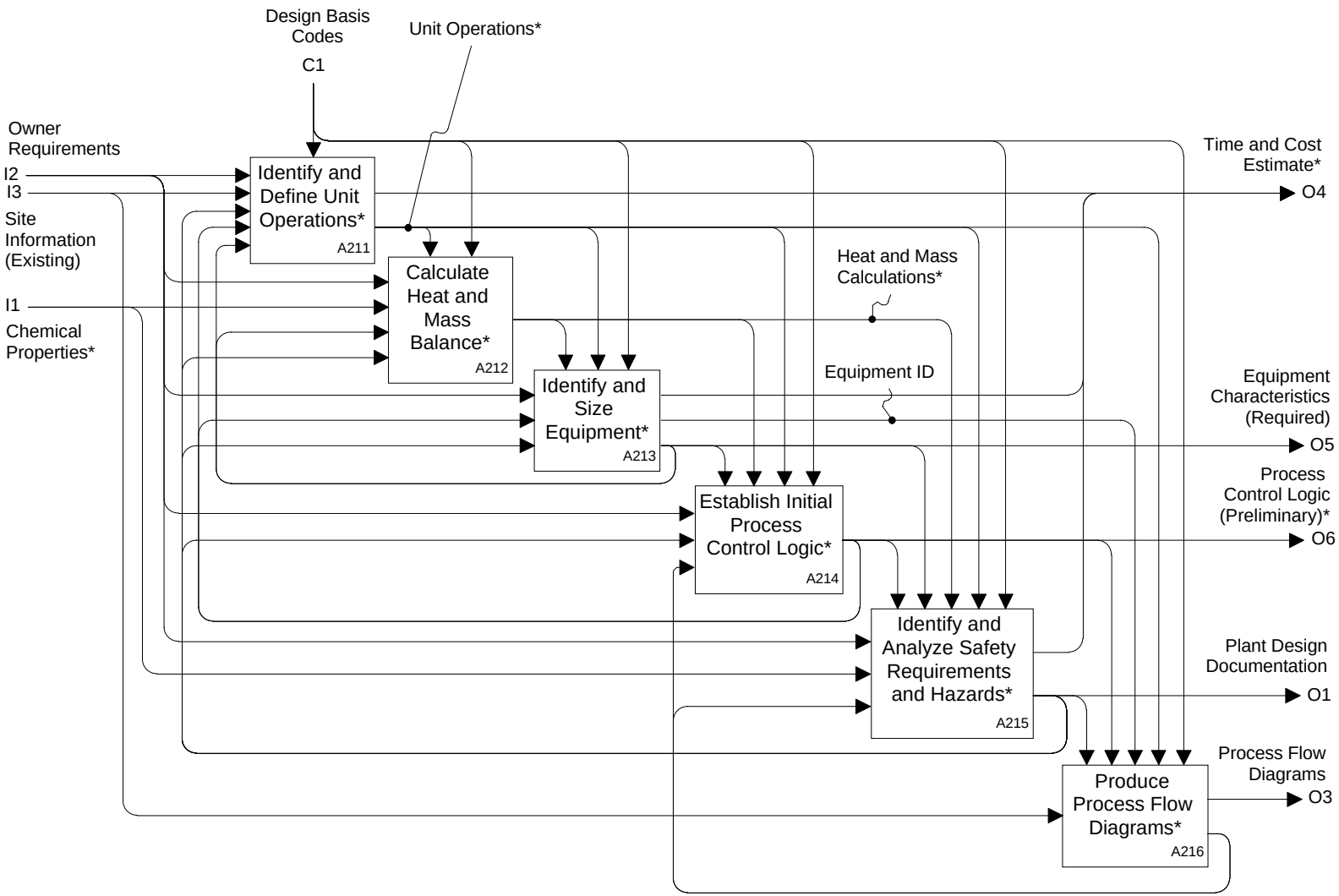


Figure F.6 - A21: Produce Conceptual Process Design

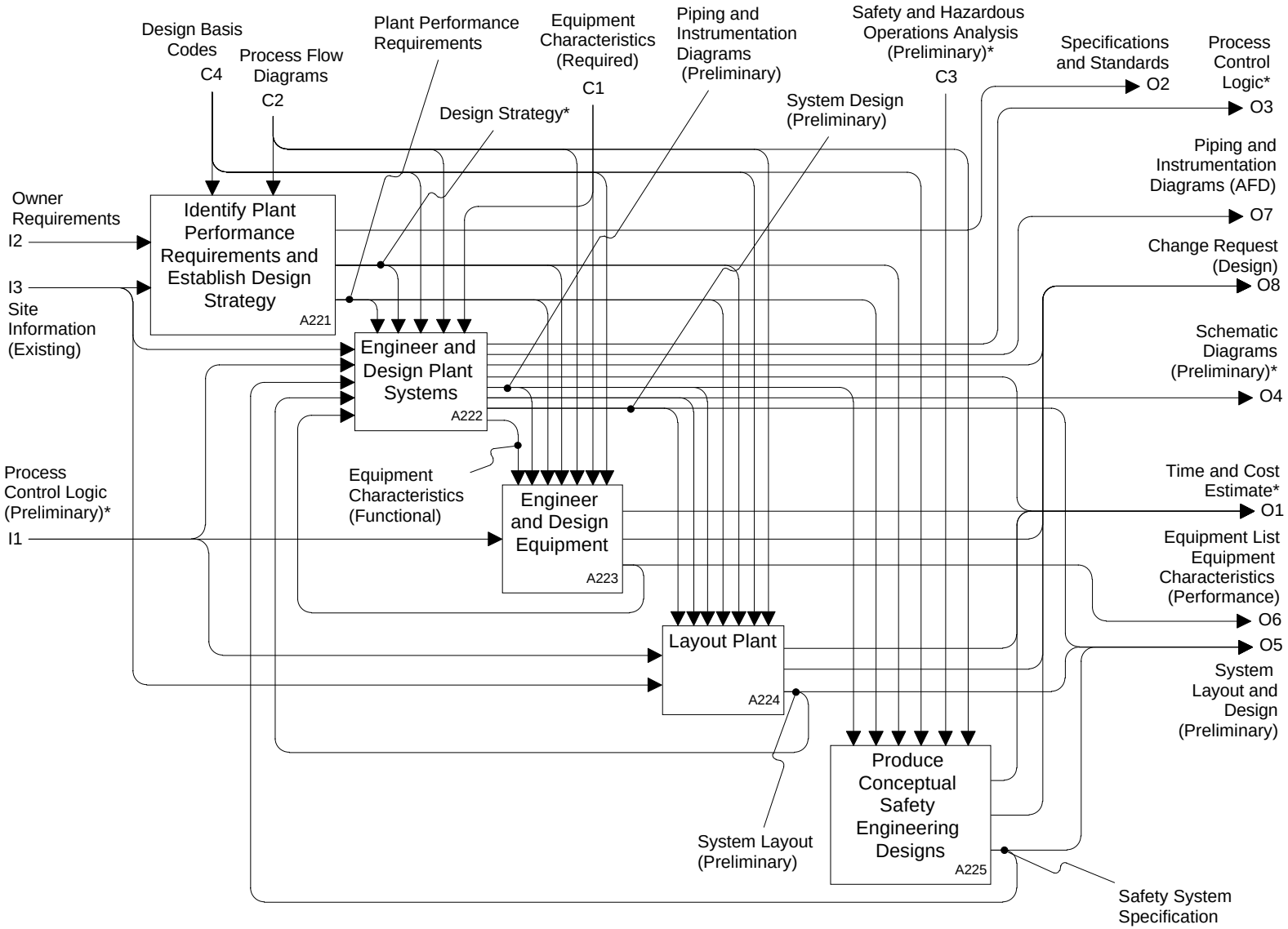


Figure F.7 - A22: Produce Conceptual Plant Design

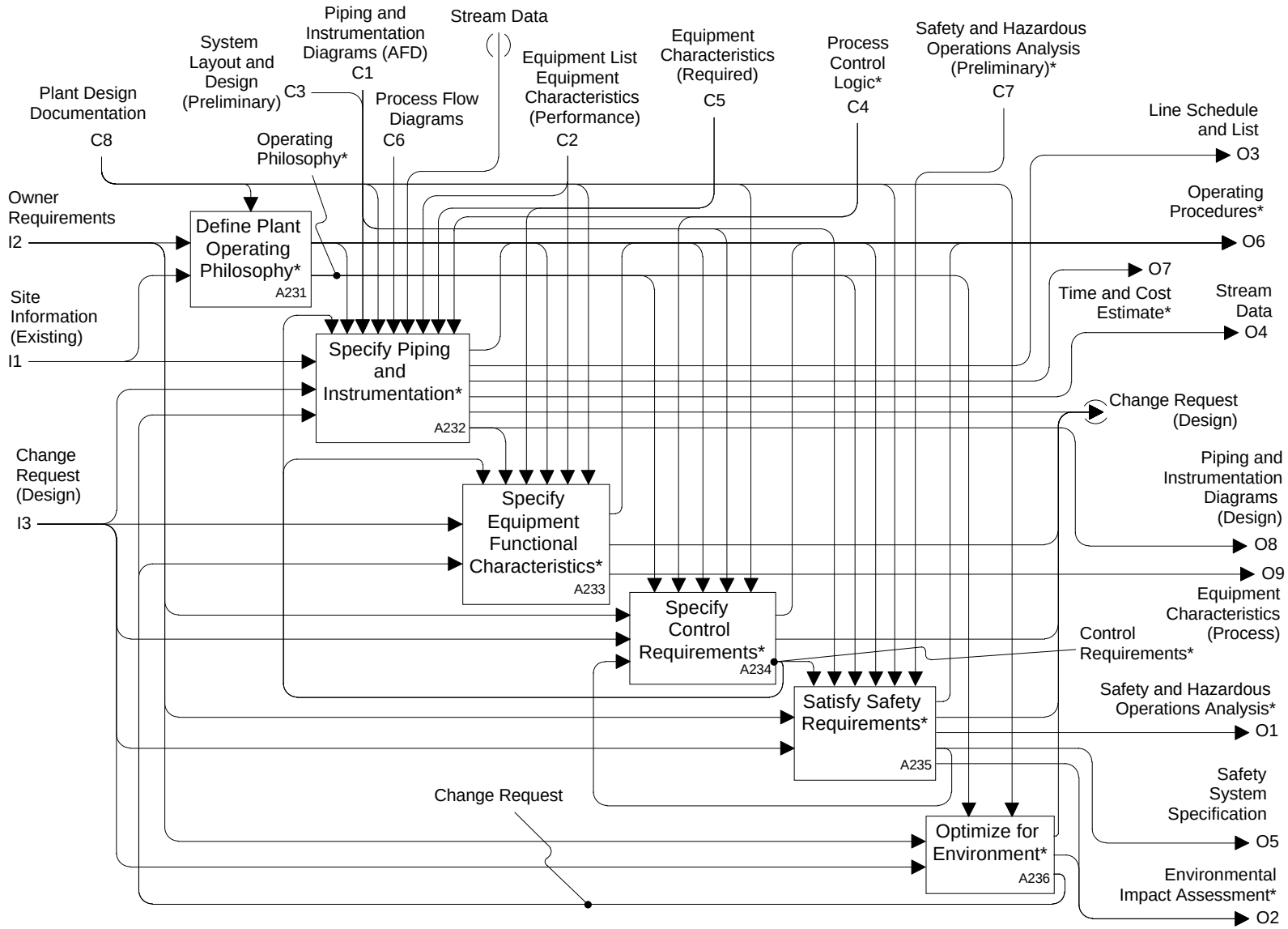


Figure F.8 - A23: Produce Final Process Design

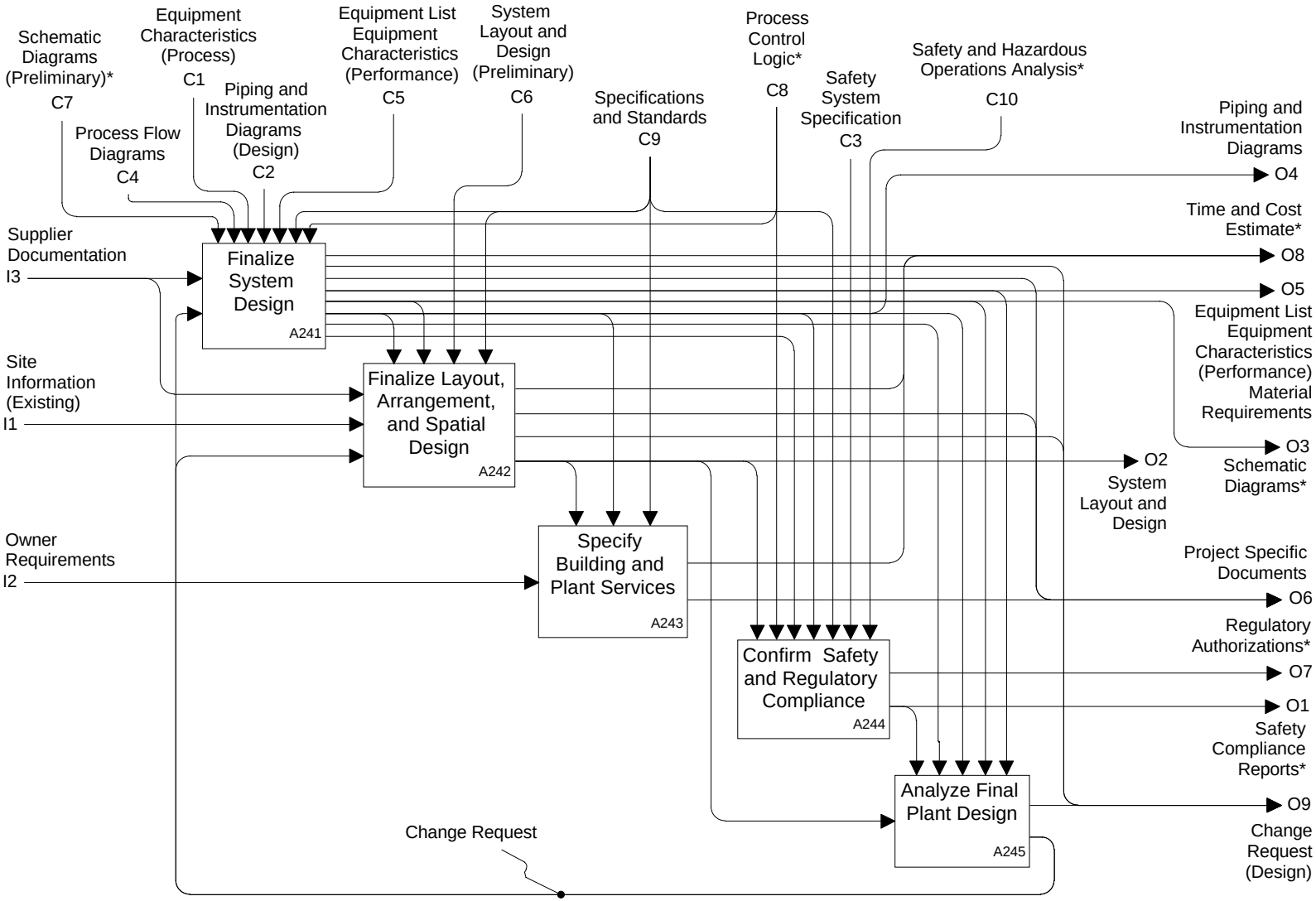


Figure F.9 - A24: Produce Final Plant Design

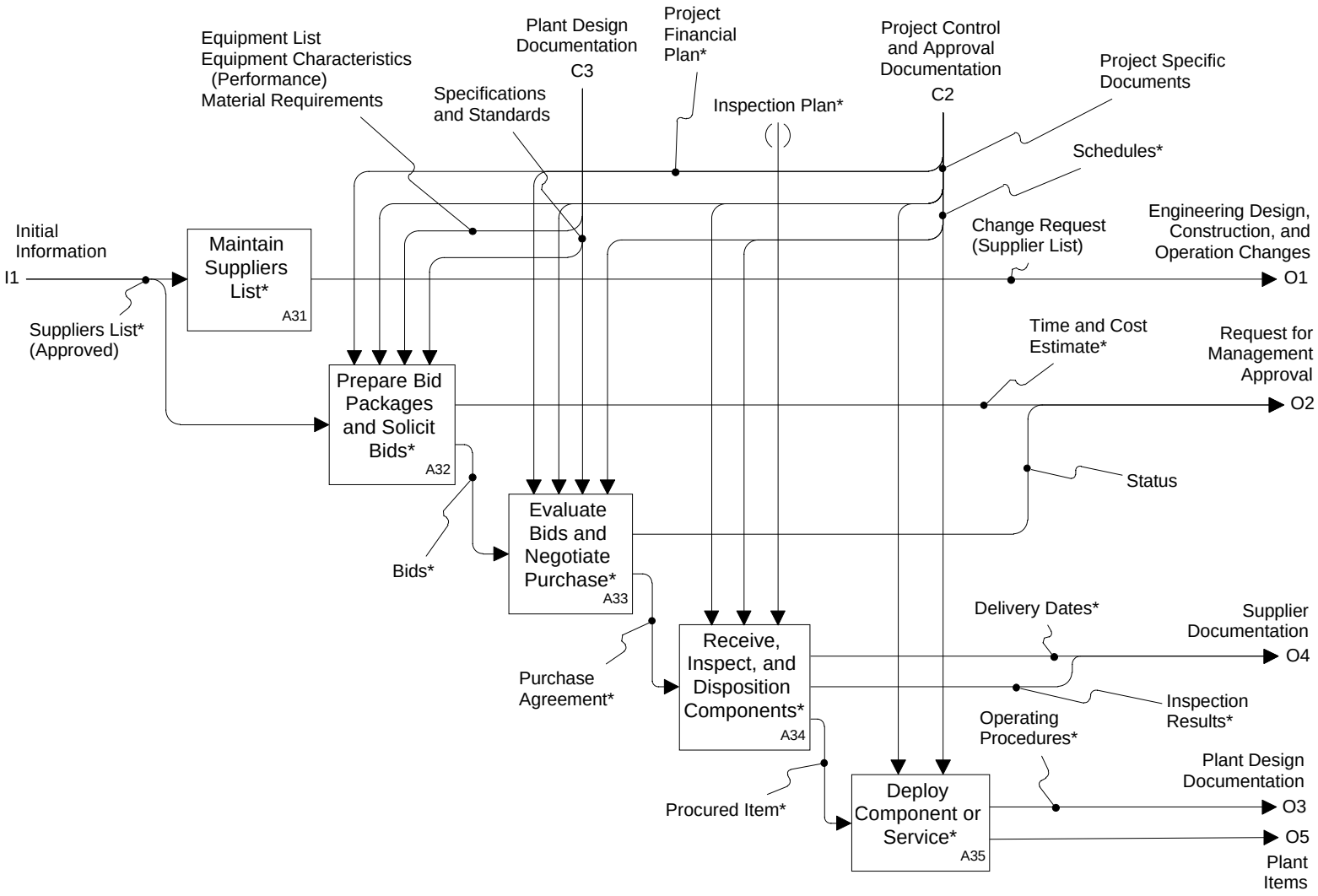


Figure F.10 - A3: Procure Goods and Services

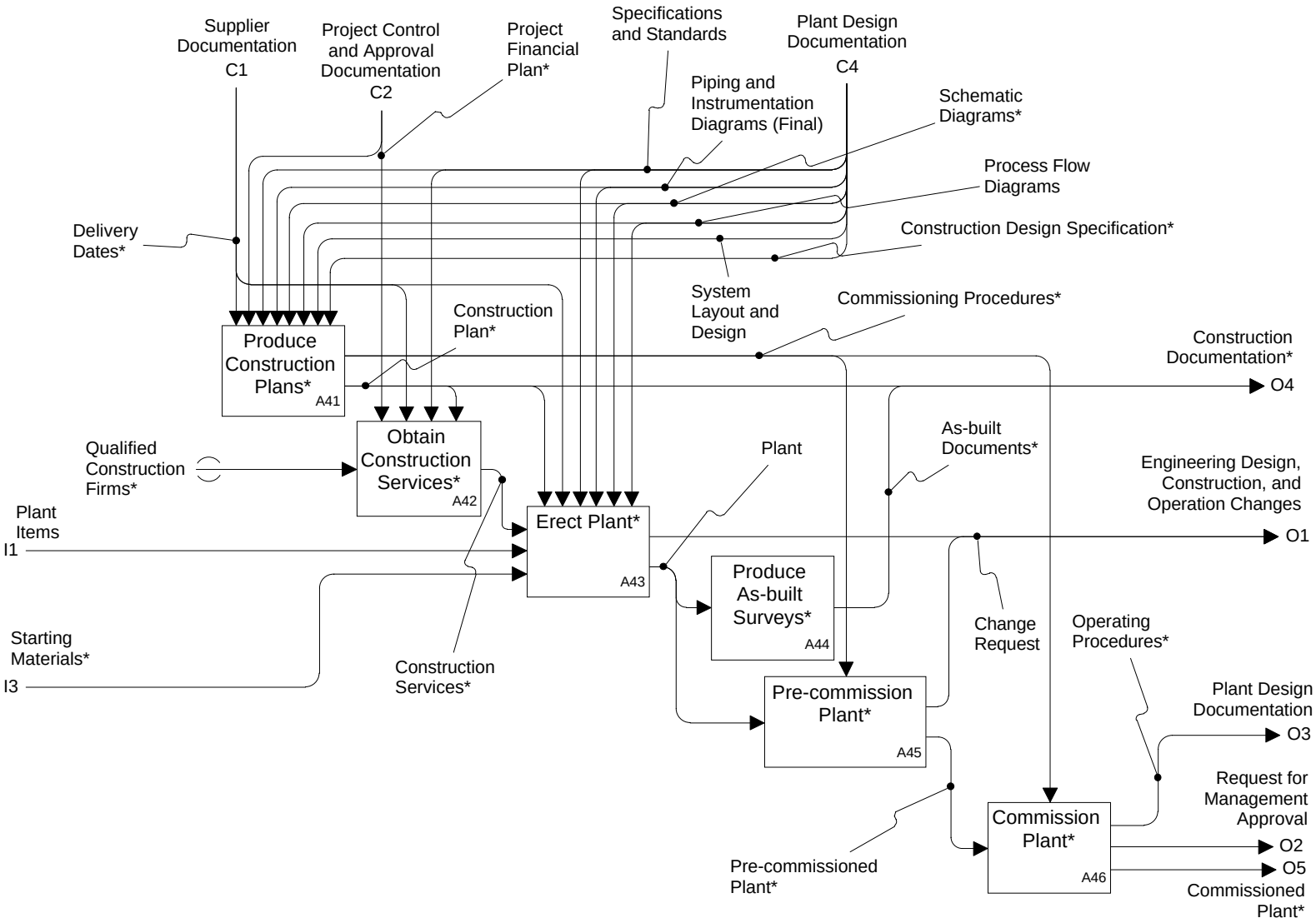


Figure F.11 - A4: Construct and Commission Plant

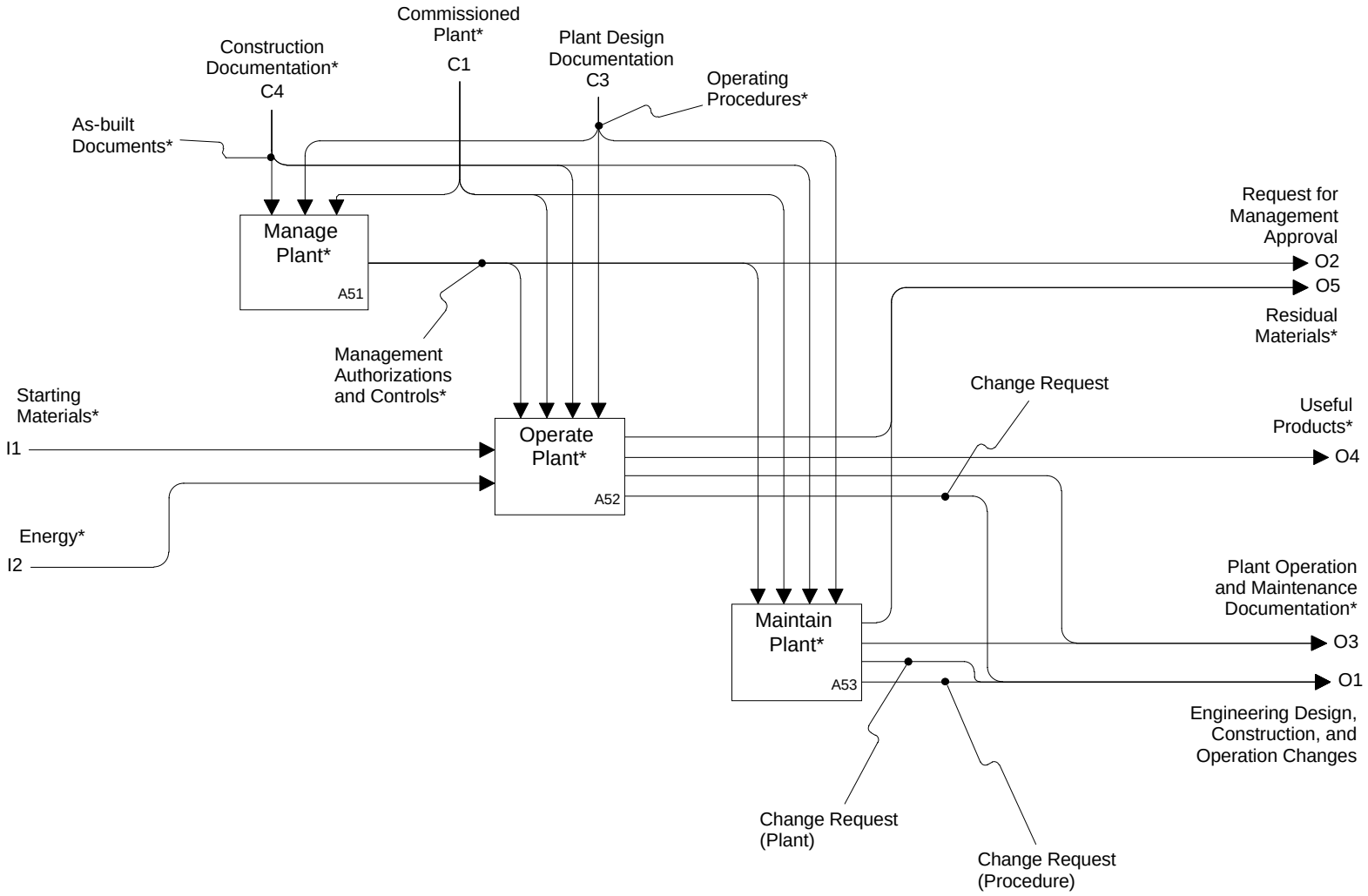


Figure F.12 - A5: Manage, Operate, and Maintain Plant

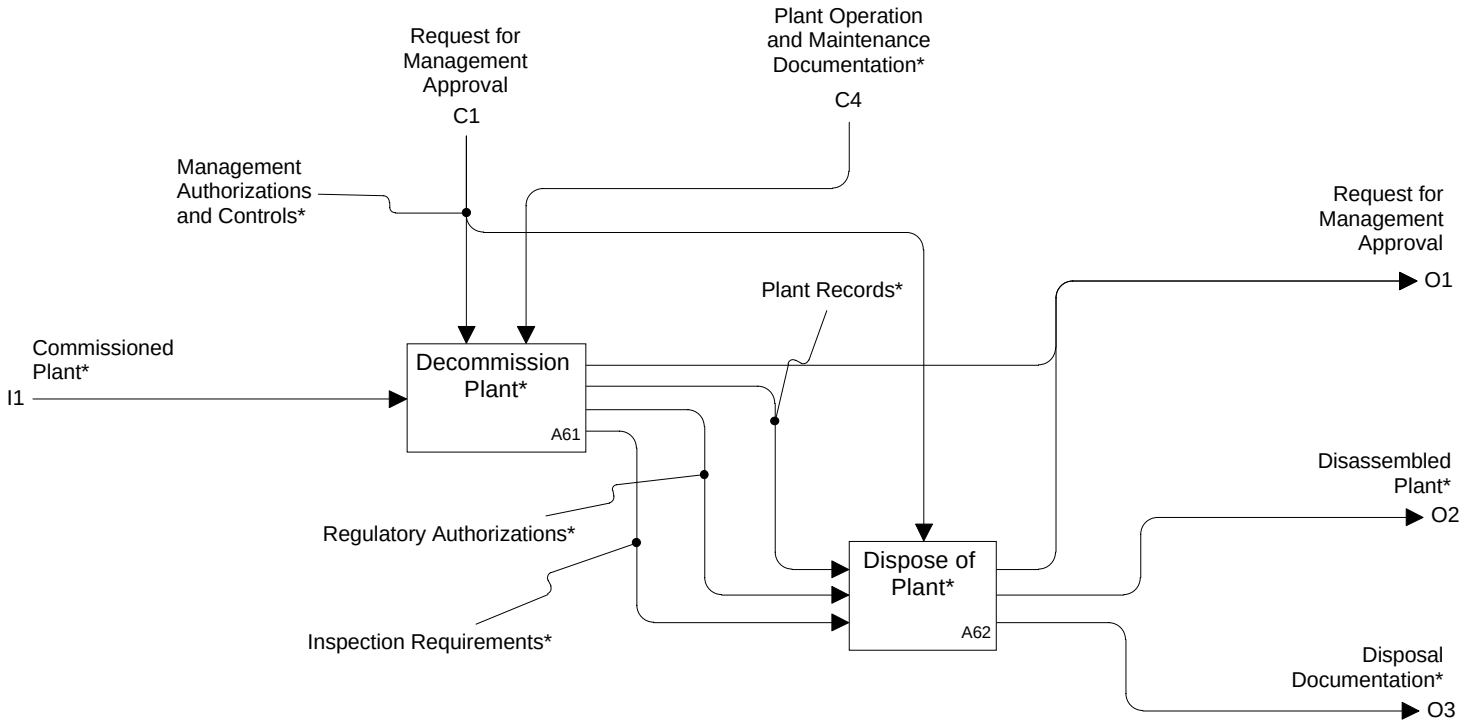


Figure F.13 - A6: Decommission and Dispose of Plant

F.1.3 AAM/ARM Correspondence

An analysis of the correspondence between the in-scope data flows of the AAM and the ARM has been completed. This analysis mapped the in-scope inputs, controls, outputs, or mechanisms (ICOMs) identified in this annex to the ARM UoFs and entities identified in 4.1 and 4.2, respectively. The AAM ICOMs and their corresponding ARM UoFs and entities are shown in Table F.1. The results of this analysis indicated that all of the in-scope ICOMs were covered by one or more ARM entities.

Table F.1 - AAM ICOM to ARM UoF/entity mapping

AAM ICOM	ARM UoF	ARM Entity
Change Request Change Request (Design) Change Request (Plant) Change Request (Procedure) Change Request (Supplier List)	Change_information	All entities in the UoF
Equipment Characteristics (Functional) Equipment Characteristics (Performance) Equipment Characteristics (Process) Equipment Characteristics (Required) Equipment List Equipment ID	Equipment_characterization	All entities in the UoF
	Piping_component_characterization	All entities in the UoF
Codes Corporate Standards Design Basis Guidelines and Requirements Owner Requirements Project-specific Documents Regulatory Requirements Safety System Specification Specifications and Standards	Connector	Piping_connector Piping_connector_service_-characteristic
	Equipment_characterization	Equipment
	Piping_component_characterization	Piping_size_description Pressure_class Schedule
	Piping_system_functional_-characterization	Piping_specification Piping_system Piping_system_line Stream_design_case
	Plant_characterization	Piping_system

Table F.1 - AAM ICOM to ARM UoF/entity mapping (concluded)

AAM ICOM	ARM UoF	ARM Entity
(continued)	Plant_item_characterization	Construction_material Design_project Functional_design_view Material_specification_selection Physical_design_view Piping_system_component Required_material_description Specification_item_family Structural_component
Line Schedule and List	Piping_system_functional_-characterization	Line_piping_system_component_assignment Piping_system_line
Material Requirements	Plant_item_characterization	Material_specification_selection Material_specification_subset_-reference
Plant	Plant_characterization	Plant
Plant Items	Plant_item_characterization	Plant_item
Plant Performance Requirements	Plant_characterization	Functional_plant Plant Plant_process_capability
Site Information (Existing)	Site_characterization	Site
Status	Change_information Shape	Change Plant_item_interference_status
Stream Data	Piping_system_functional_-characterization	Stream_design_case Stream_phase
System Design (Preliminary) System Layout System Layout and Design System Layout and Design (Preliminary)	Piping_system_functional_-characterization	All entities in the UoF
	Plant_characterization	All entities in the UoF
	Plant_item_characterization	All entities in the UoF
	Site_characterization	All entities in the UoF
Supplier Data	Equipment_characterization Plant_item_characterization	Equipment Catalogue_definition Catalogue_item

The analysis also indicated that the scope of the AP described by the ARM is more refined than that of the AAM in that not all of the entities defined in the ARM map back to an AAM ICOM. A listing of the ARM entities is provided in table 4 of the *Application Protocol 227 Validation Report Version 1.1* [11]. This listing shows whether an ARM entity is related to an AAM ICOM, and if not, what UoF it is part of. The results of this review show that the all the ARM entities that are not mapped

from an AAM ICOM are related to the connections between items (connection and connector UoFs), item representation (shape_representation and wireframe_geometry UoFs), or item shape (shape UoF).

F.2 PIEBASE activity model

Working Group 2 (WG2) of PIEBASE[3)] (Process Industry Executive for achieving Business Advantage using Standards for data Exchange) is developing a generic activity model[4)] describing the process industry's activities. PIEBASE is developing this generic model to aid in the understanding and coordination of current and planned projects to deliver data exchange solutions for the process and process plant industries.

This clause describes only a portion of the generic PIEBASE activity model. This portion of the generic model shows the relationship of those activities and related data flows that directly impact this part of ISO 10303; in a larger context to other process and process plant industry activities. Therefore, F.2 describes the context in which this part of ISO 10303 will satisfy specific requirements for the process plant industries. Because of the broader context of the PIEBASE model, F.2 does not attempt to identify the in or out-of-scope activities or their related ICOMs that directly affect this part of ISO 10303. The in or out-of-scope activities and their related ICOMs are identified in F.1.

The viewpoint of the generic PIEBASE activity model is the owner of the process enterprise.

F.2.1 Activity model definitions and abbreviations

The following terms are used in the PIEBASE activity model. The definitions given in this annex do not supersede the definitions given in the main body of the text.

F.2.1.1 acquire input (A2): the activities associated with acquisition of the necessary products, energy, and data to support all life-cycle aspects of the core business.

F.2.1.2 acquired products and energy: materials, goods, and utilities required to support all life-cycle aspects of the core business.

F.2.1.3 acquisition contracts: commitments to obtain a product, energy, or data described in a legally binding document.

F.2.1.4 acquisition directives: a set of instructions that constrain the activities associated with obtaining, receiving, and paying for products, energy, and data.

F.2.1.5 acquisition resources: human resources, tools, and licensed technology used in the obtaining, receiving, and paying for products, energy, and data.

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3) PIEBASE is an organization of industry consortia actively working on the development and demonstration of standards for data exchange in the process industry. The founding consortia members are: PISTEP (UK), PlantCALS (Japan), PlantSTEP (USA), POSC (International/USA), POSC/CAESAR (Norway) and SPI-NL (The Netherlands). The mission of PIEBASE is to harmonise and coordinate consortia and standards development activities for the common benefit of the global process industry community.

4) The PIEBASE activity model is a work in progress. The PIEBASE WG2 is responsible for developing and improving the activity model. All three process plant AP projects, i.e., AP 221, AP 227, and AP 231, are participating in the PIEBASE WG2, and all three process plant APs will use the PIEBASE activity model for describing the context for the AP specific AAM.

F.2.1.6 acquisition tool provision directives: a set of instructions that constrain the activities associated with providing acquisition tools.

F.2.1.7 acquisition tool provision resources: human resources and tools used to provide acquisition tools.

F.2.1.8 acquisition tools: all devices or implements used to carry out activities associated with the obtaining, receiving, and paying for products, energy, and data.

EXAMPLE 99 - Devices and implements include computer hardware and software tools.

F.2.1.9 as-built information: site plans, detailed equipment descriptions, electrical instrumentation diagrams, and P&IDs that record the actual condition at a Plant at a specific point in time.

NOTE - These documents aid in meeting government documentation and safety requirements. Frequently, they are simply corrections or mods to existing design documents delivered to construction.

F.2.1.10 billings: printed or written statements of charges for goods supplied or services rendered.

F.2.1.11 commissioning life-cycle data: all information, documents, and drawings that are the result of process plant commissioning activities.

F.2.1.12 conduct core business (A0): the activities involved in the life cycle of a process plant from conception through final disposal.

NOTES

1 - These tasks include:

- conception;
- research;
- design;
- construction;
- operation;
- maintenance;
- retrofit;
- disposal.

2 - Major outputs from the life-cycle activities are contractual documents, regulatory compliance information, data retained beyond the life time of the plant, useful products generated by the operation of the plant, and residual materials remaining in the environment upon completion of the plant life cycle. These residual materials include waste products generated while producing the product(s) and the disassembled plant.

F.2.1.13 construct and pre-commission production plant (A5544): the process of building or modifying a physical plant, resolving any differences between the detailed design and the as-built plant, performing all testing required by regulatory agencies and the client, resolving any problems that were discovered during testing, and obtaining regulatory permission to start-up the plant for functional testing.

F.2.1.14 construction documents: all documentation related to the construction of the process plant including as-built reports, equipment certification, installed equipment nameplate information, operating manuals, testing procedures, field changes, and photographs of as-built units, modules, and plant.

F.2.1.15 construction life-cycle data: all information, documents, and drawings that are the result of process plant construction activities.

F.2.1.16 construction sold materials: material by-products or remains generated during process plant erection activities that are sold for reuse.

F.2.1.17 construction waste materials: unwanted or unusable material by-products or remains generated during process plant erection activities.

F.2.1.18 contracts: commitments to provide or aquire a product or service described in a legally binding document.

F.2.1.19 create product (A3): the activities associated with the creation of product(s) for the core business.

F.2.1.20 decision support information: information generated by research and development activities that is used in the decision making process to manage the core business.

F.2.1.21 design and engineer production plant (A5542): the activity of extending a concept into a detailed plant definition suitable to support component purchase and plant construction.

F.2.1.22 design and engineering life-cycle data: all information, documents, and drawings that are the result of the design and engineering activities of a process plant.

F.2.1.23 design and engineering resources: human resources and tools used to perform activities associated with the designing and engineering the production plant.

F.2.1.24 documentation: the collection of all project management, design, contractual, regulatory, and disposal documents produced during the life cycle of a process plant. This includes all documents retained past the end of the plant life cycle.

F.2.1.25 employment contracts: commitments to use the services of a person in return for payment described in a legally binding document.

F.2.1.26 environmentally acceptable waste: unwanted or unusable material by-products or remains generated during product creation and process plant erection activities that poses no health or safety hazard.

F.2.1.27 finance acquisition contracts: commitments to provide or acquire money described in a legally binding document.

F.2.1.28 financial resource provision directives: a set of instructions that constrain the activities associated with providing financial resources to the core business.

F.2.1.29 financial resource provision resources: human resources and tools used to provide financial resources.

F.2.1.30 hired persons: human resources that perform a task or function in return for an agreed payment.

F.2.1.31 human resource knowhow improvement material: information generated by research and development activities that is used to enhance personnel knowledge.

F.2.1.32 human resource performance data: information that details how well personnel execute or fulfill a task.

F.2.1.33 human resource provision directives: a set of instructions that constrain the activities associated with providing personnel to perform core business activities.

F.2.1.34 human resource provision resources: human resources and tools used to support the core business by providing human resources.

F.2.1.35 human resources: the individuals responsible for performing all activities performed by humans over the life cycle of the process plant.

F.2.1.36 human resources and tools performance data: information that details how well personnel and tools execute or fulfill a task.

F.2.1.37 human resources and tools requirements: a set of needs or wants defined during production resource provision support activities.

F.2.1.38 knowledge provision resources: human resources and tools used to provide knowledge necessary to conduct research and development activities.

F.2.1.39 labour market data: information regarding the availability, costs, etc., of human resources.

F.2.1.40 laid-off personnel: human resources that have been dismissed from their job.

F.2.1.41 legal, regulatory, and societal constraints: all controls imposed by federal, state, or local laws, regulatory agency rules, or society that influence the design, construction, operation, and disposal of a process plant.

F.2.1.42 licensed technology: patented or proprietary processes or design information purchased or licensed from an outside source, such as a process processor, supplier, or fabricator.

> EXAMPLE 100 - Such technology may range from laboratory synthesis data through unit operation process data to complete, detailed plant designs or equipment items and modules.

F.2.1.43 life-cycle data: the collection of all project management, design, contractual, regulatory, and disposal data produced during the life cycle of a process plant. This includes all data retained past the end of the plant life cycle.

F.2.1.44 loaned or earned money: funds acquired either by borrowing or in payment for goods or services rendered.

F.2.1.45 maintenance excess materials: extra usable materials left over from production plant maintenance activities.

F.2.1.46 maintenance instructions: a set of directions that prescribe actions to be taken to maintain the plant and its components in good repair.

F.2.1.47 manage core business (A1): provide sufficient resources to execute the business plan and check that the execution is done in accordance with the plan and any required regulations. This activity establishes a detailed technical plan and a financial plan that are consistent with the engineering, construction, and commissioning activities required to fulfill the core business objectives.

F.2.1.48 manage production plant provision (A5541): provide sufficient resources to execute the design and engineering, procurement, construction, and commissioning activities for the plant and check that the execution is done in accordance with the plan for these activities and any required regulations.

F.2.1.49 manage supporting resource provision (A51): provide sufficient resources to execute the activities associated with providing the necessary funds, personnel, tools, and knowledge to support creation of the core business product(s) and check that the execution is done in accordance with the plan for these activities and any required regulations.

F.2.1.50 manage tool provision (A551): provide sufficient resources to execute the activities associated with providing the necessary tools to support creation of the core business product(s) and check that the execution is done in accordance with the plan for these activities and any required regulations.

F.2.1.51 management directives: a set of instructions that constrain the activities associated with managing the core business.

F.2.1.52 management life-cycle data: all information and documents that are the result of process plant management activities.

F.2.1.53 management resources: human resources, tools, and licensed technology used in activities associated with management of the core business.

F.2.1.54 management tool provision directives: a set of instructions that constrain the activities associated with providing management tools.

F.2.1.55 management tool provision resources: human resources and tools used in providing management with the tools necessary to perform tool provision activities.

F.2.1.56 management tools: all devices or implements used to carry out activities associated with managing the provision of resources to support creation of the core business product(s).

F.2.1.57 market data: information regarding the availability, costs, etc., of a specific commodity or service.

F.2.1.58 materials to site: equipment and materials that have been released by a supplier for shipment to a site.

F.2.1.59 operations documents: documentation necessary to run the plant safely during the many different phases and aspects of plant operation.

F.2.1.60 paid money: funds provided in payment for goods or services rendered.

F.2.1.61 payment requests: a request for compensation in the form of money, services, or goods to compensate for the delivery of services, goods, or good will.

F.2.1.62 plant construction and commissioning resources: human resources and tools used in production plant construction and pre-commissioning activities.

F.2.1.63 plant provision management resources: human resources and tools used in the management of activities associated with providing a production plant.

F.2.1.64 plant provision resources: human resources and tools used to support activities associated with providing a production plant.

F.2.1.65 procure goods and services for production plant (A5543): the process whereby needed parts, equipment, or services are purchased or acquired.

F.2.1.66 procured materials: plant item that has been obtained from a supplier for incorporation into the plant.

F.2.1.67 procured services: assistance or advice provided by a supplier.

F.2.1.68 procurement life-cycle data: all information, documents, and drawings that are the result of process plant procurement activities.

F.2.1.69 procurement resources: human resources and tools used in the procurement of goods and services for a production plant.

F.2.1.70 produced product: the materials or energy generated through the operation of the process plant that are sold to customers for a profit.

F.2.1.71 product sales contracts: commitments to provide a product or service described in a legally binding document.

F.2.1.72 production directives: a set of instructions that constrain the activities associated with creating the core business product(s).

F.2.1.73 production plant construction and pre-commissioning directives: a set of instructions that constrain the activities associated with constructing and pre-commissioning a production plant.

F.2.1.74 production plant design and engineering directives: a set of instructions that constrain the activities associated with design and engineering a production plant.

F.2.1.75 production plant procurement directives: a set of instructions that constrain the activities associated with procuring goods and services for a production plant.

F.2.1.76 production plant provision directives: a set of instructions that constrain the activities associated with providing production plants.

F.2.1.77 production plant provision resources: human resources and tools used in providing a production plant.

F.2.1.78 production plant provision support directives: a set of instructions that constrain the activities associated with providing resources to support management, design and engineering, procurement, and construction and pre-commissioning of a production plant.

F.2.1.79 production plants: the facilities used to convert the raw material(s) needed to produce a product into the materials or energy to be sold for money or traded for services or other goods.

F.2.1.80 production resources: human resources and tools used in activities associated with creating the product(s).

F.2.1.81 provide acquisition tools (A553): the activity of supplying or furnishing all devices or implements used to carry out activities associated with the obtaining, receiving, and paying for products, energy, and data.

F.2.1.82 provide financial resources (A52): the activity of supplying or furnishing the money necessary to support the core business activities.

F.2.1.83 provide human resources (A53): the activity of supplying or furnishing the human resources necessary to support the core business activities.

F.2.1.84 provide knowledge (research and development) (A54): the activity of supplying or furnishing information on new technologies and ways to improve human resources and tools to support the core business activities.

F.2.1.85 provide management tools (A552): the activity of supplying or furnishing tools necessary to perform activities associated with the management of core business activities.

F.2.1.86 provide production plant provision support (A5545): the activity of supplying or furnishing human resources and tools used to perform support of activities necessary to provide a production plant.

F.2.1.87 provide production plants (A554): the activity of supplying or furnishing the plants necessary to create the core business product(s).

F.2.1.88 provide sales tools (A555): the activity of supplying or furnishing tools necessary to perform activities associated with marketing of the core business product(s).

F.2.1.89 provide supporting resource provision support (A56): the activity of supplying or furnishing human resources or tools used to perform activities necessary to support provision of supporting resources.

F.2.1.90 provide supporting resources (A5): the activities associated with the acquisition and deployment of the resources necessary to conduct core business activities.

EXAMPLE 101 - These resources include, but are not limited to, human resources, financial resources, knowledge, and tools (in the most generic sense, ranging from a wrench and a PC to a complete production plant).

F.2.1.91 provide tool provision support (A556): the activity of supplying or furnishing human resources or tools used to perform activities necessary to support the provision of tools.

F.2.1.92 provide tools (A55): the activity of supplying or furnishing tools used to perform core business activities.

F.2.1.93 purchase orders and contracts for materials: purchase order or contract between two parties to provide materials for a designated payment.

F.2.1.94 purchase orders and contracts for services: purchase order or contract between two parties to provide services for a designated payment.

F.2.1.95 purchase orders and contracts for tools: purchase order or contract between two parties to provide tools for a designated payment.

F.2.1.96 received products and energy: the acquired equipment, materials, and physical, chemical, and electrical resources.

F.2.1.97 reporting: narrating or describing, usually in writing, the status, results, costs, etc. of some activity or task.

F.2.1.98 reporting to authorities: narrating or describing, usually in writing, the status, results, conformance to requirements, etc. of some activity or task related to the core business.

F.2.1.99 reporting to stockholders: narrating or describing, usually in writing, the status, results, costs, profits, etc. of the core business activities.

F.2.1.100 requisitions: a written document requesting permission to purchase goods or services.

F.2.1.101 research and development directives: a set of instructions that constrain the activities associated with providing knowledge gained from research and development to other core business activities.

F.2.1.102 resource market data: information regarding the availability, costs, etc., of resources.

F.2.1.103 resource provision directives: a set of instructions that constrain the activities associated with providing resources to support core business activities.

F.2.1.104 resources: available energy, tools, materials, money, and human assets that can be used to fulfill a task or requirement.

F.2.1.105 reviewed supplier data: all information, documents, and drawings provided to a supplier for use in procurement of goods and services.

F.2.1.106 sales directives: a set of instructions that constrain the activities associated with marketing the core business product(s).

F.2.1.107 sales resources: human resources and tools used to perform activities necessary to sell the output of the production plant.

F.2.1.108 sales tool provision directives: a set of instructions that constrain the activities associated with providing tools for the marketing of the core business product(s).

F.2.1.109 sales tool provision resources: human resources and tools used in providing the sales tools.

F.2.1.110 sales tools: all devices or implements used to carry out activities associated with selling the core business product(s).

F.2.1.111 scientific information: information resulting from the systematic application of tests and observations to prove or disprove an assumption or hypothesis.

F.2.1.112 sell output (A4): the activities associated with taking the core business product(s) and marketing them to the customer(s).

F.2.1.113 service provider resources: human resources and tools used to provide a service.

F.2.1.114 sold product and energy: the materials or energy sold for money or traded for services or other goods.

F.2.1.115 strategic information: information related to the plan of action or policy for developing, producing, and marketing the core business product(s).

F.2.1.116 supplier data: drawings, manuals, calculations, etc. received from a company concerning items procured from the company, that provides information concerning design details or performance of the procured items.

NOTE - Statuses assigned to supplier documentation include:

- Preliminary (in-process design information);

- Certified (information from the supplier is warranted to correctly describe the as-delivered functional or physical data);

- Released for fabrication or construction.

F.2.1.117 support human resources: human resources provided to support activities necessary to provide supporting resources.

F.2.1.118 supporting resource provision directives: a set of instructions that constrain the activities associated with providing resources to support the core business activities.

F.2.1.119 supporting resource provision resources: human resources and tools used to support activities associated with managing supporting resources.

F.2.1.120 supporting resource provision support directives: a set of instructions that constrain the activities associated with providing supporting resource provision support.

F.2.1.121 supporting resource provision support resources: human resources and tools used to support activities associated with providing supporting resources.

F.2.1.122 tool improvement data: information generated by research and development activities that is used to enhance the capabilities of tools provided to produce the core business product(s).

F.2.1.123 tool performance Data: information about how well a tool is carrying out or fulfilling it's function.

F.2.1.124 tool provision directives: a set of instructions that constrain the activities associated with providing tools to support core business activities.

F.2.1.125 tool provision management resources: human resources and tools used in the management of activities necessary to provide tools.

F.2.1.126 tool provision resource requirements: a set of needs or wants defined during tool provision activities.

F.2.1.127 tool provision resources: human resources and tools used in the provision of tools provided to support the core business.

F.2.1.128 tool provision support directives: a set of instructions that constrain the activities associated with providing tool provision support.

F.2.1.129 tool provision support resources: human resources and tools used to support activities associated with providing tools.

F.2.1.130 tools: all devices or implements used to carry out activities associated with the core business.

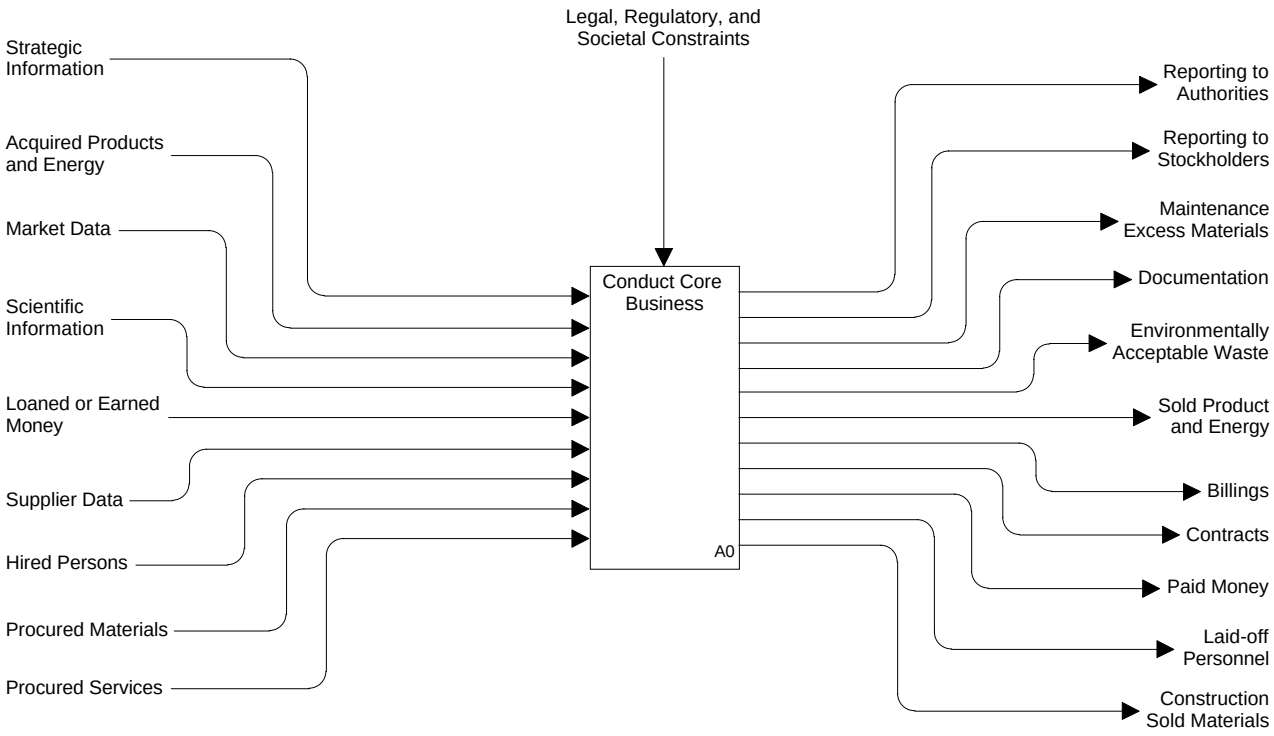
> EXAMPLE 102 - Devices and implements include computer hardware and software tools as well as hardware tools to do physical activities on the process plant such as pliers and welding devices.

F.2.1.131 waste substances: unwanted or unusable material by-products or remains.

F.2.2 Activity model diagrams

The activity model diagrams are given in figures F.14 through F.18. The graphical form of the activity model is presented in the IDEF0 activity modelling format.

Figure F.1 describes the basic notation used in IDEF0 modelling. Each activity may be decomposed to provide more detail. If an activity has been decomposed, a separate diagram is included.



VIEWPOINT: Plant owner/operator

Figure F.14 - A-0: Process Plant Life Cycle

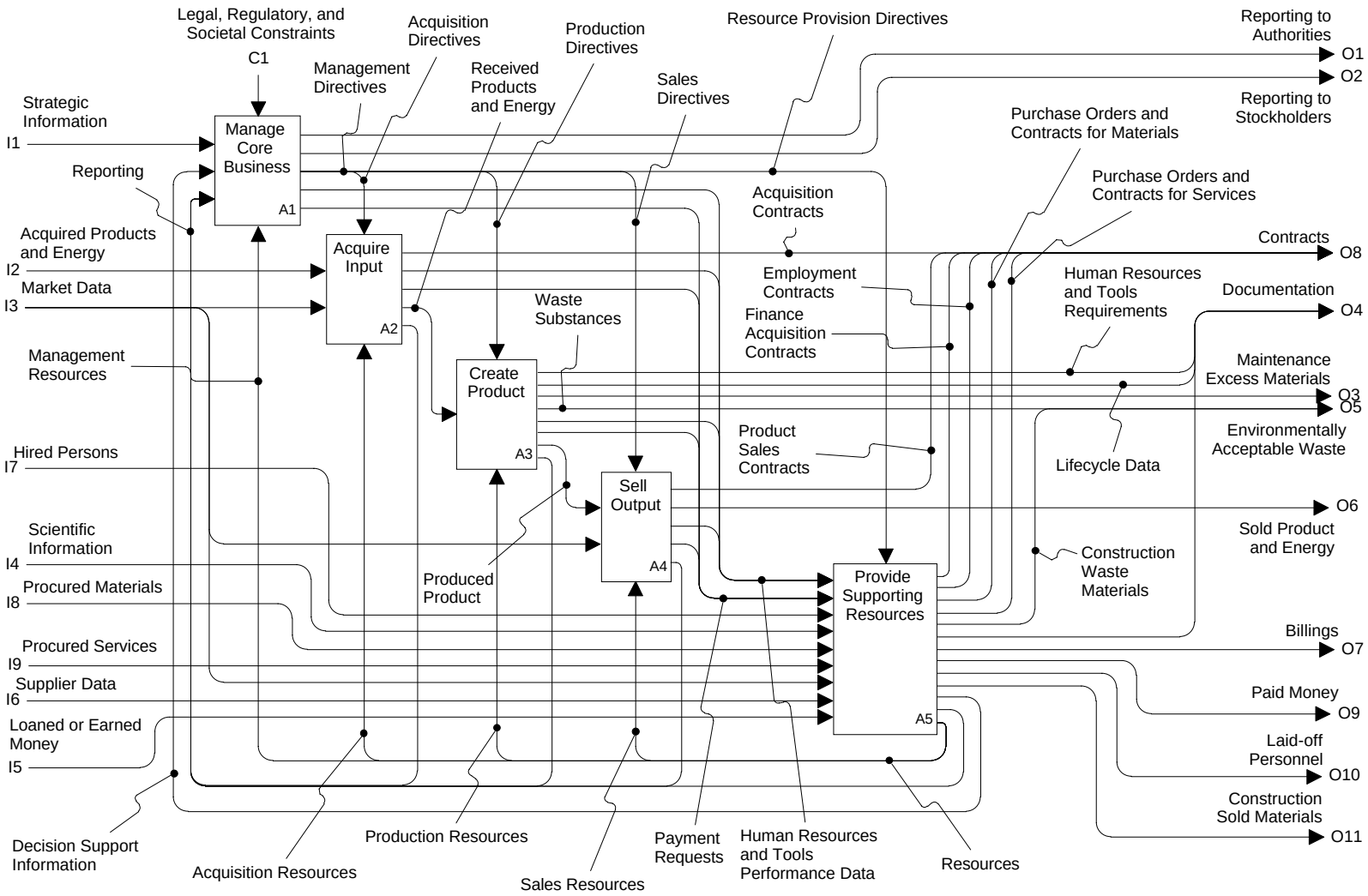


Figure F.15 - A0: Conduct Core Business

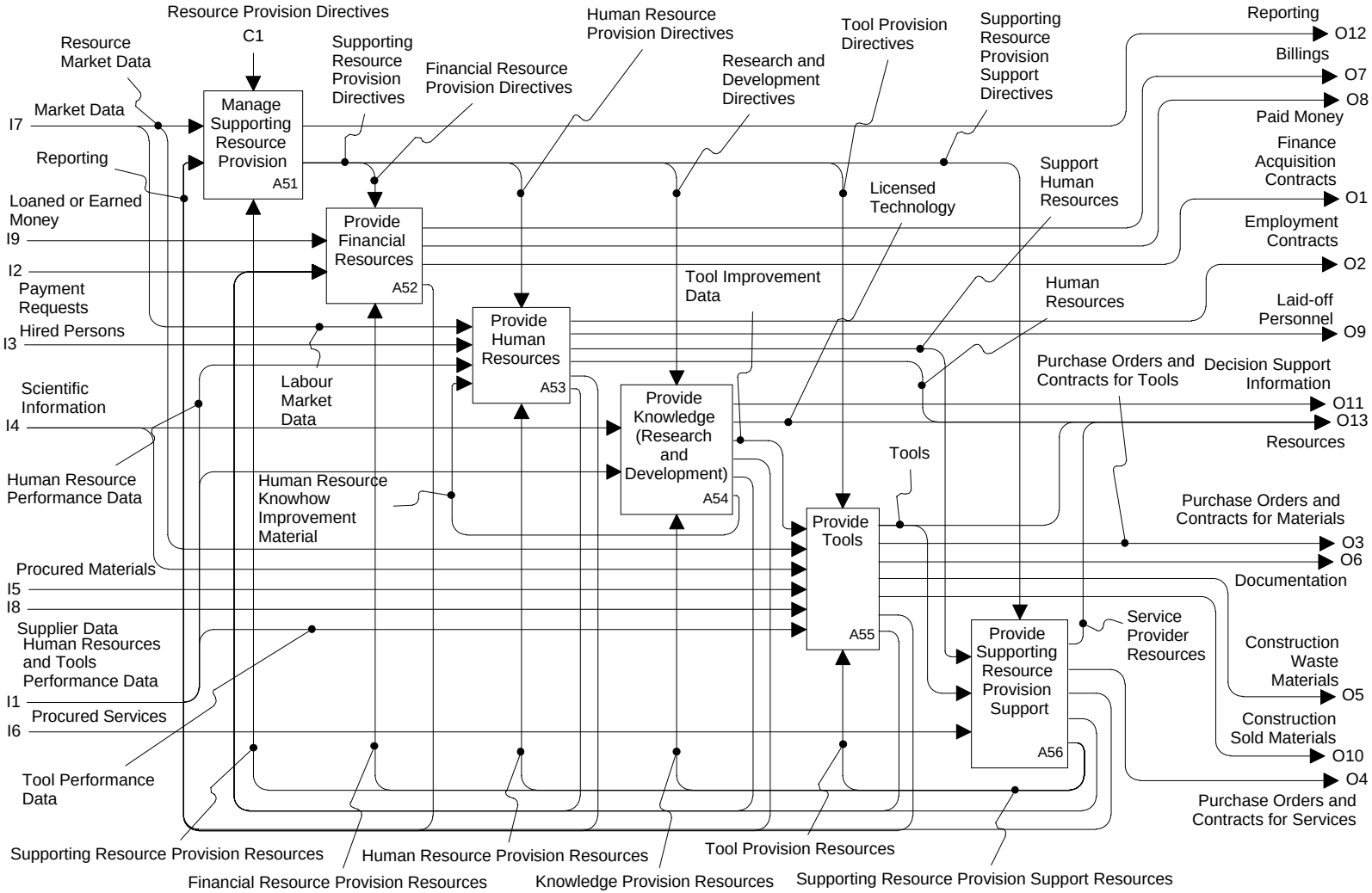


Figure F.16 - A5: Provide Supporting Resources

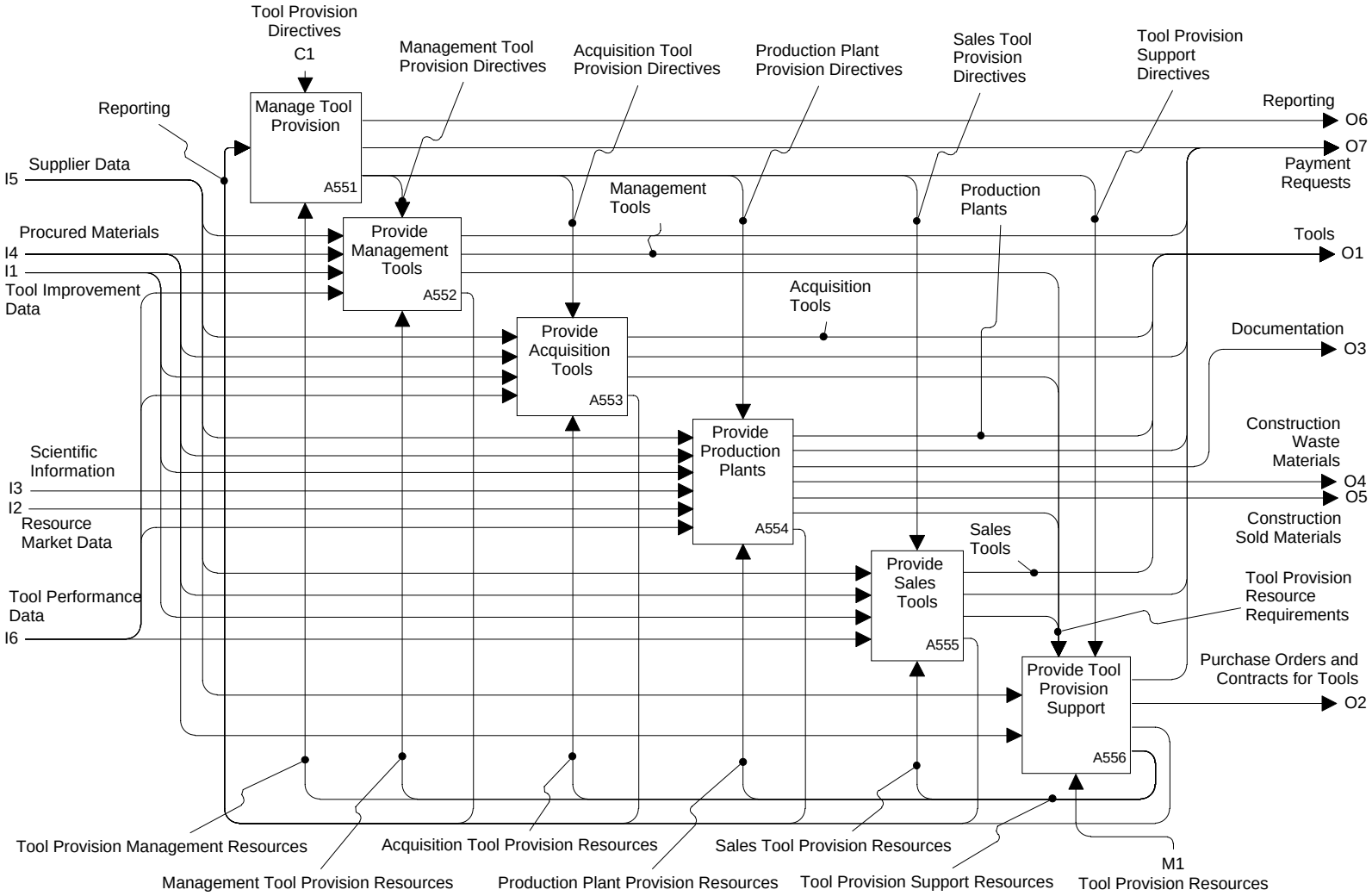


Figure F.17 - A55: Provide Tools

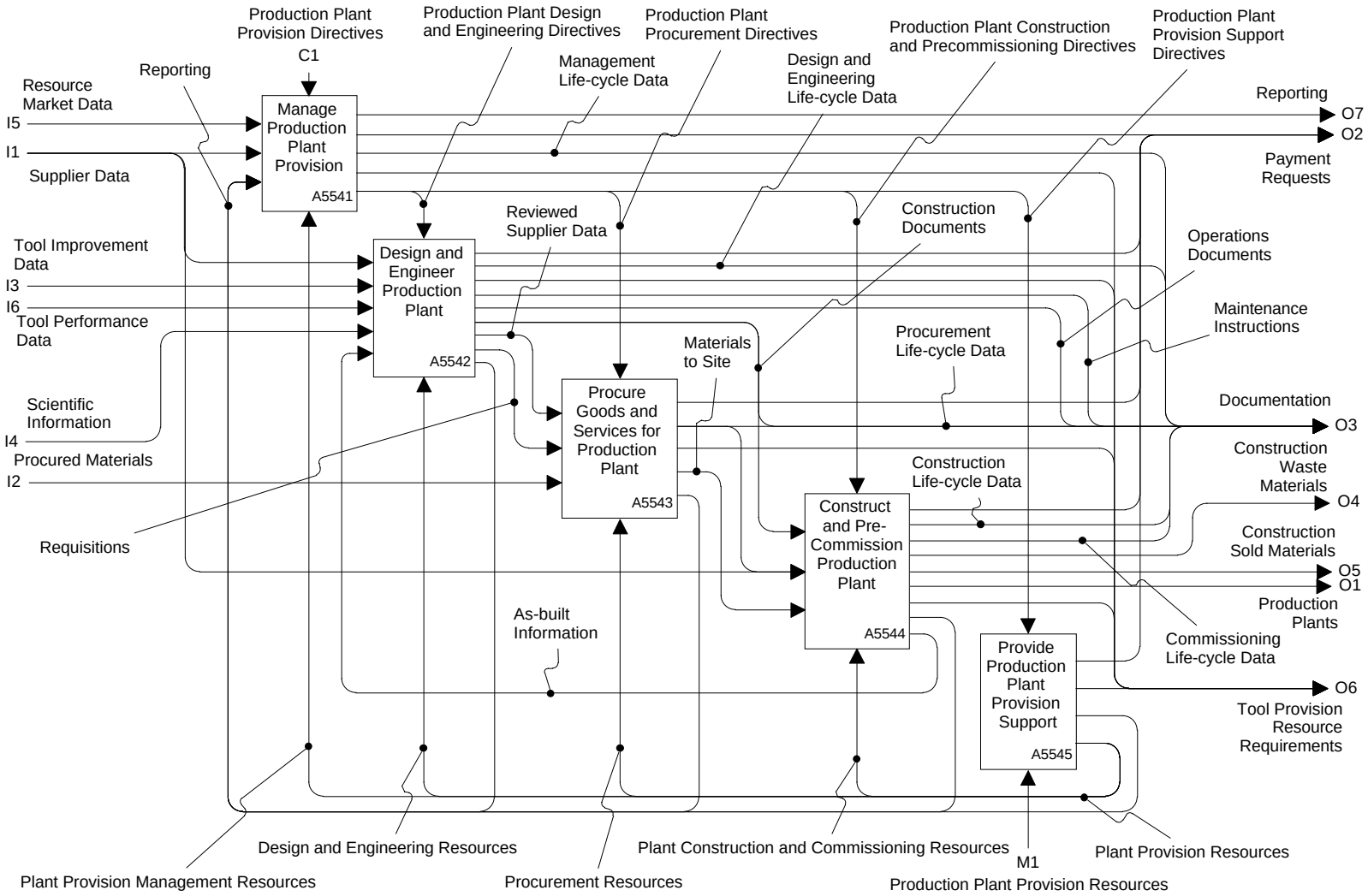


Figure F.18 - A554: Provide Production Plants

F.2.3 Correspondence between PIEBASE activity model and AAM for this part of ISO 10303

The PIEBASE activity model starts from the top most view of the life cycle of the complete process enterprise. Activity A5542, "Design and Engineer Production Plant" (see figure F.18) of the PIEBASE activity model corresponds to activity A2 of the AAM for this part of ISO 10303 (see figure F.5). Table F.2 documents the correspondence between the information flows on the PIEBASE activity model activity A5542 and the information flows on activity A2 of the AAM for this part of ISO 10303. The AAM for this part of ISO 10303 documents the activities and data flows that are in and out of scope.

The viewpoint of the generic PIEBASE activity model is the owner of the process enterprise. The viewpoint of the AAM for this part of ISO 10303 is the users of plant spatial configuration information, including owner, architect, engineer, and builder.

Table F.2 - AAM/PIEBASE activity model correspondence

AAM - A2	PIEBASE AAM - A5542
Inputs	
Initial Information	Tool Improvement Data Tool Performance Data Scientific Information As-built Information
Licensed Technologies	Supplier Data
Supplier Documentation	
Outputs	
Request for Management Approval	Payment Requests Requisitions
Plant Design Documentation	Design and Engineering Life-cycle Data Maintenance Instructions Operations Documents Construction Documents Reviewed Supplier Data
Project Control and Approval Documentation	Reporting
Controls	
Plant Life-cycle Documentation	Production Plant Design and Engineering Directives
Project Control and Approval Documentation	
Corporate Standards	
Regulatory Requirements	

Table F.2 - AAM/PIEBASE activity model correspondence (concluded)

AAM - A2	PIEBASE AAM - A5542
Societal Requirements	(continued)
Engineering Design, Construction, and Operation Changes	
Mechanisms	
Personnel Automation Tools Information Databases	Design and Engineering Resources

Annex G
(informative)

Application reference model

This annex provides the application reference model for this part of ISO 10303 and is given in figures G.2 through G.26. The application reference model is a graphical representation of the structure and constraints of the application objects specified in clause 4. The graphical form of the application reference model is presented in IDEF1X. The application reference model is independent from any implementation method.

Extensions to the IDEF1X notation are used within the ARM diagrams through the use of symbols to denote off-page connectors. The symbols for the off-page connectors and their usage are drawn from the EXPRESS-G graphical modelling language and have the same meaning. Figure G.1 illustrates how off-page connectors are used to link relationships on different pages.

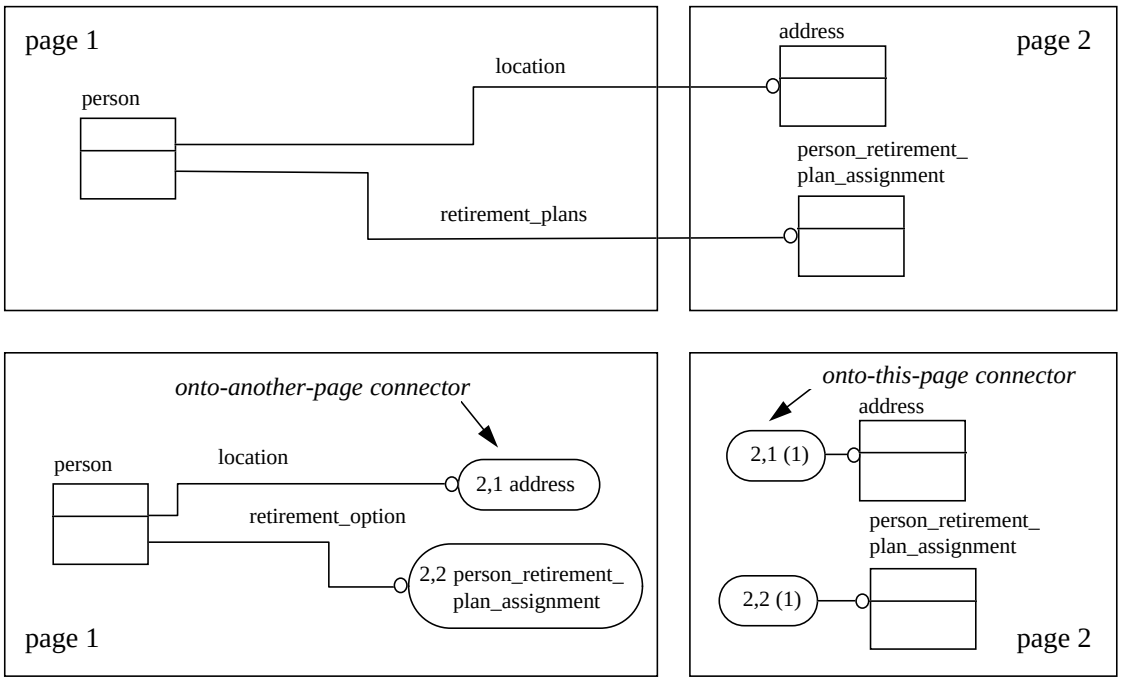


Figure G.1 - Off-page connectors

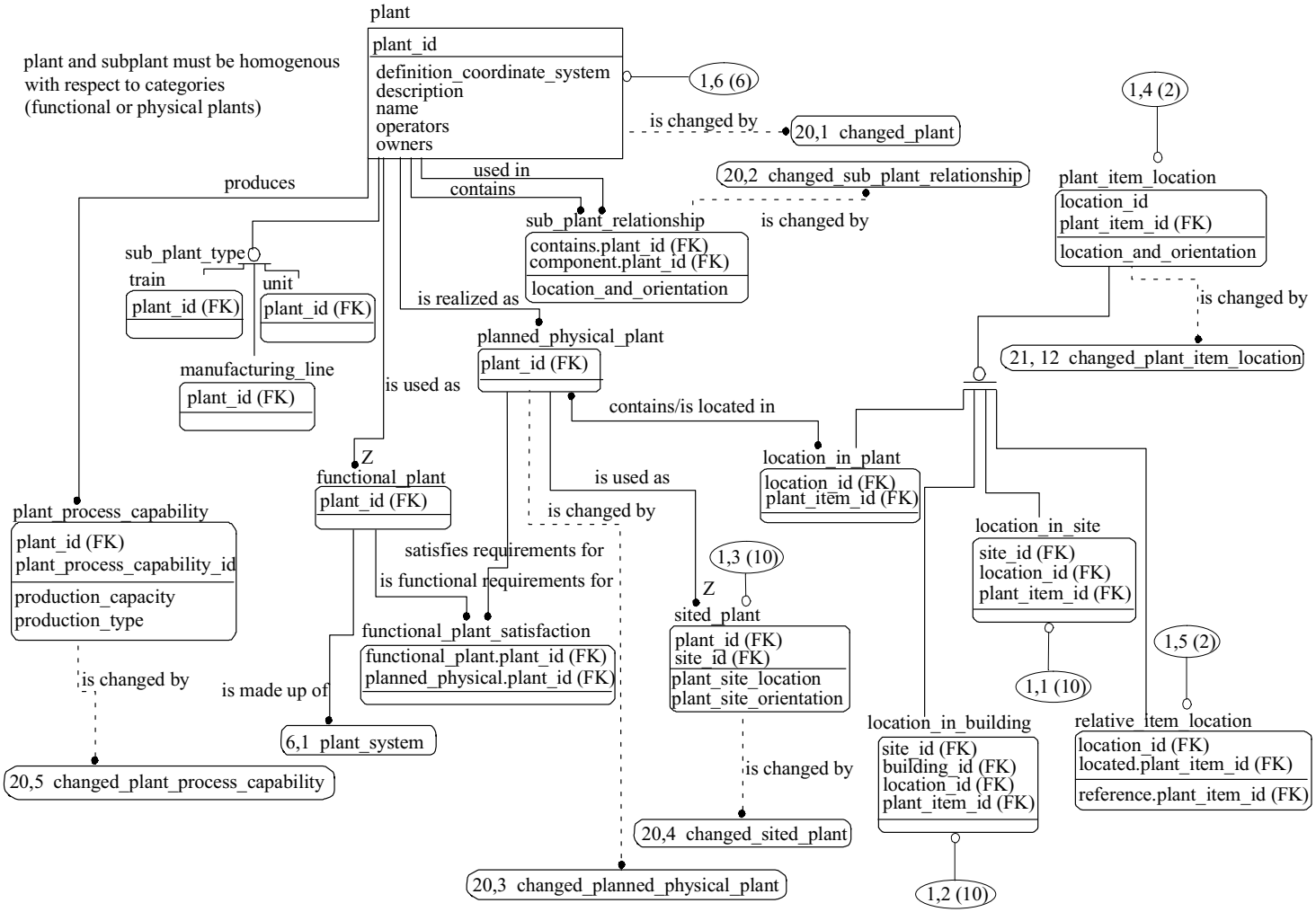


Figure G.2 - ARM diagram 1 of 25

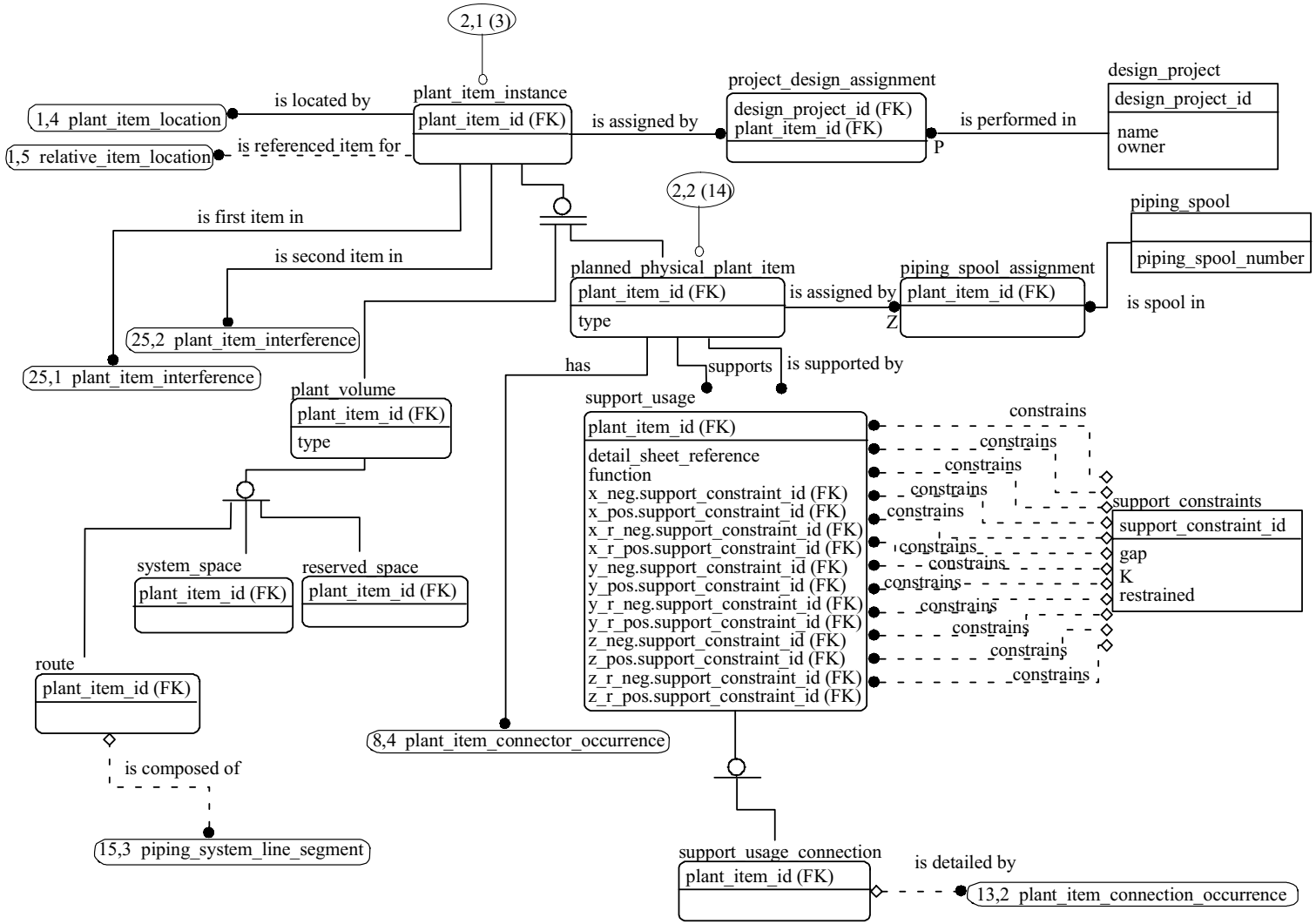


Figure G.3 - ARM diagram 2 of 25

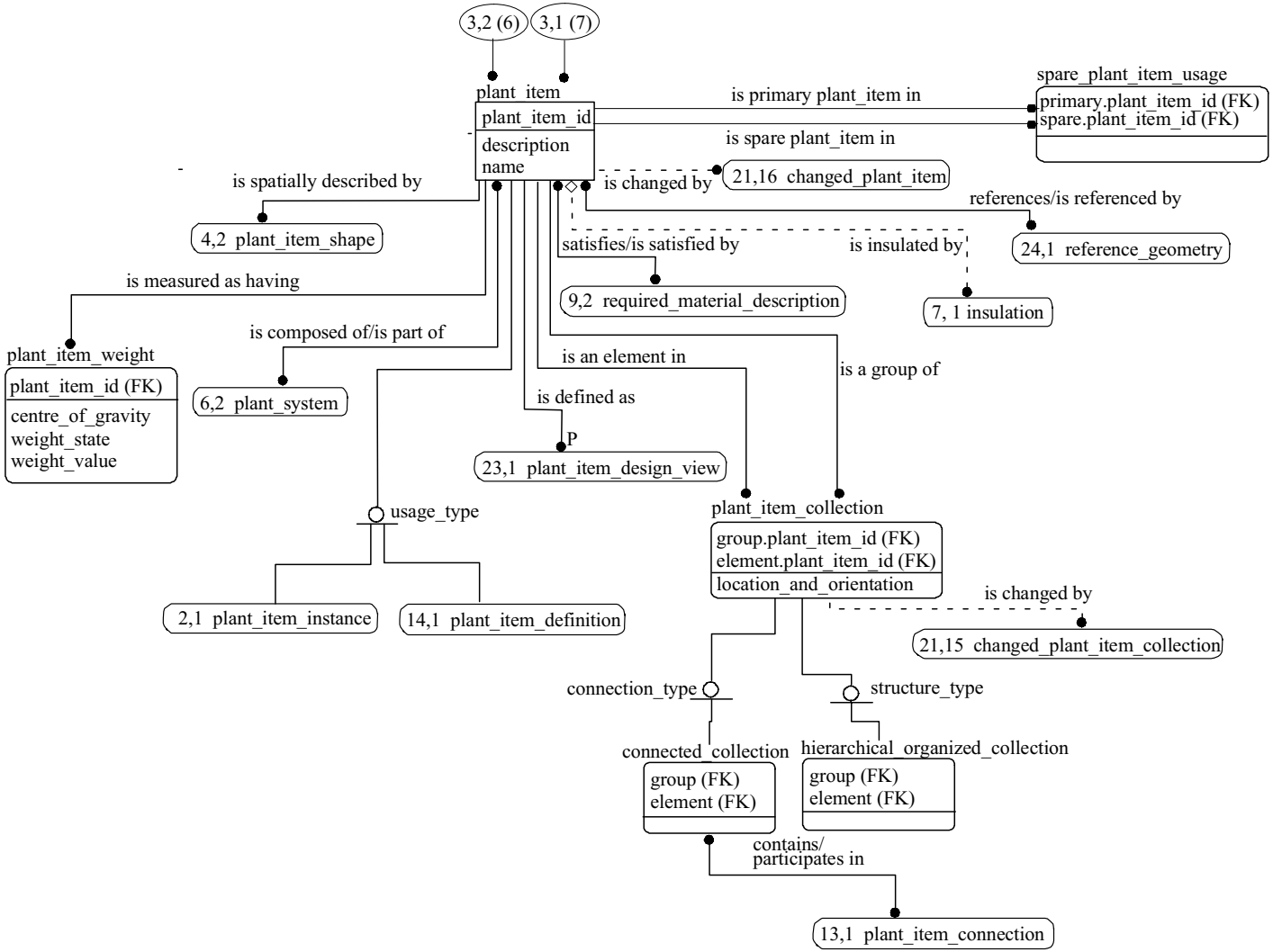


Figure G.4 - ARM diagram 3 of 25

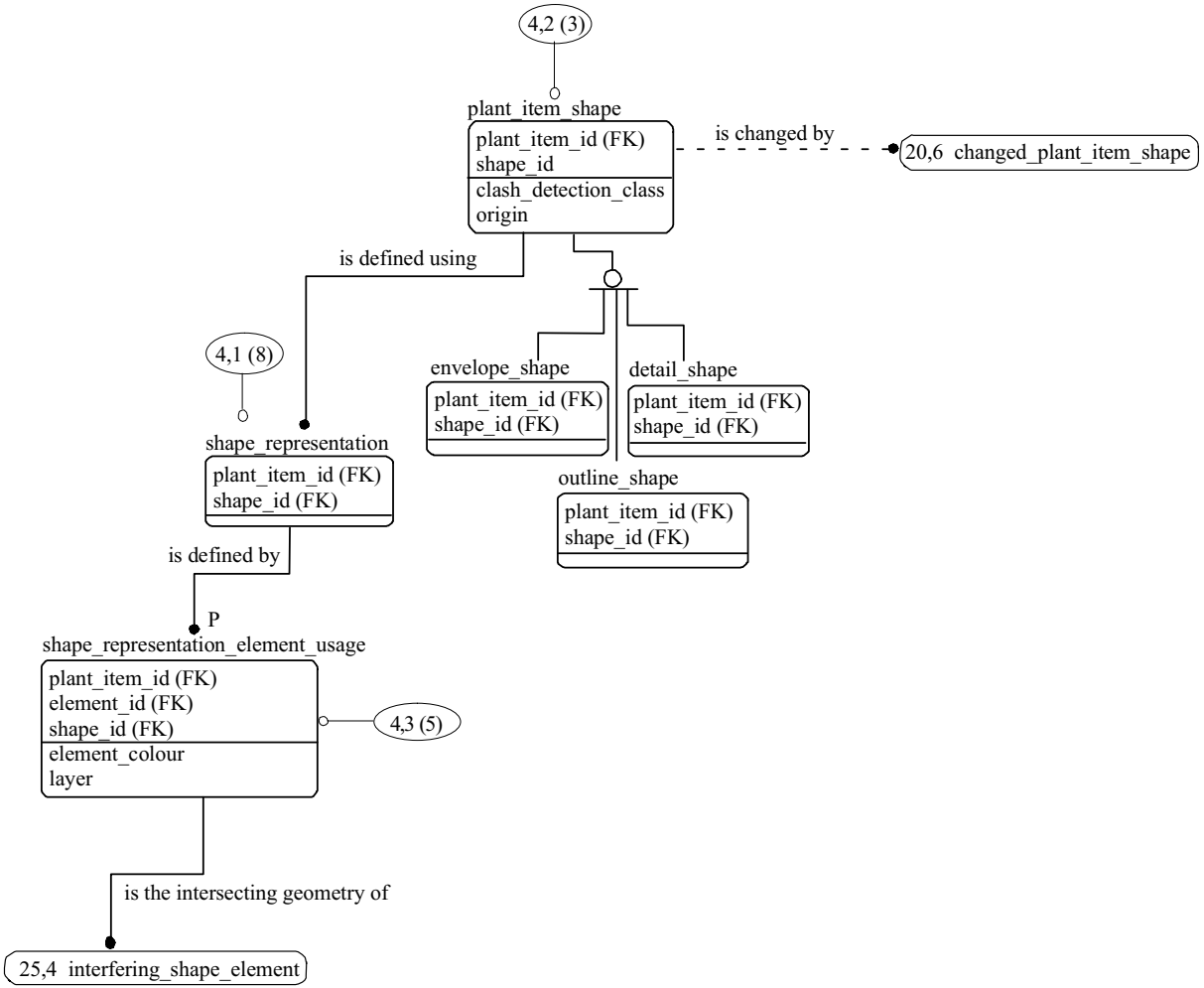


Figure G.5 - ARM diagram 4 of 25

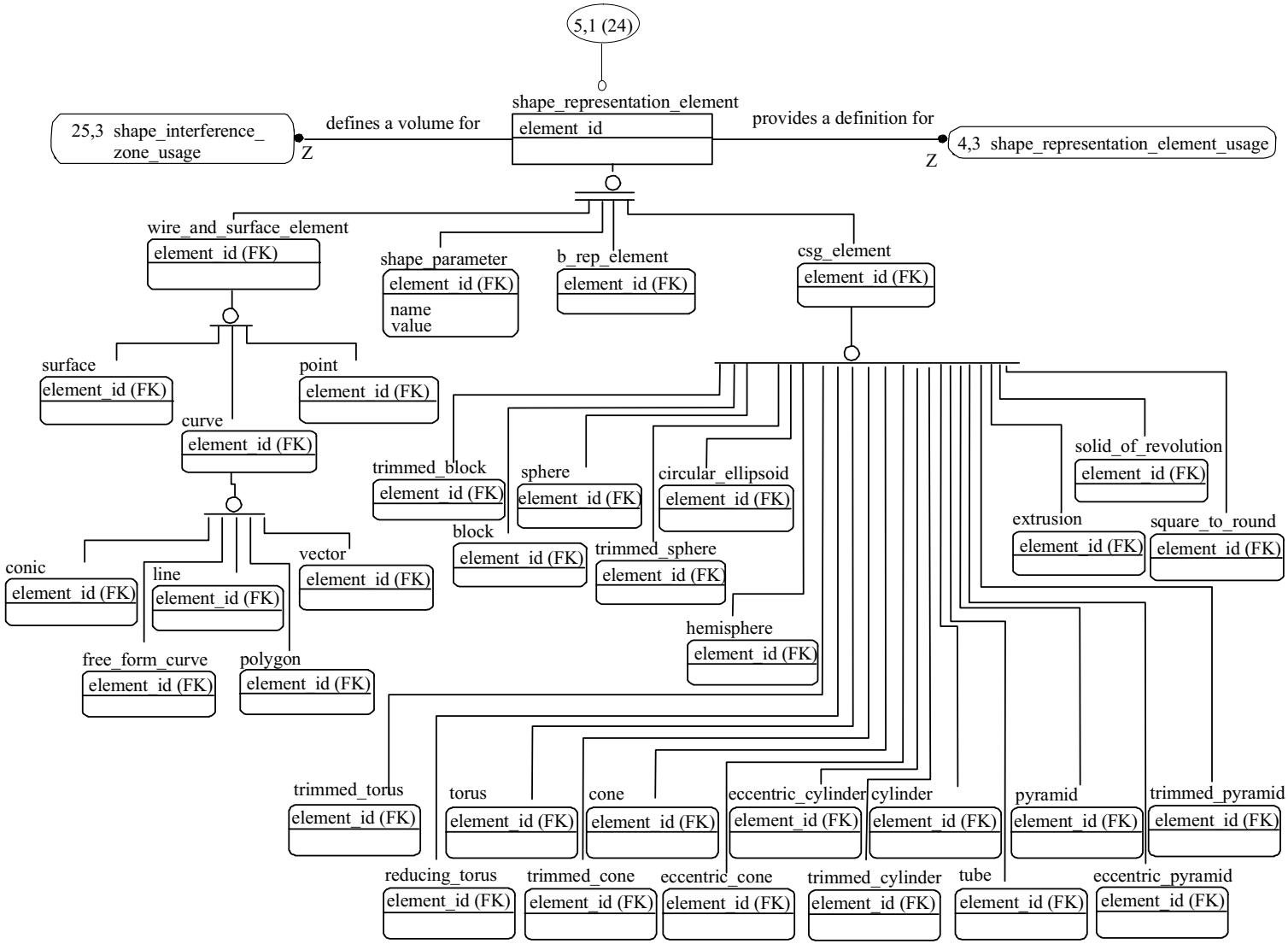


Figure G.6 - ARM diagram 5 of 25

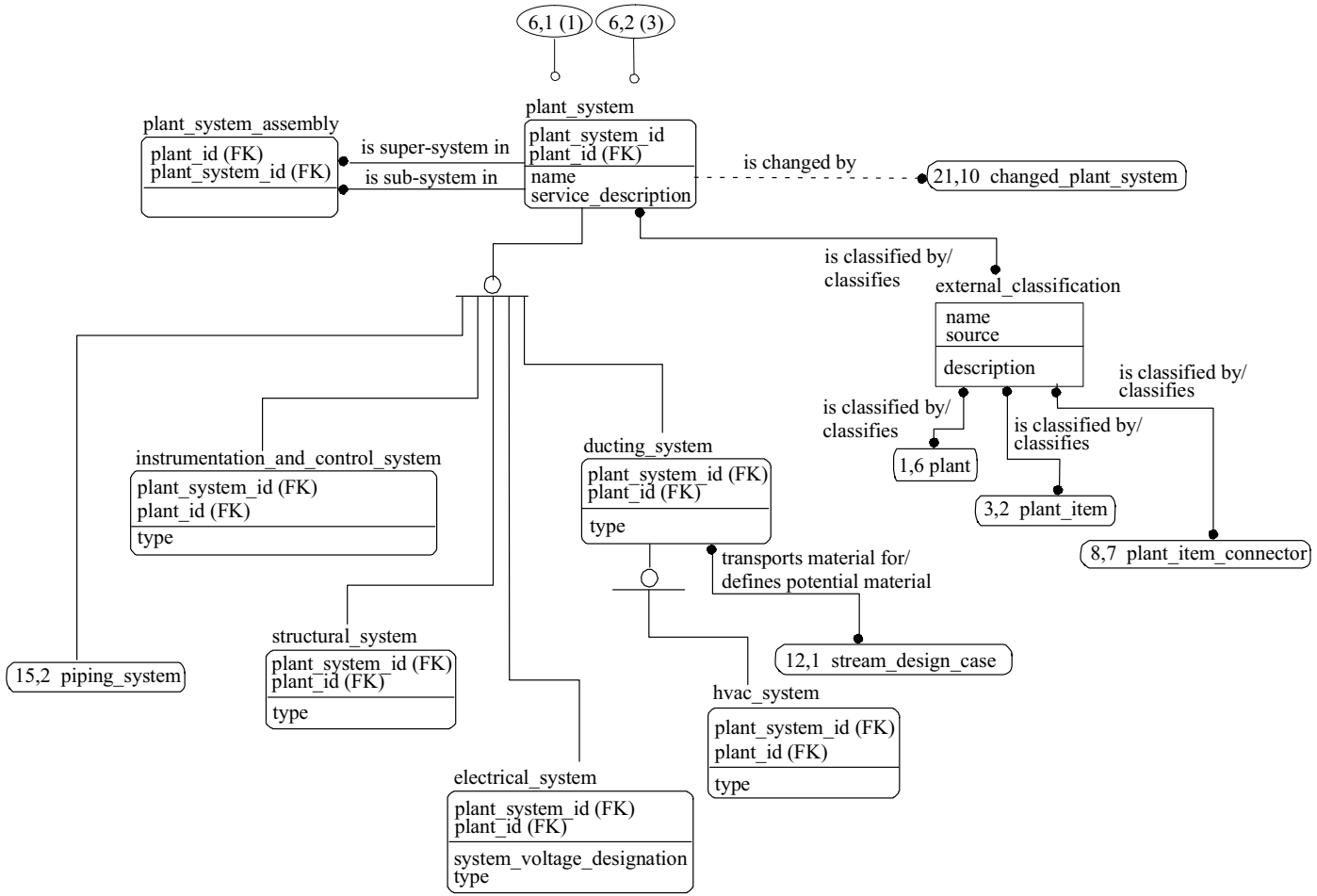


Figure G.7 - ARM diagram 6 of 25

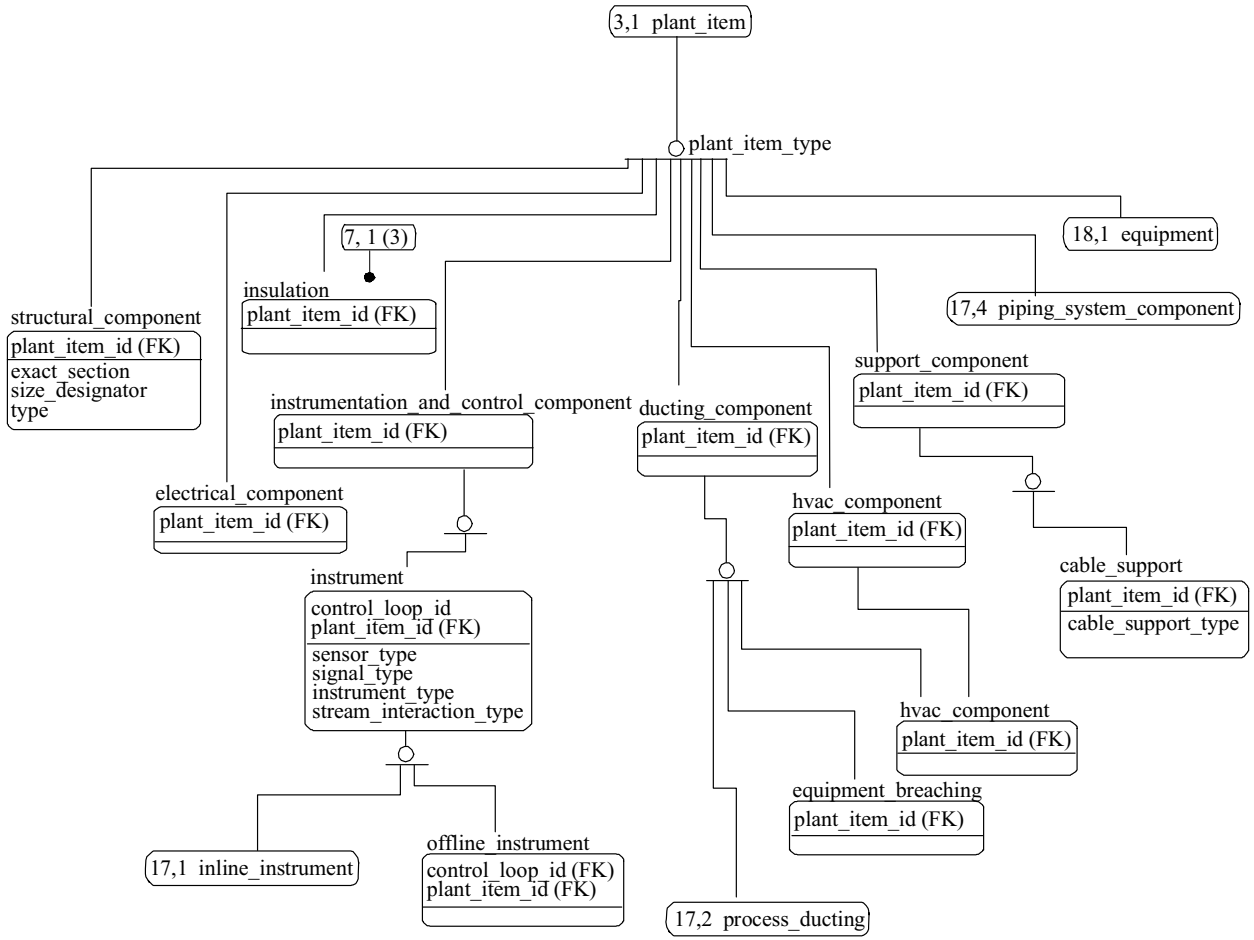


Figure G.8 - ARM diagram 7 of 25

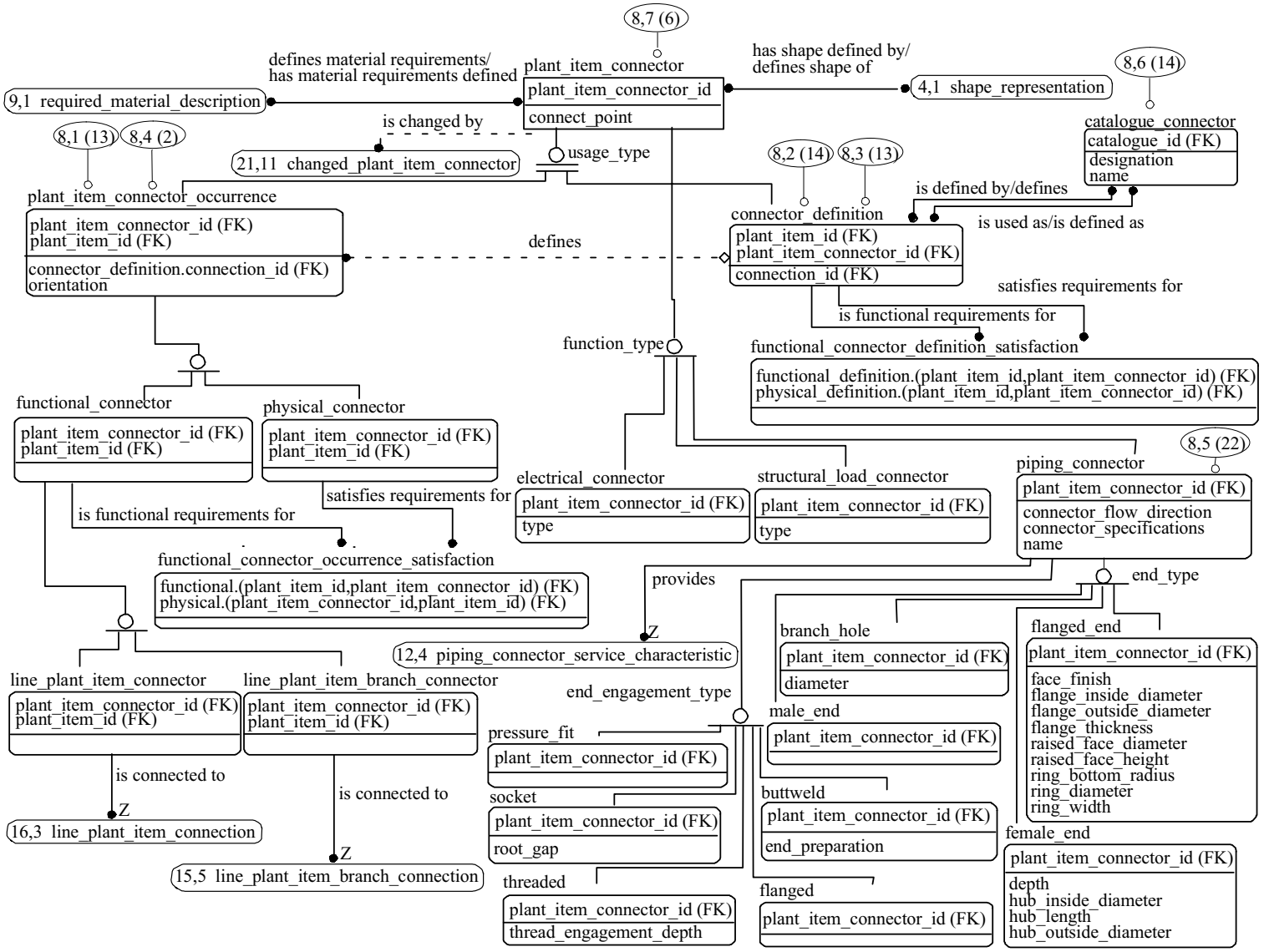


Figure G.9 - ARM diagram 8 of 25

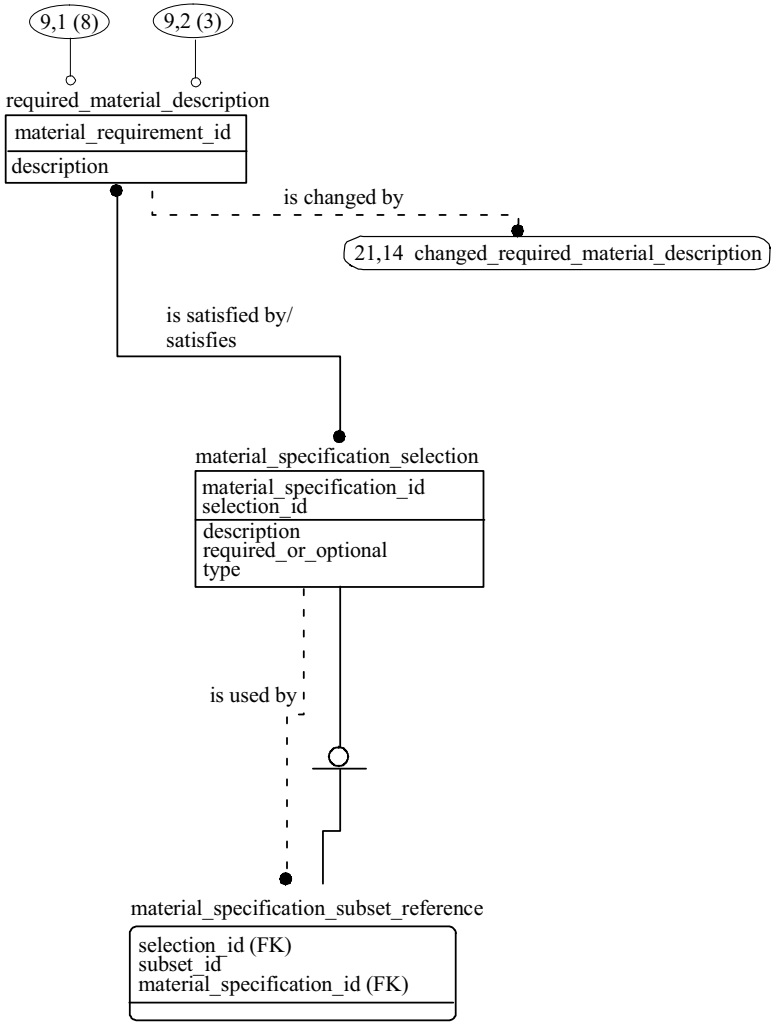


Figure G.10 - ARM diagram 9 of 25

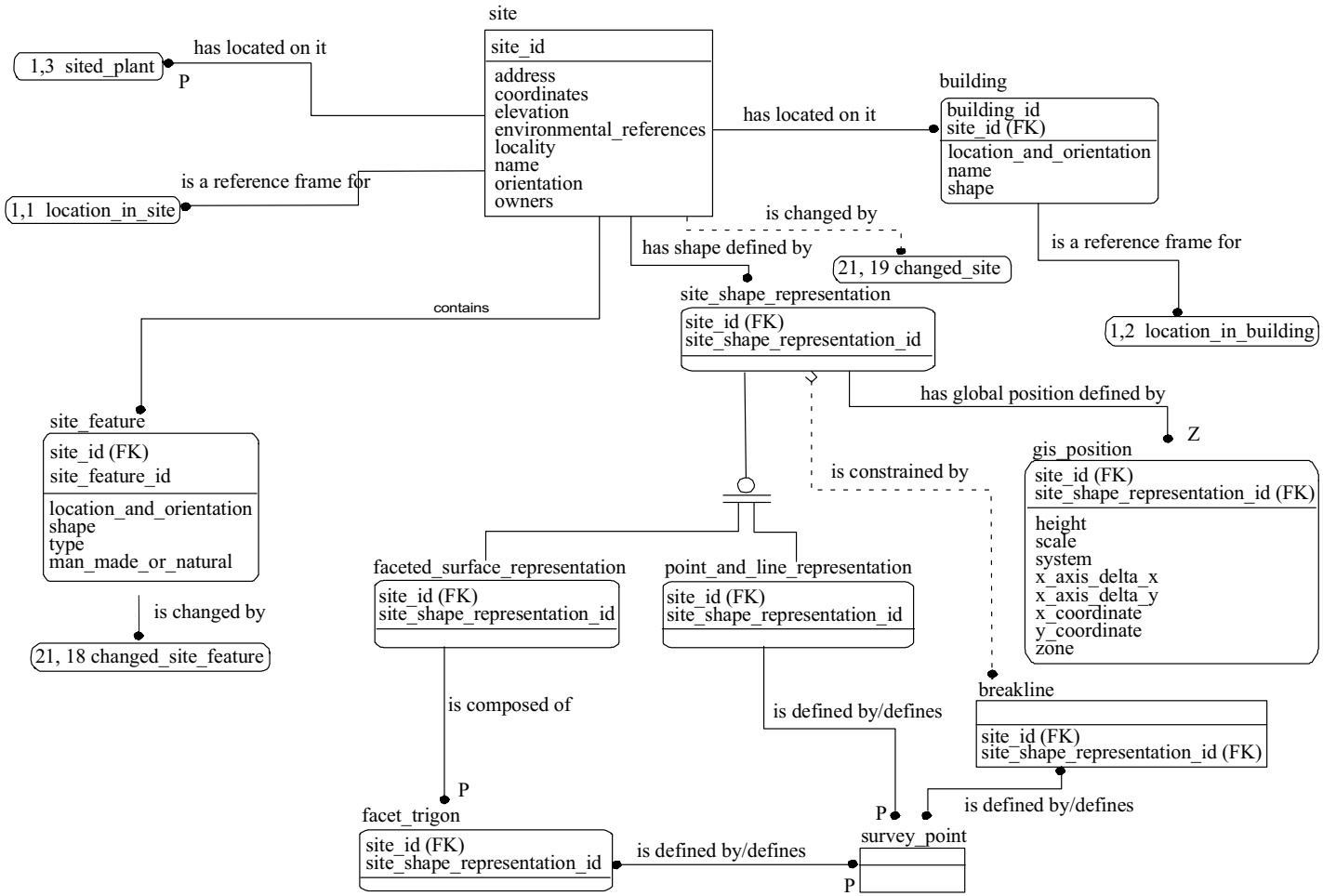


Figure G.11 - ARM diagram 10 of 25

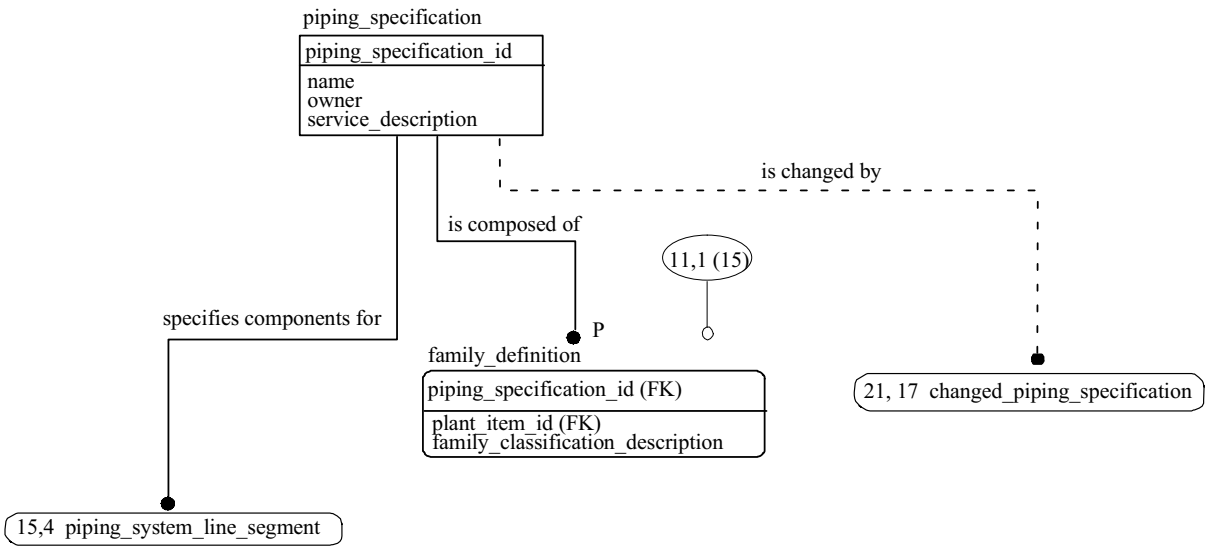


Figure G.12 - ARM diagram 11 of 25

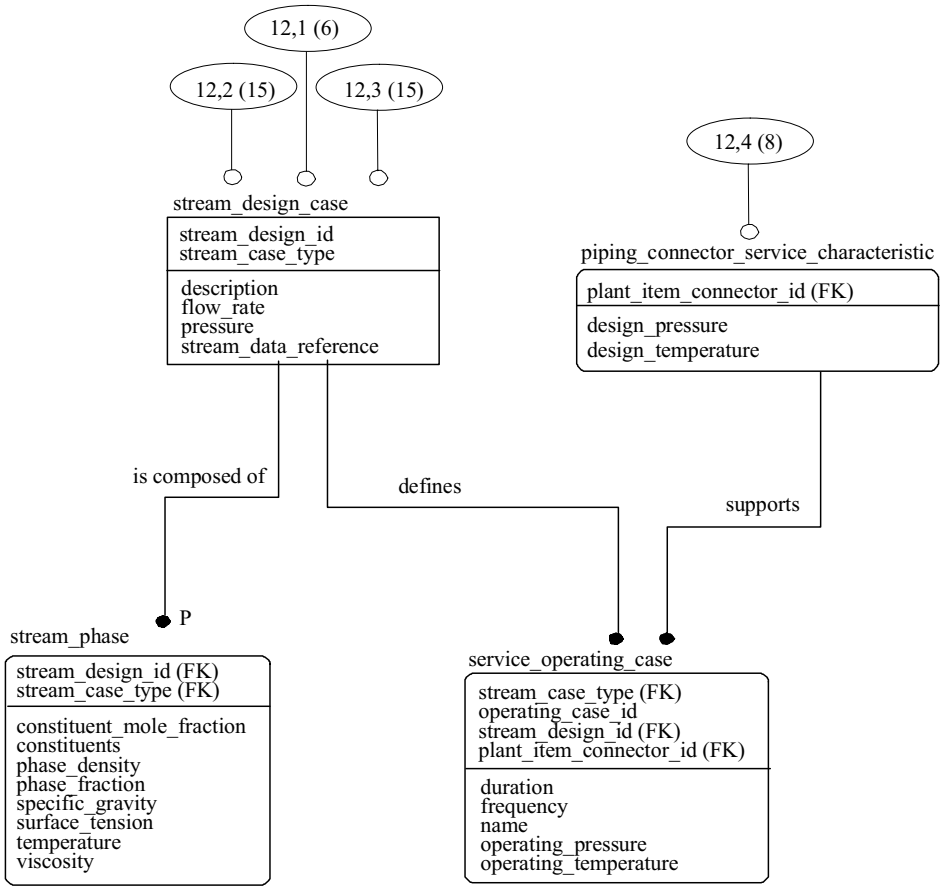
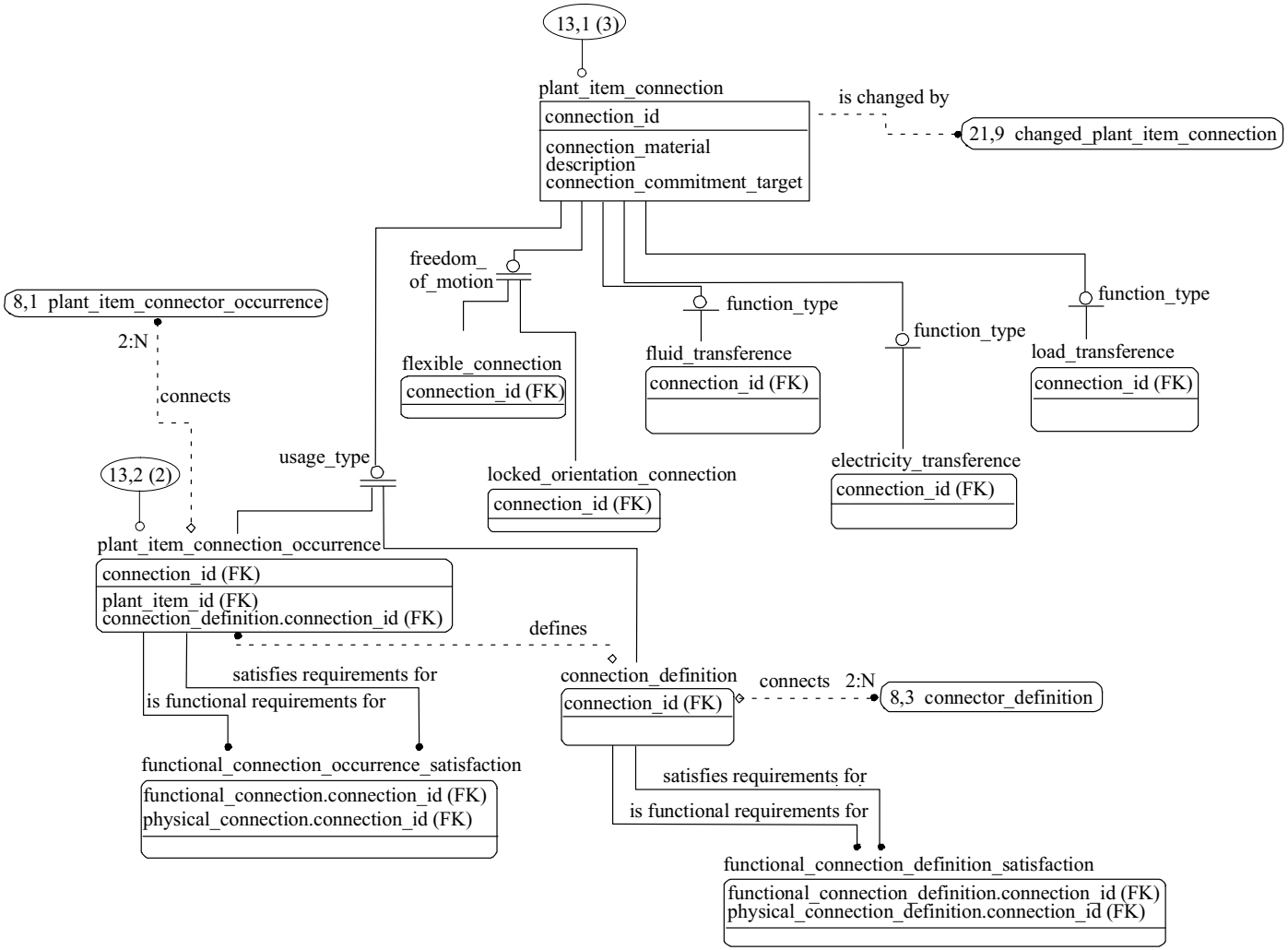


Figure G.13 - ARM diagram 12 of 25



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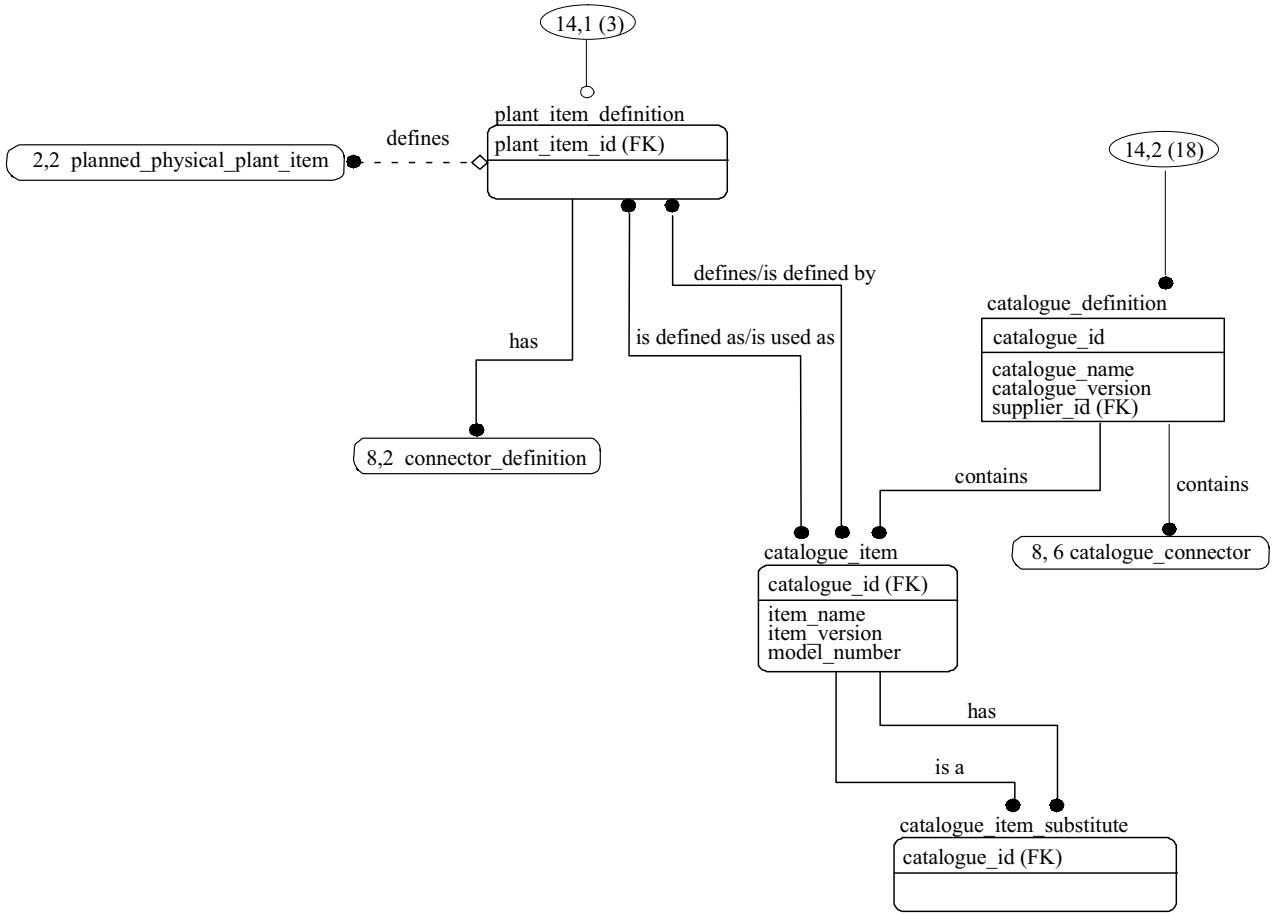


Figure G.15 - ARM diagram 14 of 25

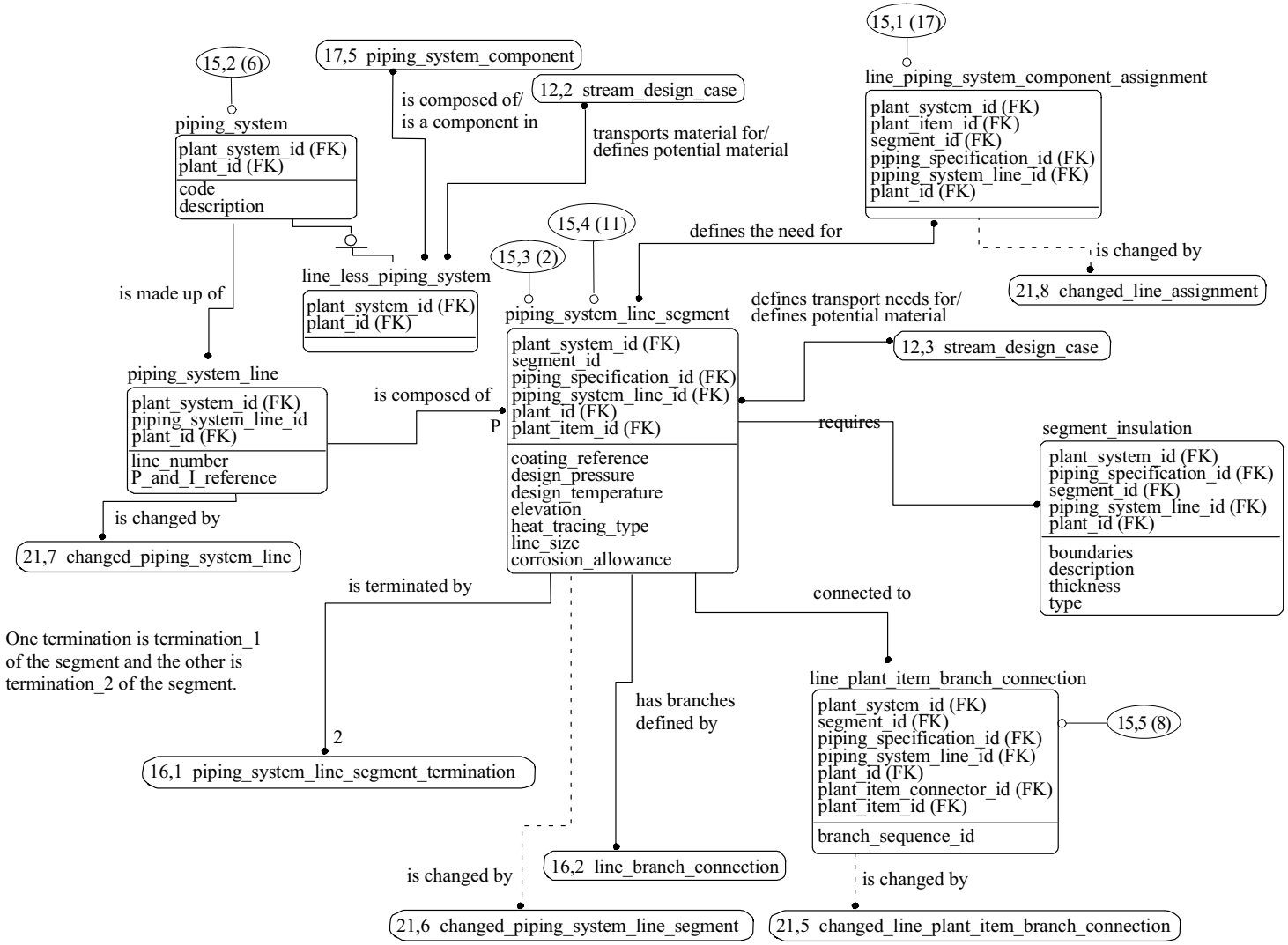


Figure G.16 - ARM diagram 15 of 25

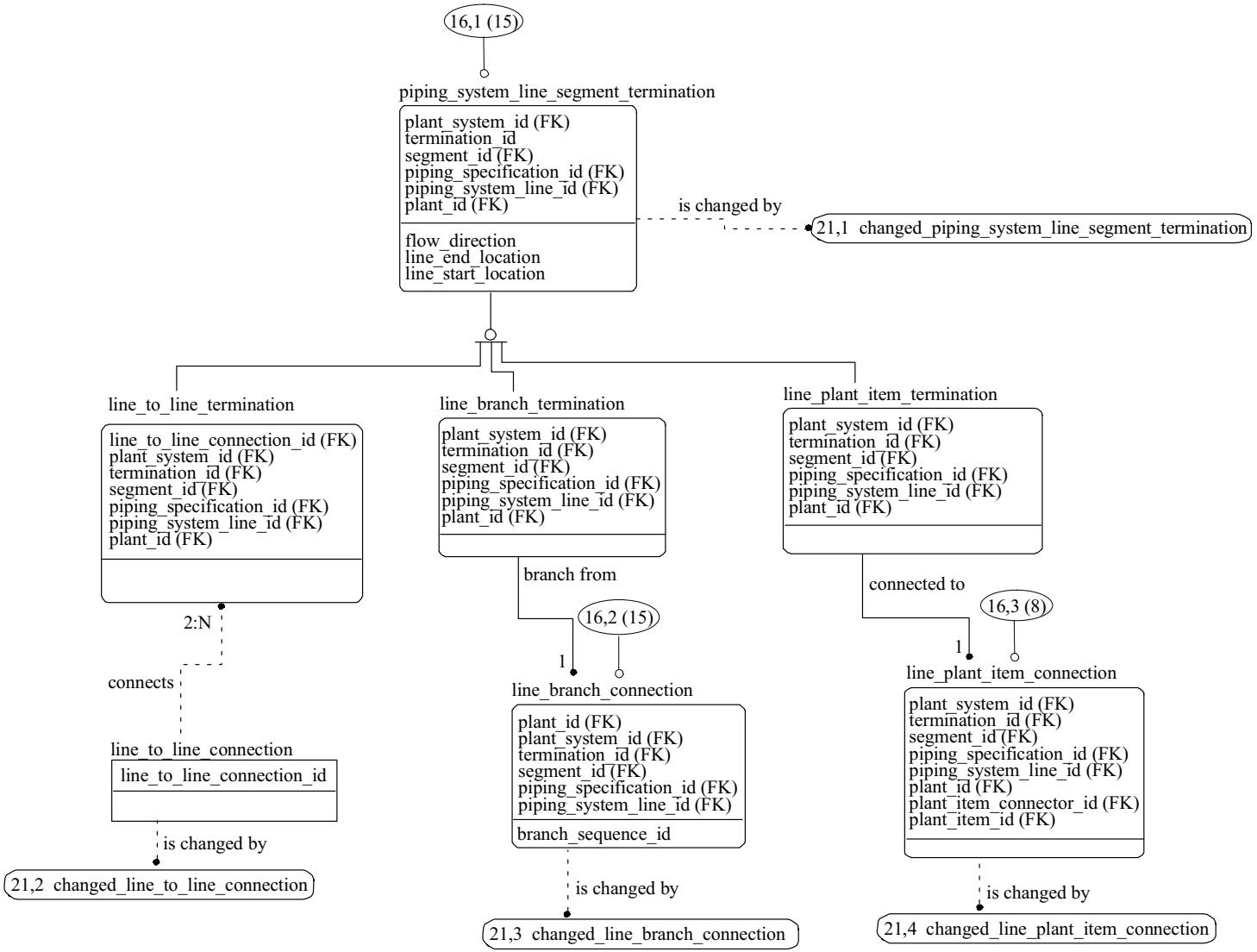


Figure G.17 - ARM diagram 16 of 25

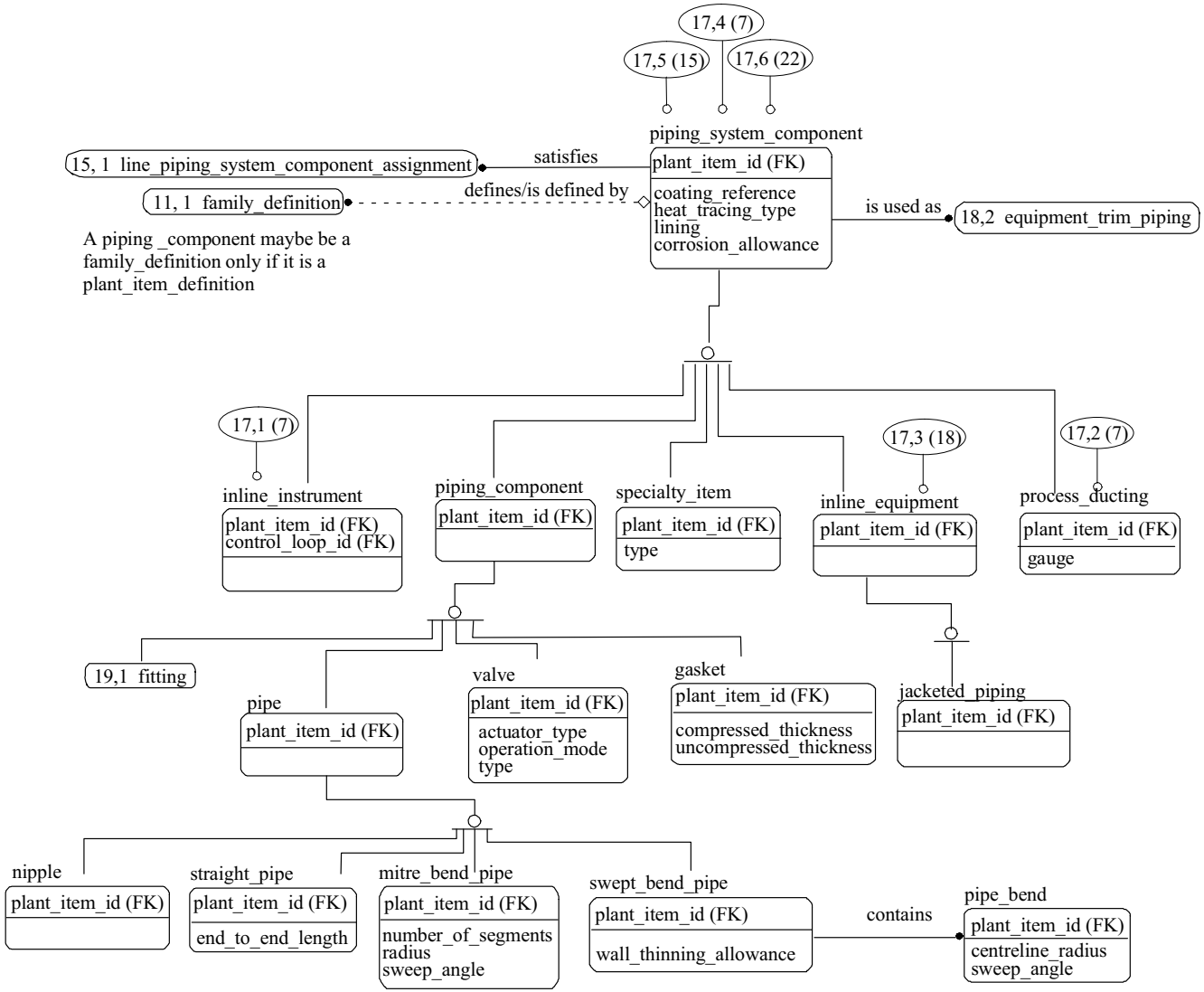


Figure G.18 - ARM diagram 17 of 25

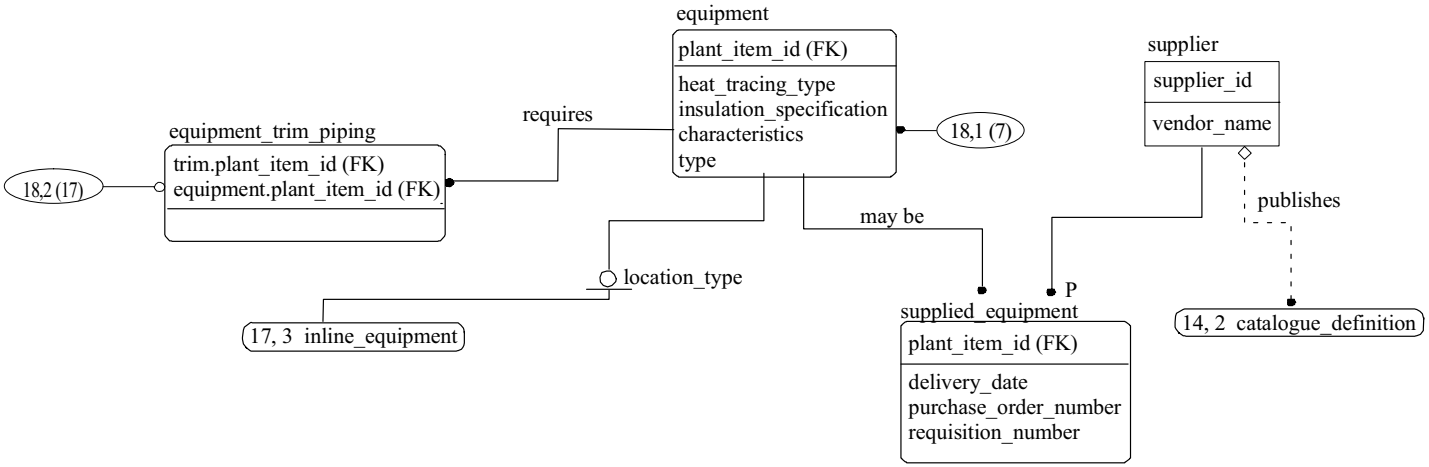


Figure G.19 - ARM diagram 18 of 25

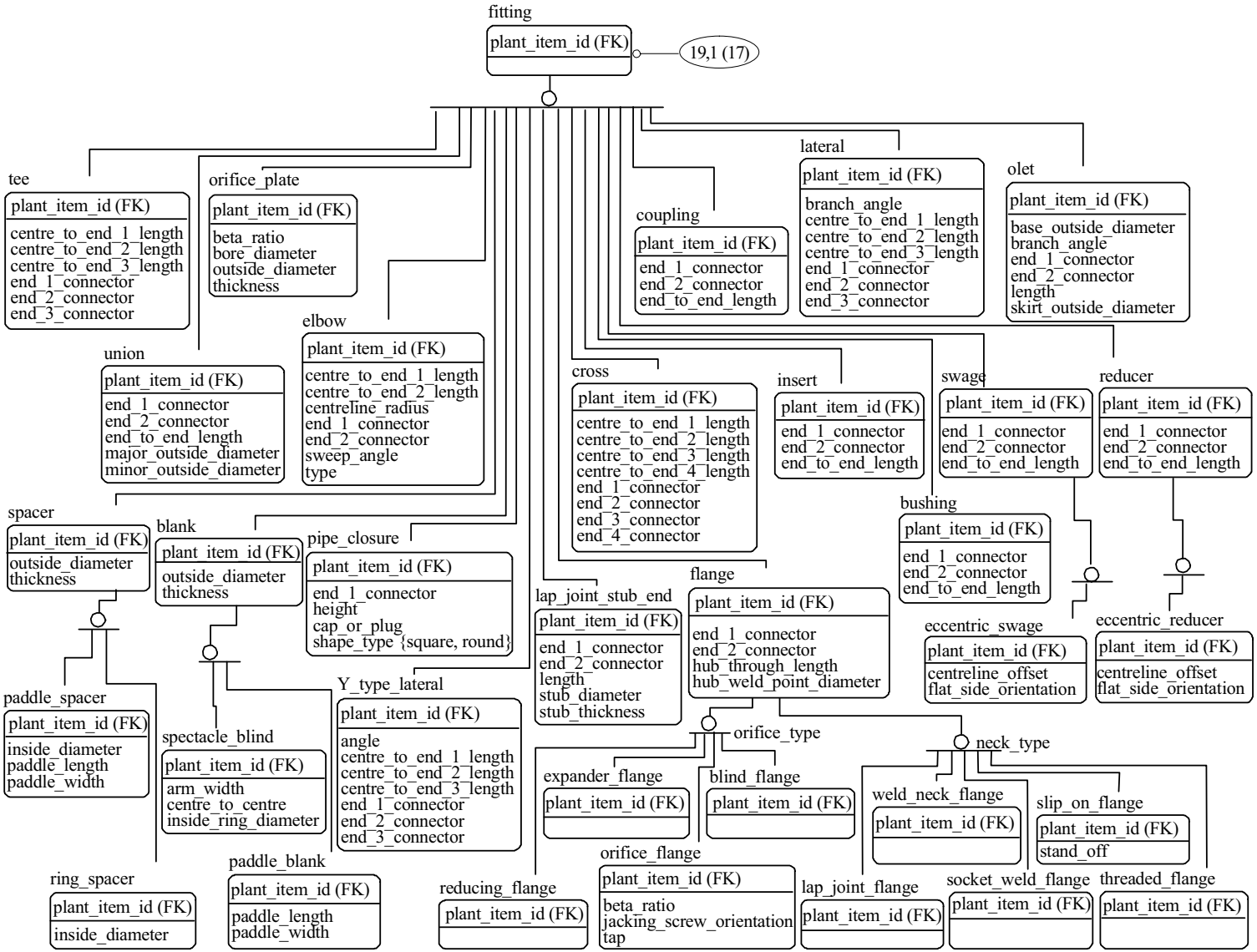


Figure G.20 - ARM diagram 19 of 25

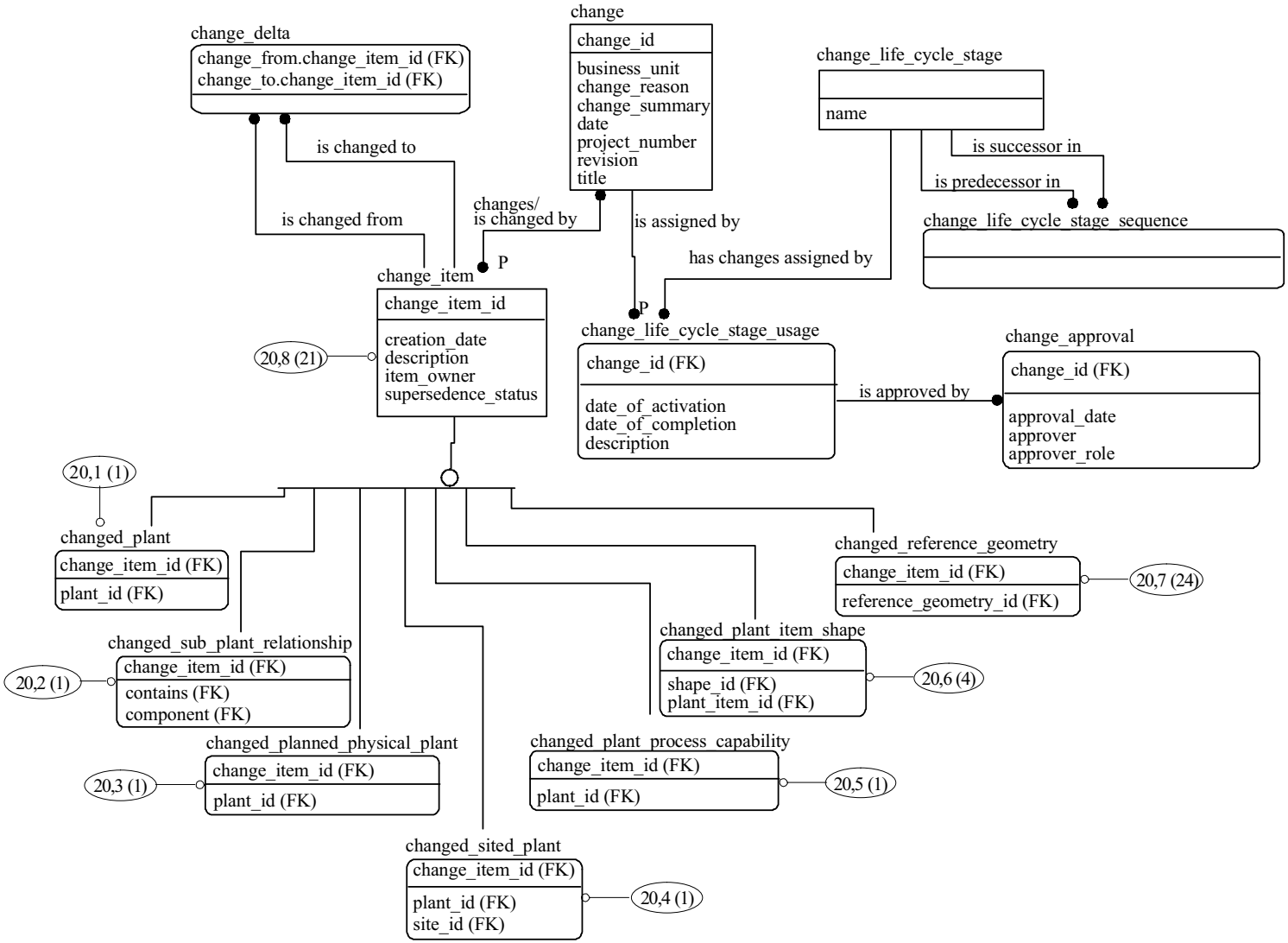


Figure G.21 - ARM diagram 20 of 25

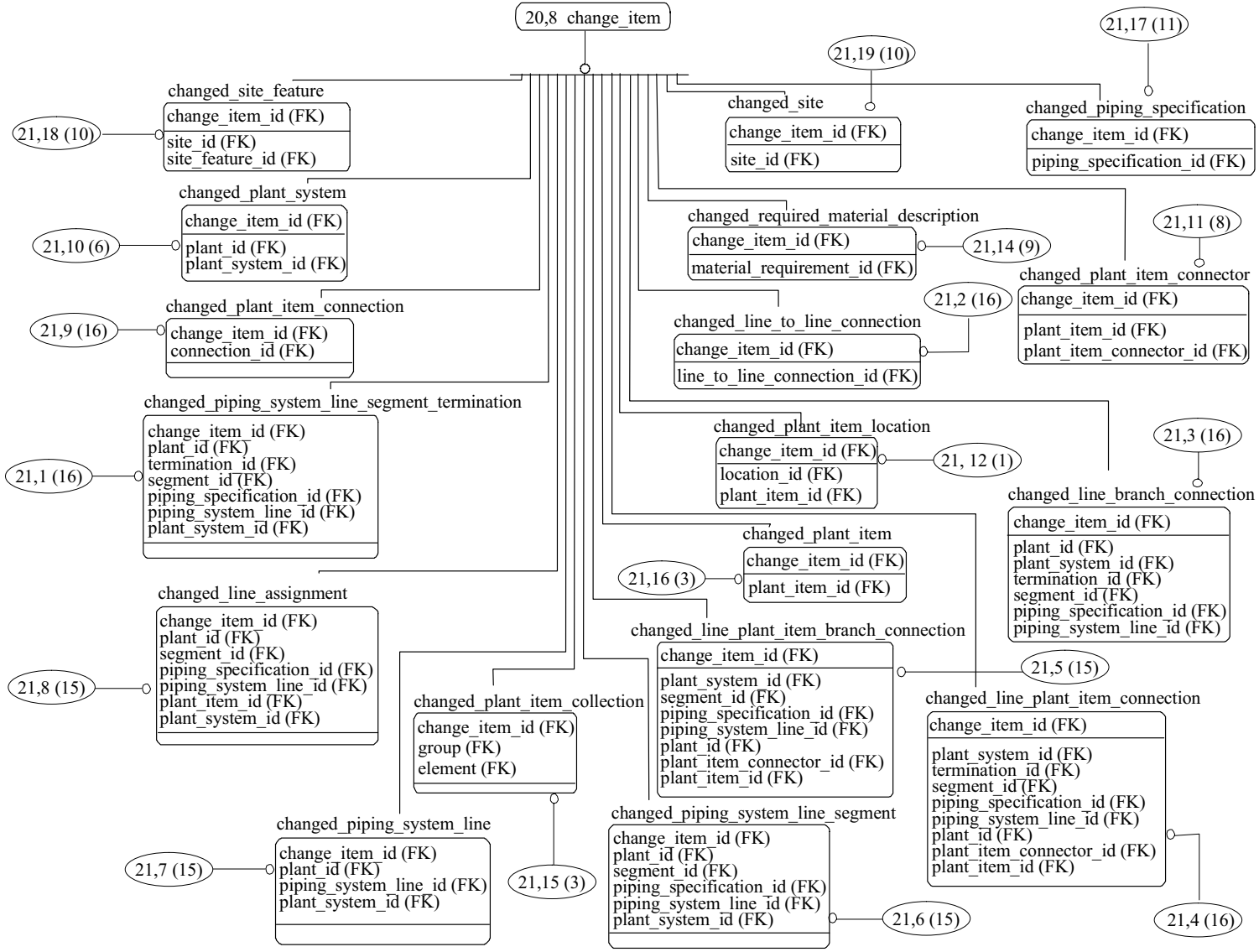


Figure G.22 - ARM diagram 21 of 25

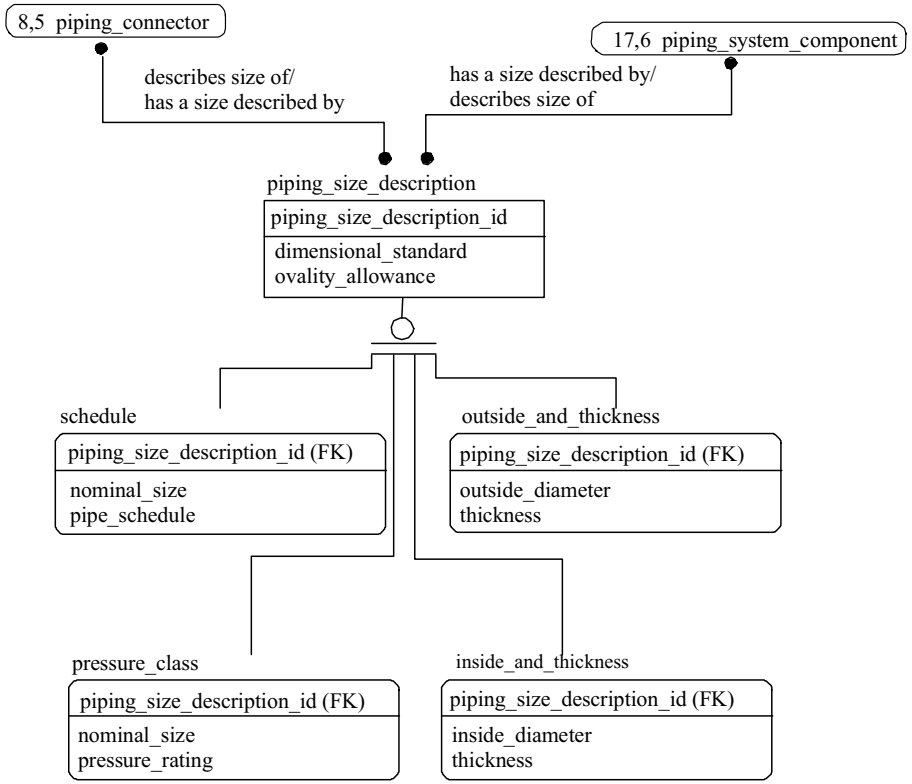


Figure G.23 - ARM diagram 22 of 25

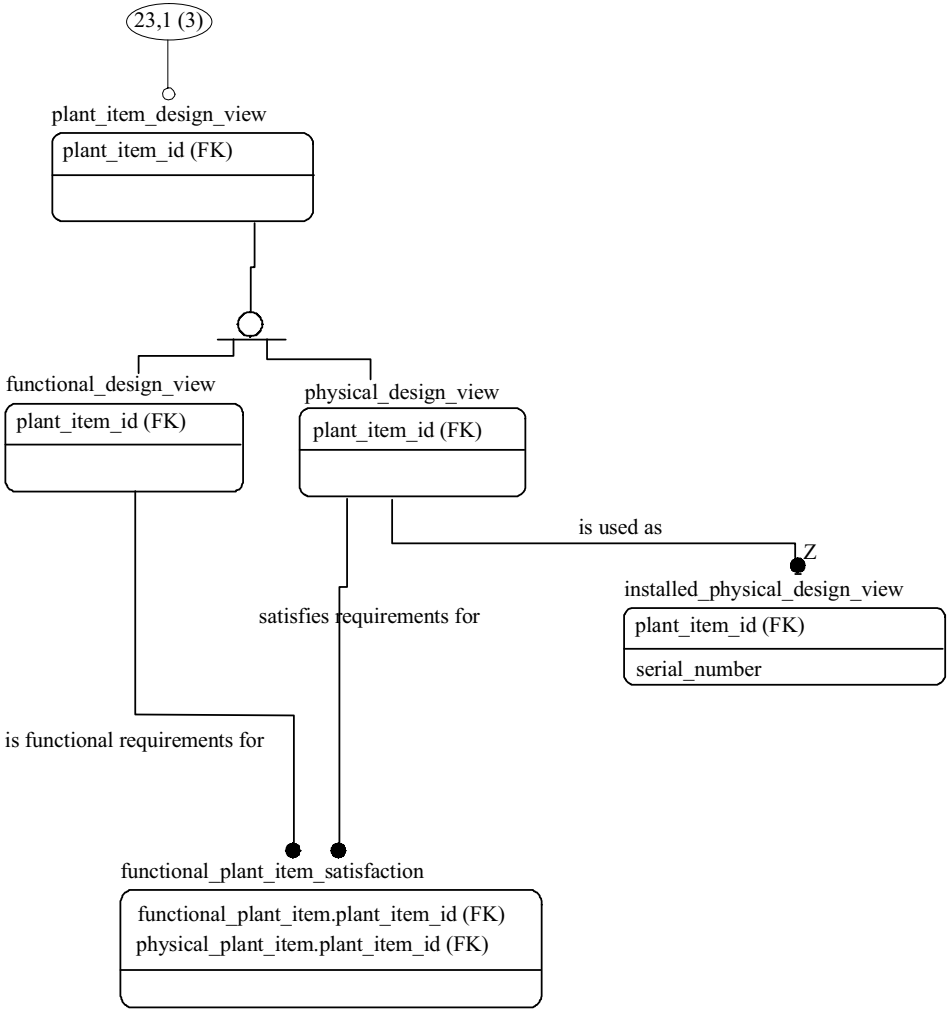


Figure G.24 - ARM diagram 23 of 25

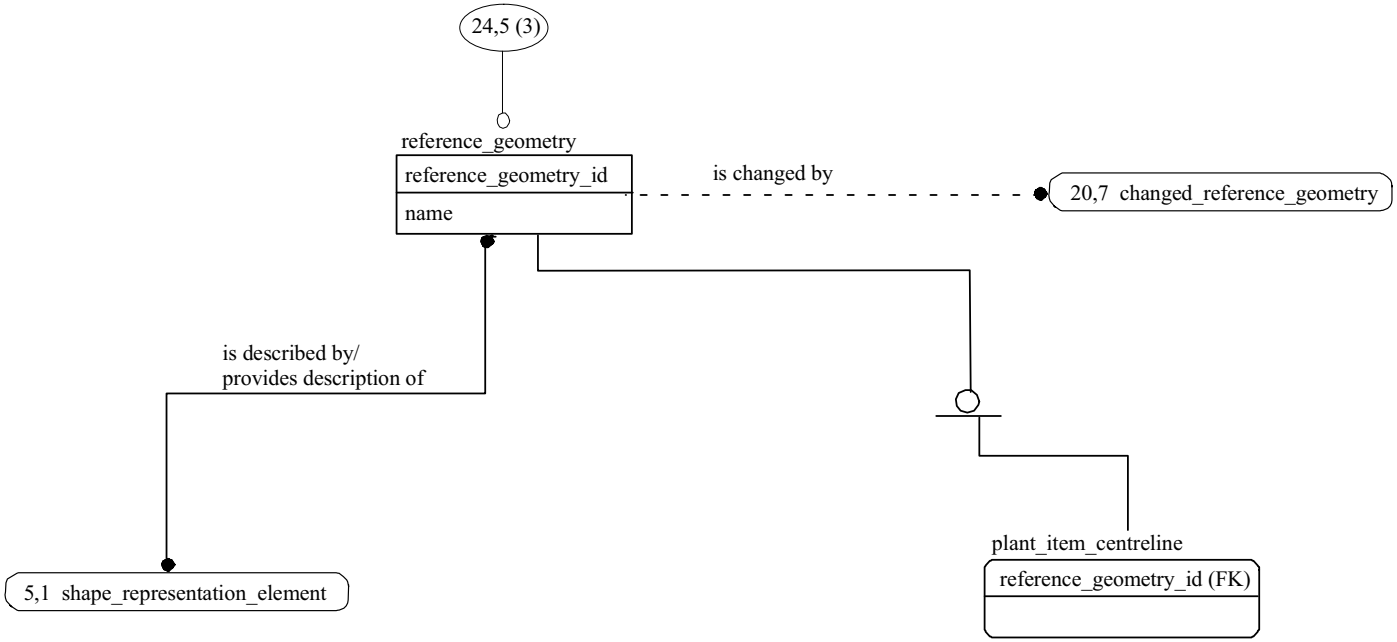


Figure G.25 - ARM diagram 24 of 25

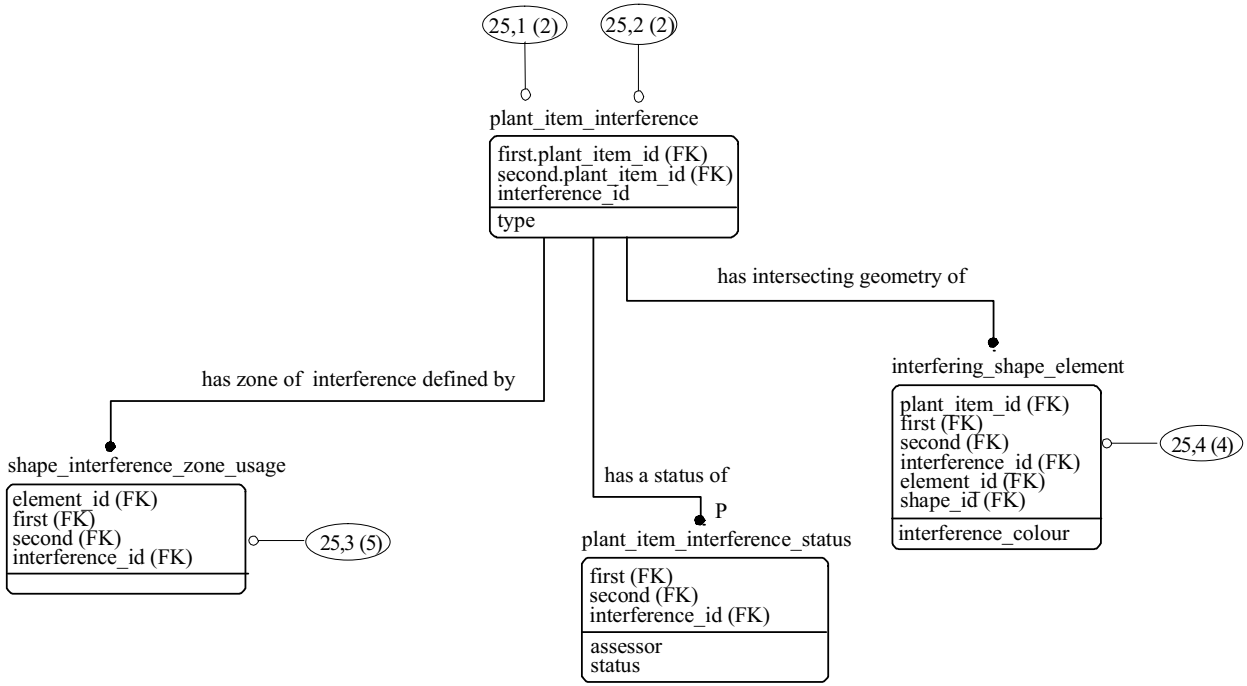


Figure G.26 - ARM diagram 25 of 25

Annex H
(informative)

AIM EXPRESS-G

Figures H.1 through H.32 correspond to the AIM EXPRESS expanded listing given in annex A. The figures use the EXPRESS-G graphical notation for the EXPRESS language. EXPRESS-G is defined in annex A of ISO 10303-11.

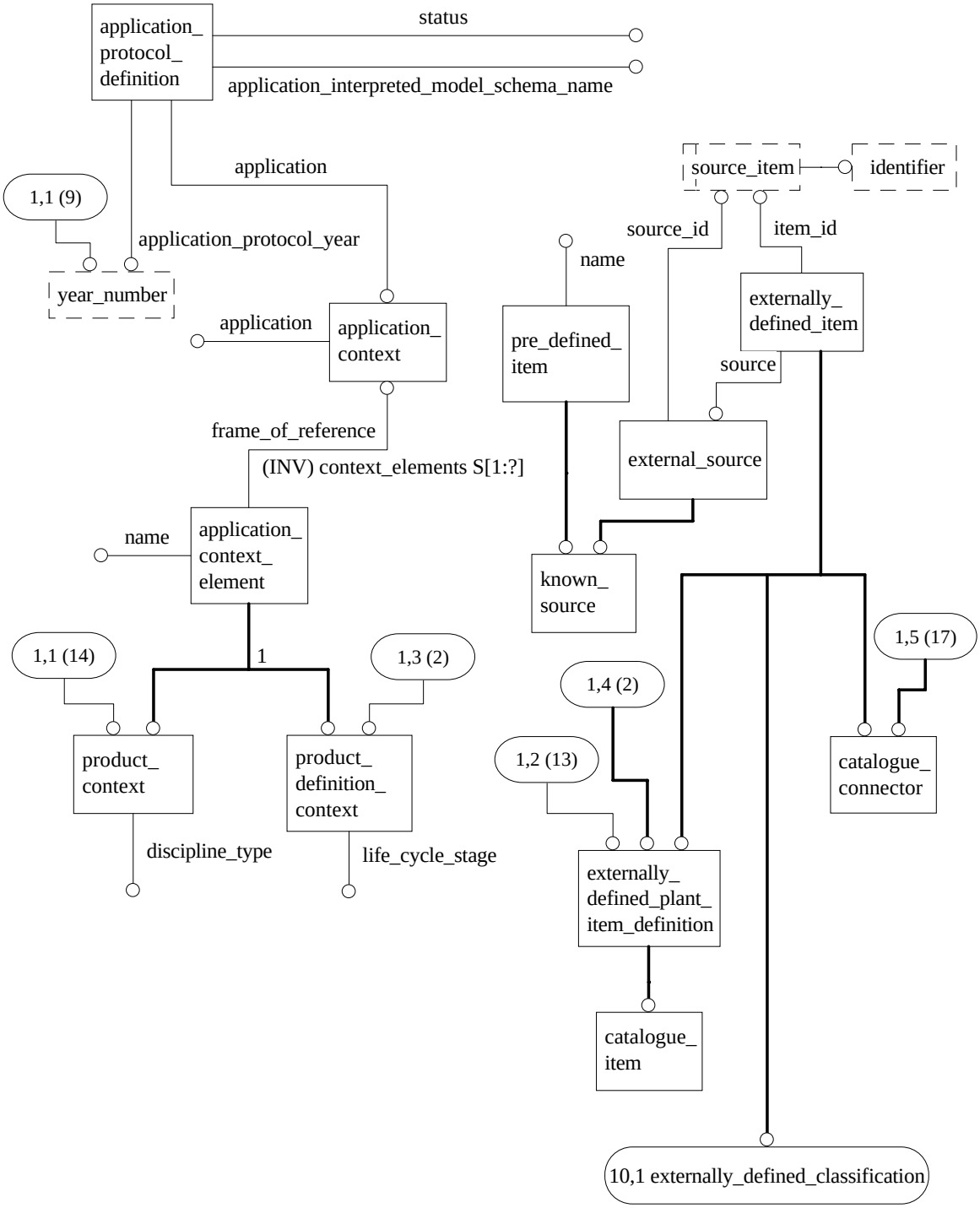


Figure H.1 - AIM EXPRESS-G diagram 1 of 32

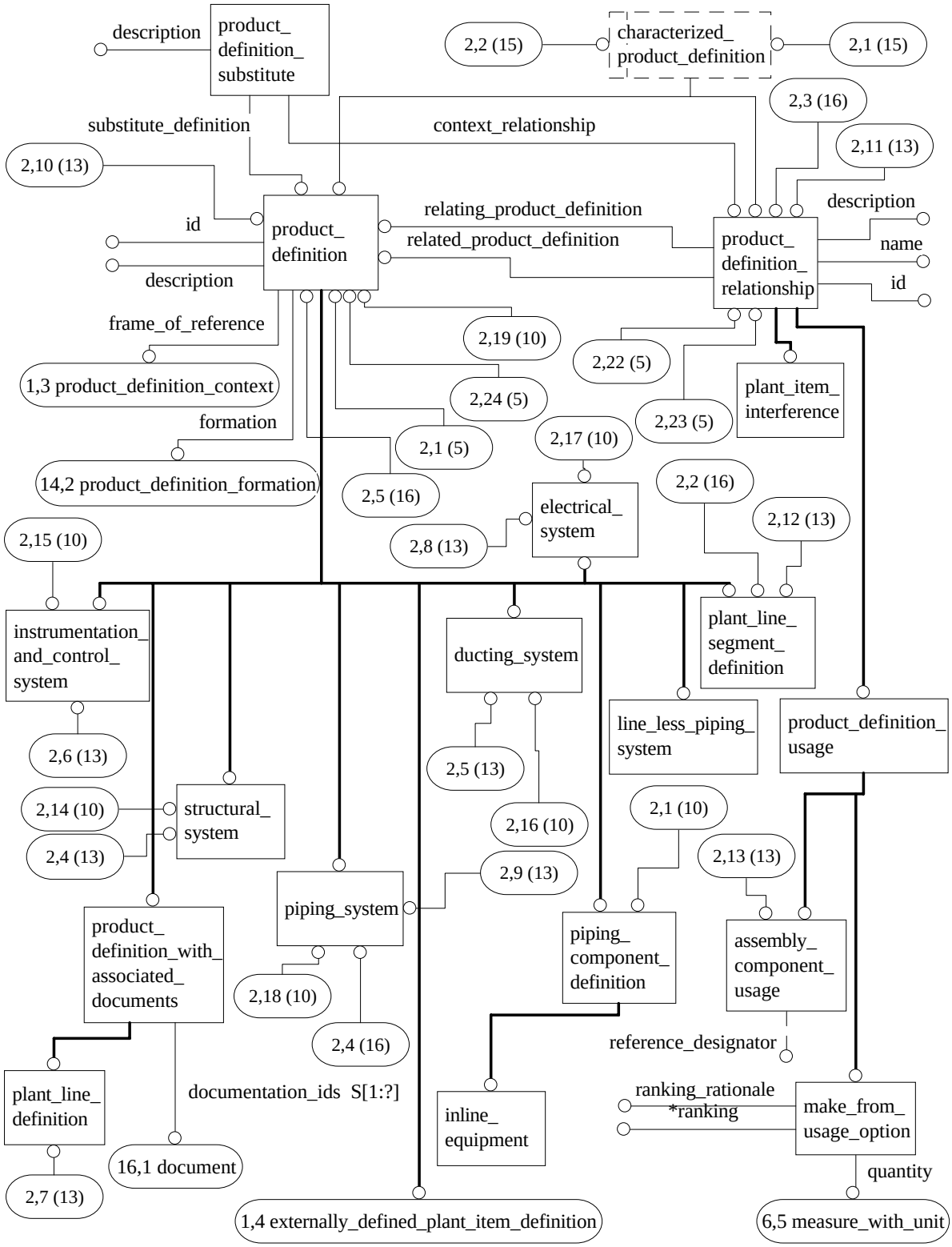


Figure H.2 - AIM EXPRESS-G diagram 2 of 32

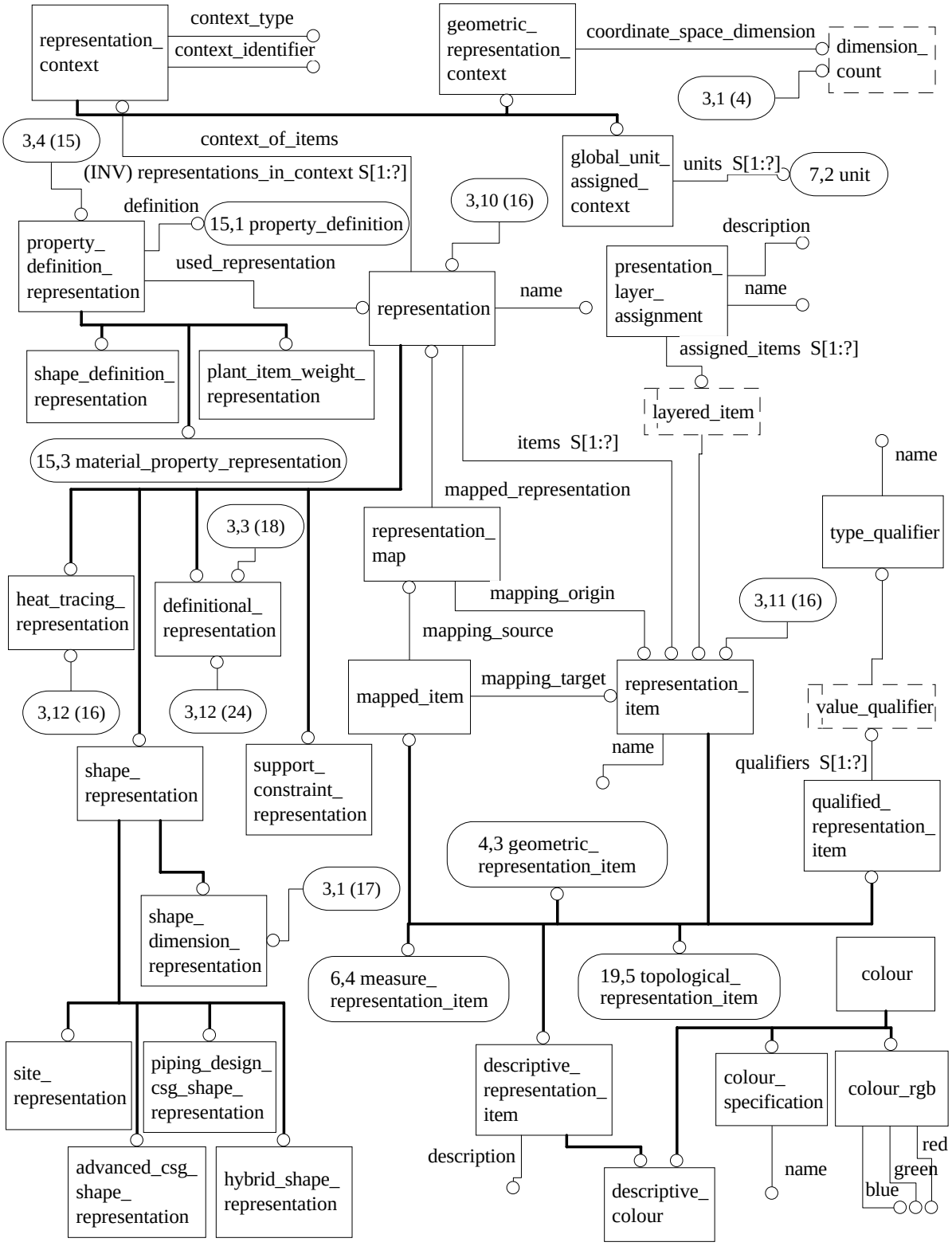


Figure H.3 - AIM EXPRESS-G diagram 3 of 32

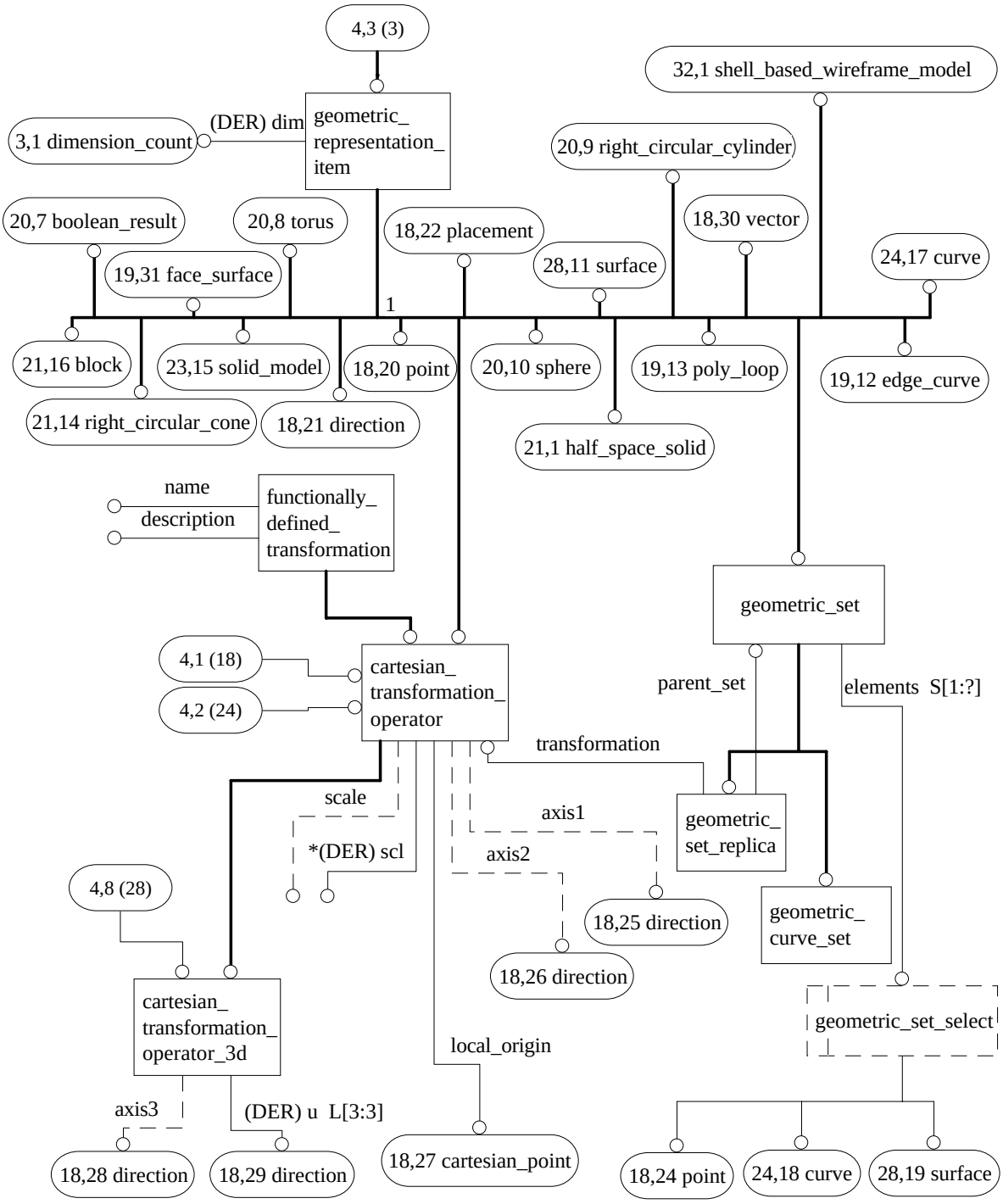


Figure H.4 - AIM EXPRESS-G diagram 4 of 32

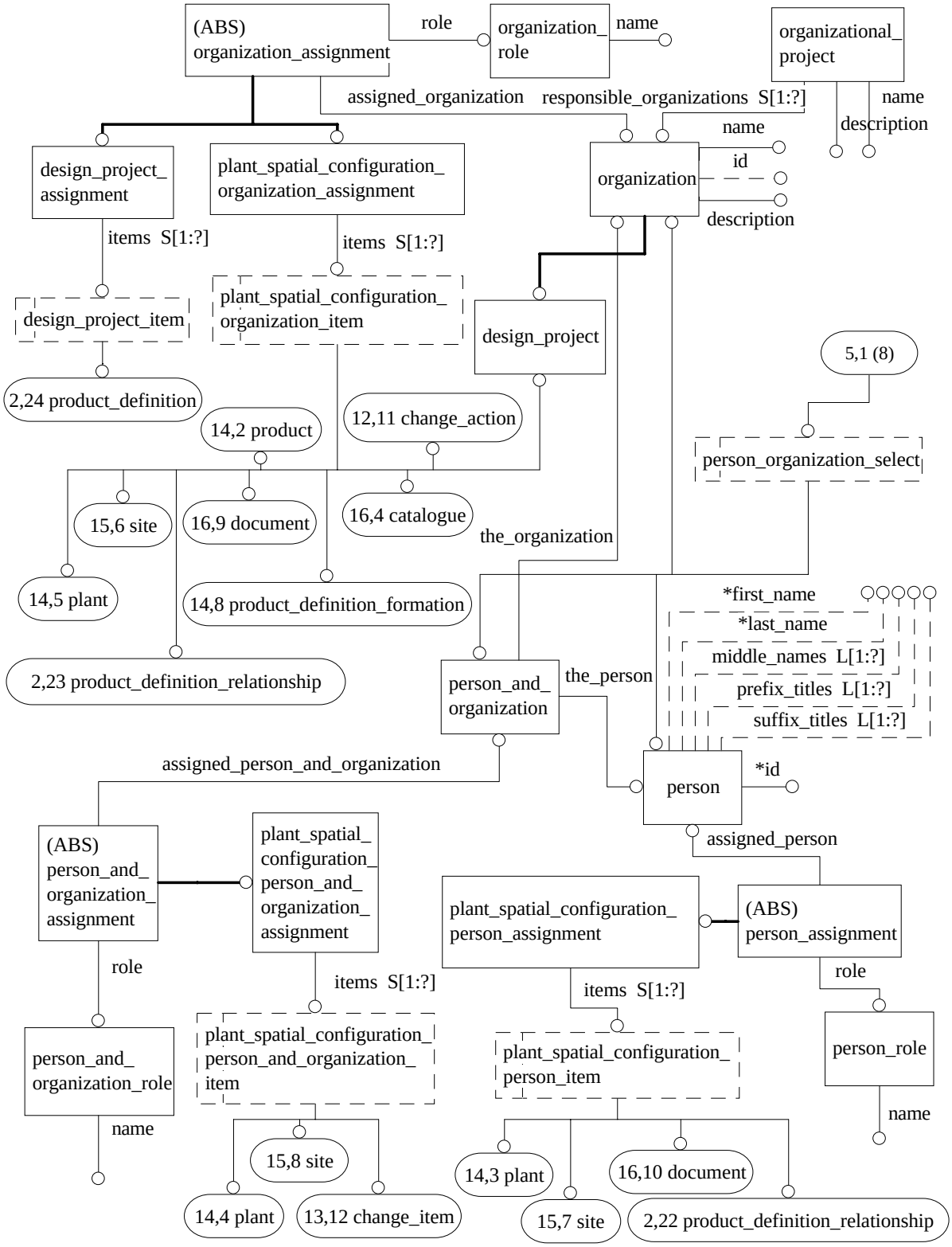


Figure H.5 - AIM EXPRESS-G diagram 5 of 32

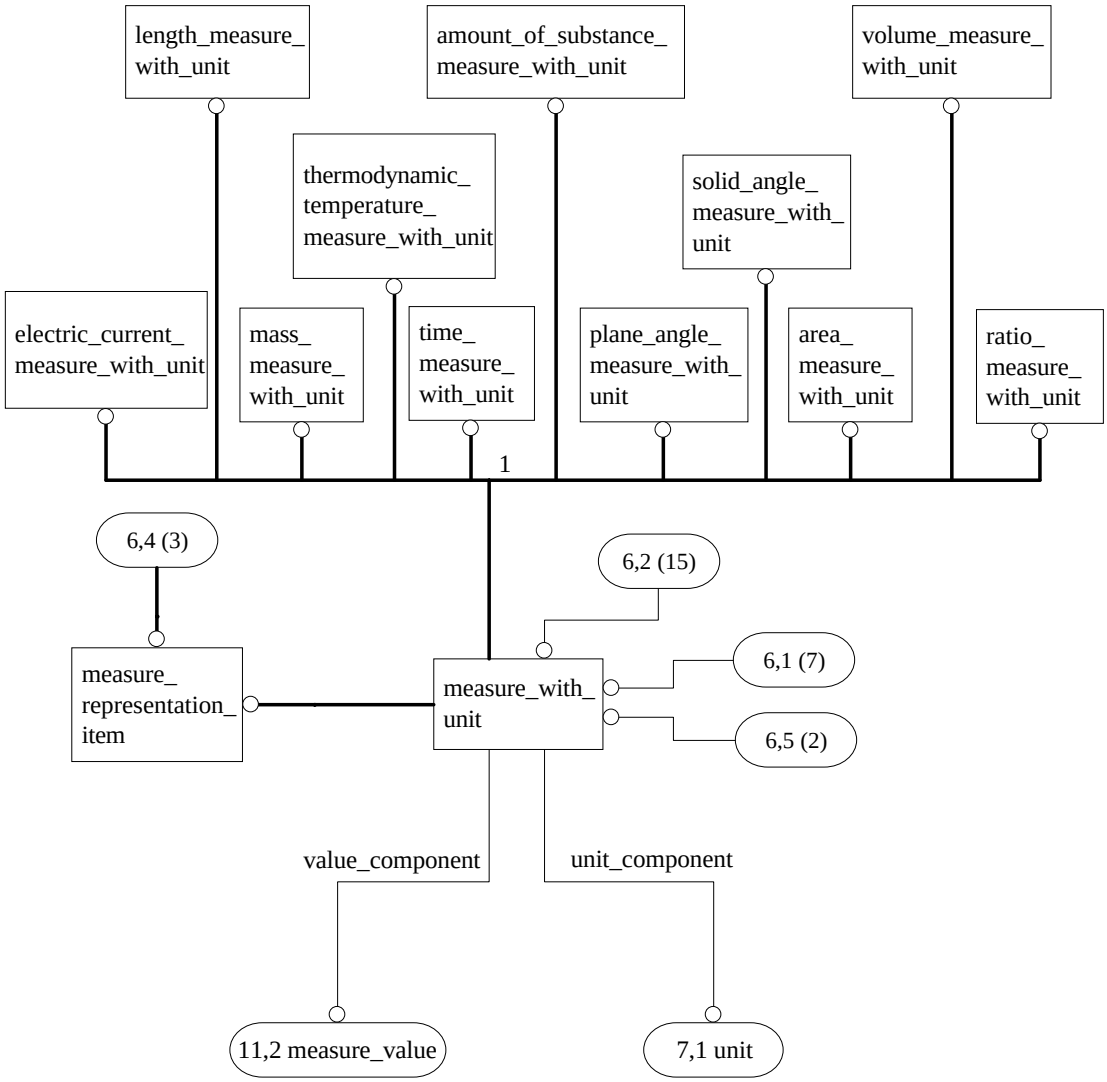


Figure H.6 - AIM EXPRESS-G diagram 6 of 32

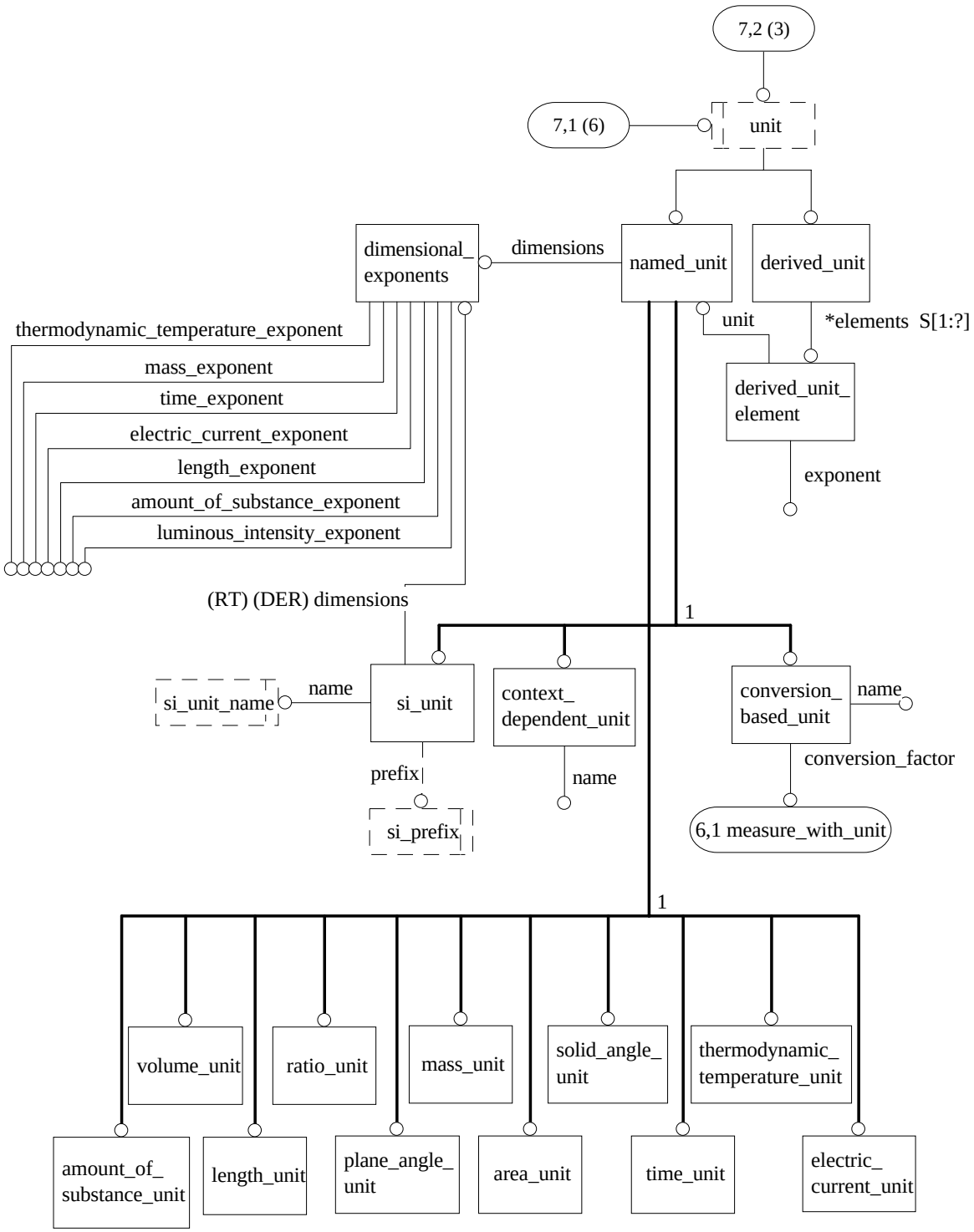


Figure H.7 - AIM EXPRESS-G diagram 7 of 32

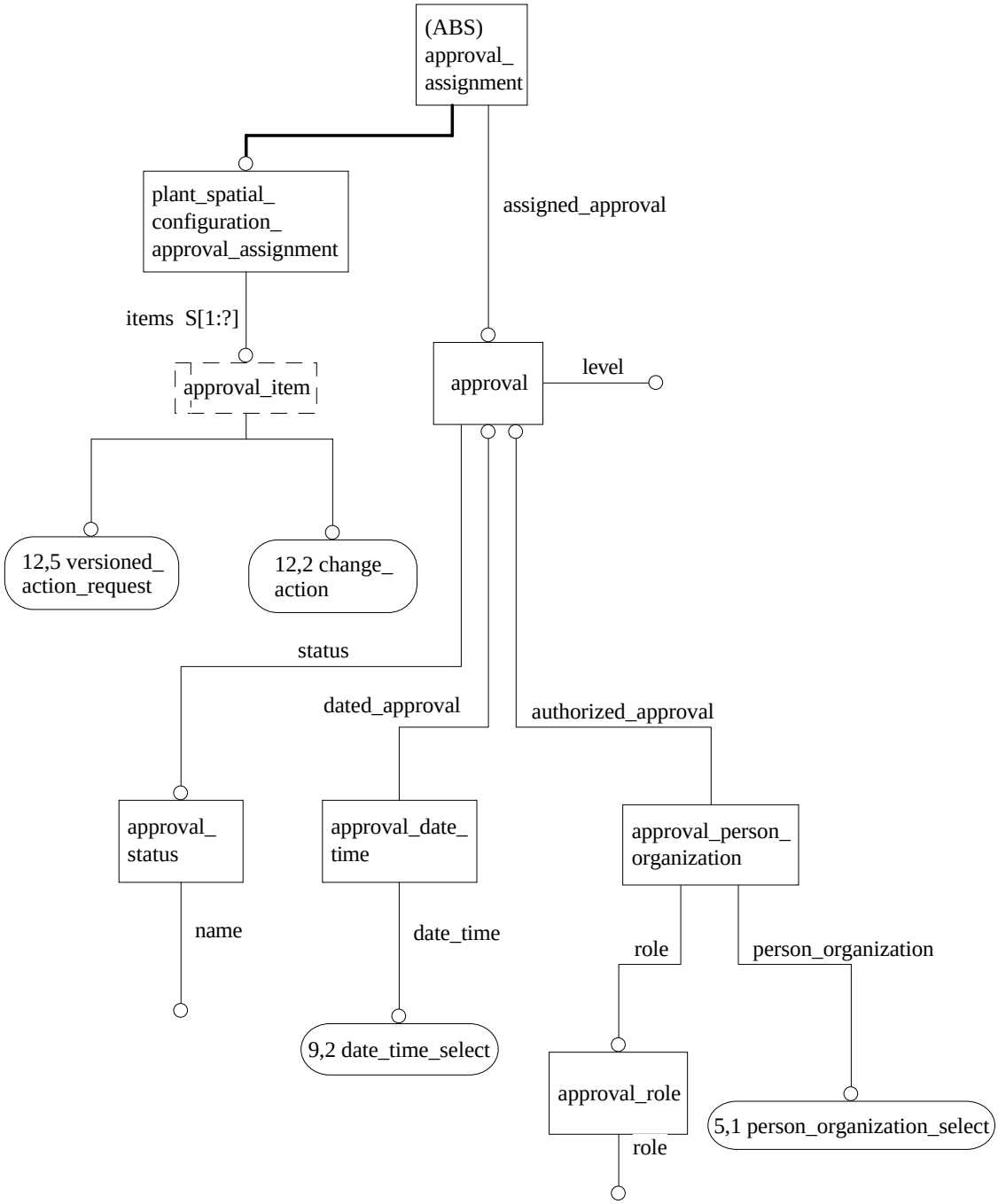


Figure H.8 - AIM EXPRESS-G diagram 8 of 32

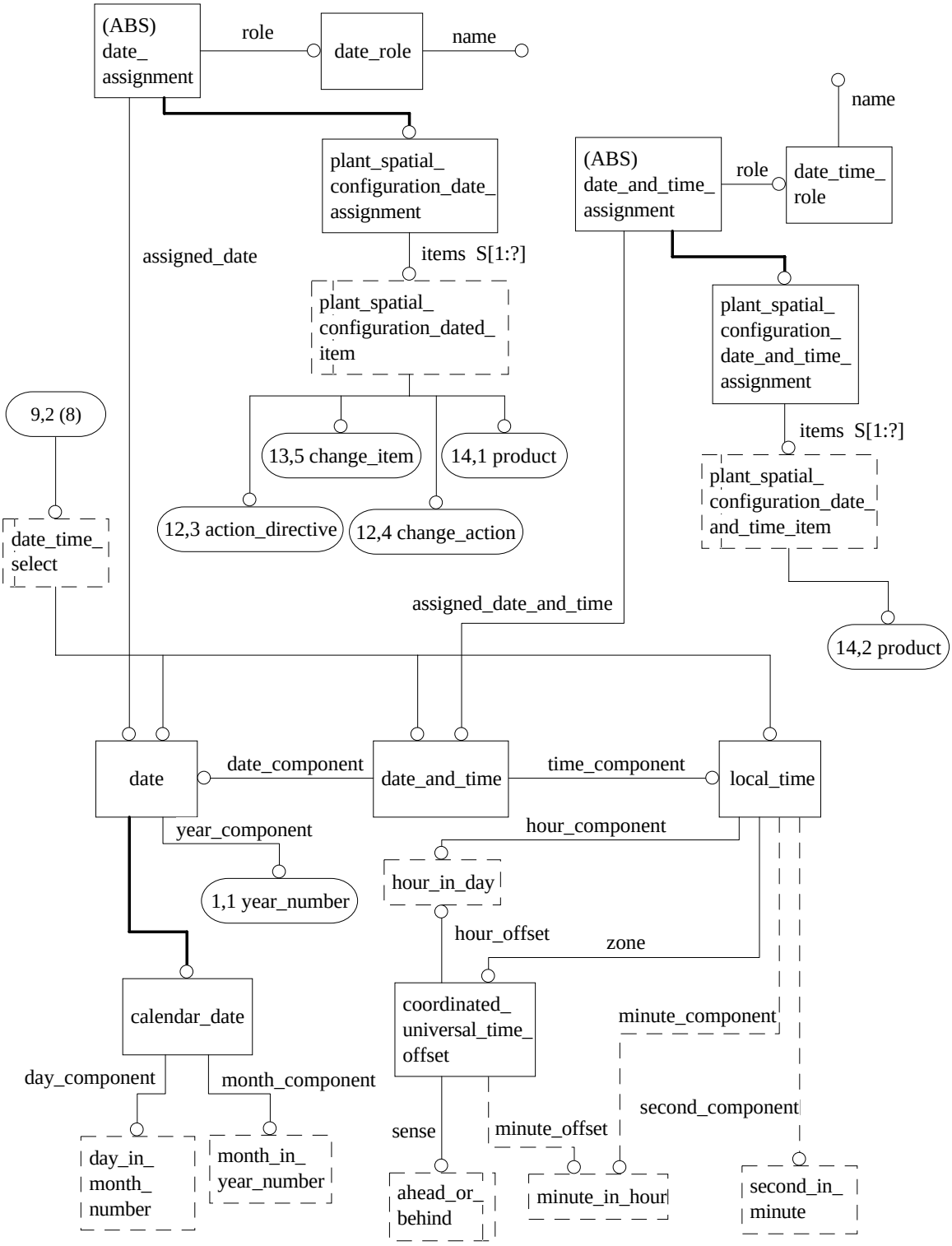


Figure H.9 - AIM EXPRESS-G diagram 9 of 32

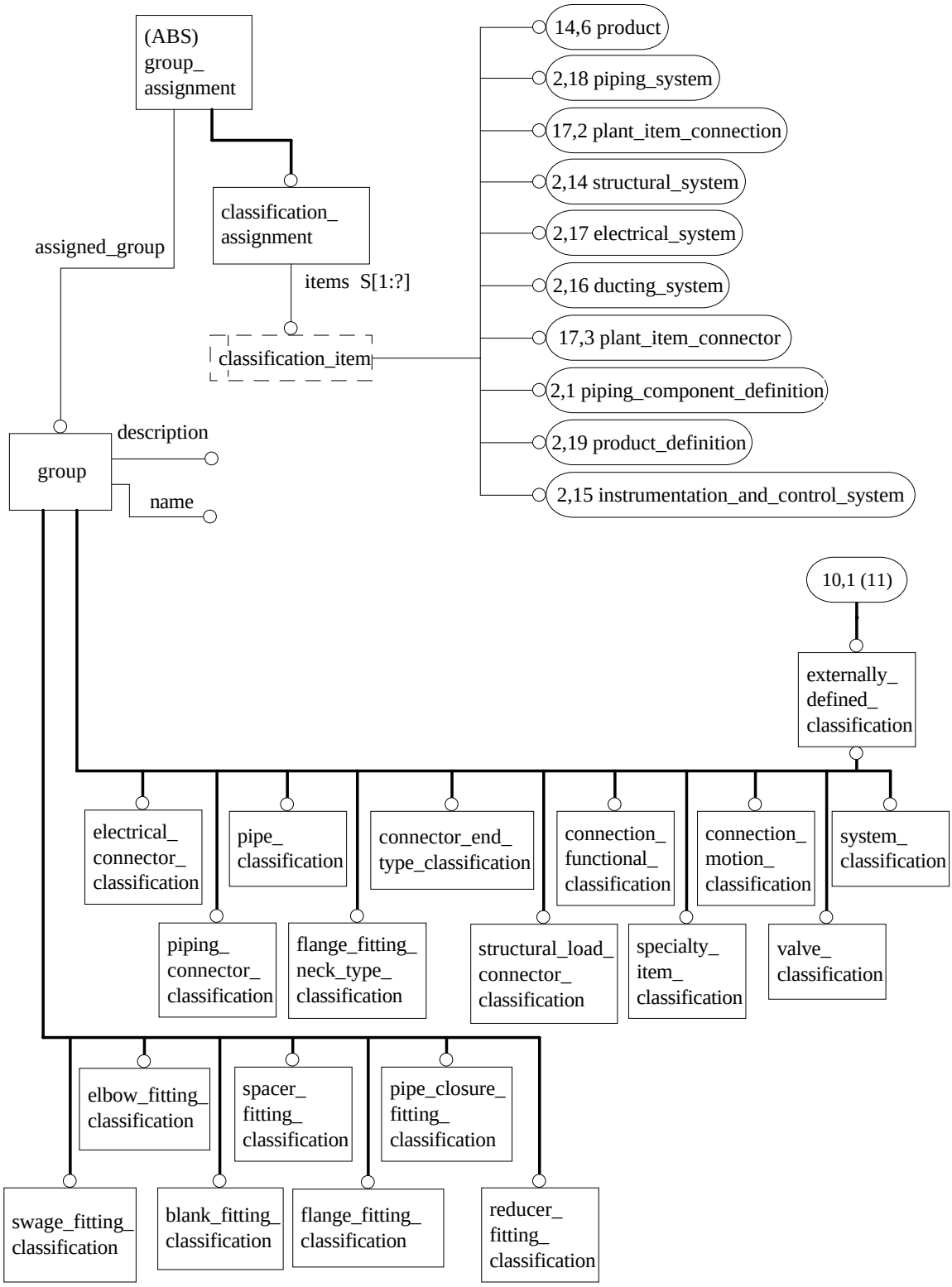


Figure H.10 - AIM EXPRESS-G diagram 10 of 32

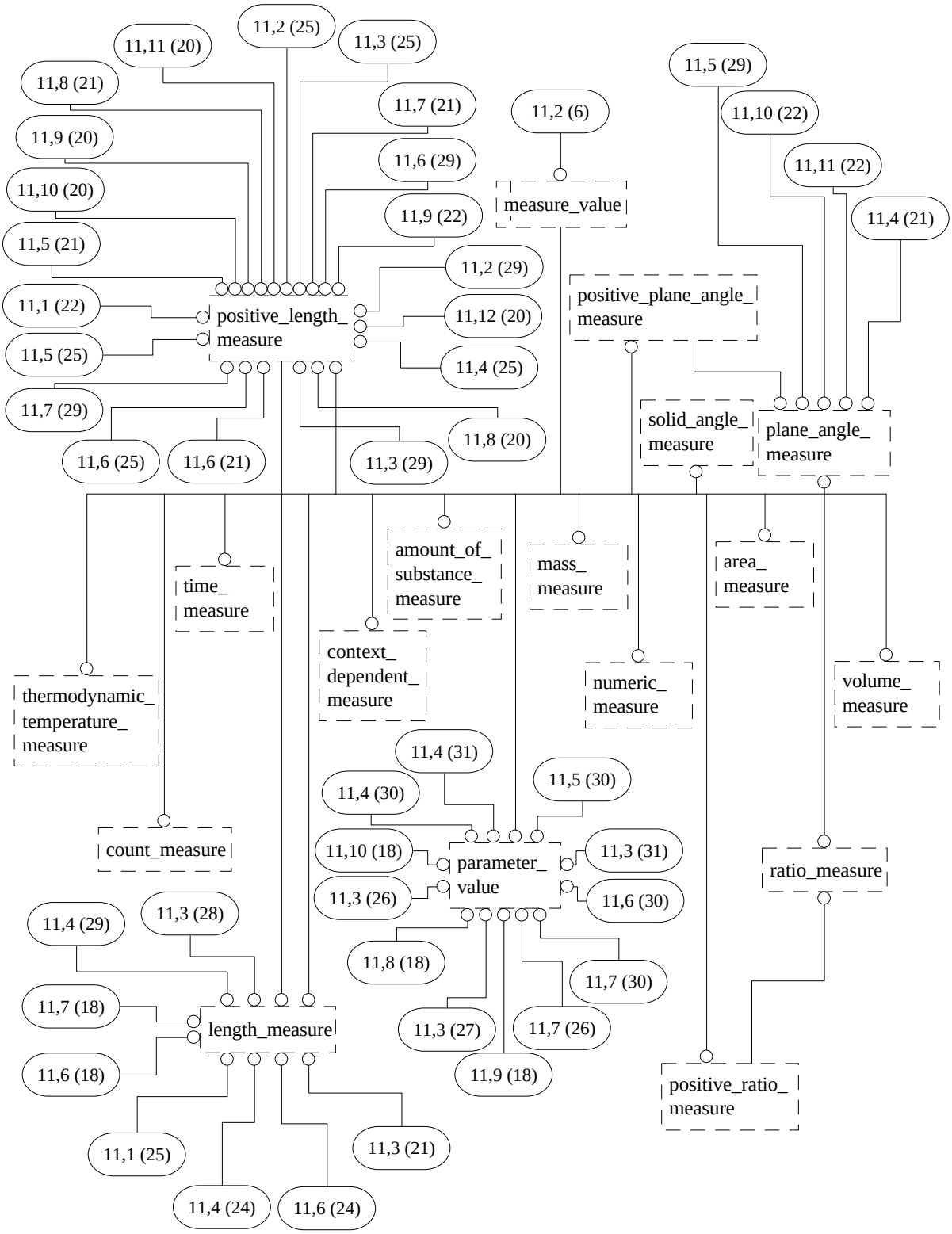


Figure H.11 - AIM EXPRESS-G diagram 11 of 32

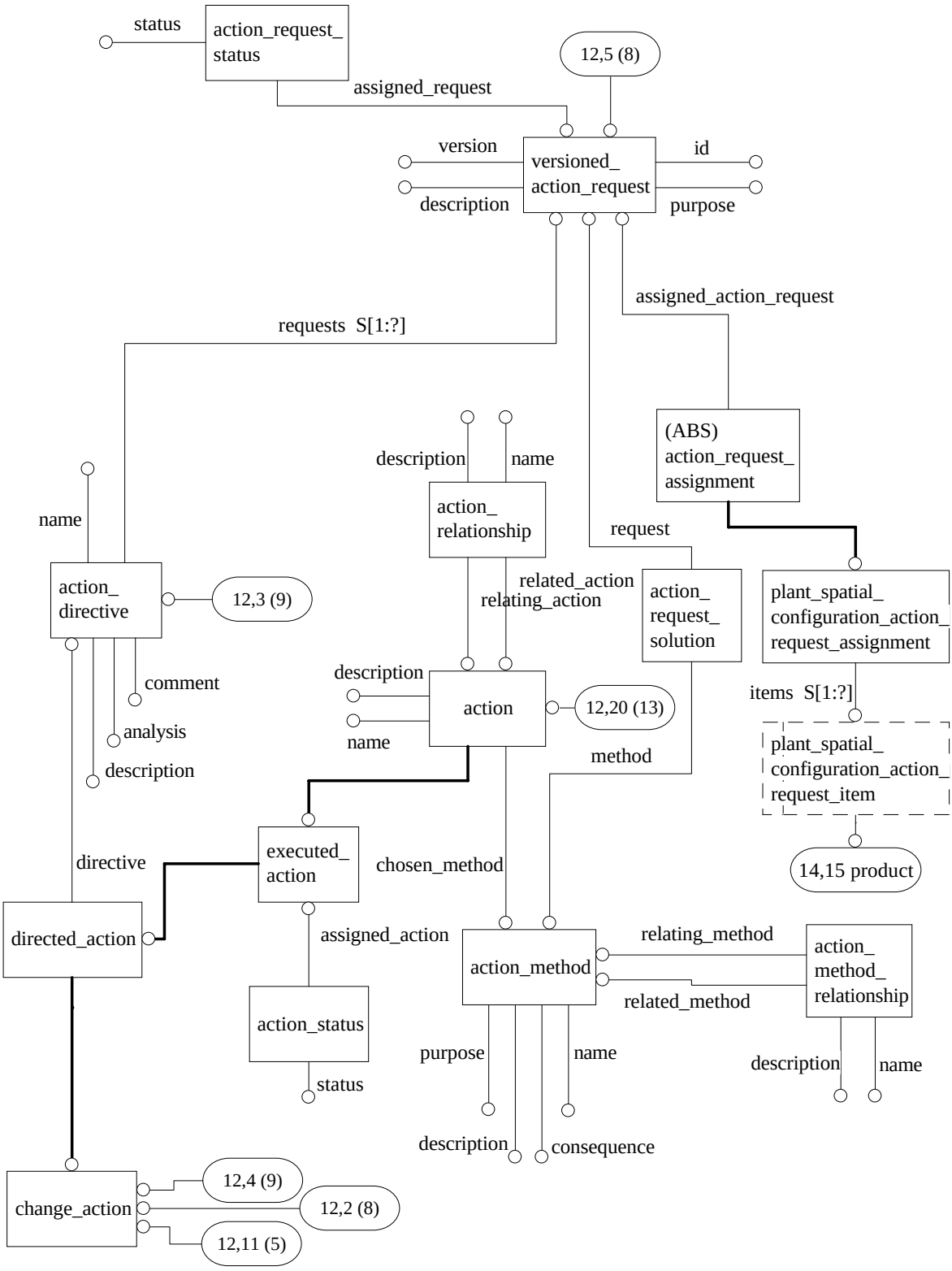


Figure H.12 - AIM EXPRESS-G diagram 12 of 32

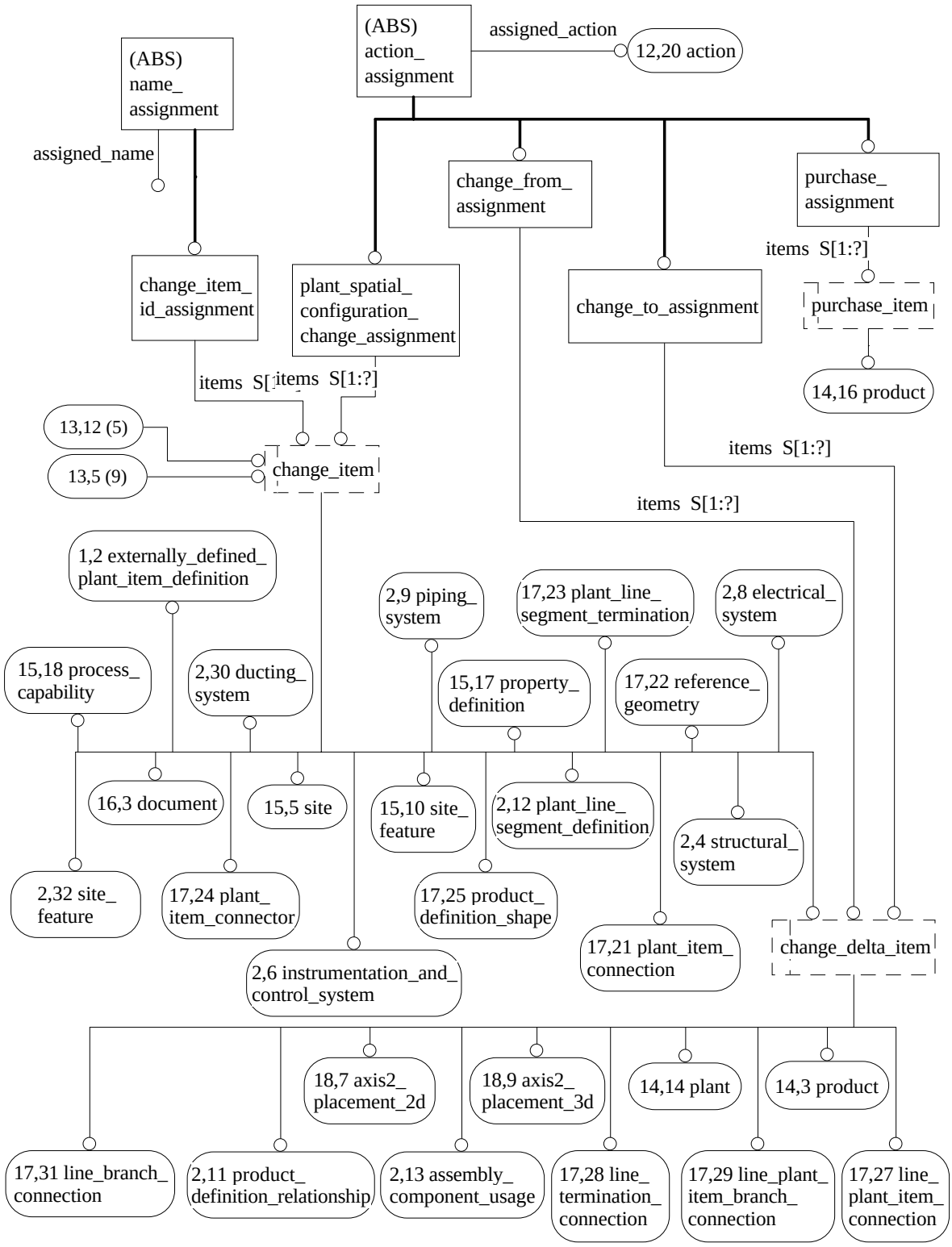


Figure H.13 - AIM EXPRESS-G diagram 13 of 32

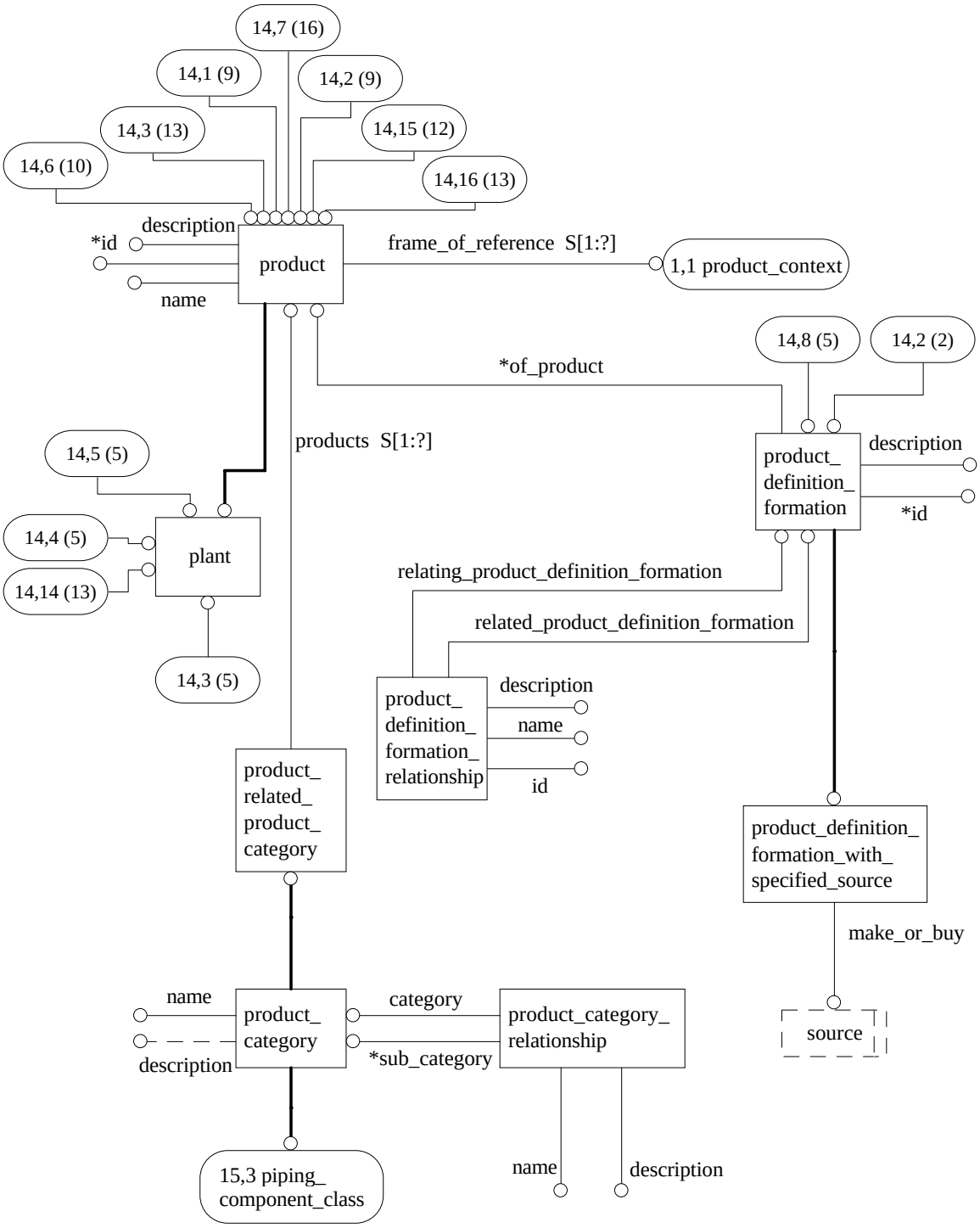


Figure H.14 - AIM EXPRESS-G diagram 14 of 32

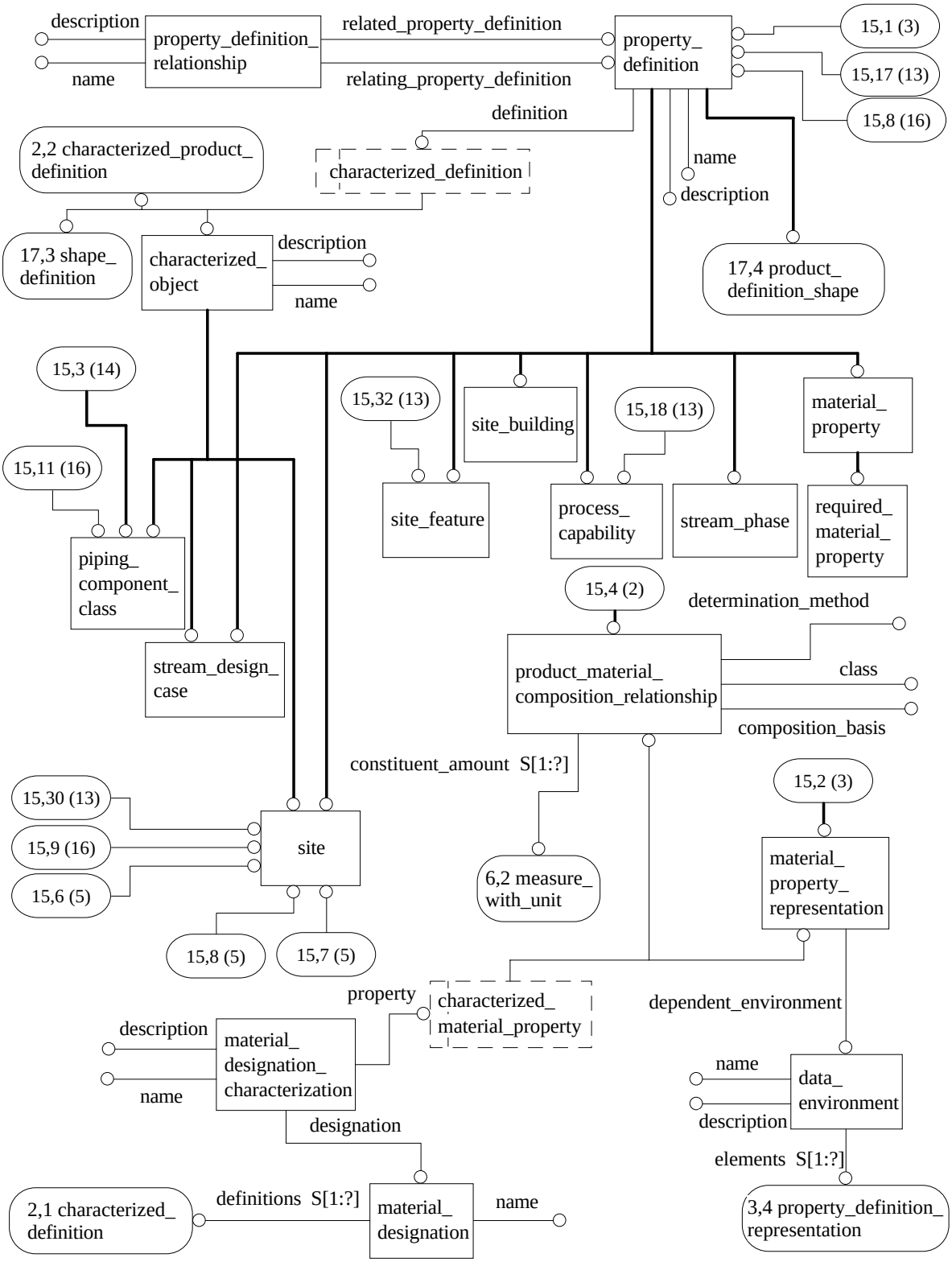


Figure H.15 - AIM EXPRESS-G diagram 15 of 32

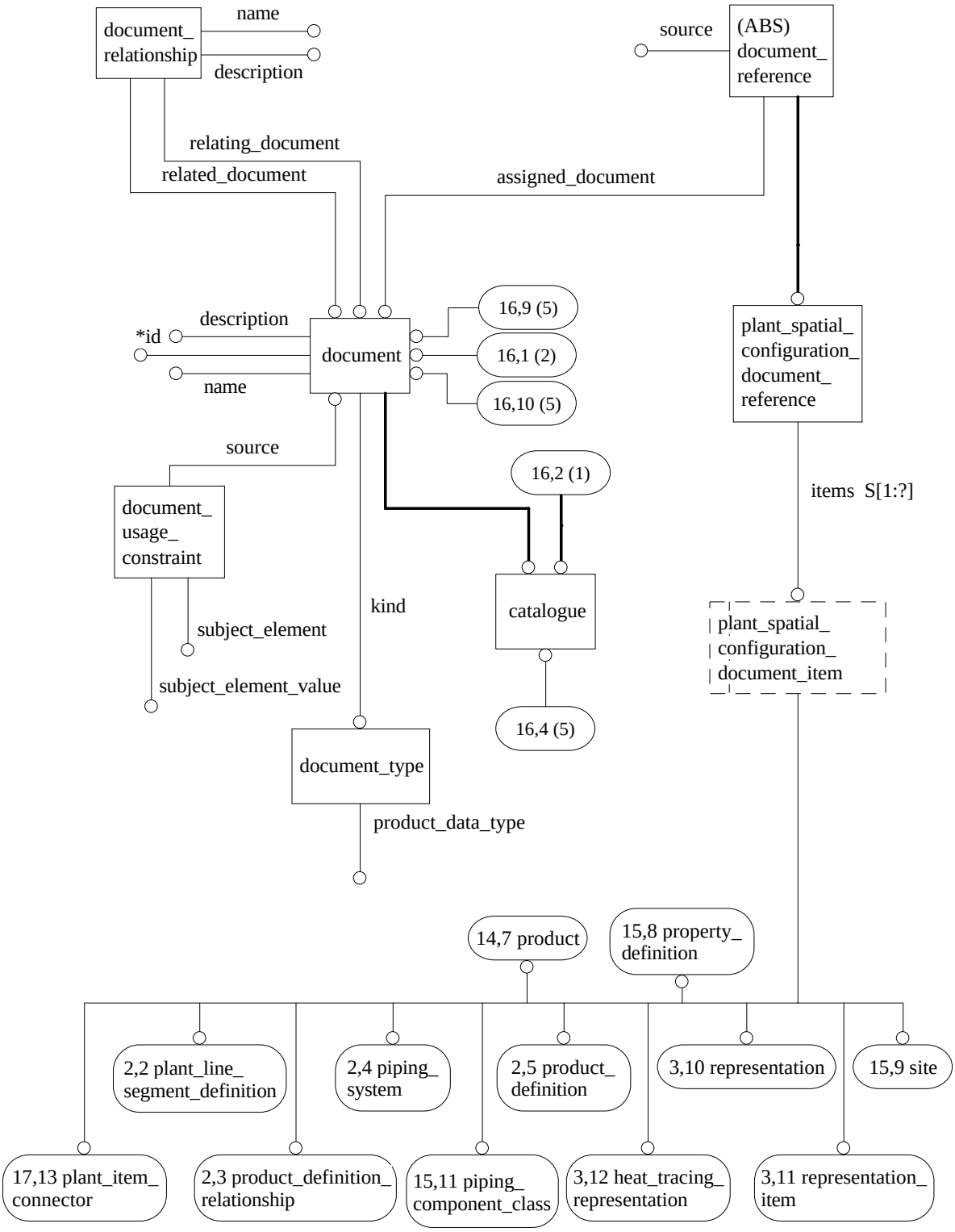


Figure H.16 - AIM EXPRESS-G diagram 16 of 32

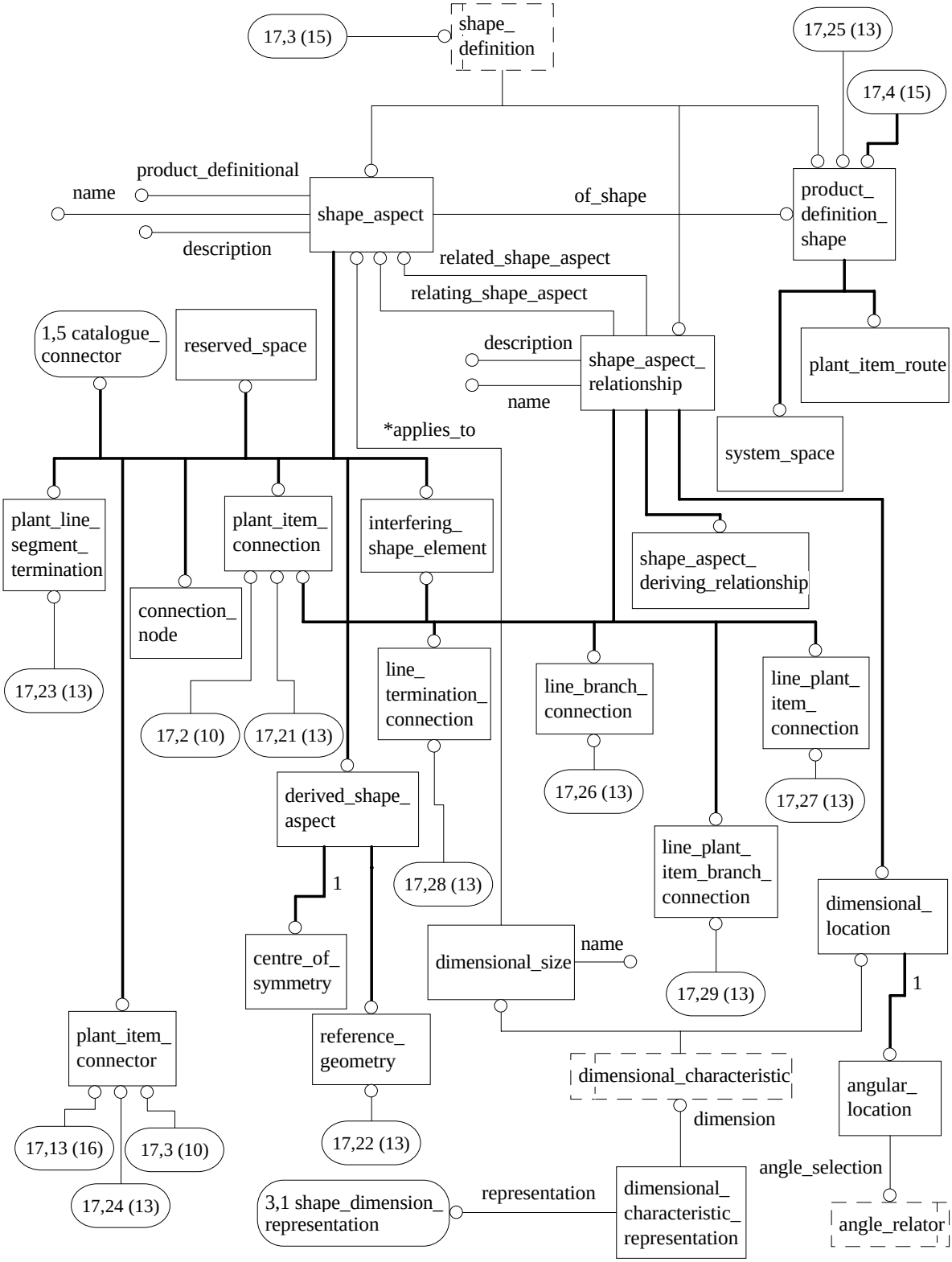


Figure H.17 - AIM EXPRESS-G diagram 17 of 32

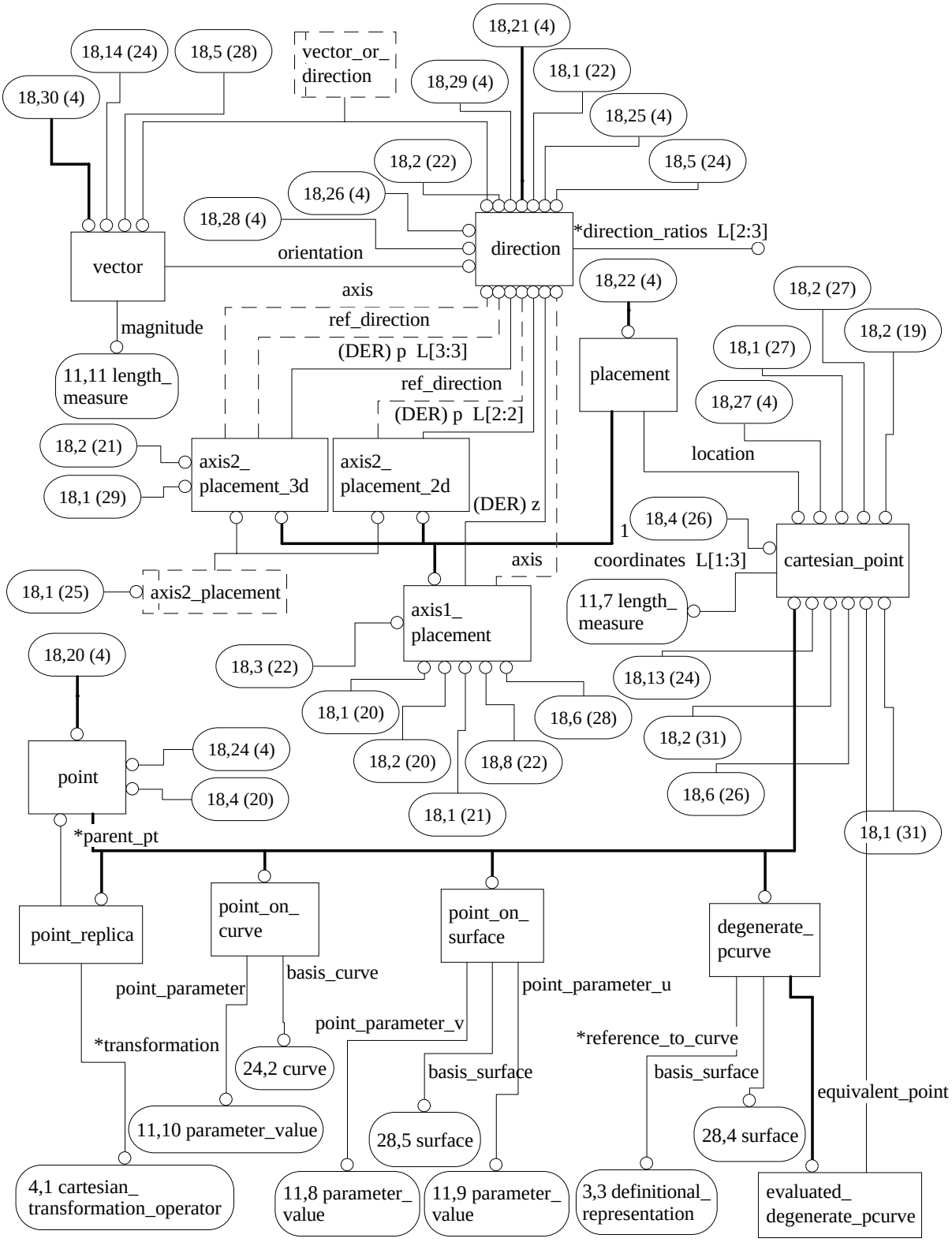


Figure H.18 - AIM EXPRESS-G diagram 18 of 32

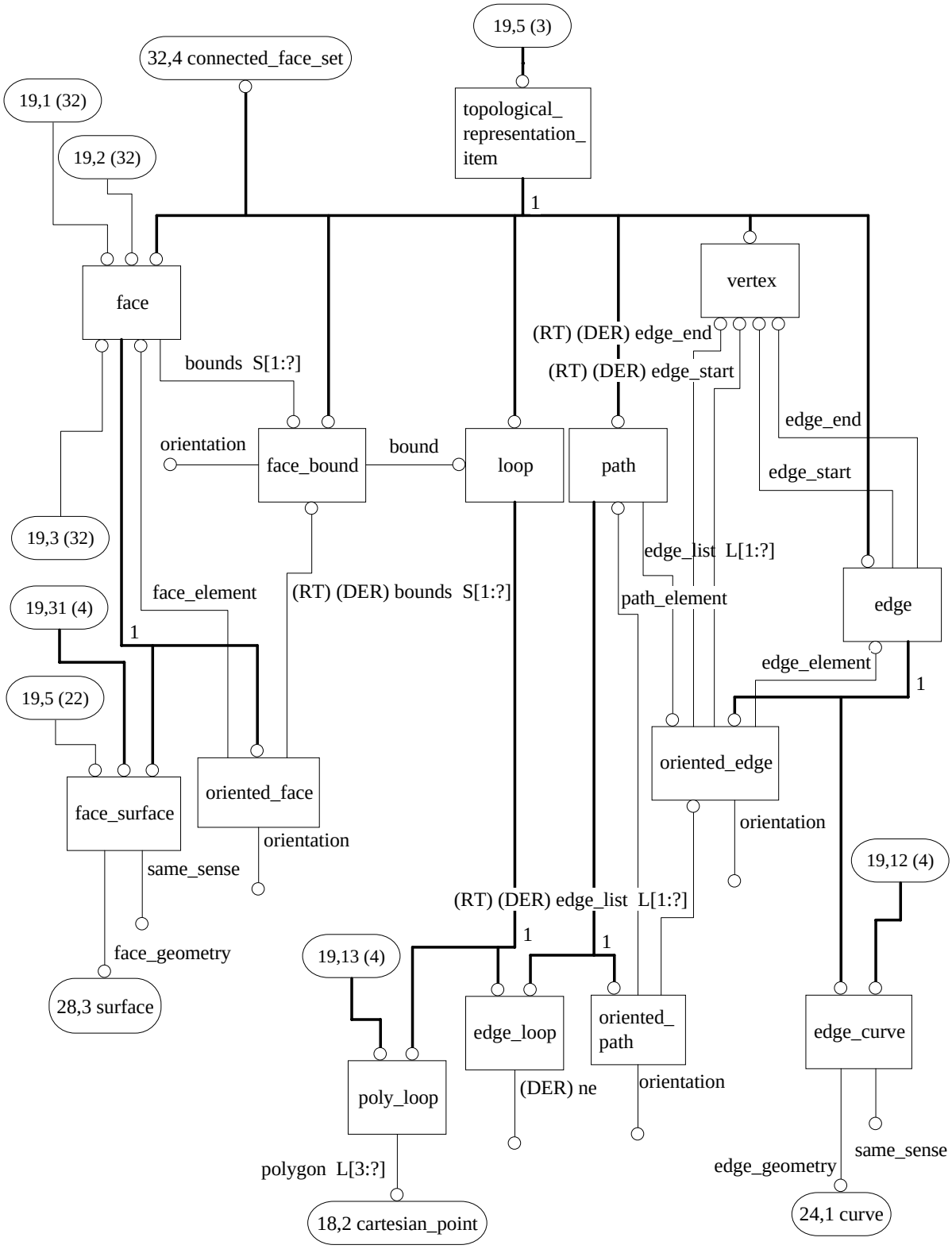


Figure H.19 - AIM EXPRESS-G diagram 19 of 32

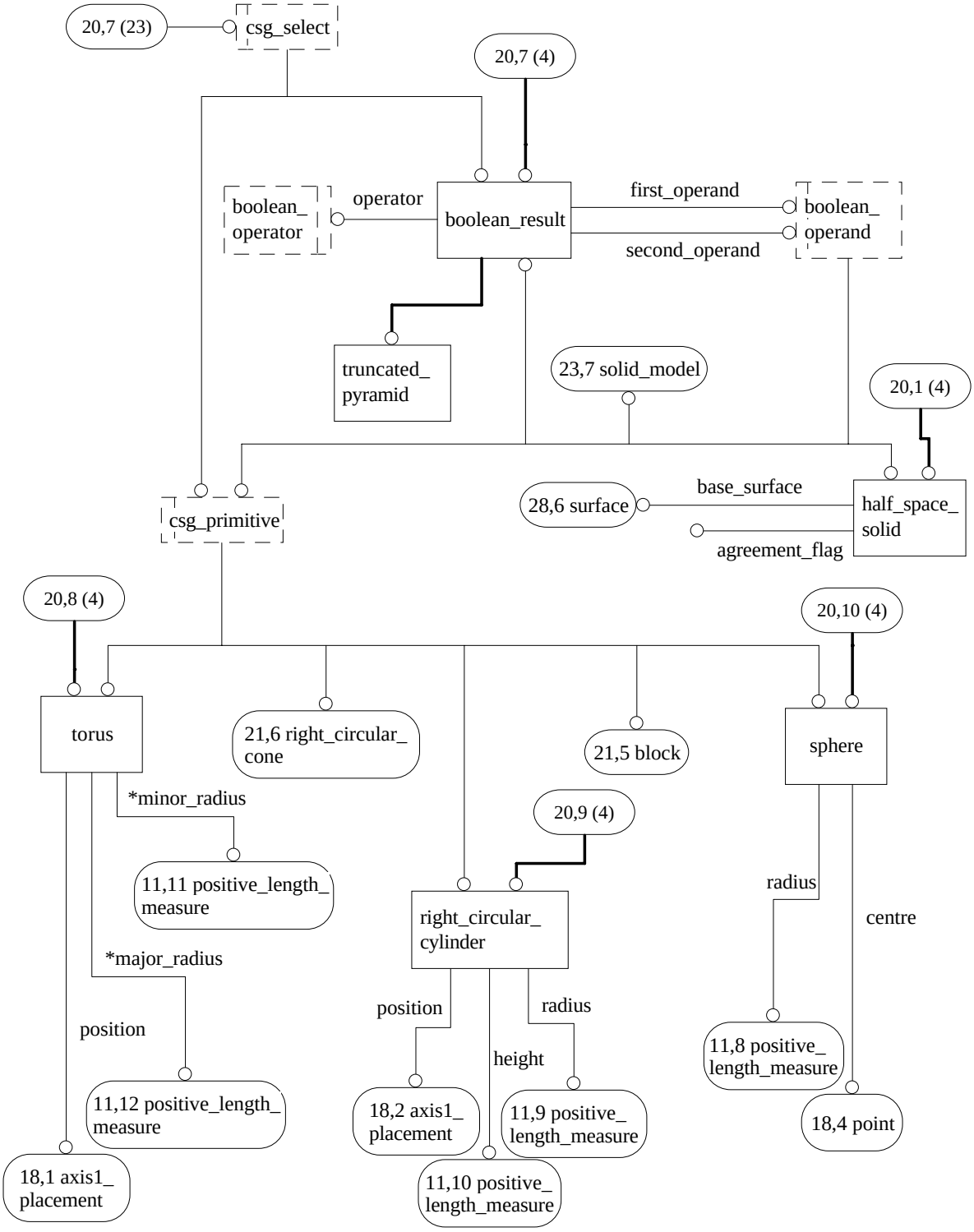


Figure H.20 - AIM EXPRESS-G diagram 20 of 32

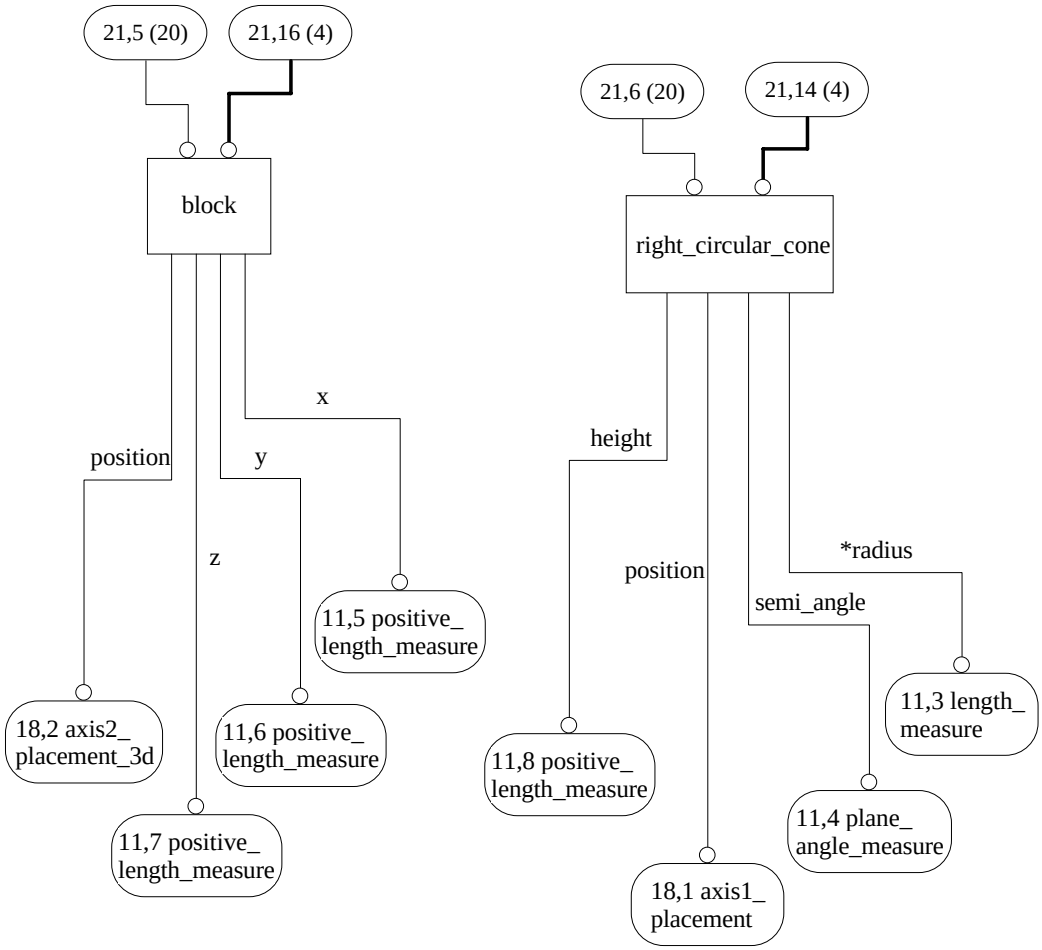


Figure H.21 - AIM EXPRESS-G diagram 21 of 32

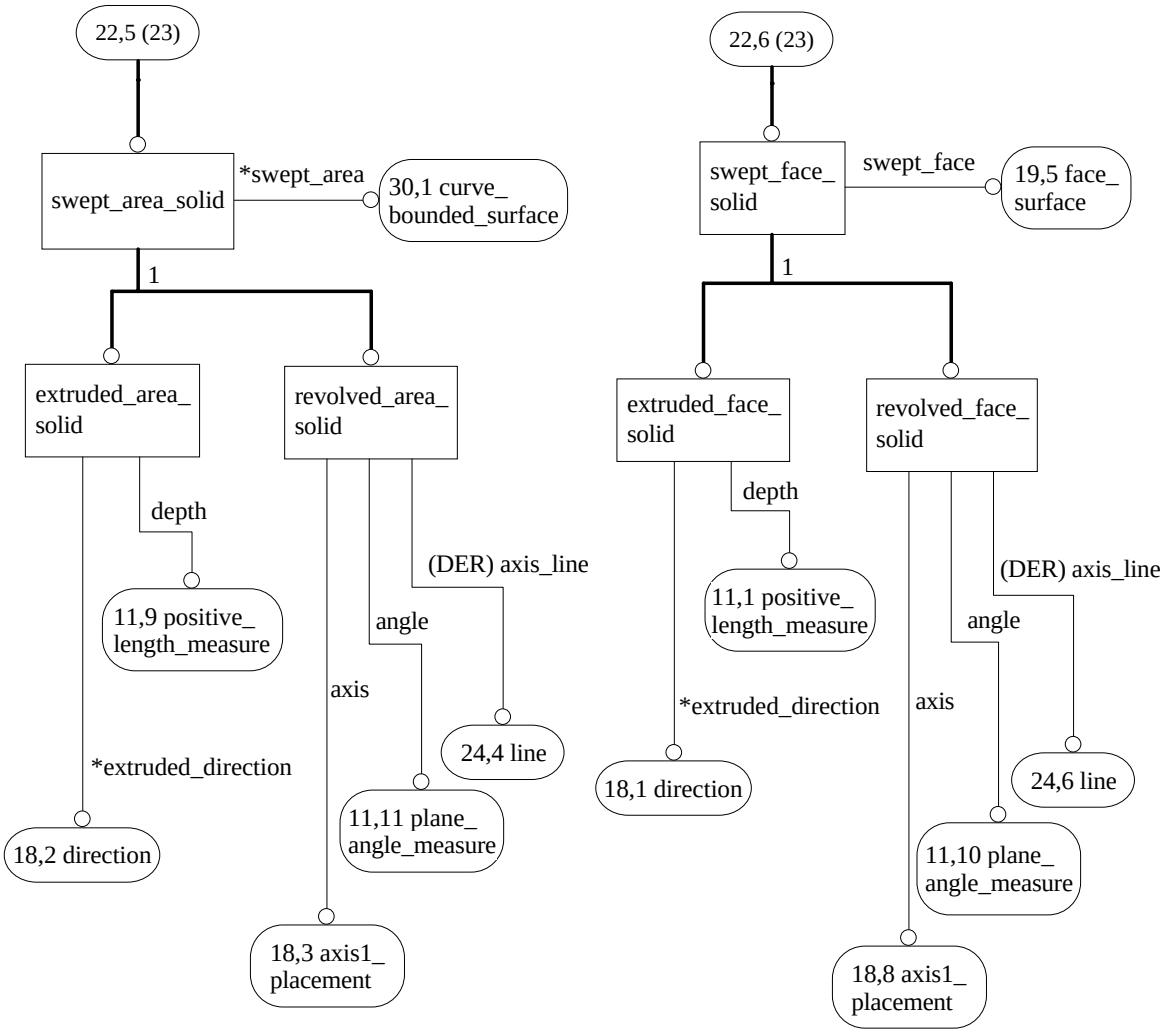


Figure H.22 - AIM EXPRESS-G diagram 22 of 32

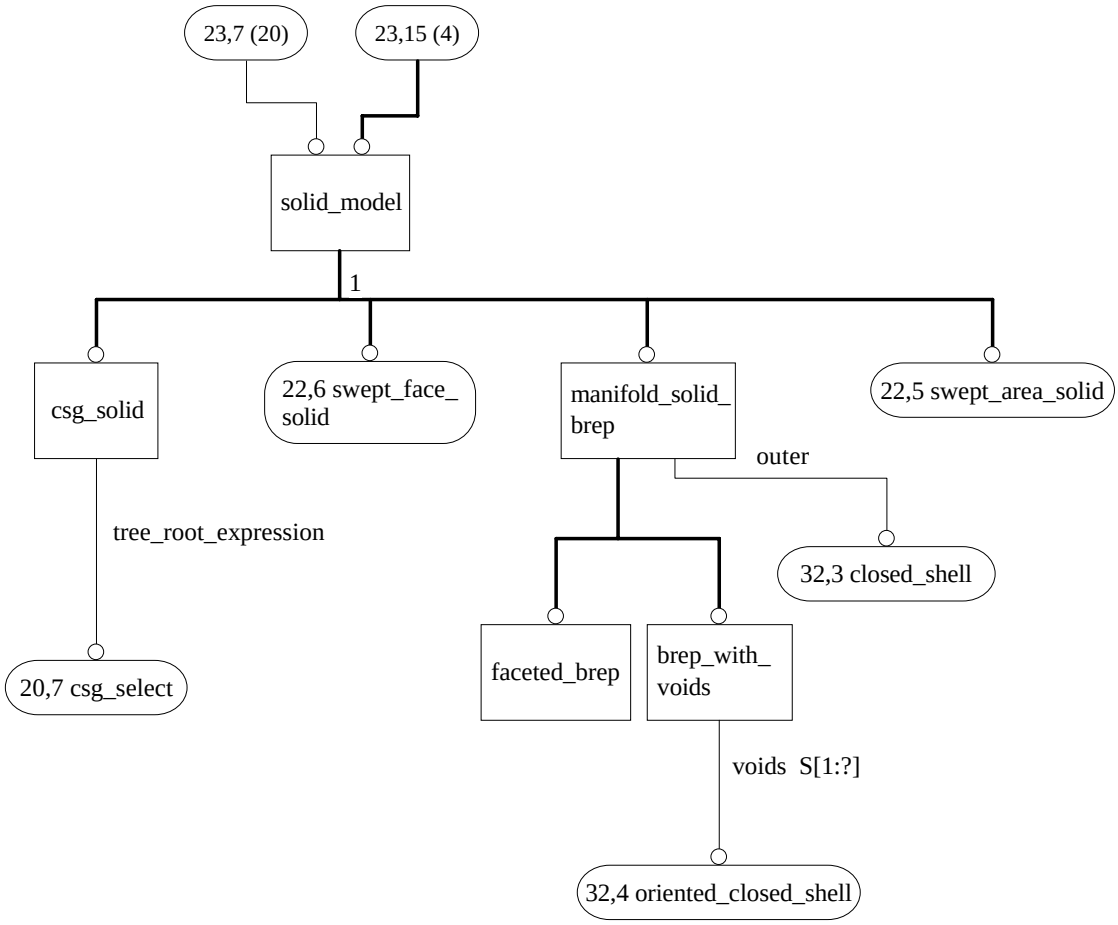


Figure H.23 - AIM EXPRESS-G diagram 23 of 32

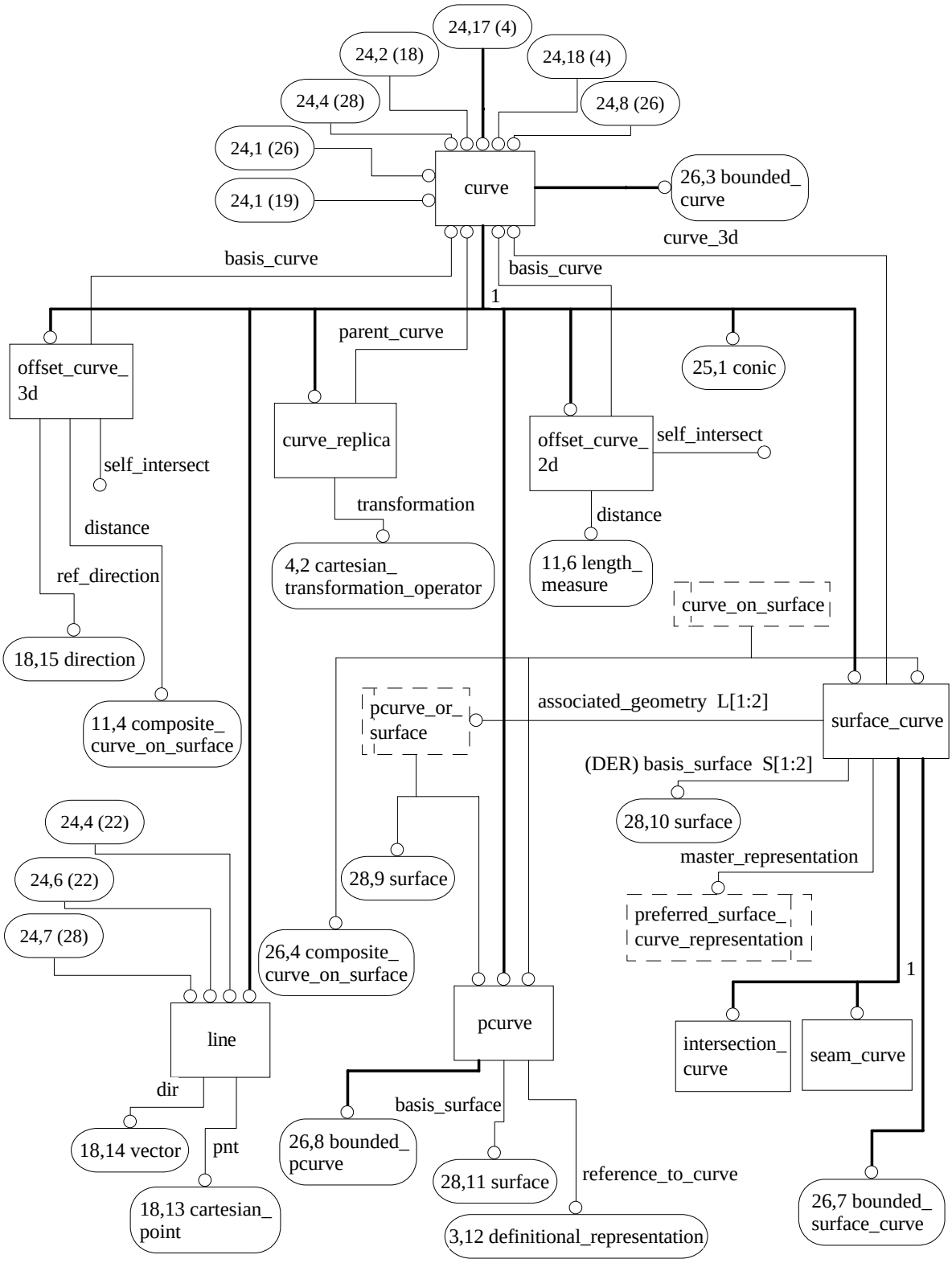


Figure H.24 - AIM EXPRESS-G diagram 24 of 32

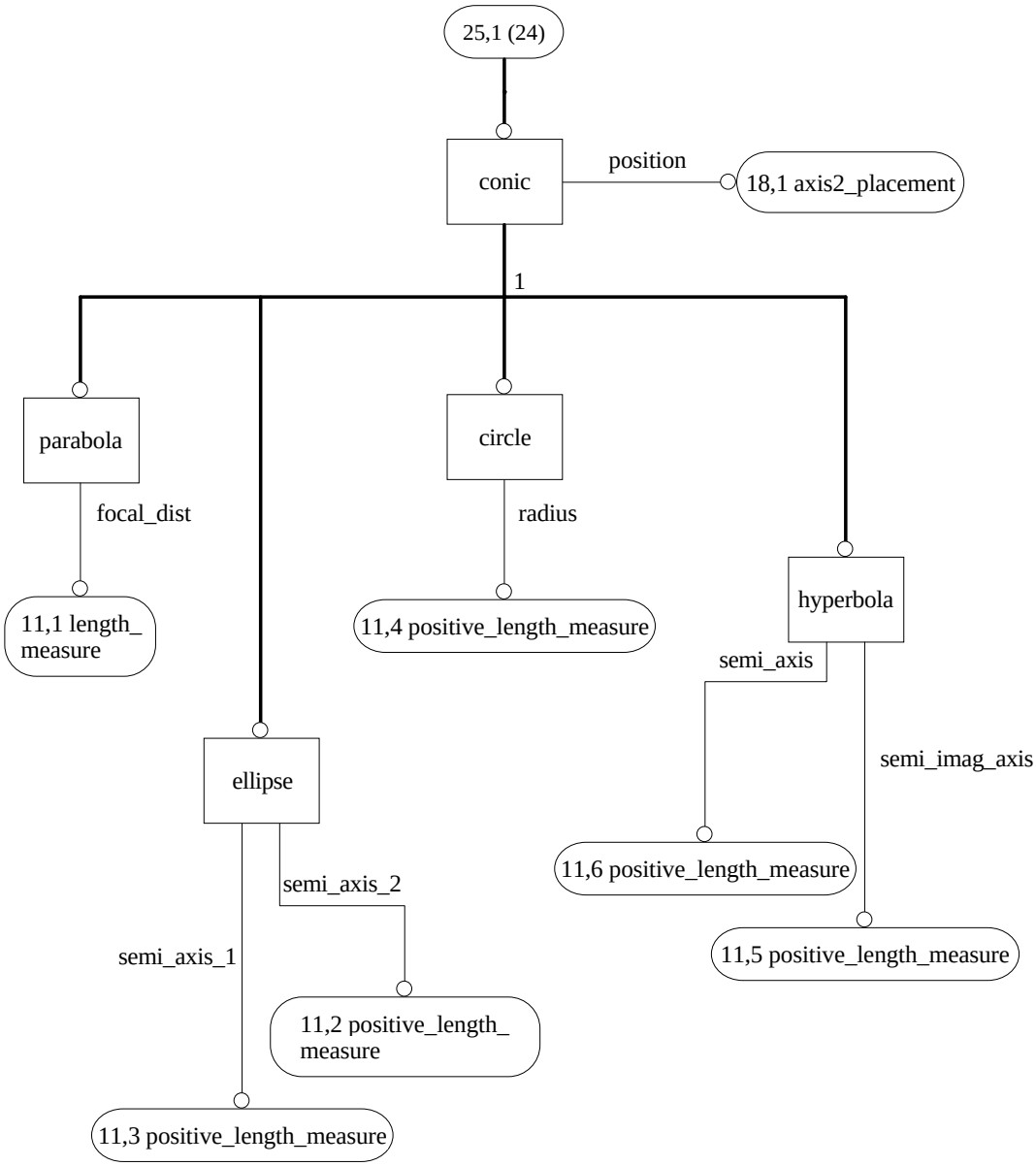


Figure H.25 - AIM EXPRESS-G diagram 25 of 32

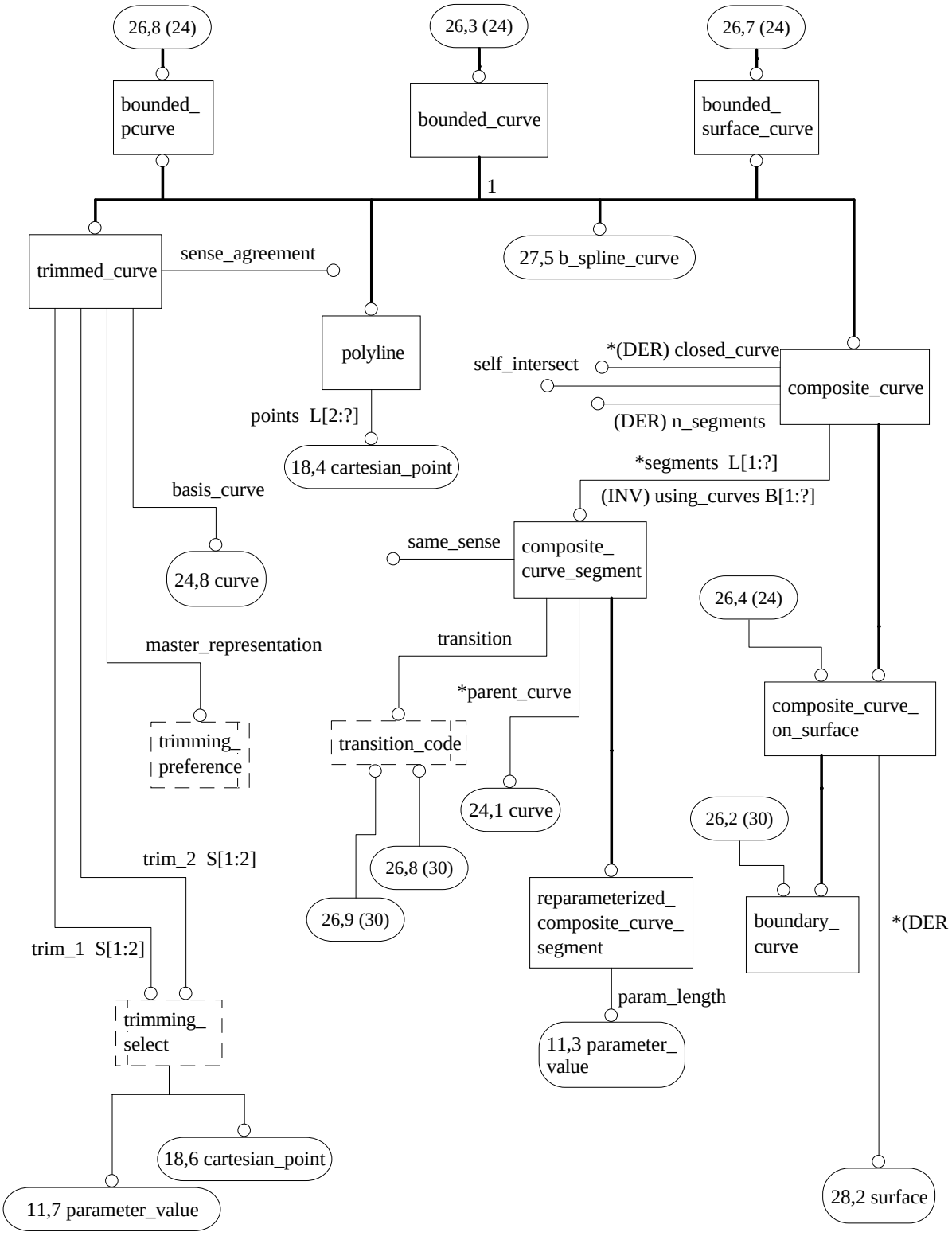


Figure H.26 - AIM EXPRESS-G diagram 26 of 32

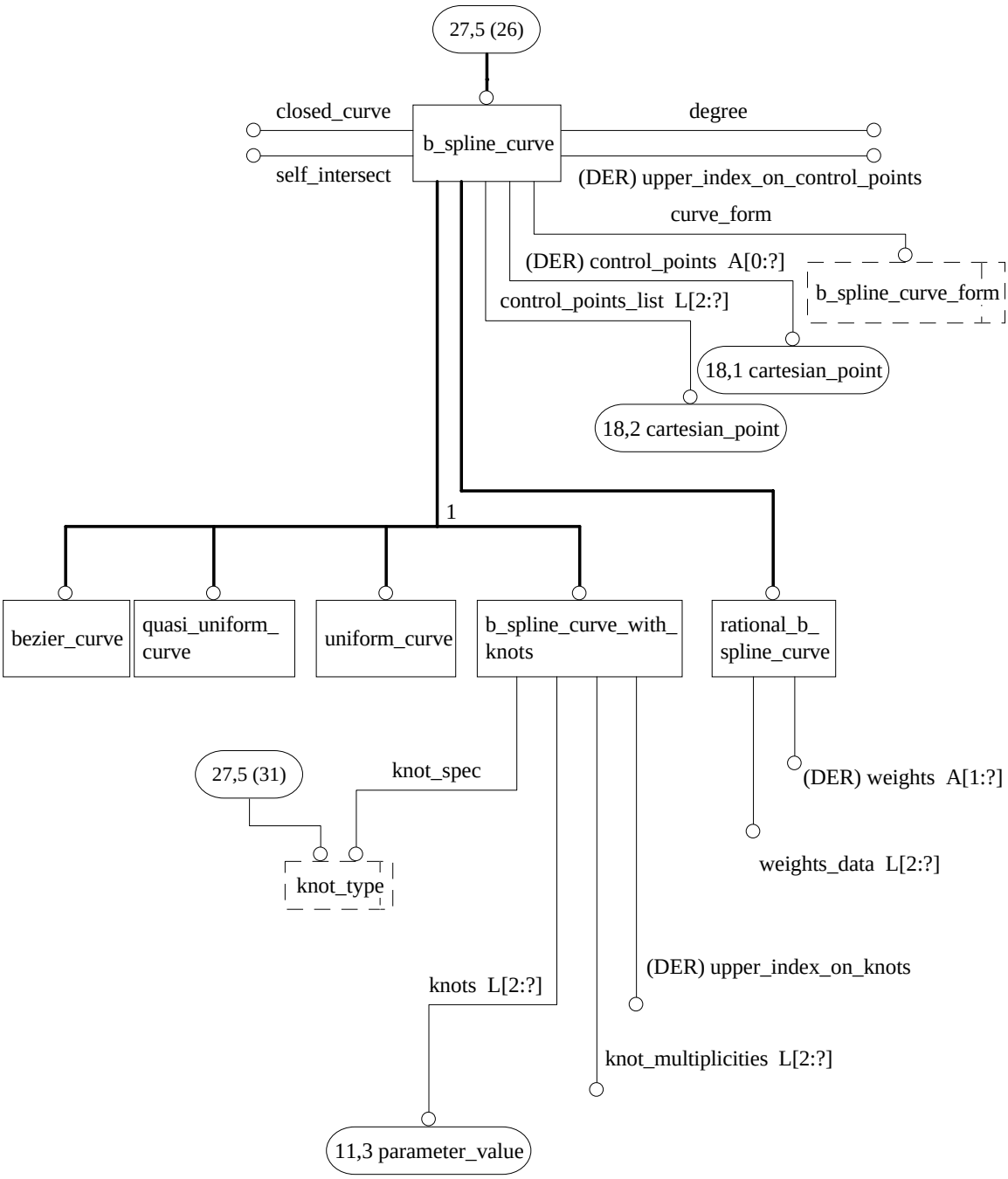


Figure H.27 - AIM EXPRESS-G diagram 27 of 32

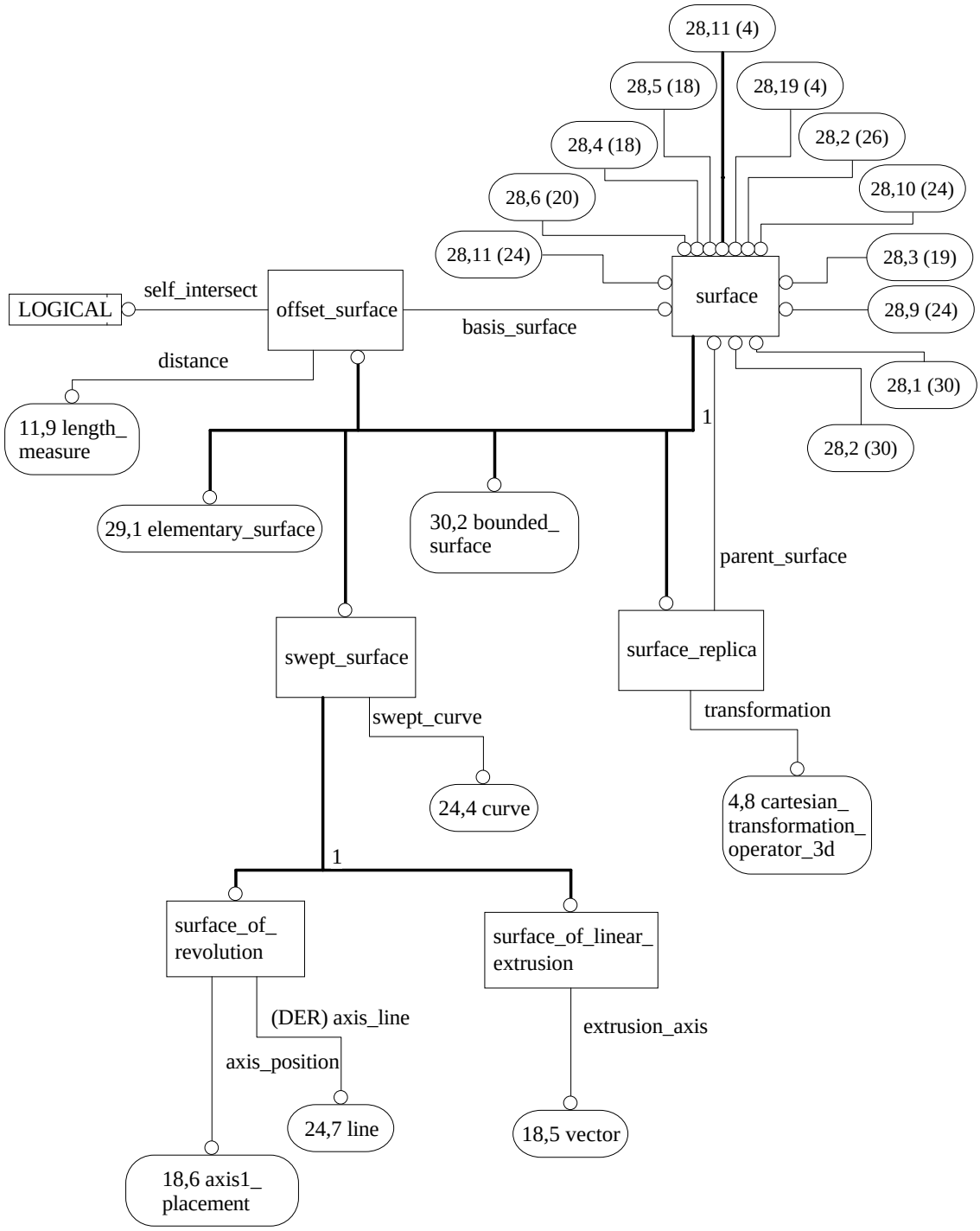


Figure H.28 - AIM EXPRESS-G diagram 28 of 32

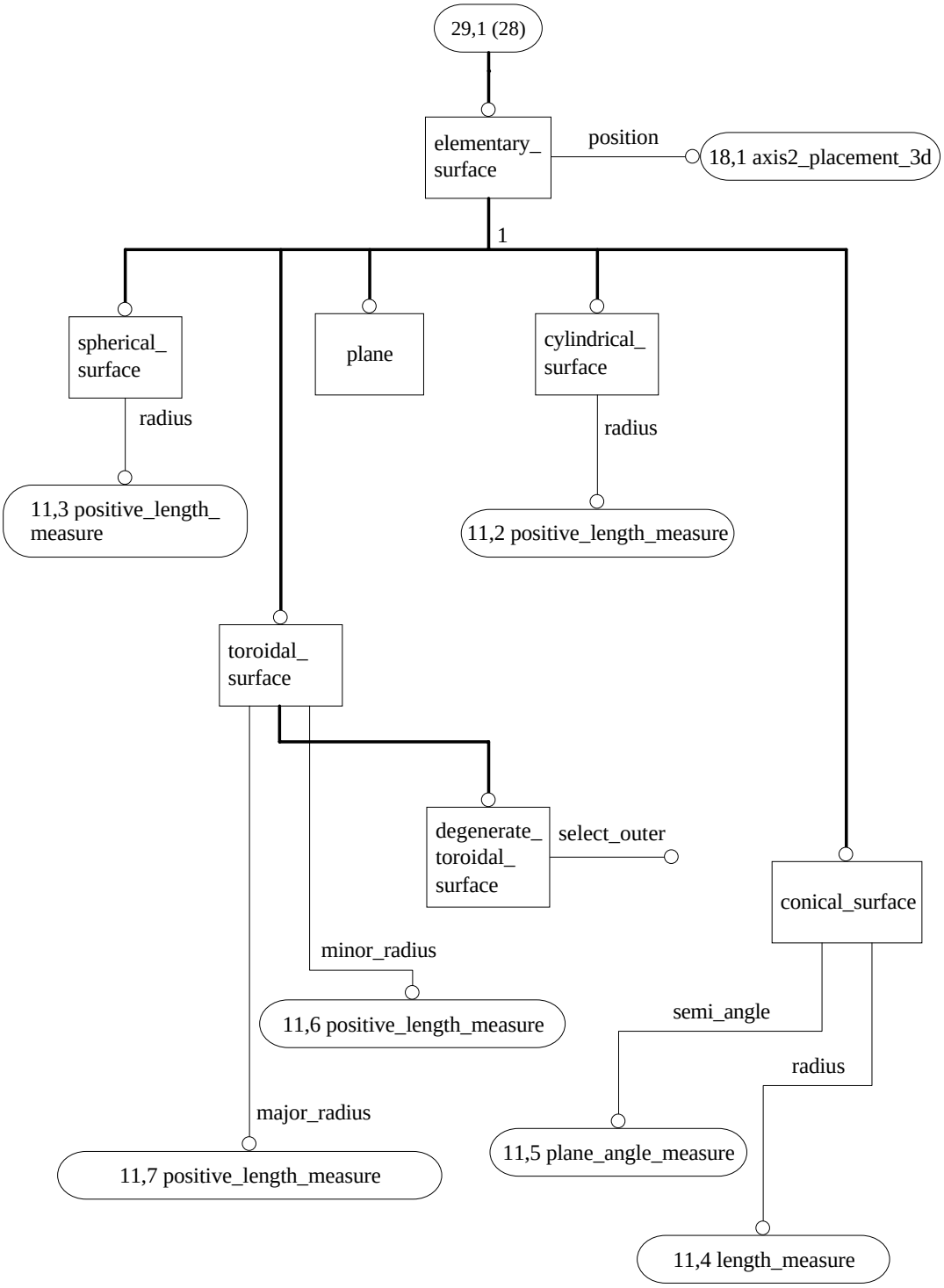


Figure H.29 - AIM EXPRESS-G diagram 29 of 32

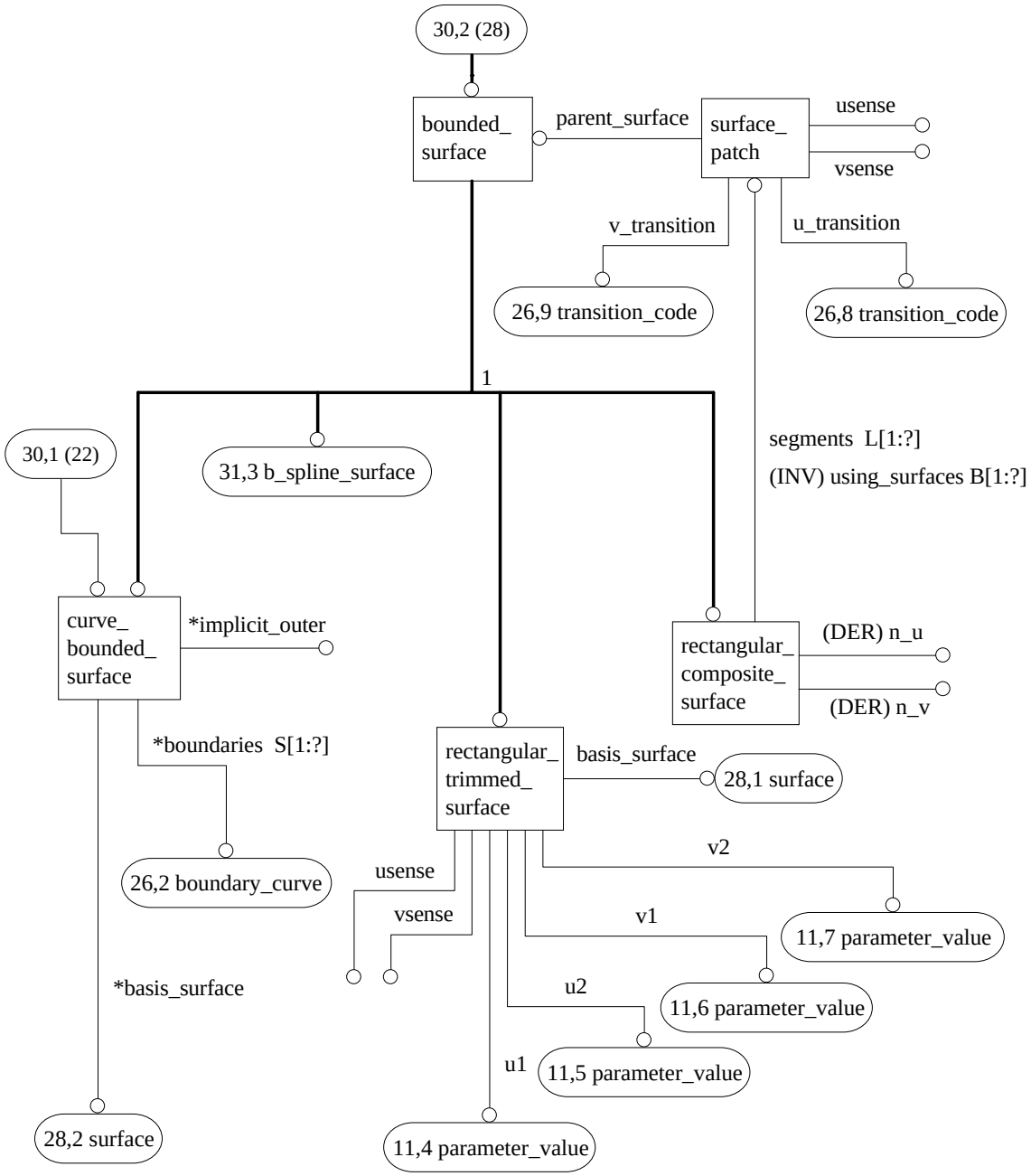


Figure H.30 - AIM EXPRESS-G diagram 30 of 32

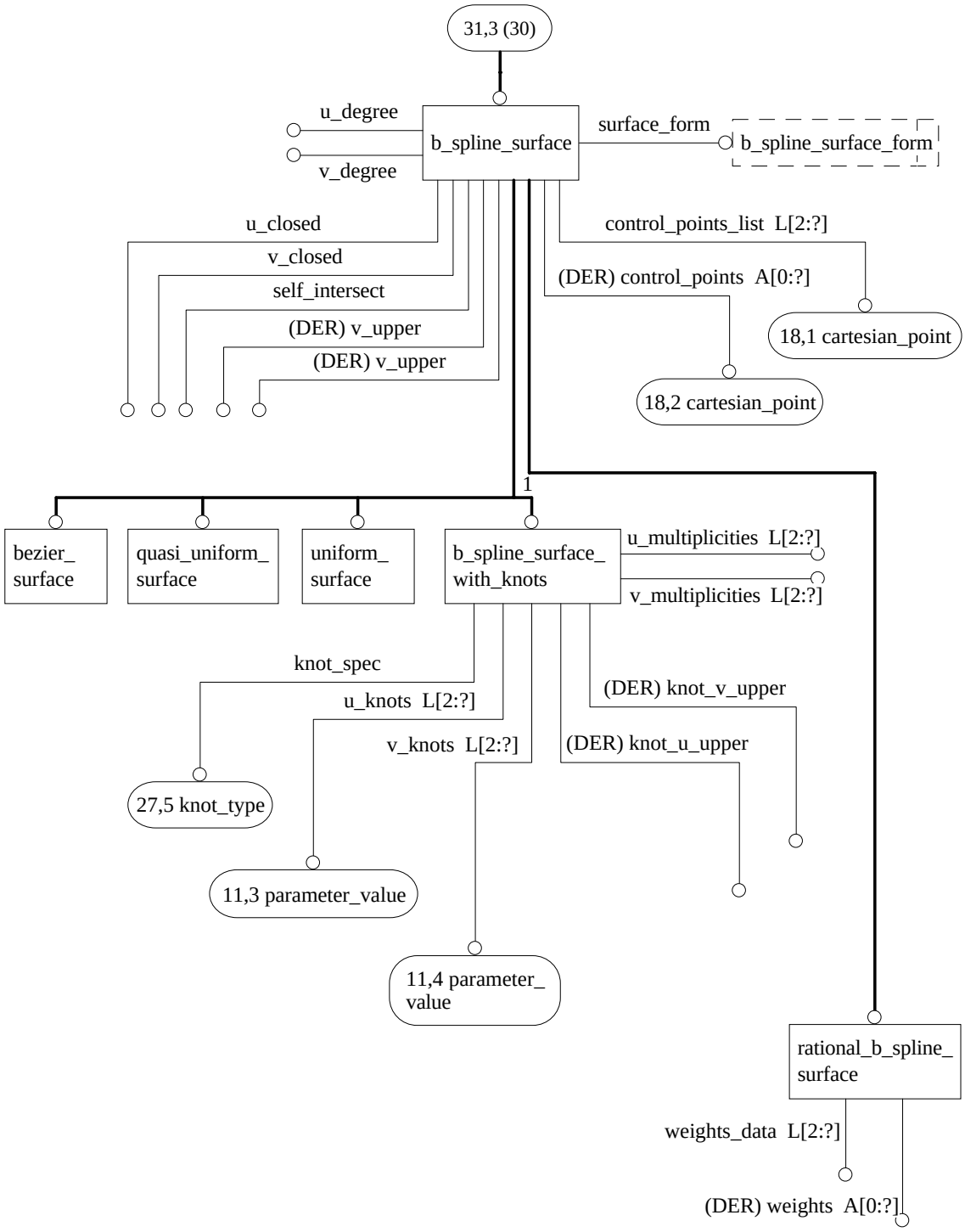


Figure H.31 - AIM EXPRESS-G diagram 31 of 32

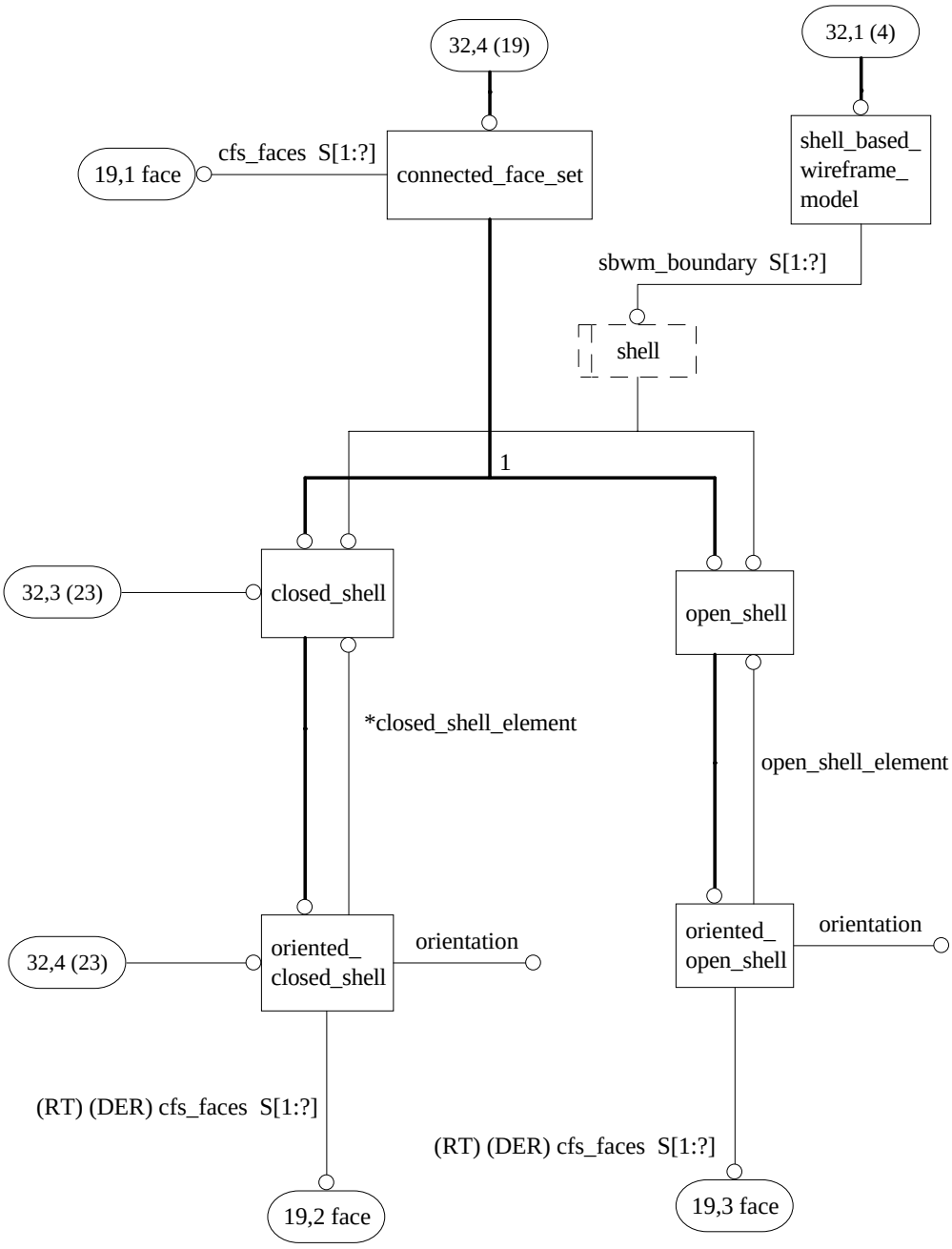


Figure H.32 - AIM EXPRESS-G diagram 32 of 32

Annex J
(informative)

AIM EXPRESS listing

This annex provides a listing of the table of short names and a listing of the EXPRESS specified in the AIM of this part of ISO 10303. No text or annotation is included. This annex is provided only in computer-interpretable form.

NOTE - The information provided on this diskette is informative; the normative text is that contained in the body of this part of ISO 10303.

Annex K
(informative)

Application protocol usage guide

This annex provides an explanation and guidance on the usage of this part of ISO 10303. The annex is divided into sections; each section addresses a different important or high-value topic or capability of this part of ISO 10303.

> NOTE - The material in this annex differs from that in the Technical Discussion, annex L, in that the purpose of the material presented herein is to explain how to use this part of ISO 10303 in several important areas.

The guidelines provided in this annex are suggestions for best usage of this part of ISO 10303. They shall be interpreted by users of this standard as recommendations rather than as requirements.

K.1 Identifiers

Identifiers are alphanumeric labels that uniquely identify an instance of an entity within a given data population. The data population may be either (1) the boundaries of an exchanged data file, (2) the boundaries of a particular project, or (3) the life-cycle of a plant. The guidelines provided herein fully address (1), but only partially address (2) and (3) since the actions and policies involved in a design project or the life-cycle of a process plant are beyond the scope of this part of ISO 10303. These guidelines do not address the instance identifiers required by ISO 10303-21.

Identifiers as used within this part of ISO 10303 fall into two classes. One class are application object identifiers that are specified in Clause 4 and the ARM. These application object identifiers and their corresponding AIM identifier and recommended usage or interpretation are listed in table K.1. The second class are those that are specified in the AIM. These AIM identifiers and their corresponding ARM uses and recommended usages or interpretations are listed in table K.2.

All application object identifiers shall be unique within the context of an exchange file and should be unique within both a project and through the life-cycle usage of a process plant. The identifier may correspond to a product data identifier used in other representations of product data, such as a part number on a drawing. If the application object identifier does not correspond to a real world identifier, an identifier shall be fabricated based on policies and procedures of the particular project or plant. This identifier is more than a system generated identifier in that it should have persistence over time as the data is used and exchanged.

Table K.1 - Application object identifiers

Application object identifier	AIM identifier	Recommended usage or interpretation
Plant_item_id	product_definition.-id	Most often this will be interpreted as a Part Number. The specific interpretation depends on usage: **Functional Design View - Plant Item Definition** This value must be fabricated. There is no real-world equivalent in common use. **Functional Design View - Plant Item Instance** This value must be fabricated. It may be associated with zero or one TAG Number. **Physical Design View - Plant Item Definition** This value may be fabricated, but it typically corresponds to a Part Number. **Physical Design View - Plant Item Instance** This value may be fabricated, but it corresponds to the use of a part in a design (i.e., instance number). It may be associated with zero or one serial number.
Catalogue_id	document.id	This corresponds to a volume number or issue number or a date that uniquely identifies a published (i.e,. configuration controlled) version of a catalogue. This value should be unique across the project and plant life cycle.
Change_id	action.name	This corresponds to designations such as Engineering Change Notice (ECN) numbers and similar codes used to identify, track, and control changes made to the design data. It is strongly recommended that it be unique throughout the life cycle of the plant.
Change_item_-id	Change_item_id_-assignment (name_-assignment.name)	Since a Change_item is not a new thing, the Change_-item_id is an extra identifier associated with something that already exists. It does not correspond to any real world identifier. It is strongly recommended that the value of the attribute change_item_id_assignment (name_-assignment.name) be unique throughout the life cycle of the plant.
Design_-project_id	organization.id	This corresponds to a project code or some other identifier other than project number (a designation that maps to organization.description). This may be fabricated. It should be unique within the plant life cycle.

Table K.1 - Application object identifiers (continued)

Application object identifier	AIM identifier	Recommended usage or interpretation
Control_loop_-id	product.id	This corresponds to a real world control loop number or designation. It should be unique within a project and plant life cycle.
Line_to_line_-connection_id	shape_aspect_-relationship.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among connections between line segments.
Material_-specification_id	document.id	This corresponds to the identifier of a material specification or manual, e.g., ASTM A403.
Selection_id	document_usage_-constraint. subject_element	This corresponds to a table number, chapter number, line or row number, section number, or some other designation that identifies a particular portion of a material specification or manual.
Subset_id	document_-relationship.name	This corresponds to a subsection reference or other designation that identifies a portion of a material specification.
Piping_size_-description_id	property_-definition_-representation	This does not correspond to a real world identifier. It may be considered a system identifier used to differentiate among different piping size descriptions, Hence, the value of a piping_size_description_id is synonymous with the instance.
Piping_-specification_id	document.id	This corresponds to the identifying designation of a piping specification. It is strongly recommended that it be unique throughout the project and plant life cycle.
Piping_-system_line_id	product_-definition.id	This is a fabricated designation that should have a one-to-one correspondence with the line number. It is used in addition to line number because line numbers sometimes have minor variations, e.g., Line 111a, Line 111-1.
Segment_id	product_-definition.id	This is a fabricated designation that may or may not correspond to a real world designation. It is used principally to differentiate between segments of a line.
Termination_id	shape_aspect.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among terminations used to connect line segments.

Table K.1 - Application object identifiers (continued)

Application object identifier	AIM identifier	Recommended usage or interpretation
Plant_id	product.id	This corresponds to the identifying designation given to a plant, if such a designation exists. If not, a value may be fabricated. There should be a one-to-one correspondence between this value and the plant name.
Connection_id	shape_aspect.name	A connection is a shape_aspect of the assembly that contains the connection. There may or may not be a real world identifier that corresponds to a particular connection in a plant system. If such an identifier does not exist, a value shall be fabricated to uniquely identify each connection.
Plant_item_-connector_id	shape_aspect.name	A connector is a shape_aspect of a plant_item. There may or may not be a real world identifier that corresponds to a particular connector of a plant system. If such an identifier does not exist, a value shall be fabricated to uniquely identify each connector.
Interference_id	product_-definition_-relationship.name	If two plant_items clash, there is a product_definition_-relationship defined between them. This does not correspond to any real world identifier. It should be fabricated, but there is probably little need for it to be unique across a project or plant life cycle.
Location_id	representation_-item.name	A plant_item is located in a plant with a mapped_item as a representation. Hence, representation_item is used and location_id maps to representation_item.name. This does not correspond to any real world identifier.
Shape_id	property_-definition.name	Shape is a property of a plant_item. This does not correspond to any real world identifier, though it may be interpreted as a unique file name or drawing number for different representations of the shape of a plant_item.
Plant_process_capability_id	property_-definition.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among process capabilities.
Plant_system_-id	product.id	This corresponds to a unique designation given to a system within a plant. It is strongly recommended that it be unique within a project and throughout the plant life cycle.
Reference_-geometry_id	representation_-item.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among reference geometry.

Table K.1 - Application object identifiers (concluded)

Application object identifier	AIM identifier	Recommended usage or interpretation
Material_-requirement_id	product.id	This is the identifier of the material required by or for a plant_item. The material is considered as a product. It corresponds to a real world designation, but is not equivalent to a material specification identifier. It may be the part number of raw stock or a chemical designation like H_20.
Operating_-case_id	property_-definition_-relationship.name	This is a fabricated identifier that does not correspond to any real-world identifier. It is used only to differentiate among service_operating_cases.
Element_id	representation_-item.name	This does not correspond to any real world identifier. The closest real world equivalent would be the id of a geometric element in a CAD system. It may be considered a system identifier used to differentiate among geometric elements. A value may be fabricated if there is a need to uniquely identify a geometric element in a scope beyond a geometric model file.
Site_id	characterized_-object.name	This corresponds to designations that identify a site or plot of land. Examples include municipal plot or tract designations or GIS descriptions. Sites cannot be defined unless they are associated with a plant. The value may be fabricated for a particular project or plant life cycle.
Site_feature_id	property_-definition.name	This may or may not correspond to a real world identifier. It may be fabricated to differentiate among site features. A site feature is a property of a site.
Stream_-design_id	characterized_-object.name	This may or may not correspond to a real world identifier. It uniquely identifies the definition of particular stream states. A value may be fabricated is there is a need to uniquely identify a stream state (i.e., design case) across a project or plant life cycle.
Supplier_id	organization.id	This corresponds to a designation that uniquely identifies a supplier to a project or plant life cycle.
Support_-constraint_id	representation.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among support components.

Table K.2 - AIM identifiers

AIM identifier	ARM uses	Recommended usage or interpretation
document.id	catalogue_id piping_- specification_id material_- specification_id	As mapped.
organization.id	Design_project_id Supplier_id	As mapped.
person.id	none	Although individuals are not explicitly identified in the ARM, attributes such as approval.approver require the person entity. A unique value should be fabricated to differentiate among persons.
product.id	Control_loop_id Plant_id Plant_system_id Material_- requirement_id	As mapped.
product_- definition.id	Plant_item_id Piping_system_- line_id Segment_id	As mapped.
product_- definition_- formation.id	None	This may or may not correspond to a real world identifier. It is used to differentiate among versions of product design.
product_- definition_- formation_- relationship.id	None	This does not correspond to a real world identifier. A value shall be fabricated to differentiate among product_definition_formation_relationships.
product_- definition_- relationship.id	None	This does not correspond to a real world identifier. A value shall be fabricated to differentiate among product_definition_formation_relationships.
versioned_- action_request.id	None	This may or may not correspond to a real world identifier. If it does, it may correspond to an identifier found on a change request.
representation_- context.context_ identifier	None	This does not correspond to a real world identifier. A value shall be fabricated that is unique to a specific type of context and differentiates among local coordinate systems.

K.2 Units

Most measures will be expressed in terms of SI units. For units such as inches, instances of **conversion_based_unit** must be used. Figure K.1 contains a fragment of the EXPRESS-G for the measure schema (see ISO 10303-41). Compare the EXPRESS with the following fragment of an ISO 10303-21 data file:

```
/* length dimension's exponent = 1 */
#22=DIMENSIONAL_EXPONENTS(1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0);
#200=(LENGTH_UNIT()NAMED_UNIT(#22)SI_UNIT(.MILLI.,.METRE.));
/* Inches unit - length measure*/
/* conversion factor from mm to inches: 1 inch = 25.4 mm */
#201=LENGTH_MEASURE_WITH_UNIT(LENGTH_MEASURE(25.4),#200);
/* specifies length unit - based on conversion from millimeters */
#202=(CONVERSION_BASED_UNIT('inches',#201)LENGTH_UNIT()NAMED_UNIT(#22))
;
```

The units that the conversion is based upon are millimetres. The units are represented by instance #200. This instance is:

- a named unit with dimensional exponents of length;
- a length_unit; and
- a SI unit: millimetre.

Instance #201 represents the conversion of millimetre values to another value. The conversion factor is 25.4, meaning that millimetres are multiplied by 25.4 to yield another value.

Instance #202 applies the name of "inches" to the converted value. It is also a named unit (with dimensional exponents of length) and a length unit.

Note that these data are not a *converted* value, but rather are the specification of a unit (inches in #202) derived from a known SI unit. Measures that use inches would reference #202. For example, the datum:

```
/* Nominal size = 0.5" */
#100=(LENGTH_MEASURE_WITH_UNIT() MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.5),#202) REPRESENTATION_ITEM(''));
```

Represents a nominal size of one-half inch because it references #202 as the unit component.

K.3 Axis_placement

Position and orientation of objects within a geometric coordinate system are either inherently part of the geometric definition of the object or are defined through a transformation mechanism. The position and orientation mechanisms used for transformation in ISO 10303-42 are cartesian_points and the "placement" entities. EXPRESS definitions of the 3D versions of these placement entities are:

```
 ENTITY placement
   SUPERTYPE OF
(ONEOF(axis1_placement,axis2_placement_2d,axis2_placement_3d))
   SUBTYPE OF (geometric_representation_item);
   location : cartesian_point;
 END_ENTITY;
```

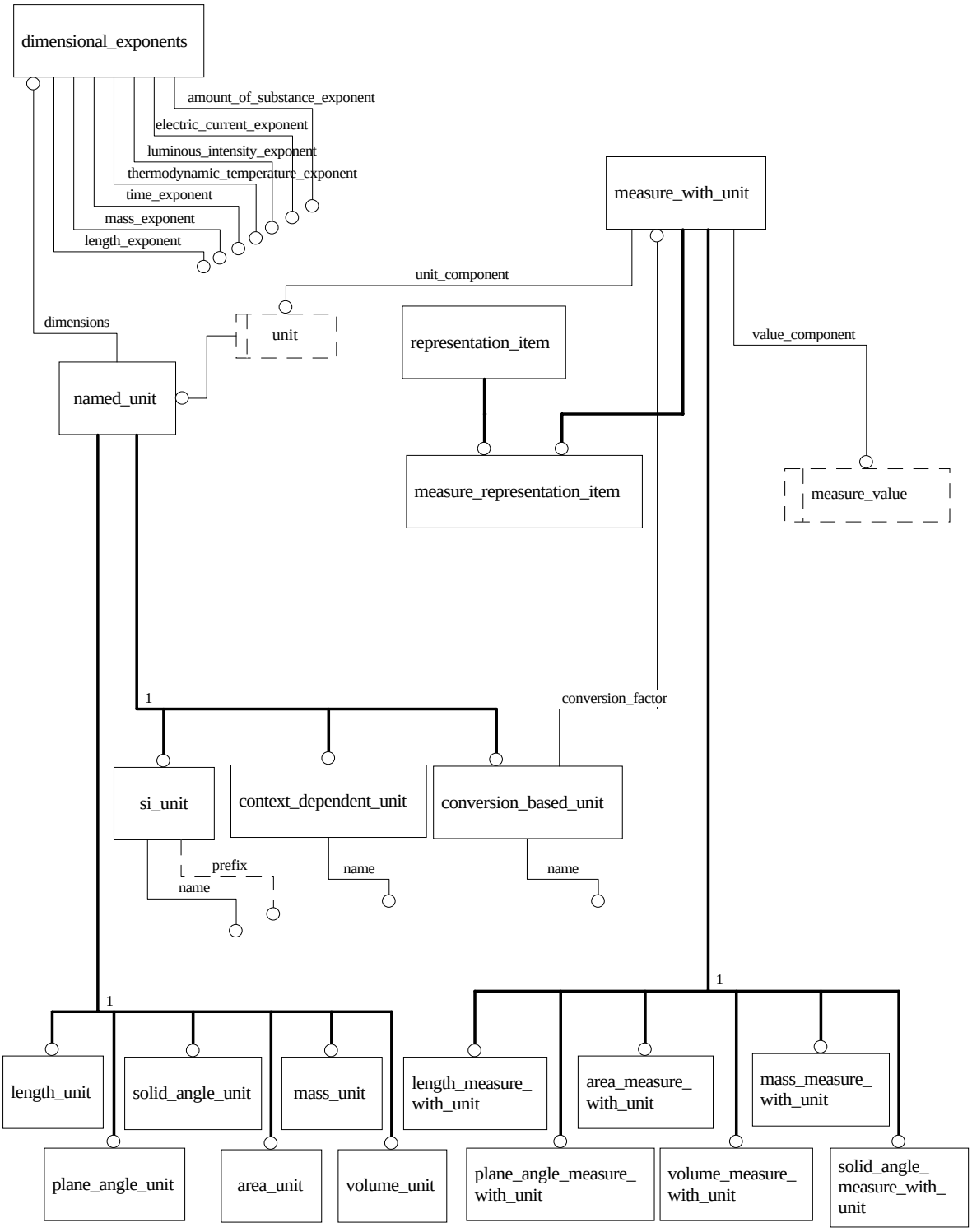


Figure K.1 - Fragment of measure_schema in EXPRESS-G

```
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;
```

The entity **axis2_placement_3d** is location point (**SELF\placement.location.dim**) and a set of orthogonal axes defined by the derived attribute **axis2_placement_3d.p**. The derivation uses the Z axis specified by the attribute **axis2_placement_3d.axis** and, optionally, an approximate X axis specified by the **axis2_placement_3d.ref_direction** to construct a set of orthogonal axes. The following fragment of an ISO 10303-21 data file illustrates a set of axes at the origin:

```
#20=CARTESIAN_POINT('origin point',(0.0, 0.0, 0.0));
#40=DIRECTION('X',(1.0,0.0,0.0));
#41=DIRECTION('Y',(0.0,1.0,0.0));
#42=DIRECTION('Z',(0.0,0.0,1.0));
#66=AXIS2_PLACEMENT_3D('generic origin',#20,#42,#40);
```

K.4 describes how **axis2_placement**s are used for positioning and orientation of shape representations.

K.4 Mapped_item and representation_item

Figure K.2 illustrates how the shape representation of one object is positioned and oriented in another shape representation. The positioning is accomplished by "superimposing" an **axis2_placement_3d** (A3: (X3, Y3, Z3)) in one shape representation (SR-B) onto another **axis2_placement_3d** (A2: (X2, Y2, Z2)) in a different shape representation (SR-C). Since A2 is positioned relative to all the geometric elements in SR-C, placing and orienting A3 so that it corresponds to A2 in SR-C will produce the effect of positioning SR-B in SR-C. This is accomplished with **mapped_item** and **representation_item**.

The EXPRESS for **mapped_item** and **representation_map** are as follows:

```
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; -- mapped_item

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; -- representation_map
```

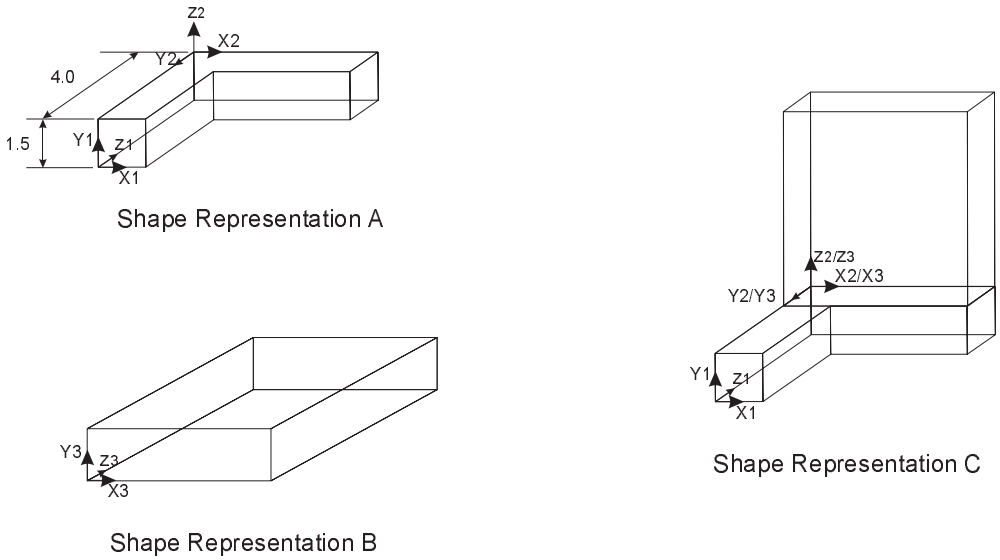


Figure K.2 - Positioning of shape representations

Using the data from above plus unit information:

```
#1=GLOBAL_UNIT_ASSIGNED_CONTEXT('contxtid:c1','contxttype:
length',(#2));
#2=(LENGTH_UNIT()NAMED_UNIT(#3)SI_UNIT(.MILLI.,.METRE.));
#3=DIMENSIONAL_EXPONENTS(1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0);
#20=CARTESIAN_POINT('origin point',(0.0, 0.0, 0.0));
#40=DIRECTION('X',(1.0,0.0,0.0));
#41=DIRECTION('Y',(0.0,1.0,0.0));
#42=DIRECTION('Z',(0.0,0.0,1.0));
#66=AXIS2_PLACEMENT_3D('generic origin',#20,#42,#40);
```

The shape_representation of A from figure K.2 is:

```
#100=CARTESIAN_POINT('location of block B',(0.0, 1.5, 4.0));
#101=AXIS2_PLACEMENT_3D('orientation of block B',#100,#41,#40);
#105=SHAPE_REPRESENTATION('shape representation A',(#66, #101, <shape
of L-shape block>),#1);
```

Things to note about these data include:

- Cartesian_point #100 as used in axis2_placement_3d #101 (A2) is the position of A2 and, thus, of shape representation B (SR-B).

- The Z axis of the axis2_placement_3d #101 ***points in the Y direction*** within shape representation A. This is very significant because by aligning the ***Z axes*** of A3 in shape representation B and A2 in shape representation A, the desired orientation of shape representation B in shape representation C is achieved.

- For simplicity, the explicit geometry of the L-shaped block is not included in shape representation #105.

The shape representation of B is:

```
#110=SHAPE_REPRESENTATION('shape representation B',(#66, <shape of
block>),#1);
```

Things to note about this datum include:

- The origin axes of both shape representation A #105 and shape representation B #110 are the same. This does not present a conflict because the same data is simply used differently, i.e., used in different contexts. The shape representation contexts of both of the representations are different. No assumption shall be made concerning the relationship of these axes unless they are made to be part of the same context.

The shape representation of C requires the use of **representation_item** and **mapped_item**.

```
#120=REPRESENTATION_MAP(#66,#110);
#121=MAPPED_ITEM('positioned shape B in C',#120,#101);
#122=SHAPE_REPRESENTATION('shape representation C',(<shape of L-shaped
block>, #121),#1);
```

Things to note about these data include:

- Representation_map #120 specifies the base mapping information: the mapped_representation #110 and the mapping_origin, #66. The mapping_origin is the element ***in the representation*** of the mapped_representation that is used to position and orient the shape. Most often this will be a set of axes at the origin, but it may be other things as well.

- Mapped_item #121 specifies the mapping transformation. The mapping_source is the representation_map to be transformed. The mapping_target is the ***destination*** of the transformation. The representation_map is moved such that the axis2_placement_3d.location of the mapping_origin is at, on top of, or corresponds with the axis2_placement_3d.location of the mapped_item.mapping_target. Similarly, the representation_map is rotated such that the axes of the mapping_origin are aligned with the axes of the mapping_item.mapping_target.

- The shape representation C consists of the L-shaped block, that is the same shape representation element used for shape representation A, and the mapped_item #121, that is the positioned shape of shape representation B.

This is just one approach for positioning the shape representation of objects within other shape representations. **It is strongly recommended that axis2_placement_3d objects be used for the representation_map.mapping_origin and mapped_item.mapping_target.**

K.5 Interfaces to ISO 13584 and ISO 10303-221

This part of ISO 10303 may be used in conjunction with ISO 13584 [13] to identify catalogue items (Parts Libraries) and classifications, and with ISO 10303-221, annex M [3], to classify plant items, plants, plant systems, and connectors. With respect to this part of ISO 10303, both ISO 13584 [13] and ISO 10303-221 are considered as external sources and are referenced using **known_source** (see

5.2.3.1.31). A **known_source** is both an **external_source** and a **pre_defined_item** (see 5.2.3.2.8). It is used for referencing ISO 13584 because ISO 13584 is an external source of information with respect to this part of ISO 10303 and is also pre-defined with respect to this part of ISO 10303.

ISO 10303-221 is referenced only as an external source. It is not pre-defined with respect to this part of ISO 10303 for reasons that are not explained here because they are not germaine to the annex K or to this part of ISO 10303.

In the following explanation, the only difference between a reference to ISO 13584 and ISO 10303-221 is that a reference to ISO 13584 is a complex instance consisting of **external_source**, **known_-source**, and **pre_defined_item** and a reference to ISO 10303-221 is a simple instance of **external_source**. **Pre_defined_item** and **known_source** are used to explicitly list the names of the allowable external sources in this part of ISO 10303.

The EXPRESS code for the external source is presented below. Figure K.3 shows the EXPRESS-G version.

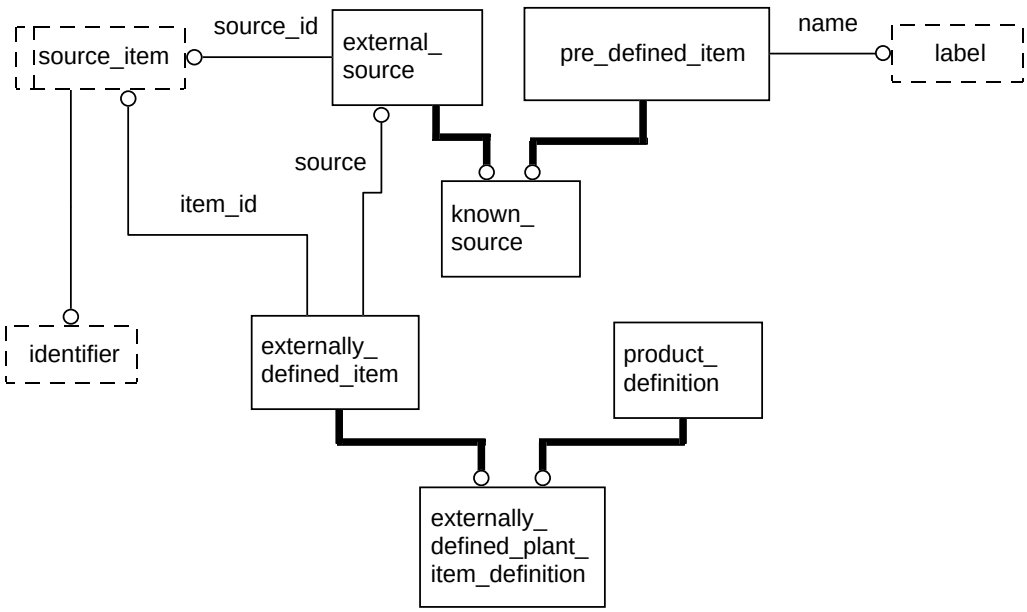


Figure K.3 - Known_source for externally defined items

```
ENTITY external_source;
    source_id : source_item;
END_ENTITY; -- external_source

ENTITY pre_defined_item;
    name : label;
END_ENTITY; -- pre_defined_item

ENTITY known_source
  SUBTYPE OF (external_source, pre_defined_item);
  WHERE
    wr1: SELF\pre_defined_item.name IN ['ISO 13584 Dictionary',
              'ISO 13584 Parts Library'];
END_ENTITY; -- known_source
```

```
TYPE source_item = SELECT
  (identifier);
END_TYPE; -- source_item

ENTITY externally_defined_item;
    item_id : source_item;
    source  : external_source;
END_ENTITY; -- externally_defined_item

ENTITY externally_defined_plant_item_definition
  SUBTYPE OF (product_definition, externally_defined_item);
END_ENTITY; -- externally_defined_plant_item_definition
```

For plant items that are defined externally to the exchange file (e.g., as in a reference to a part in a part library or to a catalogue item), the EXPRESS would be used as shown in table K.3.

Table K.3 - EXPRESS for externally defined plant items

EXPRESS	Explanation	Example
known_source/-predefined_item.name	Provides the name of the known external source.	Example: ’ISO 13584 Parts Library’
known_source/external_-source.source_id	Identifies the external source.	Example: ’ISO 13584-21:1996’
known_source	The complex instance that represents the external source.	Example: #10=(known_source() pre_defined_item(’ISO 13584 Parts Library’) external_source(’ISO 13584-21:1996’))
externally_defined_-item.source	References the **known_-source** that contains the externally defined item.	Example: references ("points at") the **known_source** for ISO 13584, #10 above.
externally_defined_-item.item_id	Identifies the item within the **known_source**.	Example: ’Reciprocating Pump Model 100’
externally_defined_-item/product_definition/-externally_defined_-plant_item_definition	The complex instance that represents an externally defined item in an exchange file using the AP 227 AIM.	Example: a reference to a catalogue item within a use of this part of ISO 10303.

Externally defined classifications follow the same approach substituting **group** for **product_definition**:

```
ENTITY externally_defined_classification
  SUBTYPE OF (group, externally_defined_item);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
      ’PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP’)
      | (’PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT’
      IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
      NOT ((SIZEOF(TYPEOF(it) * [
      ’PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM’,
      ’PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM’,
      ’PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM’,
```

```
        'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
        'PLANT_SPATIAL_CONFIGURATION.PLANT',
        'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
        'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION',
        'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1) OR ((
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF(
        it)) AND (SIZEOF(QUERY ( pc <* it.formation.of_product.
        frame_of_reference | (pc.discipline_type = 'process plant') ))
        = 1)))) )) = 0)) )) = 0;
END_ENTITY; -- externally_defined_classification
```

Figure K.4 shows the EXPRESS-G for the external classification.

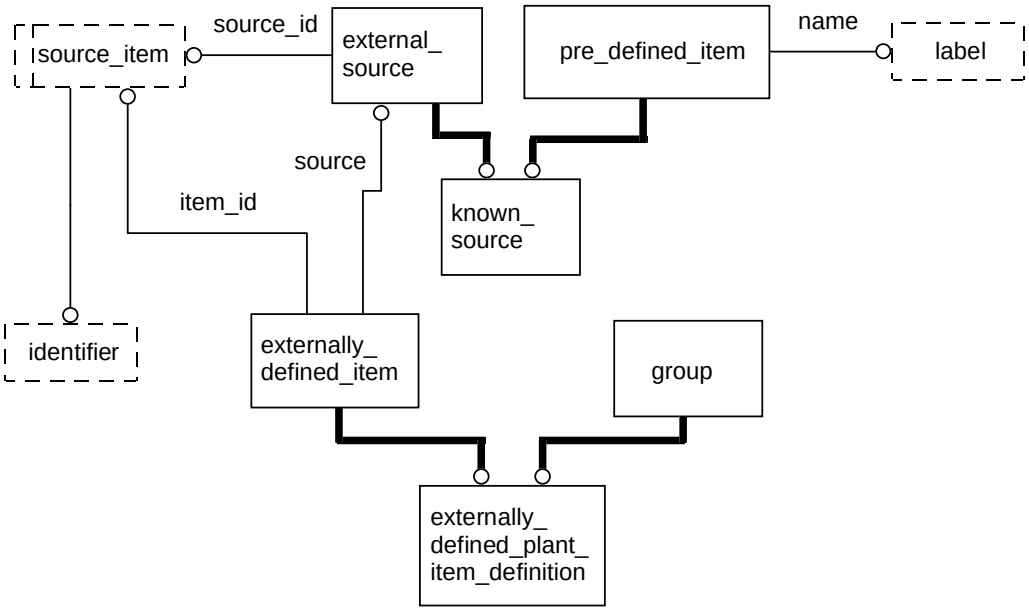


Figure K.4 - Known_source for classification

K.6 Precedence of geometric descriptions

There are three principal methods for specifying the geometric shape of a plant item:

- explicit geometric representation;

- parametric representation;

- catalogue item identification.

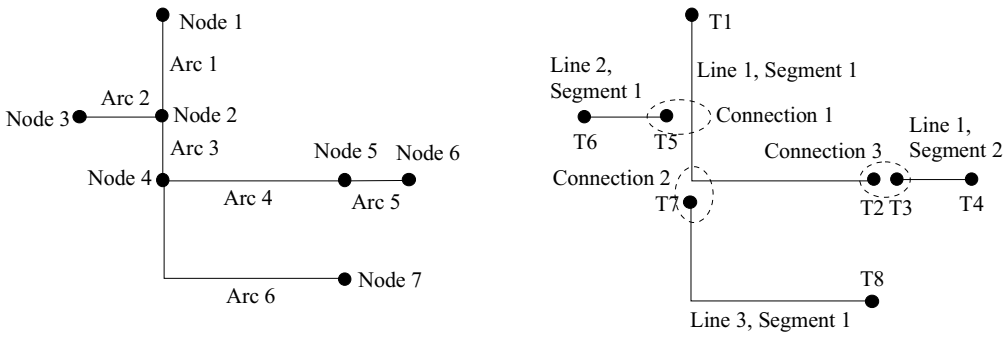
A explicit geometric representation is the wireframe, b-rep, or csg geometry (or combination thereof) that is specified as the shape of a plant item. Parametric representation may be used for fittings. This representation specifies values for certain dimensional parameters of common fittings like elbows and reducers. A catalogue item identification uses neither explicit geometry or parametric values, but rather identifies a catalogue item that is commonly understood between partners in a data exchange. In an exchange using this part of ISO 10303, all three representations may be simultaneously used. This leads to a question of precedence among the representations, particularly if there is a conflict.

There is no absolute ordering with respect to which of these representations take precedence. Rather precedence depends on the use of the geometric representation. For example, for CAD display purposes, the explicit geometry, if present, should take precedence over the parametric representation or catalogue identification. Parametric representations should take precedence over explicit geometry when connectivity checks of mating conditions are performed.

In general, since a catalogue item identification would, presumably, identify a specific plant item design that is commonly understood between partners, the shape indicated or determined by the catalogue item identification, if present, should take precedence over the explicit geometry (since it subject to errors) and the parametric representation (because it is an approximate representation of the shape.)

K.7 Lines and line segments

The purpose of this part of ISO 10303 is not to exchange piping line information equivalent to that of a P&ID, but only that subset of information necessary for piping design. In this part of ISO 10303, piping lines specify the logical connectivity and some of the characteristics of process streams. The piping lines (**piping_system_line**s) are a network of logical nodes and arcs analogous to those found on a P&ID. Figure K.5(a) illustrates piping lines as a network of nodes and arcs. These networks are purely logical and exist in the figure solely for the purpose of illustration. There are no geometric representations intended or implied.



(a) Network of nodes and arcs

(b) Piping lines, line segments and terminations

Figure K.5 - Piping line network

A piping system line, typically identified with a line number, is composed of a set of connected piping system line segments. Other piping system lines may branch from a given line, forming a piping network. In general, a piping system line segment is distinguished by the fact that the process stream has uniform characteristics over the length of the segment.

Nodes exist at:

- equipment inlets and outlets;

- line inlets and outlets (e.g., drains and vents);

- significant changes in the characteristics of the process stream;

- junctions.

Equipment and line inlets and outlets are natural nodes for a piping system line. A significant change in the characteristics of the process stream also merits a node. Reducers, for example, correspond to a single segment with nodes at each end.

Junctions are divergences or confluences of a single line. Branches are treated a little differently in this part of ISO 10303 when compared to ISO 10303-221 [3]. Since nodes represent a significant change in stream conditions, there many not be a node at a minor branch. In this case, the branch line segment connects to the main line at some point other than at a termination node. Figure K.5(b) illustrates this. Line 2 and line 3 (each consisting of a single line segment) are branches from line 1. They are connected at **line_branch_connection**s.

Figure K.5(b) also illustrates connections between piping system line segments. The three dotted ellipses represent two kinds of connections. Each line segment has a pair of terminations. Line branch connections, as described above, are connections between a termination on a branch and the line segment that it branches from. Connections between line segments, as shown in connection 3, are two or more segment terminations.

Annex L
(informative)

Technical discussions

This annex provides discussions of certain technical aspects of this part of ISO 10303 for the purpose of clarifying those aspects.

NOTE - The material in this annex differs from that in the Usage Guide, annex K, in that the purpose of the material here is to explain technical aspects of the design of this part of ISO 10303 that may be confusing or unclear as a result of the documentation format.

L.1 Fitting parameters and nominal size

The shape of fitting piping components may be defined parametrically in this part of ISO 10303. There are three aspects to this parametric definition:

- Fitting parameters;
- Connector parameters;
- Piping size description.

Fitting parameters are attributes of fitting application objects, such as an Elbow, defined in 4.2. An Elbow is defined by the attributes:

- centre_to_end_1_length;
- centre_to_end_2_length;
- centreline_radius;
- end_1_connector;
- end_2_connector;
- sweep_angle;
- type.

Centre_to_end_1_length, centre_to_end_2_length, centreline_radius, and sweep_angle are fitting parameters. End_1_connector and end_2_connector are connectors (or references to connectors) that have parameters of their own depending on the end type (e.g., socket, flange). Type is a label that classifies or describes the Elbow.

Each connector of the Elbow may have its own set of parameters. If one end of the Elbow was flanged, the parameters at the flanged end would be:

- flange_inside_diameter;
- flange_outside_diameter;
- flange_thickness;
- raised_face_diameter;
- raised_face_height;
- ring_bottom_radius;
- ring_diameter;
- ring_width.

If the other end of the elbow was a socket, the parameters at the socket end would be:

- depth;
- hub_inside_diameter;
- hub_length;
- hub_outside_diameter.

For piping components, the specification of a nominal size is a very important and very common approach to specifying the shape of the component. This is done with the piping_size_description application object. The attributes for this object are:

- dimensional_standard;
- ovality_allowance.

The four kinds of piping size descriptions are inside_and_thickness, outside_and_thickness, pressure_-class, and schedule. The attributes for the inside_and_thickness object are:

- inside_diameter;
- thickness.

The attributes for the outside_and_thickness object are:

- outside_diameter;
- thickness.

The attributes for the pressure_class object are:

- nominal_size;

- pressure_rating.

The attributes for the schedule object are:

- nominal_size;

- pipe_schedule.

All of the attributes of piping size description and the four kinds of piping size descriptions are parameters, except for dimensional standard and pipe schedule, that are references to documents. It is important to note that nominal size, as used in this part of ISO 10303, has the same meaning as the term used in process plant industry. It does not denote an actual dimension of a component (as does "outside diameter"), but rather is an approximation or description of the size of the component.

A piping size description may be applied to a piping component in its entirety or to an individual connector on a piping component. Therefore, conflicts may arise between the specification of a piping size description and the fitting or connector parameters. This part of ISO 10303 does not specify a precedence among these representations in the case of conflicts. Precedence needs to be resolved on a case-by-case or project-wide basis.

L.2 Value range, family definitions and range values

Dimensions, fitting parameters, and nominal sizes are typically associated with a single value.

EXAMPLE 103 - Single values for weld neck flange attributes are:

- hub through length:	5 inches
- hub weld point diameter:	3 inches
- flange inside diameter:	1.5 inches
- flange outside diameter:	8 inches
- flange thickness:	0.75 inches

There are occasions, however, when a family of parts needs to be described, such as in a piping specification.

EXAMPLE 104 - A range of values for the attributes of a family of weld neck flanges are:

- hub through length:	5 inches
- hub weld point diameter:	3 inches
- flange inside diameter:	1 to 2 inches
- flange outside diameter:	6 to 8 inches
- flange thickness:	0.75 to 1.25 inches

This part of ISO 10303 supports the specification of a range of values (i.e., a "value range") for a given dimension, parameter, or nominal size for the purpose of defining a family of parts. This is done by specifying two dimensional values for a given parameter. One dimension has a

representation_item.name with a value of "minimum_<parameter name>" (e.g., "minimum_flange_-inside_diameter") and the other has a **representation_item.name** with a value of "maximum_<parameter name>".

A separate but related concept is the notion of range value. A range value, like the range of values, has a minimum and maximum value. It does not, however, indicate a family of parts. It indicates a parameter that may actually vary on the physical part. A range value is not a dimension that can vary within a prescribed tolerance.

> EXAMPLE 105 - Insulation may be described as 6 inches thick, but in reality it may be 5-7 inches thick. Range values permit this to be specified.

In 4.2, the attributes that use range values are differentiated from the attributes that use value ranges by a explanatory note that follows the attribute definition.

L.3 Piping specifications

As noted in clause 1, this part of ISO 10303 is intended for the exchange of references to piping specifications, not the exchange of the specification itself. However, since piping specifications are important to piping design, some aspects of piping specifications are included. The piping_-specification.owner is the individual or organization that is responsible for its content (either as a creator or maintainer). The piping_specification.name is whatever useful designation the owner applies to it. The piping_specification.piping_specification_id is a designation that differentiates one piping specification from another (see K.1).

Service limits are specified in piping_specification.service_description. This is simply a narrative explanation or description of the conditions that the piping specification is applicable under. It is not the role of the piping specification to fully explicate the stream conditions. If it is necessary to exchange this information, Stream_design_cases may be defined.

Piping specifications identify certain families of parts that can be used given the service limits. The family of parts is specified with a Plant_item_definition (or, more precisely, a Piping_component that is also a Plant_item_definition) that has a special property. The parameter values for the component may be specified as a range of values.

> EXAMPLE 106 - A piping specification may specify a family of 90-degree elbows with a centreline radius of six inches and a nominal size of between one inch and three inches. Everything about the family is same except for the variation in the nominal size.

See L.2 for a complete explanation of value ranges.

L.4 Catalogues items and connectors

As noted in clause 1, this part of ISO 10303 is intended for the exchange of catalogue identifications, not the exchange of the catalogue itself. Catalogues play two roles in this part of ISO 10303:

- Partial catalogue information may be exchanged. This information is limited to the identification of the catalogue and the definition of plant items contained in the catalogue. The

definition of the plant items in the catalogue is exactly the same as the definition of a plant item as allowed by this part of ISO 10303.

- A plant item may be identified as being from or contained in a particular catalogue;

A catalogue may be an external, predefined catalogue or a user defined catalogue. See K.5 for a complete explanation of how external, predefined catalogues are referenced.

Many design systems also use a catalogue-based approach for connectors. This part of ISO 10303 addresses this requirement with the application object Catalogue_connector. A Catalogue_connector behaves just like a Catalogue_item as described above. The exception is that since a connector (and, therefore, a Catalogue_connector) is a **shape_aspect**, a Catalogue_connector cannot be individually instanced within an exchange file. A Catalogue_connector definition may be exchanged independently, but any Catalogue_connector instance must be part of a plant item definition. It cannot be part of a plant item instance.

L.5 Pipe lengths

The representation of piping components within a piping design makes a distinction between two kinds of **product_definition**s: a physical Plant_item_definition and a Physical plant_item_instance. The definition is defined once and instantiated numerous times within a design at different locations to reduce duplication of information. This approach accommodates situations such as the repeated use of a pressure gauge at different locations in a design - one design, many usages.

In most piping designs, individual pieces of straight pipe of a given nominal size and material come in a large variety of lengths. Given the one design-many use approach, this would require that a definition and an instance be created for each pipe of differing length (since the length property of the pipe design shape differs). It is not practical to create Plant_item_definitions for each individual piece because everything about the pipe design is the same except for the length.

The use of this part of ISO 10303 permits two approaches for addressing this situation. The first is that the Plant_item_definition may be defined without specifying a length attribute. In this case, the length of the pipe would be associated with the Plant_item_instance **product_definition**. In this approach, all the information about the pipe - material, insulation, nominal size (a shape property) - would be associated with the Plant_item_definition **product_definition**. The shape property of the instance would be represented by (i.e., have **representation_item**s of) the mapped shape of the Plant_item_definition (see discussion of mapped_item) and the parameter end_to_end_length.

The second approach is similar to the first, but specifies **descriptive_representation_item** with the attribute **description** assigned a value of "as required", rather than specifying an end_to_end_length. This completely eliminates the need to specify a length and permits the pipe to be "cut to fit" at the plant site.

L.6 Logical connectivity and relationship to physical design

Piping lines and line segments represent the logical connectivity of the process streams and equipment. This is part of a functional design in that the functional capability of the piping system is partially represented by the connectivity of the piping lines and (functional) plant items. The complete representation of the functional capabilities of the piping system is outside the scope of this part of

ISO 10303. ISO 10303-221 [3] may be used to represent the complete functionality of the piping system.

The physical design of the piping is associated with the functional design of the piping lines through line_piping_system_component_assignment. This association links an element of the physical design (an instance, not a definition), such as a valve, to a Piping_system_line_segment. This association says "this piping component is on this line". Therefore, one or more piping components may be considered as being "on" a piping line.

Since physical piping components may be connected to form piping runs or piping assemblies, two kinds of connectivity can exist within a usage of this part of ISO 10303: logical connectivity represented by piping system lines and physical connectivity represented by plant item connections. In general, **the only points where logical connections correspond to physical connections are where the line terminates at a piece of equipment.** This is due to the fact that lines may end at equipment (by definition) and equipment connectors establish connections with piping components. Most physical connections, however, do not correspond to logical connections. Figure L.1 illustrates the relationship between the piping line segments, connectivity between line segments, physical components, and the connectivity between physical components.

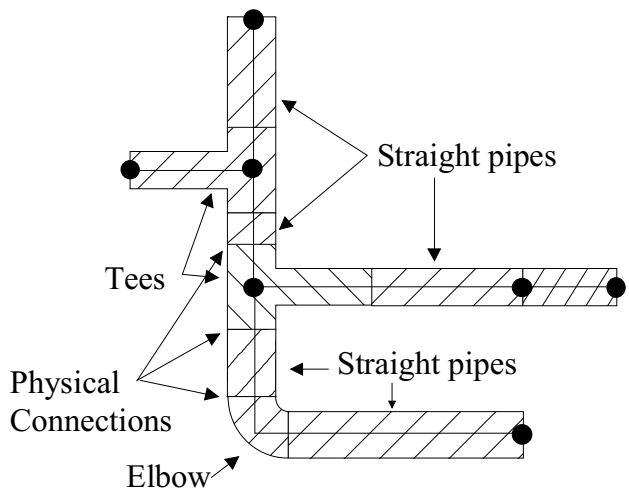


Figure L.1 - Relationship between logical connectivity and physical connectivity

Annex M
(informative)

Application reference model wallpaper version

This annex provides a "wallpaper" version of the application reference model for the exchange of plant spatial configuration information. This application reference model presents a graphical representation of the structure and constraints of the application objects specified in clause 4 of this part of ISO 10303. This version of the application reference model is structured for pasting together to facilitate viewing of the complete model. The application reference model is independent of any implementation method.

NOTES

1 - The application reference model is represented using the IDEF1X modelling language.

2 - The application reference model is presented in a tiled diagram format. The complete diagram may be assembled according to the following template:

Figure M.1	Figure M.2	Figure M.3	Figure M.4	Figure M.5
Figure M.6	Figure M.7	Figure M.8	Figure M.9	Figure M.10
Figure M.11	Figure M.12	Figure M.13	Figure M.14	Figure M.15
Figure M.16	Figure M.17	Figure M.18	Figure M.19	Figure M.20
Figure M.21				

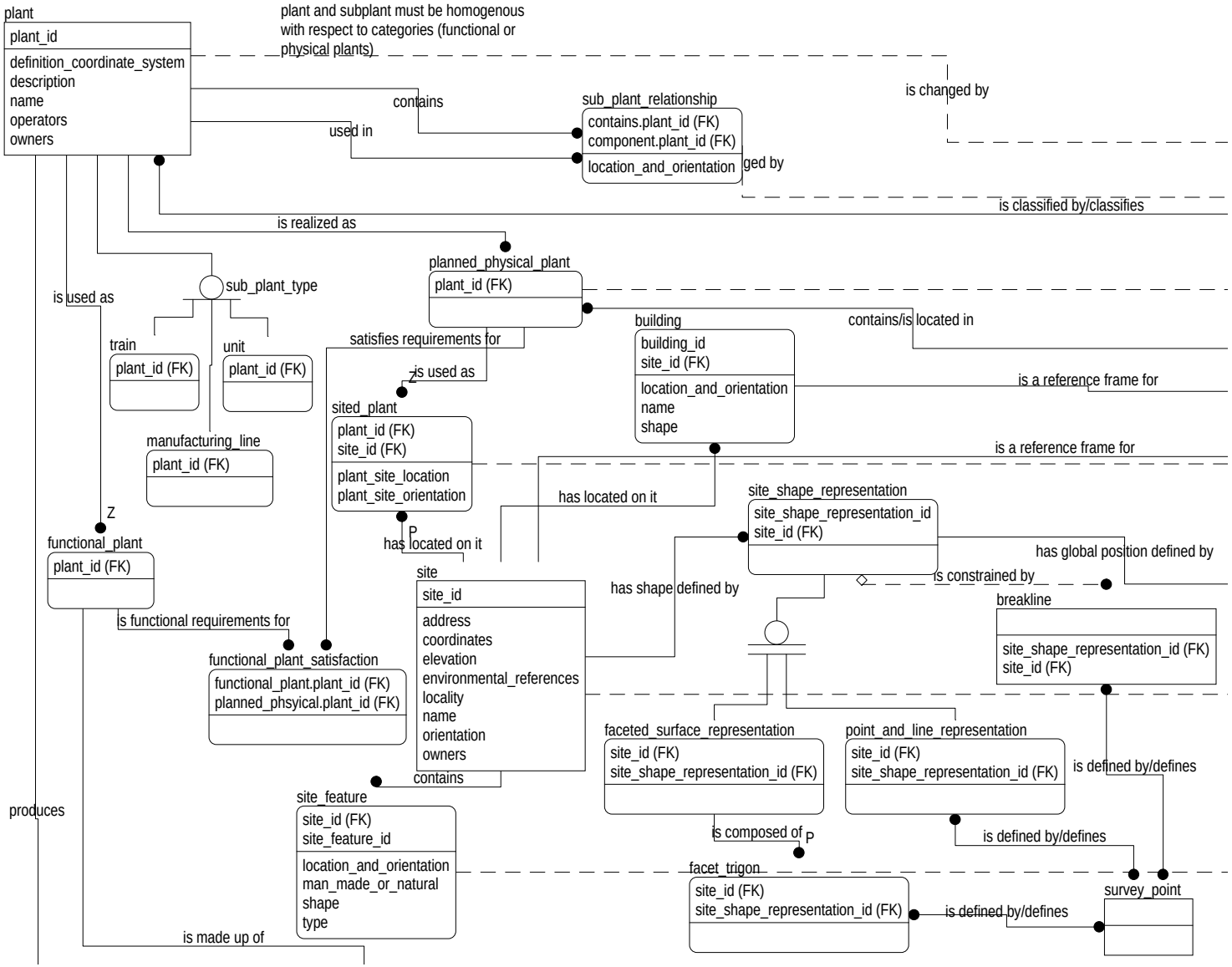


Figure M.1 - ARM diagram 1 of 21

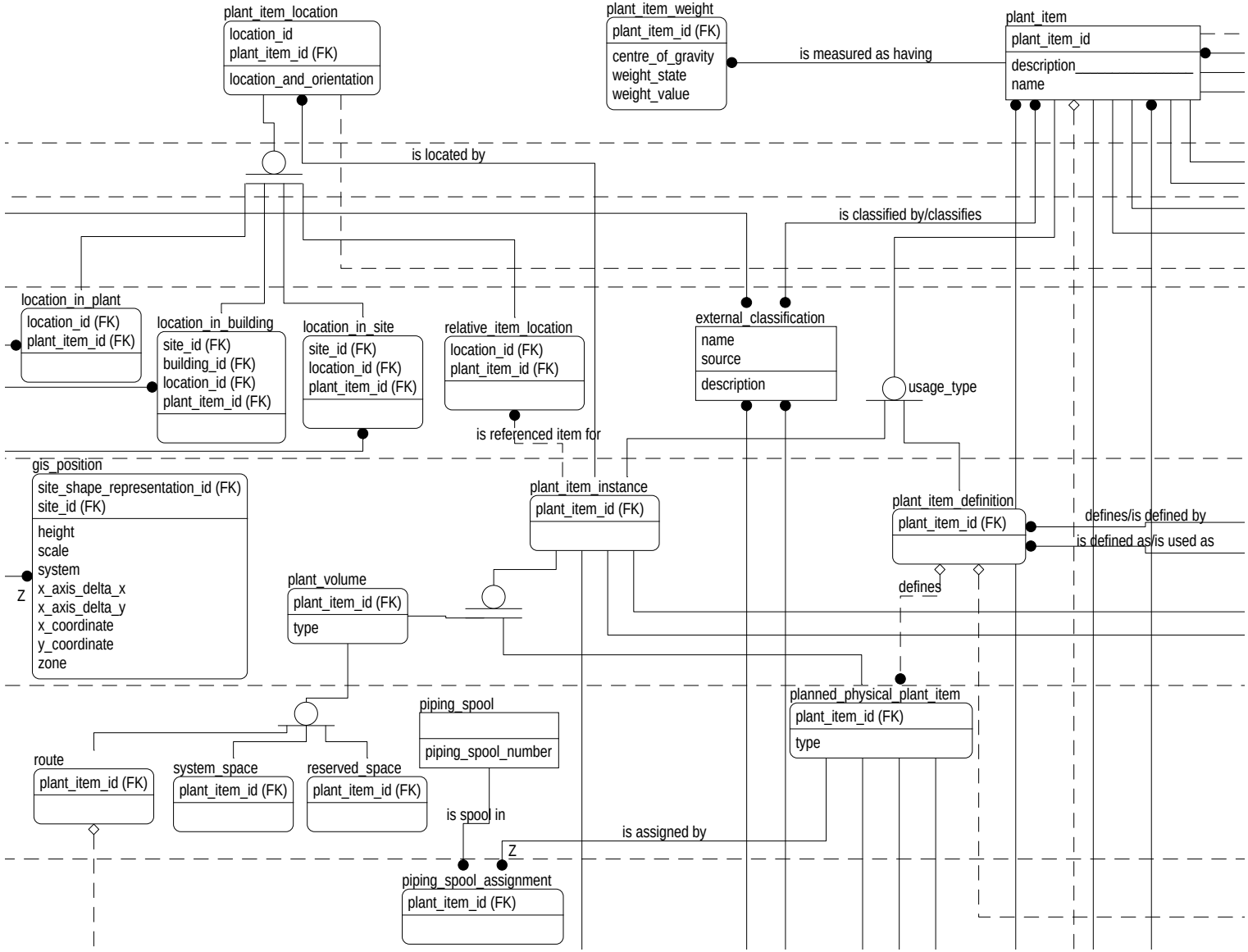


Figure M.2 - ARM diagram 2 of 21

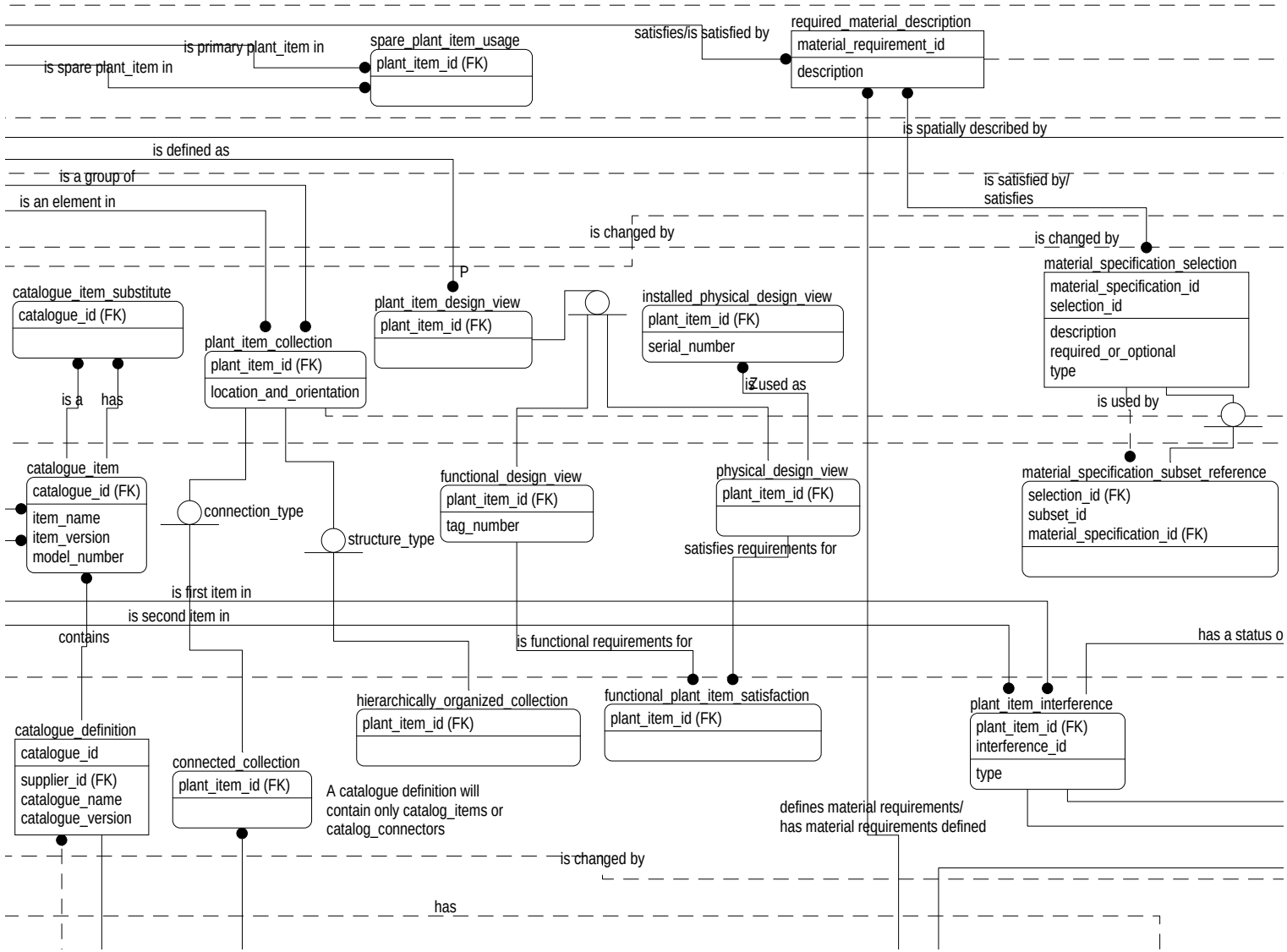


Figure M.3 - ARM diagram 3 of 21

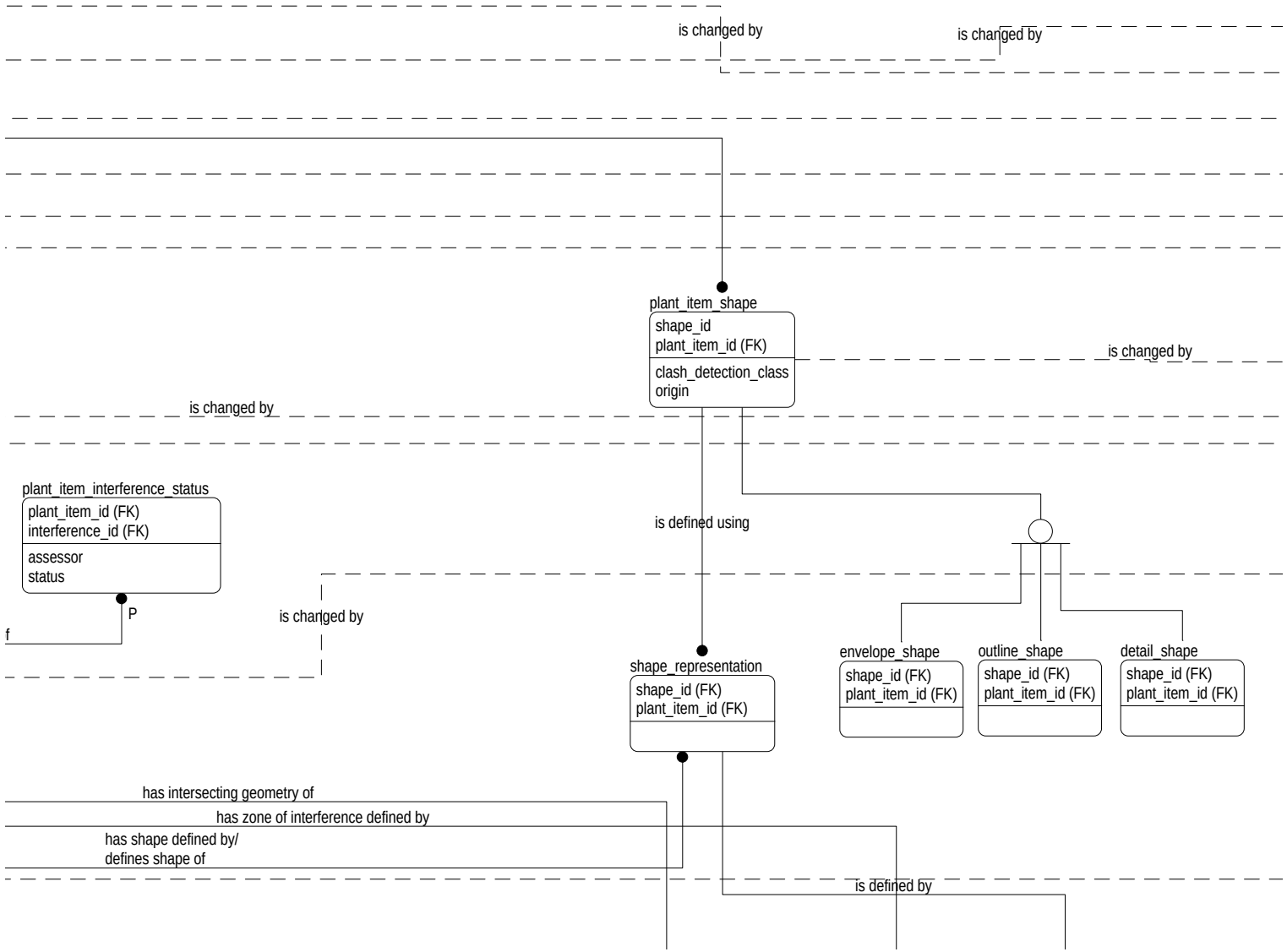
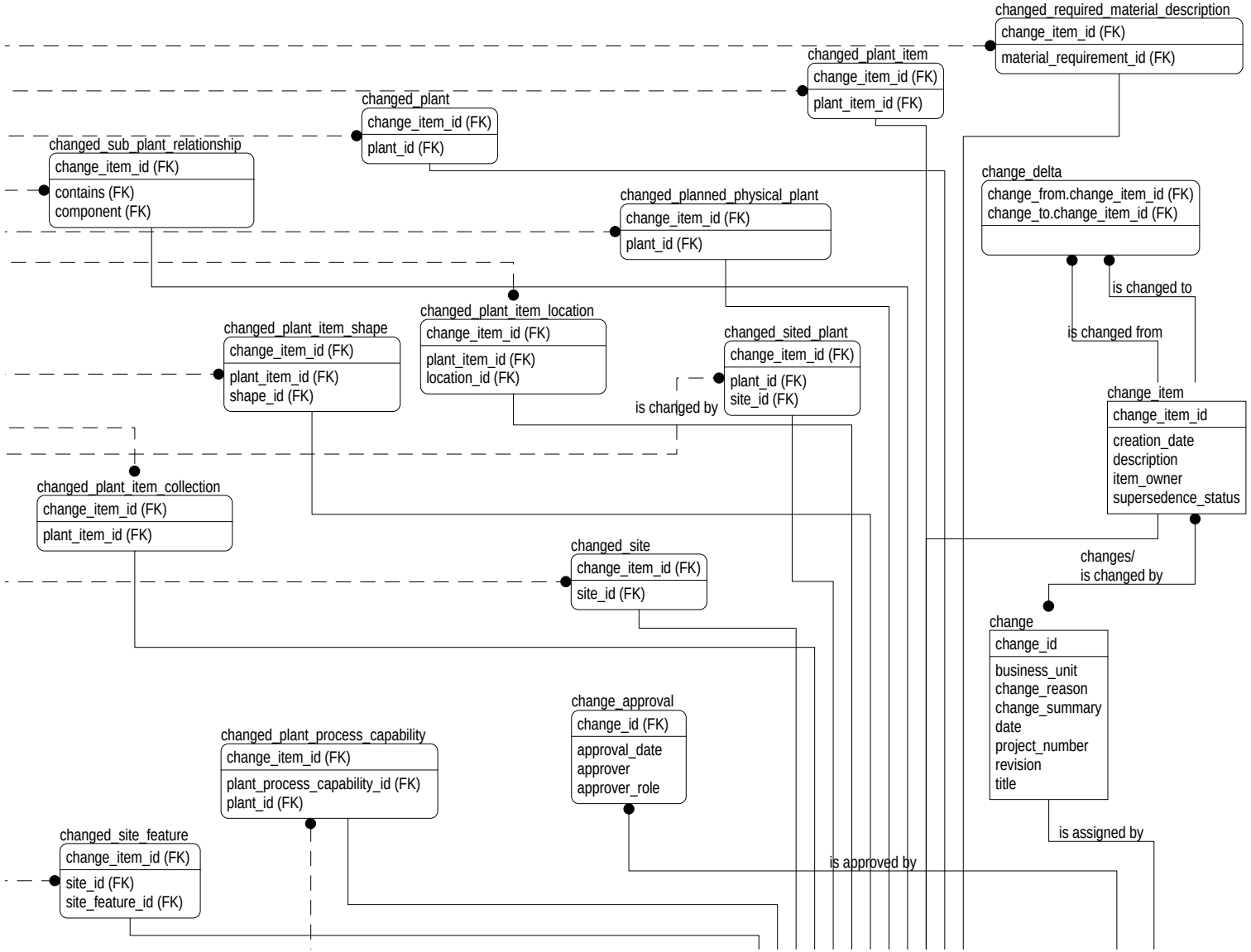


Figure M.4 - ARM diagram 4 of 21



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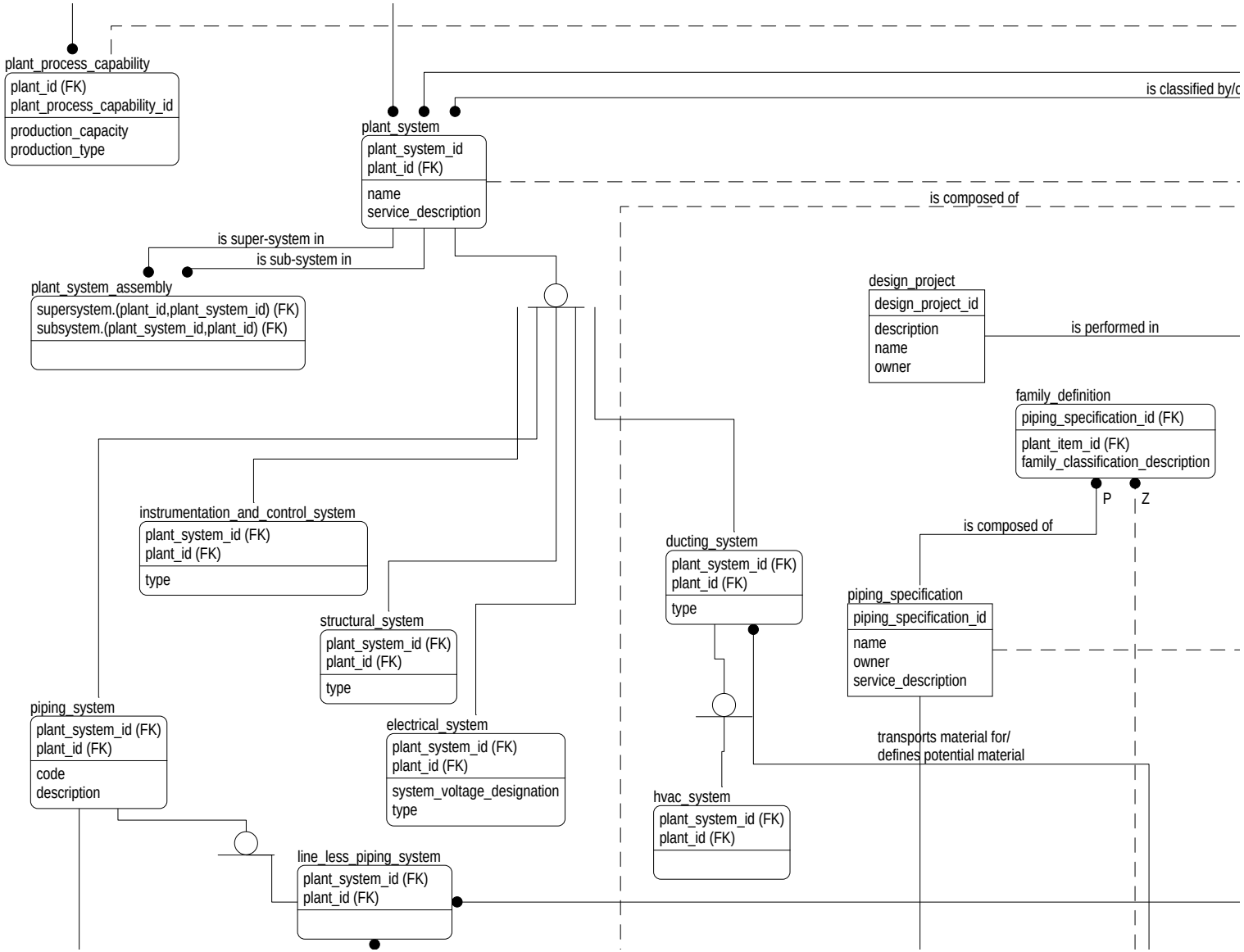
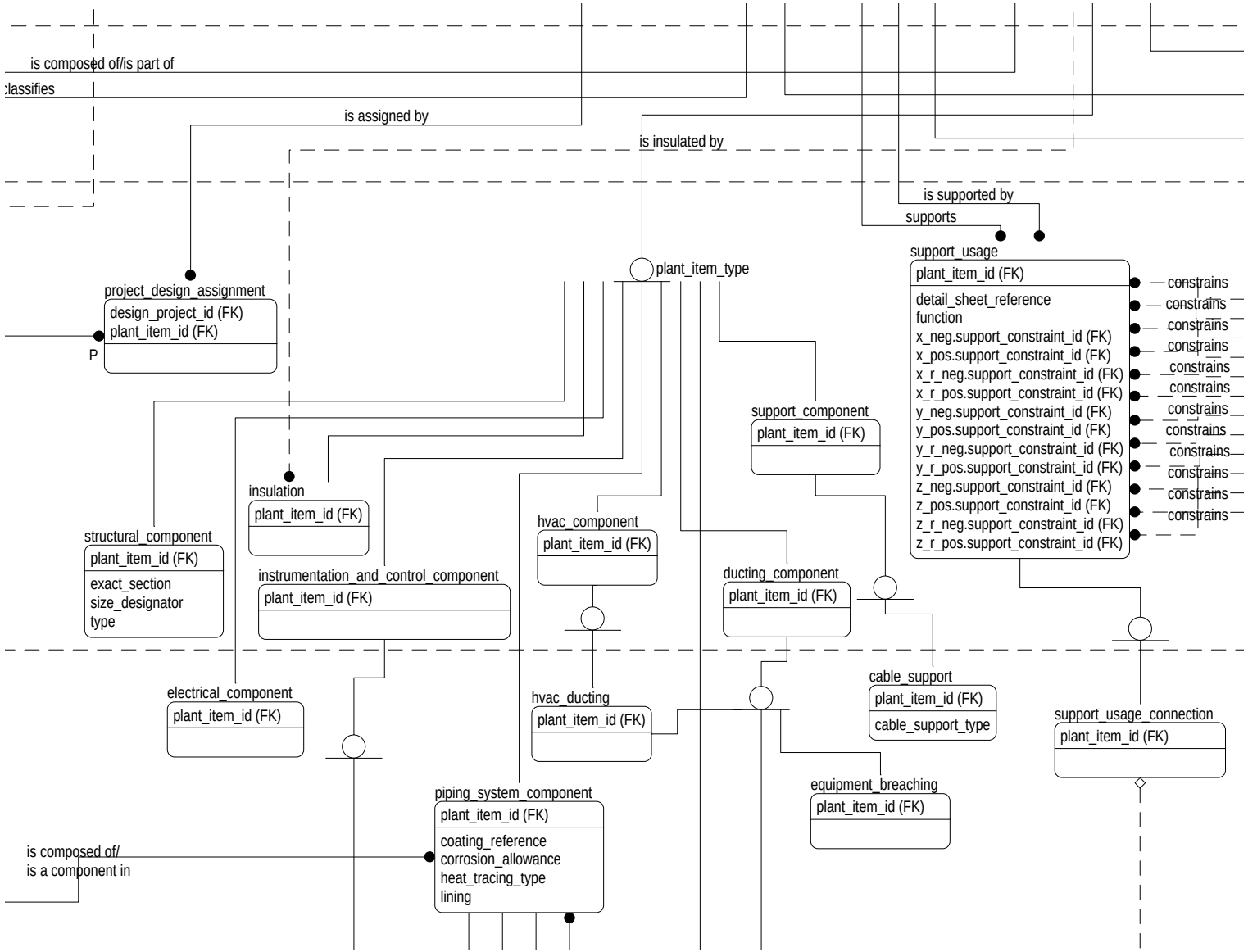


Figure M.6 - ARM diagram 6 of 21



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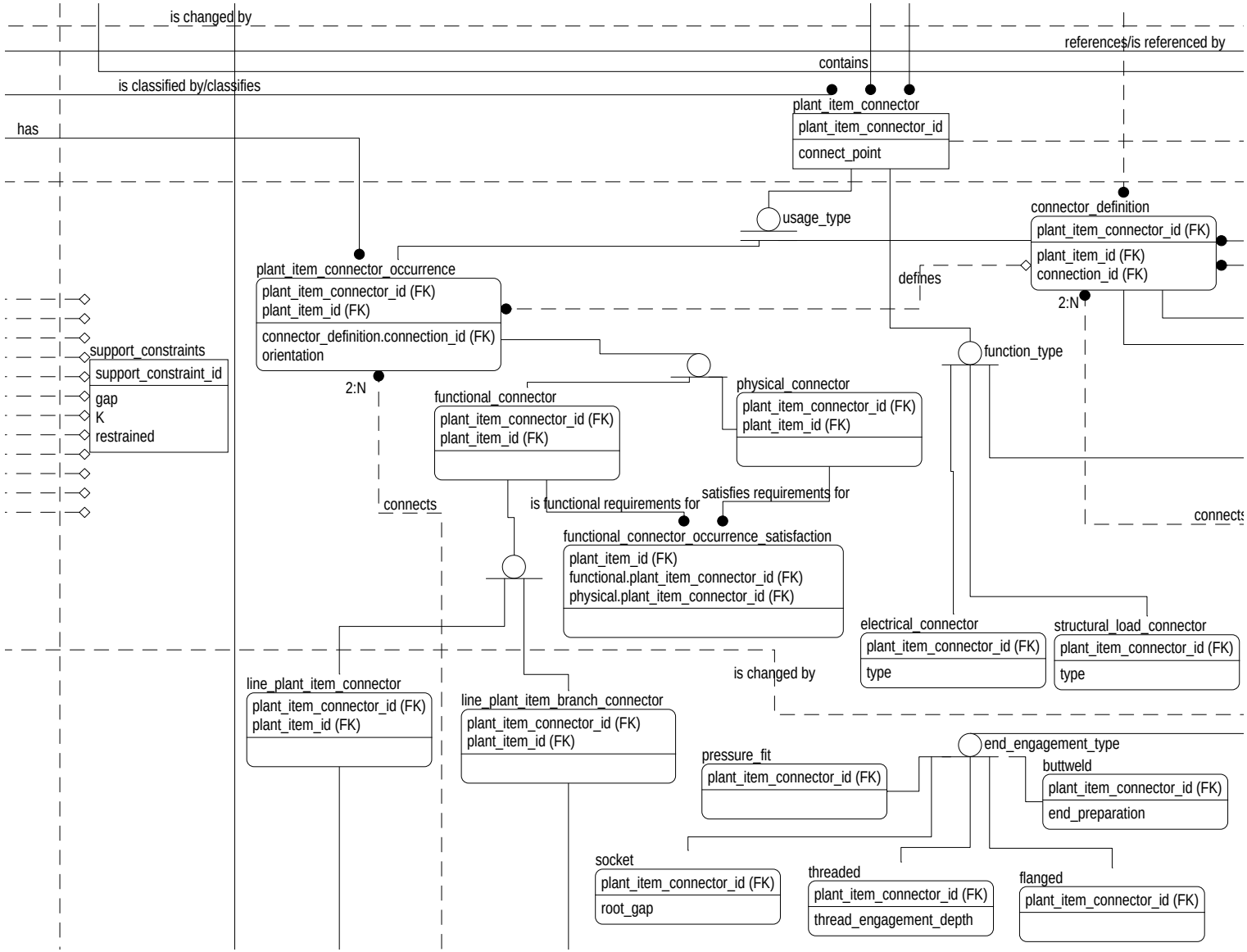

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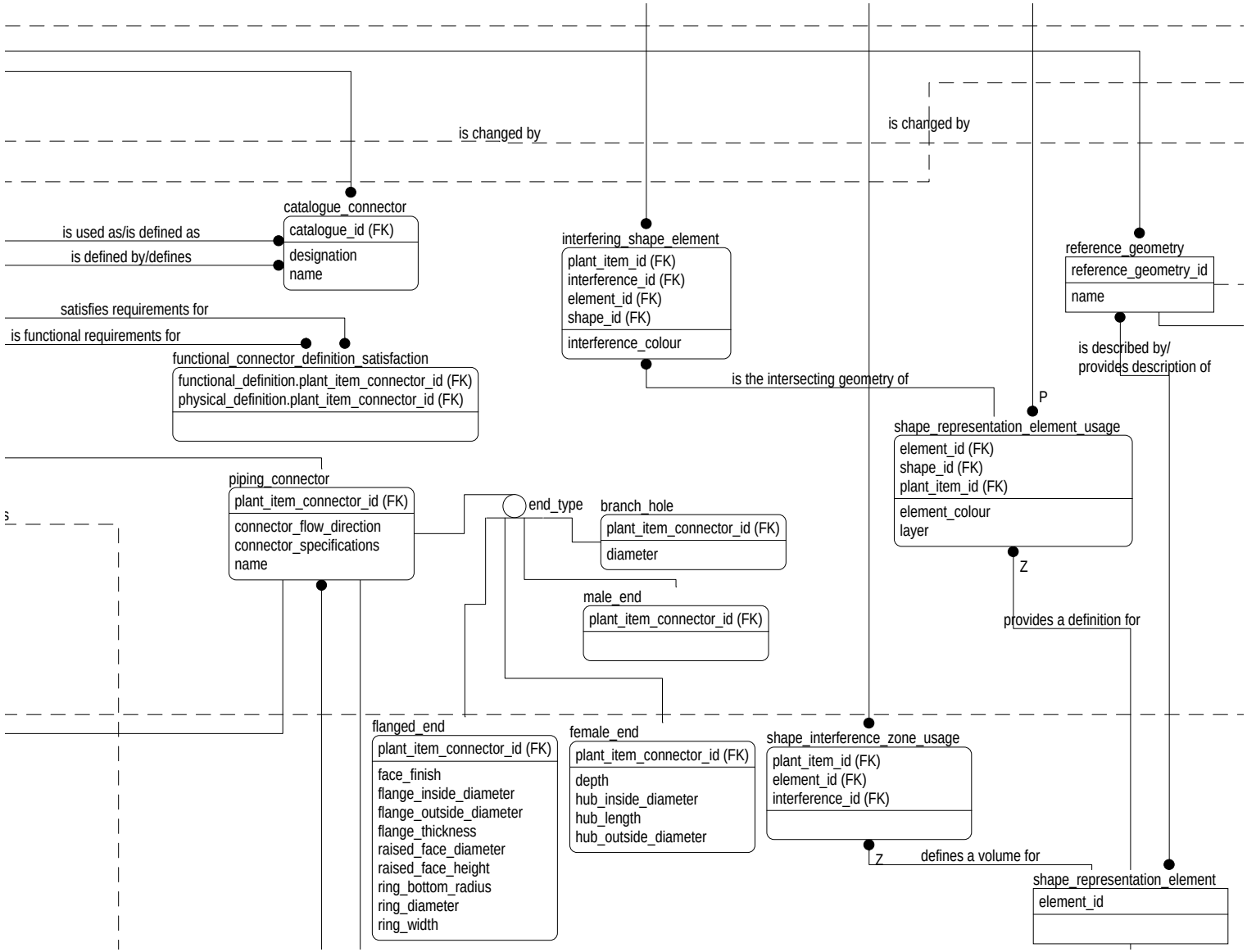

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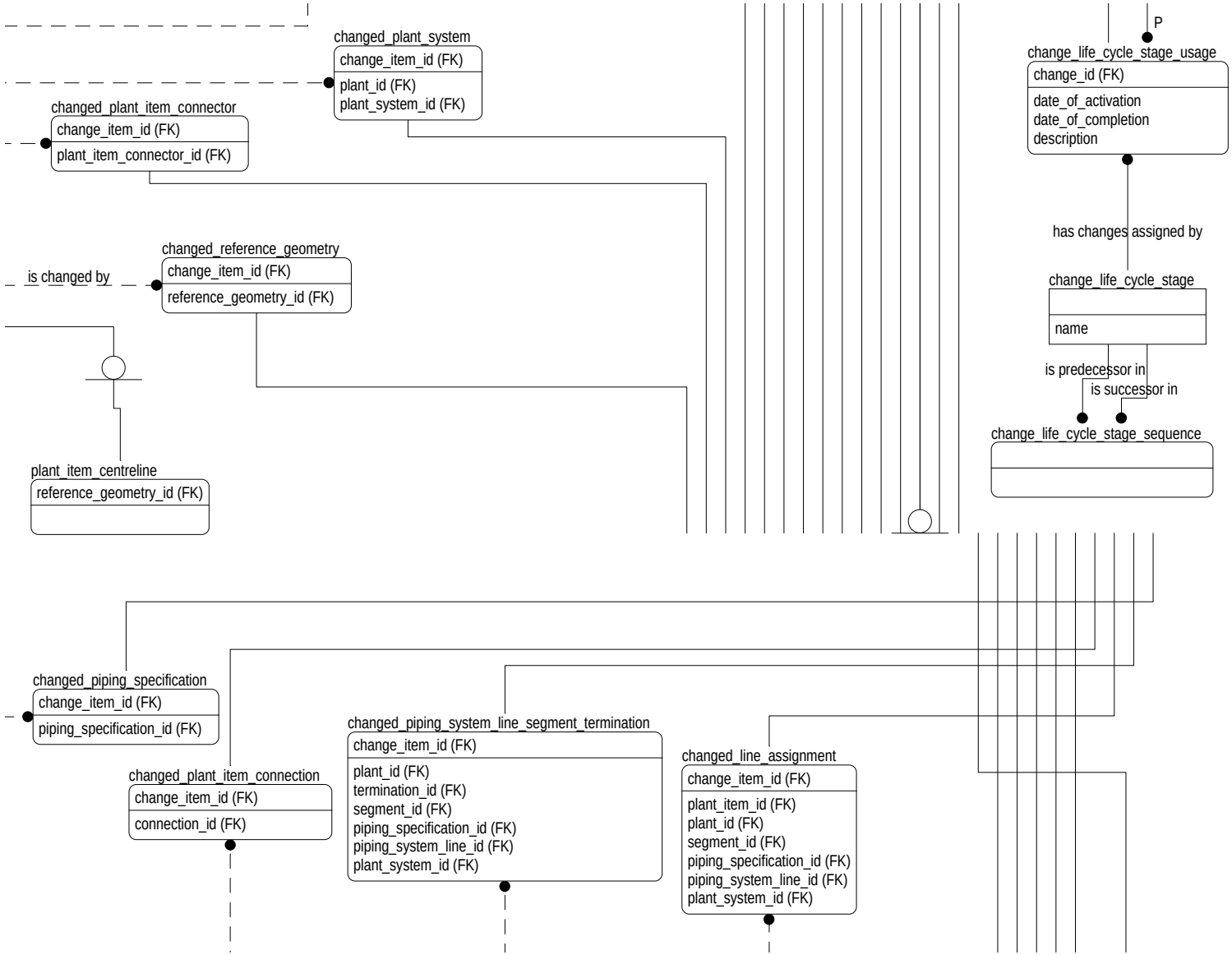

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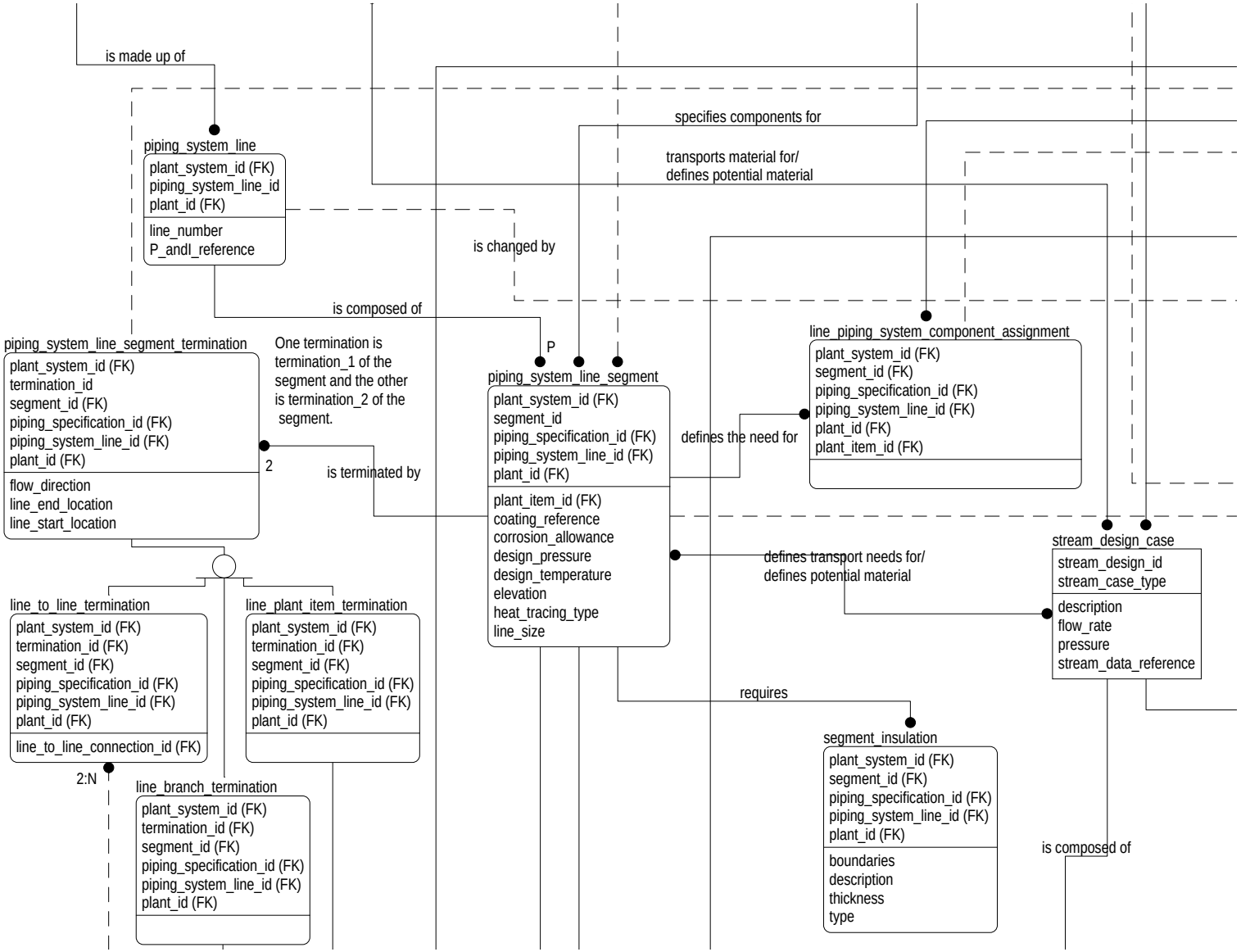


Figure M.11 - ARM diagram 11 of 21

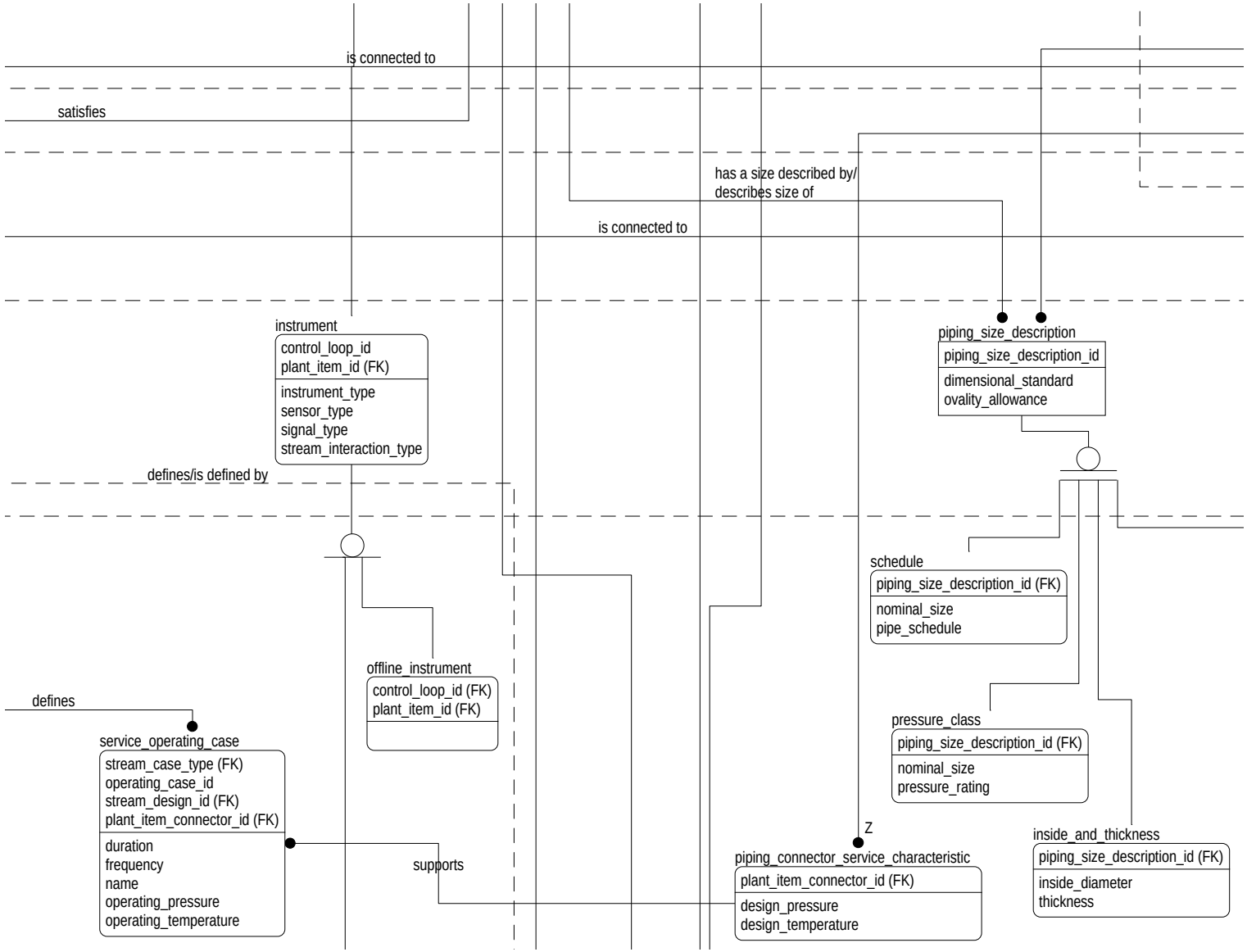
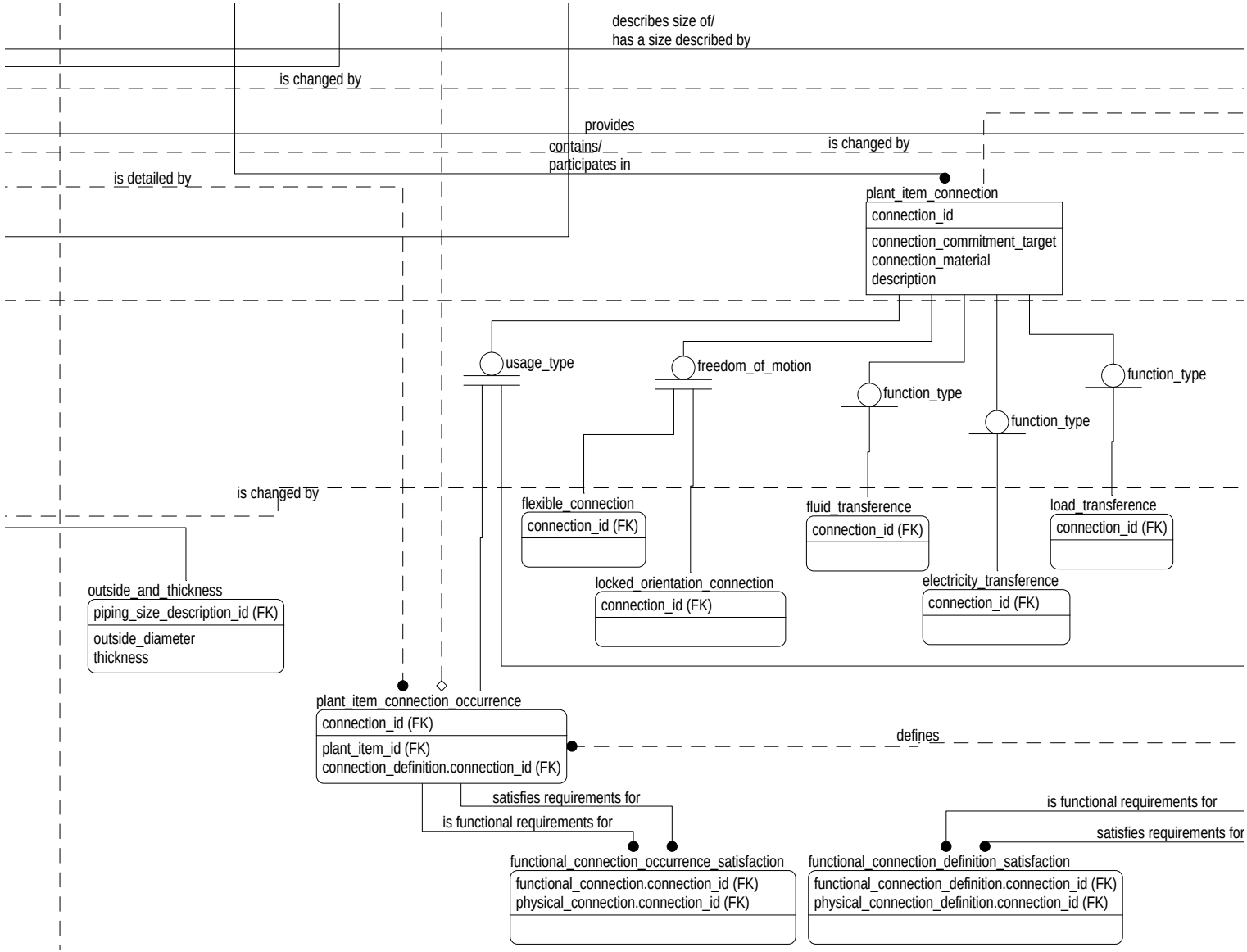


Figure M.12 - ARM diagram 12 of 21



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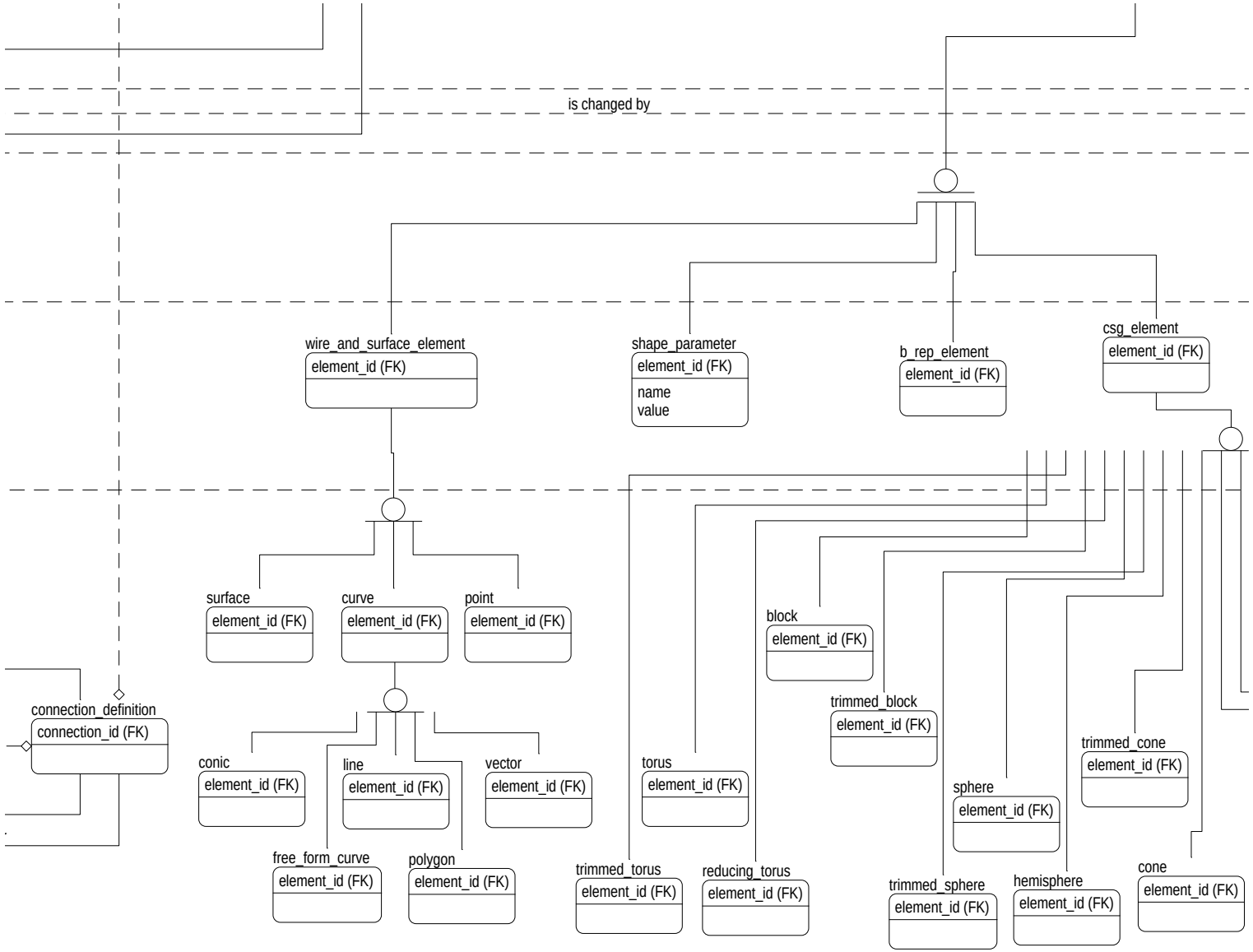
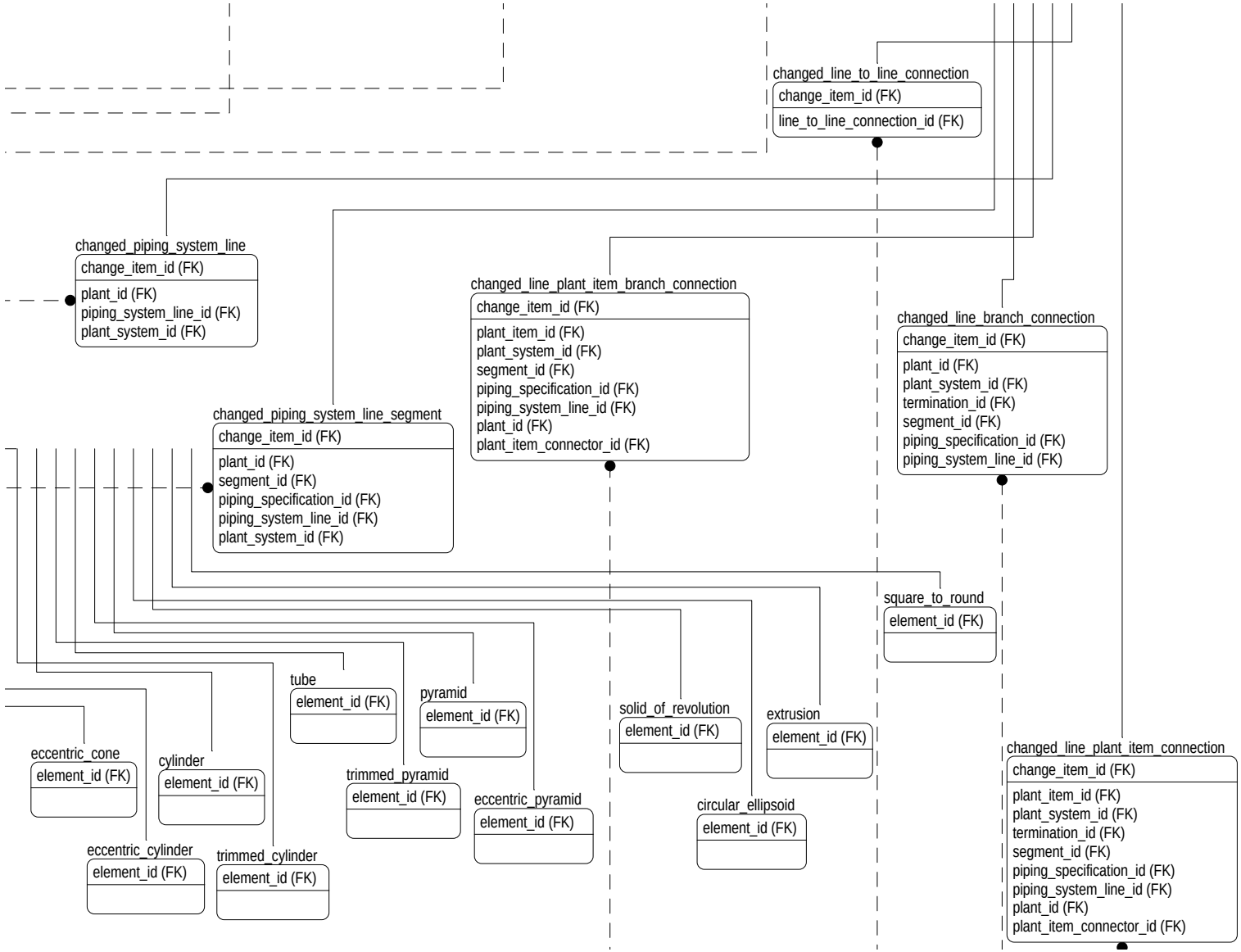


Figure M.14 - ARM diagram 14 of 21



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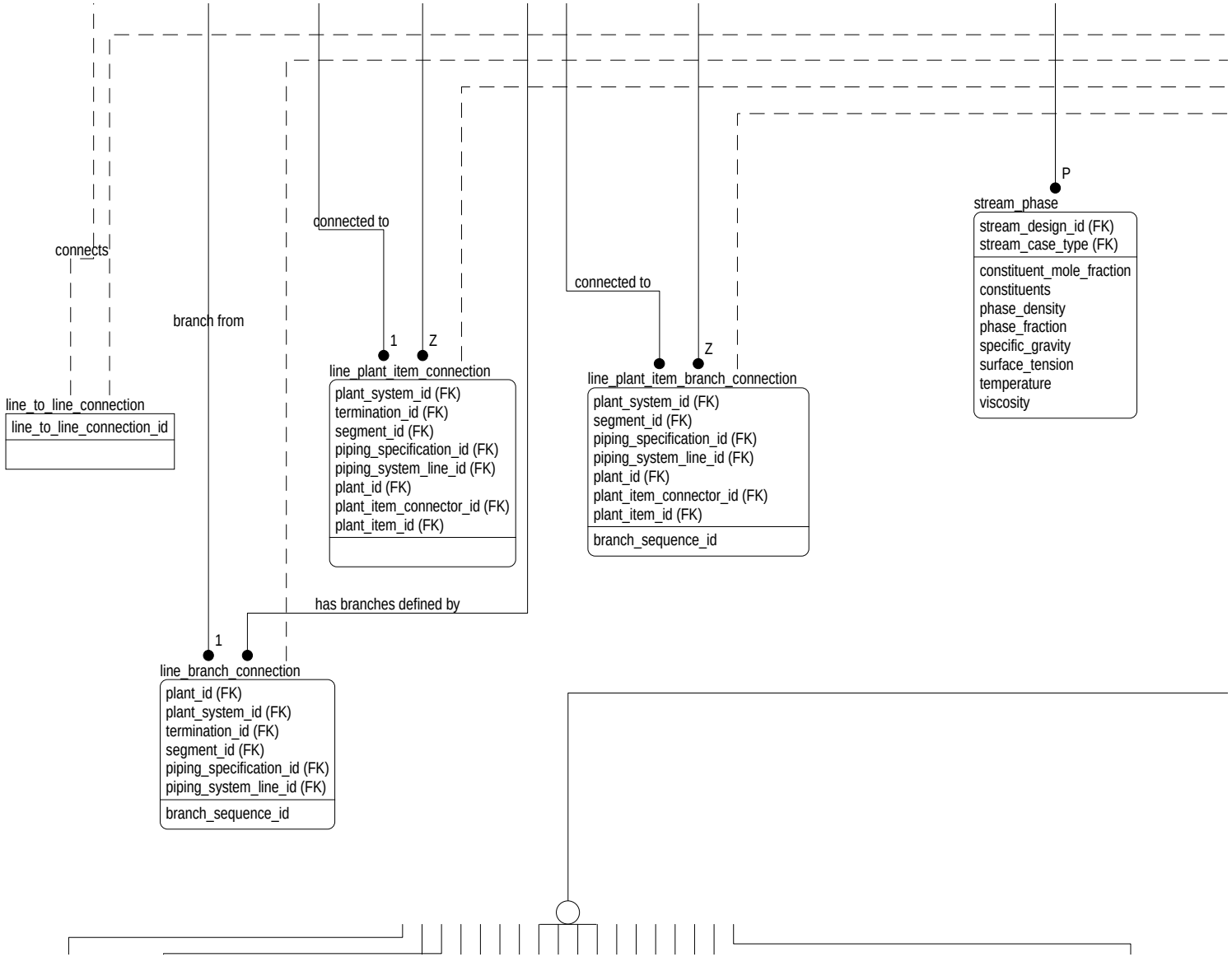

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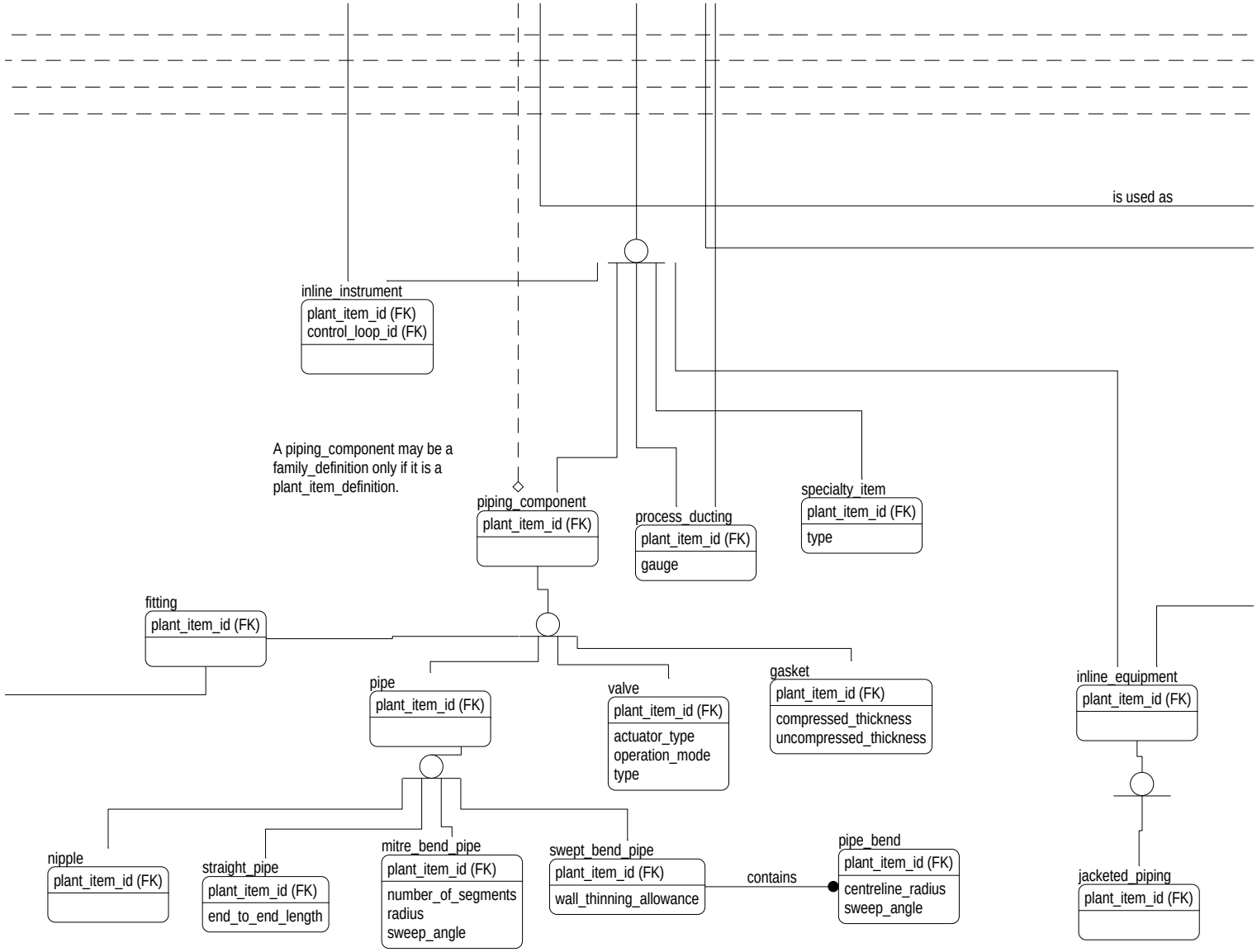

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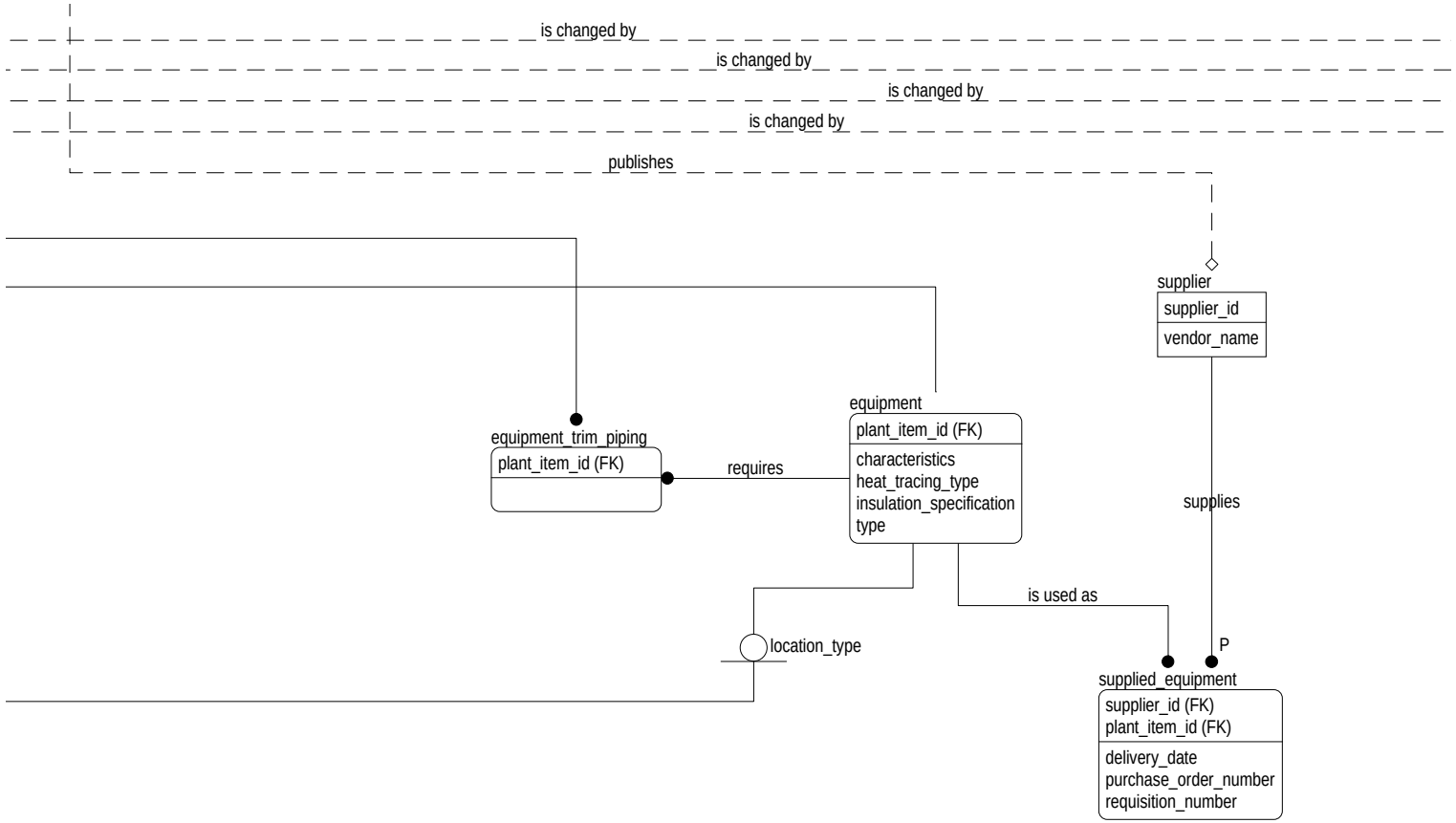

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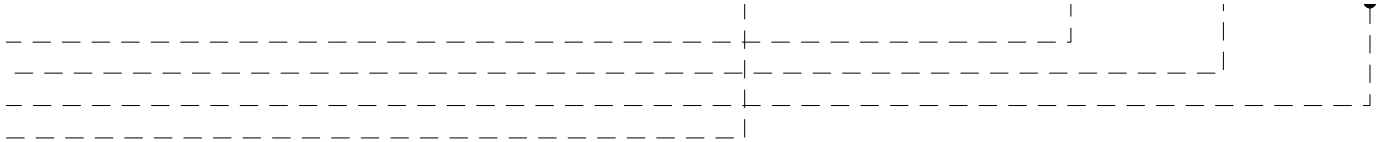
Figure M.19 - ARM diagram 19 of 21



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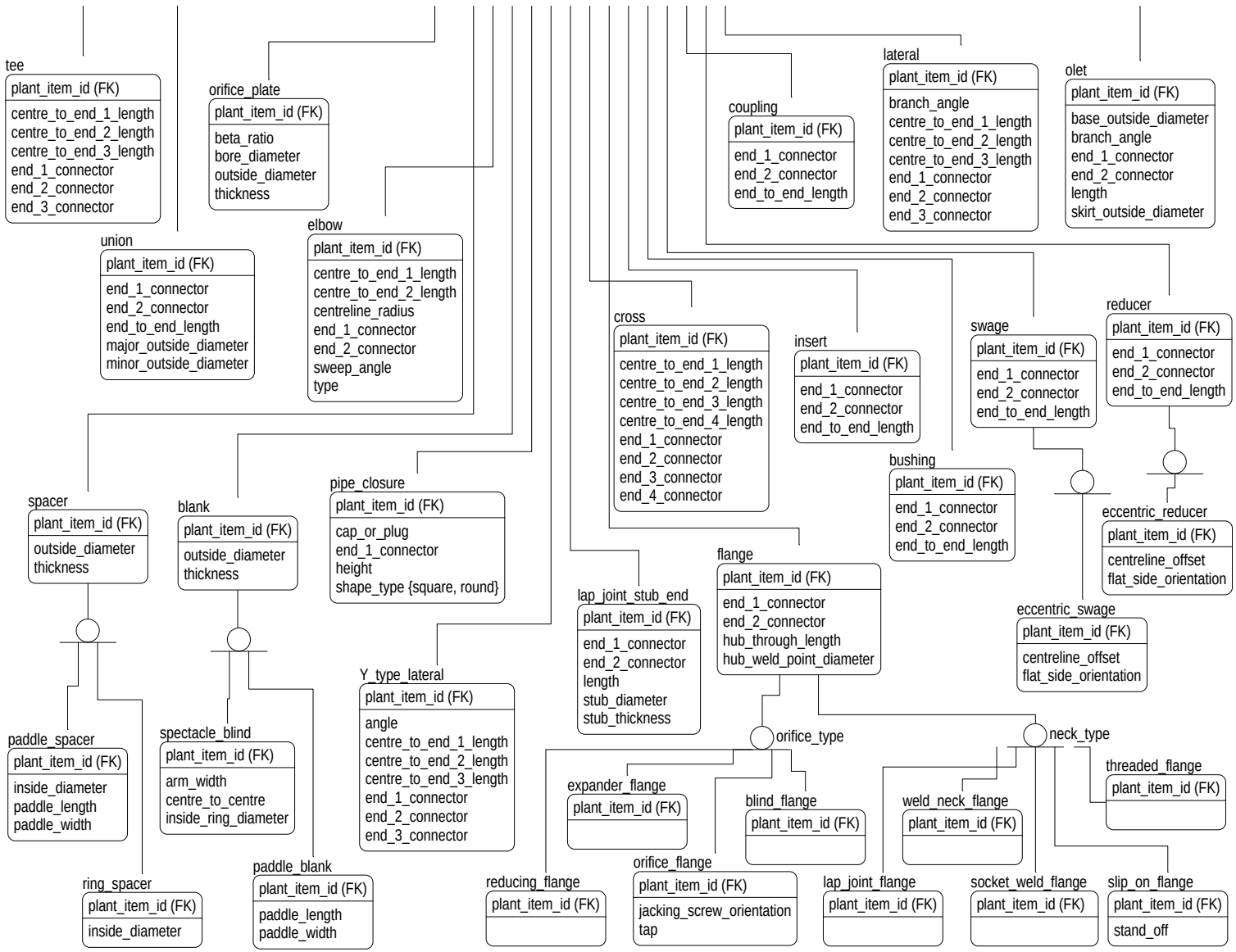

Figure M.21 - ARM diagram 21 of 21

Annex N
(informative)

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