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Group 1 for the Process Engineering Data STEP Application Protocol

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ABSTRACT

Part 231 of ISO 10303, *Process Engineering Data: Process Design and Process Specifications of Major Equipment*, specifies an application protocol (AP) for the exchange of process engineering and conceptual design information for process plants. This information forms the conceptual basis for the specification, selection, and operation of process plant equipment over the plant life cycle. This AP supports continuous and batch processes, process simulations, stream data, unit operations, conceptual design requirements for major process equipment, and conceptual process control strategies.

This document specifies the scope and information requirements for AP 231 and provides the Application Activity Model (AAM) and Application Reference Model (ARM) for the AP. The document follows the format and clause numbering scheme prescribed for this type of International Organization for Standardization (ISO) standard. The clauses and annexes contained in this document are those required by ISO for Group 1 review and comments.

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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 231 of ISO 10303, *Process Engineering Data: Process Design and Process Specifications of Major Equipment*, specifies an AP for the exchange of process engineering and conceptual design information for process plants. Process engineering information is used throughout the process plant life cycle. Process engineering information is initially generated during the process system design activities, including conceptual and final process design and a portion of the detailed engineering design specifications of process equipment. Process engineering information can be used to produce process flow diagrams (PFDs), equipment and instrument lists, process specifications on equipment datasheets, and to populate databases with process information needed later in the life cycle, e.g., process stream data. This information forms the conceptual basis for the specification, selection, and operation of process plant equipment over the plant life cycle. This AP supports continuous and batch processes, process simulations, stream data, unit operations, conceptual design requirements for major process equipment, and conceptual process control strategies. This document constitutes the Group 1 documentation for AP 231.

The *Process Engineering Data: Process Design and Process Specifications of Major Equipment Application Protocol* has been submitted for international review and comment as an ISO Group 1 document.

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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 10303-231 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 method: EXPRESS language reference manual;

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

— Part 13, Description method: Architecture and methodology reference manual;

— Part 21, Implementation method: 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 resource: Fundamentals of product description and support;

— Part 42, Integrated generic resource: Geometric and topological representation;

— Part 43, Integrated generic resource: Representation structures;

— Part 44, Integrated generic resource: Product structure configuration;

— Part 45, Integrated generic resource: Materials;

— Part 46, Integrated generic resource: 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: Design of layered electronic products;

— Part 211, Application protocol: Electronics test diagnostics and remanufacture;

— 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 mechanical design processes;

— 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 cast parts;

— Part 224, Application protocol: Mechanical product definition for process plans using mechanical feature;

— 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 package;

— 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: Design of layered electronic products;

— Part 311, Abstract test suite: Electronics test diagnostics and remanufacture;

— 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 processes;

— Part 315, Abstract test suite: Ship arrangement;

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— Part 324, Abstract test suite: Mechanical product definition for process plans using mechanical 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 package;

— 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 this International Standard reflects its structure:

— Parts 11 to 13 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, and K are for information only. Annexes A, B, C, D, H, and J are not required as part of the Group 1 version of this part. They will be included in the Committee Draft version of this part.

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 process engineering and conceptual design information for process plants. Process engineering information is used throughout the process plant life cycle. Process engineering information is initially generated during the process system design activities, including conceptual and final process design and a portion of the detailed engineering design specifications of process equipment. Process engineering information can be used to produce process flow diagrams (PFDs), equipment and instrument lists, process specifications on equipment datasheets, and to populate databases with process information needed later in the life cycle, e.g., process stream data. This information forms the conceptual basis for the specification, selection, and operation of process plant equipment over the plant life cycle. This AP supports continuous and batch processes, process simulations, stream data, unit operations, conceptual design requirements for major process equipment, and conceptual process control strategies.

This application protocol defines the context, scope, and information requirements for the exchange of process engineering data as detailed in the exchange scenarios described below and specifies the integrated resources necessary to satisfy these requirements. The AP purposes are:

— Exchange of the process engineering portion of initial and revised process design packages between an operating company and an engineering company;

— Exchange of process engineering information within an organization among various software packages that support the process engineering work activity, including internally owned software and software licensed from different software providers;

— Exchange of process engineering information among various software packages involved in various stages of the plant life cycle, which may involve disciplines other than process engineering, and which need to use process engineering information;

— Transmission of the process engineering portion of a technology package from a licensing company to an engineering company or an operating company;

NOTE - A technology package is usually less complete than a process design package and is usually site independent.

— Transmission of the process engineering portion of a process design package within a company, such as from a central office to an operating plant for review and comment;

— Transmission of the process engineering portion of a facility description during the sale of the facility.

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 (ARM), is given in annex G.

Resource constructs are interpreted to meet the information requirements. This interpretation produces the application interpreted model (AIM). This interpretation, given in 5.1 (later), 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 (later). 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 (later) contains the complete EXPRESS for the AIM without annotation. A graphical representation of the AIM is given in annex H (later). Additional requirements for specific implementation methods are given in annex D (later).

Industrial automation systems and integration — Product data representation and exchange — Part 231: Application protocol: Process engineering data: Process design and process specifications of major equipment

1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the exchange of process engineering and conceptual design information of process plants, including process designs, unit operations, process simulations, stream characteristics, and design requirements for major process equipment. The primary life cycle perspective is that of conceptual process engineering done prior to the detailed design and construction of new process plants or the modification of existing plants.

NOTE 1 - The application activity model (AAM) 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.

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

— physical properties for substances used or produced by the process industries and pseudo-components;

— simulation results;

— conceptual process design descriptions of equipment.

— information needed to make a process flow diagram (PFD); This includes:

a) identification and description of process equipment;

b) identification of major instrumentation and valves essential to process control and understanding the flowsheet;

c) stream identification, description, and properties;

d) temperature, pressure, and flow quantities;

e) utilities requirements summaries;

f) associations between process system components and symbols to represent the components on a PFD.

— basic control strategies;

NOTE 2 - Basic control is dedicated to establishing and maintaining a specific state of equipment or process operation. It includes regulatory control, interlocking, monitoring exception handling, and discrete or sequential control.

NOTE 3 - Refer to International Society for Measurement and Control (ISA) ISA-S88.01-1995, *Batch Control, Part 1: Models and Terminology*, for further details of the 'Phase', 'Procedure', 'Unit Procedure', and 'Operation' portions of the procedural control hierarchy [1].

— equipment and specific performance descriptions at specific times during batch processes;

— process topology.

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

— geometry of a physical object or piece of equipment;

— detailed simulation control methods for steady state and dynamic simulation;

— the specification of equipment for purchase;

— piping and instrumentation diagrams (P&IDs);

— complete description of the batch recipe and control methods;

— detailed design of equipment.

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 8824-1:1994, *Information technology — Open systems interconnection — Abstract syntax notation one (ASN.1) — Part 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: Material.*

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.*

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:

— application;

[1] To be published.

— application activity model (AAM);

— application interpreted model (AIM);

— application protocol (AP);

— application reference model (ARM);

— conformance class;

— implementation method;

— integrated resource;

— product;

— product data;

— 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:

— abstract test suite (ATS);

— conformance testing;

— implementation under test (IUT);

— protocol information and conformance statement (PICS).

3.3 Other definitions

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

3.3.1 actual: descriptive adjective which, when applied to an item, refers to the state of the information known about the item, upon which subsequent action can be taken. An "actual" item is an item that has existence in the real world and has physical properties that can be measured.

NOTE - See 3.3.16 and 3.3.22. The terms actual, planned, and required loosely reflect life cycle stages of an item. For example, a required item leads to a planned item that meets or satisfies the requirement.

3.3.2 babbit: a soft metallic lining that provides a low friction between a bearing surface and a rotating shaft.

3.3.3 catalogue: a list of things or a document that contains a list of things.

NOTES

1 - A catalogue may be a list of symbols or of plant items and their properties and features.

2 - A catalogue may be either an electronic or printed document.

3.3.4 component: a plant item that may be part of another plant item.

3.3.5 connection: an association between two plant items that results from a physical joining. A connection has both physical and functional properties. The properties describe both the physical nature of a connection and the functional capability that it provides.

3.3.6 construction material: the substance or substances from which a physical plant item is composed.

3.3.7 equipment: a plant item that carries out an operation on the process material. An equipment has both physical and functional properties.

NOTE - An equipment may be treated as a single item for the purpose of design, acquisition, or operation.

3.3.8 functional: descriptive adjective which, when applied to an item, refer to a set of characteristics, properties, or traits of the item. "Functional" refers to the actions, activities, or capabilities, that the item provides or may provide to fulfill a purpose.

3.3.9 functional characteristics: nomenclature, codes, and named values that describe or specify the performance or behavior of a plant item.

EXAMPLE 1 - Functional characteristics include operating pressure and maximum temperature.

3.3.10 functional requirements: nomenclature, codes, and named values that describe or specify the performance or behavior to be met by a plant item.

3.3.11 instrument: a plant item that is an individually identifiable item or combination of items that is part of a system which monitors or controls the systems in a process plant.

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

3.3.12 insulation: a volume of material that provides resistance to the flow of heat, electricity, or sound.

3.3.13 material stream: a flow of process material past a defined point along a path.

3.3.14 physical: descriptive adjective which, when applied to an item, refer to a set of characteristics, properties, or traits of the item. "Physical" refers to shape and material characteristics such as weight, size and location and orientation of the item.

3.3.15 pipe: a plant item that is hollow and approximately cylindrical, that may have a constant cross-section along its length, and that conveys fluid, vapor, or particulate flow.

3.3.16 planned: descriptive adjective which, when applied to an item, refers to the state of the information known about the item, upon which subsequent action can be taken. A "planned" item is an item that has been designed or predicted.

NOTE - See 3.3.1 and 3.3.22. The terms actual, planned, and required loosely reflect life cycle stages of an item. For example, a required item leads to a planned item that meets or satisfies the requirement.

3.3.17 plant: an assembly of one or more plant systems and plant items that is intended to perform a chemical, physical or transport process. A plant is identified as a single unit for the purposes of management and ownership. A plant has both physical and functional properties.

3.3.18 plant item: a physical object or volume of space that is, or may be, a part of a process plant. If it is a volume of space, it may or may not contain other objects. A plant item has both physical and functional properties.

3.3.19 process flow diagram: a schematic representation containing the aggregation of the results of a process design activity. A process flow diagram shows the arrangement of the equipment selected to carry out the processes, the stream connections, stream flow rates and compositions, and the operating conditions.

3.3.20 process material: a substance or substances that is used or produced by a process.

3.3.21 representation: a description or depiction of something.

3.3.22 required: descriptive adjective which, when applied to an item, refers to the state of the information known about the item, upon which subsequent action can be taken. A "required" item is an item that is essential or necessary; that is, it has to be provided or met.

NOTE - See 3.3.1 and 3.3.16. The terms actual, planned, and required loosely reflect life cycle stages of an item. For example, a required item leads to a planned item that meets or satisfies the requirement.

3.3.23 site: an area of land on which one or more process plants is or may be situated.

3.3.24 stream: a flow of something past a point along a path.

NOTE - This is assumed to be at a frozen point in time. The 'something' that flows along a path includes materials, signals, energy, information, etc.

3.4 Abbreviations

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

AACE	american association of cost engineers;
AAM	application activity model;
AIChE	american institute of chemical engineers;
AFD	approved for design;
AFNOR	french association of standardization;
AIC	application interpreted construct;
AIM	application interpreted model;
ANSI	american national standards institute;
AP	application protocol;
API	american petroleum institute;
ARM	application reference model;
ASME	american society of mechanical engineers;
ASN	abstract syntax notation;
ASTM	american society for testing and materials;
ATS	abstract test suite;
C&IS	control and information system;
CAD	computer-aided design;
CODAP	comprehensive occupational data analysis programs;
DIN	german institute for standardization;
DIPPR	design institute for physical property data;

E&C	engineering design and construction;
EPA	environmental protection agency;
FDA	food and drug administration;
ISA	international society for measurement and control;
IUPAC	international union of pure and applied chemistry;
LMTD	log mean temperature difference;
MSDS	material safety data sheets;
NPSH	net positive suction head;
OSHA	occupational safety and health administration;
P&ID	piping and instrumentation diagram;
PF&CD	process flow and control diagram;
PFD	process flow diagram;
PICS	protocol information and conformance statement;
POD	process operation definition;
QFD	quantity flow diagram;
SFD	simplified process flow diagram;
TEMA	tubular exchanger manufacturers association;
UoF	unit of functionality.

4 Information requirements

This clause specifies the information required for the exchange of process engineering and conceptual design information.

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 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 within 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.

4.1 Units of functionality

This subclause specifies the units of functionality for the Process Engineering Data: Process Design and Process Specifications of Major Equipment application protocol. This part of ISO 10303 specifies the following units of functionality:

— chemical_reaction_data UoF;

— control_strategy UoF;

— heat_transfer_equipment UoF;

— major_process_equipment UoF;

— mass_transfer_equipment UoF;

— material_data UoF;

— material_transfer_equipment UoF;

— plant_context UoF;

— plant_item_definition UoF;

— plant_system_definition UoF;

— process_description UoF;

— process_flow_diagram UoF;

— process_simulation_data UoF;

— process_vessel_equipment UoF;

— stream_data UoF;

— substance_experimental_data UoF;

— substance_model_data UoF;

— unit_operation 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.

Figure 1 contains the data planning model that provides a high level description of the UoFs of this application protocol, as well as the relationships between these UoFs.

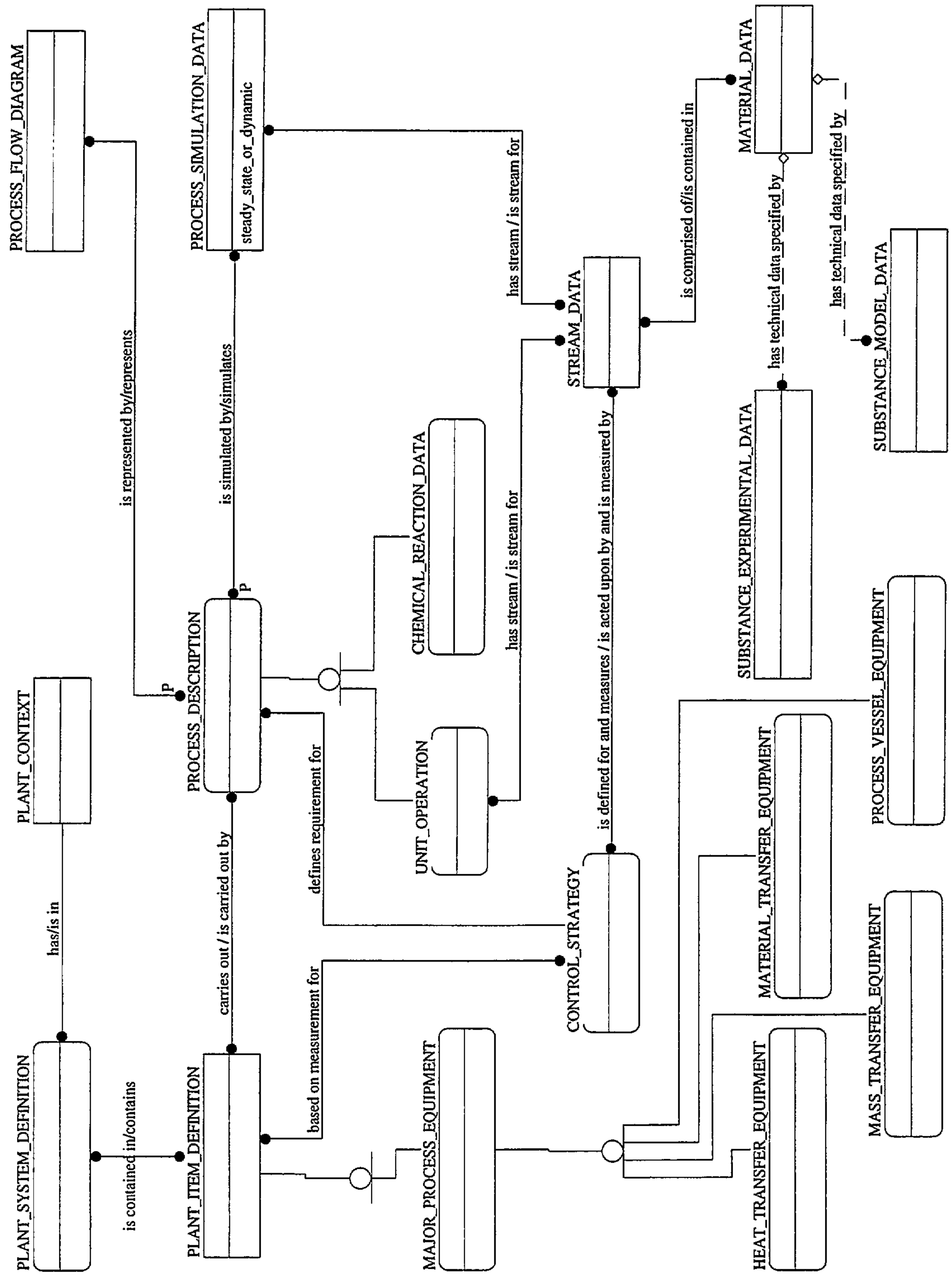


Figure 1 - Data planning model

4.1.1 chemical_reaction_data UoF

The chemical_reaction_data UoF specifies chemical equilibria, chemical reaction rates, and chemical reaction conversion criteria and constraints on stream and unit operation models.

The following application objects are used by the chemical_reaction_data UoF:

— Arrhenius_reaction;

— Chemical_reaction;

— Extents_specified_chemical_reaction;

— Interphase_chemical_reaction;

— Reaction_parametric_data;

— Reaction_rate;

— Stoichiometry.

4.1.2 control_strategy UoF

The control_strategy UoF specifies one or more control schemes for controlling the plant operation to manufacture the desired product(s). These control schemes define:

— One or more measurements of a property of a stream, material amount, site or plant item;

— The control logic whereby the measurements are used with defined control algorithms to effect control events or process adjustments to plant items or to other control schemes.

The following application objects are used by the control_strategy UoF:

— Comparison_parameter;

— Control_algorithm;

— Control_event_or_adjustment;

— Control_logic;

— Control_logic_condition;

— Control_measurement_module;

— Control_objective;

— Control_scheme;

— Control_variable;

— Logical_operation;

— Trigger.

4.1.3 heat_transfer_equipment UoF

The heat_transfer_equipment UoF specifies a type of process equipment that is used to provide a means by which fluids at different temperatures may be thermally contacted so that the heat transfer process may take place and heat is transferred from a hot stream to a cold stream.

The following application objects are used by the heat_transfer_equipment UoF:

— Air_cooled_heat_exchanger_unit;

— Cross_baffle;

— Detuning_plate;

— Distributor_belt;

— End_partition_plate;

— Exchanger_assembly;

— Exchanger_bundle;

— Exchanger_design_criteria;

— Exchanger_end;

— Exchanger_nozzle;

— Exchanger_performance;

— Exchanger_shell;

— Exchanger_zone;

— Expansion_joint;

— External_circuit_component;

— Flow_vibration_analysis;

— Heat_release_curve;

— Heat_release_point;

— Heat_transfer_equipment;

— Heat_transfer_thermodynamic_properties;

— Impingement_protection;

— Longitudinal_baffle;

— Nozzle_dome;

— Nozzle_performance;

— Partition_seal_rod;

— Passlane;

— Phase_properties;

— Reboiler_piping;

— Shell_and_tube_heat_exchanger_unit;

— Shellside_design;

— Shellside_performance;

— Tie_rod;

— Tie_rod_spacer;

— Tube_external_characteristics;

— Tube_internal_characteristics;

— Tube_type;

— Tubesheet;

— Tubeside_design;

— Tubeside_performance;

— U_bend_support;

— Vapour_belt.

4.1.4 major_process_equipment UoF

The major_process_equipment UoF specifies a Plant_item that carries out one or more operations on the process material. More details about process equipment may be found in the heat_transfer_equipment, mass_transfer_equipment, material_transfer_equipment and process_vessel_equipment UoFs.

The following application objects are used by the major_process_equipment UoF:

— Buffer_gas_system;

— Casing_nozzle;

— Elbow_nozzle_section;

— External_treatment;

— Nozzle;

— Nozzle_section;

— Nozzle_section_connection;

— Process_equipment;

— Process_equipment_driver;

— Reaction_system_equipment;

— Reducing_nozzle_section;

— Solids_processing_equipment;

— Straight_nozzle_section.

4.1.5 mass_transfer_equipment UoF

The mass_transfer_equipment UoF specifies a type of process equipment that is used to provide a means of transferring process material from one phase to another phase. The driving force for transfer is a difference in the process material concentration within the two or more phases and is used to separate and concentrate components within solution mixtures or to vapourize or condense pure components.

The following application objects are used by the mass_transfer_equipment UoF:

— Active_area_shape;

— Baffle_and_disengaging_panel_intersection;

— Baffle_and_seal_pan_intersection;

— Baffle_and_tray_panel_intersection;

— Blinding_strip;

— Blinding_strip_shape;

— Bubble_cap;

— Bubble_cap_shape;

— Bubble_slot_shape;

— Cap_shape;

— Cartesian_point;

— Corrugation;

— Curve;

— Demister_pad;

— Demister_pad_stack;

— Disengaging_panel_opening_shape;

— Downcomer;

— Downcomer_apron_section_shape;

— Downcomer_apron_shape;

— Downcomer_disengaging_panel_shape;

— Downcomer_hydraulics;

— Downcomer_liquid_flow_channel_shape;

— Downcomer_shape;

— Escape_area_shape;

— Mass_transfer_equipment;

— Matched_perimeter_segments;

— Pad_and_pad_stack;

— Pattern;

— Perforation_cover;

— Perforation_cover_shape;

— Perforation_shape;

— Perimeter;

— Perimeter_segment;

— Pressure_equalization_channel_shape;

— Riser_and_tray_panel_shape;

— Riser_shape;

— Seal_pan;

— Seal_pan_recess_shape;

— Seal_pan_shape;

— Separation_efficiency;

— Separation_packing_stack;

— Separation_tower;

— Separation_tower_internal;

— Separation_tray;

— Separation_tray_baffle;

— Separation_tray_baffle_shape;

— Separation_tray_component;

— Separation_tray_hydraulics;

— Separation_tray_shape;

— Separation_tray_stack;

— Separation_tray_structural_component;

— Tray_and_tray_stack;

— Tray_cascade;

— Tray_panel;

— Tray_panel_and_perforation_shape;

— Tray_panel_and_slot_shape;

— Tray_panel_hydraulics;

— Tray_panel_shape;

— Tray_slot_shape;

— Tray_support;

— Tray_support_shape;

— Valve_cap;

— Valve_cap_shape;

— Weir;

— Weir_and_disengaging_panel_intersection;

— Weir_and_seal_pan_intersection;

— Weir_and_tray_panel_intersection;

— Weir_shape.

4.1.6 material_data UoF

The material_data UoF specifies a physical material that is used in or by a chemical process.

> NOTE - A material_data is typified by its intrinsic properties. That is, a quantity may be divided between two vessels and each portion will have the same intrinsic properties.

The following application objects are used by the material_data UoF:

— Bulk_thermodynamic_properties;

— Bulk_thermophysical_properties;

— Bulk_vle_properties;

— Component_in_mixture_properties;

— Construction_material;

— Density_properties;

— Excess_properties;

— Interphase_thermophysical_properties;

— Material;

— Material_amount;

— Material_characterization;

— Material_cost;

— Phase_distribution_coefficient;

— Process_design_property_curve_point_usage;

— Process_material;

— Process_property_curve;

— Process_property_curve_point;

— Single_phase_thermophysical_properties;

— Thermodynamic_conditions;

— Thermodynamic_properties;

— Transport_properties.

4.1.7 material_transfer_equipment UoF

The material_transfer_equipment UoF specifies a type of process equipment that is used to provide a means of transferring process material from one location to another location or from one thermodynamic state to another thermodynamic state. Examples of this type of equipment would include both compressors and pumps.

The following application objects are used by the material_transfer_equipment UoF:

— Cc_balance_piston;

— Cc_casing;

— Cc_critical_speed;

— Cc_diaphragm;

— Cc_impeller;

— Cc_labyrinth;

— Cc_lateral_critical_speed;

— Cc_miscellaneous;

— Cc_shaft_sleeve;

— Cc_speed_control_method;

— Cc_speed_control_signal;

— Cc_torsional_critical_speed;

— Cc_weights;

— Centrifugal_compressor;

— Centrifugal_compressor_stage;

— Centrifugal_pump;

— Fluid_transfer_machine;

— Gas_transfer_machine;

— Material_transfer_equipment;

— Positive_displacement_compressor;

— Pump;

— Pump_casing;

— Pump_casing_test;

— Pump_gland;

— Pump_gland_taps;

— Pump_impeller;

— Pump_packing;

— Reciprocating_compressor;

— Reciprocating_compressor_stage;

— Service_connections.

4.1.8 plant_context UoF

The plant_context UoF specifies information about the site, utilities, process plant, and stream modelling criteria.

The following application objects are used by the plant_context UoF:

— Absolute_time_reference;

— Clock_time;

— Date;

— Electrical_service;

— Item_property_reference;

— Location_in_plant;

— Location_in_site;

— Material_amount_reference_time;

— Material_reference_time;

— Plant;

— Plant_item_reference_time;

— Process_definition_reference_time;

— Process_design_property_value;

— Process_design_property_value_usage;

— Process_simulation_reference_time;

— Reference_time_relationship;

— Referenced_object;

— Relative_time_reference;

— Site;

— Site_ambient_condition;

— Site_standard_conditions;

— Site_utility_service;

— Sited_plant;

— Stream_reference_time;

— Sub_plant_relationship;

— Time_reference;

— Utility_material_service.

4.1.9 plant_item_definition UoF

The plant_item_definition UoF specifies a physical object that is or may be a part of a process plant. Additional details about process equipment plant items may be found in the major_process_equipment, heat_transfer_equipment, mass_transfer_equipment, material_transfer_equipment and process_vessel_-equipment UoFs.

The following application objects are used by the plant_item_definition UoF:

— Alternating_current_port;

— Baseplates_and_soleplates;

— Bearing;

— Bearing_housing;

— Buttweld;

— Centrifugal_compressor_tests;

— Compression;

— Conditional_property_value;

— Connected_equipment_port;

— Control_element;

— Coupling;

— Design_project;

— Design_project_assignment;

— Direct_current_port;

— Electrical_power_port;

— Energy_port;

— Equipment_port;

— Equipment_port_connection;

— Female_end;

— Flanged;

— Flanged_end;

— Functional_volume;

— Functional_volume_service_case;

— Gasket;

— Heat_port;

— Inspection_and_tests;

— Location_conditions;

— Male_end;

— Material_port;

— Mechanical_component;

— Mechanical_power_port;

— Mechanical_seal;

— Noise_specification;

— Packaging;

— Performance_curve;

— Performance_map;

— Performance_map_curve;

— Performance_point;

— Piping_connector;

— Plant_item;

— Plant_item_assembly_relationship;

— Plant_item_collection_relationship;

— Plant_item_connector;

— Plant_item_group_relationship;

— Plant_item_location;

— Port_service_case;

— Power_port;

— Process_design_case;

— Radial_bearing;

— Reciprocating_power_port;

— Rotating_equipment_tests;

— Rotating_power_port;

— Shaft;

— Signal_port;

— Simple_performance_curve;

— Socket;

— Space_requirements;

— Spare_item_relationship;

— Threaded;

— Thrust_bearing.

4.1.10 plant_system_definition UoF

The plant_system_definition UoF specifies a part of a plant that provides/performs a service or function contributing to or enabling the operation of a plant. It consists of an assembly of one or more Plant_items.

The following application objects are used by the plant_system_definition UoF:

— Plant_system;

— Plant_system_assembly;

— Process_control_unit;

— Process_train.

4.1.11 process_description UoF

The process_description UoF specifies the description of the functional characteristics of a process that is independent of its physical implementation in the form of process equipment and independent of its process representation (e.g., in a process simulation or a PFD). Additional details of process descriptions may be found in the unit_operation and control_strategy UoFs.

NOTE - Refer to ISA-S88.01-1995 [1].

The following application objects are used by the process_description UoF:

— Aggregation_relationship;

— Alternate_relationship;

— Connected_process_port;

— Event_sequence;

— Process_definition;

— Process_definition_relationship;

— Process_port;

— Process_port_connection;

— Process_port_connection_case;

— Process_port_stream_case;

— Process_service.

4.1.12 process_flow_diagram UoF

The process_flow_diagram UoF specifies the associations between process engineering information and symbols on process flow diagrams.

The following application objects are used by the process_flow_diagram UoF:

— PFD;

— PFD_curve;

— PFD_element;

— PFD_point;

— PFD_presentation_component;

— PFD_presentation_component_composition;

— PFD_symbol_definition;

— PFD_symbol_occurrence;

— PFD_text;

— PFD_title_block.

4.1.13 process_simulation_data UoF

The process_simulation_data UoF specifies process characteristics, performance, and assumptions that are specific only to process simulations. Additional details for data used by process simulators may be found in the unit_operation, stream_data, material_data and substance_model_data UoFs.

The following application objects are used by the process_simulation_data UoF:

— Algorithm_type_parameter;

— Balance;

— Convergence_block_property_value_usage;

— Process_simulation;

— Process_simulation_relationship;

— Simulation_block;

— Simulation_centrifuge;

— Simulation_compressor;

— Simulation_countercurrent_solids_decanter;

— Simulation_crystallizer;

— Simulation_dissolver;

— Simulation_distillation;

— Simulation_distillation_stage;

— Simulation_electrostatic_precipitator;

— Simulation_fabric_filter;

— Simulation_flash;

— Simulation_gas_solid_separator;

— Simulation_heat_exchanger;

— Simulation_hydrocyclone;

— Simulation_liquid_solid_separator;

— Simulation_pipeline;

— Simulation_pipeline_node;

— Simulation_polytropic_compressor;

— Simulation_polytropic_compressor_stage;

— Simulation_rotary_filter;

— Simulation_section_relationship;

— Simulation_unit_operation;

— Stream_convergence_block;

— Thermo_property_method;

— Thermo_property_option;

— Trace_component_specification;

— User_defined_simulation_property;

— User_defined_simulation_value;

— Variable_convergence_block;

— Variable_convergence_specification.

4.1.14 process_vessel_equipment UoF

The process_vessel_equipment UoF specifies a type of process equipment that is required to contain fluid or solid materials either under a pressure or a vacuum.

NOTE - This type of equipment would include pressure vessels, bins, and atmospheric tanks.

The following application objects are used by the process_vessel_equipment UoF:

— Atmospheric_tank;

— Bin_section;

— Boot;

— Boot_location_on_cyl_section;

— Boot_location_on_head_section;

— Boot_section_relationship;

— Bounded_curve;

— Conical_head;

— Cylindrical_pressure_vessel;

— Cylindrical_pressure_vessel_connection;

— Cylindrical_pressure_vessel_section;

— Cylindrical_pv_cylinder_section;

— Cylindrical_pv_eccentric_section;

— Cylindrical_pv_head_section;

— Ellipsoidal_head;

— Flat_head;

— Hemispherical_head;

— Intersection_description;

— Nozzle_location_for_pv_cyl_section;

— Nozzle_location_for_pv_head_section;

— Pressure_vessel;

— Process_level;

— Process_vessel;

— Solids_storage_bin;

— Spherical_pressure_vessel;

— Spheroidal_pressure_vessel;

— Standard_dished_head;

— Torispherical_head.

4.1.15 stream_data UoF

The stream_data UoF specifies a flow of process material, thermal or work energy, signals or information, past a defined point along a path at a particular time. Streams usually flow into or out of a unit operation or through a port connection associated with process equipment.

The following application objects are used by the stream_data UoF:

— Distillation_stage_phase;

— Energy_stream;

— Heat_exchanger_internal_phase;

— Internal_stream_phase;

— Material_amount_phase;

— Material_stream;

— Material_stream_phase;

— Particle_fraction;

— Particle_size;

— Particle_size_distribution;

— Phase_equilibrium_relationship;

— Phase_region;

— Psd_values;

— Specific_phase;

— Stream;

— Thermal_stream;

— Utility_service_stream_demand;

— Utility_stream;

— Work_stream.

4.1.16 substance_experimental_data UoF

The substance_experimental_data UoF specifies data that is measured, or generated from an equation fit to experimental data, and is used to prepare or adjust the predictive model parameters to better match predictions against experimental data.

The following application objects are used by the substance_experimental_data UoF:

— Citation;

- Data_entry;
- Data_quality;
- Data_source;
- Distillation_curve;
- Property_data_group;
- Property_data_set;
- Property_note.

4.1.17 substance_model_data UoF

The substance_model_data UoF specifies the data associated with mathematical model parameters which can be used to predict substance thermodynamic, physical, and transport properties.

The following application objects are used by the substance_model_data UoF:

- Amorphous_solid;
- Binary_parameter;
- Binary_property_value;
- Chemical_component;
- Chemical_specie;
- Chemical_specie_structural_group_relationship;
- Coefficient_value;
- Composition_relationship;
- Defined_point_property;
- Equation_definition;
- Equation_group;
- Family;

— Mixture;

— Petroleum_cut;

— Petroleum_mixture;

— Phase;

— Point_property_value;

— Pseudo_component;

— Reference_state;

— Reference_state_variable_relationship;

— Specific_equation;

— Specific_equation_group;

— Structural_group;

— Substance;

— Substance_name;

— Thermophysical_point_property;

— Variable;

— Variable_approval_context;

— Variable_value.

4.1.18 unit_operation UoF

The unit_operation UoF specifies an equipment grouping that performs some defined transformation on process stream(s) and whose performance is calculated as a single logical entity in the steady state process flow representation.

The following application objects are used by the unit_operation UoF:

— Compressor_performance_data_point;

— Heat_exchanger_internal_data;

— Heat_transfer_coefficient;

— Process_unit_operation;

— Reactor_yield;

— Stage_column_section;

— Stream_separation_specification;

— Stream_split_specification;

— Uo_air_cooled_heat_exchanger;

— Uo_centrifugal_compressor;

— Uo_centrifugal_compressor_stage;

— Uo_centrifuge;

— Uo_complex_distillation;

— Uo_compressor;

— Uo_compressor_stage;

— Uo_countercurrent_solids_decanter;

— Uo_crusher;

— Uo_crystallizer;

— Uo_cst_reactor;

— Uo_cyclone;

— Uo_dissolver;

— Uo_distillation;

— Uo_distillation_stage;

— Uo_distillation_stage_phase_pump_around;

— Uo_double_pipe_heat_exchanger;

- Uo_electrostatic_precipitator;
- Uo_expander;
- Uo_extent_specified_reactor;
- Uo_extractor;
- Uo_fabric_filter;
- Uo_fired_heater;
- Uo_fired_reactor;
- Uo_flash;
- Uo_fluid_transfer;
- Uo_gas_solid_separator;
- Uo_heat_exchanger;
- Uo_heat_exchanger_fluid;
- Uo_heat_exchanger_side;
- Uo_hydrocyclone;
- Uo_jet_ejector;
- Uo_liquid_liquid_flash;
- Uo_liquid_solid_separator;
- Uo_liquid_vapour_flash;
- Uo_melter;
- Uo_mixer;
- Uo_multi_phase_flash;
- Uo_phase_changer;
- Uo_pipeline;

— Uo_pipeline_node;

— Uo_pipeline_segment;

— Uo_plug_flow_reactor;

— Uo_positive_displacement_compressor;

— Uo_positive_displacement_compressor_stage;

— Uo_pressure_changer;

— Uo_pump;

— Uo_reactor;

— Uo_rotary_filter;

— Uo_screen;

— Uo_separator;

— Uo_separator_three_phase_flash;

— Uo_shell_and_tube_heat_exchanger;

— Uo_single_phase_flash;

— Uo_solid_solid_separator;

— Uo_solids_decanter_stage;

— Uo_solids_dryer;

— Uo_specified_yield_reactor;

— Uo_splitter;

— Uo_stream_splitter;

— Uo_substance_splitter;

— Uo_valve;

— Uo_vapourizer;

— Uo_venturi_scrubber;

— User_defined_unit_operation_property;

— User_defined_unit_operation_value.

4.2 Application objects

This subclause specifies the application objects for the process plant engineering 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 Absolute_time_reference

An Absolute_time_reference is a definition for an independent temporal context.

NOTE - This context is usually a baseline from which other times can be established.

The data associated with Absolute_time_reference are the following:

— absolute_time_name.

The absolute_time_name specifies a string by which the Absolute_time_reference can be referred.

4.2.2 Active_area_shape

An Active_area_shape is that region of the Tray_panel (see 4.2.399) where good vapour and liquid contact is achieved. The shape is described by a Perimeter (see 4.2.216).

NOTE - There may be several active areas on a Tray_panel and they need not be contiguous.

4.2.3 Aggregation_relationship

An Aggregation_relationship is a type of Process_definition_relationship (see 4.2.255). This allows a Process_definition (see 4.2.253) to be defined as containing, or consisting of other Process_definitions.

EXAMPLE 2 - A distillation column may be represented as an aggregation of Uo_distillation_-stages (see 4.2.429), or a reactive distillation stage unit operation may be represented as an aggregation of a Uo_distillation_stage and Uo_cst_reactor (see 4.2.425).

4.2.4 Air_cooled_heat_exchanger_unit

An Air_cooled_heat_exchanger_unit is a composite of one or more air-cooled heat exchangers.

4.2.5 Algorithm_type_parameter

An Algorithm_type_parameter is a value for one parameter for the major algorithm, specified by the value of Process_simulation.algorithm_name (see 4.2.271).

The data associated with Algorithm_type_parameter are the following:

— parameter_name;

— parameter_value.

4.2.5.1 parameter_name

A parameter_name specifies the algorithm parameter whose value is being supplied.

4.2.5.2 parameter_value

A parameter_value specifies the value for the algorithm parameter specified by the value of parameter_-name.

4.2.6 Alternate_relationship

An Alternate_relationship is a Process_definition_relationship (see 4.2.255) where the relationship is between two Process_definitions (see 4.2.253) that describe either alternate processing choices for that portion of a larger process or describe alternate views of the same processing, typically differing in the amount of detail described.

4.2.7 Alternating_current_port

An Alternating_current_port is a type of Electrical_power_port (see 4.2.117) for which the electrical power at the Equipment_port (see 4.2.125) is in the form of alternating current.

The data associated with Alternating_current_port are the following:

— alternating_current_port_number_of_phases;

— voltage_cycle_frequency.

4.2.7.1 alternating_current_port_number_of_phases

An alternating_current_port_number_of_phases specifies an enumerated attribute indicating the number of phases for the alternating current of the Alternating_current_port. The value of alternating_current_-port_number_of_phases attribute shall be one of the following:

— single_phase;

— three_phase.

4.2.7.1.1 single_phase: an indication that the alternating current at an Alternating_current_port is specified as having a single phase.

4.2.7.1.2 three_phase: an indication that the alternating current at an Alternating_current_port is specified as having three phases.

4.2.7.2 voltage_cycle_frequency

A voltage_cycle_frequency specifies the frequency of the voltage cycles for the alternating current of an Alternating_current_port.

4.2.8 Amorphous_solid

An Amorphous_solid is a solid Substance (see 4.2.381) of unknown composition which is characterized by a Solid_analysis (see 4.2.360).

NOTE - An Amorphous_solid does not have a known molecular weight.

4.2.9 Arrhenius_reaction

An Arrhenius_reaction is a collection of values for an Arrhenius expression of reaction rate.

The data associated with Arrhenius_reaction are the following:

— arrhenius_activation_energy;

— arrhenius_coefficient;

— arrhenius_pexp.

4.2.9.1 arrhenius_activation_energy

An arrhenius_activation_energy specifies the value of the activation energy to be used in the Arrhenius expression for a reaction in a reactor in the simulation.

4.2.9.2 arrhenius_coefficient

An arrhenius_coefficient specifies the value of the Arrhenius coefficient for a reaction in a reactor in the simulation.

4.2.9.3 arrhenius_pexp

An arrhenius_pexp specifies the pre-exponential factor for the rate expression of the power law kinetics model.

4.2.10 Atmospheric_tank

An Atmospheric_tank is a cylindrical tank used for storage of liquids under atmospheric or near atmospheric pressure.

The data associated with Atmospheric_tank are the following:

- — atmospheric_tank_foundation;
- — atmospheric_tank_roof_type;
- — atmospheric_tank_temperature;
- — atmospheric_tank_wall_thickness;
- — atmospheric_tank_water_drawoff.

4.2.10.1 atmospheric_tank_foundation

An atmospheric_tank_foundation specifies whether the Atmospheric_tank requires a foundation.

4.2.10.2 atmospheric_tank_roof_type

An atmospheric_tank_roof_type specifies an enumerated attribute indicating the general type of roof. The value of the atmospheric_tank_roof_type attribute shall be one of the following:

- — bag;
- — fixed;
- — floating;
- — unknown.

4.2.10.2.1 bag: an indication that the atmospheric_tank_roof_type is a bag sealed roof.

4.2.10.2.2 fixed: an indication that the atmospheric_tank_roof_type is a fixed roof.

4.2.10.2.3 floating: an indication that the atmospheric_tank_roof_type is a floating roof.

4.2.10.2.4 unknown: an indication that the atmospheric_tank_roof_type is not known.

4.2.10.3 atmospheric_tank_temperature

An atmospheric_tank_temperature specifies the rated temperature for the Atmospheric_tank.

4.2.10.4 atmospheric_tank_wall_thickness

An atmospheric_tank_wall_thickness specifies the wall thickness of the Atmospheric_tank.

4.2.10.5 atmospheric_tank_water_drawoff

An atmospheric_tank_water_drawoff specifies whether the Atmospheric_tank requires a water drawoff.

4.2.11 Baffle_and_disengaging_panel_intersection

A Baffle_and_disengaging_panel_intersection is the layout of a baffle on a downcomer disengaging panel. The intersection is described by a Curve (see 4.2.86) or length.

The data associated with Baffle_and_disengaging_panel_intersection are the following:

— length.

A length specifies the horizontal baffle dimension on the downcomer disengaging panel.

4.2.12 Baffle_and_seal_pan_intersection

A Baffle_and_seal_pan_intersection is the layout of a baffle on a Seal_pan (see 4.2.309). The intersection is described by a Curve (see 4.2.86) or length.

The data associated with Baffle_and_seal_pan_intersection are the following:

— length.

A length specifies the horizontal baffle dimension on the Seal_pan (see 4.2.309).

4.2.13 Baffle_and_tray_panel_intersection

A Baffle_and_tray_panel_intersection is the layout of a baffle on a tray panel. The intersection is described by a Curve (see 4.2.86) or length.

The data associated with Baffle_and_tray_panel_intersection are the following:

— length.

A length specifies the horizontal baffle dimension on the tray panel.

4.2.14 Balance

A Balance is a check on the results of a simulation to ensure that those results obey the laws of conservation of mass, species, or energy. A Balance sums or calculates the outputs of a given type, for example, total mass flows, the inputs of that type, and computes the difference.

The data associated with Balance are the following:

— balance_error_flag;

— balance_type;

— discrepancy.

4.2.14.1 balance_error_flag

A balance_error_flag specifies an enumerated attribute that indicates whether the evaluation of a Balance produced a result that the computed balance is in excess of the tolerance allowed for that type of balance. If the tolerance is exceeded the Balance is in error. The value of the balance_error_flag attribute shall be one of the following:

— error;

— no_error.

4.2.14.1.1 error: an indication of an error message in the Balance computation in the simulation.

4.2.14.1.2 no_error: an indication of no error messages in the Balance computation in the simulation.

4.2.14.2 balance_type

A balance_type specifies an enumerated attribute that indicates what type of quantities the Balance is checking for conservation. The value of the balance_type attribute shall be one of the following:

— energy_balance;

— mass_balance;

— mole_balance.

4.2.14.2.1 energy_balance: an indication that the Balance is evaluating the balance of energy flows across the simulation.

4.2.14.2.2 mass_balance: an indication that the Balance is evaluating the balance of mass flows across the simulation.

4.2.14.2.3 mole_balance: an indication that the Balance is evaluating the balance of mole flows across the simulation.

4.2.14.3 discrepancy

A discrepancy specifies the imbalance computed by the Balance.

4.2.15 Baseplates_and_soleplates

A Baseplates_and_soleplates is rigid metal frames used to keep rotating equipment and the driver for that equipment mounted and aligned.

The data associated with Baseplates_and_soleplates are the following:

— baseplate_for_common;

— drip_rim;

— horiz_adj_screws;

— nonskid_deckplate;

— open_construction;

— open_drain;

— other_configuration;

— plate_grouting_type;

— plate_support;

— plate_weight;

— soleplate_for_driver;

— soleplate_for_gear;

— soleplate_for_mach;

— stainless_shims_thickness;

— trans_mach_only.

4.2.15.1 baseplate_for_common

A baseplate_for_common specifies whether the baseplate is common for the entire package or divided among elements.

4.2.15.2 drip_rim

A drip_rim specifies that a drip rim should be used for handling fluid drips.

4.2.15.3 horiz_adj_screws

A horiz_adj_screws specifies the presence or absence of horizontal adjusting screws for equipment.

4.2.15.4 nonskid_deckplate

A nonskid_deckplate specifies the presence or absence of a non-skid plate placed on the baseplate for the safety of maintenance and operating personnel.

4.2.15.5 open_construction

The open_construction specifies an alternative to use of a deck plate.

4.2.15.6 open_drain

The open_drain specifies that fluid drips will be allowed to flow into an open drain.

4.2.15.7 other_configuration

An other_configuration specifies a baseplate configuration other than under the transfer machine only or under all elements of the package.

4.2.15.8 plate_grouting_type

The plate_grouting_type specifies the type of grouting used of the baseplate.

4.2.15.9 plate_support

A plate_support specifies an enumerated attribute which indicates the type of support used for the baseplates. The value of the plate_support attribute shall be one of the following:

- perimeter;
- point.

4.2.15.9.1 perimeter: an indication that the baseplate support is a perimeter type.

4.2.15.9.2 point: an indication that the baseplate support is point type.

4.2.15.10 plate_weight

A plate_weight specifies the total weight of the baseplate and soleplate combination.

4.2.15.11 soleplate_for_driver

A soleplate_for_driver specifies the presence or absence of a soleplate exclusively for the driver element.

4.2.15.12 soleplate_for_gear

A soleplate_for_gear specifies the presence or absence of a soleplate exclusively for the gear reducer element.

4.2.15.13 soleplate_for_mach

A soleplate_for_mach specifies the presence or absence of a soleplate exclusively for the transfer machine element.

4.2.15.14 stainless_shims_thickness

A stainless_shims_thickness specifies the allowable thickness of levelling shims for the mounting.

4.2.15.15 trans_mach_only

A trans_mach_only specifies the presence or absence of a baseplate exclusively for the transfer machine element.

4.2.16 Bearing

A Bearing is a machine element between a rotating Shaft (see 4.2.325) and a static housing or casing (integral housing) which reduces the coefficient of friction between the Shaft and its static supporting element namely, a Bearing_housing (see 4.2.17). Each Bearing may be one of the following: Radial_-bearing (see 4.2.289) or a Thrust_bearing (see 4.2.390).

The data associated with Bearing are the following:

— bearing_area;

— bearing_babbit_thickness;

— bearing_babbit_type;

— bearing_centre_pivot;

— bearing_loading_actual;

— bearing_loading_allowed;

— bearing_lubrication_type;

— bearing_offset_pivot;

— bearing_pad_material;

— bearing_type.

4.2.16.1 bearing_area

A bearing_area specifies the interfacial area or area of contact between the Shaft (see 4.2.325) and static Bearing.

4.2.16.2 bearing_babbit_thickness

A bearing_babbit_thickness specifies the thickness of the Bearing lining.

4.2.16.3 bearing_babbit_type

A bearing_babbitt_type specifies the type of Bearing babbit.

> NOTE - Babbitt is a soft metallic lining that provides for low friction between the Bearing surface and the rotating Shaft (see 4.2.325).

4.2.16.4 bearing_centre_pivot

A bearing_centre_pivot specifies that a centre pivot Bearing is used.

4.2.16.5 bearing_loading_actual

A bearing_loading_actual specifies the actual torque transmitted between Bearing and Shaft (see 4.2.325).

4.2.16.6 bearing_loading_allowed

A bearing_loading_allowed specifies the maximum torque allowed between the Bearing and Shaft (see 4.2.325).

4.2.16.7 bearing_lubrication_type

A bearing_lubrication_type specifies an enumerated attribute which indicates the type of lubrication. The value of the bearing_lubrication_type attribute shall be one of the following:

- API614;
- flood;
- grease;
- oil_mist;
- pressure;
- ring_oil.

4.2.16.7.1 API614: an indication that the bearing_lubrication_type is API (American Petroleum Institute) 614.

4.2.16.7.2 flood: an indication that the bearing_lubrication_type is flooded lubrication.

4.2.16.7.3 grease: an indication that the bearing_lubrication_type is a grease.

4.2.16.7.4 oil_mist: an indication that the bearing_lubrication_type is an oil misting system.

4.2.16.7.5 pressure: an indication that the bearing_lubrication_type is a pressurized lubricant.

4.2.16.7.6 ring_oil: an indication that the bearing lubrication is oil rings.

4.2.16.8 bearing_offset_pivot

A bearing_offset_pivot specifies that an offset pivot Bearing is used.

4.2.16.9 bearing_pad_material

A bearing_pad_material specifies the Material (see 4.2.178) supporting the Babbitt sleeve in the Bearing.

4.2.16.10 bearing_type

A bearing_type specifies the type of Bearing used.

4.2.17 Bearing_housing

A Bearing_housing is the enclosure around a Bearing (see 4.2.16) whose purpose is to keep dirt and water out and any lubricant in the Bearing.

The data associated with Bearing_housing are the following:

— bearing_housing_type.

A bearing_housing_type specifies how the Bearing_housing is incorporated in rotating machinery. The value of the bearing_housing_type attribute shall be one of the following:

— integral;

— separate.

4.2.17.0.1 integral: an indication that the Bearing_housing is integral to the machine it is for.

4.2.17.0.2 separate: an indication that the Bearing_housing is separate from the machine it is for.

4.2.18 Bin_section

A Bin_section is a section of a Solids_storage_bin (see 4.2.362).

The data associated with Bin_section are the following:

— bin_section_agitated;

— bin_section_flexible_or_rigid_sides;

— bin_section_height;

— bin_section_wall_thickness.

4.2.18.1 bin_section_agitated

A bin_section_agitated specifies if the Bin_section has agitation.

4.2.18.2 bin_section_flexible_or_rigid_sides

A bin_section_flexible_or_rigid_sides specifies an enumerated attribute from Bin_section that describes the physical characteristic of the walls of the bin. The value of the bin_section_flexible_or_rigid_sides attribute shall be one of the following:

— flexible;

— rigid.

4.2.18.2.1 flexible: an indication that the bin walls are flexible.

4.2.18.2.2 rigid: an indication that the bin walls are rigid.

4.2.18.3 bin_section_height

A bin_section_height specifies the height of the Bin_section.

4.2.18.4 bin_section_wall_thickness

A bin_section_wall_thickness specifies the wall thickness of the Bin_section.

4.2.19 Binary_parameter

A Binary_parameter is a variable_method property between exactly two Chemical_components (see 4.2.56), which describes departure from ideal mixing assumptions. A Binary_parameter is an input Variable (see 4.2.489) used by variable method equations for the purpose of calculating more accurate Phase (see 4.2.230) equilibrium behavior of Mixtures (see 4.2.192) containing the two specified Chemical_components.

The data associated with Binary_parameter are the following:

— symmetric.

A symmetric specifies whether the value of the Binary_parameter is dependent on the order of the Chemical_components (see 4.2.56), that is whether the ijth element is equal to the jith element.

4.2.20 Binary_property_value

A Binary_property_value is a type of Variable_value (see 4.2.493) that indicates the interaction of two Substances (see 4.2.381) in Phase (see 4.2.230) behaviour models that cause the Phase behaviour to depart from ideal mixing assumptions

4.2.21 Blinding_strip

A Blinding_strip is an unperforated plate that is attached to a separation tray so as to cover some perforations and tray slots.

NOTE - This increases the vapour load to uncovered perforations and tray slots.

4.2.22 Blinding_strip_shape

A Blinding_strip_shape is described by a Perimeter (see 4.2.216) and indicates the number of blinded perforations or tray slots.

4.2.23 Boot

A Boot is a number of Cylindrical_pressure_vessel_sections (see 4.2.89) that are attached to a section belonging directly to a Pressure_vessel (see 4.2.251) that functions as a draw-off Boot.

4.2.24 Boot_location_on_cyl_section

A Boot_location_on_cyl_section is the location of the Boot (see 4.2.23) on the Cylindrical_pv_cylinder_-section (see 4.2.90).

4.2.25 Boot_location_on_head_section

A Boot_location_on_head_section is the location of the Boot (see 4.2.23) on a Cylindrical_pv_head_-section (see 4.2.92).

4.2.26 Boot_section_relationship

A Boot_section_relationship is the position of the boot in relationship with the Cylindrical_pressure_-vessel_section (see 4.2.89).

4.2.27 Bounded_curve

A Bounded_curve is the outside shape for a Spheroidal_pressure_vessel (see 4.2.369) and the upper and lower cross section for a Bin_section (see 4.2.18).

4.2.28 Bubble_cap

A Bubble_cap is a type of perforation cover that reverses the vapour flow up through the riser down in the annular space between the riser and the cap and into the liquid surrounding the cap on the top of the Tray_panel (see 4.2.399).

4.2.29 Bubble_cap_shape

A Bubble_cap_shape is composed of a riser and a cap. The riser creates a weir for each perforation and is covered by a cap to reverse the vapour flow.

The data associated with Bubble_cap_shape are the following:

— type_code;

— type_name.

4.2.29.1 type_code

A type_code specifies a descriptive code for identifying various Bubble_caps (see 4.2.28).

4.2.29.2 type_name

A type_name specifies the naming convention for various types of Bubble_caps (see 4.2.28).

4.2.30 Bubble_slot_shape

A Bubble_slot_shape is described by a Perimeter (see 4.2.216) and the distance from the bottom of the cap to the bottom of the bubble slot.

The data associated with Bubble_slot_shape are the following:

— distance_from_bottom_of_cap.

A distance_from_bottom_of_cap specifies the distance the bottom of the cap is from the tray deck.

4.2.31 Buffer_gas_system

A Buffer_gas_system is an environmental control system which prevents leakage of noxious Substances (see 4.2.381) into the environment by forcing high pressure gas into the chemical process at interfaces between Bearings (see 4.2.16) and Shafts (see 4.2.325).

NOTE - The gas is determined by its association with a Utility_stream (see 4.2.485) through Plant_item (see 4.2.237) and Equipment_port (see 4.2.125).

The data associated with Buffer_gas_system are the following:

— buffer_gas_system_pressure_drop;

— buffer_gas_system_required_for.

4.2.31.1 buffer_gas_system_pressure_drop

A buffer_gas_system_pressure_drop specifies the pressure drop through the passages irrigated by the Buffer_gas_system.

4.2.31.2 buffer_gas_system_required_for

A buffer_gas_system_required_for specifies an enumerated attribute for the operating scenario for when the Buffer_gas_system is required. The value of the buffer_gas_system_required_for attribute shall be one of the following:

— air_run_in;

— other;

— startup.

4.2.31.2.1 air_run_in: an indication that the Buffer_gas_system is needed only for air run of the compressor.

4.2.31.2.2 other: an indication that the Buffer_gas_system is needed during operations other than those covered by the other enumerations given.

4.2.31.2.3 startup: an indication that the Buffer_gas_system is needed only for start up.

4.2.32 Bulk_thermodynamic_properties

A Bulk_thermodynamic_properties is a collection of properties loosely classified as thermodynamic properties which can be estimated or calculated for the composite, or bulk, contents of a Material_stream (see 4.2.186), a Material_amount (see 4.2.179), a Specific_phase (see 4.2.367), or a Process_material (see 4.2.263) at a given Thermodynamic_conditions (see 4.2.386).

The data associated with Bulk_thermodynamic_properties are the following:

— heat_of_fusion;

— heat_of_vaporization;

— ideal_gas_heat_capacity_mass_basis;

— ideal_gas_heat_capacity_mole_basis;

— specific_enthalpy_mass_basis;

— specific_enthalpy_mole_basis;

— specific_entropy_mass_basis;

— specific_entropy_mole_basis.

4.2.32.1 heat_of_fusion

A heat_of_fusion specifies the heat required to change the bulk fluid from a solid phase to a liquid phase at its normal freezing point and one atmosphere pressure per mole of bulk fluid.

4.2.32.2 heat_of_vaporization

A heat_of_vaporization specifies the heat required to change the bulk fluid from a liquid phase to a vapor phase at its normal boiling point and one atmosphere pressure per mole of bulk fluid.

4.2.32.3 ideal_gas_heat_capacity_mass_basis

An ideal_gas_heat_capacity_mass_basis specifies the instantaneous rate of change of the internal energy with respect to changes in temperature at constant pressure for a unit mass of an ideal gas of the same composition as the bulk fluid.

4.2.32.4 ideal_gas_heat_capacity_mole_basis

An ideal_gas_heat_capacity_mole_basis specifies the instantaneous rate of change of the internal energy with respect to changes in temperature at constant pressure for a mole of an ideal gas of the same composition as the bulk fluid.

4.2.32.5 specific_enthalpy_mass_basis

A specific_enthalpy_mass_basis specifies the enthalpy, the sum of the internal energy and the product of pressure and volume, per unit mass for any given portion of the bulk fluid.

4.2.32.6 specific_enthalpy_mole_basis

A specific_enthalpy_mole_basis specifies the enthalpy, the sum of the internal energy and the product of pressure and volume, per mole for any given portion of the bulk fluid.

4.2.32.7 specific_entropy_mass_basis

A specific_entropy_mass_basis specifies the entropy per unit mass for any given portion of the bulk fluid.

4.2.32.8 specific_entropy_mole_basis

A specific_entropy_mole_basis specifies the entropy per mole for any given portion of the bulk fluid.

4.2.33 Bulk_thermophysical_properties

A Bulk_thermophysical_properties is a collection of commonly used physical and thermodynamic properties calculated or estimated for the composite, or bulk, phase of a fluid. The fluid may be a Material_stream (see 4.2.186), a Material_amount (see 4.2.179), a Specific_phase (see 4.2.367), or a Process_material (see 4.2.263) at a given Thermodynamic_conditions (see 4.2.386).

4.2.34 Bulk_vle_properties

A Bulk_vle_properties is a collection of commonly used properties that describe the vapour liquid equilibrium of a bulk fluid.

The data associated with Bulk_vle_properties are the following:

— bubble_point_pressure;

— bubble_point_temperature;

— dew_point_pressure;

— dew_point_temperature;

— quality;

— retrograde_dew_point_pressure.

4.2.34.1 bubble_point_pressure

A bubble_point_pressure specifies the pressure at which a liquid of the same composition and temperature as the bulk fluid may be in equilibrium with a small amount of vapour (bubble).

4.2.34.2 bubble_point_temperature

A bubble_point_temperature specifies the temperature at which a liquid of the same composition and pressure as the bulk fluid may be in equilibrium with a small amount of vapour (bubble).

4.2.34.3 dew_point_pressure

A dew_point_pressure specifies the pressure at which a vapour of the same composition and temperature as the bulk fluid may be in equilibrium with a small amount of liquid (dew drop).

4.2.34.4 dew_point_temperature

A dew_point_temperature specifies the temperature at which a vapour of the same composition and pressure as the bulk fluid may be in equilibrium with a small amount of liquid (dew drop).

4.2.34.5 quality

A quality specifies the ratio of moles of vapour to the total moles of the bulk fluid.

4.2.34.6 retrograde_dew_point_pressure

A retrograde_dew_point_pressure specifies the second pressure at which a vapour of the same composition and temperature of the bulk fluid may be in equilibrium with a drop of liquid.

> NOTE - The Phase (see 4.2.230) behaviour at the retrograde region is counter-intuitive to the "normal dew point" in that decreasing the bulk fluid pressure from the retrograde_dew_point_-pressure results in additional condensation of liquid. Continuing to decrease pressure isothermally will eventually re-vapourize the liquid condensate and return it to the normal dew point at the lower pressure. Retrograde condensation may occur in a mixture above its critical temperature. If a Retrograde_dew_point exists, it is the higher of the two dew point pressures predicted.

4.2.35 Buttweld

A Buttweld is a type of Piping_connector (see 4.2.235) that indicates that pipe ends are butted together and then welded.

4.2.36 Cap_shape

A Cap_shape is characterized by its height, the number of bubble slots in the cap, and the number of serrations in the bottom edge of the cap.

The data associated with Cap_shape are the following:

— height;

— number_of_bubble_slots;

— number_of_serrations_in_bottom_edge.

4.2.36.1 height

A height specifies the physical height or dimension of the cap.

4.2.36.2 number_of_bubble_slots

A number_of_bubble_slots specifies the numeric quantity of bubble slots in the cap circumference.

4.2.36.3 number_of_serrations_in_bottom_edge

A number_of_serrations_in_bottom_edge specifies a rate of serrations expressed as the number of serrations per unit length in the bottom edge of the cap.

4.2.37 Cartesian_point

A Cartesian_point is the rectangular coordinates for a particular point on a tray.

4.2.38 Casing_nozzle

A Casing_nozzle is the interaction between a Nozzle (see 4.2.194) and a pump or compressor casing.

The data associated with Casing_nozzle are the following:

- casing_nozzle_allowable_force;
- casing_nozzle_allowable_moment;
- casing_nozzle_flange_velocity;
- casing_nozzle_position.

4.2.38.1 casing_nozzle_allowable_force

A casing_nozzle_allowable_force specifies the allowable force between a Nozzle (see 4.2.194) and a pump or compressor casing.

4.2.38.2 casing_nozzle_allowable_moment

A casing_nozzle_allowable_moment specifies the allowable moment between a Nozzle (see 4.2.194) and a pump or compressor casing.

4.2.38.3 casing_nozzle_flange_velocity

A casing_nozzle_flange_velocity specifies the velocity of the process fluid at the Nozzle (see 4.2.194) Flanged_end (see 4.2.146).

4.2.38.4 casing_nozzle_position

A casing_nozzle_position specifies the position of a Nozzle (see 4.2.194) on a pump or compressor casing. The value of the casing_nozzle_position attribute shall be one of the following:

— discharge;

— inlet;

— other.

4.2.38.4.1 discharge: an indication that the Nozzle (see 4.2.194) is a discharge nozzle.

4.2.38.4.2 inlet: an indication that the Nozzle (see 4.2.194) is an inlet nozzle to the casing.

4.2.38.4.3 other: an indication that the Nozzle (see 4.2.194) is not an inlet or outlet nozzle.

4.2.39 Cc_balance_piston

A Cc_balance_piston is an element of a Centrifugal_compressor (see 4.2.52) that provides some thrust compensation against the full force generated by the shaft-impeller system.

The data associated with Cc_balance_piston are the following:

— cc_balance_piston_area;

— cc_balance_piston_fixation_method.

4.2.39.1 cc_balance_piston_area

A cc_balance_piston_area specifies the area of contact for the balance piston and the gas.

4.2.39.2 cc_balance_piston_fixation_method

A cc_balance_piston_fixation_method specifies a Citation (see 4.2.60) to a standard construction method.

4.2.40 Cc_casing

A Cc_casing is the external shell of a Centrifugal_compressor (see 4.2.52) which contains the fluid.

The data associated with Cc_casing are the following:

- cc_casing_casing_split_seal;
- cc_casing_corr_allowance;
- cc_casing_max_casing_cap;
- cc_casing_max_no_impellers;
- cc_casing_max_oper_temp;
- cc_casing_max_work_press;
- cc_casing_min_oper_temp;
- cc_casing_radiograph_quality;
- cc_casing_split;
- cc_casing_test_press_helium;
- cc_casing_test_press_hydro;
- cc_casing_thickness.

4.2.40.1 cc_casing_casing_split_seal

A cc_casing_casing_split_seal specifies a sealing device used in split casing closure.

4.2.40.2 cc_casing_corr_allowance

A cc_casing_corr_allowance specifies the additional wall thickness of the casing provided for metal loss due to chemical or mechanical attack by the process Stream (see 4.2.374).

> NOTE - The implication is that the casing thickness minus the corrosion allowance is the thickness of the wall which was designed to contain the maximum design pressure under some standard design methodology.

4.2.40.3 cc_casing_max_casing_cap

A cc_casing_max_casing_cap specifies the maximum volumetric capacity of the casing in process gas flow.

4.2.40.4 cc_casing_max_no_impellers

A cc_casing_max_no_impellers specifies the maximum number of impellers in the Centrifugal_compressor (see 4.2.52).

4.2.40.5 cc_casing_max_oper_temp

A cc_casing_max_oper_temp specifies the specified temperature at which the casing wall thickness is to be calculated and tested.

4.2.40.6 cc_casing_max_work_press

A cc_casing_max_work_press specifies the maximum pressure intended for sustained operation.

4.2.40.7 cc_casing_min_oper_temp

A cc_casing_min_oper_temp specifies the minimum temperature intended for sustained operation.

> NOTE - For compressors, as the pressure is increased and the temperature is dropped, the work load can be increased so that the mechanical stress on the equipment goes up. These two items are intended to set limits on the operation.

4.2.40.8 cc_casing_radiograph_quality

A cc_casing_radiograph_quality specifies an indication of whether radiography will be used in testing the integrity of the casing.

4.2.40.9 cc_casing_split

A cc_casing_split specifies an indication of the type of casing split.

> EXAMPLE 3 - Types of cc_casing_split are horizontal and vertical.

4.2.40.10 cc_casing_test_press_helium

A cc_casing_test_press_helium specifies the pressure used for leak testing a device during construction in which helium pressure is placed on the casing and a detection device is used to find leaks in the Cc_-casing.

4.2.40.11 cc_casing_test_press_hydro

A cc_casing_test_press_hydro specifies the hydraulic test pressure applied to test the mechanical integrity of the casing during construction and inspection.

4.2.40.12 cc_casing_thickness

A cc_casing_thickness specifies the nominal wall thickness of the Cc_casing.

4.2.41 Cc_critical_speed

A Cc_critical_speed is a resonant frequency(ies) of the rotor-bearing support system. Each Cc_critical_-speed may be one of the following: Cc_lateral_critical_speed (see 4.2.45) or a Cc_torsional_critical_speed (see 4.2.50).

The data associated with Cc_critical_speed are the following:

— cc_critical_speed_level;

— cc_critical_speed_type.

4.2.41.1 cc_critical_speed_level

A cc_critical_speed_level specifies an enumerated attribute of which critical speed is being described. The value of the cc_critical_speed_level attribute shall be one of the following:

— first;

— fourth;

— second;

— third.

4.2.41.1.1 first: an indication that the first critical speed is being described.

4.2.41.1.2 fourth: an indication that the fourth critical speed is being described.

4.2.41.1.3 second: an indication that the second critical speed is being described.

4.2.41.1.4 third: an indication that the third critical speed is being described.

4.2.41.2 cc_critical_speed_type

A cc_critical_speed_type specifies the lateral or torsional critical speed from the natural frequencies of the system and from forcing phenomenon.

4.2.42 Cc_diaphragm

A Cc_diaphragm is the diaphragm in the Centrifugal_compressor (see 4.2.52).

4.2.43 Cc_impeller

A Cc_impeller is a wheel-like device mounted on the Shaft (see 4.2.325) of the Centrifugal_compressor (see 4.2.52) with vanes that provides the impulsive force to the fluid to cause motion or pressure.

The data associated with Cc_impeller are the following:

- cc_impeller_diameter;
- cc_impeller_fabrication_type;
- cc_impeller_max_head_at_rated_speed;
- cc_impeller_max_mach_at_eye;
- cc_impeller_no_vanes;
- cc_impeller_number;
- cc_impeller_smallest_tip_internal_width;
- cc_impeller_stage_number;
- cc_impeller_tip_speed_at_max_cont_rpm;
- cc_impeller_tip_speed_at_rated_speed;
- cc_impeller_type.

4.2.43.1 cc_impeller_diameter

A cc_impeller_diameter specifies the diameter of the locus of points furthest from the centre of rotation when the impeller is turned on its Shaft (see 4.2.325).

4.2.43.2 cc_impeller_fabrication_type

A cc_impeller_fabrication_type specifies a Citation (see 4.2.60) to a fabrication method for impellers.

NOTE - Fabrication types include cast, forged, and machined.

4.2.43.3 cc_impeller_max_head_at_rated_speed

A cc_impeller_max_head_at_rated_speed specifies the maximum pressure rise in the gas being compressed at the rated rpm of the machine.

4.2.43.4 cc_impeller_max_mach_at_eye

A cc_impeller_max_mach_at_eye specifies the maximum velocity at the eye of the impeller as a fraction of the speed of sound.

4.2.43.5 cc_impeller_no_vanes

A cc_impeller.no_vanes specifies the actual number of vanes mounted on a Shaft (see 4.2.325) within a casing.

4.2.43.6 cc_impeller_number

A cc_impeller_number specifies the particular impeller number of all impellers assembled on a Shaft (see 4.2.325).

4.2.43.7 cc_impeller_smallest_tip_internal_width

A cc_impeller_smallest_tip_internal_width specifies the width at the tip of the smallest vane.

4.2.43.8 cc_impeller_stage_number

A cc_impeller_stage_number specifies the particular stage number of all the stages within the compressor.

4.2.43.9 cc_impeller_tip_speed_at_max_cont_rpm

A cc_impeller_tip_speed_at_max_cont_rpm specifies the linear velocity at the maximum continuous allowed rotation speed of the impeller.

4.2.43.10 cc_impeller_tip_speed_at_rated_speed

A cc_impeller_tip_speed_at_rated_speed specifies the linear velocity at the maximum speed for which the machine is design for continuous operation.

4.2.43.11 cc_impeller_type

A cc_impeller_type specifies an enumerated attribute that provides a Citation (see 4.2.60) to a standard impeller design. The value of the cc_impeller_type attribute shall be one of the following:

— enclosed;

— open.

4.2.43.11.1 enclosed: an indication that the impeller design consists of a disk, vanes, and cover.

4.2.43.11.2 open: an indication that the impeller design consists of a disk and vanes.

4.2.44 Cc_labyrinth

A Cc_labyrinth is a series of perpendicular baffles with low contact area with the Shaft (see 4.2.325) that act as a high resistance barrier to gas leakage.

The data associated with Cc_labyrinth are the following:

— cc_labyrinth_location.

A cc_labyrinth_location specifies an enumerated attribute which indicates the location within the compressor where the labyrinth is located. The value of the cc_labyrinth_location attribute shall be one of the following:

— bal_piston;

— interstage.

4.2.44.0.1 bal_piston: an indication that a balance piston is located at the discharge end of the rotor and works to balance the differential pressure across the system.

4.2.44.0.2 interstage: an indication that there is a seal on both the inlet and discharge sides of each impeller.

4.2.45 Cc_lateral_critical_speed

A Cc_lateral_critical_speed is a type of Cc_critical_speed (see 4.2.41) that is the lateral critical speed for the compressor.

The data associated with Cc_lateral_critical_speed are the following:

— cc_lateral_critical_speed_damped;

— cc_lateral_critical_speed_lateral_basis;

— cc_lateral_critical_speed_mode_shape;

— cc_lateral_critical_speed_undamped.

4.2.45.1 cc_lateral_critical_speed_damped

A cc_lateral_critical_speed_damped specifies the critical speed under damped conditions.

4.2.45.2 cc_lateral_critical_speed_lateral_basis

A cc_lateral_critical_speed_lateral_basis specifies an enumerated attribute which indicates under what conditions the critical speed was determined. The value of the cc_lateral_critical_speed_lateral_basis attribute shall be one of the following:

— damped;

— other;

— shop_test;

— unbalance.

4.2.45.2.1 damped: an indication that the critical speed was determined under damped conditions.

4.2.45.2.2 other: an indication that the critical speed was determined under some other condition than those given by other enumeration values.

4.2.45.2.3 shop_test: an indication the critical speed was determined with a shop test.

4.2.45.2.4 unbalance: an indication that the critical speed was determined under unbalanced rotor conditions.

4.2.45.3 cc_lateral_critical_speed_mode_shape

A cc_lateral_critical_speed_mode_shape specifies the shape of the mode of the critical speed.

4.2.45.4 cc_lateral_critical_speed_undamped

A cc_lateral_critical_speed_undamped specifies the critical speed under undamped conditions.

4.2.46 Cc_miscellaneous

A Cc_miscellaneous is a miscellaneous collection of specifications for the Centrifugal_compressor (see 4.2.52).

The data associated with Cc_miscellaneous are the following:

- optical_align_flats_reqd;
- pipe_diam_before_suction;
- provision_for_water_wash_before_open_casing_by;
- torsional_analysis_report_reqd;
- vendor_review_of_piping_and_foundation_reqd.

4.2.46.1 optical_align_flats_reqd

An optical_align_flats_reqd specifies optical alignment of the rotor Shaft (see 4.2.325) to determine flat spots.

4.2.46.2 pipe_diam_before_suction

A pipe_diam_before_suction specifies the diameter of the pipe connected to the suction side of the Centrifugal_compressor (see 4.2.52).

4.2.46.3 provision_for_water_wash_before_open_casing_by

A provision_for_water_wash_before_open_casing_by specifies connections to water wash the compressor prior to opening the compressor for maintenance.

4.2.46.4 torsional_analysis_report_reqd

A torsional_analysis_report_reqd specifies the torque settings for all bolts on the compressor.

4.2.46.5 vendor_review_of_piping_and_foundation_reqd

A vendor_review_of_piping_and_foundation_reqd specifies the necessary drawings to be reviewed for both compressor piping and compressor foundations.

4.2.47 Cc_shaft_sleeve

A Cc_shaft_sleeve is a Shaft (see 4.2.325) sleeve for the Centrifugal_compressor (see 4.2.52).

The data associated with Cc_shaft_sleeve are the following:

— cc_shaft_sleeve_location.

A cc_shaft_sleeve_location specifies an enumerated attribute giving the location of the Shaft (see 4.2.325) sleeve being described. The value of the cc_shaft_sleeve_location attribute shall be one of the following:

— interstage;

— shaft_seals.

4.2.47.0.1 interstage: an indication that the Shaft (see 4.2.325) sleeve is an interstage sleeve.

4.2.47.0.2 shaft_seals: an indication that the Shaft (see 4.2.325) sleeve is at the seals.

4.2.48 Cc_speed_control_method

A Cc_speed_control_method is the method of controlling the speed of the Centrifugal_compressor (see 4.2.52) when using a non-electric motor-driven compressor.

The data associated with Cc_speed_control_method are the following:

— anti_surge_bypass;

— bypass;

— other_speed_control_method;

— speed_variation;

— suction_throttling.

4.2.48.1 anti_surge_bypass

An anti_surge_bypass specifies the type of anti-surge bypass used to control the Centrifugal_compressor (see 4.2.52) to maintain a constant speed. The value of the anti_surge_bypass attribute shall be one of the following:

— automatic;

— manual.

4.2.48.1.1 automatic: an indication that automatic anti-surge bypass is used.

4.2.48.1.2 manual: an indication that manual anti-surge bypass is used.

4.2.48.2 bypass

A bypass specifies the origin and destination of the anti-surge bypass.

4.2.48.3 other_speed_control_method

An other_speed_control_method specifies alternative methods for controlling the speed of a Centrifugal_-compressor (see 4.2.52) with variable speed drivers.

> NOTE - Variable speed drivers include steam pistons, steam turbines, gas engines, and diesel engines.

4.2.48.4 speed_variation

A speed_variation specifies the range of speeds available to the controller including turn-down values.

4.2.48.5 suction_throttling

A suction_throttling specifies the range of suction throttling pressures available or allowed when unloading the compressor flow rates.

4.2.49 Cc_speed_control_signal

A Cc_speed_control_signal is the transducer signal used to signal speed to a speed controller as a portion of the overall compressor speed control mechanism..

The data associated with Cc_speed_control_signal are the following:

— cc_speed_control_signal_source;

— cc_speed_control_signal_type;

— range_other;

— range_pneumatic_control.

4.2.49.1 cc_speed_control_signal_source

A cc_speed_control_signal_source specifies the location of the speed variable on the compressor.

4.2.49.2 cc_speed_control_signal_type

A cc_speed_control_signal_type specifies an enumerated attribute that indicates whether the type of signal from the speed control variable is analog or digital.

4.2.49.3 range_other

A range_other specifies an array showing the relationship between required speed in rpm and the control signal value for other than pneumatic signaling.

4.2.49.4 range_pneumatic_control

A range_pneumatic_control specifies an array relating control signal value and desired rpm for pneumatic control.

4.2.50 Cc_torsional_critical_speed

A Cc_torsional_critical_speed is a type of Cc_critical_speed (see 4.2.41) that is the torsional critical speed for the Centrifugal_compressor (see 4.2.52).

4.2.51 Cc_weights

A Cc_weights is the total weight in pounds or kilograms for the Centrifugal_compressor (see 4.2.52).

The data associated with Cc_weights are the following:

- cc_weights_compr_upper_case;
- cc_weights_compressor_only;
- cc_weights_rotor_compr;
- cc_weights_rotor_driver;
- cc_weights_rotor_gear;

4.2.51.1 cc_weights_compr_upper_case

A cc_weights_compr_upper_case specifies the weight for the upper case portion of the Centrifugal_-compressor (see 4.2.52).

4.2.51.2 cc_weights_compressor_only

A cc_weights_compressor_only specifies the weight for only the compressor portion of the total assembly.

4.2.51.3 cc_weights_rotor_compr

A cc_weights_rotor_compr specifies the weight for only the compressor rotor portion of the total assembly.

4.2.51.4 cc_weights_rotor_driver

A cc_weights_rotor_driver specifies the weight for only the rotor driver portion of the total assembly.

4.2.51.5 cc_weights_rotor_gear

A Cc_weights_rotor_gear specifies the weight for the rotor gear box portion of the total assembly.

4.2.52 Centrifugal_compressor

A Centrifugal_compressor is a machine that raises the pressure of a gas or vapour Stream (see 4.2.374) through rotating radial vanes which impel the gas toward the periphery of the Centrifugal_compressor casing where it is either redirected to another stage of compression or to a discharge pipe.

The data associated with Centrifugal_compressor are the following:

— centrifugal_compressor_estimated_surge;

— centrifugal_compressor_guarantee_point;

— centrifugal_compressor_number_of_stages;

— centrifugal_compressor_speed_trip;

— manufacturer_performance_curve_no.

4.2.52.1 centrifugal_compressor_estimated_surge

A centrifugal_compressor_estimated_surge specifies the estimated surge point or point of instability for the Centrifugal_compressor.

4.2.52.2 centrifugal_compressor_guarantee_point

A centrifugal_compressor_guarantee_point specifies a point on the Performance_curve (see 4.2.212) that a performance guarantee must meet.

NOTE - The manufacturer guarantees the performance of the compressor at a specific point on the compressor's performance curve.

4.2.52.3 centrifugal_compressor_number_of_stages

A centrifugal_compressor_number_of_stages specifies the number of stages in the Centrifugal_compressor.

4.2.52.4 centrifugal_compressor_speed_trip

A centrifugal_compressor_speed_trip specifies the maximum speed at which the compressor will be tripped or shut down because the unit has exceeded the maximum speed for that particular compressor.

4.2.52.5 manufacturer_performance_curve_no

The manufacturer_performance_curve_no specifies a relationship in graphical form among the power requirement, head, or differential pressure generated and inlet flow rate in a Centrifugal_pump (see 4.2.55).

NOTE - The curve number presumably relates to a catalogue of such Performance_curves (see 4.2.212) depending on the properties of the fluid being compressed.

4.2.53 Centrifugal_compressor_stage

A Centrifugal_compressor_stage is that portion of the compressor that causes a pressure rise in the compressed gas or fluid.

NOTE - Multiple stages are used within a compressor when the compression required is higher than can be achieved in a single stage.

The data associated with Centrifugal_compressor_stage are the following:

— centrifugal_compressor_stage_number_2.

A centrifugal_compressor_stage_number_2 specifies the number assigned to the Centrifugal_compressor_-stage.

4.2.54 Centrifugal_compressor_tests

A Centrifugal_compressor_tests is a type of Rotating_equipment_tests (see 4.2.307) that specifies which tests are to be performed by a compressor manufacturer prior to delivery of the machine to the customer.

The data associated with Centrifugal_compressor_tests are the following:

— performance_test_air;

— performance_test_gas.

4.2.54.1 performance_test_air

A performance_test_air specifies that air will be used for the centrifugal compressor performance test.

4.2.54.2 performance_test_gas

A performance_test_gas specifies the gas to be used during the centrifugal compressor performance test.

4.2.55 Centrifugal_pump

A Centrifugal_pump is a machine that raises the pressure of a liquid Stream (see 4.2.374) through rotating radial vanes which impel the fluid toward the periphery of the Pump_casing (see 4.2.283) where it is redirected to a discharge pipe.

The data associated with Centrifugal_pump are the following:

— centrifugal_pump_corrosion_erosion_caused_by;

— centrifugal_pump_npsh_available;

— centrifugal_pump_npsh_required;

— centrifugal_pump_proposal_curve_number;

— centrifugal_pump_speed_rpm;

— centrifugal_pump_suction_specific_speed.

4.2.55.1 centrifugal_pump_corrosion_erosion_caused_by

A centrifugal_pump_corrosion_erosion_caused_by specifies the properties of the fluid or contaminants within the fluid that may cause corrosion or erosion of the Centrifugal_pump and rotor.

4.2.55.2 centrifugal_pump_npsh_available

A centrifugal_pump_npsh_available specifies the net pressure, or net positive suction head (NPSH) available at the suction Equipment_port (see 4.2.125) of a Centrifugal_pump.

4.2.55.3 centrifugal_pump_npsh_required

A centrifugal_pump_npsh_required specifies the NPSH required for the safe operation of the Centrifugal_-pump.

NOTE - The required NPSH must be exceeded in order to avoid pump cavitation due to the release of gases in solution.

4.2.55.4 centrifugal_pump_proposal_curve_number

A centrifugal_pump_proposal_curve_number specifies a Citation (see 4.2.60) to a catalogue of performance curves.

NOTE - The catalogue provides specific head vs capacity curves that describes the vendor's proposed equipment for the specified service. These catalogues are specific for each manufacturer's equipment.

4.2.55.5 centrifugal_pump_speed_rpm

A centrifugal_pump_speed_rpm specifies the rotational speed of the Centrifugal_pump in revolutions per minute.

4.2.55.6 centrifugal_pump_suction_specific_speed

A centrifugal_pump_suction_specific_speed specifies the necessary Centrifugal_pump speed to provide adequate operation at the pump suction.

4.2.56 Chemical_component

A Chemical_component is a Substance (see 4.2.381) that is viewed as a single indivisible chemical compound. Each Chemical_component may be one of the following: Chemical_specie (see 4.2.58) or a Pseudo_component (see 4.2.281).

4.2.57 Chemical_reaction

A Chemical_reaction is a chemical reaction associated with the Uo_reactor (see 4.2.462) objects in the simulation.

The data associated with Chemical_reaction are the following:

— reaction_name;

A reaction_name specifies a name which uniquely identifies a reaction in a reactor in the simulation.

4.2.58 Chemical_specie

A Chemical_specie is a type of Chemical_component (see 4.2.56) that is a single molecular species.

The data associated with Chemical_specie are the following:

- cas_registry_number;
- cma_number;
- dippr_id;
- dot_number;
- formula;
- iupac_name;
- molecular_weight.

4.2.58.1 cas_registry_number

A cas_registry_number specifies a string containing the registry number issued by the Chemical Abstracts Registry System of the Chemical Abstracts Services for the Chemical_specie.

4.2.58.2 cma_number

A cma_number specifies a unique identifier assigned to a Chemical_specie by the Chemical Manufacturers Association.

4.2.58.3 dippr_id

A dippr_id specifies the identification given to a Chemical_specie for the Design Institute for Physical PRoperty data (DIPPR) databank.

4.2.58.4 dot_number

A dot_number specifies the number issued by the United States of America Department of Transport for a Substance (see 4.2.381).

NOTE - Only those numbers which are issued for Chemical_species are part of this data model.

4.2.58.5 formula

A formula specifies the molecular formula for a Chemical_specie.

4.2.58.6 iupac_name

An iupac_name specifies a standard name for the Chemical_specie approved by the International Union of Pure and Applied Chemistry (IUPAC).

NOTE - These names are not necessarily unique for a species.

4.2.58.7 molecular_weight

A molecular_weight specifies the numerical value of the molecular weight of the Chemical_specie.

4.2.59 Chemical_specie_structural_group_relationship

A Chemical_specie_structural_group_relationship is the association between a Chemical_specie (see 4.2.58) and a Structural_group (see 4.2.379) present in the Chemical_specie.

The data associated with Chemical_specie_structural_group_relationship are the following:

— group_occurrence_quantity.

A group_occurrence_quantity specifies the number of occurrences of a Structural_group (see 4.2.379) in a Chemical_specie (see 4.2.58).

4.2.60 Citation

A Citation is a literature or source reference.

The data associated with Citation are the following:

— bibliographic_info;

— citation_name.

4.2.60.1 bibliographic_info

A bibliographic_info specifies bibliographic information for the Citation.

4.2.60.2 citation_name

A citation_name specifies an identifying name for the Citation.

4.2.61 Clock_time

A Clock_time is a local time based upon an offset from greenwich mean time.

The data associated with Clock_time are the following:

— hour;

— minute;

— second;

— time_zone.

4.2.61.1 hour

A hour specifies the number in the 24 hour clock.

NOTE - The hour shall be an integer between 0 and 24.

4.2.61.2 minute

A minute specifies the number of minutes after the hour.

NOTE - The minute shall be an integer between 0 and 59.

4.2.61.3 second

A second specifies the number of seconds after the minute.

NOTE - The second shall be a number between 0 and 59.

4.2.61.4 time_zone

A time_zone specifies the offset from greenwich mean time.

4.2.62 Coefficient_value

A Coefficient_value is an object which holds the value for a coefficient of a Specific_equation (see 4.2.365).

The data associated with Coefficient_value are the following:

— coefficient_type;

— coefficient_value_name;

— symbol

4.2.62.1 coefficient_type

A coefficient_type specifies the type of coefficient in the Specific_equation (see 4.2.365).

4.2.62.2 coefficient_value_name

A coefficient_value_name specifies the name of a coefficient in a given Specific_equation (see 4.2.365).

4.2.62.3 symbol

A symbol specifies which coefficient in the Specific_equation (see 4.2.365) is referenced.

4.2.62.4 value_of_coefficient

A value_of_coefficient specifies the numerical value of a Coefficient_value object.

4.2.63 Comparison_parameter

A Comparison_parameter is a type of Control_variable (see 4.2.81) in which a Control_variable is compared to a Control_variable value using a comparison_operator.

The data associated with Comparison_parameter are the following:

— comparison_operator.

A comparison_operator specifies a logical comparison relationship between a measured Control_variable (see 4.2.81) and a specified Control_variable value to meet a requirement for control of a process.

NOTE - Valid values of comparison_operator are <, <=, >, >=, =, and !=.

4.2.64 Component_in_mixture_properties

A Component_in_mixture_properties is a collection of properties for one Chemical_component (see 4.2.56) of one Phase (see 4.2.230) of a multi-component mixture. The Phase may be a Specific_phase (see 4.2.367), or one Phase of a Material_amount (see 4.2.179), Material_stream (see 4.2.186), or one Phase of a Process_material (see 4.2.263) at a given Thermodynamic_conditions (see 4.2.386).

The data associated with Component_in_mixture_properties are the following:

- activity_coefficient;
- activity_coefficient_pressure_correction;
- diffusion_coefficient;
- fugacity;
- partial_molar_volume.

4.2.64.1 activity_coefficient

An activity_coefficient specifies the ratio of the activity of one Chemical_component (see 4.2.56) in a liquid or solid Phase (see 4.2.230) of a Mixture (see 4.2.192) to its mole fraction in that Phase.

4.2.64.2 activity_coefficient_pressure_correction

An activity_coefficient_pressure_correction specifies the exponent of the integral for the vapour pressure of a Chemical_component (see 4.2.56) in a Mixture (see 4.2.192) to the pressure of that Mixture of the molar volume of the Chemical_component divided by the product of the temperature of the Mixture and the ideal gas constant.

4.2.64.3 diffusion_coefficient

A diffusion_coefficient specifies the diffusion coefficient for one Chemical_component (see 4.2.56) in a Phase (see 4.2.230). The diffusion coefficient is a proportionality coefficient for the mass flux of a Chemical_component in a Phase to the mass gradient for that Chemical_component.

4.2.64.4 fugacity

A fugacity specifies a function used instead of chemical potential to define equilibrium of a Chemical_-component (see 4.2.56) in a Mixture (see 4.2.192). As pressure of the Mixture approaches zero, the fugacity approaches the mole fraction of the Chemical_component in the Mixture times the pressure of the Mixture.

4.2.64.5 partial_molar_volume

A partial_molar_volume specifies the instantaneous change in volume of a Phase (see 4.2.230) with the change in the number of moles of a Chemical_component (see 4.2.56) with the number of moles of all other Chemical_components and the temperature and pressure of the Phase held constant.

4.2.65 Composition_relationship

A Composition_relationship specifies the fraction of a Substance (see 4.2.381) in a Mixture (see 4.2.192).

The data associated with Composition_relationship are the following:

— mass_fraction;

— mole_fraction;

— special_equil;

— volume_fraction.

4.2.65.1 mass_fraction

A mass_fraction specifies the ratio of the mass of one Substance (see 4.2.381) in a Mixture (see 4.2.192) to the mass of that Mixture.

4.2.65.2 mole_fraction

A mole_fraction specifies the ratio of the moles of one Substance (see 4.2.381) in a Mixture (see 4.2.192) to the total moles of the Mixture.

4.2.65.3 special_equil

A special_equil specifies an enumerated attribute which indicates the type of equilibrium relationship that the Substance (see 4.2.381) participates in the Mixture (see 4.2.192). The value of the special_equil attribute shall be one of the following:

— inert_solid;

— noncondensable;

— nonvolatile;

— normal;

— supercritical.

4.2.65.3.1 inert_solid: an indication that the Substance (see 4.2.381) is a solid which does not participate in the equilibrium of the Mixture (see 4.2.192) under the time frame of consideration.

4.2.65.3.2 noncondensable: an indication the Substance (see 4.2.381) may be present only vapour phase of the Mixture (see 4.2.192).

4.2.65.3.3 nonvolatile: an indication that the Substance (see 4.2.381) will not be present in the vapour phase of the Mixture (see 4.2.192).

4.2.65.3.4 normal: an indication that the Substance (see 4.2.381) participates in normal equilibrium relationships within the Mixture (see 4.2.192).

4.2.65.3.5 supercritical: an indication that within liquid Phases (see 4.2.230) of the Mixture (see 4.2.192) the Substance (see 4.2.381) exists as a dissolved supercritical gas.

4.2.65.4 volume_fraction

A volume_fraction specifies the ratio of the volume occupied by one Substance (see 4.2.381) in a Mixture (see 4.2.192) to the entire volume of the Mixture.

4.2.66 Compression

A Compression is a type of end engagement for a Piping_connector (see 4.2.235) indicating that the connection is accomplished by mechanical deformation of the piping ends caused by exerting compressive force between two pieces of pipe.

4.2.67 Compressor_performance_data_point

A Compressor_performance_data_point is one data point for the performance of a Uo_compressor_stage (see 4.2.421) in the simulation.

The data associated with Compressor_performance_data_point are the following:

— actual_efficiency;

— adiabatic_efficiency;

— delta_pressure;

— head_developed;

— inlet_volume_flow_rate;

— polytropic_efficiency.

4.2.67.1 actual_efficiency

An actual_efficiency specifies the actual efficiency at the data point.

4.2.67.2 adiabatic_efficiency

An adiabatic_efficiency specifies the adiabatic efficiency of the compressor stage at the data point.

4.2.67.3 delta_pressure

A delta_pressure specifies the pressure difference across the compressor stage unit operation at the data point.

4.2.67.4 head_developed

A head_developed specifies the fluid head developed at the data point.

4.2.67.5 inlet_volume_flow_rate

An inlet_volume_flow_rate specifies the volumetric flow rate at inlet conditions for the data point.

4.2.67.6 polytropic_efficiency

A polytropic_efficiency specifies the polytropic efficiency of the stage at the data point.

4.2.68 Conditional_property_value

A Conditional_property_value is a type of Process_design_property_value (see 4.2.258).

> NOTE - Support for the information described in a Conditional_property_value is not a requirement of applications that conform to this standard.

The data associated with Conditional_property_value are the following:

— limit_condition.

A limit_condition specifies the numerical value associated with the property.

4.2.69 Conical_head

A Conical_head is a type of head for the Cylindrical_pv_head_section (see 4.2.92) with a truncated cone shape.

The data associated with Conical_head are the following:

— conical_head_height;

— conical_head_inside_diameter_large_end;

— conical_head_inside_diameter_small_end;

— conical_head_outside_diameter_large_end;

— conical_head_outside_diameter_small_end.

4.2.69.1 conical_head_height

A conical_head_height specifies the height of the Conical_head.

4.2.69.2 conical_head_inside_diameter_large_end

A conical_head_inside_diameter_large_end specifies the inside diameter of the large end of the Conical_-head.

4.2.69.3 conical_head_inside_diameter_small_end

A conical_head_inside_diameter_small_end specifies the inside diameter of the small end of the Conical_-head.

4.2.69.4 conical_head_outside_diameter_large_end

A conical_head_outside_diameter_large_end specifies the outside diameter of the large end of the Conical_head.

4.2.69.5 conical_head_outside_diameter_small_end

A conical_head_outside_diameter_small_end specifies the outside diameter of the small end of the Conical_head.

4.2.70 Connected_equipment_port

A Connected_equipment_port is an Equipment_port (see 4.2.125) that is connected to another Equipment_-port.

The data associated with Connected_equipment_port are the following:

— flow_state.

A flow_state specifies an enumerated attribute that indicates that the flow of a Connected_equipment_port is in the intended direction, the opposite of the intended direction, or is not occurring. The value of the flow_state attribute shall be one of the following:

— normal;

— reverse;

— static.

4.2.70.0.1 normal: an indication that the flow in a Connected_equipment_port is in the intended direction as defined by the normal flow direction of the Equipment_port (see 4.2.125).

4.2.70.0.2 reverse: an indication that the flow in a Connected_equipment_port is in the reverse of the intended direction as defined by the normal flow direction of the Equipment_port (see 4.2.125).

4.2.70.0.3 static: an indication that flow in a Connected_equipment_port is not occurring.

4.2.71 Connected_process_port

A Connected_process_port is a Process_port (see 4.2.264) that is connected to another Process_port.

The data associated with Connected_process_port are the following:

— flow_state.

A flow_state specifies an enumerated attribute that indicates that the flow of a Connected_process_port is in the intended direction, the opposite of the intended direction, or is not occurring. The value of the flow_state attribute shall be one of the following:

— normal;

— reverse;

— static.

4.2.71.0.1 normal: an indication that the flow in a Connected_process_port is in the intended direction as defined by the normal flow direction of the Process_port (see 4.2.264).

4.2.71.0.2 reverse: an indication that the flow in a Connected_process_port is in the reverse of the intended direction as defined by the normal flow direction of the Process_port (see 4.2.264).

4.2.71.0.3 static: an indication that flow in a Connected_process_port is not occurring.

4.2.72 Construction_material

A Construction_material is a type of Material (see 4.2.178) which is used to fabricate the Process_-equipment (see 4.2.260) or other Plant_items (see 4.2.237) which may contain Process_material (see 4.2.263).

4.2.73 Control_algorithm

A Control_algorithm is the method that is used by the Control_logic (see 4.2.76) for determining the appropriate control function response to the manipulated variable using a combination of Control_variables (see 4.2.81).

The data associated with Control_algorithm are the following:

— algorithm_name;

— description;

— source.

4.2.73.1 algorithm_name

An algorithm_name specifies a name which identifies the algorithm that is associated with a particular Control_variable (see 4.2.81). The value of the algorithm_name attribute shall be one of the following:

— cascade_feedback;

— constraint_feedback;

— cycle;

— feed_forward_control;

— high_low_alarm;

— high_low_interlock;

- indicate_display;
- manual_automatic_control;
- multivariate_control;
- non_linear_feedback;
- on_off_feedback;
- open_close;
- p_feedback;
- pi_feedback;
- pid_feedback;
- press_release;
- record_trend;
- self_regulated_feedback;
- sequence;
- set_point_control;
- set_switch;
- split_range_feedback;
- two_out_of_three_vote;
- user_defined;
- wait;
- wait_until.

4.2.73.1.1 cascade_feedback: an indication of an arrangement of feedback control where the manipulated variable is the set point of another feedback loop.

EXAMPLE 4 - Temperature is measured and used to adjust the set point of a flow control feedback loop. The flow control loop responds to the flow set point change.

4.2.73.1.2 constraint_feedback: an indication of a feedback control loop to keep a controlled variable within a specified range. When the variable is inside the range, no control action is taken. When the controlled variable exceeds a limit (either high or low), then the control function is applied.

4.2.73.1.3 cycle: an indication that a set of control events is done in a sequence, which is then repeated until a specified condition is met.

4.2.73.1.4 feed_forward_control: an indication that the measured variable is used to predict the value of the controlled variable using a predictive model and the control function is applied to correct anticipated errors.

NOTE - This method is usually used in conjunction with feedback control.

4.2.73.1.5 high_low_alarm: an indication of an attention-getting auditory or visual cue to an operator to take action. The High/Low Alarm event occurs when a controlled variable exceeds a specified limit condition.

4.2.73.1.6 high_low_interlock: an indication of an automatic control event, such as closing or opening a valve or relay switch in response to a controlled variable exceeding a specified limit condition.

4.2.73.1.7 indicate_display: an indication that there is no control function except to indicate or display a measured variable to a human.

4.2.73.1.8 manual_automatic_control: an indication of an event whereby a controller's operating mode is changed.

4.2.73.1.9 multivariate_control: an indication that several measured variables are used with a predictive model to adjust one or more manipulated variables to drive the model errors to zero.

4.2.73.1.10 non_linear_feedback: an indication of a form of PID or PI control where the proportionality coefficient is not linear (proportional) with error, but is raised to a power either less than or greater than one.

4.2.73.1.11 on_off_feedback: an indication that the control function is full On or full Off when the controlled variable deviates from the set point.

NOTE - A simple example of On-Off control is a home heating/air-conditioning thermostat.

4.2.73.1.12 open_close: an indication of a control event initiated by an automated system or by the operator to open or close a specified valve or relay switch.

4.2.73.1.13 p_feedback: an indication of proportional feedback control. A controlled variable is compared to a set point to compute an error. The computed control function is to adjust the manipulated variable proportionally to the error.

4.2.73.1.14 pi_feedback: an indication of proportional-integral feedback control. A controlled variable is compared to a set point to compute an error. The computed control function is to adjust the manipulated variable proportionally to the error and to the integral of the error.

4.2.73.1.15 pid_feedback: an indication of proportional-integral-derivative feedback control. A controlled variable is compared to a set point to compute an error. The computed control function is to adjust the manipulated variable proportionally to the error, to the integral of the error and to the derivative of the error.

4.2.73.1.16 press_release: an indication of a control event initiated by the operator to press or release a switch or button.

4.2.73.1.17 record_trend: an indication that the measured variable is recorded onto persistent media such as a chart or onto a digital system magnetic disk.

4.2.73.1.18 self_regulated_feedback: an indication of a form of feedback control where the measured variable is directly used to control the controlled variable.

NOTE - A common example is a back-pressure regulator.

4.2.73.1.19 sequence: an indication that a set of control events is done in a specified order.

4.2.73.1.20 set_point_control: an indication of the event whereby a controller's set point is changed.

4.2.73.1.21 set_switch: an indication of a control event initiated by an automated system or by the operator to set a multiplexed switching device to a specified position.

4.2.73.1.22 split_range_feedback: an indication of a feedback control loop where different algorithms (or control constants) are used depending on the value of the controlled variable. If the controlled variable is within one range of values, one algorithm is used. If it is within a different range of values, then a different algorithm (or set of constants) is used.

4.2.73.1.23 two_out_of_three_vote: an indication of an interlock event that is dependent upon at least two out of three measurement variables which have exceeded a specified limit condition.

4.2.73.1.24 user_defined: an indication that the control_algorithm is not covered in the enumerated algorithm names.

4.2.73.1.25 wait: an indication of a control event associated with a timer or with an operator to wait for a specified period of time before taking the next action.

4.2.73.1.26 wait_until: an indication of a control event associated with an automated system or with an operator to wait until a specified logical condition is true prior to taking the next action.

4.2.73.2 description

A description specifies a summary of key aspects of the Control_algorithm.

4.2.73.3 source

A source specifies an optional text string, which specifies a reference for where the algorithm is defined.

4.2.74 Control_element

A Control_element is a type of Plant_item (see 4.2.237) that carries out the actions associated with a Control_event_or_adjustment (see 4.2.75).

EXAMPLE 5 - Control_elements include control valves and relay switches.

4.2.75 Control_event_or_adjustment

A Control_event_or_adjustment is a type of Process_definition (see 4.2.253) that defines a control event or a continuous adjustment that carries out the Control_algorithm (see 4.2.73) as applied to the Control_variables (see 4.2.81).

The data associated with Control_event_or_adjustment are the following:

— action_id;

— mode.

4.2.75.1 action_id

An action_id specifies the unique identification of the Control_event_or_adjustment.

4.2.75.2 mode

A mode specifies the state of the control_algorithm.

NOTE - Values for mode are manual, automatic and semi-automatic.

4.2.76 Control_logic

A Control_logic is the definition of how the Control_algorithm (see 4.2.73) is applied with applicable Control_logic_conditions (see 4.2.77) and Control_variables (see 4.2.81) to achieve the desired results of a particular Control_scheme (see 4.2.80).

The data associated with Control_logic are the following:

— description;

— procedure_name.

4.2.76.1 description

A description specifies an optional additional text description of the Control_logic.

4.2.76.2 procedure_name

A procedure_name specifies the unique name of the Control_logic.

4.2.77 Control_logic_condition

A Control_logic_condition is a logical condition that indicates whether or not a Control_logic (see 4.2.76) will be executed. The condition may be either the result of a simple measurement of a property of a Site (see 4.2.354), Stream (see 4.2.374), Material_amount (see 4.2.179), or Plant_item (see 4.2.237), or it may be a logical combination of the results of measurements and the state of other control events. Each Control_logic_condition may be one of the following: a Logical_operation (see 4.2.173) or a Control_variable (see 4.2.81).

The data associated with Control_logic_condition is:

— name.

A name specifies the label of the Control_logic_condition within the context of the Control_scheme (see 4.2.80).

4.2.78 Control_measurement_module

A Control_measurement_module is a type of Process_definition (see 4.2.253) that measures properties of a Site (see 4.2.354), Material_amount (see 4.2.179), Stream (see 4.2.374), or another Plant_item (see 4.2.237).

The data associated with Control_measurement_module are:

— module_description;

— module_name.

4.2.78.1 module_description

A module_description specifies an optional entry to further describe the module_name.

4.2.78.2 module_name

A module_name specifies the name of the variable being measured.

NOTE - Non-limiting examples of names that might be used here are Temperature sensor, Pressure sensor, Flow sensor (e.g., orifice plate), Level sensor, Composition analyzer, Rotation Speed, Vibration frequency, Vibration amplitude, Rainfall (rain gauge), and Wind Speed (anemometer).

4.2.79 Control_objective

A Control_objective is the goal that the Control_scheme (see 4.2.80) is designed to satisfy for the control of the process.

NOTE - The Control_objective is often selected from a list of possible objectives within a particular enterprise.

EXAMPLE 6 - During steady-state operation, maintain Tank 101 level at a setpoint of 50%.

The data associated with Control_objective are the following:

— objective_description;

— objective_name;

— operating_state.

4.2.79.1 objective_description

An objective_description specifies an optional text description of the Control_objective.

EXAMPLE 7 - For example, maintain Tank 101 level at 50 percent or charge tank with feed.

4.2.79.2 objective_name

An objective_name specifies the unique label for the Control_objective.

EXAMPLE 8 - For example, Tank 101 level regulatory control or Tank 101 high level alarm.

4.2.79.3 operating_state

An operating_state specifies the operating state of the process.

EXAMPLE 9 - For example, startup, shutdown, standby, or steady-state.

4.2.80 Control_scheme

A Control_scheme defines the basic controls, instrument and information methods to permit a process to manufacture a desired product.

The data associated with Control_scheme are:

— control_loop_id;

— scheme_type.

4.2.80.1 control_loop_id

A control_loop_id specifies a unique identification for the Control_scheme.

4.2.80.2 scheme_type

A scheme_type specifies an enumerated attribute that identifies the general category of the Control_-scheme. The value of the regulatory_or_procedural attribute shall be one of the following:

— alarms;

— interlocks;

— procedural_logic;

— recording_indication;

— regulatory_control.

4.2.80.2.1 alarms: an indication that the control generates attention-getting auditory/visual cues to the operator when specified limit conditions are exceeded.

4.2.80.2.2 interlocks: an indication that the control generates automated control events, such as activate relays or open/close valves, when specified limit conditions are exceeded.

4.2.80.2.3 procedural_logic: an indication that the control generates automated control events, such as activate relays or open/close valves, in a sequence, a cycle or when a logical condition has been satisfied.

4.2.80.2.4 recording_indication: an indication that measured variables are recorded on persistent media such as paper charts or digital computer magnetic disks or are indicated to humans. No control action is taken.

4.2.80.2.5 regulatory_control: an indication that the control is to maintain controlled variables at specified set point(s).

4.2.81 Control_variable

A Control_variable is a type of Control_logic_condition (see 4.2.77) that is a measured variable of a Site (see 4.2.354), Stream (see 4.2.374), Material_amount (see 4.2.179), or Plant_item (see 4.2.237) that defines the requirement for a control action to be taken in order to provide the desired control of the process. In addition to measured variables, a Control_variable may also be a controlled variable, a set point or a manipulated variable associated with a Control_logic (see 4.2.76). Each Control_variable may be a Comparison_parameter (see 4.2.63) that may be used in a logical expression associated with a Control_-logic_condition.

> EXAMPLE 10 - Examples of Control_variables include temperature, pressure, flow, level, composition, rotation speed, vibration frequency, vibration amplitude, rainfall, wind speed, valve position, switch position, and controller set point.

The data associated with Control_variable are the following:

- variable_name;
- variable_value.

4.2.81.1 variable_name

A variable_name specifies the unique identification of the measured, controlled, set point, or manipulated variable.

4.2.81.2 variable_value

A variable_value specifies the value associated with the variable.

4.2.82 Convergence_block_property_value_usage

A Convergence_block_property_value_usage is the use of a Process_design_property_value (see 4.2.258) by a Stream_convergence_block (see 4.2.375) indicating that the property is a converging variable or an ignored variable in the calculation.

The data associated with Convergence_block_property_value_usage are the following:

- converging_or_ignored.

A converging_or_ignored specifies whether Process_design_property_value is a converging or an ignored variable.

4.2.83 Corrugation

A Corrugation is the design for a type of Tray_panel (see 4.2.399) as described by a corrugation_type, height, and length or by a Curve (see 4.2.86).

The data associated with Corrugation are the following:

— corrugation_type;

— height;

— length.

4.2.83.1 corrugation_type

A corrugation_type specifies an enumerated attribute that indicates the Corrugation is triangular, rectangular, sinusoidal, or an other shape.

4.2.83.2 height

A height specifies the vertical height of the Corrugation.

4.2.83.3 length

A length specifies the horizontal length for each Corrugation that may also be described as a Curve (see 4.2.86).

4.2.84 Coupling

A Coupling is the Mechanical_component (see 4.2.189) that links the driver and pump or compressor in Material_transfer_equipment (see 4.2.188).

The data associated with Coupling are the following:

— coupling_lubrication;

— coupling_rating;

— coupling_spacer_required;

— idling_adapter_reqd;

— keying_or_fit;

— limited_end_float_reqd;

— mount_driver_coupling_half;

— rotation_viewed_from_driven_end.

4.2.84.1 coupling_lubrication

A coupling_lubrication specifies the lubrication provided for the Coupling.

4.2.84.2 coupling_rating

A coupling_rating specifies the torque rating of the Coupling.

4.2.84.3 coupling_spacer_required

A coupling_spacer_required specifies that the Coupling requires a spacer.

4.2.84.4 idling_adapter_reqd

An idling_adapter_reqd specifies a mechanical feature of a Coupling that would allow either the pump/compressor or the driver to rotate independently.

4.2.84.5 keying_or_fit

A keying_or_fit specifies the type of attachment of the Coupling to a Shaft (see 4.2.325) (keying) or to its mating half (hydraulic). The value of the keying_or_fit attribute shall be one of the following:

— hydraulic;

— one;

— two.

4.2.84.5.1 hydraulic: an indication that the Coupling is attached using a hydraulic fit.

4.2.84.5.2 one: an indication that the Coupling is attached with a single key.

4.2.84.5.3 two: an indication that the Coupling is attached with a double key.

4.2.84.6 limited_end_float_reqd

A limited_end_float_reqd specifies that a floating end limiting device is required.

4.2.84.7 mount_driver_coupling_half

A mount_driver_coupling_half specifies who is to mount the driver half of the Coupling to mate with the driven half. The value of the mount_driver_coupling_half attribute shall be one of the following:

— mach_mfr;

— drive_mfr;

— purchaser.

4.2.84.7.1 mach_mfr: an indication that the machinery manufacturer will mount the driver side Coupling half.

4.2.84.7.2 drive_mfr: an indication that the drive manufacturer mounts the driver side Coupling half.

4.2.84.7.3 purchaser: an indication that the purchaser will mount the driver side Coupling half.

4.2.84.8 rotation_viewed_from_driven_end

A rotation_viewed_from_driven_end specifies an enumerated attribute which indicates the direction the Coupling rotates. The value of the rotation_viewed_from_driven_end attribute shall be one of the following:

— ccw;

— cw.

4.2.84.8.1 ccw: an indication that the Coupling rotates counter-clockwise when viewed from the driver side.

4.2.84.8.2 cw: an indication that the Coupling rotates clockwise when viewed from the driver side.

4.2.85 Cross_baffle

A Cross_baffle is a sheet of material in a heat exchanger placed in the bundle to alter the flow pattern of the shell side fluid flow.

The data associated with Cross_baffle are the following:

— cut_out_of_window;

— diameter;

— dist_from_tubesheet_face;

— elastic_modulus;

— orientation;

— outer_ring_width;

— percent_diameter_first_cut;

— percent_diameter_second_cut;

— percent_diameter_third_cut;

— thermal_conductivity;

— thickness;

— thickness_at_tube_hole;

— type.

4.2.85.1 cut_out_of_window

A cut_out_of_window specifies whether or not the baffle window is integral to the baffle. The value of the cut_out_of_window attribute shall be one of the following:

— no;

— unspecified;

— yes.

4.2.85.1.1 no: an indication that the baffle window is not integral to the baffle (see item 1 in Figure 2).

4.2.85.1.2 unspecified: an indication that whether a baffle has a baffle window is not specified.

4.2.85.1.3 yes: an indication that the baffle window is integral to the baffle (see item 2 in Figure 2).

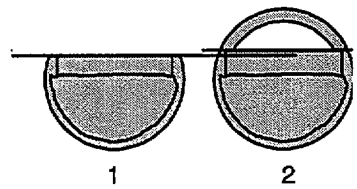


Figure 2 - Baffle Window

4.2.85.2 diameter

A diameter specifies the outside diameter of the Cross_baffles.

4.2.85.3 dist_from_tubesheet_face

A dist_from_tubesheet_face specifies the distance from the center of a single baffle to the front face of the front tubesheet.

4.2.85.4 elastic_modulus

An elastic_modulus specifies the modulus of elasticity for the baffle.

4.2.85.5 orientation

An orientation specifies an enumerated attribute giving the baffle cut orientation of a segmental type baffle. The value of the type attribute shall be one of the following:

- none;
- parallel;
- perpendicular;
- rotated;
- unspecified.

4.2.85.5.1 none: an indication that there is no baffle cut.

4.2.85.5.2 parallel: an indication that the baffle cut orientation is parallel (normally vertical) to the shell side inlet nozzle axis.

4.2.85.5.3 perpendicular: an indication that the baffle cut orientation is perpendicular (normally horizontal) to the shell side inlet nozzle axis.

4.2.85.5.4 rotated: an indication that the baffle cut orientation is rotated 45 degrees with respect to the shell side inlet nozzle axis.

4.2.85.5.5 unspecified: an indication that the baffle cut orientation is not specified.

4.2.85.6 outer_ring_width

An outer_ring_width specifies the width of the outer ring.

4.2.85.7 percent_diameter_first_cut

A percent_diameter_first_cut varies with the type of segmental baffle. For a single-segmental baffle, it is defined as the segment opening height expressed as a percentage of the shell inside diameter. For double-segmental and triple-segmental baffles, it is defined as the segment height of the innermost baffle window as a percent of the shell inside diameter.

4.2.85.8 percent_diameter_second_cut

A percent_diameter_second_cut varies with the type of segmental baffle. For a double-segmental baffle, it is defined as the segment height of the outermost baffle window as a percent of the shell inside diameter. For a triple-segmental baffle, it is defined as the segment height of the intermediate baffle window as a percent of the shell inside diameter.

4.2.85.9 percent_diameter_third_cut

A percent_diameter_third_cut specifies the segment height of the outermost baffle window of a triple-segmental baffle as a percent of the shell inside diameter.

4.2.85.10 thermal_conductivity

A thermal_conductivity specifies the thermal conductivity of the baffle.

4.2.85.11 thickness

A thickness specifies the thickness of the Cross_baffles.

4.2.85.12 thickness_at_tube_hole

A thickness_at_tube_hole specifies the thickness of the Cross_baffles at the tube holes.

4.2.85.13 type

A type specifies an enumerated attribute giving the type of baffle in a heat exchanger. The value of the type attribute shall be one of the following:

- disk_and_donut;
- double_segmental;
- full_support;
- no_baffles;
- rod;
- single_segmental;
- strip;
- triple_segmental;
- unspecified.

4.2.85.13.1 disk_and_donut: an indication that the type of baffle is a disk and donut (see item 7 in Figure 3).

4.2.85.13.2 double_segmental: an indication that the type of baffle is a double-segmental (see item 2 in Figure 3).

4.2.85.13.3 full_support: an indication that the type of baffle is a full-support (see item 4 in Figure 3).

4.2.85.13.4 no_baffles: an indication that there is no baffle.

4.2.85.13.5 rod: an indication that the type of baffle is a rod (see item 5 in Figure 3).

4.2.85.13.6 single_segmental: an indication that the type of baffle is a single-segmental (see item 1 in Figure 3).

4.2.85.13.7 strip: an indication that the type of baffle is a strip (see item 6 in Figure 3).

4.2.85.13.8 triple_segmental: an indication that the type of baffle is a triple-segmental (see item 3 in Figure 3).

4.2.85.13.9 unspecified: an indication that the type of baffle is not specified.

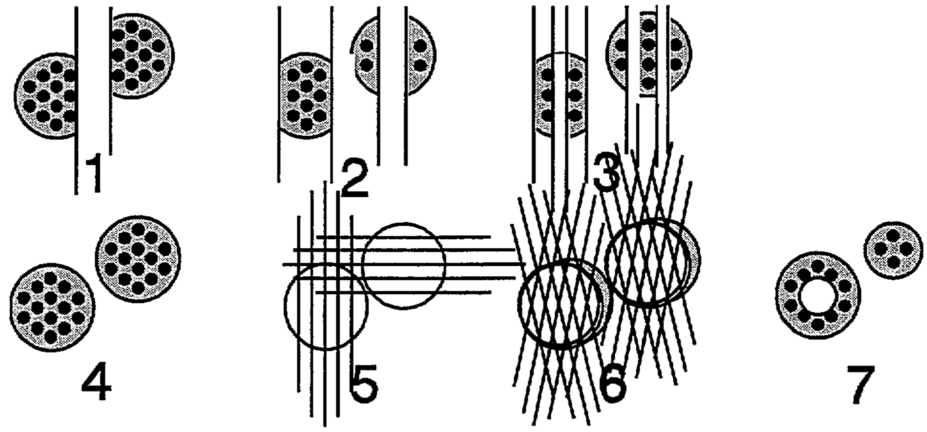


Figure 3 - Baffle Type

4.2.86 Curve

A Curve is the particular shape used to describe a geometric form or intersection.

4.2.87 Cylindrical_pressure_vessel

A Cylindrical_pressure_vessel is a type of Pressure_vessel (see 4.2.251) having cylindrical geometry.

The data associated with Cylindrical_pressure_vessel are the following:

— cylindrical_pressure_vessel_orientation;

— cylindrical_pressure_vessel_overall_height;

— cylindrical_pressure_vessel_overall_length.

4.2.87.1 cylindrical_pressure_vessel_orientation

A cylindrical_pressure_vessel_orientation specifies an enumerated attribute giving the overall orientation of the Cylindrical_pressure_vessel. The value of the cylindrical_pressure_vessel_orientation attribute shall be one of the following:

— horizontal;

— other;

— unknown;

— vertical.

4.2.87.1.1 horizontal: an indication that the general orientation of the Cylindrical_pressure_vessel is along a horizontal axis.

4.2.87.1.2 other: an indication that the general orientation of the Cylindrical_pressure_vessel is along an axis other than horizontal or vertical.

4.2.87.1.3 unknown: an indication that the orientation of the Cylindrical_pressure_vessel is unknown or unspecified.

4.2.87.1.4 vertical: an indication that the general orientation of the Cylindrical_pressure_vessel is along a vertical axis.

4.2.87.2 cylindrical_pressure_vessel_overall_height

A cylindrical_pressure_vessel_overall_height specifies the overall height associated with the Cylindrical_-pressure_vessel.

4.2.87.3 cylindrical_pressure_vessel_overall_length

A cylindrical_pressure_vessel_overall_length specifies the overall length associated with the Cylindrical_-pressure_vessel.

4.2.88 Cylindrical_pressure_vessel_connection

A Cylindrical_pressure_vessel_connection is the connection between two Cylindrical_pressure_vessel_-sections.

The data associated with Cylindrical_pressure_vessel_connection are the following:

— cylindrical_pressure_vessel_connection_inside_radius;

— cylindrical_pressure_vessel_connection_thickness;

— cylindrical_pressure_vessel_connection_type.

4.2.88.1 cylindrical_pressure_vessel_connection_inside_radius

A cylindrical_pressure_vessel_connection_inside_radius specifies the inside radius of the transition of a Cylindrical_pressure_vessel_connection between two unequal sized sections.

4.2.88.2 cylindrical_pressure_vessel_connection_thickness

A cylindrical_pressure_vessel_connection_thickness specifies the wall thickness of the Cylindrical_-pressure_vessel_connection.

4.2.88.3 cylindrical_pressure_vessel_connection_type

A cylindrical_pressure_vessel_connection_type specifies an enumerated attribute specifying the type of Cylindrical_pressure_vessel_connection. The value of the cylindrical_pressure_vessel_connection_type attribute shall be one of the following:

— flanged;

— unspecified;

— welded.

4.2.88.3.1 flanged: an indication that the type of connection is flanged for the Cylindrical_pressure_-vessel_connection.

4.2.88.3.2 unspecified: an indication that the type of connection is unspecified for the Cylindrical_-pressure_vessel_connection.

4.2.88.3.3 welded: an indication that the type of connection is welded for the Cylindrical_pressure_-vessel_connection.

4.2.89 Cylindrical_pressure_vessel_section

A Cylindrical_pressure_vessel_section is a section of a Cylindrical_pressure_vessel (see 4.2.87). Each Cylindrical_pressure_vessel_section may be one of the following: a Cylindrical_pv_eccentric_section (see 4.2.91), a Cylindrical_pv_cylinder_section (see 4.2.90), or a Cylindrical_pv_head_section (see 4.2.92).

The data associated with Cylindrical_pressure_vessel_section are the following:

— cylindrical_pressure_vessel_section_corrosion_allowance;

— cylindrical_pressure_vessel_section_joint_efficiency;

— cylindrical_pressure_vessel_section_wall_thickness.

4.2.89.1 cylindrical_pressure_vessel_section_corrosion_allowance

A cylindrical_pressure_vessel_section_corrosion_allowance specifies the corrosion allowance for the Cylindrical_pressure_vessel (see 4.2.87).

4.2.89.2 cylindrical_pressure_vessel_section_joint_efficiency

A cylindrical_pressure_vessel_section_joint_efficiency specifies the joint efficiency for the Cylindrical_-pressure_vessel (see 4.2.87).

4.2.89.3 cylindrical_pressure_vessel_section_wall_thickness

A cylindrical_pressure_vessel_section_wall_thickness specifies the wall thickness of the Cylindrical_-pressure_vessel (see 4.2.87).

4.2.90 Cylindrical_pv_cylinder_section

A Cylindrical_pv_cylinder_section is a straight walled section in the Cylindrical_pressure_vessel (see 4.2.87) with two possible diameters.

The data associated with Cylindrical_pv_cylinder_section are the following:

— cylinder_section_diameter_1;

— cylinder_section_diameter_2;

— cylinder_section_length.

4.2.90.1 cylinder_section_diameter_1

A cylinder_section_diameter_1 specifies one of the two possible diameters of a Cylindrical_pv_cylinder_-section.

NOTE - If tapered, it is for the end towards the lowest ordered section of the vessel.

4.2.90.2 cylinder_section_diameter_2

A cylinder_section_diameter_2 specifies the possible diameter for a tapered cylinder for the Cylinder_pv_-cylinder_section. It is for the ends towards the highest ordered section.

NOTE - If untapered, it is NULL valued.

4.2.90.3 cylinder_section_length

A cylinder_section_length specifies the length associated with the Cylindrical_pv_cylinder_section.

4.2.91 Cylindrical_pv_eccentric_section

A Cylindrical_pv_eccentric_section is a type of Cylindrical_pressure_vessel_section (see 4.2.89) which has the geometry of an eccentric cylinder.

The data associated with Cylindrical_pv_eccentric_section are the following:

— angular_offset_of_small_side;

— eccentric_diameter_1;

— eccentric_diameter_2;

— eccentric_length.

4.2.91.1 angular_offset_of_small_side

An angular_offset_of_small_side specifies the angular offset of the small side of the section associated with the Cylindrical_pv_eccentric_section.

4.2.91.2 eccentric_diameter_1

An eccentric_diameter_1 specifies the diameter of the Cylindrical_pv_eccentric_section towards the lowest number section.

4.2.91.3 eccentric_diameter_2

An eccentric_diameter_2 specifies the diameter of the Cylindrical_pv_eccentric_section towards the highest numbered section.

4.2.91.4 eccentric_length

An eccentric_length specifies the length of the Cylindrical_pv_eccentric_section.

4.2.92 Cylindrical_pv_head_section

A Cylindrical_pv_head_section is a Cylindrical_pressure_vessel_section (see 4.2.89) that is a head. Each Cylindrical_pv_head_section may be one of the following: a Conical_head (see 4.2.69), an Ellipsoidal_-head (see 4.2.119), a Flat_head (see 4.2.147), a Hemispherical_head (see 4.2.162), a Standard_dished_head (see 4.2.371), or a Torispherical_head (see 4.2.394).

4.2.93 Data_entry

A Data_entry is the association of a given Data_entry to a set of independent Variables (see 4.2.489) and a set of dependent Variables.

The data associated with Data_entry are the following:

— data_entry_name.

A data_entry_name specifies a name for the Data_entry.

4.2.94 Data_quality

A Data_quality is a measurement or estimation of the quality of the data in a Variable_value (see 4.2.493).

The data associated with Data_quality are the following:

— accuracy;

— standard_deviation.

4.2.94.1 accuracy

An accuracy specifies the absolute accuracy of the Variable_value (see 4.2.493).

4.2.94.2 standard_deviation

A standard_deviation specifies the standard deviation of the accuracies of the group of values which the Variable_value (see 4.2.493) is a part.

4.2.95 Data_source

A Data_source is information about the source and nature of the data contained in one or more Variable_-values (see 4.2.493).

The data associated with Data_source are the following:

— accuracy_source;

— date_of_update;

— kind_of_data;

— nature_of_data_source;

— provider.

4.2.95.1 accuracy_source

An accuracy_source specifies an enumerated attribute that specifies the source of the reported accuracy of the data in the Data_source. The value of the accuracy_source attribute shall be one of the following:

— author;

— reviewer.

4.2.95.1.1 author: an indication that the reported accuracy was supplied by the author or provider of the Data_source.

4.2.95.1.2 reviewer: an indication that the reported accuracy was supplied by an independent reviewer or source.

4.2.95.2 date_of_update

A date_of_update specifies the date on which the Data_source was last updated.

4.2.95.3 kind_of_data

A kind_of_data specifies an enumerated attribute that specifies the general nature of the data in the Data_-source. The value of the kind_of_data attribute shall be one of the following:

— calculated;

— estimated;

— literature;

— raw_experimental;

— regressed;

— smoothed_experimental;

— unspecified.

4.2.95.3.1 calculated: an indication that the data in the Data_source was generated from some model with fitted or estimated parameters.

4.2.95.3.2 estimated: an indication that the data in the Data_source was generated by an estimation technique from similar experimental or regressed data.

4.2.95.3.3 literature: an indication that the Data_source is from a published journal or databank with no further indication of the nature of the data contained.

4.2.95.3.4 raw_experimental: an indication that the Data_source contains unprocessed experimental data.

4.2.95.3.5 regressed: an indication that the data is the result of applying regression technique(s) to some other data.

4.2.95.3.6 smoothed_experimental: an indication that the Data_source contains experimental data that has been modified by some smoothing or data reconciliation technique(s).

4.2.95.3.7 unspecified: an indication that the nature of the data in the Data_source is unknown or unspecified.

4.2.95.4 nature_of_data_source

A nature_of_data_source specifies an enumerated attribute that specifies the general reliability of the Data_source. The value of the nature_of_data_source shall be one of the following:

— approved;

— evaluated;

— unevaluated.

4.2.95.4.1 approved: an indication that the Data_source has been approved and is suitable for the current use.

4.2.95.4.2 evaluated: an indication that the Data_source has been evaluated and its reliability is known.

4.2.95.4.3 unevaluated: an indication that the Data_source has not yet been evaluated for reliability or suitability.

4.2.95.5 provider

A provider specifies the name of the person or organization who publishes, provides, or maintains the Data_source.

4.2.96 Date

The Date is a day in a month in a year.

The data associated with Date are the following:

— day;

— month;

— year;

4.2.96.1 day

A day specifies the day within a month.

NOTE - The day shall be an integer between 1 and 31.

4.2.96.2 month

A month specifies the month within a year.

NOTE - The month shall be an integer between 1 and 12.

4.2.96.3 year

A year specifies the year for a date.

NOTE - The year shall be specified according to the Gregorian calendar.

4.2.97 Defined_point_property

A Defined_point_property is a type of Thermophysical_point_property (see 4.2.388) where the property name and content of the Thermophysical_point_property is specified as one from a limited set of property definitions.

The data associated with Defined_point_property are the following:

— defined_pp_type.

A defined_pp_type specifies an enumerated attribute that defines which of the property definitions has been specified for the Defined_point_property and specifies the property name. The value of the defined_-pp_type attribute shall be one of the following:

— alkyl_paraffin_content;

— aromatic_index;

— basic_nitrogen_content;

— c5_asphaltene_content;

— c7_asphaltene_content;

— cetane_number;

— cyclic_olefin_content;

— di_aromatic_content;

— gas_liquid_ratio;

— gas_oil_ratio;

— iso_olefin_content;

— iso_paraffin_content;

— liquid_specific_gravity_25c_wrt_water_4c;

— luminosity_number;

— mono_aromatic_content;

— mono_olefin_content;

— motor_octane_number;

— net_heating_value;

— noack_volatility;

— nonbasic_nitrogen_content;

— normal_paraffin_content;

— penetration_index;

— penta_aromatic_content;

— poly_paraffin_content;

— ramsbottom_carbon_residue;

— research_octane_number;

— ring_index;

— tetra_aromatic_content;

— total_acid_number;

— total_aromatic_content;

— total_naphthenes;

— total_nitrogen_content;

— total_paraffin_content;

— tri_aromatic_content;

— vapour_pressure_@_100_degf;

— vapour_specific_gravity_60f_wrt_air_60f;

— water_content;

— water_liquid_ratio;

— wax_content.

4.2.97.0.1 alkyl_paraffin_content: an indication that the defined_pp_type is alkyl_paraffin_content. Alkyl_paraffin_content is the mass fraction of alkyl paraffins and applies to petroleum mixtures.

4.2.97.0.2 aromatic_index: an indication that the defined_pp_type is aromatic_index. Aromatic_index is a measurement which indicates the amount of aromatic species in a mixture.

4.2.97.0.3 basic_nitrogen_content: an indication that the defined_pp_type is basic_nitrogen_content. Basic_nitrogen_content is the mass fraction of nitrogen atoms in a substance that are in basic functional groups.

4.2.97.0.4 c5_asphaltene_content: an indication that the defined_pp_type is C5_asphaltene_content. C5_-asphaltene_content is the mass fraction of asphaltenes with a five carbon ring structure and applies to petroleum mixtures.

4.2.97.0.5 c7_asphaltene_content: an indication that the defined_pp_type is C7_asphaltene_content. C7_-asphaltene_content is the mass fraction of asphaltenes with a seven carbon ring structure and applies to petroleum mixtures.

4.2.97.0.6 cetane_number: an indication that the defined_pp_type is cetane_number. Cetane_number is a measurement that indicates the suitability of the mixture for use in diesel engines. It is a measurement of the autoignition of fuel in a test engine.

4.2.97.0.7 cyclic_olefin_content: an indication that the defined_pp_type is cyclic_olefin_content. Cyclic_-olefin_content is the mass fraction of olefins that contain a non-aromatic ring structure.

4.2.97.0.8 di_aromatic_content: an indication that the defined_pp_type is di_aromatic_content. Di_-aromatic_content is the mass fraction of compounds which contain a double aromatic ring structure.

4.2.97.0.9 gas_liquid_ratio: an indication that the defined_pp_type is gas_liquid_ratio. Gas_liquid_ratio is the ratio of the mass fraction of the gas phase to the mass fraction of all liquid phases in a multi-phase mixture.

4.2.97.0.10 gas_oil_ratio: an indication that the defined_pp_type is gas_oil_ratio. Gas_oil_ratio is the ratio of the mass fraction of the gas phase to the mass fraction of the hydrocarbon phase in a multi-phase mixture.

4.2.97.0.11 iso_olefin_content: an indication that the defined_pp_type is iso_olefin_content. The iso_-olefin_content is the mass fraction of branched compounds containing at least one unsaturated bond in a mixture.

4.2.97.0.12 iso_paraffin_content: an indication that the defined_pp_type is iso_paraffin_content. The iso_paraffin_content is the mass fraction of branched paraffins in the mixture.

4.2.97.0.13 liquid_specific_gravity_25c_wrt_water_4c: an indication that the defined_pp_type is liquid specific gravity of water. The ratio of the mass of a substance at 25C to the mass of a like volume of water at 4C.

4.2.97.0.14 luminosity_number: an indication that the defined_pp_type is luminosity_number. The luminosity_number is a test that measures the luminosity of the flame produced by combusting a mixture.

4.2.97.0.15 mono_aromatic_content: an indication that the defined_pp_type is mono_aromatic_content. Mono_aromatic_content is the mass fraction of compounds that have a single aromatic ring structure.

4.2.97.0.16 mono_olefin_content: an indication that the defined_pp_type is mono_olefin_content. Mono_olefin_content is the mass fraction of compounds with exactly one carbon-carbon double or triple bond.

4.2.97.0.17 motor_octane_number: an indication that the defined_pp_type is motor_octane_number. Motor_octane_number is a measurement of the performance degradation of a gasoline blend in an internal combustion engine caused by autoignition.

> NOTE - It is measured using the American Society for Testing and Materials (ASTM) D2700-92 test method.

4.2.97.0.18 net_heating_value: an indication that the defined_pp_type is net_heating_value. The net heating value is associated with the heat of combustion.

4.2.97.0.19 noack_volatility: an indication that the defined_pp_type is noack_volatility. The noack_-volatility is a test that measures the volatility of a mixture.

4.2.97.0.20 nonbasic_nitrogen_content: an indication that the defined_pp_type is nonbasic_nitrogen_-content. The nonbasic_nitrogen_content is the mass fraction of Nitrogen atoms in a compound that are not basic functional groups.

4.2.97.0.21 normal_paraffin_content: an indication that the defined_pp_type is normal_paraffin_content. The normal_paraffin_content is the mass fraction of compounds that are normal paraffins. This attribute applies to petroleum mixtures.

4.2.97.0.22 penta_aromatic_content: an indication that the defined_pp_type is penta_aromatic_content. The penta_aromatic_content is the mass fraction of compounds that contain five aromatic rings.

4.2.97.0.23 ramsbottom_carbon_residue: an indication that the defined_pp_type is ramsbottom_carbon_-residue. The ramsbottom_carbon_attribute is a test that yields the amount of carbon yielded by coking a mixture.

4.2.97.0.24 research_octane_number: an indication that the defined_pp_type is research_octane_number. The motor_octane_number is a measurement of the performance degradation of a gasoline blend in an internal combustion engine caused by autoignition.

NOTE - It is measured using the ASTM D2699-92 test method.

4.2.97.0.25 tetra_aromatic_content: an indication that the defined_pp_type is tetra_aromatic_content. The tetra_aromatic_content is the mass fraction of compounds with four aromatic rings.

4.2.97.0.26 total_aromatic_content: an indication that the defined_pp_type is total_aromatic_content. The total_aromatic_content is the mass fraction of all compounds containing aromatic rings in the mixture.

4.2.97.0.27 total_naphthenes: an indication that the defined_pp_type is total_naphthenes. The total_-naphthenes is the mass fraction of naphthenes in the mixture.

4.2.97.0.28 total_nitrogen_content: an indication that the defined_pp_type is total_nitrogen_content. The total_nitrogen_content is the mass fraction of Nitrogen atoms in a compound.

4.2.97.0.29 total_paraffin_content: an indication that the defined_pp_type is total_paraffin_content. The total_paraffin_content is the mass fraction of paraffins in the mixture.

4.2.97.0.30 tri_aromatic_content: an indication that the defined_pp_type is tri_aromatic_content. The tri_aromatic_content is the mass fraction of compounds with three aromatic rings in the mixture.

4.2.97.0.31 vapour_pressure_@_100_degf: an indication that the defined_pp_type is pressure of the vapour in equilibrium with the liquid or solid at 100 degrees Fahrenheit.

4.2.97.0.32 vapour_specific_gravity_60f_wrt_air_60f: an indication that the defined_pp_type is the ratio of the mass of a volume of vapour at 60 degrees Fahrenheit to the mass of a like volume of air at 60 degrees Fahrenheit.

4.2.97.0.33 water_content: an indication that the defined_pp_type is water_content. The water_content is the mass fraction of water in the mixture.

4.2.97.0.34 water_liquid_ratio: an indication that the defined_pp_type is water_liquid_ratio. Water_-liquid_ratio is the ratio of the mass fraction of the aqueous phase to the mass fraction of all liquid phases in a multi-phase mixture.

4.2.97.0.35 wax_content: an indication that the defined_pp_type is wax_content. Wax_content is the mass fraction of waxes in the mixture.

4.2.98 Demister_pad

A Demister_pad is a circular pad located above the top tray used to separate liquid particles from the vapour.

4.2.99 Demister_pad_stack

A Demister_pad_stack is a group of Demister_pads (see 4.2.98) stacked together for disengaging liquid particles from the vapour.

4.2.100 Density_properties

A Density_properties is a collection of properties that specify the relationships between volume and moles or mass for a Phase (see 4.2.230) in a Mixture (see 4.2.192) at a given Thermodynamic_conditions (see 4.2.386). Density_properties must be used by at least one Single_phase_thermophysical_properties (see 4.2.353) or one Bulk_thermophysical_properties (see 4.2.33).

The data associated with Density_properties are the following:

— average_molecular_weight;

— compressibility;

— density_mass_basis;

— density_mole_basis;

— specific_volume_mass_basis;

— specific_volume_mole_basis.

4.2.100.1 average_molecular_weight

An average_molecular_weight specifies the mole fraction weighted average of the molecular weights of all Substances (see 4.2.381) present.

4.2.100.2 compressibility

A compressibility specifies the ratio of the product of the pressure and volume of any portion of the Phase (see 4.2.230) to the product of the ideal gas constant, the temperature, and the number of moles contained in that portion.

4.2.100.3 density_mass_basis

A density_mass_basis specifies the ratio of the mass of any portion of a Phase (see 4.2.230) to its volume.

4.2.100.4 density_mole_basis

A density_mole_basis specifies the ratio of the number of moles in any portion of a Phase (see 4.2.230) to its volume.

4.2.100.5 specific_volume_mass_basis

A specific_volume_mass_basis specifies the ratio of the volume of any portion of a Phase (see 4.2.230) to its mass.

4.2.100.6 specific_volume_mole_basis

A specific_volume_mole_basis specifies the ratio of the volume of any portion of a Phase (see 4.2.230) to the number of moles in that portion.

4.2.101 Design_project

A Design_project is a task with a specifically defined purpose and scope.

The data associated with Design_project are the following:

- design_project_id;
- design_project_name;
- design_project_number;
- design_project_owner.

4.2.101.1 design_project_id

A design_project_id specifies a unique identifier for the Design_project.

4.2.101.2 design_project_name

A design_project_name specifies a textual designation or label for the Design_project.

4.2.101.3 design_project_number

A design_project_number specifies a numeric designation for the Design_project.

4.2.101.4 design_project_owner

A design_project_owner specifies the name of the organization that owns the Design_project id, name, and number.

4.2.102 Design_project_assignment

A Design_project_assignment is an association between a Plant_item (see 4.2.237) and a Design_project (see 4.2.101) whereby the design of specific Plant_items are performed in specific Design_projects.

4.2.103 Detuning_plate

A Detuning_plate is a piece of plate that is attached to the bundle to change the vibration or acoustic resonance tendencies within the bundle.

The data associated with Detuning_plate are the following:

— distance_from_shell_centre;

— length;

— thickness;

— width.

4.2.103.1 distance_from_shell_centre

A distance_from_shell_centre specifies the distance from the Detuning_plate to the centreline of the shell.

4.2.103.2 length

A length specifies the length of the Detuning_plate.

4.2.103.3 thickness

A thickness specifies the thickness of the Detuning_plate.

4.2.103.4 width

A width specifies the width of the Detuning_plate.

4.2.104 Direct_current_port

A Direct_current_port is a type of Electrical_power_port (see 4.2.117) for which the electrical power is in the form of direct current.

4.2.105 Disengaging_panel_opening_shape

A Disengaging_panel_opening_shape is any area for liquid flow lost to Tray_support (see 4.2.405) such as a support ring.

4.2.106 Distillation_curve

A Distillation_curve is a data set that is used for a distillation curve.

The data associated with Distillation_curve are the following:

— distillation_curve_method_used.

A distillation_curve_method_used specifies the method used to produce the Distillation_curve.

4.2.107 Distillation_stage_phase

A Distillation_stage_phase is a type of Internal_stream_phase (see 4.2.165) that exists on a Uo_-distillation_stage (see 4.2.429) representing either the liquid or the vapour flows that are in contact on the Uo_distillation_stage.

4.2.108 Distributor_belt

A Distributor_belt is a donut-shaped section constructed around the shell which aids the distribution of a fluid into the shell side of the heat exchanger and reduces the entrance velocity of the fluid.

The data associated with Distributor_belt are the following:

— inside_diameter;

— length;

— outside_diameter;

— radial_clearance;

— slot_area;

— type.

4.2.108.1 inside_diameter

An inside_diameter specifies the inside diameter of the Distributor_belt.

4.2.108.2 length

A length specifies the length of the Distributor_belt.

4.2.108.3 outside_diameter

An outside_diameter specifies the outside diameter of the Distributor_belt.

4.2.108.4 radial_clearance

A radial_clearance specifies the radial clearance between the Distributor_belt and the shell.

4.2.108.5 slot_area

A slot_area specifies the total area of the distribution slots in the Distributor_belt.

4.2.108.6 type

A type specifies the type of the Distributor_belt as a gap, slot, or unspecified.

4.2.109 Downcomer

A Downcomer is an aggregate of a downcomer disengaging panel with one or more disengaging panel openings and one or more downcomer aprons.

4.2.110 Downcomer_apron_section_shape

A Downcomer_apron_section_shape is characterized by a vertical height and a horizontal pitch that is always such that the cross-sectional area of the flow channel will be smaller at the bottom of the Downcomer (see 4.2.109) apron section that at the top.

The data associated with Downcomer_apron_section_shape are the following:

— apron_section_number_from_top;

— horizontal_pitch;

— vertical_height.

4.2.110.1 apron_section_number_from_top

An apron_section_number_from_top specifies the particular apron section.

4.2.110.2 horizontal_pitch

A horizontal_pitch specifies the angle for making the Downcomer (see 4.2.109) wall smaller at its base than at the top.

4.2.110.3 vertical_height

A vertical_height specifies the apron section vertical height.

4.2.111 Downcomer_apron_shape

A Downcomer_apron_shape is characterized by the combination of section shapes, either perfectly vertical or angled from vertical.

The data associated with Downcomer_apron_shape are the following:

— number_of_apron_sections.

A number_of_apron_sections specifies the total number of sections required for the complete Downcomer_apron_shape.

4.2.112 Downcomer_disengaging_panel_shape

A Downcomer_disengaging_panel_shape is the geometric features described by a Perimeter (see 4.2.216).

4.2.113 Downcomer_hydraulics

A Downcomer_hydraulics is the fluid flow dynamics in the Downcomer (see 4.2.109).

The data associated with Downcomer_hydraulics are the following:

- clear_liquid_height;
- flooding_safety_factor;
- froth_height;
- liquid_height_at_flood_point;
- liquid_residence_time;
- liquid_velocity_at_top;
- maximum_liquid_height;
- maximum_liquid_velocity.

4.2.113.1 clear_liquid_height

A clear_liquid_height specifies the height of the liquid containing no vapour or froth at the bottom of the Downcomer (see 4.2.109).

4.2.113.2 flooding_safety_factor

A flooding_safety_factor specifies the percentage safety factor built into the Downcomer (see 4.2.109) design to estimate flooding conditions when the Downcomer is handling maximum liquid flow.

4.2.113.3 froth_height

A froth_height specifies the level of froth over the clear liquid inside the Downcomer (see 4.2.109).

4.2.113.4 liquid_height_at_flood_point

A liquid_height_at_flood_point specifies the liquid height in the Downcomer (see 4.2.109) at the point of flooding.

4.2.113.5 liquid_residence_time

A liquid_residence_time specifies the holdup time required for liquid flow through the Downcomer (see 4.2.109).

4.2.113.6 liquid_velocity_at_top

A liquid_velocity_at_top specifies the velocity of the liquid flow at the top of the Downcomer (see 4.2.109) and as it enters the Downcomer.

4.2.113.7 maximum_liquid_height

A maximum_liquid_height specifies the maximum possible liquid height inside the Downcomer (see 4.2.109).

4.2.113.8 maximum_liquid_velocity

A maximum_liquid_velocity specifies the maximum liquid velocity possible inside the Downcomer (see 4.2.109).

4.2.114 Downcomer_liquid_flow_channel_shape

A Downcomer_liquid_flow_channel_shape is described by the volume and the Perimeter (see 4.2.216) at the top and bottom of the channel.

NOTE - The shape is confined by the Downcomer (see 4.2.109) apron section.

The data associated with Downcomer_liquid_flow_channel_shape are the following:

— volume.

A volume specifies the size of the Downcomer (see 4.2.109) liquid flow channel.

4.2.115 Downcomer_shape

A Downcomer_shape is the geometric features of a Downcomer (see 4.2.109).

The data associated with Downcomer_shape are the following:

— downcomer_location_type.

A downcomer_location_type specifies the location of the Downcomer (see 4.2.109) disengaging panel on the Separation_tray (see 4.2.316) and is either a side downcomer, a center downcomer, or an off-center downcomer.

4.2.116 Elbow_nozzle_section

An Elbow_nozzle_section is a type of Nozzle_section (see 4.2.199) which contains a simple bend.

The data associated with Elbow_nozzle_section are the following:

- elbow_nozzle_section_bend_radius;
- elbow_nozzle_section_included_angle.

4.2.116.1 elbow_nozzle_section_bend_radius

An elbow_nozzle_section_bend_radius specifies the inside bend radius of the Elbow_nozzle_section.

4.2.116.2 elbow_nozzle_section_included_angle

An elbow_nozzle_section_included_angle specifies the included angle for the bend of the Elbow_nozzle_-section.

4.2.117 Electrical_power_port

An Electrical_power_port is a type of Power_port (see 4.2.249) in which the power is in the form of electrical energy. Each Electrical_power_port may be one of the following: an Alternating_current_port (see 4.2.7) or a Direct_current_port (see 4.2.104).

The data associated with Electrical_power_port are the following:

- electrical_power_port_line_voltage;
- electrical_power_port_type;
- normal_current;
- peak_current;
- rated_current.

4.2.117.1 electrical_power_port_line_voltage

An electrical_power_port_line_voltage specifies the specification for the voltage of the electrical energy of an Electrical_power_port.

4.2.117.2 electrical_power_port_type

An electrical_power_port_type specifies an indication that an Electrical_power_port is either a Direct_-current_port (see 4.2.104) or an Alternating_current_port (see 4.2.7).

4.2.117.3 normal_current

A normal_current specifies the normal electrical current expected for the electrical energy of an Electrical_power_port.

4.2.117.4 peak_current

A peak_current specifies the peak electrical current expected for the electrical energy of an Electrical_-power_port.

4.2.117.5 rated_current

A rated_current specifies the manufacturer's rating for the maximum electrical current for the electrical energy of an Electrical_power_port.

4.2.118 Electrical_service

An Electrical_service is a type of Site_utility_service (see 4.2.357) available at a Site (see 4.2.354) in which the service is electricity.

The data associated with Electrical_service are the following:

— continuous_current_demand;

— current_category;

— line_voltage;

— number_of_phases;

— peak_current_demand.

4.2.118.1 continuous_current_demand

A continuous_current_demand specifies the current demand that is available on a continuous basis for the Electrical_service at the Site (see 4.2.354).

4.2.118.2 current_category

A current_category specifies an enumerated attribute that indicates whether the current of the Electrical_-service is alternating current or direct current. The value of the current_category attribute shall be one of the following:

— alternating;

— direct.

4.2.118.2.1 alternating: an indication that the current of the Electrical_service is alternating current.

4.2.118.2.2 direct: an indication that the current of the Electrical_service is direct current.

4.2.118.3 line_voltage

A line_voltage specifies the voltage of the Electrical_service available at the Site (see 4.2.354).

4.2.118.4 number_of_phases

A number_of_phases specifies the number of phases for the electricity of the Electrical_service.

4.2.118.5 peak_current_demand

A peak_current_demand specifies the peak current demand that is available for the Electrical_service at the Site (see 4.2.354).

4.2.119 Ellipsoidal_head

An Ellipsoidal_head is a type of head for the Cylindrical_pv_head_section (see 4.2.92) which has an ellipsoidal shape.

The data associated with Ellipsoidal_head are the following:

— ellipsoidal_head_inside_diameter;

— ellipsoidal_head_outside_diameter.

4.2.119.1 ellipsoidal_head_inside_diameter

An ellipsoidal_head_inside_diameter specifies the inside diameter of the Ellipsoidal_head.

4.2.119.2 ellipsoidal_head_outside_diameter

An ellipsoidal_head_outside_diameter specifies the outside diameter of the Ellipsoidal_head.

4.2.120 End_partition_plate

An End_partition_plate is a piece of plate in the front or rear heads used to partition the heads for multiple tube passes.

The data associated with End_partition_plate are the following:

- distance_from_centre;
- length;
- orientation;
- thickness;
- width.

4.2.120.1 distance_from_centre

A distance_from_centre specifies the distance from the tubesheet centreline to the End_partition_plate.

4.2.120.2 length

A length specifies the length of the End_partition_plate.

4.2.120.3 orientation

An orientation specifies whether the orientation of the End_partition_plate is horizontal, vertical, or unspecified.

4.2.120.4 thickness

A thickness specifies the thickness of the End_partition_plate.

4.2.120.5 width

A width specifies the width of the End_partition_plate.

4.2.121 Energy_port

An Energy_port is a type of Equipment_port (see 4.2.125) through which energy is intended to flow without any Material_stream (see 4.2.186). Each Energy_port may be one of the following: a Heat_port (see 4.2.156) or a Power_port (see 4.2.249).

The data associated with Energy_port are the following:

- energy_port_type;
- port_energy_category.

4.2.121.1 energy_port_type

An energy_port_type specifies that an Energy_port is either a Power_port (see 4.2.249) or a Heat_port (see 4.2.156).

4.2.121.2 port_energy_category

A port_energy_category specifies an enumerated attribute that indicates the source or destination of the energy at an Energy_port. The value of the port_energy_category attribute shall be one of the following:

- ambient;
- process;
- product;
- utility;
- waste.

4.2.121.2.1 ambient: an indication that the energy at an Energy_port is obtained from or exhausted to the surroundings.

4.2.121.2.2 process: an indication that the energy at an Energy_port is created and consumed within the Plant (see 4.2.236).

4.2.121.2.3 product: an indication that the energy at an Energy_port is considered a salable product of the Plant (see 4.2.236).

4.2.121.2.4 utility: an indication that the energy at an Energy_port is created by an external utility supply system.

4.2.121.2.5 waste: an indication that the energy at an Energy_port is a waste and will require disposal.

4.2.122 Energy_stream

An Energy_stream is a Stream (see 4.2.374) that is the flow of some sort of energy. Each Energy_stream may be one of the following: a Thermal_stream (see 4.2.383) or a Work_stream (see 4.2.499).

The data associated with Energy_stream are the following:

— energy_flow.

An energy_flow specifies the rate at which energy is carried by the Stream (see 4.2.374).

4.2.123 Equation_definition

An Equation_definition is the definition of an equation.

The data associated with Equation_definition are the following:

— equation_definition_text.

An equation_definition_text specifies a simplified textual representation of the equation.

4.2.124 Equation_group

An Equation_group is a collection of related Equation_definitions (see 4.2.123).

The data associated with Equation_group are the following:

— equation_group_name;

— equation_type.

4.2.124.1 equation_group_name

An equation_group_name specifies the name of an Equation_group.

4.2.124.2 equation_type

An equation_type specifies a category for organizing the general type of an Equation_group.

4.2.125 Equipment_port

An Equipment_port is a portion of a Plant_item (see 4.2.237) boundary through which Material (see 4.2.178), energy, or signals can flow. Each Equipment_port may be one of the following: an Energy_port (see 4.2.121), a Material_port (see 4.2.184), or a Signal_port (see 4.2.329).

The data associated with Equipment_port are the following:

- equipment_port_name;
- equipment_port_type;
- normal_flow_direction.

4.2.125.1 equipment_port_name

An equipment_port_name specifies the label or name given to the Equipment_port.

4.2.125.2 equipment_port_type

An equipment_port_type specifies that an Equipment_port is either a Material_port (see 4.2.184), an Energy_port (see 4.2.121), or a Signal_port (see 4.2.329).

4.2.125.3 normal_flow_direction

A normal_flow_direction specifies an enumerated attribute that indicates the normal direction of flow at an Equipment_port. The value of the normal_flow_direction attribute shall be one of the following:

- inlet;
- outlet;
- static.

4.2.125.3.1 inlet: an indication that the intended direction of flow is from outside of the Plant_item (see 4.2.237) boundary to inside.

4.2.125.3.2 outlet: an indication that the intended direction of flow is from inside of the Plant_item (see 4.2.237) boundary to outside.

4.2.125.3.3 static: an indication that no flow is expected at an Equipment_port.

4.2.126 Equipment_port_connection

An Equipment_port_connection is exactly two Connected_equipment_ports (see 4.2.70) of the same type that share common portions.

4.2.127 Escape_area_shape

An Escape_area_shape is that portion of the tray used for vapour escape. It is described by a Perimeter (see 4.2.216).

4.2.128 Event_sequence

An Event_sequence is a Process_definition_relationship (see 4.2.255) in which the execution of the two related Process_definitions (see 4.2.253) is correlated.

The data associated with Event_sequence are the following:

— sequence_type.

A sequence_type specifies the type of execution relationship between the Process_definitions. The value of the sequence_type attribute shall be one of the following:

— parallel;

— sequential;

— serial;

— unspecified.

4.2.128.0.1 parallel: an indication that the two Process_definitions (see 4.2.253) are executing coincidentally.

4.2.128.0.2 sequential: an indication that there is a numbered position among all peers that are related to a common parent by a set of sequential relationships.

4.2.128.0.3 serial: an indication that the two Process_definitions (see 4.2.253) are to be performed in series.

4.2.128.0.4 unspecified: an indication that the type of execution relationship of the two Process_-definitions (see 4.2.253) is not specified.

4.2.129 Excess_properties

An Excess_properties is a collection of Thermodynamic_properties (see 4.2.387) for a given Phase (see 4.2.230) in a Mixture (see 4.2.192) that are calculated with respect to a Reference_state (see 4.2.300), where the Reference_state is defined as an ideal solution at the same temperature, pressure, and composition as the Phase.

The data associated with Excess_properties are the following:

— excess_enthalpy_mass_basis;

— excess_enthalpy_mole_basis;

— excess_entropy_mass_basis;

— excess_entropy_mole_basis;

— excess_gibbs_free_energy_mass_basis;

— excess_gibbs_free_energy_mole_basis;

— excess_helmholtz_free_energy_mass_basis;

— excess_helmholtz_free_energy_mole_basis.

4.2.129.1 excess_enthalpy_mass_basis

An excess_enthalpy_mass_basis specifies the difference between the enthalpies per unit mass of the Phase (see 4.2.230) and the ideal solution Reference_state (see 4.2.300).

4.2.129.2 excess_enthalpy_mole_basis

An excess_enthalpy_mole_basis specifies the difference between the enthalpies per mole of the Phase (see 4.2.230) and the ideal solution Reference_state (see 4.2.300).

4.2.129.3 excess_entropy_mass_basis

An excess_entropy_mass_basis specifies the difference between the entropies per unit mass of the Phase (see 4.2.230) and the ideal solution Reference_state (see 4.2.300).

4.2.129.4 excess_entropy_mole_basis

An excess_entropy_mole_basis specifies the difference between the entropies per mole of the Phase (see 4.2.230) and the ideal solution Reference_state (see 4.2.300).

4.2.129.5 excess_gibbs_free_energy_mass_basis

An excess_gibbs_free_energy_mass_basis specifies the difference between the Gibbs free energies per unit mass of the Phase (see 4.2.230) and the ideal solution Reference_state (see 4.2.300).

4.2.129.6 excess_gibbs_free_energy_mole_basis

An excess_gibbs_free_energy_mole_basis specifies the difference between the Gibbs free energies per mole of the Phase (see 4.2.230) and the ideal solution Reference_state (see 4.2.300).

4.2.129.7 excess_helmholtz_free_energy_mass_basis

An excess_Helmholtz_free_energy_mass_basis specifies the difference between the Helmholtz free energy per unit mass of the Phase (see 4.2.230) and the ideal solution Reference_state (see 4.2.300).

4.2.129.8 excess_helmholtz_free_energy_mole_basis

An excess_Helmholtz_free_energy_mole_basis specifies the difference between the Helmholtz free energies per mole of the Phase (see 4.2.230) and the ideal solution Reference_state (see 4.2.300).

4.2.130 Exchanger_assembly

An Exchanger_assembly is the combination of one Exchanger_bundle (see 4.2.131), one Exchanger_shell (see 4.2.136), zero or one Reboiler_piping (see 4.2.295), zero, one, or many Exchanger_ends (see 4.2.133), and zero, one, or many Exchanger_nozzles (see 4.2.134) into a unit to be used in a Shell_and_tube_heat_exchanger_unit (see 4.2.326).

The data associated with Exchanger_assembly are the following:

— dry_weight;

— wet_weight.

4.2.130.1 dry_weight

A dry_weight specifies the weight of the Exchanger_assembly when empty.

4.2.130.2 wet_weight

A wet_weight specifies the weight of the Exchanger_assembly when filled with water.

4.2.131 Exchanger_bundle

An Exchanger_bundle is the tube bundle of the heat exchanger which consists of tubes, baffles, supports, tie rods, and spacers.

The data associated with Exchanger_bundle are the following:

— baffle_inlet_spacing;

— baffle_outlet_spacing;

— baffle_to_shell_clearance;

— bundle_to_shell_clearance;

— bundle_weight;

— effective_area_in_ubends;

— floating_head_support_type;

— kettle_tuberows_removed_at_bottom;

— kettle_tuberows_removed_at_top;

— nominal_baffle_spacing;

— number_inlet_intermediate_supports;

— number_midspace_intermediate_supports;

— number_of_cross_baffles;

— number_of_seal_strip_pairs;

— number_of_tube_passes_shell;

— number_of_tubes_in_window;

— number_outlet_intermediate_supports;

— outer_tube_limit;

— percent_baffle_overlap;

— total_number_of_tubes;

— tube_to_baffle_clearance;

— tubes_in_windows.

4.2.131.1 baffle_inlet_spacing

A baffle_inlet_spacing specifies the distance between the tubesheet (or support plate) and the first baffle at the point where the shell side flow enters the heat exchanger.

4.2.131.2 baffle_outlet_spacing

A baffle_outlet_spacing specifies the distance the tubesheet (or support plate) and the last baffle at the point where the shell side flow exits the heat exchanger.

4.2.131.3 baffle_to_shell_clearance

A baffle_to_shell_clearance specifies the diametric distance between the baffle outside diameter and the shell inside diameter.

4.2.131.4 bundle_to_shell_clearance

A bundle_to_shell_clearance specifies the diametric distance between the outer tube limit and shell inside diameter.

4.2.131.5 bundle_weight

A bundle_weight specifies the weight of the heat exchanger bundle.

4.2.131.6 effective_area_in_ubends

An effective_area_in_ubends specifies the effective heat transfer surface area in the u-bends used for heat transfer.

4.2.131.7 floating_head_support_type

A floating_head_support_type specifies an enumerated attribute for the type of floating head support for the bundle of a heat exchanger with an S or T-type rear head. The value of the floating_head_support_type attribute shall be one of the following:

— full_support_plate;

— none;

— support_with_opening;

— two_supports_with_vertical_cut_windows;

— unspecified.

4.2.131.7.1 full_support_plate: an indication that the floating head support is a full plate.

4.2.131.7.2 none: an indication that there is no floating head support.

4.2.131.7.3 support_with_opening: an indication that the support plates have a section cut from the support baffle.

4.2.131.7.4 two_supports_with_vertical_cut_windows: an indication that the support plates are constructed from two vertical-cut baffles with windows.

4.2.131.7.5 unspecified: an indication that the type of floating head support is not specified.

4.2.131.8 kettle_tuberows_removed_at_bottom

A kettle_tuberows_removed_at_bottom specifies the number of tube rows removed at the bottom of a full tube layout bundle in a kettle.

4.2.131.9 kettle_tuberows_removed_at_top

A kettle_tuberows_removed_at_top specifies the number of tube rows removed at the top of a full tube layout bundle in a kettle.

4.2.131.10 nominal_baffle_spacing

A nominal_baffle_spacing specifies the distance from the centre of one baffle to the centre of the next baffle.

4.2.131.11 number_inlet_intermediate_supports

A number_inlet_intermediate_supports specifies the number of intermediate supports for the bundle located between the tubesheet and the first baffle at the shell side inlet of the heat exchanger.

4.2.131.12 number_midspace_intermediate_supports

A number_midspace_intermediate_supports specifies the number of intermediate supports for the bundle between baffles of the heat exchanger.

4.2.131.13 number_of_cross_baffles

A number_of_cross_baffles specifies the number of Cross_baffles (see 4.2.85) in the heat exchanger.

4.2.131.14 number_of_seal_strip_pairs

A number_of_seal_strip_pairs specifies the number of seal strip pairs in the heat exchanger. A pair consists of two sealing strips, one on each side of the bundle.

4.2.131.15 number_of_tube_passes_shell

A number_of_tube_passes_shell specifies the number of times the tube side flow travels the length of the exchanger for a single shell and tube heat exchanger.

4.2.131.16 number_of_tubes_in_window

A number_of_tubes_in_window specifies the number of tubes in the baffle window of the heat exchanger.

NOTE - The baffle window is the open area of a single segmented baffle.

4.2.131.17 number_outlet_intermediate_supports

A number_outlet_intermediate_supports specifies the number of intermediate supports for the bundle located between the tubesheet and the last baffle at the shell side outlet of the heat exchanger.

4.2.131.18 outer_tube_limit

An outer_tube_limit specifies the diameter of a circle beyond which no tubes can be placed in the tubesheet.

4.2.131.19 percent_baffle_overlap

A percent_baffle_overlap specifies the percent of adjacent baffle overlap based on the shell inside diameter.

4.2.131.20 total_number_of_tubes

A total_number_of_tubes specifies the total number of tubes in the heat exchanger. For U-tube bundles, the total number of tubes would be the number of tube holes in the tubesheet.

4.2.131.21 tube_to_baffle_clearance

A tube_to_baffle_clearance specifies the diametric distance between the hole in the baffle for the tube and the tube outside diameter.

4.2.131.22 tubes_in_windows

A tubes_in_windows specifies whether tubes in the baffle window (open area) of a baffle for a heat exchanger are present, not present, or are not specified.

4.2.132 Exchanger_design_criteria

An Exchanger_design_criteria is the design criteria for the heat exchanger.

The data associated with Exchanger_design_criteria are the following:

- code_requirement;
- condensation_option;
- condensing_correlation;
- dimensional_standard;
- dry_wall_desuperheating;
- fraction_entrainment;
- hot_fluid_allocation;
- material_standard;
- maximum_heat_flux;
- maximum_shells_in_parallel;
- maximum_shells_in_series;
- minimum_excess_surface;
- minimum_lmtd_correction_factor;
- minimum_shells_in_parallel;
- minimum_shells_in_series;
- minimum_temperature_approach;
- mode_of_operation;

— nucleate_boiling;

— service_class;

— tema_class;

— vapourization_option.

4.2.132.1 code_requirement

A code_requirement specifies an enumerated attribute giving the code requirement of a heat exchanger design as AD Merkblätter (German), ASME (American Society of Mechanical Engineers), CODAP (Comprehensive Occupational Data Analysis Programs), other, or unspecified.

4.2.132.2 condensation_option

A condensation_option specifies an enumerated attribute indicating the type of condensation option as normal, knockback reflux, or unspecified.

4.2.132.3 condensing_correlation

A condensing_correlation specifies an enumerated attribute giving the type of condensing correlation as a mass transfer film model, modified proration model, or not specified.

4.2.132.4 dimensional_standard

A dimensional_standard specifies an enumerated attribute giving the type of dimensional standards as ANSI (American National Standards Institute), DIN (German Institute for Standardization), ISO, other, or unspecified.

4.2.132.5 dry_wall_desuperheating

A dry_wall_desuperheating specifies an indication of whether dry wall desuperheating is present, not present, or not specified.

4.2.132.6 fraction_entrainment

A fraction_entrainment specifies the weight fraction of entrained liquid allowed.

4.2.132.7 hot_fluid_allocation

A hot_fluid_allocation specifies an enumerated attribute that indicates the location of hot fluid. The value of the hot_fluid_allocation attribute shall be one of the following:

— shell;

— tube;

— unspecified.

4.2.132.7.1 **shell:** an indication that the hot fluid is in the shell side of the heat exchanger.

4.2.132.7.2 **tube:** an indication that the hot fluid is in the tube side of the heat exchanger.

4.2.132.7.3 **unspecified:** an indication that the hot fluid location is not specified.

4.2.132.8 material_standard

A material_standard specifies an enumerated attribute giving the type of material standards as AFNOR (French Association of Standardization), ASTM, DIN, other, or unspecified.

4.2.132.9 maximum_heat_flux

A maximum_heat_flux specifies the allowed maximum heat flux in the associated heat exchanger design.

4.2.132.10 maximum_shells_in_parallel

A maximum_shells_in_parallel specifies the maximum shells in parallel in the heat exchanger design.

4.2.132.11 maximum_shells_in_series

A maximum_shells_in_series specifies the maximum shells in series in the heat exchanger design.

4.2.132.12 minimum_excess_surface

A minimum_excess_surface specifies the minimum excess surface area allowed in the associated heat exchanger design.

4.2.132.13 minimum_lmtd_correction_factor

A minimum_lmtd_correction_factor specifies the minimum log mean temperature difference (LMTD) correction factor allowed in the associated heat exchanger design.

4.2.132.14 minimum_shells_in_parallel

A minimum_shells_in_parallel specifies the minimum shells in parallel in the heat exchanger design.

4.2.132.15 minimum_shells_in_series

A minimum_shells_in_series specifies the minimum shells in series in the heat exchanger design.

4.2.132.16 minimum_temperature_approach

A minimum_temperature_approach specifies the minimum temperature approach allowed in the associated heat exchanger design.

4.2.132.17 mode_of_operation

A mode_of_operation specifies an enumerated attribute indicating the mode of operation as design, rating, simulation, or unspecified.

4.2.132.18 nucleate_boiling

A nucleate_boiling specifies an indication of whether nucleate boiling is present, not present, or not specified.

4.2.132.19 service_class

A service_class specifies an enumerated attribute giving the type of service class as lethal, low temperature, normal, or unspecified.

4.2.132.20 tema_class

A tema_class specifies an enumerated attribute indicating the classification assigned to a particular type of heat exchangers by the Tubular Exchanger Manufacturer's Association (TEMA). The value of the tema_class attribute shall be one of the following:

— B;

— C;

— code_only;

— R;

— unspecified.

4.2.132.20.1 B: an indication that the heat exchanger is designed for chemical service.

4.2.132.20.2 C: an indication that the heat exchanger is designed for general service.

4.2.132.20.3 code_only: an indication that the heat exchanger is designed to a private code standard.

4.2.132.20.4 R: an indication that the heat exchanger is designed for refinery service.

4.2.132.20.5 unspecified: an indication that the heat exchanger service design is not specified.

4.2.132.21 vapourization_option

A vapourization_option specifies an enumerated attribute indicating the type of vaporization option as falling film, forced circulation, pool boiling, thermosiphon, or unspecified.

4.2.133 Exchanger_end

An Exchanger_end is the head and cover for one end of a heat exchanger.

The data associated with Exchanger_end are the following:

— body_flange_type;

— head_cover_inside_diameter;

— head_cover_outside_diameter;

— head_cover_thickness;

— head_cover_type;

— head_cylinder_inside_diameter;

— head_cylinder_outside_diameter;

— head_cylinder_thickness;

— head_type;

— location.

4.2.133.1 body_flange_type

A body_flange_type specifies an enumerated attribute giving the type of body flange on the heat exchanger end as integral straight hub, integral tapered hub, lap joint, none, ring, or unspecified.

4.2.133.2 head_cover_inside_diameter

A head_cover_inside_diameter specifies the inside diameter of the head cover.

4.2.133.3 head_cover_outside_diameter

A head_cover_outside_diameter specifies the outside diameter of the head cover.

4.2.133.4 head_cover_thickness

A head_cover_thickness specifies the thickness of the head cover.

4.2.133.5 head_cover_type

A head_cover_type specifies an enumerated attribute giving the type of head cover on the heat exchanger end as cone, dished, elbow, ellipsoidal, flat bolted, flat welded, hemispherical, torispherical, or unspecified.

4.2.133.6 head_cylinder_inside_diameter

A head_cylinder_inside_diameter specifies the inside diameter of the head cylinder.

4.2.133.7 head_cylinder_outside_diameter

A head_cylinder_outside_diameter specifies the outside diameter of the head cylinder.

4.2.133.8 head_cylinder_thickness

A head_cylinder_thickness specifies the thickness of the head cylinder.

4.2.133.9 head_type

A head_type specifies an enumerated attribute giving the type of head on the end of the heat exchanger. The value of the head_type attribute shall be one of the following:

— A;

— B;

— C;

— D;

— L;

— M;

— N;

— P;

— R;

— S;

— T;

— U;

— unspecified;

— W.

4.2.133.9.1 **A:** an indication that the head_type is a channel and removable cover.

4.2.133.9.2 **B:** an indication that the head_type is a bonnet bolted or integral with the tubesheet.

4.2.133.9.3 **C:** an indication that the head_type is a channel integral with the tubesheet and removable bundle.

4.2.133.9.4 **D:** an indication that the head_type is a high pressure enclosure.

4.2.133.9.5 **L:** an indication that the head_type is a fixed tubesheet with a removable channel and flat cover.

4.2.133.9.6 **M:** an indication that the head_type is a fixed tubesheet with a removable or integral bonnet.

4.2.133.9.7 **N:** an indication that the head_type is a channel integral with a tubesheet and non-removable bundle.

4.2.133.9.8 **P:** an indication that the head_type is an outside packed floating head.

4.2.133.9.9 **R:** an indication that the head_type is a fixed tubesheet with an integral channel and removable flat cover.

4.2.133.9.10 **S:** an indication that the head_type is a floating head with a backing device.

4.2.133.9.11 **T:** an indication that the head_type is a pull-through floating head.

4.2.133.9.12 **U:** an indication that the head_type is a U-tube bundle.

4.2.133.9.13 unspecified: an indication that the head_type is not specified.

4.2.133.9.14 W: an indication that the head_type is an externally sealed floating tubesheet.

4.2.133.10 location

A location specifies an enumerated attribute giving the location of the heat exchanger end as the front of heat exchanger, rear of heat exchanger, or unspecified.

4.2.134 Exchanger_nozzle

An Exchanger_nozzle is a physical opening for fluid to enter or exit the heat exchanger.

The data associated with Exchanger_nozzle are the following:

— angle;

— axial_location;

— distance_from_tubesheet;

— distribution_type;

— entrance_type;

— exchanger_side;

— flange_design;

— flange_facing;

— flange_rating;

— flange_type;

— function;

— height_under_nozzle;

— inside_diameter;

— nominal_diameter;

— outside_diameter.

4.2.134.1 angle

An angle specifies the orientation angle of the nozzle in clockwise.

4.2.134.2 axial_location

An axial_location specifies the axial location for the nozzle along the length of the heat exchanger.

4.2.134.3 distance_from_tubesheet

A distance_from_tubesheet specifies the distance from the centreline of the nozzle to the front face of the front tubesheet.

4.2.134.4 distribution_type

A distribution_type specifies an enumerated attribute giving the distribution type of each nozzle in a heat exchanger as distributor, impingement, none, plain, sparge, or unspecified.

4.2.134.5 entrance_type

An entrance_type specifies an enumerated attribute giving the type of entrance of each nozzle as axial, elbow, radial, tangential, or unspecified.

4.2.134.6 exchanger_side

An exchanger_side specifies an enumerated attribute giving the heat exchanger side of each nozzle as shell, tube, or unspecified.

4.2.134.7 flange_design

A flange_design specifies an enumerated attribute that indicates the type of flange design for each Exchanger_nozzle as either ANSI, DIN, ISO, optimized design, or unspecified.

4.2.134.8 flange_facing

A flange_facing specifies an enumerated attribute giving the type of flange facing for each nozzle as flat face, raised face, tongue and groove, or unspecified.

4.2.134.9 flange_rating

A flange_rating specifies the nozzle flange rating.

4.2.134.10 flange_type

A flange_type specifies an enumerated attribute giving the type of flange for each nozzle as lap weld, long weld neck, self-reinforce neck, slip-on, unspecified, or weld neck.

4.2.134.11 function

A function specifies an enumerated attribute giving the function of each nozzle as drain (no flow), inlet, inspection port, liquid inlet, manhole, outlet, safety valve, sparge, unspecified, vapour outlet, or vent (no flow).

4.2.134.12 height_under_nozzle

A height_under_nozzle specifies the distance between the shell inside diameters and the edge of the first tube row beneath the nozzle.

4.2.134.13 inside_diameter

An inside_diameter specifies the inside diameter of the nozzle.

4.2.134.14 nominal_diameter

A nominal_diameter specifies the nominal diameter of the nozzle.

4.2.134.15 outside_diameter

An outside_diameter specifies the outside diameter of the nozzle.

4.2.135 Exchanger_performance

An Exchanger_performance is the overall thermal performance of the heat exchanger.

The data associated with Exchanger_performance are the following:

— effective_area;

— effective_temperature_difference;

— heat_duty;

— lmtd_correction_factor;

— overall_heat_transfer_coefficient;

— total_area.

4.2.135.1 effective_area

An effective_area specifies the effective surface area of the heat exchanger.

4.2.135.2 effective_temperature_difference

An effective_temperature_difference specifies the effective temperature difference of the heat exchanger.

4.2.135.3 heat_duty

A heat_duty specifies the total heat duty of the heat exchanger.

4.2.135.4 lmtd_correction_factor

A lmtd_correction_factor specifies the correction factor for the log mean temperature difference of the heat exchanger.

4.2.135.5 overall_heat_transfer_coefficient

An overall_heat_transfer_coefficient specifies the overall rate at which heat is transferred from the hot fluid on one side of the heat exchanger to the cold fluid on the other side.

4.2.135.6 total_area

A total_area specifies the total surface area of the heat exchanger.

4.2.136 Exchanger_shell

An Exchanger_shell is the shell of a shell-and-tube heat exchanger.

The data associated with Exchanger_shell are the following:

— body_flange_type;

— entrance_construction;

— exit_construction;

— inside_diameter;

— kettle_inside_diameter;

- kettle_outside_diameter;
- kettle_thickness;
- kettle_type;
- number_shell_passes;
- outside_diameter;
- shell_cover_type;
- tema_shell_type;
- thickness.

4.2.136.1 body_flange_type

A body_flange_type specifies an enumerated attribute giving the type of body flange on the shell. The value of the body_flange_type attribute shall be one of the following:

- integral_straight_hub;
- integral_tapered_hub;
- lap_joint;
- none;
- ring.

4.2.136.1.1 integral_straight_hub: an indication that the body_flange_type is a flange with a straight hub that is butt-welded to a cylinder or head.

4.2.136.1.2 integral_tapered_hub: an indication that the body_flange_type is a flange with a sloping hub which is butt-welded to a cylinder or head.

4.2.136.1.3 lap_joint: an indication that the body_flange_type is a loose flange normally made of carbon steel which is placed behind a lap joint ring made of alloy material which is integral with the cylinder.

4.2.136.1.4 none: an indication that there is no shell side body flange.

4.2.136.1.5 ring: an indication that the body_flange_type is a ring flange which is welded to a cylinder or head.

4.2.136.2 entrance_construction

An entrance_construction specifies the construction layout at the entrance of the shell as distributor belt with full tube layout, full tube layout, nozzle dome with full tube layout, remove enough tubes to meet TEMA requirement of maximum fluid density times fluid velocity squared, remove tubes so that the entrance area equals the inlet nozzle area, remove tubes within the nozzle projection, unspecified, or user defined.

4.2.136.3 exit_construction

An exit_construction specifies the construction layout at the exit of the shell as distributor belt with full tube layout, full tube layout, nozzle dome with full tube layout, remove enough tubes to meet TEMA requirement of maximum fluid density times fluid velocity squared, remove tubes so that the exit area equals the outlet nozzle area, remove tubes within the nozzle projection, unspecified, or user defined.

4.2.136.4 inside_diameter

An inside_diameter specifies the inside diameter of the shell of the heat exchanger.

4.2.136.5 kettle_inside_diameter

A kettle_inside_diameter specifies the inside diameter of the kettle cylinder.

4.2.136.6 kettle_outside_diameter

A kettle_outside_diameter specifies the outside diameter of the kettle cylinder.

4.2.136.7 kettle_thickness

A kettle_thickness specifies the thickness of the kettle cylinder.

4.2.136.8 kettle_type

A kettle_type specifies an enumerated attribute that indicates the type of kettle shell as an enlarged shell with eccentric reducer(s), an enlarged shell with formed head(s), or unspecified.

4.2.136.9 number_shell_passes

A number_shell_passes specifies the number of times the shell side flow travels all or part of the shell in the longitudinal direction.

NOTE - The G-type shell has 2 passes; the H-type shell has 4 passes.

4.2.136.10 outside_diameter

An outside_diameter specifies the outside diameter of the shell of the heat exchanger.

4.2.136.11 shell_cover_type

A shell_cover_type specifies an enumerated attribute that gives the type of cover attached to the rear of the shell when there is no rear tubesheet or when the rear tubesheet does not provide containment of the shell side fluid as ellipsoidal, flat bolted, flat welded, torispherical, or unspecified.

4.2.136.12 tema_shell_type

A tema_shell_type specifies the designation given to a shell configuration according to TEMA (with additions). The value of the tema_shell_type attribute shall be one of the following:

— E;

— F;

— G;

— H;

— I;

— J;

— K;

— none;

— unspecified;

— V;

— X.

4.2.136.12.1 E: an indication that the tema_shell_type is a one shell pass (see item 2 in Figure 4).

4.2.136.12.2 F: an indication that the tema_shell_type is a two passes with long baffle (see item 3 in Figure 4).

4.2.136.12.3 G: an indication that the tema_shell_type is a split flow (see item 4 in Figure 4).

4.2.136.12.4 H: an indication that the tema_shell_type is a double split flow (see item 5 in Figure 4).

4.2.136.12.5 I: an indication that the tema_shell_type is a combining divided flow (see item 6 in Figure 4).

4.2.136.12.6 J: an indication that the tema_shell_type is a dividing divided flow (see item 7 in Figure 4).

4.2.136.12.7 K: an indication that the tema_shell_type is a kettle (see item 8 in Figure 4).

4.2.136.12.8 none: an indication that there is no tema_shell_type.

4.2.136.12.9 unspecified: an indication that the tema_shell_type is not specified.

4.2.136.12.10 V: an indication that the tema_shell_type is a vapour belt (see item 10 in Figure 4).

4.2.136.12.11 X: an indication that the tema_shell_type is a cross flow (see item 9 in Figure 4).

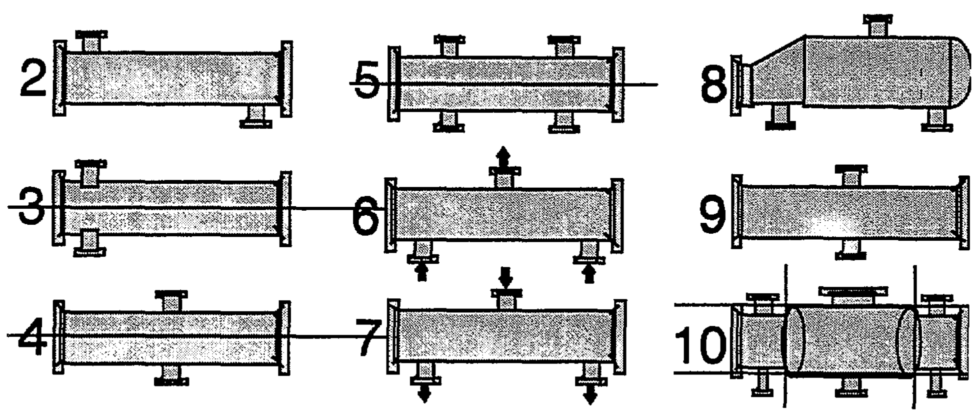


Figure 4 - TEMA Shell Type

4.2.136.13 thickness

A thickness specifies the thickness of the shell of the heat exchanger.

4.2.137 Exchanger_shell_side_fluid_velocity

An Exchanger_shell_side_fluid_velocity is the velocity associated with the midpoint of the shell side of a heat exchanger.

4.2.138 Exchanger_zone

An Exchanger_zone is an arbitrary section of a heat exchanger. Zones may be associated either with the shell side or the tube side of the heat exchanger.

The data associated with Exchanger_zone are the following:

- cold_bulk_film_coefficient;
- cold_bulk_temperature;
- cold_clean_pressure_drop;
- cold_controlling_regime;
- cold_dirty_pressure_drop;
- cold_effective_vapour_coefficient;
- cold_flow_regime_parameter;
- cold_liquid_prandtl_number;
- cold_liquid_reynolds_number;
- cold_pressure;
- cold_sensible_liquid_coefficient;
- cold_sensible_vapour_coefficient;
- cold_vapour_phase_resistance;
- cold_vapour_prandtl_number;
- cold_vapour_reynolds_number;
- cold_vapour_weight_fraction;
- cold_wall_temperature;
- condensate_film_coefficient;
- convective_boiling_coefficient;
- desc;
- effective_area;
- film_boiling_coefficient;

— heat_duty;

— hot_bulk_film_coefficient;

— hot_bulk_temperature;

— hot_clean_pressure_drop;

— hot_controlling_regime;

— hot_dirty_pressure_drop;

— hot_effective_vapour_coefficient;

— hot_flow_regime_parameter;

— hot_liquid_prandtl_number;

— hot_liquid_reynolds_number;

— hot_pressure;

— hot_sensible_liquid_coefficient;

— hot_sensible_vapour_coefficient;

— hot_vapour_phase_resistance;

— hot_vapour_prandtl_number;

— hot_vapour_reynolds_number;

— hot_vapour_weight_fraction;

— hot_wall_temperature;

— local_heat_flux;

— local_overall_heat_transfer_coeff;

— mean_temperature_difference;

— nucleate_boiling_coefficient;

— shellside_flow_fraction_a;

— shellside_flow_fraction_b;

— shellside_flow_fraction_c;

— shellside_flow_fraction_e;

— shellside_window_velocity;

— shellside_crossflow_velocity;

— tubeside_velocity;

— x_coordinate;

— y_coordinate;

— z_coordinate.

4.2.138.1 cold_bulk_film_coefficient

A cold_bulk_film_coefficient specifies the Heat_transfer_coefficient (see 4.2.159) of the bulk fluid in the cold side of the Exchanger_zone.

4.2.138.2 cold_bulk_temperature

A cold_bulk_temperature specifies the temperature of the cold side bulk fluid on the cold side in the Exchanger_zone.

4.2.138.3 cold_clean_pressure_drop

A cold_clean_pressure_drop specifies the pressure drop in the cold side of the Exchanger_zone when it is clean.

4.2.138.4 cold_controlling_regime

A cold_controlling_regime specifies the flow regime category for a given Exchanger_zone.

4.2.138.5 cold_dirty_pressure_drop

A cold_dirty_pressure_drop specifies the pressure drop in the cold side of the Exchanger_zone when it is dirty.

4.2.138.6 cold_effective_vapour_coefficient

A cold_effective_vapour_coefficient specifies the effective vapour coefficient on the cold side of the associated Exchanger_zone.

4.2.138.7 cold_flow_regime_parameter

A cold_flow_regime_parameter specifies a parameter associated with the flow regime in the cold Exchanger_zone.

4.2.138.8 cold_liquid_prandtl_number

A cold_liquid_prandtl_number specifies the Prandtl number for the cold Exchanger_zone. The Prandtl number is the ratio of the kinematic viscosity of the fluid to its thermal diffusivity.

4.2.138.9 cold_liquid_reynolds_number

A cold_liquid_reynolds_number specifies the Reynolds number for the cold Exchanger_zone. The Reynolds number is any number of dimensionless quantities which are proportional to the ratio of the inertial force to viscous force in a flow system.

4.2.138.10 cold_pressure

A cold_pressure specifies the pressure in the cold side of the Exchanger_zone.

4.2.138.11 cold_sensible_liquid_coefficient

A cold_sensible_liquid_coefficient specifies the sensible liquid coefficient in the cold side of the Exchanger_zone.

4.2.138.12 cold_sensible_vapour_coefficient

A cold_sensible_vapour_coefficient specifies the sensible vapour coefficient in the cold side of the Exchanger_zone.

4.2.138.13 cold_vapour_phase_resistance

A cold_vapour_phase_resistance specifies the vapour phase resistance on the cold side of the associated Exchanger_zone.

4.2.138.14 cold_vapour_prandtl_number

A cold_vapour_prandtl_number specifies the Prandtl number of the vapour on the cold side in the Exchanger_zone.

4.2.138.15 cold_vapour_reynolds_number

A cold_vapour_reynolds_number specifies the Reynolds number of the vapour on the cold side in the Exchanger_zone.

4.2.138.16 cold_vapour_weight_fraction

A cold_vapour_weight_fraction specifies the vapour weight fraction in the cold side of the Exchanger_-zone.

4.2.138.17 cold_wall_temperature

A cold_wall_temperature specifies the temperature on the cold side in the Exchanger_zone.

4.2.138.18 condensate_film_coefficient

A condensate_film_coefficient specifies the Heat_transfer_coefficient (see 4.2.159) for the condensate films in the associated Exchanger_zone.

4.2.138.19 convective_boiling_coefficient

A convective_boiling_coefficient specifies the convective boiling coefficient in the associated heat Exchanger_zone.

4.2.138.20 desc

A desc specifies a description of the Exchanger_zone.

4.2.138.21 effective_area

An effective_area specifies the effective area of the associated Exchanger_zone.

4.2.138.22 film_boiling_coefficient

A film_boiling_coefficient specifies the film boiling coefficient in the associated heat Exchanger_zone.

4.2.138.23 heat_duty

A heat_duty specifies the heat duty associated with the Exchanger_zone.

4.2.138.24 hot_bulk_film_coefficient

A hot_bulk_film_coefficient specifies the film coefficient of the bulk fluid on the hot side in the Exchanger_zone.

4.2.138.25 hot_bulk_temperature

A hot_bulk_temperature specifies the temperature of the hot side bulk fluid in the hot side of the Exchanger_zone.

4.2.138.26 hot_clean_pressure_drop

A hot_clean_pressure_drop specifies the pressure drop on the hot side in the Exchanger_zone when it is clean.

4.2.138.27 hot_controlling_regime

A hot_controlling_regime specifies the flow regime category for a given Exchanger_zone.

4.2.138.28 hot_dirty_pressure_drop

A hot_dirty_pressure_drop specifies the pressure drop on the hot side in the Exchanger_zone when it is dirty.

4.2.138.29 hot_effective_vapour_coefficient

A hot_effective_vapour_coefficient specifies the effective vapour coefficient on the hot side of the associated Exchanger_zone.

4.2.138.30 hot_flow_regime_parameter

A hot_flow_regime_parameter specifies a parameter associated with the flow regime in the hot Exchanger_zone.

4.2.138.31 hot_liquid_prandtl_number

A hot_liquid_prandtl_number specifies the Prandtl number of the liquid on the hot side in the Exchanger_-zone. The Prandtl number is the ratio of the kinematic viscosity of the fluid to its thermal diffusivity.

4.2.138.32 hot_liquid_reynolds_number

A hot_liquid_reynolds_number specifies the Reynolds number of the liquid on the hot side in the Exchanger_zone. The Reynolds number is any number of dimensionless quantities which are proportional to the ratio of the inertial force to viscous force in a flow system.

4.2.138.33 hot_pressure

A hot_pressure specifies the pressure on the hot side in the Exchanger_zone.

4.2.138.34 hot_sensible_liquid_coefficient

A hot_sensible_liquid_coefficient specifies the sensible liquid coefficient on the hot side in the Exchanger_zone.

4.2.138.35 hot_sensible_vapour_coefficient

A hot_sensible_vapour_coefficient specifies the sensible vapor coefficient on the hot side in the Exchanger_zone.

4.2.138.36 hot_vapour_phase_resistance

A hot_vapour_phase_resistance specifies the vapour phase resistance for the hot side of the associated Exchanger_zone.

4.2.138.37 hot_vapour_prandtl_number

A hot_vapour_prandtl_number specifies the Prandtl number of the vapour on the hot side in the Exchanger_zone.

4.2.138.38 hot_vapour_reynolds_number

A hot_vapour_reynolds_number specifies the Reynolds number of the vapour on the hot side in the Exchanger_zone.

4.2.138.39 hot_vapour_weight_fraction

A hot_vapour_weight_fraction specifies the vapour weight fraction on the hot side in the Exchanger_zone.

4.2.138.40 hot_wall_temperature

A hot_wall_temperature specifies the tube wall temperature on the hot side in the Exchanger_zone.

4.2.138.41 local_heat_flux

A local_heat_flux specifies the local heat flux in the associated Exchanger_zone.

4.2.138.42 local_overall_heat_transfer_coeff

A local_overall_heat_transfer_coeff specifies the overall Heat_transfer_coefficient (see 4.2.159) in the associated Exchanger_zone.

4.2.138.43 mean_temperature_difference

A mean_temperature_difference specifies the mean temperature difference across the associated Exchanger_zone.

4.2.138.44 nucleate_boiling_coefficient

A nucleate_boiling_coefficient specifies the nucleate boiling coefficient in the associated heat Exchanger_-zone.

4.2.138.45 shellside_flow_fraction_a

A shellside_flow_fraction_a specifies the fractional flow through clearance between the baffle hole and tube outside diameter.

4.2.138.46 shellside_flow_fraction_b

A shellside_flow_fraction_b specifies the fractional flow across the bundle.

4.2.138.47 shellside_flow_fraction_c

A shellside_flow_fraction_c specifies the fractional flow through clearance between the shell inside diameter and bundle outer tube limit.

4.2.138.48 shellside_flow_fraction_e

A shellside_flow_fraction_e specifies the fraction flow through clearance between the shell inside diameter and baffle outside diameter.

4.2.138.49 shellside_window_velocity

A shellside_window_velocity specifies the velocity through the baffle window on shell side in the Exchanger_zone.

4.2.138.50 shellside_crossflow_velocity

A shellside_crossflow_velocity specifies the velocity of shell side crossflow in an Exchanger_zone.

4.2.138.51 tubeside_velocity

A tubeside_velocity specifies the velocity of tubeside flow in an Exchanger_zone.

4.2.138.52 x_coordinate

A x_coordinate specifies the x direction coordinate of a central point within a physical Exchanger_zone measured off the vertical centreline of the front tubesheet.

4.2.138.53 y_coordinate

A y_coordinate specifies the y direction coordinate of a central point within a physical Exchanger_zone measured off the horizontal centreline of the front tubesheet.

4.2.138.54 z_coordinate

A z_coordinate specifies the z direction coordinate of a central point within a physical Exchanger_zone measured from the outer face of the front tubesheet.

4.2.139 Expansion_joint

An Expansion_joint is a cylindrical device located in the shell cylinder for fixed tubesheet exchangers. It is designed to relieve the stress caused by the difference in expansion or contraction of the tube and shell materials due to temperature or pressure.

The data associated with Expansion_joint are the following:

- diameter;
- length;
- location;
- type.

4.2.139.1 diameter

A diameter specifies the outside diameter of the Expansion_joint.

4.2.139.2 length

A length specifies the length of the Expansion_joint parallel to the axis of the shell.

4.2.139.3 location

A location specifies the axial location of an Expansion_joint from the face of the front tubesheet to the centreline of the Expansion_joint.

4.2.139.4 type

A type specifies enumerated attribute that gives the type of Expansion_joint as flanged and flued, flanged only, none, reinforced bellows, unreinforced bellows, or unspecified.

4.2.140 Extents_specified_chemical_reaction

An Extents_specified_chemical_reaction is an indication of the amount of reactants in a Chemical_reaction (see 4.2.57) that will react.

The data associated with Extents_specified_chemical_reaction are the following:

— amount_of_reaction_extent;

— key_component_conversion;

— reaction_temperature_offset.

4.2.140.1 amount_of_reaction_extent

An amount_of_reaction_extent specifies the extent of a reaction in the simulation, defined by the moles generated for a Chemical_component (see 4.2.56) divided by its stoichiometric coefficient.

4.2.140.2 key_component_conversion

An key_component_conversion specifies the fraction conversion of the key Chemical_component (see 4.2.56) in a reactor.

4.2.140.3 reaction_temperature_offset

An reaction_temperature_offset specifies the reaction temperature offset related attribute of the Amount_-of_reaction, associated with the Uo_reactor (see 4.2.462) objects in the simulation.

4.2.141 External_circuit_component

An External_circuit_component is all inlet and outlet piping pertaining to a thermosiphon reboiler system.

The data associated with External_circuit_component are the following:

- bend_angle;
- bend_radius;
- circuit_location;
- circuit_position;
- component_code;
- component_height;
- component_inside_diameter;
- component_length;
- contraction_coefficient;
- extra_equivalent_length;
- head_flowrate;
- head_gained;
- orifice_downstream_diameter;
- piping_design_area_ratio;
- surface_roughness.

4.2.141.1 bend_angle

A bend_angle specifies the angle of the piping bend.

4.2.141.2 bend_radius

A bend_radius specifies the radius of the piping bend.

4.2.141.3 circuit_location

A circuit_location specifies an enumerated attribute identifying the circuit as inlet or outlet piping or unspecified.

4.2.141.4 circuit_position

A circuit_position specifies the order of the component within the external circuit.

4.2.141.5 component_code

A component_code specifies an enumerated attribute identifying the type of component as straight pipe (i.e main pipe), bend, sudden enlargement, sudden contraction, globe valve, gate valve, thin orifice, thick orifice, dummy fitting, header pipe, nozzle pipe, tee (flow is assumed to divide evenly between the branches of the tee), Inside face of the bottom tubesheet (for vertical units), Inside face of the top tubesheet (for vertical units), Bottom inside surface of the shell (for horizontal units), or Top inside surface of the shell (for horizontal units).

4.2.141.6 component_height

A component_height specifies the height of the component above the reference level (of inlet to component for inlet circuit, outlet of component for outlet circuit).

4.2.141.7 component_inside_diameter

A component_inside_diameter specifies the inside diameter of the component.

4.2.141.8 component_length

A component_length specifies the longitudinal length of the component.

4.2.141.9 contraction_coefficient

A contraction_coefficient specifies the Cd value to be used in the pressure loss calculation for the component.

4.2.141.10 extra_equivalent_length

An extra_equivalent_length specifies the extra equivalent piping length specified as a number of diameters.

NOTE - This allows for additional pressure losses, such as from partly open valves.

4.2.141.11 head_flowrate

A head_flowrate specifies the flowrate.

4.2.141.12 head_gained

A head_gained specifies the head gained at the given flowrate.

4.2.141.13 orifice_downstream_diameter

An orifice_downstream_diameter specifies the diameter downstream for the orifice.

4.2.141.14 piping_design_area_ratio

A piping_design_area_ratio is different for tube and shell side thermosiphons. For tube side thermosiphons, it is the ratio of the main pipe flow area divided by the total tube flow area. For shell side thermosiphons, it is the ratio of the main pipe diameter divided by the bundle diameter.

4.2.141.15 surface_roughness

A surface_roughness specifies the surface roughness factor for the component.

4.2.142 External_treatment

An External_treatment is a collection of attributes which describe types of external treatments that a section or vessel might receive.

The data associated with External_treatment are the following:

- external_treatment_heat_tracing_required;
- external_treatment_insulation_thickness;
- external_treatment_insulation_type;
- external_treatment_jacket_required;
- external_treatment_paint_spec.

4.2.142.1 external_treatment_heat_tracing_required

An external_treatment_heat_tracing_required specifies that heat tracing is required for the vessel.

4.2.142.2 external_treatment_insulation_thickness

An external_treatment_insulation_thickness specifies the thickness of the insulation used as an External_-treatment.

4.2.142.3 external_treatment_insulation_type

An external_treatment_insulation_type specifies the type of insulation used as an External_treatment.

4.2.142.4 external_treatment_jacket_required

An external_treatment_jacket_required specifies that jacketing is required for the vessel.

4.2.142.5 external_treatment_paint_spec

An external_treatment_paint_spec specifies the specifications for a paint that is used as an External_-treatment.

4.2.143 Family

A Family is a group of structurally related Chemical_species.

The data associated with Family are the following:

— family_name.

A family_name specifies the name of a Family.

4.2.144 Female_end

A Female_end is an end type of Piping_connector (see 4.2.235). A Female_end piping connector is used in conjunction with a Male_end (see 4.2.175) piping connector to form a pipe fitting connection.

4.2.145 Flanged

A Flanged is an end engagement type of a Piping_connector (see 4.2.235) which denotes that the end engagement is a flanged connection.

4.2.146 Flanged_end

A Flanged_end is a pipe flange.

The data associated with Flanged_end are the following:

— face_finish;

— flange_nominal_rating;

— flange_piping_schedule;

— flange_type.

4.2.146.1 face_finish

A face_finish specifies an enumerated attribute that describes the type of facing for the Flange. The value of the flange_finish attribute shall be one of the following:

— flat_face;

— raised_face;

— ring;

— unspecified.

4.2.146.1.1 flat_face: an indication that the face_finish is flat faced for the Flange.

4.2.146.1.2 raised_face: an indication that the face_finish is raised_face for the Flange.

4.2.146.1.3 ring: an indication that the face_finish is ring joint for the Flange.

4.2.146.1.4 unspecified: an indication that the face_finish is unspecified.

4.2.146.2 flange_nominal_rating

A flange_nominal_rating specifies the nominal pressure rating of the Flange.

4.2.146.3 flange_piping_schedule

A flange_piping_schedule specifies the piping schedule used for the flange. The piping schedule indication indicates the inner and outer diameter dimensions of the pipe end of the flange.

4.2.146.4 flange_type

A flange_type specifies an enumerated attribute of Flange that indicates the type of Flange. The value of the flange_type attribute shall be one of the following:

— slip_on;

— threaded;

— unspecified;

— welded.

4.2.146.4.1 slip_on: an indication that the type of Flange is a slip on flange.

4.2.146.4.2 threaded: an indication that the type of Flange is threaded.

4.2.146.4.3 unspecified: an indication that the type of Flange is unspecified.

4.2.146.4.4 welded: an indication that the type of Flange is a welded on flange.

4.2.147 Flat_head

A Flat_head is a type of Cylindrical_pv_head_section (see 4.2.92) which is made of a flat plate with possible buttresses.

The data associated with Flat_head are the following:

— flat_head_diameter;

— flat_head_number_of_buttresses.

4.2.147.1 flat_head_diameter

A flat_head_diameter specifies the outer diameter of the Flat_head.

4.2.147.2 flat_heat_number_of_buttresses

A flat_head_number_of_buttresses specifies the number of buttresses for the Flat_head.

4.2.148 Flow_vibration_analysis

A Flow_vibration_analysis specifies an analysis done to determine the vibration tendency in the heat exchanger.

The data associated with Flow_vibration_analysis are the following:

— acoustic_damping_factor;

— acoustic_resonance_indicator;

— acoustic_turb_buffeting_ratio;

— acoustic_vortex_shedding_ratio;

— added_mass_factor;

— average_crossflow_velocity;

— axial_stress_loading;

— baffle_tip_cross_velocity;

— bundle_crossflow_velocity;

— bundle_shell_velocity;

— chen_number;

— critical_velocity;

— crossflow_amplitude;

— crossflow_momentum;

— instability_threshold_beta;

— length_for_natural_frequency;

— length_for_tema_max_span;

— location;

— log_decrement_for_damping;

— number_of_spans;

— parallel_flow_amplitude;

— shell_acoustic_frequency;

— tube_gap;

— tube_natural_frequency;

— tube_position;

— tube_turb_buffeting_ratio;

— tube_vortex_shedding_ratio;

— unsupported_span;

— vibration_indicator;

— window_parallel_velocity.

4.2.148.1 acoustic_damping_factor

An acoustic_damping_factor specifies the damping factor to adjust the acoustic frequency as a result of the characteristic of vapour or liquid phase.

4.2.148.2 acoustic_resonance_indicator

An acoustic_resonance_indicator specifies whether acoustic resonance of the heat exchanger is present, not present, or undetermined.

4.2.148.3 acoustic_turb_buffeting_ratio

An acoustic_turb_buffeting_ratio specifies the ratio of the shell acoustic frequency divided by the turbulent buffeting frequency.

4.2.148.4 acoustic_vortex_shedding_ratio

An acoustic_vortex_shedding_ratio specifies the ratio of the acoustic frequency divided by the vortex shedding frequency.

4.2.148.5 added_mass_factor

An added_mass_factor specifies the mass factor of the tubes which is a function of tube pattern and the ratio of tube pitch divided by the tube diameter.

4.2.148.6 average_crossflow_velocity

An average_crossflow_velocity specifies the average crossflow velocity in the heat exchanger in the heat exchanger vibration analysis.

4.2.148.7 axial_stress_loading

An axial_stress_loading specifies the axial forces which are imposed by the thermal expansion of tubes in relation to the shell.

4.2.148.8 baffle_tip_cross_velocity

A baffle_tip_cross_velocity specifies the local cross flow velocity at the baffle tips.

4.2.148.9 bundle_crossflow_velocity

A bundle_crossflow_velocity specifies the crossflow velocity through the bundle of a heat exchanger.

4.2.148.10 bundle_shell_velocity

A bundle_shell_velocity specifies the velocity in the direction parallel to the shell through the bundle.

4.2.148.11 chen_number

A chen_number specifies a factor indicating the probability of damage of the tubes.

4.2.148.12 critical_velocity

A critical_velocity specifies the velocity of fluid flow through a given heat exchanger above which fluid elastic coupling becomes unstable.

4.2.148.13 crossflow_amplitude

A crossflow_amplitude specifies the distance between maximum and minimum vibrations in the direction perpendicular to the fluid flow.

4.2.148.14 crossflow_momentum

A crossflow_momentum specifies the momentum of the flow in the crossflow direction.

4.2.148.15 instability_threshold_beta

An instability_threshold_beta specifies the beta factor for the critical velocity calculation.

4.2.148.16 length_for_natural_frequency

A length_for_natural_frequency specifies the length used to calculate the natural frequency of the tubes.

4.2.148.17 length_for_tema_max_span

A length_for_tema_max_span specifies the length of the maximum allowable span per TEMA classification type.

4.2.148.18 location

A location specifies the distance from the front tubesheet to the actual position where the vibration analysis is calculated.

4.2.148.19 log_decrement_for_damping

A log_decrement_for_damping specifies the logarithm of the difference in successive amplitude peaks.

4.2.148.20 number_of_spans

A number_of_spans specifies the number of spans in a heat exchanger.

4.2.148.21 parallel_flow_amplitude

A parallel_flow_amplitude specifies the distance between maximum and minimum vibrations in the direction parallel to the fluid flow.

4.2.148.22 shell_acoustic_frequency

A shell_acoustic_frequency specifies the natural frequency of the shell of the heat exchanger.

4.2.148.23 tube_gap

A tube_gap specifies the gap between the tubes in the bundle.

4.2.148.24 tube_natural_frequency

A tube_natural_frequency specifies the natural frequency of the tubes.

4.2.148.25 tube_position

A tube_position specifies an enumerated attribute giving the position of the tube associated with the vibration analysis of a heat exchanger as bottom row, row inside baffle overlap at bottom, row inside baffle overlap at top, top row, row outside baffle overlap, or undetermined.

4.2.148.26 tube_turb_buffeting_ratio

A tube_turb_buffeting_ratio specifies the ratio of the natural tube frequency divided by the turbulent buffeting frequency.

4.2.148.27 tube_vortex_shedding_ratio

A tube_vortex_shedding_ratio specifies the ratio of the natural tube frequency divided by the vortex shedding frequency.

4.2.148.28 unsupported_span

An unsupported_span specifies the length of the unsupported span.

4.2.148.29 vibration_indicator

A vibration_indicator specifies whether vibration of the heat exchanger is present, not present, or undetermined.

4.2.148.30 window_parallel_velocity

A window_parallel_velocity specifies the velocity parallel to the fluid flow in the windows of a heat exchanger.

4.2.149 Fluid_transfer_machine

A Fluid_transfer_machine is a machine for moving a fluid, gas, liquid or both, from one place to another, generally making the transfer possible by merely raising the pressure of the process Stream (see 4.2.374). Each Fluid_transfer_machine may be one of the following: a Centrifugal_pump (see 4.2.55) or a Gas_-transfer_machine (see 4.2.152).

The data associated with Fluid_transfer_machine are the following:

— fluid_transfer_machine_type.

A fluid_transfer_machine_type specifies the type of Fluid_transfer_machine.

4.2.150 Functional_volume

A Functional_volume is an internal portion of a Plant_item (see 4.2.237) that is holding or performing some process function.

> NOTE - This internal portion may be a fixed volume, such as the volume below an overflow weir, or may vary with process conditions, such as the volume of decanted water in a separation drum.

— description.

A description specifies a summary of the key aspects of the Functional_volume.

4.2.151 Functional_volume_service_case

A Functional_volume_service_case is the state of a Functional_volume (see 4.2.150) in a Plant_item (see 4.2.237) performing a specific Process_service (see 4.2.270) under a single operating case.

4.2.152 Gas_transfer_machine

A Gas_transfer_machine is a machine for moving a gas from one place to another, generally making the transfer possible by merely raising the pressure of the process Stream (see 4.2.374). Each Gas_transfer_-machine may be one of the following: a Centrifugal_compressor (see 4.2.52), a Centrifugal_compressor_-stage (see 4.2.53), or a Positive_displacement_compressor (see 4.2.248).

The data associated with Gas_transfer_machine are the following:

— gas_transfer_machine_type;

— isentropic_efficiency.

4.2.152.1 gas_transfer_machine_type

A gas_transfer_machine_type specifies the type of the Gas_transfer_machine.

4.2.152.2 isentropic_efficiency

An isentropic_efficiency specifies the efficiency defined as the isentropic work divided by the actual work required.

4.2.153 Gasket

A Gasket is a packing made of deformable Material (see 4.2.178), usually in the form of a sheet or ring, used to make a pressure-tight joint between stationary parts.

The data associated with Gasket are the following:

— gasket_inside_diameter;

— gasket_nominal_diameter;

— gasket_outside_diameter;

— gasket_pipe_schedule;

— gasket_thickness;

— gasket_type.

4.2.153.1 gasket_inside_diameter

A gasket_inside_diameter specifies the diameter of the Gasket opening.

4.2.153.2 gasket_nominal_diameter

A gasket_nominal_diameter specifies the nominal diameter of the Gasket opening.

4.2.153.3 gasket_outside_diameter

A gasket_outside_diameter specifies the outside diameter of a Gasket.

4.2.153.4 gasket_pipe_schedule

A gasket_pipe_schedule specifies the pipe schedule of a Flanged_end (see 4.2.146) that the Gasket is made to fit.

4.2.153.5 gasket_thickness

A gasket_thickness specifies the thickness of a Gasket.

4.2.153.6 gasket_type

A gasket_type specifies an enumerated attribute of Gasket which specifies a type of Gasket. The value of the gasket_type attribute shall be one of the following:

— flat;

— full_face_spiral;

— full_faced_flat;

— o-ring;

— other;

— ring;

— spiral_wound;

— unspecified.

4.2.153.6.1 flat: an indication that the gasket_type is flat.

4.2.153.6.2 full_face_spiral: an indication that the gasket_type is full_face_spiral.

4.2.153.6.3 full_faced_flat: an indication that the gasket_type is full_faced_flat.

4.2.153.6.4 o-ring: an indication that the gasket_type is an o-ring.

4.2.153.6.5 other: an indication that the gasket_type is other.

4.2.153.6.6 ring: an indication that the gasket_type is a ring.

4.2.153.6.7 spiral_wound: an indication that the gasket_type is spiral_wound.

4.2.153.6.8 unspecified: an indication that the gasket_type is unspecified.

4.2.154 Heat_exchanger_internal_data

A Heat_exchanger_internal_data is the collection of internal components used to describe the internal construction of a heat exchanger.

The data associated with Heat_exchanger_internal_data are the following:

- heat_exchanger_cumulative_duty;
- heat_exchanger_position;
- heat_exchanger_pressure;
- heat_exchanger_temperature.

4.2.154.1 heat_exchanger_cumulative_duty

A heat_exchanger_cumulative_duty specifies the heat transferred from the inlet of the exchanger through the current zone or position.

4.2.154.2 heat_exchanger_position

A heat_exchanger_position specifies the location of the heat exchanger in the heat exchanger unit relative to the first exchanger in the unit.

4.2.154.3 heat_exchanger_pressure

A heat_exchanger_pressure specifies the system pressure at any point within the heat exchanger unit.

4.2.154.4 heat_exchanger_temperature

A heat_exchanger_temperature specifies the system temperature at any point within the heat exchanger unit.

4.2.155 Heat_exchanger_internal_phase

A Heat_exchanger_internal_phase is a type of Internal_stream_phase (see 4.2.165) that exists at some point along the flow path within a Uo_heat_exchanger (see 4.2.442).

4.2.156 Heat_port

A Heat_port is a type of Energy_port (see 4.2.121) for which the energy at the Equipment_port (see 4.2.125) is in the form of heat.

The data associated with Heat_port are the following:

- clean_heat_duty;
- fouled_heat_duty;
- normal_heat_duty.

4.2.156.1 clean_heat_duty

A clean_heat_duty specifies a specification for the maximum expected rate of heat transfer through a Heat_port.

4.2.156.2 fouled_heat_duty

A fouled_heat_duty specifies a specification for the minimum expected rate of heat transfer through a Heat_port.

4.2.156.3 normal_heat_duty

A normal_heat_duty specifies a specification for the normal rate of heat transfer expected through a Heat_-port.

4.2.157 Heat_release_curve

A Heat_release_curve specifies a curve representing the performance of the heat release for the Material_-stream (see 4.2.186). The Heat_release_curve shall be associated with at least one of Tubeside_design (see 4.2.412) or Shellside_design (see 4.2.327).

The data associated with Heat_release_curve are the following:

— independent_variable;

— isobaric_curve;

— non_condensables;

— number_of_components;

— number_of_liquids;

— phase_change;

— single_component;

— super_critical.

4.2.157.1 independent_variable

An independent_variable specifies an enumerated attribute that indicates whether the basis for curve construction was equal duty, equal fraction of vapour, equal temperature, or unspecified.

4.2.157.2 isobaric_curve

An isobaric_curve specifies an enumerated attribute for determining the operating pressure basis for the Heat_release_curve.

NOTE - The value of the isobaric_curve attribute shall be no, unspecified, or yes. If the value is no, the Heat_release_curve is non-isobaric. The pressure changes with each point on the curve. If the value is yes, the Heat_release_curve is isobaric. The pressure is constant for every point on the curve.

4.2.157.3 non_condensables

A non_condensables specifies an enumerated attribute that indicates whether non-condensable fluids are present, not present, or unspecified in the Heat_release_curve.

NOTE - If the value of the non_condensables attribute is no, there are no non-condensable fluids included in Heat_release_curve. If the value is yes, there are non-condensable fluids included in Heat_release_curve.

4.2.157.4 number_of_components

A number_of_components specifies the number of components included in a Heat_release_curve of Material_stream (see 4.2.186).

4.2.157.5 number_of_liquids

A number_of_liquids specifies the number of liquids included in a Heat_release_curve of the Material_-stream (see 4.2.186).

4.2.157.6 phase_change

A phase_change specifies an enumerated attribute indicating the Phase (see 4.2.230) of the Material_stream (see 4.2.186) as liquid, two-phase, vapour, or unspecified.

4.2.157.7 single_component

A single_component specifies an enumerated attribute that indicates whether the Heat_release_curve is based on a single component or a Mixture (see 4.2.192). The value of the single_component attribute shall be one of the following:

— no;

— unspecified;

— yes.

4.2.157.7.1 no: an indication that the Heat_release_curve is based on a Mixture (see 4.2.192).

4.2.157.7.2 unspecified: an indication that the basis for the Heat_release_curve is not specified.

4.2.157.7.3 yes: an indication that the Heat_release_curve is based on a single component.

4.2.157.8 super_critical

A super_critical specifies an enumerated attribute that indicates whether the fluid is above the critical temperature. The value for the super_critical attribute shall be one of the following:

— no;

— unspecified;

— yes.

4.2.157.8.1 **no:** an indication that the fluid is not above the critical temperature.

4.2.157.8.2 **unspecified:** an indication that it is not specified whether the fluid is above the critical temperature.

4.2.157.8.3 **yes:** an indication that the fluid is above the critical temperature.

4.2.158 Heat_release_point

A Heat_release_point specifies the Heat_transfer_thermodynamic_properties (see 4.2.161) and Phase_-properties (see 4.2.233) about each Heat_release_point in the Heat_release_curve (see 4.2.157).

The data associated with Heat_release_point are the following:

— bubble_point;

— dew_point;

— number_of_phases.

4.2.158.1 bubble_point

A bubble_point specifies an enumerated attribute indicating if the bubble point is available, not available, or unspecified for the Heat_release_point.

NOTE - If the value of the bubble_point attribute is no, the bubble point is not available for the Heat_release_point. If the value is yes, the bubble_point is available for the Heat_release_point.

4.2.158.2 dew_point

A dew_point specifies an enumerated attribute indicating if the dew point is available, not available, or unspecified for the Heat_release_point.

NOTE - If the value of the dew_point attribute is not, the dew point is not available for the Heat_-release_point. If the value is yes, the dew point is available for the Heat_release_point.

4.2.158.3 number_of_phases

A number_of_phases specifies the number of Phases (see 4.2.230) present in a Heat_release_point.

4.2.159 Heat_transfer_coefficient

A Heat_transfer_coefficient is the heat transfer coefficient to use when the conditions in the Uo_heat_-exchanger (see 4.2.442) match its key.

The data associated with Heat_transfer_coefficient are the following:

— coefficient_of_heat_transfer;

— phase_coefficient_key.

4.2.159.1 coefficient_of_heat_transfer

A coefficient_of_heat_transfer specifies the value of the Heat_transfer_coefficient associated with the Uo_-heat_exchanger (see 4.2.442) in the simulation.

4.2.159.2 phase_coefficient_key

A phase_coefficient_key specifies an enumerated attribute, that defines the different phases used for the calculation of the Heat_transfer_coefficient in the simulation. The value of the phase_coefficient_key attribute shall be one of the following:

— B-B;

— B-L;

— B-V;

— L-B;

— L-L;

— L-V;

— V-B;

— V-L;

— V-V.

4.2.159.2.1 B-B: an indication of the phase_coefficient_key, defining a shell side boiling liquid - tube side boiling liquid relation, for the Heat_transfer_coefficient in the simulation.

4.2.159.2.2 B-L: an indication of the phase_coefficient_key, defining a shell side boiling liquid - tube side liquid relation, for the Heat_transfer_coefficient in the simulation.

4.2.159.2.3 B-V: an indication of the phase_coefficient_key, defining a shell side boiling liquid - tube side vapour relation, for the Heat_transfer_coefficient in the simulation.

4.2.159.2.4 L-B: an indication of the phase_coefficient_key, defining a shell side liquid - tube side boiling liquid relation, for the Heat_transfer_coefficient in the simulation.

4.2.159.2.5 L-L: an indication of the phase_coefficient_key, defining a shell side liquid- tube side liquid relation, for the Heat_transfer_coefficient in the simulation.

4.2.159.2.6 L-V: an indication of the phase_coefficient_key, defining a shell side liquid - tube side vapour relation, for the Heat_transfer_coefficient in the simulation.

4.2.159.2.7 V-B: an indication of the phase_coefficient_key, defining a shell side vapour - tube side boiling liquid relation, for the Heat_transfer_coefficient in the simulation.

4.2.159.2.8 V-L: an indication of the phase_coefficient_key, defining a shell side vapour - tube side liquid relation, for the Heat_transfer_coefficient in the simulation.

4.2.159.2.9 V-V: an indication of the phase_coefficient_key, defining a shell side vapour - tube side vapour relation, for the Heat_transfer_coefficient in the simulation.

4.2.160 Heat_transfer_equipment

A Heat_transfer_equipment is a type of Process_equipment (see 4.2.260) that has as a principle function the transfer of energy in the form of heat from one Material (see 4.2.178) to another. Each Heat_transfer_-equipment may be one of the following: an Air_cooled_heat_exchanger_unit (see 4.2.4) or a Shell_and_-tube_heat_exchanger_unit (see 4.2.326).

> EXAMPLE 11 - Heat_transfer_equipment includes fired heaters, heat exchangers, and evaporators.

The data associated with Heat_transfer_equipment are the following:

— heat_transfer_coefficient;

— heat_transfer_equipment_type.

4.2.160.1 heat_transfer_coefficient

A heat_transfer_coefficient specifies the overall Heat_transfer_coefficients (see 4.2.159) for the Heat_-transfer_equipment.

4.2.160.2 heat_transfer_equipment_type

A heat_transfer_equipment_type specifies the type of Heat_transfer_equipment.

4.2.161 Heat_transfer_thermodynamic_properties

Heat_transfer_thermodynamic_properties are a collection of properties loosely classified as thermodynamic properties for a Phase (see 4.2.230) of a Mixture (see 4.2.192).

The data associated with Heat_transfer_thermodynamic_properties are the following:

— pressure;

— spec_enthalpy_mass_basis;

— spec_enthalpy_mole_basis;

— temperature;

— vapour_mass_fraction;

— vapour_mole_fraction.

4.2.161.1 pressure

A pressure specifies the amount of force per unit area at a certain Heat_release_point (see 4.2.158) that any portion of a Material (see 4.2.178) exerts on its surroundings at the thermodynamic state.

4.2.161.2 spec_enthalpy_mass_basis

A spec_enthalpy_mass_basis specifies the enthalpy, the sum of the internal energy and the product of pressure and volume, per unit mass for any given portion of a Material (see 4.2.178) at the Thermodynamic_conditions (see 4.2.386).

4.2.161.3 spec_enthalpy_mole_basis

A spec_enthalpy_mole_basis specifies the enthalpy, the sum of the internal energy and the product of pressure and volume, per mole for any given portion of a Material (see 4.2.178) at the Thermodynamic_-conditions (see 4.2.386).

4.2.161.4 temperature

A temperature specifies the temperature of a Material (see 4.2.178) at a certain Heat_release_point (see 4.2.158) at the thermodynamic state measured in one of the common scales of thermodynamic or thermometric temperature.

4.2.161.5 vapour_mass_fraction

A vapour_mass_fraction specifies the mass fraction of vapour of a Material (see 4.2.178) at a certain Heat_release_point (see 4.2.158).

4.2.161.6 vapour_mole_fraction

A vapour_mole_fraction specifies the mole fraction of vapour of a Material (see 4.2.178) at a certain Heat_release_point (see 4.2.158).

4.2.162 Hemispherical_head

A Hemispherical_head is a type of head for the Cylindrical_pv_head_section (see 4.2.92) that has a hemispherical geometry.

The data associated with Hemispherical_head are the following:

— hemispherical_head_inside_diameter;

— hemispherical_head_outside_diameter.

4.2.162.1 hemispherical_head_inside_diameter

A hemispherical_head_inside_diameter specifies the inside diameter for the Hemispherical_head.

4.2.162.2 hemispherical_head_outside_diameter

A hemispherical_head_outside_diameter specifies the outside diameter for the Hemispherical_head.

4.2.163 Impingement_protection

An Impingement_protection is a flow distribution device used to protect the tube bundle from damage due to excessive velocities or two-phase flow.

The data associated with Impingement_protection are the following:

— diameter;

— length;

— location;

— number_of_rod_rows;

— number_of_rods;

— rod_diameter;

— rod_layout_angle;

— thickness;

— type;

— width.

4.2.163.1 diameter

A diameter specifies the diameter of the impingement plate.

4.2.163.2 length

A length specifies the length of the impingement plate.

4.2.163.3 location

A location specifies an enumerated attribute giving the impingement plate location as in the nozzle dome, on the bundle, tubeside, or unspecified.

4.2.163.4 number_of_rod_rows

A number_of_rod_rows specifies the number of rod rows used as impingement protection.

4.2.163.5 number_of_rods

A number_of_rods specifies the number of rods used as impingement protection.

4.2.163.6 rod_diameter

A rod_diameter specifies the diameter of the rod used as impingement protection.

4.2.163.7 rod_layout_angle

A rod_layout_angle specifies the layout angle of the rod used as impingement protection.

4.2.163.8 thickness

A thickness specifies the thickness of the impingement plate.

4.2.163.9 type

A type specifies an enumerated attribute which specifies the type of impingement protection used. The value of the type shall be one of the following:

— none;

— circular_plate;

— rectangular_plate;

— rod;

— unspecified.

4.2.163.9.1 none: an indication that no impingement protection is provided.

4.2.163.9.2 circular_plate: an indication the impingement protection is provided by a circular plate.

4.2.163.9.3 rectangular_plate: an indication the impingement protection is provided by a rectangular plate.

4.2.163.9.4 rod: an indication the impingement protection is provided by a number of rods. The rod type is used to protect tubes from impingement.

4.2.163.9.5 unspecified: an indication that the impingement protection is not specified.

4.2.163.10 width

A width specifies the width of the impingement plate.

4.2.164 Inspection_and_tests

An Inspection_and_tests is inspections and tests performed on Plant_items (see 4.2.237) by a manufacturer prior to the delivery of the Plant_item to a customer.

The data associated with Inspection_and_tests are the following:

— board_certification_required;

— design_code;

— disassm_reassm_after_test;

— full_oper_pressure_test;

— hydrotest_pressure;

— noise_level_test;

— radiographs_required;

— shop_inspection;

— stress_relief_required;

— test_helium_leak;

— test_hydrostatic;

— test_other.

4.2.164.1 board_certification_required

A board_certification_required specifies an enumerated attribute that indicates status with respect to board certification. The value of the board_certification_required attribute shall be one or more of the following:

— observed;

— required;

— witnessed.

4.2.164.1.1 observed: an indication that the required board certification has or has not been observed.

4.2.164.1.2 required: an indication that the required board certification is or is not required.

4.2.164.1.3 witnessed: an indication that the required board certification has or has not been witnessed.

4.2.164.2 design_code

A design_code specifies which design code is required.

EXAMPLE 12 - Design codes include ASTM and ASME.

4.2.164.3 disassm_reassm_after_test

A disassm_reassm_after_test specifies whether the Plant_item (see 4.2.237) should be disassembled, inspected, and reassembled after the test is complete.

4.2.164.4 full_oper_pressure_test

A full_oper_pressure_test specifies whether the Plant_item (see 4.2.237) should be tested its full operating pressure.

4.2.164.5 hydrotest_pressure

A hydrotest_pressure specifies the pressure at which the hydrostatic test is to be performed.

4.2.164.6 noise_level_test

A noise_level_test specifies whether a noise level test is to be performed.

4.2.164.7 radiographs_required

A radiographs_required specifies whether radiographs of the Plant_item (see 4.2.237) are required.

4.2.164.8 shop_inspection

A shop_inspection specifies whether an inspection of the Plant_item (see 4.2.237) at the manufacturer's shop is required.

4.2.164.9 stress_relief_required

A stress_relief_required specifies whether stress-relieving of the Plant_item (see 4.2.237) is required.

4.2.164.10 test_helium_leak

A test_helium_leak specifies whether a leak test using helium is to be performed.

4.2.164.11 test_hydrostatic

A test_hydrostatic specifies whether a hydrostatic test is to be performed on the Plant_item (see 4.2.237).

4.2.164.12 test_other

A test_other specifies other tests that are required.

4.2.165 Internal_stream_phase

An Internal_stream_phase is a type of Specific_phase (see 4.2.367) that represents the internal flow of a single phase within a Process_unit_operation (see 4.2.275). An Internal_stream_phase exists independent of any Stream (see 4.2.374). Each Internal_stream_phase may be one of the following: a Distillation_-stage_phase (see 4.2.107) or a Heat_exchanger_internal_phase (see 4.2.155).

The data associated with Internal_stream_phase are the following:

— internal_stream_phase_description;

— internal_stream_phase_name;

— mass_flow_rate;

— mole_flow_rate;

— stdvol_flow_rate.

4.2.165.1 internal_stream_phase_description

An internal_stream_phase_description specifies key elements about the phase and its function.

4.2.165.2 internal_stream_phase_name

An internal_stream_phase_name specifies a label given to the phase.

4.2.165.3 mass_flow_rate

A mass_flow_rate specifies how much is flowing in the Internal_stream_phase on a mass basis.

4.2.165.4 mole_flow_rate

A mole_flow_rate specifies how much is flowing in the Internal_stream_phase on a mole basis.

4.2.165.5 stdvol_flow_rate

A stdvol_flow_rate specifies how much is flowing in the Internal_stream_phase on a standard volume basis.

4.2.166 Interphase_chemical_reaction

An Interphase_chemical_reaction is a chemical reaction that takes place on the boundary between two Specific_phases (see 4.2.367).

4.2.167 Interphase_thermophysical_properties

An Interphase_thermophysical_properties is a loose collection of properties of the interface between two Specific_phases (see 4.2.367).

The data associated with Interphase_thermophysical_properties are the following:

— surface_tension.

A surface_tension specifies the force per unit length exerted by the surface at the interface.

4.2.168 Intersection_description

An Intersection_description is a description of how a Boot (see 4.2.23) or Nozzle (see 4.2.194) fits into a Cylindrical_pv_cylinder_section (see 4.2.90) or Cylindrical_pv_head_section (see 4.2.92).

The data associated with Intersection_description are the following:

— relative_location;

— relative_orientation.

4.2.168.1 relative_location

A relative_location specifies the location of the Boot (see 4.2.23) or Nozzle (see 4.2.194) relative to a Cylindrical_pv_cylinder_section (see 4.2.90) or Cylindrical_pv_head_section (see 4.2.92).

4.2.168.2 relative_orientation

A relative_orientation specifies the orientation of the Boot (see 4.2.23) or Nozzle (see 4.2.194) relative to a Cylindrical_pv_cylinder_section (see 4.2.90) or Cylindrical_pv_head_section (see 4.2.92).

4.2.169 Item_property_reference

An Item_property_reference is the identification of a Process_design_property_value (see 4.2.258) and the Referenced_object (see 4.2.303) of which the Process_design_property_value is the value.

4.2.170 Location_conditions

A Location_conditions is any special environmental conditions associated with a Plant_item (see 4.2.237) location.

The data associated with Location_conditions are the following:

— location_cover;

— location_electrical_area_class;

— location_unusual_conditions.

4.2.170.1 location_cover

A location_cover specifies whether the Plant_item (see 4.2.237) is located within an area that is covered.

4.2.170.2 location_electrical_area_class

A location_electrical_area_class specifies the electrical class of the area where the Plant_item (see 4.2.237) is located.

4.2.170.3 location_unusual_conditions

A location_unusual_conditions specifies any other unusual environmental conditions associated with a Plant_item (see 4.2.237) location.

4.2.171 Location_in_plant

A Location_in_plant is a type of Plant_item_location (see 4.2.242) that is the position of the Plant_item (see 4.2.237) relative to a defined reference location or set of coordinates in the Plant (see 4.2.236).

4.2.172 Location_in_site

A Location_in_site is a type of Plant_item_location (see 4.2.242) that is the position of the Plant_item (see 4.2.237) relative to a defined reference location or set of coordinates in the Site (see 4.2.354).

4.2.173 Logical_operation

A Logical_operation is a type of Control_logic_condition (see 4.2.77) that is a boolean operation between two operands that results in a value of true or false.

> NOTE - This construct allows complex logical expressions to be described to support simple procedural controls that depend on logical conditions being satisfied, or are dependent upon other Control_logic_conditions (see 4.2.77) associated with Comparison_parameter (see 4.2.63) types of Control_variables (see 4.2.81).

The data associated with Logical_operation are the following:

— operator.

An operator specifies the particular boolean operation that is being defined. The operator shall contain one of the following values: OR, AND, XOR.

4.2.174 Longitudinal_baffle

A Longitudinal_baffle is baffle sheets or plates within a heat exchanger that are parallel to the long dimension of the vessel.

> NOTE - They are used to direct fluid flow in the desired flow pattern.

The data associated with Longitudinal_baffle are the following:

— baffle_to_shell_clearance;

— elastic_modulus;

— insulated;

— leakage;

— length;

— seal_type;

— thermal_conductivity;

— thickness;

— width.

4.2.174.1 baffle_to_shell_clearance

A baffle_to_shell_clearance specifies the distance between the edge of the baffle to the shell inside diameter.

4.2.174.2 elastic_modulus

An elastic_modulus specifies the modulus of elasticity for the Longitudinal_baffle.

4.2.174.3 insulated

An insulated specifies whether the Longitudinal_baffle is insulated to minimize heat losses.

4.2.174.4 leakage

A leakage specifies the percent of the total flow which leaks around the Longitudinal_baffle.

4.2.174.5 length

A length specifies the length of the Longitudinal_baffle.

4.2.174.6 seal_type

A seal_type specifies an enumerated attribute giving the type of seal used for the baffle. The value of the baffle_seal_type attribute shall be one of the following:

— channel_strips;

— lamiflex;

— unspecified;

— welded.

4.2.174.6.1 channel_strips: an indication that one or two strips which are welded to each side of the shell, upon or in which the Longitudinal_baffle sits.

4.2.174.6.2 lamiflex: an indication that one or more flexible strips are clamped to the inlet side, along the length of the Longitudinal_baffle.

4.2.174.6.3 unspecified: an indication that the baffle_seal_type is not specified.

4.2.174.6.4 welded: an indication that the plate is welded to the shell and the front tubesheet.

4.2.174.7 thermal_conductivity

A thermal_conductivity specifies the thermal conductivity of the Longitudinal_baffle. It is the heat flow across a surface per unit area per unit time, divided by the negative of the rate of change of temperature with distance in a direction perpendicular to the surface.

4.2.174.8 thickness

A thickness specifies the thickness of the Longitudinal_baffle.

4.2.174.9 width

A width specifies the width of the Longitudinal_baffle.

4.2.175 Male_end

A Male_end is an end type of Piping_connector (see 4.2.235). A Male_end piping connector is used in conjunction with a Female_end (see 4.2.144) piping connector to form a pipe fitting connection.

The data associated with Male_end are the following:

— bevelled.

A bevelled specifies whether the Male_end has a bevelled or flat edge.

4.2.176 Mass_transfer_equipment

A Mass_transfer_equipment is a type of Process_equipment (see 4.2.260) that is used to transfer Process_-material (see 4.2.263) from one Phase (see 4.2.230) to another Phase.

The data associated with Mass_transfer_equipment are the following:

— mass_transfer_equipment_type.

A mass_transfer_equipment_type specifies the various types of equipment that are used to transfer Process_material (see 4.2.263) from one Phase (see 4.2.230) to another.

EXAMPLE 13 - A type of mass transfer equipment are separation towers.

4.2.177 Matched_perimeter_segments

A Matched_perimeter_segments is exactly two Perimeter (see 4.2.216) segments, one from one Perimeter and one from another Perimeter, that are in common. Each segment should have an association with the same lengths.

4.2.178 Material

A Material is matter that is produced, consumed, transformed, or used by a process. Material is not a physical Substance (see 4.2.381) but rather a processes abstraction of that Substance.

EXAMPLE 14 - Cooling water is a Material commonly used in a process. The actual Substance that makes it up is a complex (and mostly indeterminate) mixture of water, dissolved salts, dissolved gases, dissolved and emulsified organic liquids, suspended solids, foams, biological components, and so on. The physical and thermodynamic properties of a Material are commonly estimated by approximating its contents with a Substance.

Each Material may be one of the following: Construction_material (see 4.2.72) or Process_material (see 4.2.263).

The data associated with Material are the following:

— material_description;

— material_name.

4.2.178.1 material_description

A material_description specifies a piece of information describing key aspects of the Material.

4.2.178.2 material_name

A material_name specifies a label which uniquely identifies a Material.

4.2.179 Material_amount

A Material_amount is an inventory or hold-up of Process_material (see 4.2.263) within a Process_unit_-operation (see 4.2.275) or within a Plant_item (see 4.2.237).

The data associated with Material_amount are the following:

— description;

— mass;

— material_amount_name;

— moles;

— volume.

4.2.179.1 description

A description specifies key aspects about the Material_amount.

4.2.179.2 mass

A mass specifies the amount of mass in a Material_amount.

4.2.179.3 material_amount_name

A material_amount_name specifies a label which identifies a Material_amount.

4.2.179.4 moles

A moles specifies the number of moles present in a Material_amount.

4.2.179.5 volume

A volume specifies the volume occupied by a Material_amount.

4.2.180 Material_amount_phase

A Material_amount_phase is a type of Specific_phase (see 4.2.367) that is a single Phase (see 4.2.230) or a group of Phases that is treated as a single Phase and is associated with a Material_amount (see 4.2.179).

The data associated with Material_amount_phase are the following:

- mass;
- mass_fraction;
- mole_fraction;
- moles;
- volume;
- volume_fraction.

4.2.180.1 mass

A mass specifies the amount of mass in the Material_amount_phase.

4.2.180.2 mass_fraction

A mass_fraction specifies the ratio of the mass in the Material_amount_phase to the mass in the Material_-amount (see 4.2.179).

4.2.180.3 mole_fraction

A mole_fraction specifies the ratio between the number of moles in the Material_amount_phase and the number of moles in the Material_amount (see 4.2.179).

4.2.180.4 moles

A moles specifies the number of moles present in a Material_amount_phase.

4.2.180.5 volume

A volume specifies the volume occupied by the Material_amount_phase.

4.2.180.6 volume_fraction

A volume_fraction specifies the ratio of the volume of the Material_amount_phase to the volume of the Material_amount (see 4.2.179).

4.2.181 Material_amount_reference_time

A Material_amount_reference_time is the association of a time with a Material_amount (see 4.2.179).

4.2.182 Material_characterization

A Material_characterization is the specification of the Substance (see 4.2.381) that constitutes a Process_-material (see 4.2.263).

4.2.183 Material_cost

A Material_cost is the value or cost for a Process_material (see 4.2.263) at a specified location, quality, temperature, and pressure.

The data associated with Material_cost are the following:

— average_cost;

— cost_basis.

4.2.183.1 average_cost

An average_cost specifies the average cost of the Process_material (see 4.2.263) over the quality range between the Material_cost point and the previous cost point.

4.2.183.2 cost_basis

A cost_basis specifies the ratio of the currency unit to the amount unit on which the average_cost is computed.

4.2.184 Material_port

A Material_port is a type of Equipment_port (see 4.2.125) through which Material (see 4.2.178) is intended to flow.

4.2.185 Material_reference_time

A Material_reference_time is a snapshot of a Material (see 4.2.178) at a specified point in time.

4.2.186 Material_stream

A Material_stream is a type of Stream (see 4.2.374) that describes the flow of matter.

The data associated with Material_stream are the following:

— mass_flow_rate;

— mole_flow_rate;

— stdvol_flow_rate.

4.2.186.1 mass_flow_rate

A mass_flow_rate specifies how much is flowing in the Material_stream on a mass basis.

4.2.186.2 mole_flow_rate

A mole_flow_rate specifies how much is flowing in the Material_stream on a mole basis.

4.2.186.3 stdvol_flow_rate

A stdvol_flow_rate specifies how much is flowing in the Material_stream on a standard volume basis.

4.2.187 Material_stream_phase

A Material_stream_phase is an arbitrary subdivision of a Material_stream (see 4.2.186).

The data associated with Material_stream_phase are the following:

— mass_flow_rate;

— mass_fraction;

— mole_flow_rate;

— mole_fraction;

— stdvol_flow_rate;

— volume_fraction.

4.2.187.1 mass_flow_rate

A mass_flow_rate specifies how much is flowing in the Material_stream_phase on a mass basis.

4.2.187.2 mass_fraction

A mass_fraction specifies the ratio between the mass flow rate in the Material_stream_phase to that in the Material_stream (see 4.2.186).

4.2.187.3 mole_flow_rate

A mole_flow_rate specifies how much is flowing in the Material_stream_phase on a mole basis.

4.2.187.4 mole_fraction

A mole_fraction specifies the ratio between the mole flow rate in the Material_stream_phase to that in the Material_stream (see 4.2.186).

4.2.187.5 stdvol_flow_rate

A stdvol_flow_rate specifies how much is flowing in the Material_stream_phase on a standard volume basis.

4.2.187.6 volume_fraction

A volume_fraction specifies the ratio between the volumetric flow rate in the Material_stream_phase to that in the Material_stream (see 4.2.186).

4.2.188 Material_transfer_equipment

A Material_transfer_equipment is a type of Process_equipment (see 4.2.260) that, as a principle function, produces or requires the movement of Process_materials. Each Material_transfer_equipment may be a Fluid_transfer_machine (see 4.2.149).

NOTE - The Process_materials may be solid, liquid, gas, or multi-phase.

The data associated with Material_transfer_equipment are the following:

— material_transfer_equipment_type.

A material_transfer_equipment_type specifies the type of equipment performing the transfer of Process_-materials (see 4.2.263).

NOTE - Material_transfer_equipment includes pumps, fans, blowers, compressors, conveyors, elevators, jet ejectors, turbines, and expanders.

4.2.189 Mechanical_component

A Mechanical_component is an equipment item that is associated with the operation of rotating equipment. The Mechanical_component is a replaceable component of the rotating equipment and often is tracked by the plant for maintenance and spare parts. Each Mechanical_component may be one of the following: a Baseplates_and_soleplates (see 4.2.15), a Bearing (see 4.2.16), a Bearing_housing (see 4.2.17), a Cc_-balance_piston (see 4.2.39), a Cc_casing (see 4.2.40), a Cc_diaphragm (see 4.2.42), a Cc_impeller (see 4.2.43), a Cc_labyrinth (see 4.2.44), a Cc_shaft_sleeve (see 4.2.47), a Coupling (see 4.2.84), a Mechanical_seal (see 4.2.191), a Pump_gland (see 4.2.285), or a Shaft (see 4.2.325).

The data associated with Mechanical_component are the following:

— mechanical_component_manufacturer;

— mechanical_component_model;

— mechanical_component_serial_number;

— mechanical_component_size;

— mechanical_component_type;

— mechanical_component_weight.

4.2.189.1 mechanical_component_manufacturer

A mechanical_component_manufacturer specifies the manufacturer of the Mechanical_component.

4.2.189.2 mechanical_component_model

A mechanical_component_model specifies the model designation assigned to the Mechanical_component by the manufacturer.

4.2.189.3 mechanical_component_serial_number

A mechanical_component_serial_number specifies the serial number assigned to the Mechanical_-component.

4.2.189.4 mechanical_component_size

A mechanical_component_size specifies the external dimensions of the Mechanical_component.

4.2.189.5 mechanical_component_type

A mechanical_component_type specifies the type of Mechanical_component.

4.2.189.6 mechanical_component_weight

A mechanical_component_weight specifies the weight of the Mechanical_component.

4.2.190 Mechanical_power_port

A Mechanical_power_port is a type of Power_port (see 4.2.249) in which the power at the Equipment_port (see 4.2.125) is in a mechanical form. Each Mechanical_power_port may be one of the following: a Reciprocating_power_port (see 4.2.298) or a Rotating_power_port (see 4.2.308).

The data associated with Mechanical_power_port are the following:

— mechanical_power_port_type.

A mechanical_power_port_type specifies that a Mechanical_power_port is either a Reciprocating_power_-port (see 4.2.298) or a Rotating_power_port (see 4.2.308).

4.2.191 Mechanical_seal

A Mechanical_seal is a mechanical Shaft (see 4.2.325) seal.

The data associated with Mechanical_seal are the following:

- api_class_code;
- inner_oil_leakage;
- mechanical_seal_system_type;
- mechanical_seal_type;
- settling_out_press.

4.2.191.1 api_class_code

An api_class_code specifies the API class code for the seal.

4.2.191.2 inner_oil_leakage

An inner_oil_leakage specifies the rate of oil leakage on the inner seal.

4.2.191.3 mechanical_seal_system_type

A mechanical_seal_system_type specifies the seal system type.

4.2.191.4 mechanical_seal_type

A mechanical_seal_type specifies the seal type.

4.2.191.5 settling_out_press

A settling_out_press specifies the settling out pressure for the seal.

4.2.192 Mixture

A Mixture is a Substance (see 4.2.381) which is made up of a combination of two or more other Substances. Each Mixture may be a Petroleum_mixture (see 4.2.219).

The data associated with Mixture are the following:

- mixture_type_name.

A mixture_type_name specifies the name assigned to the type of Mixture.

4.2.193 Noise_specification

A Noise_specification is the permissible noise levels when the compressor is operating under normal load conditions.

The data associated with Noise_specification are the following:

- noise_specification_acoustic_housing;
- noise_specification_appl_to_machine;
- noise_specification_appl_to_neighborhood.

4.2.193.1 noise_specification_acoustic_housing

A noise_specification_acoustic_housing specifies whether an acoustic enclosure will be required to meet environmental noise constraints.

4.2.193.2 noise_specification_appl_to_machine

A noise_specification_appl_to_machine specifies the noise level specification for personnel working at the compressor or in the immediate vicinity.

4.2.193.3 noise_specification_appl_to_neighborhood

A noise_specification_appl_to_neighborhood specifies the appropriate noise level for the compressor in the area surrounding the machine, such as the compressor room or the building.

4.2.194 Nozzle

A Nozzle is a physical opening in certain Plant_items (see 4.2.237) through which Material (see 4.2.178) is intended to flow.

The data associated with Nozzle are the following:

- nozzle_entrance_type;
- nozzle_function;
- nozzle_nominal_size;
- nozzle_piping_schedule;

— nozzle_pressure_rating;

— nozzle_tag;

— nozzle_temperature_rating;

— nozzle_vortex_breaker;

— nozzle_wall_thickness.

4.2.194.1 nozzle_entrance_type

A nozzle_entrance_type specifies an enumerated attribute of Nozzle which specifies the type of Nozzle entrance. The value of the nozzle_entrance_type attribute shall be one of the following:

— axial;

— elbow;

— radial;

— tangential;

— unspecified.

4.2.194.1.1 axial: an indication that the type of Nozzle is specified as axial (see item 4 in Figure 5).

4.2.194.1.2 elbow: an indication that the type of Nozzle specified is an elbow (see item 3 in Figure 5).

4.2.194.1.3 radial: an indication that the type of Nozzle is specified as radial (see item 1 in Figure 5).

4.2.194.1.4 tangential: an indication that the type of Nozzle is specified as tangential (see item 2 in Figure 5).

4.2.194.1.5 unspecified: an indication that the type of Nozzle is not specified.

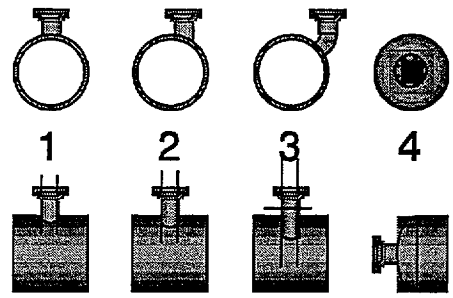


Figure 5 - Nozzle Entrance Type

4.2.194.2 nozzle_function

A nozzle_function specifies an enumerated attribute which gives the function of the Nozzle. The value of the nozzle_function attribute shall be one of the following:

— drain;

— inlet;

— inspection_port;

— liquid_inlet;

— manhole;

— outlet;

— safety_valve;

— sparge;

— unspecified;

— vapour_outlet;

— vent.

4.2.194.2.1 drain: an indication which specifies the function of the Nozzle as a drain (no flow).

4.2.194.2.2 inlet: an indication which specifies the function of the Nozzle as inlet.

4.2.194.2.3 inspection_port: an indication which specifies the function of the Nozzle as an inspection port.

4.2.194.2.4 liquid_inlet: an indication which specifies the function of the Nozzle as a liquid inlet.

4.2.194.2.5 manhole: an indication which specifies the function of the Nozzle as manhole.

4.2.194.2.6 outlet: an indication which specifies the function of the Nozzle as outlet.

4.2.194.2.7 safety_valve: an indication which specifies the function of the Nozzle as a safety valve.

4.2.194.2.8 sparge: an indication which specifies the function of the Nozzle as a sparge.

4.2.194.2.9 unspecified: an indication that the function of the Nozzle is not specified.

4.2.194.2.10 vapour_outlet: an indication which specifies the function of the Nozzle as a vapour outlet.

4.2.194.2.11 vent: an indication which specifies the function of the Nozzle as a vent.

4.2.194.3 nozzle_nominal_size

A nozzle_nominal_size specifies the nominal size of a Nozzle.

4.2.194.4 nozzle_piping_schedule

A nozzle_piping_schedule specifies the pipe schedule of the Nozzle.

4.2.194.5 nozzle_pressure_rating

A nozzle_pressure_rating specifies the pressure rating of the Nozzle.

4.2.194.6 nozzle_tag

A nozzle_tag specifies a tag name for the Nozzle.

4.2.194.7 nozzle_temperature_rating

A nozzle_temperature_rating specifies the rated temperature of the Nozzle.

4.2.194.8 nozzle_vortex_breaker

A nozzle_vortex_breaker specifies that a vortex breaker is required for the Nozzle.

4.2.194.9 nozzle_wall_thickness

A nozzle_wall_thickness specifies the wall thickness of the Nozzle.

4.2.195 Nozzle_dome

A Nozzle_dome is an enlarged nozzle neck used to reduce the velocity entering the heat exchanger and aid the distribution of a fluid into the heat exchanger.

The data associated with Nozzle_dome are the following:

— height;

— inside_diameter;

— nominal_diameter.

4.2.195.1 height

A height specifies the height of the Nozzle_dome.

4.2.195.2 inside_diameter

An inside_diameter specifies the inside diameter of the Nozzle_dome.

4.2.195.3 nominal_diameter

A nominal_diameter specifies the nominal_diameter of the Nozzle_dome.

4.2.196 Nozzle_location_for_pv_cyl_section

A Nozzle_location_for_pv_cyl_section specifies the Nozzle (see 4.2.194) location on a Cylindrical_pv_-cylinder_section (see 4.2.90).

The data associated with Nozzle_location_for_pv_cyl_section are the following:

— cyl_section_flush_with_inside.

A cyl_section_flush_with_inside specifies that the child Nozzle_section (see 4.2.199) is made flush with the inside surface of the parent section.

4.2.197 Nozzle_location_for_pv_head_section

A Nozzle_location_for_pv_head_section specifies the location of a Nozzle (see 4.2.194) attached to a head section.

The data associated with Nozzle_location_for_pv_head_section are the following:

— head_section_flush_with_inside.

A head_section_flush_with_inside specifies that the child Nozzle_section (see 4.2.199) is made flush with the inside surface of the parent section.

4.2.198 Nozzle_performance

A Nozzle_performance specifies the overall performance of a Nozzle (see 4.2.194) on a heat exchanger.

The data associated with Nozzle_performance are the following:

— pressure_drop;

— rhov2;

— velocity.

4.2.198.1 pressure_drop

A pressure_drop specifies the pressure drop of fluid through the Nozzle (see 4.2.194).

4.2.198.2 rhov2

A rhov2 specifies the ρv^2 (fluid density times velocity squared) in the Nozzle (see 4.2.194).

4.2.198.3 velocity

A velocity specifies the fluid velocity in the Nozzle (see 4.2.194).

4.2.199 Nozzle_section

A Nozzle_section is a section of a Nozzle (see 4.2.194). Each Nozzle_section may be one of the following: an Elbow_nozzle_section (see 4.2.116), a Reducing_nozzle_section (see 4.2.299), or a Straight_nozzle_section (see 4.2.373).

The data associated with Nozzle_section are the following:

— nozzle_section_inside_diameter;

— nozzle_section_nominal_diameter;

— nozzle_section_outside_diameter;

— nozzle_section_piping_schedule;

— nozzle_section_wall_thickness.

4.2.199.1 nozzle_section_inside_diameter

A nozzle_section_inside_diameter specifies the inside diameter of the Nozzle_section.

4.2.199.2 nozzle_section_nominal_diameter

A nozzle_section_nominal_diameter specifies the nominal diameter of the Nozzle_section.

4.2.199.3 nozzle_section_outside_diameter

A nozzle_section_outside_diameter specifies the outer diameter of the Nozzle_section.

4.2.199.4 nozzle_section_piping_schedule

A nozzle_section_piping_schedule specifies the pipe schedule of the Nozzle_section.

4.2.199.5 nozzle_section_wall_thickness

A nozzle_section_wall_thickness specifies the wall thickness of the Nozzle_section.

4.2.200 Nozzle_section_connection

A Nozzle_section_connection is the connection of two sections of the Nozzle (see 4.2.194).

The data associated with Nozzle_section_connection are the following:

— nozzle_section_connection_angular_offset;

— nozzle_section_connection_inside_radius;

— nozzle_section_connection_thickness;

— nozzle_section_connection_type.

4.2.200.1 nozzle_section_connection_angular_offset

A nozzle_section_connection_angular_offset specifies the angle between the plane of the next lowest ordered Elbow_nozzle_section (see 4.2.116) in the Nozzle (see 4.2.194) and the plane of the Elbow_-nozzle_section being connected.

4.2.200.2 nozzle_section_connection_inside_radius

A nozzle_section_connection_inside_radius specifies the inside radius of the transition of the Nozzle_-section_connection between two unequally sized Nozzle_sections (see 4.2.199).

4.2.200.3 nozzle_section_connection_thickness

A nozzle_section_connection_thickness specifies the wall thickness of the Nozzle_section_connection.

4.2.200.4 nozzle_section_connection_type

A nozzle_section_connection_type specifies an enumerated attribute of the Nozzle_section_connection describing the type of connection. The value of the nozzle_section_connection_type attribute shall be one of the following;

— flanged;

— open;

— threaded;

— unspecified;

— welded.

4.2.200.4.1 flanged: an indication which describes the connection type as flanged.

4.2.200.4.2 open: an indication which describes the connection type to be open. If the connection is open only one section may be associated with the Nozzle_section_connection.

4.2.200.4.3 threaded: an indication which describes the connection type as threaded.

4.2.200.4.4 unspecified: an indication which describes the connection type to be unspecified.

4.2.200.4.5 welded: an indication which describes the connection type as welded.

4.2.201 Packaging

A Packaging is the packaging and shipping requirements.

The data associated with Packaging are the following:

— packaging_shipping_wt.

A packaging_shipping_wt specifies the shipping weight of the package.

4.2.202 Pad_and_pad_stack

A Pad_and_pad_stack is the total number of Demister_pads (see 4.2.98) used in the column.

The data associated with Pad_and_pad_stack are the following:

— pad_number_from_bottom_of_stack;

— pad_number_from_top_of_stack.

4.2.202.1 pad_number_from_bottom_of_stack

A pad_number_from_bottom_of_stack specifies the number of the pad when counting from the bottom to the top.

4.2.202.2 pad_number_from_top_of_stack

A pad_number_from_top_of_stack specifies the number of the pad when counting from the top to the bottom.

4.2.203 Particle_fraction

A Particle_fraction is the fraction of solid particles that occur within a range defined by two Particle_sizes (see 4.2.204). A Psd_values (see 4.2.280) specifies which particles are considered in determining the fraction.

The data associated with Particle_fraction are the following:

— cumulative_mass_fraction;

— mass_fraction.

4.2.203.1 cumulative_mass_fraction

A cumulative_mass_fraction specifies the ratio of all particles smaller than the upper bound defined by a corresponding Particle_size (see 4.2.204) to the total mass of particles.

4.2.203.2 mass_fraction

A mass_fraction specifies the ratio of the mass of the particles that fall between two corresponding Particle_sizes (see 4.2.204) to the total mass of particles.

4.2.204 Particle_size

A Particle_size is an absolute size or a screen size that specifies the bounds on an interval for a Particle_-size_distribution (see 4.2.205).

The data associated with Particle_size are the following:

— size_value.

A size_value specifies the absolute size or screen size that segregates particles.

4.2.205 Particle_size_distribution

A Particle_size_distribution is the classification of the solid particles of a Substance (see 4.2.381) or particles of an aggregate of multiple Substances by segregation by size intervals or by physical screening. The size intervals for a Particle_size_distribution are supplied by one or more Particle_sizes (see 4.2.204). The smallest size interval has a lower bound of 0 while the largest size interval contains all particles larger than the largest Particle_size.

4.2.206 Partition_seal_rod

A Partition_seal_rod is a rod connecting two baffles which is located near the pass partition lane to divert the shell side fluid from flowing through the pass partition lane.

The data associated with Partition_seal_rod are the following:

— diameter;

— horiz_dist_from_tubesheet_centre;

— length;

— vert_distance_from_tubesheet_centre.

4.2.206.1 diameter

A diameter specifies the diameter of the seal rod.

4.2.206.2 horiz_dist_from_tubesheet_centre

A horiz_dist_from_tubesheet_centre specifies the horizontal distance from the vertical centreline of the tubesheet to the centre of the seal rod.

4.2.206.3 length

A length specifies the total length of the seal rod.

4.2.206.4 vert_distance_from_tubesheet_centre

A vert_distance_from_tubesheet_centre specifies the vertical distance from the horizontal centreline of the tubesheet to the centre of the seal rod.

4.2.207 Passlane

A Passlane is an opening lane between tube passes.

The data associated with Passlane are the following:

- length;
- location;
- number_of_seal_rods;
- orientation;
- width.

4.2.207.1 length

A length specifies the length of the Passlane.

4.2.207.2 location

A location specifies the distance between the centre of the Passlane and the centreline of the tubesheet.

4.2.207.3 number_of_seal_rods

A number_of_seal_rods specifies the number of seals rods to prevent fluid bypassing through.

4.2.207.4 orientation

An orientation specifies an enumerated attribute giving the orientation of the Passlane as horizontal, vertical, or unspecified.

4.2.207.5 width

A width specifies the width of the Passlane from tube edge to tube edge.

4.2.208 Pattern

A Pattern is the layout of the perforations on the Tray_panel (see 4.2.399).

The data associated with Pattern are the following:

— name;

— pattern_description;

— pitch_separation_distance;

— pitch_type.

4.2.208.1 name

A name specifies the unique name or label for the perforation layout.

4.2.208.2 pattern_description

A pattern_description specifies a textual description for the perforation layout.

4.2.208.3 pitch_separation_distance

A pitch_separation_distance specifies the separation distance for the particular pitch pattern.

4.2.208.4 pitch_type

A pitch_type specifies an enumerated attribute that designates the pitch as triangular, square, rectangular, radial, or an other pitch.

4.2.209 Perforation_cover

A Perforation_cover is on the top of the tray to help prevent downward liquid flow through the perforation as the vapour Phase (see 4.2.230) flows upward.

4.2.210 Perforation_cover_shape

A Perforation_cover_shape is either a Bubble_cap (see 4.2.28) or a Valve_cap (see 4.2.486).

4.2.211 Perforation_shape

A Perforation_shape is described by a geometry that includes the top edge and bottom edge geometry.

The data associated with Perforation_shape are the following:

— bottom_edge;

— top_edge.

4.2.211.1 bottom_edge

A bottom_edge specifies an enumerated attribute that indicates whether the bottom edge of the perforation is sharp or smooth.

4.2.211.2 top_edge

A top_edge specifies an enumerated attribute that indicates whether the top edge of the perforation is sharp or smooth.

4.2.212 Performance_curve

A Performance_curve is a representation of a curve or family of related curves of equipment or unit operation performance versus one or more operating conditions. Each Performance_curve may be one of the following: Performance_map (see 4.2.213) or Simple_performance_curve (see 4.2.330).

The data associated with Performance_curve are the following:

— description;

— identifier.

4.2.212.1 description

A description specifies a summary of key aspects of the Performance_curve.

4.2.212.2 identifier

An identifier specifies a unique identifier for the Performance_curve.

4.2.213 Performance_map

A Performance_map is a type of Performance_curve (see 4.2.212) that provides for more than one independent variable by containing nested subordinate Performance_curves. Each value of the independent variable in the Performance_map is associated with one of a family of related, that is having the same independent and dependent variables defined, Performance_curves. Each of the dependent Performance_-map_curves (see 4.2.214) shall have the same independent variable property name.

4.2.214 Performance_map_curve

A Performance_map_curve is one of the family of related Performance_curves (see 4.2.212) belonging to a Performance_map (see 4.2.213) for a specific value of the independent variable.

4.2.215 Performance_point

A Performance_point is one point of a Simple_performance_curve (see 4.2.330). A Performance_point is the collection of dependent variable values associated with a specific value of exactly one independent variable.

4.2.216 Perimeter

A Perimeter is the edges of a bounded surface.

The data associated with Perimeter are the following:

— number_of_perimeter_segments;

— perimeter_length;

— surface_area_enclosed.

4.2.216.1 number_of_perimeter_segments

A number_of_perimeter_segments specifies the aggregate quantity of segments included in the Perimeter.

4.2.216.2 perimeter_length

A perimeter_length specifies the numeric total length of all Perimeter_segments (see 4.2.217).

4.2.216.3 surface_area_enclosed

A surface_area_enclosed specifies the total area enclosed by the Perimeter.

4.2.217 Perimeter_segment

A Perimeter_segment is described by a Curve (see 4.2.86).

The data associated with Perimeter_segment are the following:

— liquid_flow_status;

— segment_length;

— segment_number.

4.2.217.1 liquid_flow_status

A liquid_flow_status specifies an enumerated attribute that designates the Perimeter_segment as a barrier edge (no flow), an inlet flow edge, or an outlet flow edge.

4.2.217.2 segment_length

A segment_length specifies the total length of each Perimeter_segment.

4.2.217.3 segment_number

A segment_number specifies the identification for each Perimeter_segment.

NOTE - Many Perimeter_segments may be described by the same Curve (see 4.2.86) and they need not be contiguous.

4.2.218 Petroleum_cut

A Petroleum_cut is a Petroleum_mixture (see 4.2.219) derived from a distillation cut.

NOTE - A Petroleum_cut is similar to a petroleum fraction but is further divided.

The data associated with Petroleum_cut are the following:

— petroleum_cut_begin_temperature;

— petroleum_cut_end_temperature.

4.2.218.1 petroleum_cut_begin_temperature

A petroleum_cut_begin_temperature specifies the starting temperature of the distillation cut producing the Petroleum_cut.

4.2.218.2 petroleum_cut_end_temperature

A petroleum_cut_end_temperature specifies the ending temperature of the distillation cut producing the Petroleum_cut.

4.2.219 Petroleum_mixture

A Petroleum_mixture is a Mixture (see 4.2.192) which is primarily petroleum or a derivative of petroleum. Each Petroleum_mixture may be a Petroleum_cut (see 4.2.218).

4.2.220 PFD

A PFD is a process flow diagram. The PFD is comprised of a PFD_title_block (see 4.2.229) and a number of PFD_presentation_components (see 4.2.224). A PFD is a schematic representation containing the aggregation of the results of a process design activity. A PFD shows the arrangement of the equipment selected to carry out the processes, the stream connections, stream flow rates and compositions, and the operating conditions.

The data associated with PFD are the following:

— description;

— id;

— version.

4.2.220.1 description

A description specifies a summary of key aspects of the PFD.

4.2.220.2 id

An id specifies a unique identifier for the PFD.

4.2.220.3 version

A version specifies the revision level of the PFD.

4.2.221 PFD_curve

A PFD_curve is the placement of a curve or curves on a PFD (see 4.2.220) to represent a portion or all of a PFD_element (see 4.2.222).

The data associated with PFD_curve are the following:

— defining_curve.

A defining_curve specifies a particular line such as a box, circle, ellipsoid, free form curve, or straight line that is used to draw the PFD_curve.

4.2.222 PFD_element

A PFD_element is the specific representation of a piece of Process_equipment (see 4.2.260), or a particular Stream (see 4.2.374), or a control element, or a Process_unit_operation (see 4.2.275) depicted on the PFD (see 4.2.220).

The data associated with PFD_element are the following:

— placement;

— style.

4.2.222.1 placement

A placement specifies the location of the PFD_element on the PFD.

4.2.222.2 style

A style specifies a combination of points, curves, and text that are assembled to represent an element.

4.2.223 PFD_point

A PFD_point is the placement of a point or points on a PFD (see 4.2.220) to represent a portion or all of a PFD_element (see 4.2.222).

The data associated with PFD_point are the following:

— point_coordinates.

A point_coordinates specifies the exact location on the PFD (see 4.2.220) in both X and Y coordinates for the PFD_point.

4.2.224 PFD_presentation_component

A PFD_presentation_component specifies how the depicted PFD (see 4.2.220) conforms to a certain type of PFD.

The data associated with PFD_presentation_component are the following:

— type.

A type specifies the various types of PFDs (see 4.2.220) that can be depicted.

NOTE - This type could consist of a Simplified PFD (SFD), a Quantity Flow Diagram (QFD), a PFD, or finally a Process Flow and Control Diagram (PF&CD).

4.2.225 PFD_presentation_component_composition

A PFD_presentation_component_composition is the composition makeup for a particular view of the component.

The data associated with PFD_presentation_component_composition are the following:

— clipping_O;

— projection_O.

4.2.225.1 clipping_O

A clipping_O specifies eliminating a portion of the drawing either inside the fenced or selected area and maintaining everything outside that area or outside the fenced or selected area and maintaining everything inside that area.

4.2.225.2 projection_O

A projection_O specifies the particular view to be shown for that depicted PFD (see 4.2.220).

4.2.226 PFD_symbol_definition

A PFD_symbol_definition specifies a combination of one or more of PFD_points (see 4.2.223), PFD_-curves (see 4.2.221), PFD_text (see 4.2.228), and PFD_symbol_occurrences (see 4.2.227) to generate a symbol and place it on the PFD (see 4.2.220).

The data associated with PFD_symbol_definition are the following:

— description;

— identifier;

— name;

— source.

4.2.226.1 description

A description specifies the description of a specific named symbol.

EXAMPLE 15 - For example, the symbol named pump may be described as a centrifugal pump with an electrical driver.

4.2.226.2 identifier

An identifier specifies a unique identifier for the PFD_symbol_definition.

4.2.226.3 name

A name specifies a label given to a particular symbol.

4.2.226.4 source

A source specifies whether a symbol is available to the drawing from a standard cell library, from a specifically generated cell library, or from the drawing tool palette.

4.2.227 PFD_symbol_occurrence

A PFD_symbol_occurrence consists of the use of a previously drawn symbol that is available from a palette or cell library and can be placed on the PFD (see 4.2.220) as a complete symbol.

4.2.228 PFD_text

A PFD_text is the placement of alphanumeric text on a PFD (see 4.2.220) as part of the PFD_element (see 4.2.222) or as textual notes.

The data associated with PFD_text are the following:

— text_literal.

A text_literal specifies bringing together alphanumeric text on a PFD (see 4.2.220) as either notes on the depicted drawing, or as a description on or near the PFD_element (see 4.2.222), or as text on the PFD_-title_block (see 4.2.229).

4.2.229 PFD_title_block

A PFD_title_block is the process flow diagram title block.

NOTE - The title block is usually located in the lower right corner of the drawing and contains the project name, project receiver, and project owner.

The data associated with PFD_title_block are the following:

- approvals;
- contractor_info.

4.2.229.1 approvals

An approvals specifies who has approved the basic design as depicted on that particular PFD (see 4.2.220).

4.2.229.2 contractor_info

A contractor_info specifies what contractor, if any, has contributed to that particular PFD (see 4.2.220) and in what way they have made a contribution.

4.2.230 Phase

A Phase is a homogeneous region of matter.

NOTE - A Phase need not be continuous.

The data associated with Phase are the following:

- description;
- name;
- physical_state.

4.2.230.1 description

A description specifies a summary of key aspects about the Phase.

4.2.230.2 name

A name specifies an identifier for the Phase.

4.2.230.3 physical_state

A physical_state specifies the physical behavior of the Phase. The value of the physical_state attribute shall be one of the following:

— liquid;

— solid;

— vapour.

4.2.230.3.1 liquid: a Phase that is in liquid form.

4.2.230.3.2 solid: a Phase that is in solid form.

4.2.230.3.3 vapour: a Phase that is in vapour form.

4.2.231 Phase_distribution_coefficient

A Phase_distribution_coefficient is the partitioning of a Chemical_component (see 4.2.56) between two Specific_phases (see 4.2.367).

The data associated with Phase_distribution_coefficient are the following:

— coefficient_type;

— value.

4.2.231.1 coefficient_type

A coefficient_type indicates the type of partitioning specified by the Phase_distribution_coefficient. The value of the coefficient_type attribute shall be one of the following:

— k_value;

— partition_coefficient.

4.2.231.1.1 k_value: an indication that the partitioning is between a liquid and a vapour phase in equilibrium.

4.2.231.1.2 partition_coefficient: an indication that the partitioning is between two liquid phases in equilibrium.

4.2.231.2 value

A value specifies the ratio of the mole or mass fraction of the Chemical_component (see 4.2.56) in the light Specific_phase (see 4.2.367) to the mole or mass fraction in the heavy Specific_phase.

4.2.232 Phase_equilibrium_relationship

A Phase_equilibrium_relationship is an association of two or more Specific_phases (see 4.2.367) indicating that they are in equilibrium with each other.

4.2.233 Phase_properties

A Phase_properties is a collection of properties associated with the Phase (see 4.2.230) for a material at a given thermodynamic state.

The data associated with Phase_properties are the following:

- cp_constant_pressure_mass_basis;
- cp_constant_pressure_mole_basis;
- density_mass_basis;
- density_mole_basis;
- mole_fractions;
- molecular_weight;
- phase;
- spec_enthalpy_mass_basis;
- spec_enthalpy_mole_basis;
- surface_tension;
- thermal_conductivity;
- viscosity.

4.2.233.1 cp_constant_pressure_mass_basis

A cp_constant_pressure_mass_basis specifies the instantaneous rate of change of the internal energy with respect to changes in temperature at constant pressure for any given portion of a Material (see 4.2.178) at a Heat_release_point (see 4.2.158).

4.2.233.2 cp_constant_pressure_mole_basis

A cp_constant_pressure_mole_basis specifies the instantaneous rate of change of the internal energy with respect to changes in temperature at constant pressure for any given portion of a Material (see 4.2.178) at a Heat_release_point (see 4.2.158).

4.2.233.3 density_mass_basis

A density_mass_basis specifies the ratio of the mass to the volume in any portion of the Material (see 4.2.178) at a Heat_release_point (see 4.2.158).

4.2.233.4 density_mole_basis

A density_mole_basis specifies the ratio of the moles to the volume in any portion of the Material (see 4.2.178) at a Heat_release_point (see 4.2.158).

4.2.233.5 mole_fractions

A mole_fractions specifies the molar composition of each component associated with the Phase (see 4.2.230).

4.2.233.6 molecular_weight

A molecular_weight specifies the molecular weight of each component associated with the Phase (see 4.2.230).

4.2.233.7 phase

A phase specifies an enumerated attribute that indicates the phase of the Heat_release_point (see 4.2.158). The value of the phase attribute shall be one of the following:

— liquid_1;

— liquid_1_volatile;

— liquid_2;

— liquid_2_volatile;

— mixed;

— unspecified;

— vapour;

— vapour_condensable;

— vapour_noncondensable.

4.2.233.7.1 liquid_1: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is liquid 1 with low density.

4.2.233.7.2 liquid_1_volatile: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is liquid 1 volatile with low density.

4.2.233.7.3 liquid_2: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is liquid 2 with high density.

4.2.233.7.4 liquid_2_volatile: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is liquid 2 volatile with high density.

4.2.233.7.5 mixed: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is mixed Phase.

4.2.233.7.6 unspecified: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is not specified.

4.2.233.7.7 vapour: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is vapour.

4.2.233.7.8 vapour_condensable: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is vapour condensable.

4.2.233.7.9 vapour_noncondensable: an indication that the Phase (see 4.2.230) of the Heat_release_point (see 4.2.158) is noncondensable vapour.

4.2.233.8 spec_enthalpy_mass_basis

A spec_enthalpy_mass_basis specifies the enthalpy, the sum of the internal energy and the product of pressure and volume, per unit mass for any given portion of a Material (see 4.2.178) at a certain Heat_release_point (see 4.2.158) at the Thermodynamic_conditions (see 4.2.386).

4.2.233.9 spec_enthalpy_mole_basis

A spec_enthalpy_mole_basis specifies the enthalpy, the sum of the internal energy and the product of pressure and volume, per mole for any given portion of a Material (see 4.2.178) at a certain Heat_release_-point (see 4.2.158) at the Thermodynamic_conditions (see 4.2.386).

4.2.233.10 surface_tension

A surface_tension specifies the force per unit length exerted by the surface of one liquid Phase (see 4.2.230) at the Phase boundary at a certain Heat_release_point (see 4.2.158).

4.2.233.11 thermal_conductivity

A thermal_conductivity specifies the amount of thermal energy per unit time, per unit length and per unit temperature that a Material (see 4.2.178) at certain Heat_release_point (see 4.2.158) at the Thermodynamic_conditions (see 4.2.386) will transport by conduction.

4.2.233.12 viscosity

A viscosity specifies the ratio of the shearing stress per unit area to the velocity gradient necessary to produce that stress for the given Thermodynamic_conditions (see 4.2.386) and shearing stress, for a given portion of a Material (see 4.2.178) at a certain Heat_release_point (see 4.2.158).

4.2.234 Phase_region

A Phase_region is a portion of the property and composition space of a Mixture (see 4.2.192) that applies to a single physical or logical Phase (see 4.2.230). For a physical Phase_region, the Mixture properties inside that region apply to a single physical Phase and is bounded by the phase envelope for that Phase. For a logical Phase_region, the Mixture properties are composite or average values for one or more Phases, the properties may be purely hypothetical for part or all of a logical Phase_region. A point within a Phase_region may be given by a Specific_phase (see 4.2.367).

The data associated with Phase_region are the following:

- description;
- phase_name;
- physical_or_logical.

4.2.234.1 description

A description specifies key aspects about the Phase_region.

4.2.234.2 phase_name

A phase_name specifies the Phase (see 4.2.230) or composite that the Phase_region encompasses.

4.2.234.3 physical_or_logical

A physical_or_logical specifies the type of the region that the Phase_region encompasses.

4.2.235 Piping_connector

A Piping_connector is a type of Plant_item_connector (see 4.2.240) that describes the way in which two pieces of piping are connected. Each Piping_connector may be one of the following: a Buttweld (see 4.2.35), Compression (see 4.2.66), Flanged (see 4.2.145), Socket (see 4.2.359), or Threaded (see 4.2.389) connector.

The data associated with Piping_connector are the following:

— end_engagement_type;

— end_type;

— connector_piping_schedule;

— inner_diameter;

— nominal_diameter;

— outer_diameter;

— thickness.

4.2.235.1 end_engagement_type

An end_engagement_type specifies whether the Piping_connector is a Buttweld (see 4.2.35), Compression (see 4.2.66), Flanged (see 4.2.145), Socket (see 4.2.359), or Threaded (see 4.2.389) connector.

4.2.235.2 end_type

An end_type specifies whether the Piping_connector end type is a Female_end (see 4.2.144), Flanged_end (see 4.2.146), or a Male_end (see 4.2.175).

4.2.235.3 connector_piping_schedule

A connector_piping_schedule specifies the piping schedule used for the Piping_connector.

4.2.235.4 inner_diameter

An inner_diameter specifies the inside diameter of the pipe associated with the Piping_connector.

4.2.235.5 nominal_diameter

A nominal_diameter specifies the nominal diameter of the pipe associated with the Piping_connector.

4.2.235.6 outer_diameter

An outer_diameter specifies the outside diameter of the pipe associated with the Piping_connector.

4.2.235.7 thickness

A thickness specifies the wall thickness of the pipe associated with the Piping_connector.

4.2.236 Plant

A Plant is an aggregate of one or more Plant_items (see 4.2.237) interconnected so as to provide mechanisms for the interchange of Material (see 4.2.178), energy, or signals. The Plant is intended to isolate Material from the surroundings so that one or more chemical or physical transformations can be made to occur on the Material.

The data associated with Plant are the following:

— name;

— plant_description;

— plant_function;

— plant_id;

— sub_plant_type.

4.2.236.1 name

A name specifies the designation or label given to the Plant.

4.2.236.2 plant_description

A plant_description specifies a description of the Plant.

4.2.236.3 plant_function

A plant_function specifies a description of the intended function of the Plant.

4.2.236.4 plant_id

A plant_id specifies a unique identifier for the Plant.

4.2.236.5 sub_plant_type

A sub_plant_type specifies a descriptive name for a Plant when it is contained within another Plant.

4.2.237 Plant_item

A Plant_item is an entity made from formed Materials (see 4.2.178), perhaps an assembly of components, with moving parts, or deformable, that has a boundary with portions that are specifically intended to be permeable to the flow of Material, energy, or signals. Each Plant_item may be one of the following: a Buffer_gas_system (see 4.2.31) or a Process_equipment (see 4.2.260).

The data associated with Plant_item are the following:

— boundary;

— delivered_capital_cost;

— description;

— function;

— installed_capital_cost;

— manufacturer;

— maximum_weight_for_maintenance;

— name;

— operating_factor;

— plant_item_id;

— purchased_capital_cost;

— tag;

— type;

— weight.

4.2.237.1 boundary

A boundary specifies a description of the closed surface, portions of which can be imaginary or dynamic, that encloses the Plant_item.

4.2.237.2 delivered_capital_cost

A delivered_capital_cost specifies the capital cost of the Plant_item delivered to the Site (see 4.2.354).

4.2.237.3 description

A description specifies a description of the Plant_item.

4.2.237.4 function

A function specifies a description of the intended function of the Plant_item unit.

4.2.237.5 installed_capital_cost

An installed_capital_cost specifies the capital cost of the Plant_item delivered and installed at the Site (see 4.2.354).

4.2.237.6 manufacturer

A manufacturer specifies the manufacturer or fabricator of the Plant_item.

4.2.237.7 maximum_weight_for_maintenance

A maximum_weight_for_maintenance specifies the maximum weight of the Plant_item to be used for planning maintenance.

4.2.237.8 name

A name specifies a label assigned to each Plant_item.

4.2.237.9 operating_factor

An operating_factor specifies the fraction of time that the Plant_item is expected to be in operational service.

4.2.237.10 plant_item_id

A plant_item_id specifies a unique identifier for the Plant_item.

4.2.237.11 purchased_capital_cost

A purchased_capital_cost specifies the capital cost of the Plant_item purchased at the location of manufacture or fabrication.

4.2.237.12 tag

A tag specifies an identifier affixed to the Plant_item.

NOTE - The uniqueness of the identifier is a matter of corporation policy.

4.2.237.13 type

A type specifies that the category of Plant_item is generally assigned according to the Plant_item function.

4.2.237.14 weight

A weight specifies the weight of the Plant_item.

4.2.238 Plant_item_assembly_relationship

A Plant_item_assembly_relationship is a type of Plant_item_group_relationship (see 4.2.241). The assembly relationship reflects the fact that a particular Plant_item (see 4.2.237) (the whole) is composed of an assembly of other Plant_items (the parts).

4.2.239 Plant_item_collection_relationship

A Plant_item_collection_relationship is a type of Plant_item_group_relationship (see 4.2.241). The collection relationship indicates that the Plant_item (see) is a member of a collection of similar Plant_-items.

NOTE - Collections of similar Plant_items are described in catalogues and spare parts inventory lists.

4.2.240 Plant_item_connector

A Plant_item_connector is a feature of a Plant_item (see 4.2.237) that is designed to connect to a connector on another Plant_item. Each Plant_item_connector may be one of the following: a Piping_-connector (see 4.2.235).

The data associated with Plant_item_connector are the following:

— connector_description;

— connector_name;

— function_type.

4.2.240.1 connector_description

A connector_description specifies a summary of key aspects of the Plant_item_connector.

4.2.240.2 connector_name

A connector_name specifies a name or label given to the Plant_item_connector.

4.2.240.3 function_type

A function_type specifies the type of Plant_item_connector.

4.2.241 Plant_item_group_relationship

A Plant_item_group_relationship is a method for logically linking or grouping two or more Plant_items (see 4.2.237). Each Plant_item_group_relationship may be one of the following: a Plant_item_assembly_-relationship (see 4.2.238) or a Plant_item_collection_relationship (see 4.2.239).

The data associated with Plant_item_group_relationship are the following:

— location_and_orientation.

A location_and_orientation specifies the relative position and orientation of the Plant_item (see 4.2.237) relative to the another Plant_item.

4.2.242 Plant_item_location

A Plant_item_location is the position of the Plant_item (see 4.2.237) within a Plant (see 4.2.236). Each Plant_item_location is either a Location_in_plant (see 4.2.171) or a Location_in_site (see 4.2.172).

The data associated with Plant_item_location are the following:

— location_and_orientation;

— location_id.

4.2.242.1 location_and_orientation

A location_and_orientation specifies the relative position and orientation of the Plant_item (see 4.2.237) within the Plant (see 4.2.236).

4.2.242.2 location_id

A location_id specifies a unique identifier for the Plant_item_location.

4.2.243 Plant_item_reference_time

A Plant_item_reference_time is a snapshot of a Plant_item (see 4.2.237) at a specified point in time.

4.2.244 Plant_system

A Plant_system is a combination of Plant_item (see 4.2.237) objects which perform a function required for the Plant (see 4.2.236) to operate to produce product(s). Each Plant_system may be one of the following: a Process_train (see 4.2.274) or a Process_control_unit (see 4.2.252).

EXAMPLE 16 - Types of plant systems include piping system, control system, protection system, and utility system.

The data associated with Plant_system are the following:

— name;

— plant_system_id;

— service_description.

4.2.244.1 name

A name specifies a designation or label assigned to the Plant_system.

4.2.244.2 plant_system_id

A plant_system_id specifies a unique identifier for the Plant_system.

4.2.244.3 service_description

A service_description specifies a descriptive label for the system.

EXAMPLE 17 - Labels include Boiler Feedwater System, Paraxylene System, Pipe Rack K, and 4160V Power System.

4.2.245 Plant_system_assembly

A Plant_system_assembly is a collection of Plant_system (see 4.2.244) objects into a higher-level system to perform a functional capability.

4.2.246 Point_property_value

A Point_property_value is a type of Variable_value (see 4.2.493) that is the value for a Thermophysical_-point_property (see 4.2.388) for a Substance (see 4.2.381).

4.2.247 Port_service_case

A Port_service_case is the data associated with a Equipment_port (see 4.2.125) being used for a Process_-service (see 4.2.270) under some operating case or criteria.

4.2.248 Positive_displacement_compressor

A Positive_displacement_compressor is a generic class of machines that move gases or raise their pressure by pushing or shrinking the occupied volume. Each Positive_displacement_compressor may be one of the following: a Reciprocating_compressor (see 4.2.296) or a Reciprocating_compressor_stage (see 4.2.297).

The data associated with Positive_displacement_compressor are the following:

— positive_displacement_compressor_type;

— volumetric_efficiency.

4.2.248.1 positive_displacement_compressor_type

A positive_displacement_compressor_type specifies a type of Positive_displacement_compressor.

4.2.248.2 volumetric_efficiency

A volumetric efficiency specifies the volume moved on every stroke of the displacing device divided by the total volume of the cavity wetted by fluid.

4.2.249 Power_port

A Power_port is a type of Energy_port (see 4.2.121) in which the energy at the Equipment_port (see 4.2.125) is in the form of power. Each Power_port may be one of the following: an Electrical_power_port (see 4.2.117) or a Mechanical_power_port (see 4.2.190).

The data associated with Power_port are the following:

— normal_power;

— peak_power;

— power_port_type;

— rated_maximum_sustained_power.

4.2.249.1 normal_power

A normal_power specifies the specification for the normal power transmission expected through a Power_-port.

4.2.249.2 peak_power

A peak_power specifies the specification for the maximum instantaneous power transmission expected through a Power_port.

4.2.249.3 power_port_type

A power_port_type specifies that a Power_port is either a Mechanical_power_port (see 4.2.190) or an Electrical_power_port (see 4.2.117).

4.2.249.4 rated_maximum_sustained_power

A rated_maximum_sustained_power specifies the maximum power that the Power_port is rated to be capable of transmitting on a sustained basis.

4.2.250 Pressure_equalization_channel_shape

A Pressure_equalization_channel_shape is described by a length and a channel cross-section described by a Perimeter (see 4.2.216).

The data associated with Pressure_equalization_channel_shape are the following:

— length.

A length specifies the numeric length of the pressure equalization channel.

4.2.251 Pressure_vessel

A Pressure_vessel is a type of Process_vessel (see 4.2.276) which is designed to operate under pressure in excess of five inches of water head or under a vacuum. Each Pressure_vessel may be one of the following: a Cylindrical_pressure_vessel (see 4.2.87), a Spherical_pressure_vessel (see 4.2.368), or a Spheroidal_pressure_vessel (see 4.2.369).

The data associated with Pressure_vessel are the following:

— pressure_vessel_shape.

A pressure_vessel_shape specifies the type of Pressure_vessel as a Cylindrical_pressure_vessel (see 4.2.87), a Spherical_pressure_vessel (see 4.2.368), a Spheroidal_pressure_vessel (see 4.2.369), or some other shape.

4.2.252 Process_control_unit

A Process_control_unit is a type of Plant_system (see 4.2.244) that is a collection of one or more associated control elements, control modules, and equipment modules that performs a coordinated function. Process_control_unit objects operate relatively independently of one another. A Process_control_unit includes both physical equipment and all associated control functions.

NOTE - This definition was adapted from ISA-S88.01-1995.

The data associated with Process_control_unit are the following:

— process_control_unit_function.

A process_control_unit_function specifies a description of the intended function of the Process_control_-unit.

4.2.253 Process_definition

A Process_definition is the identification and description of a process. It is independent of the representation of the process, such as a process flow diagram or a simulation, and also independent of the particular equipment used to carry out the process. Each Process_definition may be one of the following: a Control_event_or_adjustment (see 4.2.75), a Control_measurement_module (see 4.2.78), an Internal_-stream_phase (see 4.2.165), a Process_service (see 4.2.270), a Process_unit_operation (see 4.2.275), a Uo_distillation_stage (see 4.2.429), a Uo_heat_exchanger_side (see 4.2.444), or a Uo_solids_decanter_-stage (see 4.2.470).

The data associated with Process_definition are the following:

— description;

— process_definition_name;

— process_definition_type.

4.2.253.1 description

A description specifies a description of the function or purpose of the Process_definition.

4.2.253.2 process_definition_name

A process_definition_name specifies the label given to the Process_definition.

4.2.253.3 process_definition_type

A process_definition_type specifies the general nature or category of a given Process_definition.

4.2.254 Process_definition_reference_time

A Process_definition_reference_time is a snapshot of a Process_definition (see 4.2.253) at a specified point in time.

4.2.255 Process_definition_relationship

A Process_definition_relationship specifies an association between two Process_definition (see 4.2.253) objects. Each Process_definition_relationship may be an Aggregation_relationship (see 4.2.3) or an Alternate_relationship (see 4.2.6).

NOTE - Specializations of this relationship may indicate that one Process_definition (see 4.2.253) follows another.

4.2.256 Process_design_case

A Process_design_case is a case used in the design of the Plant_item (see 4.2.237) that is an aggregate of cases on the attributes of Plant_item, perhaps other than the Plant_item of the design case, the attributes of Plant_item aggregates, the attributes of the Plant (see 4.2.236), the attributes of the Site (see 4.2.354), the attributes of Equipment_ports (see 4.2.125), the attributes of Material (see 4.2.178) flowing through the Material_ports (see 4.2.184), and the attributes of Material within the Plant_item.

The data associated with Process_design_case are the following:

— agitation_condition_category;

— description;

— flow_condition_category;

— heat_transfer_condition_category;

— level_condition_category;

— plant_item_design_condition_name;

— temperature_condition_category.

4.2.256.1 agitation_condition_category

An agitation_condition_category specifies an enumerated attribute that indicates the agitation condition category of the Process_design_case. The value of the agitation_condition_category attribute shall be one of the following:

— none;

— normal;

— other;

— perfect_mixing;

— plug_flow;

— rated.

4.2.256.1.1 none: an indication that there is no agitation condition for the Process_design_case.

4.2.256.1.2 normal: an indication that the agitation condition for the Process_design_case is normal.

4.2.256.1.3 other: an indication that the agitation condition for the Process_design_case is peculiar and is described further in the description.

4.2.256.1.4 perfect_mixing: an indication that the agitation condition for the Process_design_case is perfectly mixed.

4.2.256.1.5 plug_flow: an indication that the agitation condition for the Process_design_case is plug flow.

4.2.256.1.6 rated: an indication that the agitation condition for the Process_design_case is as rated.

4.2.256.2 description

A description specifies a description of the agitation condition for the Process_design_case.

4.2.256.3 flow_condition_category

A flow_condition_category specifies an enumerated attribute that indicates the flow condition category of a Process_design_case. The value of the flow_condition_category attribute shall be one of the following:

— maximum;

— minimum;

— none;

— normal;

— other;

— rated.

4.2.256.3.1 maximum: an indication that the flow condition for the Process_design_case is a maximum.

4.2.256.3.2 minimum: an indication that the flow condition for the Process_design_case is a minimum.

4.2.256.3.3 none: an indication that there is no flow condition for Process_design_case.

4.2.256.3.4 normal: an indication that the flow condition for the Process_design_case is normal.

4.2.256.3.5 other: an indication that the flow condition for the Process_design_case is peculiar and is described further in the description.

4.2.256.3.6 rated: an indication that the flow condition for the Process_design_case is as rated.

4.2.256.4 heat_transfer_condition_category

A heat_transfer_condition_category specifies an enumerated attribute that indicates the heat transfer condition category of a Process_design_case. The value of the heat_transfer_condition_category attribute shall be one of the following:

— clean;

— fouled;

— none;

— normal;

— other;

— rated.

4.2.256.4.1 clean: an indication that the heat transfer condition for the Process_design_case is for a clean surface.

4.2.256.4.2 fouled: an indication that the heat transfer condition for the Process_design_case is for a fouled surface.

4.2.256.4.3 none: an indication that there is no heat transfer condition for the Process_design_case.

4.2.256.4.4 normal: an indication that the heat transfer condition for the Process_design_case is normal.

4.2.256.4.5 other: an indication that the heat transfer condition for the Process_design_case is peculiar and is described further in the description.

4.2.256.4.6 rated: an indication that the heat transfer condition for the Process_design_case is as rated.

4.2.256.5 level_condition_category

A level_condition_category specifies an enumerated attribute that indicates the level condition category of a Process_design_case. The value of the level_condition_category attribute shall be one of the following:

— maximum;

— minimum;

— none;

— normal;

— other;

— rated.

4.2.256.5.1 maximum: an indication that the level condition for the Process_design_case is a maximum.

4.2.256.5.2 minimum: an indication that the level condition for the Process_design_case is a minimum.

4.2.256.5.3 none: an indication that there is no level condition for the Process_design_case.

4.2.256.5.4 normal: an indication that the level condition for the Process_design_case is normal.

4.2.256.5.5 other: an indication that the level condition for the Process_design_case is peculiar and is described further in the description.

4.2.256.5.6 rated: an indication that the level condition for the Process_design_case is as rated.

4.2.256.6 plant_item_design_condition_name

A plant_item_design_condition_name specifies a name assigned to the Process_design_case.

NOTE - Each Process_design_case name must be unique for a Plant_item (see 4.2.237).

4.2.256.7 temperature_condition_category

A temperature_condition_category specifies an enumerated attribute that indicates the temperature condition category of the Process_design_case. The value of the temperature_condition_category attribute shall be one of the following:

— maximum;

— minimum;

— none;

— normal;

— other;

— rated.

4.2.256.7.1 maximum: an indication that the temperature condition for the Process_design_case is a maximum.

4.2.256.7.2 minimum: an indication that the temperature condition for the Process_design_case is a minimum.

4.2.256.7.3 none: an indication that there is no temperature condition for the Process_design_case.

4.2.256.7.4 normal: an indication that the temperature condition for the Process_design_case is normal.

4.2.256.7.5 other: an indication that the temperature condition for the Process_design_case is peculiar and is described further in the description.

4.2.256.7.6 rated: an indication that the temperature condition for the Process_design_case is as rated.

4.2.257 Process_design_property_curve_point_usage

A Process_design_property_curve_point_usage is the use of exactly one Process_design_property_value (see 4.2.258) or Item_property_reference (see 4.2.169) as a dependent, independent, or fixed variable by a Process_property_curve_point (see 4.2.269).

The data associated with Process_design_property_curve_point_usage are the following:

— variable_type.

A variable_type specifies an enumerated attribute that indicates the type of usage of the Process_design_-property_value (see 4.2.258). The value of the variable_type attribute shall be one of the following:

— dependent;

— fixed;

— independent.

4.2.257.0.1 dependent: an indication that the Process_design_property_value (see 4.2.258) is considered to be a variable that is a function of other variables.

4.2.257.0.2 fixed: an indication that the Process_design_property_value (see 4.2.258) is not considered to be a variable that is a function of other variables.

4.2.257.0.3 independent: an indication that the Process_design_property_value (see 4.2.258) is considered to be a constant, not a variable.

4.2.258 Process_design_property_value

A Process_design_property_value is a property that is not defined in the standard along with an upper limit, lower limit, or a nominal value. A Process_design_property_value shall define property values of at least one of Stream (see 4.2.374), Plant_system (see 4.2.244), Plant (see 4.2.236), Site (see 4.2.354), Material (see 4.2.178), Equipment_port (see 4.2.125), Plant_item (see 4.2.237), Phase (see 4.2.230), Thermodynamic_conditions (see 4.2.386), Reaction_rate (see 4.2.292), Chemical_reaction (see 4.2.57), or Substance (see 4.2.381).

> NOTE - Support for the information described in a Process_design_property_value is not a requirement of applications that conform to this standard.

The data associated with Process_design_property_value are the following:

— attribute_id;

— lower_limit_value;

— nominal_value;

— property_description;

— property_name;

— upper_limit_value.

4.2.258.1 attribute_id

An attribute_id specifies a unique identifier for the attribute whose value is being described.

4.2.258.2 lower_limit_value

A lower_limit_value specifies the low value for the property.

4.2.258.3 nominal_value

A nominal_value specifies a value for the property that is not defined as a limiting value.

4.2.258.4 property_description

A property_description specifies a textual summary of the Process_design_property_value.

4.2.258.5 property_name

A property_name specifies the designation or label given to the Process_design_property_value.

4.2.258.6 upper_limit_value

An upper_limit_value specifies the high value for the property.

4.2.259 Process_design_property_value_usage

A Process_design_property_value_usage is the use of a Process_design_property_value (see 4.2.258) as a dependent, independent, or fixed variable by exactly one Performance_point (see 4.2.215) or Performance_map_curve (see 4.2.214).

The data associated with Process_design_property_value_usage are the following:

— variable_type.

A variable_type specifies an enumerated attribute that indicates the type of usage of the Process_design_property_value (see 4.2.258). The value of the variable_type attribute shall be one of the following:

— dependent;

— fixed;

— independent.

4.2.259.0.1 dependent: an indication that the Process_design_property_value (see 4.2.258) is considered to be a variable that is a function of other variables.

4.2.259.0.2 fixed: an indication that the Process_design_property_value (see 4.2.258) is not considered to be a variable that is a function of other variables.

4.2.259.0.3 independent: an indication that the Process_design_property_value (see 4.2.258) is considered to be a constant, not a variable.

4.2.260 Process_equipment

A Process_equipment is a type of Plant_item (see 4.2.237) that is intended to be in direct contact with the Material (see 4.2.178) isolated from the surroundings by the Plant (see 4.2.236). Each Process_equipment may be one of the following: a Heat_transfer_equipment (see 4.2.160), a Mass_transfer_equipment (see 4.2.176), a Material_transfer_equipment (see 4.2.188), a Process_equipment_driver (see 4.2.261), a Process_vessel (see 4.2.276), a Reaction_system_equipment (see 4.2.293), or a Solids_processing_equipment (see 4.2.361).

The data associated with Process_equipment are the following:

- process_equipment_type;
- water_filled_weight.

4.2.260.1 process_equipment_type

A process_equipment_type specifies that the Process_equipment is either a Material_transfer_equipment (see 4.2.188), control element, separation tower, piping system, Process_vessel (see 4.2.276), separation tower internal, chemical reactor, or Heat_transfer_equipment (see 4.2.160).

4.2.260.2 water_filled_weight

A water_filled_weight specifies the weight of the Process_equipment when filled with water.

4.2.261 Process_equipment_driver

A Process_equipment_driver is a type of Process_equipment (see 4.2.260).

4.2.262 Process_level

A Process_level is the level of a process fluid in a vessel or section of a vessel.

NOTE - The level of the process fluid does NOT reflect actual conditions.

The data associated with Process_level are the following:

- process_level_description;
- process_level_tag_name;
- process_level_type;
- process_level_volume_above;
- process_level_volume_below.

4.2.262.1 process_level_description

A process_level_description specifies key aspects of the Process_level.

4.2.262.2 process_level_tag_name

A process_level_tag_name specifies a tag name or number associated with the Process_level.

4.2.262.3 process_level_type

A process_level_type specifies an enumerated attribute describing the type or function of the Process_-level. The value of the process_level_type attribute shall be one of the following:

— high_level;

— high_shutdown_level;

— low_level;

— low_shutdown_level;

— maximum_level;

— minimum_level;

— normal_level;

— other_level;

— overflow_level;

— unspecified_level.

4.2.262.3.1 high_level: an indication that the Process_level is the high level for the vessel.

4.2.262.3.2 high_shutdown_level: an indication that the Process_level is the high shutdown level for the vessel.

4.2.262.3.3 low_level: an indication that the Process_level is the low level for the vessel.

4.2.262.3.4 low_shutdown_level: an indication that the Process_level is the low shutdown level for the vessel.

4.2.262.3.5 maximum_level: an indication that the Process_level the maximum level for the vessel.

4.2.262.3.6 minimum_level: an indication that the Process_level is the minimum level for the vessel.

4.2.262.3.7 normal_level: an indication that the Process_level is the normal operating level.

4.2.262.3.8 other_level: an indication that the Process_level has some other function besides high, high shutdown, maximum, overflow, low, low shutdown, or minimum levels.

4.2.262.3.9 overflow_level: an indication that the Process_level is the level at which overflow starts to occur.

4.2.262.3.10 unspecified_level: an indication that the Process_level does not have a specified function.

4.2.262.4 process_level_volume_above

A process_level_volume_above specifies the volume of the vessel or section associated with the level above the point of the level.

4.2.262.5 process_level_volume_below

A process_level_volume_below specifies the volume of the vessel or section associated with the level below the point of the level.

4.2.263 Process_material

A Process_material is a type of Material (see 4.2.178) that is used in or produced by a process that is being described.

The data associated with Process_material are the following:

— process_material_class.

A process_material_class specifies an enumerated attribute indicating the use of the Process_material (see 4.2.263) in a process. The value of the process_material_class attribute shall be one of the following:

— ambient_process_material;

— internal_process_material;

— product_process_material;

— raw_process_material;

— unspecified_process_material;

— utility_process_material;

— waste_process_material.

4.2.263.0.1 ambient_process_material: an indication that the Material (see 4.2.178) has an ambient source when used by a process.

EXAMPLE 18 - For example, Atmospheric Air used by a blower.

4.2.263.0.2 internal_process_material: an indication that the Material (see 4.2.178) is used only internally by a process.

4.2.263.0.3 product_process_material: an indication that the Material (see 4.2.178) is produced as a product in a process.

4.2.263.0.4 raw_process_material: an indication the Material (see 4.2.178) is used by a process as a raw or feed Material (see 4.2.178).

4.2.263.0.5 unspecified_process_material: an indication that no use is specified for the Material (see 4.2.178).

4.2.263.0.6 utility_process_material: an indication the Material (see 4.2.178) is used as a Utility_stream (see 4.2.485) in a process.

4.2.263.0.7 waste_process_material: an indication the Material (see 4.2.178) is produced as a waste by a process.

4.2.264 Process_port

A Process_port represents a flow of material, energy, or signal through the boundary of a Process_-definition (see 4.2.253) or a Process_simulation (see 4.2.271).

The data associated with a Process_port are the following:

— direction;

— function;

— process_port_type.

4.2.264.1 direction

A direction is an enumerated attribute that specifies the normal direction of the flow through the Process_-port. Normal direction defines the meaning of positive and negative flow rates of items associated with the Process_port. The value for direction shall be one of the following:

— inlet;

— outlet;

— static.

4.2.264.1.1 inlet: an indication that the normal flow direction is through the Process_port into the containing Process_definition (see 4.2.253) or Process_simulation (see 4.2.271).

4.2.264.1.2 outlet: an indication that the normal flow direction is out of the containing Process_definition (see 4.2.253) or Process_simulation (see 4.2.271) through the Process_port.

4.2.264.1.3 static: an indication that no flow is occurring through the Process_port.

4.2.264.2 function

A function specifies the role the flow through the Process_port plays in the Process_definition (see 4.2.253) or the Process_simulation (see 4.2.271) that contains the Process_port.

4.2.264.3 process_port_type

A process_port_type specifies an enumerated attribute that specifies what flows through the Process_port. The value of process_port_type shall be one of the following:

— energy;

— material;

— signal.

4.2.264.3.1 energy: an indication the thermal or mechanical energy flows through the Process_port.

4.2.264.3.2 material: an indication that material flows through the Process_port.

4.2.264.3.3 signal: an indication that information or a digital or an analog signal flows through the Process_port.

4.2.265 Process_port_connection

A Process_port_connection is the topological connection of two Process_ports (see 4.2.264).

The data associated with Process_port_connection are the following:

— description;

A description specifies a summary of key aspects of the Process_port_connection.

4.2.266 Process_port_connection_case

A Process_port_connection_case is the Stream (see 4.2.374) defined at the point of a Process_port_-connection (see 4.2.265).

4.2.267 Process_port_stream_case

A Process_port_stream_case is the Stream (see 4.2.374) defined at the point of the Process_port (see 4.2.264).

4.2.268 Process_property_curve

A Process_property_curve is a curve or a set of curves that describe how the thermophysical properties of a Process_material (see 4.2.263) vary with temperature or temperature and pressure. The properties described may be bulk properties or the properties of one or more phases.

The data associated with Process_property_curve are the following:

— curve_name.

A curve_name specifies what independent variables should be used for the curve. The value of curve_-name shall be one of the following:

— T;

— P;

— TP.

4.2.268.0.1 T: specifies that a single independent variable, temperature, is to be used. Pressure is to be fixed.

4.2.268.0.2 P: specifies that a single independent variable, pressure, is to be used. Temperature is fixed.

4.2.268.0.3 TP: specifies that two independent variables are used, temperature and pressure.

4.2.269 Process_property_curve_point

A Process_property_curve_point is single data point in a Process_property_curve (see 4.2.268). Exactly one of the Process_design_property_curve_point_usage (see 4.2.257) in the one to many set is an independent variable, and that same Process_design_property_curve_point_usage is used by an Item_-property_reference (see 4.2.169) that is defined by a Thermodynamic_conditions (see 4.2.386).

4.2.270 Process_service

A Process_service is a type of Process_definition (see 4.2.253) that provides a simple description of a portion of a process. A Process_service may not contain any subordinate Process_definition.

The data associated with Process_service are the following:

— description.

A description specifies a summary of key aspects of the Process_service.

4.2.271 Process_simulation

A Process_simulation is a mathematical model of one or more interconnected unit operations or Streams (see 4.2.374) or the algorithms used to solve that model. Each Process_simulation may be one of the following: a Simulation_block (see 4.2.331).

NOTE - A Process_simulation may be constructed of other Process_simulations.

The data associated with Process_simulation are the following:

— algorithm_name;

— algorithm_type;

— module_name;

— name;

— simulation_error_flag;

— version.

4.2.271.1 algorithm_name

An algorithm_name specifies the algorithm used to solve the simulation or to calculate the unit operation model.

4.2.271.2 algorithm_type

An algorithm_type specifies the general type of algorithm used by the Process_simulation. The value of algorithm_type shall be one of the following:

— broyden;

— complex;

— continuation;

— direct;

— newton;

— model;

— other;

— secant;

— sqp;

— wegstein.

4.2.271.2.1 broyden: an indication that the algorithm is a convergence algorithm based on Broyden's method.

4.2.271.2.2 complex: an indication that the algorithm is a optimization algorithm with inequality constraints based on the complex method.

4.2.271.2.3 continuation: an indication that the algorithm is a equation set solution based on a continuation variable method.

4.2.271.2.4 direct: an indication that the algorithm is a convergence or equation set solution based on a direct substitution method.

4.2.271.2.5 newton: an indication that the algorithm is a convergence or equation set solution based on the Newton method.

4.2.271.2.6 model: an indication that the algorithm is the calculation of an unit operation model.

4.2.271.2.7 other: an indication that some other algorithm is used by the Process_simulation.

4.2.271.2.8 secant: an indication that the algorithm is a convergence algorithm based on the secant method.

4.2.271.2.9 sqp: an indication that the algorithm is an optimization algorithm based on sequential linear programming.

4.2.271.2.10 wegstein: an indication that the algorithm is a convergence algorithm based on Wegstein's method.

4.2.271.3 module_name

A module_name specifies the vendor specific name of the software module that is used to implement the Process_simulation.

4.2.271.4 name

A name specifies a user defined name that identifies a Process_simulation.

4.2.271.5 simulation_error_flag

A simulation_error_flag specifies whether the computer execution of the Process_simulation yielded any error conditions.

4.2.271.6 version

A version specifies the vendor specific version number of the software module implementing the Process_-simulation.

4.2.272 Process_simulation_reference_time

A Process_simulation_reference_time is a snapshot of a Process_simulation (see 4.2.271) at a specified point in time.

4.2.273 Process_simulation_relationship

A Process_simulation_relationship is an association between two Process_simulation (see 4.2.271) objects. Each Process_simulation_relationship may be a Simulation_section_relationship (see 4.2.351).

4.2.274 Process_train

A Process_train is a type of Plant_system (see 4.2.244) that is a collection of one or more associated Process_control_units (see 4.2.252) and equipment modules, arranged in serial or parallel paths, used to make a complete batch.

NOTE - This definition was adapted from ISA-S88.01-1995.

The data associated with Process_train are the following:

— process_train_function.

A process_train_function specifies a description of the intended function of the Process_train.

4.2.275 Process_unit_operation

A Process_unit_operation is a type of Process_definition (see 4.2.253) that is an abstraction for the chemical and physical transformations that can generally be performed in Plant_item (see 4.2.237). Each Process_unit_operation may be one of the following: a Uo_complex_distillation (see 4.2.419), a Uo_crusher (see 4.2.423), a Uo_distillation (see 4.2.428), a Uo_fired_heater (see 4.2.437), a Uo_flash (see 4.2.439), a Uo_gas_solid_separator (see 4.2.441), a Uo_heat_exchanger (see 4.2.442), a Uo_liquid_solid_separator (see 4.2.448), a Uo_mixer (see 4.2.451), a Uo_pipeline (see 4.2.454), a Uo_pipeline_node (see 4.2.455), a Uo_pipeline_segment (see 4.2.456), a Uo_pressure_changer (see 4.2.460), a Uo_reactor (see 4.2.462), a Uo_screen (see 4.2.464), a Uo_solids_dryer (see 4.2.471), or a Uo_splitter (see 4.2.473).

The data associated with Process_unit_operation are the following:

— process_unit_operation_type.

A process_unit_operation_type specifies a simple type discriminator.

EXAMPLE 19 - Process_unit_operation_types include Uo_complex_distillation and Uo_crusher.

4.2.276 Process_vessel

A Process_vessel is a type of Process_equipment (see 4.2.260) for the principle purpose of containment of Materials (see 4.2.178). Each Process_vessel may be one of the following: an Atmospheric_tank (see 4.2.10), a Pressure_vessel (see 4.2.251), or a Solids_storage_bin (see 4.2.362).

The data associated with Process_vessel are the following:

— capacity;

— diking_required;

— process_vessel_type.

4.2.276.1 capacity

A capacity specifies the available volume for storing a Process_material (see 4.2.263).

4.2.276.2 diking_required

A diking_required specifies whether the Process_vessel requires a dike around it.

4.2.276.3 process_vessel_type

A process_vessel_type specifies a type of Process_vessel (see 4.2.276).

4.2.277 Property_data_group

A Property_data_group is a number of related Property_data_sets (see 4.2.278).

4.2.278 Property_data_set

A Property_data_set is data generated from a group of Specific_equations (see 4.2.365). Each Property_-data_set may be one of the following: a Distillation_curve (see 4.2.106).

The data associated with Property_data_set are the following:

— data_set_name.

A data_set_name specifies a unique name for the Property_data_set.

4.2.279 Property_note

A Property_note is explanatory text about another object.

The data associated with Property_note are the following:

— note_name;

— note_string.

4.2.279.1 note_name

A note_name specifies an identifier for the Property_note.

4.2.279.2 note_string

A note_string specifies the text of a Property_note.

4.2.280 Psd_values

A Psd_values is the values of the particle intervals for a Particle_size_distribution (see 4.2.205) in a Material_stream (see 4.2.186) or Material_amount (see 4.2.179). A Psd_values may apply to the particles in the entire Material_stream or Material_amount or may be limited to particles that from a specific solid Phase (see 4.2.230). A Psd_values consists of a number of Particle_fractions (see 4.2.203). The intervals for the Particle_fractions are specified by the Particle_size_distribution.

4.2.281 Pseudo_component

A Pseudo_component is a type of Chemical_component (see 4.2.56) that is a combination of Chemical_-species (see 4.2.58) that is treated as though it were a single Chemical_specie and characterized by assigning "molecular" constants to it.

The data associated with Pseudo_component are the following:

- pseudo_component_average_temperature;
- pseudo_component_begin_temperature;
- pseudo_component_end_temperature;
- pseudo_component_generating_source;
- pseudo_component_type.

4.2.281.1 pseudo_component_average_temperature

A pseudo_component_average_temperature specifies the average temperature for a distillation cut for a Pseudo_component (see 4.2.281) characterized by a distillation method or estimation.

4.2.281.2 pseudo_component_begin_temperature

A pseudo_component_begin_temperature specifies the lower temperature bound for a distillation cut for a Pseudo_component (see 4.2.281) characterized by a distillation method or estimation.

4.2.281.3 pseudo_component_end_temperature

A pseudo_component_end_temperature specifies the upper temperature bound for a distillation cut for a Pseudo_component (see 4.2.281) characterized by a distillation method or estimation.

4.2.281.4 pseudo_component_generating_source

A pseudo_component_generating_source specifies the source that generated the Pseudo_component (see 4.2.281).

4.2.281.5 pseudo_component_type

A pseudo_component_type specifies a type of Pseudo_component (see 4.2.281).

4.2.282 Pump

A Pump is a type of Fluid_transfer_machine (see 4.2.149) that raises the pressure of a liquid Stream (see 4.2.374). Each Pump may be one of the following: a Centrifugal_pump (see 4.2.55).

The data associated with Pump are the following:

— pump_type.

A pump_type specifies the type of Pump.

4.2.283 Pump_casing

A Pump_casing is that portion of the Pump (see 4.2.282) that houses the Pump rotor and enables the pumped fluid to flow from suction to discharge.

The data associated with Pump_casing are the following:

— pump_casing_mount;

— pump_casing_split;

— pump_casing_type.

4.2.283.1 pump_casing_mount

A pump_casing_mount specifies how the Pump_casing is mounted on the baseplate. The value of the pump_casing_mount attribute shall be one of the following:

— bracket;

— centreline;

— foot;

— inline;

— near_centreline;

— sump;

— vertical;

— vertical_barrel.

4.2.283.1.1 bracket: an indication that the Pump_casing is bracket mounted.

4.2.283.1.2 centreline: an indication that the Pump_casing is centreline mounted.

4.2.283.1.3 foot: an indication that the Pump_casing is foot mounted.

4.2.283.1.4 inline: an indication the Pump_casing is an inline mounting.

4.2.283.1.5 near_centreline: an indication that the Pump_casing has a near centreline mount.

4.2.283.1.6 sump: an indication that the Pump_casing is for a sump mounted Pump (see 4.2.282).

4.2.283.1.7 vertical: an indication that the Pump_casing is vertically mounted.

4.2.283.1.8 vertical_barrel: an indication that the Pump_casing has a vertical barrel mount.

4.2.283.2 pump_casing_split

A pump_casing_split specifies that the Pump_casing is not a continuous piece but is split in one of two directions so that the casing may be disassembled in the field for maintenance. The value of the pump_-casing_split attribute shall be one of the following:

— axial;

— radial.

4.2.283.2.1 axial: an indication that the Pump_casing is axially spilt.

4.2.283.2.2 radial: an indication that the Pump_casing is vertically split.

4.2.283.3 pump_casing_type

A pump_casing_type specifies the type of Pump_casing. The value of the pump_casing_type attribute shall be one of the following:

— diffuser;

— double_volute;

— single_volute;

— staggered_volute.

4.2.283.3.1 diffuser: an indication that the casing is for a Pump (see 4.2.282) with a diffuser.

4.2.283.3.2 double_volute: an indication the Pump_casing is for a double volute Pump (see 4.2.282).

4.2.283.3.3 single_volute: an indication the Pump_casing is for a single volute Pump (see 4.2.282).

4.2.283.3.4 staggered_volute: an indication that the Pump_casing is for a staggered volute Pump (see 4.2.282).

4.2.284 Pump_casing_test

A Pump_casing_test is the operating test for the Pump_casing (see 4.2.283) to determine if the Pump (see 4.2.282) meets design criteria.

The data associated with Pump_casing_test are the following:

— pump_casing_hydro_test_pressure;

— pump_casing_location;

— pump_casing_max_allowable_pressure;

— pump_casing_test_temperature.

4.2.284.1 pump_casing_hydro_test_pressure

A pump_casing_hydro_test_pressure specifies the hydraulic test pressure with a liquid inside the Pump_-casing (see 4.2.283) to determine the maximum allowable working pressure.

4.2.284.2 pump_casing_location

A pump_casing_location specifies the location for the Pump_casing_test. The value of the pump_casing_-location attribute shall be one of the following;

— inner;

— outer.

4.2.284.2.1 inner: an indication that the test is for an inner case.

4.2.284.2.2 outer: an indication that the test is for the outer case.

4.2.284.3 pump_casing_max_allowable_pressure

A pump_casing_max_allowable_pressure specifies the maximum continuous pressure for which the manufacturer has designed the Pump_casing (see 4.2.283).

4.2.284.4 pump_casing_test_temperature

A pump_casing_test_temperature specifies the temperature of the fluid used in the Pump_casing_test. The value of the pump_casing_test_temperature attribute shall be one of the following:

— at_15c;

— normal_temp.

4.2.284.4.1 at_15c: an indication that the test is carried out at 15 degrees C.

4.2.284.4.2 normal_temp: an indication that the test is carried out at normal operating temperatures.

4.2.285 Pump_gland

A Pump_gland is a pump seal or packing gland.

4.2.286 Pump_gland_taps

A Pump_gland_taps is the connection taps on a gland as part of a mechanical seal or packing.

The data associated with Pump_gland_taps are the following:

— pump_gland_taps_number;

— pump_gland_taps_type.

4.2.286.1 pump_gland_taps_number

A pump_gland_taps_number specifies the number of taps available for that particular Pump_gland (see 4.2.285).

4.2.286.2 pump_gland_taps_type

A pump_gland_taps_type specifies the function of the taps being described. The value of the pump_-gland_taps_type attribute shall be one of the following:

— drain;

— flush;

— quench;

— vent.

4.2.286.2.1 drain: an indication the taps are for the gland drain.

4.2.286.2.2 flush: an indication that the taps are for a seal flushing Stream (see 4.2.374).

4.2.286.2.3 quench: an indication the taps are for a safety quench.

4.2.286.2.4 vent: an indication the taps are for a gland vent.

4.2.287 Pump_impeller

A Pump_impeller is the moving element in a Centrifugal_pump (see 4.2.55), generally with integral vanes to deliver a velocity impulse to the fluid.

The data associated with Pump_impeller are the following:

— pump_imp_diameter;

— pump_imp_mount.

4.2.287.1 pump_imp_diameter

A pump_imp_diameter specifies the diameter size of the Pump_impeller.

> NOTE - Usually, the impeller size is specified as a trimmed version of the maximum diameter, such as 11.25/12. This means that the actual diameter is 11.25 inches and the maximum diameter is 12 inches for that particular size Pump (see 4.2.282).

4.2.287.2 pump_imp_mount

A pump_imp_mount specifies the type of mounting that is used for the Pump_impeller. The value of the pump_imp_mount attribute shall be one of the following:

— btwn_bearings;

— overhung.

4.2.287.2.1 btwn_bearings: an indication the impeller is mounted between Bearings (see 4.2.16).

4.2.287.2.2 overhung: an indication the impeller has an overhung mounting.

4.2.288 Pump_packing

A Pump_packing is a compressible ring of Material (see 4.2.178) used to seal the space between the Shaft (see 4.2.325) and packing gland against leakage of process fluid.

The data associated with Pump_packing are the following:

— pump_packing_number_of_rings.

A pump_packing_number_of_rings specifies the actual number of rings of packing that are used in the Pump_packing assembly.

4.2.289 Radial_bearing

A Radial_bearing is a type of Bearing (see 4.2.16) that is a machine element placed between the Shaft (see 4.2.325) and the casing to isolate the casing from the torque generated by the Shaft and to align the Shaft. A Radial_bearing is wrapped around the Shaft radial_bearing_span.

The data associated with Radial_bearing are the following:

— radial_bearing_fluid_mach_number;

— radial_bearing_span.

4.2.289.1 radial_bearing_fluid_mach_number

A radial_bearing_fluid_mach_number specifies the design maximum mach number the bearing is rated for.

4.2.289.2 radial_bearing_span

A radial_bearing_span specifies the width of the contact surface between the Shaft (see 4.2.325) and the Bearing (see 4.2.16).

4.2.290 Raw_property_value

A Raw_property_value is a single raw value for a point property of a Substance (see 4.2.381).

The data associated with Raw_property_value are the following:

— value_of_raw_property.

A value_of_raw_property specifies the numerical value of a Raw_property_value.

4.2.291 Reaction_parametric_data

A Reaction_parametric_data (see 4.2.291) is the parametric data for a Chemical_reaction (see 4.2.57) at a given temperature and pressure. Each entry of Reaction_parametric_data must include data for all of the attributes defined below.

4.2.292 Reaction_rate

A Reaction_rate (see 4.2.292) is the reaction rate of a Chemical_reaction (see 4.2.57) associated with the Uo_reactor (see 4.2.462) objects in the simulation. Each Reaction_rate may be an Arrhenius_reaction (see 4.2.9).

The data associated with Reaction_rate are the following:

— description;

— reaction_order.

4.2.292.1 description

A description specifies a short summary of key aspects of the Reaction_rate.

4.2.292.2 reaction_order

A reaction_order specifies a reaction order of the Substance (see 4.2.381) for the Reaction_rate (see 4.2.292).

4.2.293 Reaction_system_equipment

A Reaction_system_equipment is a type of Process_equipment (see 4.2.260).

4.2.294 Reactor_yield

A Reactor_yield is the reactor yield associated with the Uo_specified_yield_reactor (see 4.2.472) in the simulation for one Substance (see 4.2.381) in one Phase (see 4.2.230).

The data associated with Reactor_yield are the following:

— reactor_yield_mass_ratio;

— reactor_yield_mole_ratio.

4.2.294.1 reactor_yield_mass_ratio

A reactor_yield_mass_ratio specifies the Reactor_yield, expressed as a mass ratio, associated with the Uo_-specified_yield_reactor (see 4.2.472) in the simulation.

4.2.294.2 reactor_yield_mole_ratio

A reactor_yield_mole_ratio specifies the Reactor_yield, expressed as a mole ratio, associated with the Uo_-specified_yield_reactor (see 4.2.472) in the simulation.

4.2.295 Reboiler_piping

A Reboiler_piping is all inlet and outlet piping pertaining to a thermosiphon reboiler system.

The data associated with Reboiler_piping are the following:

- fraction_deltap_across_inlet_valve;
- number_feed_lines_from_column;
- number_return_lines_to_column;
- offset_to_reference_level;
- reboiler_piping_type;
- total_inlet_change_in_height;
- total_inlet_equivalent_length;
- total_outlet_change_in_height;
- total_outlet_equivalent_length.

4.2.295.1 fraction_deltap_across_inlet_valve

A fraction_deltap_across_inlet_valve specifies the fraction of the total piping pressure drop that occurs across an inlet valve or orifice expressed as a percentage.

4.2.295.2 number_feed_lines_from_column

A number_feed_lines_from_column specifies the number of feed lines from the column to the thermosiphon inlet.

4.2.295.3 number_return_lines_to_column

A number_return_lines_to_column specifies the number of return lines from the thermosiphon to the column.

4.2.295.4 offset_to_reference_level

An offset_to_reference_level specifies the distance from the bottom of the distillation column to the top tubesheet for a vertical heat exchanger and the distance from the bottom of the distillation column to the bottom of the shell for a horizontal heat exchanger.

4.2.295.5 reboiler_piping_type

A reboiler_piping_type specifies an enumerated attribute that indicates the type of Reboiler_piping as a forced flow reboiler with pump, a thermosiphon reboiler, or unspecified.

4.2.295.6 total_inlet_change_in_height

A total_inlet_change_in_height specifies the total change in elevation (height) from the bottom of the tower to the inlet of the heat exchanger for all thermosiphon inlet piping. The height is specified to the inside bottom tubesheet face for vertical units and the bottom of the inside of the shell for horizontal units.

NOTE - This is an optional specification rather than using External_circuit_component (see 4.2.141) description of each piping element. Normally negative.

4.2.295.7 total_inlet_equivalent_length

A total_inlet_equivalent_length specifies the total equivalent length of all thermosiphon inlet piping.

NOTE - This is an optional specification rather than using External_circuit_component (see 4.2.141) description of each piping element.

4.2.295.8 total_outlet_change_in_height

A total_outlet_change_in_height specifies the total change in elevation (height) from the heat exchanger to the tower for all thermosiphon outlet piping. The height is specified from the inside top tubesheet face for vertical units and the top of the inside of the shell for horizontal units.

NOTE - This is an optional specification rather than using External_circuit_component (see 4.2.141) description of each piping element.

4.2.295.9 total_outlet_equivalent_length

A total_outlet_equivalent_length specifies the total equivalent length of all thermosiphon outlet piping.

NOTE - This is an optional specification rather than using External_circuit_component (see 4.2.141) description of each piping element.

4.2.296 Reciprocating_compressor

A Reciprocating_compressor is a gas compressor that operates on the principle of a two-stroke piston, a suction followed by discharge. The piston may be replaced by a flexible diaphragm which oscillates back and forth.

The data associated with Reciprocating_compressor are the following:

— reciprocating_compressor_number_of_stages.

A reciprocating_compressor_number of stages specifies the number of stages in a Reciprocating_-compressor.

4.2.297 Reciprocating_compressor_stage

A Reciprocating_compressor_stage is one compressor stage that is part of a multi-stage compression system.

NOTE - The number of stages is determined by the required compression ratio.

The data associated with Reciprocating_compressor_stage are the following:

— reciprocating_compressor_stage_clearance_fraction;

— reciprocating_compressor_stage_displacement;

— reciprocating_compressor_stage_number;

— reciprocating_compressor_stage_type.

4.2.297.1 reciprocating_compressor_stage_clearance_fraction

A reciprocating_compressor_stage_clearance_fraction specifies the fraction of the total displacement volume that is needed to make room for valves, such as intake and exhaust, and any other top works in the compression chamber.

4.2.297.2 reciprocating_compressor_stage_displacement

A reciprocating_compressor_stage_displacement specifies the volumetric displacement of each compressor stage.

4.2.297.3 reciprocating_compressor_stage_number

A reciprocating_compressor_stage_number specifies the specific stage number as part of the total number of stages.

EXAMPLE 20 - Stage 3 of 6 indicates the third stage in a six stage compressor.

4.2.297.4 reciprocating_compressor_stage_type

A reciprocating_compressor_stage_type specifies the type stage used in the Reciprocating_compressor (see 4.2.296) based on material construction requirements and compression requirements. The value of the reciprocating_compressor_stage_type shall be one of the following:

— diaphragm;

— piston.

4.2.297.4.1 diaphragm: an indication that the stage is a diaphragm type.

4.2.297.4.2 piston: an indication that the stage is a reciprocating piston type.

4.2.298 Reciprocating_power_port

A Reciprocating_power_port is a type of Mechanical_power_port (see 4.2.190) for which the mechanical power at the Equipment_port (see 4.2.125) is in the form of reciprocating pistons.

The data associated with Reciprocating_power_port are the following:

— normal_stroke_frequency;

— number_of_pistons;

— rated_maximum_stroke_frequency.

4.2.298.1 normal_stroke_frequency

A normal_stroke_frequency specifies the normal frequency of the piston cycles of a Reciprocating_-power_port.

4.2.298.2 number_of_pistons

A number_of_pistons specifies the number of pistons in the Reciprocating_power_port.

4.2.298.3 rated_maximum_stroke_frequency

A rated_maximum_stroke_frequency specifies the maximum rated frequency of the piston cycles for a Reciprocating_power_port.

4.2.299 Reducing_nozzle_section

A Reducing_nozzle_section is a Nozzle_section (see 4.2.199) that is a straight length with a reducer.

The data associated with Reducing_nozzle_section are the following:

— reducing_nozzle_section_angular_offset_of_small_circle;

— reducing_nozzle_section_eccentric;

— reducing_nozzle_section_inside_diameter2;

— reducing_nozzle_section_nominal_diameter2;

— reducing_nozzle_section_outside_diameter2.

4.2.299.1 reducing_nozzle_section_angular_offset_of_small_circle

A reducing_nozzle_section_angular_offset_of_small_circle specifies the angular offset associated with the small circle of the Reducing_nozzle_section.

4.2.299.2 reducing_nozzle_section_eccentric

A reducing_nozzle_section_eccentric specifies that the Reducing_nozzle_section has eccentric sides.

4.2.299.3 reducing_nozzle_section_inside_diameter2

A reducing_nozzle_section_inside_diameter_2 specifies the second inside diameter for the Reducing_-nozzle_section. This is the side toward the highest numbered section of the Nozzle (see 4.2.194).

4.2.299.4 reducing_nozzle_section_nominal_diameter2

A reducing_nozzle_section_nominal_diameter_2 specifies the second nominal diameter for the Reducing_-nozzle_section. This is the side toward the highest numbered section of the Nozzle (see 4.2.194).

4.2.299.5 reducing_nozzle_section_outside_diameter2

A reducing_nozzle_section_outside_diameter_2 specifies the second outside diameter for the Reducing_-nozzle_section. This is the side toward the highest numbered section of the Nozzle (see 4.2.194).

4.2.300 Reference_state

A Reference_state is a collection of Variables (see 4.2.489) which define a Reference_state.

The data associated with Reference_state are the following:

— mixture_type.

A mixture_type specifies an enumerated attribute which gives the category of Mixture (see 4.2.192) (basis) that the Reference_state is. The value of the mixture_type attribute shall be one of the following:

— ideal_gas;

— ideal_solution;

— infinite_dilution;

— other_mixture_type;

— pure_component;

— real_mixture.

4.2.300.0.1 ideal_gas: an indication the Reference_state is for an ideal gas.

4.2.300.0.2 ideal_solution: an indication the Reference_state is an ideal solution.

4.2.300.0.3 infinite_dilution: an indication the Reference_state is for a Mixture (see 4.2.192) with infinite dilution for solutes.

4.2.300.0.4 other_mixture_type: an indication the Reference_state is for a Mixture (see 4.2.192) type not defined by the other values.

4.2.300.0.5 pure_component: an indication the Reference_state is for a pure Chemical_component (see 4.2.56) basis.

4.2.300.0.6 real_mixture: an indication the Reference_state is for a real Mixture (see 4.2.192).

4.2.301 Reference_state_variable_relationship

A Reference_state_variable_relationship is the association between a Reference_state (see 4.2.300) and one of the Variables (see 4.2.489) which define it.

The data associated with Reference_state_variable_relationship are the following:

— reference_state_variable_value.

A reference_state_variable_value specifies the numerical value of the Variable (see 4.2.489) for the Reference_state (see 4.2.300).

4.2.302 Reference_time_relationship

A Reference_time_relationship specifies an association between two Time_references (see 4.2.393) in which one Time_reference occurs prior to another Time_reference.

4.2.303 Referenced_object

A Referenced_object is an object that is associated with at least one Process_design_property_value (see 4.2.258) by an Item_property_reference (see 4.2.169). The possible objects referenced are: Bulk_-thermophysical_properties (see 4.2.33), Chemical_reaction (see 4.2.57), Composition_relationship (see 4.2.65), Equipment_port (see 4.2.125), Material (see 4.2.178), Mixture (see 4.2.192), Phase (see 4.2.230), Plant_item (see 4.2.237), Plant_system (see 4.2.244), Reaction_rate (see 4.2.292), Site (see 4.2.354), Specific_phase (see 4.2.367), Stream (see 4.2.374), and Thermodynamic_conditions (see 4.2.386).

4.2.304 Relative_time_reference

A Relative_time_reference is a temporal context that is specified as a time displacement measured from a particular Absolute_time_reference (see 4.2.1).

The data associated with Relative_time_reference are the following:

— relative_time_name;

— offset_amount.

4.2.304.1 relative_time_name

A relative_time_name specifies a string by which the Relative_time_reference can be referred.

4.2.304.2 offset_amount

An offset_amount specifies a measure of time by which the Relative_time_reference is displaced from the Absolute_time_reference (see 4.2.1).

4.2.305 Riser_and_tray_panel_shape

A Riser_and_tray_panel_shape is the geometric description of the Bubble_cap (see 4.2.28) riser and the Tray_panel_shape (see 4.2.403) characterized by the rise above the panel top.

The data associated with Riser_and_tray_panel_shape are the following:

— rise_above_panel_top.

A rise_above_panel_top specifies the difference between the rise above base and the thickness of the material from which the Tray_panel (see 4.2.399) is made.

4.2.306 Riser_shape

A Riser_shape is described by Perimeters (see 4.2.216).

The data associated with Riser_shape are the following:

— rise_above_base;

— width_of_base.

4.2.306.1 rise_above_base

A rise_above_base specifies the distance from the top of the expanded base to the top of the riser.

4.2.306.2 width_of_base

A width_of_base specifies the dimension such that the riser will fit up through the perforation but the expanded base will seal against the bottom of the Tray_panel (see 4.2.399).

4.2.307 Rotating_equipment_tests

A Rotating_equipment_tests is a type of Inspection_and_tests (see 4.2.164) which are performed on Plant_items (see 4.2.237) which are also rotating equipment.

> NOTE - These tests are carried out by a manufacturer prior to the delivery of the rotating equipment Plant_item to a customer.

The data associated with Rotating_equipment_tests are the following:

— chk_brgs_and_seals_after_test;

— test_compr_less_driver;

— test_compr_with_driver;

— test_fit_in_spare_rotor;

— test_job_lube_and_seal_syst;

— test_job_vibr_and_axial_probes_oscillators_and_detectors;

— test_mechanical_run;

— test_mechanical_run_spare_rotor;

— test_resid_elect_mech_runout;

— test_shop_lube_and_seal_syst;

— test_shop_vibr_probes.

4.2.307.1 chk_brgs_and_seals_after_test

A chk_brgs_and_seals_after_test specifies whether the Plant_item (see 4.2.237) bearings and seals are to be inspected after completion of the test.

4.2.307.2 test_compr_less_driver

A test_compr_less_driver specifies whether the compressor is to be tested without its driver.

4.2.307.3 test_compr_with_driver

A test_compr_with_driver specifies whether the compressor is to be tested with its driver.

4.2.307.4 test_fit_in_spare_rotor

A test_fit_in_spare_rotor specifies whether a performance test is to be made using the spare rotor.

4.2.307.5 test_job_lube_and_seal_syst

A test_job_lube_and_seal_syst specifies whether the lubrication and seal system is to be tested after installation.

4.2.307.6 test_job_vibr_and_axial_probes_oscillators_and_detectors

A test_job_vibr_and_axial_probes_oscillators_and_detectors specifies whether vibration probes will be used on a performance test after installation.

4.2.307.7 test_mechanical_run

A test_mechanical_run specifies whether a mechanical run test is to be performed.

4.2.307.8 test_mechanical_run_spare_rotor

A test_mechanical_run_spare_rotor specifies whether a mechanical run test is to be performed using the spare rotor.

4.2.307.9 test_resid_elect_mech_runout

A test_resid_elect_mech_runout specifies whether a residual mechanical runout test is to be performed.

4.2.307.10 test_shop_lube_and_seal_syst

A test_shop_lube_and_seal_syst specifies whether the lubrication and seal system is tested at the shop.

4.2.307.11 test_shop_vibr_probes

A test_shop_vibr_probes specifies whether vibration probes will be used on the shop performance test.

4.2.308 Rotating_power_port

A Rotating_power_port is a type of Mechanical_power_port (see 4.2.190) for which the mechanical power at the Equipment_port (see 4.2.125) is in the form of a rotating Shaft (see 4.2.325).

The data associated with Rotating_power_port are the following:

- allowable_peak_to_peak_vibration;
- normal_revolution_frequency;
- normal_torque;

— rated_maximum_revolution_frequency;

— rated_maximum_torque;

— rotation_direction.

4.2.308.1 allowable_peak_to_peak_vibration

An allowable_peak_to_peak_vibration specifies the specification for the maximum allowable peak to peak vibration for the Shaft (see 4.2.325) of a Rotating_power_port.

4.2.308.2 normal_revolution_frequency

A normal_revolution_frequency specifies the specification for the normal frequency of the Shaft (see 4.2.325) revolutions for a Rotating_power_port.

4.2.308.3 normal_torque

A normal_torque specifies the specification for the normal torque applied to the rotating Shaft (see 4.2.325) of a Rotating_power_port.

4.2.308.4 rated_maximum_revolution_frequency

A rated_maximum_revolution_frequency specifies the specification for the maximum rated frequency of the Shaft (see 4.2.325) revolutions for a Rotating_power_port.

4.2.308.5 rated_maximum_torque

A rated_maximum_torque specifies the specification for the maximum rated torque for the rotating Shaft (see 4.2.325) of a Rotating_power_port.

4.2.308.6 rotation_direction

A rotation_direction specifies an enumerated attribute that indicates the allowable rotation direction of a Rotating_power_port. The value of the rotation_direction attribute shall be one of the following:

— both;

— clockwise;

— counterclockwise.

4.2.308.6.1 both: an indication that the allowable rotation direction for a Rotating_power_port is both clockwise and counterclockwise when facing the end of the rotating Shaft (see 4.2.325).

4.2.308.6.2 clockwise: an indication that the allowable rotation direction for a Rotating_power_port is clockwise when facing the end of the rotating Shaft (see 4.2.325).

4.2.308.6.3 counterclockwise: an indication that the allowable rotation direction for a Rotating_power_-port is counterclockwise when facing the end of the rotating Shaft (see 4.2.325).

4.2.309 Seal_pan

A Seal_pan is used to redirect liquid across the Separation_tray (see 4.2.316) to help provide a liquid seal to prevent the vapour from flowing upward through the liquid flow channel.

> NOTE - The Seal_pan is located beneath the liquid flow channels, has no perforations, and may have recessed areas to collect liquid and aid in the creation of an effective liquid seal.

4.2.310 Seal_pan_recess_shape

A Seal_pan_recess_shape is described by a Perimeter (see 4.2.216) and is used to collect liquid and aid in the creation of a liquid seal.

The data associated with Seal_pan_recess_shape are the following:

— recess_depth.

A recess_depth specifies the vertical depth of the recessed area.

4.2.311 Seal_pan_shape

A Seal_pan_shape is a geometry described by a Perimeter (see 4.2.216) and is dependent on whether the liquid flow is chordal, radial, or reverse.

The data associated with Seal_pan_shape are the following:

— seal_pan_location_type.

A seal_pan_location_type specifies an enumerated attribute that indicates that the Seal_pan (see 4.2.309) is a side, center, or off-center Seal_pan.

4.2.312 Separation_efficiency

A Separation_efficiency is the percentage efficiency for a Separation_tray (see 4.2.316) between the theoretical and actual separation within the Separation_tower (see 4.2.314).

The data associated with Separation_efficiency are the following:

— efficiency_method;

— efficiency_type;

— efficiency_value.

4.2.312.1 efficiency_method

An efficiency_method specifies an enumerated attribute that indicates whether the method used is an uncorrected Murphree plate efficiency or a corrected Murphree plate efficiency.

4.2.312.2 efficiency_type

An efficiency_type specifies the effects of liquid entrainment by the vapour Phase (see 4.2.230).

4.2.312.3 efficiency_value

An efficiency_value specifies the percentage number that specifies the Separation_efficiency.

NOTE - This value is usually between 50 and 100 percent.

4.2.313 Separation_packing_stack

A Separation_packing_stack is a combination of structural or randomly packed mass transfer packing material.

4.2.314 Separation_tower

A Separation_tower is a type of Process_equipment (see 4.2.260) generally used to perform a chemical separation that is a composite of one or more Cylindrical_pressure_vessels (see 4.2.87) and zero or more Separation_tower_internals (see 4.2.315).

The data associated with Separation_tower are the following:

— number_of_demister_pad_stacks;

— number_of_demister_pads;

— number_of_separate_tray_stacks;

— number_of_separation_packing_stacks;

— separation_tower_type.

4.2.314.1 number_of_demister_pad_stacks

A number_of_demister_pad_stacks specifies the numeric quantity of Demister_pad_stacks (see 4.2.99) within the Separation_tower.

4.2.314.2 number_of_demister_pads

A number_of_demister_pads specifies the number of Demister_pads (see 4.2.98) within each set of Demister_pad_stacks (see 4.2.99).

4.2.314.3 number_of_separate_tray_stacks

A number_of_separate_tray_stacks specifies the assembly of one or more Separation_trays (see 4.2.316) in a vertical arrangement.

4.2.314.4 number_of_separation_packing_stacks

A number_of_separation_packing_stacks specifies the number of different Separation_packing_stacks (see 4.2.313) within a Separation_tower.

4.2.314.5 separation_tower_type

A separation_tower_type specifies an enumerated attribute that designates a Separation_tower to be a distillation column, extraction column, stripping column, rectifying column, splash tower, spray tower, wetted-wall column, absorption column, or an other column.

4.2.315 Separation_tower_internal

A Separation_tower_internal is a type of Process_equipment (see 4.2.260) made of Construction_material (see 4.2.72) that permanently resides inside the Cylindrical_pressure_vessel (see 4.2.87).

The data associated with Separation_tower_internal are the following:

— tower_internal_type.

A tower_internal_type specifies composites of other Separation_tower_internals.

EXAMPLE 21 - Other internals include Separation_tray_stacks (see 4.2.322) that are composites of Separation_trays (see 4.2.316) that are composites of Separation_tray_components (see 4.2.319).

4.2.316 Separation_tray

A Separation_tray is a type of Separation_tower_internal (see 4.2.315) whose purpose is to contact a liquid Phase (see 4.2.230) and vapour Phase, generally to effect mass transfer, but occasionally to effect heat transfer between the Phases.

4.2.317 Separation_tray_baffle

A Separation_tray_baffle is a vertical barrier that is placed in the liquid flow to force the liquid to flow around the barrier.

> NOTE - There may be a number of baffles on a Separation_tray (see 4.2.316) and they may reside on the Tray_panels (see 4.2.399), Seal_pans (see 4.2.309), and the Downcomer (see 4.2.109) disengaging panels.

4.2.318 Separation_tray_baffle_shape

A Separation_tray_baffle_shape is the geometric features of a baffle.

The data for Separation_tray_baffle_shape are the following:

— attachment_method;

— disengaging_panel_intersection_length;

— height;

— seal_pan_intersection_length;

— tray_panel_intersection_length.

4.2.318.1 attachment_method

An attachment_method specifies an enumerated attribute that indicates whether the baffle is welded, extends between tray components, or is bolted.

4.2.318.2 disengaging_panel_intersection_length

A disengaging_panel_intersection_length specifies the length of the intersection between the Separation_-tray_baffle (see 4.2.317) and the disengaging panel.

4.2.318.3 height

A height specifies the vertical distance from the Separation_tray (see 4.2.316) to the top of the Separation_tray_baffle (see 4.2.317).

4.2.318.4 seal_pan_intersection_length

A seal_pan_intersection_length specifies the length of the intersection between the Separation_tray_baffle (see 4.2.317) and the Seal_pan (see 4.2.309).

4.2.318.5 tray_panel_intersection_length

A tray_panel_intersection_length specifies the length of the intersection between the Separation_tray_baffle (see 4.2.317) and the Tray_panel (see 4.2.399).

4.2.319 Separation_tray_component

A Separation_tray_component is one or more components of Separation_trays (see 4.2.316).

The data associated with Separation_tray_component are the following:

— separation_tray_component_type.

A separation_tray_component_type specifies the types of components that make up a Separation_tray (see 4.2.316) including Seal_pans (see 4.2.309), Tray_panels (see 4.2.399), Downcomers (see 4.2.109), Perforation_covers (see 4.2.209), and Weirs (see 4.2.494).

4.2.320 Separation_tray_hydraulics

A Separation_tray_hydraulics is a description of the hydraulic features of the Separation_tray (see 4.2.316).

The data associated with Separation_tray_hydraulics are the following:

— absorption_factor;

— capacity_parameter;

— dry_tray_pressure_drop;

— entrainment_rate;

— flow_parameter;

— fractional_entrainment;

— jet_flood_vapour_load_at_constant_liquid_flow;

— jet_flood_vapour_load_at_constant_molar_overflow;

— liquid_height;

— liquid_residence_time;

— percentage_probability_of_flooding;

— safety_factor_for_flooding;

— tray_pressure_drop;

— vapour_capacity_factor;

— vapour_load_at_dump_point;

— vapour_load_at_weep_point;

— vapour_load_limit;

— vapour_residence_time;

— weep_fraction;

— weep_rate.

4.2.320.1 absorption_factor

An absorption_factor specifies the rate of absorption on each Separation_tray (see 4.2.316).

4.2.320.2 capacity_parameter

A capacity_parameter specifies the hydraulic capacity for each Separation_tray (see 4.2.316).

4.2.320.3 dry_tray_pressure_drop

A dry_tray_pressure_drop specifies the pressure drop across the Separation_tray (see 4.2.316) when there is no liquid on the Separation_tray.

4.2.320.4 entrainment_rate

An entrainment_rate specifies the rate of liquid entrainment in the vapour on each Separation_tray (see 4.2.316).

4.2.320.5 flow_parameter

A flow_parameter specifies the hydraulic flow across the Separation_tray (see 4.2.316).

4.2.320.6 fractional_entrainment

A fractional_entrainment specifies the portion of liquid entrainment in the vapour flow rate.

4.2.320.7 jet_flood_vapour_load_at_constant_liquid_flow

A jet_flood_vapour_load_at_constant_liquid_flow specifies the maximum vapour flow rate at a particular constant liquid flow rate.

4.2.320.8 jet_flood_vapour_load_at_constant_molar_overflow

A jet_flood_vapour_load_at_constant_molar_overflow specifies a maximum vapour flow rate at a constant molar liquid flow on the Separation_tray (see 4.2.316).

4.2.320.9 liquid_height

A liquid_height specifies the hydraulic liquid depth on the Separation_tray (see 4.2.316).

NOTE - The liquid_height varies across the Separation_tray due to a hydraulic gradient that enables liquid flow across the Separation_tray.

4.2.320.10 liquid_residence_time

A liquid_residence_time specifies the time that the liquid is on the Separation_tray_structural_component (see 4.2.323).

4.2.320.11 percentage_probability_of_flooding

A percentage_probability_of_flooding specifies a percentage value indicating the probability for tray flooding.

4.2.320.12 safety_factor_for_flooding

A safety_factor_for_flooding specifies the design safety factor for the Separation_tray (see 4.2.316) to prevent liquid flooding.

4.2.320.13 tray_pressure_drop

A tray_pressure_drop specifies the pressure drop across the Separation_tray (see 4.2.316) when it is operating with normal hydraulic liquid flows.

4.2.320.14 vapour_capacity_factor

A vapour_capacity_factor specifies a numeric value indicating the vapour capacity of the Separation_tray (see 4.2.316) and how close the design approaches this value.

4.2.320.15 vapour_load_at_dump_point

A vapour_load_at_dump_point specifies the reduced vapour load when the Separation_tray (see 4.2.316) begins to dump liquid down the Separation_tower (see 4.2.314).

4.2.320.16 vapour_load_at_weep_point

A vapour_load_at_weep_point specifies the vapour load at the point that weeping begins to occur on the Separation_tray (see 4.2.316).

NOTE - Weeping is when liquid starts flowing down through the perforation.

4.2.320.17 vapour_load_limit

A vapour_load_limit specifies the upper vapour flow rate limit for the Separation_tray (see 4.2.316).

4.2.320.18 vapour_residence_time

A vapour_residence_time specifies the time it takes for the vapour to pass through the liquid on the Separation_tray (see 4.2.316).

4.2.320.19 weep_fraction

A weep_fraction specifies the portion of weeping that occurs on each Separation_tray (see 4.2.316) at design conditions.

4.2.320.20 weep_rate

A weep_rate specifies the flow rate for tray weeping on each Separation_tray (see 4.2.316).

4.2.321 Separation_tray_shape

A Separation_tray_shape is the geometric feature that describes the shape of the Separation_tray (see 4.2.316). The Separation_tray_shape may have a Perimeter (see 4.2.216) and is described by an aggregation of one or more Tray_panel_shapes (see 4.2.403), zero or more Seal_pan_shapes (see 4.2.311), zero or more Downcomer_shapes (see 4.2.115), zero or more Weir_shapes (see 4.2.498), zero or more Baffle_cap_shapes (see 4.2.29), and zero or more Blinding_strip_shapes (see 4.2.22). If the Separation_-tray_shape describes a cascade tray, there will be one or more Tray_cascades (see 4.2.398) associated with the Separation_tray_shape.

The data associated with Separation_tray_shape are the following:

— liquid_flow_type;

— number_of_baffles;

— number_of_blinding_strips;

— number_of_cascades;

— number_of_downcomers;

— number_of_liquid_passes;

— number_of_liquid_reverses;

— number_of_panels;

— number_of_seal_pans;

— number_of_weirs;

— tray_repeat_frequency;

— tray_to_tray_image;

— tray_to_tray_rotation_angle;

— tray_type.

4.2.321.1 liquid_flow_type

A liquid_flow_type specifies an enumerated attribute that indicates whether the liquid flow is radial, chordal, or reverse. The value of the liquid_flow_attribute shall be one of the following:

— chordal;

— radial;

— reverse.

4.2.321.1.1 chordal: an indication that liquid flow is along a radius of the circular tower cross-section.

4.2.321.1.2 radial: an indication that liquid flow is from chord of the circular tower cross-section to another chord.

4.2.321.1.3 reverse: an indication that liquid flow encounters obstructions that require the liquid to reverse its direction of flow on portions of the Separation_tray (see 4.2.316).

4.2.321.2 number_of_baffles

A number_of_baffles specifies the numeric quantity of baffles associated with each Separation_tray (see 4.2.316).

4.2.321.3 number_of_blinding_strips

A number_of_blinding_strips specifies the numeric quantity of blinding strips associated with each Separation_tray (see 4.2.316).

4.2.321.4 number_of_cascades

A number_of_cascades specifies the numeric quantity of Tray_cascades (see 4.2.398) associated with each Separation_tray (see 4.2.316).

4.2.321.5 number_of_downcomers

A number_of_downcomers specifies the numeric quantity of Downcomers (see 4.2.109) associated with each Separation_tray (see 4.2.316).

4.2.321.6 number_of_liquid_passes

A number_of_liquid_passes specifies the numeric quantity of discontiguous liquid flows on the Separation_tray (see 4.2.316).

4.2.321.7 number_of_liquid_reverses

A number_of_liquid_reverses specifies the numeric quantity of times the flow is reversed on the Separation_tray (see 4.2.316).

4.2.321.8 number_of_panels

A number_of_panels specifies the numeric quantity of Tray_panels (see 4.2.399) that are used on each Separation_tray (see 4.2.316).

4.2.321.9 number_of_seal_pans

A number_of_seal_pans specifies the numeric quantity of Seal_pans (see 4.2.309) that are used on each Separation_tray (see 4.2.316).

4.2.321.10 number_of_weirs

A number_of_weirs specifies the numeric quantity of Weirs (see) used with each Separation_tray (see 4.2.316).

4.2.321.11 tray_repeat_frequency

A tray_repeat_frequency specifies an enumerated attribute that indicates whether every Separation_tray (see 4.2.316) in the Separation_tray_stack (see 4.2.322) is identical in shape and orientation, or that every other Separation_tray in the Separation_tray_stack is identical in shape and orientation, or that some other frequency occurs.

4.2.321.12 tray_to_tray_image

A tray_to_tray_image specifies an enumerated attribute that indicates whether the Separation_tray_shape of one Separation_tray (see 4.2.316) is an identical image, a mirror image, or some other image of the next Separation_tray in the Separation_tray_stack (see 4.2.322).

4.2.321.13 tray_to_tray_rotation_angle

A tray_to_tray_rotation_angle specifies that every Separation_tray (see 4.2.316) in the Separation_tray_-stack (see 4.2.322) is similar in shape but is oriented by a rotation angle from one Separation_tray to the next.

4.2.321.14 tray_type

A tray_type specifies an enumerated attribute that indicates whether the Separation_tray (see 4.2.316) is a cross-flow, counter-flow, or splash-flow tray.

4.2.322 Separation_tray_stack

A Separation_tray_stack is a collection of one or more Separation_trays (see 4.2.316) in a vertical arrangement.

> NOTE - The gross flow of the liquid Phase (see 4.2.230) is from the top to the bottom of the Separation_tray_stack while the vapour Phase gross flow is from the bottom to the top.

The data associated with Separation_tray_stack are the following:

- number_of_trays;
- overall_corrected_efficiency;
- overall_uncorrected_efficiency;
- stack_type;
- tray_spacing.

4.2.322.1 number_of_trays

A number_of_trays specifies the total number of Separation_trays (see 4.2.316) in each Separation_tray_-stack.

4.2.322.2 overall_corrected_efficiency

An overall_corrected_efficiency specifies the Separation_efficiency (see 4.2.312) of the Separation_trays (see 4.2.316) in a Separation_tray_stack based on the overall wet vapour efficiency and the effect of liquid entrainment by the vapour Phase (see 4.2.230).

4.2.322.3 overall_uncorrected_efficiency

An overall_uncorrected_efficiency specifies the Separation_efficiency (see 4.2.312) of the Separation_trays (see 4.2.316) in a Separation_tray_stack based on the overall dry vapour efficiency.

4.2.322.4 stack_type

A stack_type specifies an enumerated attribute that indicates that the Separation_tray_stack is a preassembled stack or a stack assembled in tower.

4.2.322.5 tray_spacing

A tray_spacing specifies the distance between Separation_trays (see 4.2.316) within a Separation_tray_-stack.

4.2.323 Separation_tray_structural_component

A Separation_tray_structural_component is the part of a Separation_tray (see 4.2.316) that does not have ports.

The data associated with Separation_tray_structural_component are the following:

— separation_tray_structural_component_type.

A separation_tray_structural_component_type specifies an enumerated attribute that indicates whether the Separation_tray_structural_components are baffles or blinding strips.

4.2.324 Service_connections

A Service_connections is miscellaneous external connections on a Fluid_transfer_machine (see 4.2.149), such as a compressor or pump.

NOTE - These external connections are most likely pipe taps or fittings.

The data associated with Service_connections are the following:

— connection_between_brg_and_seal;

— connection_between_seal_and_fluid;

— connection_brg_housing_purge;

— connection_casing_drain;

— connection_cooling_water;

— connection_lube_oil_inlet;

— connection_lube_oil_outlet;

— connection_pressure_tap;

— connection_seal_oil_inlet;

— connection_seal_oil_outlet;

— connection_solvent_injection;

— connection_stage_drain;

— connection_temperature_tap;

— connection_vents;

— connection_warm_up.

4.2.324.1 connection_between_brg_and_seal

A connection_between_brg_and_seal specifies the service connections between the compressor or pump bearings and mechanical seal.

4.2.324.2 connection_between_seal_and_fluid

A connection_between_seal_and_fluid specifies the service connections between the compressor or pump mechanical seal and the fluid being transferred.

4.2.324.3 connection_brg_housing_purge

A connection_brg_housing_purge specifies the service connections on the purge for the bearing housing.

4.2.324.4 connection_casing_drain

A connection_casing_drain specifies the service connections for the casing drain from the Pump_casing (see 4.2.283) or compressor casing.

4.2.324.5 connection_cooling_water

A connection_cooling_water specifies the service connection for cooling water.

4.2.324.6 connection_lube_oil_inlet

A connection_lube_oil_inlet specifies the service connections for the lubrication oil inlet to the pump or compressor.

4.2.324.7 connection_lube_oil_outlet

A connection_lube_oil_outlet specifies the service connections for the lubrication oil outlet from the pump or compressor.

4.2.324.8 connection_pressure_tap

A connection_pressure_tap specifies the service connections for pressure measurement taps on the pump or compressor.

4.2.324.9 connection_seal_oil_inlet

A connection_seal_oil_inlet specifies the service connections for the mechanical seal oil inlet to the pump or compressor.

4.2.324.10 connection_seal_oil_outlet

A connection_seal_oil_outlet specifies the service connections for the mechanical seal oil outlet from the pump or compressor.

4.2.324.11 connection_solvent_injection

A connection_solvent_injection specifies the service connections for solvent injection to the pump or compressor.

4.2.324.12 connection_stage_drain

A connection_stage_drain specifies the service connections for each drain stage from the pump or compressor.

4.2.324.13 connection_temperature_tap

A connection_temperature_tap specifies the service connections for temperature measurement on the pump or compressor.

4.2.324.14 connection_vents

A connections_vents specifies the service connections for vents from the pump or compressor.

4.2.324.15 connection_warm_up

A connections_warm_up specifies the service connections for warm-up connections on the pump or compressor.

4.2.325 Shaft

A Shaft is a rotating cylinder that connects a driver such as a motor, turbine. or expander to an associated rotating equipment such as a compressor or pump.

NOTE - A Shaft can connect a driver to several pieces of equipment at the same time. For example, a gas turbine driver connected to four compressors on a common Shaft.

The data associated with Shaft are the following:

— shaft_diam_at_coupling_end;

— shaft_diam_at_impellers.

4.2.325.1 shaft_diam_at_coupling_end

A shaft_diam_at_coupling_end specifies the geometry of the shaft at the coupling point. The value of the shaft_diam_at_coupling_end attribute shall be one of the following:

— cylindrical;

— tapered.

4.2.325.1.1 cylindrical: an indication that the Shaft is not tapered at the Coupling (see 4.2.84) end.

4.2.325.1.2 tapered: an indication the Shaft is tapered at the Coupling (see 4.2.84) end.

4.2.325.2 shaft_diam_at_impellers

A shaft_diam_at_coupling_end_impellers specifies the diameter of the Shaft at the point where the Shaft is coupled to the impellers.

4.2.326 Shell_and_tube_heat_exchanger_unit

A Shell_and_tube_heat_exchanger_unit is a heat exchanger that is a composite of two or more shell-and-tube heat exchangers.

The data associated with Shell_and_tube_heat_exchanger_unit are the following:

— angle;

— bottoms_drawoff_rate;

— clean_coefficient;

— dirty_coefficient;

— discharge_pressure;

— effective_area;

— effective_temperature_difference;

— flow_direction;

— heat_duty;

— liquid_height_in_column;

— number_shell_passes;

— number_shells_in_parallel;

— number_shells_in_series;

— number_tube_passes;

— pressure_at_liquid_level;

— program;

— service_coefficient;

— shellside_fouling_factor;

— total_area;

— total_number_of_shells;

— tubeside_fouling_factor.

4.2.326.1 angle

An angle specifies the degree of inclination of a shell and tube heat exchanger from horizontal in the longitudinal direction.

4.2.326.2 bottoms_drawoff_rate

A bottoms_drawoff_rate specifies the flow rate of the bottoms liquid leaving the pool boiler.

4.2.326.3 clean_coefficient

A clean_coefficient specifies the predicted overall rate at which heat is transferred from the hot fluid on one side of the heat exchanger to the cold fluid on the other side, in the clean condition, within the Uo_-heat_exchanger (see 4.2.442) in the simulation.

4.2.326.4 dirty_coefficient

A dirty_coefficient specifies the predicted overall rate at which heat is transferred from the hot fluid on one side of the heat exchanger to the cold fluid on the other side, in the dirty condition, within the Uo_-heat_exchanger (see 4.2.442) in the simulation.

4.2.326.5 discharge_pressure

A discharge_pressure specifies the pressure discrepancy of the thermosiphon outlet line at the distillation column.

4.2.326.6 effective_area

An effective_area specifies the total tube outside surface area, including finned area, available for heat transfer for the heat exchanger.

4.2.326.7 effective_temperature_difference

An effective_temperature_difference specifies the log mean temperature difference associated with the Uo_heat_exchanger (see 4.2.442).

4.2.326.8 flow_direction

A flow_direction specifies an enumerated attribute indicating the relative fluid flow direction between the shell side and the first tube side pass. The value of the flow_direction attribute shall be one of the following:

— cocurrent;

— countercurrent;

— unspecified.

4.2.326.8.1 cocurrent: an indication that the flow of the shell and tube side fluids are in the same direction.

4.2.326.8.2 countercurrent: an indication that the flow of shell and tube side fluids are in opposite directions.

4.2.326.8.3 unspecified: an indication that the flow is not specified.

4.2.326.9 heat_duty

A heat_duty specifies the total heat duty associated with the heat exchanger.

4.2.326.10 liquid_height_in_column

A liquid_height_in_column specifies the height of the liquid level in the column referenced to the bottom of the column.

4.2.326.11 number_shell_passes

A number_shell_passes specifies the number of times the shell side flow travels all or part of the shell in the longitudinal direction.

NOTE - A G-type shell has two passes. A H-type shell has four passes.

4.2.326.12 number_shells_in_parallel

A number_shells_in_parallel specifies the number of shells connected so that the shell side fluid is divided equally to each shell.

4.2.326.13 number_shells_in_series

A number_shells_in_series specifies the number of shells connected so that the shell side fluid flows through each shell consecutively.

4.2.326.14 number_tube_passes

A number_tube_passes specifies the number of times the tube side flow travels the length of the heat exchanger for a single shell and tube heat exchanger.

4.2.326.15 pressure_at_liquid_level

A pressure_at_liquid_level specifies the immediate pressure above the liquid level of the column.

4.2.326.16 program

A program specifies the application program, version, date, etc. from which the associated performance data was derived.

4.2.326.17 service_coefficient

A service_coefficient specifies the overall rate at which heat is transferred from the hot fluid on one side of the heat exchanger to the cold fluid on the other side, in the maximum fouled condition, within the Uo_heat_exchanger (see 4.2.442) in the simulation.

4.2.326.18 shellside_fouling_factor

A shellside_fouling_factor specifies the thermal resistance of fouling layers on the shell side of the heat exchanger.

4.2.326.19 total_area

A total_area specifies the total tube outside surface area, including non-effective heat transfer area, associated with the heat exchanger.

4.2.326.20 total_number_of_shells

A total_number_of_shells specifies the total number of shell and tube heat exchangers for the heat exchanger.

4.2.326.21 tubeside_fouling_factor

A tubeside_fouling_factor specifies the thermal resistance of fouling layers on the tube side of the heat exchanger.

4.2.327 Shellside_design

A Shellside_design is the design criteria on the shell side of the heat exchanger.

The data associated with Shellside_design are the following:

— allow_baffles_under_nozzles;

— allowable_number_of_baffles;

— allowable_pressure_drop;

— coefficient_method;

— corrosion_allowance;

— cut_proportional_to_spacing;

- cylinders_for_small_shells;
- design_pressure;
- design_temperature;
- expansion_joint_indicator;
- film_coefficient;
- film_coefficient_multiplier;
- front_head_reference;
- maximum_baffle_spacing;
- maximum_shell_diameter;
- maximum_velocity;
- minimum_baffle_spacing;
- minimum_shell_diameter;
- minimum_velocity;
- pressure_drop_multiplier;
- shell_diameter_increment;
- test_pressure;
- vacuum_service_design_pressure.

4.2.327.1 allow_baffles_under_nozzles

An allow_baffles_under_nozzles specifies an indicator of whether baffles are allowed under the nozzles. The value of the allow_baffles_under_nozzles attribute shall be yes, no, or unspecified.

4.2.327.2 allowable_number_of_baffles

An allowable_number_of_baffles specifies an enumerated attribute indicating the type of allowable number of baffles of the heat exchanger as even, odd, any (odd or even), or unspecified.

4.2.327.3 allowable_pressure_drop

An allowable_pressure_drop specifies the maximum allowable pressure drop on the shell side of the heat exchanger.

4.2.327.4 coefficient_method

A coefficient_method specifies whether the Heat_transfer_coefficient (see 4.2.159) used in the shell side design is based on clean, dirty, or service conditions.

4.2.327.5 corrosion_allowance

A corrosion_allowance specifies the thickness to be added for corrosion allowance on the shellside Material (see 4.2.178).

4.2.327.6 cut_proportional_to_spacing

A cut_proportional_to_spacing specifies an indicator of having the baffle cut proportional to baffle spacing. The value of the cut_proportional_to_spacing attribute shall be yes, no, or unspecified.

4.2.327.7 cylinders_for_small_shells

A cylinders_for_small_shells specifies an enumerated attribute indicating the type of cylinder for small shells as pipe, plate, or unspecified.

NOTE - A small shell is up through 600 mm or 24 inches for carbon steel and up through 300 mm or 12 inches for alloys.

4.2.327.8 design_pressure

A design_pressure specifies the design pressure of the shell side of the heat exchanger.

4.2.327.9 design_temperature

A design_temperature specifies the design temperature of the shell side of the heat exchanger.

4.2.327.10 expansion_joint_indicator

An expansion_joint_indicator specifies an enumerated attribute indicator for the expansion joint. The value of the expansion_joint_indicator shall be yes, no, program control, or unspecified.

4.2.327.11 film_coefficient

A film_coefficient specifies the film heat transfer coefficient.

4.2.327.12 film_coefficient_multiplier

A film_coefficient_multiplier specifies a multiplier applied to the calculated film coefficient of the shell side of the heat exchanger.

4.2.327.13 front_head_reference

A front_head_reference specifies an enumerated attribute indicating which diameter will be the reference diameter for the shell and front head cylinder. The value of the front_head_reference attribute shall be inside diameter, outside diameter, or unspecified.

4.2.327.14 maximum_baffle_spacing

A maximum_baffle_spacing specifies the maximum baffle spacing in the heat exchanger.

4.2.327.15 maximum_shell_diameter

A maximum_shell_diameter specifies the maximum shell diameter of the heat exchanger.

4.2.327.16 maximum_velocity

A maximum_velocity specifies the maximum limit for fluid velocity anywhere within the shell side of the heat exchanger.

4.2.327.17 minimum_baffle_spacing

A minimum_baffle_spacing specifies the minimum baffle spacing in the heat exchanger.

4.2.327.18 minimum_shell_diameter

A minimum_shell_diameter specifies the minimum shell diameter of the heat exchanger.

4.2.327.19 minimum_velocity

A minimum_velocity specifies the minimum limit for fluid velocity anywhere within the shell side of the heat exchanger.

4.2.327.20 pressure_drop_multiplier

A pressure_drop_multiplier specifies a multiplier applied to the calculated shell side pressure drop excluding the pressure drop through the nozzles.

4.2.327.21 shell_diameter_increment

A shell_diameter_increment specifies the increment by which the shell diameter is to change.

4.2.327.22 test_pressure

A test_pressure specifies the test pressure at which the shellside of the heat exchanger is hydrotested.

4.2.327.23 vacuum_service_design_pressure

A vacuum_service_design_pressure specifies the vacuum service design pressure for the shellside of the heat exchanger.

4.2.328 Shellside_performance

A Shellside_performance is the overall shell side performance of the heat exchanger.

The data associated with Shellside_performance are the following:

— average_skin_temperature;

— beta_correction;

— bulk_film_coefficient;

— bundle_entrance_area;

— bundle_entrance_rhov2;

— bundle_exit_area;

— bundle_exit_rhov2;

— clean_pressure_drop;

— crossflow_nominal_velocity;

— dirty_pressure_drop;

- end_correction;
- fin_correction;
- fin_efficiency;
- fouling_resistance;
- fouling_thickness;
- gamma_correction;
- long_baffle_bulk_film_coefficient;
- longitudinal_baffle_correction;
- midpoint_velocity;
- outlet_temperature;
- pressure_drop_in_baffle_window;
- pressure_drop_in_crossflow;
- pressure_drop_in_ends;
- shell_entrance_area;
- shell_entrance_rhov2;
- shell_exit_area;
- shell_exit_rhov2;
- thermal_resistance;
- total_heat_transfer_correction;
- wall_film_coefficient;
- wall_temperature.

4.2.328.1 average_skin_temperature

An average_skin_temperature specifies the temperature of the tube outside fouling layer.

4.2.328.2 beta_correction

A beta_correction specifies a correction factor applied to the log mean temperature difference to account for partial counter-current flow patterns in a heat exchanger.

4.2.328.3 bulk_film_coefficient

A bulk_film_coefficient specifies the Heat_transfer_coefficient (see 4.2.159) between the bulk fluid and the fluid film for the shell side of the heat exchanger.

4.2.328.4 bundle_entrance_area

A bundle_entrance_area specifies the bundle entrance area of the bundle side of a heat exchanger.

4.2.328.5 bundle_entrance_rhov2

A bundle_entrance_rhov2 specifies the ρv^2 (fluid density times velocity squared) at the bundle entrance of the bundle side of a heat exchanger.

4.2.328.6 bundle_exit_area

A bundle_exit_area specifies the bundle exit area of the bundle side of a heat exchanger.

4.2.328.7 bundle_exit_rhov2

A bundle_exit_rhov2 specifies the ρv^2 (fluid density times velocity squared) at the bundle exit of the bundle side of a heat exchanger.

4.2.328.8 clean_pressure_drop

A clean_pressure_drop specifies the clean condition pressure drop on the shell side of the heat exchanger.

4.2.328.9 crossflow_nominal_velocity

A crossflow_nominal_velocity specifies the nominal velocity associated with the cross flow sections on the shell side of the heat exchanger.

4.2.328.10 dirty_pressure_drop

A dirty_pressure_drop specifies the dirty condition pressure drop on the shell side of the heat exchanger.

4.2.328.11 end_correction

An end_correction specifies the correction factor for the Heat_transfer_coefficient (see 4.2.159) associated with the inlet and outlet zones of the shell side of the heat exchanger.

4.2.328.12 fin_correction

A fin_correction specifies the correction factor to the Heat_transfer_coefficient (see 4.2.159) associated with the fins on tubes.

4.2.328.13 fin_efficiency

A fin_efficiency specifies the heat transfer efficiency of the fins on tubes.

4.2.328.14 fouling_resistance

A fouling_resistance specifies the thermal resistance of the fouling layer on the outside of the tube.

4.2.328.15 fouling_thickness

A fouling_thickness specifies the thickness of the fouling layer on the outside of the tube.

4.2.328.16 gamma_correction

A gamma_correction specifies a correction factor applied to the log mean temperature difference to account for partial counter-current flow patterns in a heat exchanger.

4.2.328.17 long_baffle_bulk_film_coefficient

A long_baffle_bulk_film_coefficient specifies the bulk film coefficient of the Longitudinal_baffle (see 4.2.174).

4.2.328.18 longitudinal_baffle_correction

A longitudinal_baffle_correction specifies the correction factor for the Heat_transfer_coefficient (see 4.2.159) associated with the longitudinal baffle on the shell side of a heat exchanger.

4.2.328.19 midpoint_velocity

A midpoint_velocity specifies the velocity associated with the midpoint of the shell side of a heat exchanger.

4.2.328.20 outlet_temperature

An outlet_temperature specifies the outlet temperature of shellside of the heat exchanger.

4.2.328.21 pressure_drop_in_baffle_window

A pressure_drop_in_baffle_window specifies the pressure drop associated with the baffle windows of the shell side of the heat exchanger.

4.2.328.22 pressure_drop_in_crossflow

A pressure_drop_in_crossflow specifies the pressure drop associated with the cross flow sections of the shell side of the heat exchanger.

4.2.328.23 pressure_drop_in_ends

A pressure_drop_in_ends specifies the pressure drop associated with the inlet and outlet zones of the shell side of the heat exchanger.

4.2.328.24 shell_entrance_area

A shell_entrance_area specifies the shell entrance area of the shell side of a heat exchanger.

4.2.328.25 shell_entrance_rhov2

A shell_entrance_rhov2 specifies the ρv^2 (fluid density times velocity squared) at the shell entrance of the shell side of a heat exchanger.

4.2.328.26 shell_exit_area

A shell_exit_area specifies the shell exit area of the shell side of a heat exchanger.

4.2.328.27 shell_exit_rhov2

A shell_exit_rhov2 specifies the ρv^2 (fluid density times velocity squared) at the shell exit of the shell side of a heat exchanger.

4.2.328.28 thermal_resistance

A thermal_resistance specifies the thermal resistance on the shell side of the heat exchanger.

4.2.328.29 total_heat_transfer_correction

A total_heat_transfer_correction specifies the total heat transfer correction associated with the shell side of the heat exchanger.

4.2.328.30 wall_film_coefficient

A wall_film_coefficient specifies the value of the convective Heat_transfer_coefficient (see 4.2.159) at the tube wall for the shell side of the heat exchanger.

4.2.328.31 wall_temperature

A wall_temperature specifies the outside wall temperature of the tubes.

4.2.329 Signal_port

A Signal_port is a type of Equipment_port (see 4.2.125) through which a signal is intended to flow.

4.2.330 Simple_performance_curve

A Simple_performance_curve is a type a Performance_curve (see 4.2.212) that is a representation of the plot of one or more dependent variables versus a single independent variable. Each of the dependent variables shall have the same independent variable property name.

4.2.331 Simulation_block

A Simulation_block is a type of Process_simulation (see 4.2.271) that is a block of calculations that are a single step in the calculation order of a sequential-modular Process_simulation or provide a related set of equations and variables in an equation based Process_simulation. Each Simulation_block may be one of the following: a Stream_convergence_block (see 4.2.375), a Simulation_unit_operation (see 4.2.352), or a Variable_convergence_block (see 4.2.491).

The data associated with Simulation_block are the following:

- description;
- simulation_block_type.

4.2.331.1 description

A description specifies a summary of key aspects about the Simulation_block.

4.2.331.2 simulation_block_type

A simulation_block_type specifies whether the Simulation_block is a Stream_convergence_block (see 4.2.375), a Simulation_unit_operation (see 4.2.352), a Variable_convergence_block (see 4.2.491), or some other type of Simulation_block.

4.2.332 Simulation_centrifuge

A Simulation_centrifuge is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_-centrifuge (see 4.2.418) unit operation.

The data associated with Simulation_centrifuge are the following:

- diameter_list;
- rpm_list.

4.2.332.1 diameter_list

A diameter_list specifies a listing of allowable diameters used for design.

4.2.332.2 rpm_list

A rpm_list specifies a listing of allowable rotational speeds used for design.

4.2.333 Simulation_compressor

A Simulation_compressor is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_-compressor (see 4.2.420) unit operation. Each Simulation_compressor may be: a Simulation_polytropic_-compressor (see 4.2.348) or a Simulation_polytropic_compressor_stage (see 4.2.349).

The data associated with Simulation_compressor are the following:

- calculation_method;
- cooler_dp;
- cooler_temp.

4.2.333.1 calculation_method

A calculation_method specifies what to calculate, for example, outlet pressure, and what model is used to perform the calculation.

4.2.333.2 cooler_dp

A cooler_dp specifies the pressure drop across the compressor after cooler.

4.2.333.3 cooler_temp

A cooler_temp specifies the desired outlet temperature for the compressor after cooler.

4.2.334 Simulation_countercurrent_solids_decanter

A Simulation_countercurrent_solids_decanter is a type of Simulation_unit_operation (see 4.2.352) which simulates a Uo_countercurrent_solids_decanter (see 4.2.422) unit operation.

The data associated with Simulation_countercurrent_solids_decanter are the following:

— stages_maximum;

— stages_minimum.

4.2.334.1 stages_maximum

A stages_maximum specifies the maximum number of stages that the simulator may use in the Simulation_countercurrent_solids_decanter.

4.2.334.2 stages_minimum

A stages_minimum specifies the minimum number of stages that the simulator may use in the Simulation_countercurrent_solids_decanter.

4.2.335 Simulation_crystallizer

A Simulation_crystallizer is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_-crystallizer (see 4.2.424) unit operation.

> NOTE - Crystallization is used in industrial processes for the manufacturing of organics, inorganics, fertilizers, biochemicals, and polymers.

The data associated with Simulation_crystallizer are the following:

— equation_coefficient;

— equation_exponent;

— equation_identifier;

— shape_factor.

4.2.335.1 equation_coefficient

An equation_coefficient specifies the linear parameter in the model for solid-liquid equilibrium used by the Simulation_crystallizer.

4.2.335.2 equation_exponent

An equation_exponent specifies the exponential parameter in the model for solid-liquid equilibrium used by the Simulation_crystallizer.

4.2.335.3 equation_identifier

An equation_identifier specifies kinetic expressions that define the growth and nucleation expressions.

4.2.335.4 shape_factor

A shape_factor specifies the crystal shape factor.

> NOTE - This factor is used to define the approximate shape of the crystal. Values range from 1.0. indicating a cubic crystal, to a factor of pi/6, indicating a spherical shaped crystal.

4.2.336 Simulation_dissolver

A Simulation_dissolver is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_dissolver (see 4.2.427) unit operation.

> NOTE - Mass transfer controlled dissolution is a unit operation used in both organic and inorganic processes. The most common is the stirred tank dissolver, in which the liquid is assumed to be well mixed. The primary objective of the dissolver is to transform crystals in solution from the solid to the liquid phase.

The data associated with Simulation_dissolver are the following:

— mass_transfer_coefficients;

— mass_transfer_expression.

4.2.336.1 mass_transfer_coefficients

A mass_transfer_coefficients specifies the parameters used in the mass_transfer_expression.

4.2.336.2 mass_transfer_expression

A mass_transfer_expression specifies the mass transfer rate in solution.

4.2.337 Simulation_distillation

A Simulation_distillation is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_-distillation (see 4.2.428) unit operation.

The data associated with Simulation_distillation are the following:

- feed_stage_number_optimum;
- initial_estimation_method;
- initial_reflux;
- initial_reflux_ratio;
- number_of_stages_minimum;
- reflux_ratio_multiplier.

4.2.337.1 feed_stage_number_optimum

A feed_stage_number_optimum specifies the optimal stage for supplying the feed to the distillation column.

4.2.337.2 initial_estimation_method

An initial_estimation_method specifies what method is used to provide initial values for the column profiles.

4.2.337.3 initial_reflux

An initial_reflux specifies the initial value for the reflux rate to the column.

4.2.337.4 initial_reflux_ratio

An initial_reflux_ratio specifies the initial value of the reflux ratio for the distillation column.

4.2.337.5 number_of_stages_minimum

A number_of_stages_minimum specifies the minimum number of stages for the Uo_distillation.

> NOTE - This number is used in the shortcut model to define a factor by which the minimum number of stages is multiplied by to determine the actual number of stages.

4.2.337.6 reflux_ratio_multiplier

A reflux_ratio_multiplier specifies a factor by which the minimum reflux ratio is multiplied to determine the actual reflux ratio.

4.2.338 Simulation_distillation_stage

A Simulation_distillation_stage is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_-distillation_stage (see 4.2.429) in a Simulation_distillation (see 4.2.337).

The data associated with Simulation_distillation_stage are the following:

— initial_stage_pressure;

— initial_stage_temperature.

4.2.338.1 initial_stage_pressure

An initial_stage_pressure specifies the initial value for the pressure for that stage in the Simulation_-distillation (see 4.2.337).

4.2.338.2 initial_stage_temperature

An initial_stage_temperature specifies the initial value for the temperature for that stage in the Simulation_distillation (see 4.2.337).

4.2.339 Simulation_electrostatic_precipitator

A Simulation_electrostatic_precipitator is a type of Process_simulation (see 4.2.271) that simulates a Uo_-electrostatic_precipitator (see 4.2.432) unit operation.

The data associated with Simulation_electrostatic_precipitator are the following:

— gas_velocity_profile_std_deviation.

A gas_velocity_profile_std_deviation specifies the standard deviation for the measurements of points in the velocity profile associated with the Simulation_electrostatic_precipitator in the simulation.

4.2.340 Simulation_fabric_filter

A Simulation_fabric_filter is a type of Process_simulation (see 4.2.271) that simulates a Uo_fabric_filter (see 4.2.436) unit operation.

The data associated with Simulation_fabric_filter are the following:

— calculation_mode.

A calculation_mode specifies an enumerated attribute giving the type of calculation to perform for the Simulation_fabric_filter. The value of the calculation_mode attribute shall be one of the following:

— calc_press_drop;

— calc_time.

4.2.340.0.1 calc_press_drop: an indication that a pressure drop calculation is to be done.

4.2.340.0.2 calc_time: an indication that cycle time calculation is to be done.

4.2.341 Simulation_flash

A Simulation_flash is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_flash (see 4.2.439) unit operation.

NOTE - It may occur when a Stream (see 4.2.374) is throttled across a valve with the resulting pressure drop causing vapourization.

The data associated with Simulation_flash are the following:

— pressure_estimate;

— temperature_estimate;

— three_phase_calculation.

4.2.341.1 pressure_estimate

A pressure_estimate specifies an initial value for the pressure of the Simulation_flash.

4.2.341.2 temperature_estimate

A temperature_estimate specifies an initial value for the temperature of the Simulation_flash.

4.2.341.3 three_phase_calculation

A three_phase_calculation specifies an enumerated attribute that indicates the method or model used by the Simulation_flash to calculate the distribution of Chemical_components (see 4.2.56) across the vapor Phase (see 4.2.230) and two liquid Phases, if a second liquid Phase is present. The value of the three_-phase_calculation attribute shall be one of the following:

- gibbs;
- equilibrium;
- none;
- other;
- rigorous;
- unknown;
- water_decanted.

4.2.341.3.1 gibbs: an indication that a minimized Gibbs free energy three phase calculation is done.

4.2.341.3.2 equilibrium: an indication that an equilibrium three phase calculation is done.

4.2.341.3.3 none: an indication that no three phase calculation is done.

4.2.341.3.4 other: an indication that another method is used for three phase calculation other than rigorous, Gibbs, equilibrium, or water_decanted.

4.2.341.3.5 rigorous: an indication that a rigorous three phase calculation is done.

4.2.341.3.6 unknown: an indication that the three phase calculation is unknown or unspecified.

4.2.341.3.7 water_decanted: an indication that a water free basis three phase calculation is done.

4.2.342 Simulation_gas_solid_separator

A Simulation_gas_solid_separator is a type of Process_simulation (see 4.2.271) that simulates a Uo_gas_-solid_separator (see 4.2.441) unit operation.

The data associated with Simulation_gas_solid_separator are the following:

— calculation_option.

A calculation_option specifies an enumerated attribute that indicates whether the Simulation_gas_solid_-separator is to simulate the performance of a gas solid separator based on geometry parameters supplied as input or whether the Simulation_gas_solid_separator is to size the separator based on performance constraints. The value of the calculation_option attribute shall be one of the following:

— design;

— simulation.

4.2.342.0.1 design: an indication of calculation_option, describing the option for the Simulation_gas_-solid_separator.

4.2.342.0.2 simulation: an indication of calculation_option, describing the option for the Simulation_-gas_solid_separator.

4.2.343 Simulation_heat_exchanger

A Simulation_heat_exchanger is a Simulation_unit_operation (see 4.2.352) that simulates a Uo_heat_-exchanger (see 4.2.442) unit operation.

The data associated with Simulation_heat_exchanger are the following:

— uamax.

A uamax specifies the maximum value for the overall Heat_transfer_coefficient (see 4.2.159) that may be assigned to the Simulation_heat_exchanger.

4.2.344 Simulation_hydrocyclone

A Simulation_hydrocyclone is a type of Process_simulation (see 4.2.271) that simulates a Uo_-hydrocyclone (see 4.2.445) unit operation.

The data associated with Simulation_hydrocyclone are the following:

— particle_velocity_equation_coefficient;

— particle_velocity_equation_exponent.

4.2.344.1 particle_velocity_equation_coefficient

A particle_velocity_equation_coefficient specifies the constant for the particle velocity equation for the Simulation_hydrocyclone in the simulation.

4.2.344.2 particle_velocity_equation_exponent

A particle_velocity_equation_exponent specifies the exponent for the particle velocity equation for the Simulation_hydrocyclone in the simulation.

4.2.345 Simulation_liquid_solid_separator

A Simulation_liquid_solid_separator is a type of Process_simulation (see 4.2.271) that simulates a Uo_-liquid_solid_separator (see 4.2.448) unit operation.

The data associated with Simulation_liquid_solid_separator are the following:

— calculation_option.

A calculation_option specifies an enumerated attribute which indicates whether the unit operation is to be simulated or a design equation is used. The value of the calculation_option attribute shall be one of the following:

— design;

— simulate.

4.2.345.0.1 design: an indication that the unit operation is a design calculation only.

4.2.345.0.2 simulate: an indication that the unit operation is to be simulated.

4.2.346 Simulation_pipeline

A Simulation_pipeline is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_pipeline (see 4.2.454) unit operation.

The data associated with Simulation_pipeline are the following:

— calculation_direction;

— maximum_dp;

— maximum_velocity;

— minimum_radius;

— numerical_integration_key;

— pipe_sizes;

— thermal_simulation_key.

4.2.346.1 calculation_direction

A calculation_direction specifies an enumerated attribute that indicates whether the Stream (see 4.2.374) conditions are to be calculated for the exit end of the Simulation_pipeline are based on Stream conditions at the inlet or whether the Stream conditions are to be calculated for the inlet end of the Simulation_-pipeline based on conditions at the exit end. The value of the calculation_direction attribute shall be one of the following:

— backward;

— forward.

4.2.346.1.1 backward: an indication that the calculation direction is backwards for the Simulation_-pipeline.

4.2.346.1.2 forward: an indication that the calculation direction is forward for Simulation_pipeline.

4.2.346.2 maximum_dp

A maximum_dp specifies the maximum limit of differential pressure across the Simulation_pipeline.

4.2.346.3 maximum_velocity

A maximum_velocity specifies the maximum limit for fluid velocity anywhere within the Simulation_-pipeline.

4.2.346.4 minimum_radius

A minimum_radius specifies the minimum bend radius that is allowed in the pipeline.

4.2.346.5 numerical_integration_key

A numerical_integration_key specifies an enumerated attribute giving the type of integration used by the Simulation_pipeline. The value of the numerical_integration_key attribute shall be one of the following:

— closed_form_method;

— numerical_integration.

4.2.346.5.1 closed_form_method: an indication that a closed form integration is used.

4.2.346.5.2 numerical_integration: an indication that a numerical integration is used.

4.2.346.6 pipe_sizes

A pipe_sizes specifies a list of allowable pipe diameters that the Simulation_pipeline can use in designing the pipeline.

4.2.346.7 thermal_simulation_key

A thermal_simulation_key specifies an enumerated attribute giving the type of thermal separation to perform for the Simulation_pipeline. The value of the thermal_simulation_key attribute shall be one of the following:

— energy_balance;

— linear_temp_profile.

4.2.346.7.1 energy_balance: an indication that an energy Balance (see 4.2.14) is performed.

4.2.346.7.2 linear_temp_profile: an indication that the generation of a linear temperature profile is performed.

4.2.347 Simulation_pipeline_node

A Simulation_pipeline_node is a type of Simulation_unit_operation (see 4.2.352) that simulates a Uo_-pipeline_node (see 4.2.455) unit operation as a single point in a Simulation_pipeline (see 4.2.346).

The data associated with Simulation_pipeline_node are the following:

— erosion_velocity_calculation_constant.

An erosion_velocity_calculation_constant specifies the erosion velocity calculation constant for the node.

4.2.348 Simulation_polytropic_compressor

A Simulation_polytropic_compressor is a type of Simulation_compressor (see 4.2.333) that is the simulation of a multi-stage compressor whose stages are simulated unit operation in the simulation.

The data associated with Simulation_polytropic_compressor are the following:

— radial_frequency.

A radial_frequency specifies rotational speed of the compressor.

4.2.349 Simulation_polytropic_compressor_stage

A Simulation_polytropic_compressor_stage is a type of Simulation_compressor (see 4.2.333) that simulates a Uo_centrifugal_compressor_stage (see 4.2.417) by specifying its polytropic efficiency. Polytropic efficiency is used to calculate a polytropic coefficient to use in place of the heat capacity ratio, C_p/C_v, in the equation for the polytropic, or irreversible, operation of a compressor or expander. Simulation_-polytropic_compressor_stage is part of a Simulation_polytropic_compressor (see 4.2.348)..

The data associated with Simulation_polytropic_compressor_stage are the following:

— polytropic_efficiency;

— stage_number.

4.2.349.1 polytropic_efficiency

A polytropic_efficiency specifies the value for the polytropic efficiency associated assigned to the stage.

4.2.349.2 stage_number

A stage_number specifies the position of the Simulation_polytropic_compressor_stage within the Simulation_polytropic_compressor (see 4.2.348).

4.2.350 Simulation_rotary_filter

A Simulation_rotary_filter is a Simulation_unit_operation (see 4.2.352) that simulates a Uo_rotary_filter (see 4.2.463) unit operation.

The data associated with Simulation_rotary_filter are the following:

— pressure_drop_maximum;

— wdratio.

4.2.350.1 pressure_drop_maximum

A pressure_drop_maximum specifies the maximum difference between the inlet and outlet pressures of the Simulation_rotary_filter allowed in the design.

4.2.350.2 wdratio

A wdratio specifies the specification of the allowed width to diameter ratio for the Simulation_rotary_filter design.

4.2.351 Simulation_section_relationship

A Simulation_section_relationship is a type of Process_simulation_relationship (see 4.2.273) in which one is the containing Process_simulation (see 4.2.271) and the other is a simulation section for the containing Process_simulation.

NOTE - The relating simulation specifies the containing Process_simulation (see 4.2.271) and the related simulation specifies the simulation section.

The data associated with Simulation_section_relationship are the following:

— process_simulation_section_name.

A process_simulation_section_name specifies a label that identifies the Process_simulation (see 4.2.271) section within the containing Process_simulation.

4.2.352 Simulation_unit_operation

A Simulation_unit_operation is a type of Simulation_block (see 4.2.331) that is the simulation of a Process_unit_operation (see 4.2.275). A Simulation_unit_operation may be one of the following: Simulation_compressor (see 4.2.333), Simulation_countercurrent_solids_decanter (see 4.2.334), Simulation_crystallizer (see 4.2.335), Simulation_dissolver (see 4.2.336), Simulation_distillation (see 4.2.337), Simulation_distillation_stage (see 4.2.338), Simulation_electrostatic_precipitator (see 4.2.339), Simulation_fabric_filter (see 4.2.340), Simulation_flash (see 4.2.341), Simulation_gas_solid_separator (see 4.2.342), Simulation_heat_exchanger (see 4.2.343), Simulation_hydrocyclone (see 4.2.344), Simulation_-liquid_solid_separator (see 4.2.345), Simulation_pipeline (see 4.2.346), Simulation_pipeline_node (see 4.2.347), Simulation_polytropic_compressor (see 4.2.348), Simulation_polytropic_compressor_stage (see 4.2.349), or a Simulation_rotary_filter (see 4.2.350).

4.2.353 Single_phase_thermophysical_properties

A Single_phase_thermophysical_properties is a collection of commonly used physical and thermodynamic properties calculated or estimated for a single Phase (see 4.2.230) of a Mixture (see 4.2.192). The Mixture may be a single Specific_phase (see 4.2.367) or may be a composite Mixture contained in a Material_-amount (see 4.2.179), Material_stream (see 4.2.186), or Specific_phase or may be a Process_material (see 4.2.263) at a given Thermodynamic_conditions (see 4.2.386).

4.2.354 Site

A Site is a geographical specification associated with a collection of one or more Plant (see 4.2.236) objects.

The data associated with Site are the following:

- acreage;
- address;
- coordinates;
- elevation;
- environmental_references;
- legal_description;
- locality;
- name;
- orientation;
- owners;
- site_id.

4.2.354.1 acreage

An acreage specifies the extent of the measure of the land at the Site.

4.2.354.2 address

An address specifies the street address, including city, state, and zip code, as appropriate, of the Site.

4.2.354.3 coordinates

A coordinates specifies the longitude and latitude coordinates of the Site with respect to a known point on the Site.

4.2.354.4 elevation

An elevation specifies the distance that the Site is located above sea level with respect to a known point on the Site.

NOTE - The known point referenced here is the same known point referenced under coordinates.

4.2.354.5 environmental_references

An environmental_references specifies a reference to a document that provides environmental information relevant to the Site.

EXAMPLE 22 - Environmental information includes the temperature, humidity, precipitation pattern, and wind patterns of the region.

4.2.354.6 legal_description

A legal_description specifies the legal description for the land at the Site.

4.2.354.7 locality

A locality specifies the municipality or region where the Site is located.

4.2.354.8 name

A name specifies the designation or label given to the Site.

4.2.354.9 orientation

An orientation specifies the relative alignment of the Site with respect to a given compass direction.

4.2.354.10 owners

An owners specify the company or organization that is financially responsible the Site.

4.2.354.11 site_id

A site_id specifies a unique identifier for the Site.

4.2.355 Site_ambient_condition

A Site_ambient_condition is a measurement associated with Site (see 4.2.354) environmental data. A Site_ambient_condition may also be used by a Control_measurement_module (see 4.2.78) as part of a Control_scheme (see 4.2.80).

NOTE - Measured conditions include temperature, pressure, and rain fall.

The data associated with Site_ambient_condition are the following:

— average_value;

— max_value;

— measurement_duration;

— measurement_start_time;

— measurement_type;

— min_value.

4.2.355.1 average_value

An average_value specifies the result of dividing the sum of the values measured by the number of measurements.

4.2.355.2 max_value

A max_value specifies the maximum value measured over the measurement duration.

4.2.355.3 measurement_duration

A measurement_duration specifies the length of time over which the Site_ambient_condition measurement was taken.

4.2.355.4 measurement_start_time

A measurement_start_time specifies the date and time when the Site_ambient_condition measurement began.

4.2.355.5 measurement_type

A measurement_type specifies an enumerated attribute that indicates the type of measurement taken. The value for the measurement_type attribute shall be one of the following:

— ambient_temperature;

— infrared_radiation;

— other_site_ambient_measurement;

— precipitation;

— relative_humidity;

— substance_composition;

— wind_speed.

4.2.355.5.1 ambient_temperature: an indication that the ambient air temperature is the type of measurement.

4.2.355.5.2 infrared_radiation: an indication that infrared radiation is the type of measurement.

NOTE - This type of measurement may be taken in the presence of a fire.

4.2.355.5.3 other_site_ambient_measurement: an indication that the Site_ambient_condition is for some quantity that is not enumerated in this list.

4.2.355.5.4 precipitation: an indication that the amount of precipitation is the type of measurement.

4.2.355.5.5 relative_humidity: an indication that the ratio of water content in the air relative to the saturation water content of air is the type of measurement.

4.2.355.5.6 substance_composition: an indication that the composition of a substance is the type of measurement.

EXAMPLE 23 - The measurement of the ambient levels of hydrogen sulfide.

4.2.355.5.7 wind_speed: an indication that the velocity of the wind is the type of measurement.

4.2.355.6 min_value

A min_value specifies the minimum value measured over the measurement duration.

4.2.356 Site_standard_conditions

A Site_standard_conditions is the legally accepted values of temperature and pressure for custody transfer of gases and liquids on a volumetric basis.

The data associated with Site_standard_conditions are the following:

— custody_type;

— description;

— pressure;

— temperature.

4.2.356.1 custody_type

A custody_type specifies an enumerated attribute that indicates the type of Material (see 4.2.178) that the Site_standard_conditions is being specified for. The value of the custody_type attribute shall be one of the following:

— gas;

— gas_and_liquid;

— liquid.

4.2.356.1.1 gas: an indication that the standard conditions are for gas volumes.

4.2.356.1.2 gas_and_liquid: an indication that the standard conditions are for both gas and liquid volumes.

4.2.356.1.3 liquid: an indication that the standard conditions are for liquid volumes.

4.2.356.2 description

A description specifies a summary of key aspects of or references for the Site_standard_conditions.

4.2.356.3 pressure

A pressure specifies the pressure associated with the Site_standard_condition.

4.2.356.4 temperature

A temperature specifies the temperature associated with the Site_standard_conditions.

4.2.357 Site_utility_service

A Site_utility_service is a utility service available at a Site (see 4.2.354). Each Site_utility_service may be one of the following: an Electrical_service (see 4.2.118) or a Utility_material_service (see 4.2.483).

The data associated with Site_utility_service are the following:

— cost_basis;

— cost_basis_value;

— site_utility_service_name;

— site_utility_service_type;

— source.

4.2.357.1 cost_basis

A cost_basis specifies the cost basis used to calculate a utility cost.

EXAMPLE 24 - Examples include $/KWH, $/1000 lb steam, and $/1000 SCUF.

4.2.357.2 cost_basis_value

A cost_basis_value specifies the basis conditions used to determine the cost_basis_value.

EXAMPLE 25 - For example, 150 lb steam, 25C standard gas conditions.

4.2.357.3 site_utility_service_name

A site_utility_service_name specifies an identifier assigned to each Site_utility_service at a Site (see 4.2.354). The site_utility_service_name must be unique for each Site_utility_service at a Site.

4.2.357.4 site_utility_service_type

A site_utility_service_type specifies that a Site_utility_service is either a Utility_material_service (see 4.2.483) or an Electrical_service (see 4.2.118).

4.2.357.5 source

A source specifies whether the utilities are produced on-site or off-site.

4.2.358 Sited_plant

A Sited_plant is a Plant (see 4.2.236) for which a site location has been defined.

The data associated with Sited_plant are the following:

— plant_site_location;

— plant_site_orientation.

4.2.358.1 plant_site_location

A plant_site_location specifies the geographic position of the Plant (see 4.2.236) relative to the Site (see 4.2.354) or a feature of the Site.

4.2.358.2 plant_site_orientation

A plant_site_orientation specifies the directional orientation of the Plant (see 4.2.236) with respect to the Site (see 4.2.354).

4.2.359 Socket

A Socket is a type of end engagement for a Piping_connector (see 4.2.235) which uses a socket as the connection mechanism.

4.2.360 Solid_analysis

A Solid_analysis is a collection of the results of a set of laboratory analysis for solid Materials (see 4.2.178).

The data associated with Solid_analysis are the following:

— solid_analysis_type.

A solid_analysis_type specifies the analysis method used.

4.2.361 Solids_processing_equipment

A Solids_processing_equipment is a type of Process_equipment (see 4.2.260) used to process solid Materials (see 4.2.178).

4.2.362 Solids_storage_bin

A Solids_storage_bin is a type of Process_vessel (see 4.2.276) that is primarily for the storage of solid Material (see 4.2.178).

The data associated with Solids_storage_bin are the following:

— solids_storage_bin_description_of_discharge;

— solids_storage_bin_top_type.

4.2.362.1 solids_storage_bin_description_of_discharge

A solids_storage_bin_description_of_discharge specifies a description of the discharge for the Solids_-storage_bin (see 4.2.362).

4.2.362.2 solids_storage_bin_top_type

A solids_storage_bin_top_type specifies an enumerated attribute which specifies the top type of the bin. The value of the solids_storage_bin_top_type attribute shall be one of the following:

— closed;

— open;

— other;

— unspecified.

4.2.362.2.1 closed: an indication that the top of the Solids_storage_bin is closed.

4.2.362.2.2 open: an indication that the top of the Solids_storage_bin is open.

4.2.362.2.3 other: an indication that the top of the Solids_storage_bin is other.

4.2.362.2.4 unspecified: an indication that the top of the Solids_storage_bin is unspecified.

4.2.363 Space_requirements

A Space_requirements is the spatial area occupied by a Plant_item (see 4.2.237) plus any space allowances for safety or maintenance considerations.

The data associated with Space_requirements are the following:

— area_required;

— item_description.

4.2.363.1 area_required

An area_required specifies the spatial area requirements allowing for the Plant_item (see 4.2.237) dimensions plus any additional dimensions required for maintenance or safety considerations.

4.2.363.2 item_description

An item_description specifies a textual description of the Space_requirements elucidating additional details or rationale for the area requirement.

4.2.364 Spare_item_relationship

A Spare_item_relationship is the relationship between the spare item and the piece of the Plant (see 4.2.236) equipment the spare item is associated with.

EXAMPLE 26 - For example, a spare pump may be placed in line and connected to the process, while a spare impeller would be placed in storage.

4.2.365 Specific_equation

A Specific_equation is a single equation for a Substance (see 4.2.381) in a given Phase (see 4.2.230) with a given set of constants.

The data associated with Specific_equation are the following:

— specific_equation_name.

A specific_equation_name specifies a label for the Specific_equation.

4.2.366 Specific_equation_group

A Specific_equation_group is a group of related Specific_equations which are solved simultaneously, sequentially, or in some order determined procedurally to yield one or more Substance (see 4.2.381) properties.

The data associated with Specific_equation_group are the following:

— specific_equation_group_name.

A specific_equation_group_name specifies a label for the Specific_equation_group.

4.2.367 Specific_phase

A Specific_phase is a single logical or physical phase of a Mixture (see 4.2.192) at a given condition. A physical Specific_phase is a homogeneous part of a Mixture whose physical state is given by a Phase (see 4.2.230). A logical Specific_phase is a heterogeneous part of a Mixture that is lumped together to ease calculations for or descriptions of the Mixture. A Specific_phase may be one of the following: an Internal_stream_phase (see 4.2.165), a Material_amount_phase (see 4.2.180), or a Material_stream_phase (see 4.2.187).

The data associated with Specific_phase are the following:

- description;
- equilibrium_phase;
- phase_name;
- physical_or_logical.

4.2.367.1 description

A description specifies key aspects about the Specific_phase.

4.2.367.2 equilibrium_phase

An equilibrium_phase specifies that the Specific_phase is at some phase equilibrium condition.

4.2.367.3 phase_name

A phase_name specifies a label that identifies the Specific_phase.

4.2.367.4 physical_or_logical

A physical_or_logical specifies the type of the Specific_phase.

4.2.368 Spherical_pressure_vessel

A Spherical_pressure_vessel is a type of Pressure_vessel (see 4.2.251) which has a spherical shape.

The data associated with Spherical_pressure_vessel are the following:

- spherical_pressure_vessel_inside_diameter;
- spherical_pressure_vessel_outside_diameter;
- spherical_pressure_vessel_wall_thickness.

4.2.368.1 spherical_pressure_vessel_inside_diameter

A spherical_pressure_vessel_inside_diameter specifies the inside diameter of the Spherical_pressure_vessel.

4.2.368.2 spherical_pressure_vessel_outside_diameter

A spherical_pressure_vessel_outside_diameter specifies the outside diameter of the Spherical_pressure_-vessel.

4.2.368.3 spherical_pressure_vessel_wall_thickness

A spherical_pressure_vessel_wall_thickness specifies the wall thickness of the Spherical_pressure_vessel.

4.2.369 Spheroidal_pressure_vessel

A Spheroidal_pressure_vessel is a type of Pressure_vessel (see 4.2.251) which has a spheroidal shape.

The data associated with Spheroidal_pressure_vessel are the following:

— spheroidal_pressure_vessel_axis_of_rotation_orientation;

— spheroidal_pressure_vessel_wall_thickness.

4.2.369.1 spheroidal_pressure_vessel_axis_of_rotation_orientation

A spheroidal_pressure_vessel_axis_of_rotation_orientation specifies an enumerated attribute of Spheroidal_pressure_vessel (see 4.2.369) which describes the orientation of the axis of rotation of the outside_shape sweeping out the vessel's outer surface. The value of the spheroidal_pressure_vessel_axis_-of_rotation_orientation attribute shall be one of the following:

— horizontal;

— other;

— unknown;

— vertical.

4.2.369.1.1 horizontal: an indication of axis_of_rotation_orientation, which describes the orientation as horizontal.

4.2.369.1.2 other: an indication of axis_of_rotation_orientation, which describes the orientation as other than horizontal or vertical.

4.2.369.1.3 unknown: an indication of axis_of_rotation_orientation, which describes the orientation as unknown or unspecified.

4.2.369.1.4 vertical: an indication of axis_of_rotation_orientation, which describes the orientation as vertical.

4.2.369.2 spheroidal_pressure_vessel_wall_thickness

A spheroidal_pressure_vessel_wall_thickness specifies the wall thickness of the Spheroidal_pressure_-vessel.

4.2.370 Stage_column_section

A Stage_column_section is a group of contiguous Uo_distillation_stages (see 4.2.429) within a Uo_-distillation. The grouping of stages into a section allows the stages to be assigned some common or average properties over the entire section.

The data associated with a Stage_column_section are the following:

— section_diameter;

— stage_range.

4.2.370.1 section_diameter

A section_diameter specifies the actual or the nominal inside diameter of the column throughout the section.

4.2.370.2 stage_range

A stage_range specifies the range of stage numbers that specifies which stages are in the section.

4.2.371 Standard_dished_head

A Standard_dished_head is a type of head for the Cylindrical_pv_head_section (see 4.2.92).

The data associated with Standard_dished_head are the following:

— standard_dished_head_inside_diameter;

— standard_dished_head_knuckle_radius;

— standard_dished_head_nominal_diameter;

— standard_dished_head_outside_diameter.

4.2.371.1 standard_dished_head_inside_diameter

A standard_dished_head_inside_diameter specifies the inside diameter of the Standard_dished_head.

4.2.371.2 standard_dished_head_knuckle_radius

A standard_dished_head_knuckle_radius specifies the knuckle radius of the Standard_dished_head.

4.2.371.3 standard_dished_head_nominal_diameter

A standard_dished_head_nominal_diameter specifies the nominal diameter of the Standard_dished_head.

4.2.371.4 standard_dished_head_outside_diameter

A standard_dished_head_outside_diameter specifies the outside diameter of the Standard_dished_head.

4.2.372 Stoichiometry

A Stoichiometry is the stoichiometry for one Substance (see 4.2.381) in a Phase (see 4.2.230) for a Chemical_reaction (see 4.2.57) in the simulation.

The data associated with Stoichiometry are the following:

— stoichiometry_coefficient.

A stoichiometry_coefficient specifies the value for the stoichiometric coefficient for the Stoichiometry.

4.2.373 Straight_nozzle_section

A Straight_nozzle_section is a straight piece of Nozzle_section (see 4.2.199).

The data associated with Straight_nozzle_section are the following:

— straight_nozzle_section_length.

A straight_nozzle_section_length specifies the length of the Straight_nozzle_section.

4.2.374 Stream

A Stream is the Material (see 4.2.178), energy, or information that flows between unit operations in a simulation. Each Stream may be one of the following: an Energy_stream (see 4.2.122), a Material_stream (see 4.2.186), or a Utility_stream (see 4.2.485).

The data associated with Stream are the following:

— stream_name.

A stream_name specifies a label identifying the Stream in a simulation run.

4.2.375 Stream_convergence_block

A Stream_convergence_block is a Simulation_block (see 4.2.331) that implements a convergence or optimization algorithm for a Process_simulation (see 4.2.271) that modifies the values of one or more tear Streams (see 4.2.374) or Simulation_blocks (see 4.2.331) to achieve convergence.

The data_associated with Stream_convergence_block are the following:

— acceleration_method;

— calculation_sequence_type;

— stream_convergence_block_type;

— tolerance_method;

— tolerance_value.

4.2.375.1 acceleration_method

An acceleration_method specifies a method to accelerate or control the convergence step applied by the Process_simulation.algorithm_type (see 4.2.271).

4.2.375.2 calculation_sequence_type

A calculation_sequence_type specifies how the Process_simulation (see 4.2.271) orders block calculations inside the Stream_convergence_block and how it selects variables to converge on. The value of the calculation_sequence_type attribute shall be one of the following:

— algorithm_only;

— calculation_order;

— calculation_order_and_algorithm;

— complete_tear_stream;

— complete_tear_stream_and_algorithm;

— partial_tear_stream;

— partial_tear_stream_and_algorithm;

— system_default.

4.2.375.2.1 algorithm_only: an indication that only the convergence algorithm method and values are supplied.

4.2.375.2.2 calculation_order: an indication that the blocks inside the convergence loop are specified but that the algorithm choice is left to the module.

4.2.375.2.3 calculation_order_and_algorithm: an indication that the blocks inside the convergence loop are specified and the convergence algorithm method and values are supplied.

4.2.375.2.4 complete_tear_stream: an indication that all tear streams for the block are specified but that the algorithm choice is left to the module.

4.2.375.2.5 complete_tear_stream_and_algorithm: an indication that all tear streams for the block are specified and the convergence algorithm method and values are supplied.

4.2.375.2.6 partial_tear_stream: an indication that one or more tear streams are specified but that the algorithm choice is left to the module. If insufficient tear streams are specified the module will chose the remainder.

4.2.375.2.7 partial_tear_stream_and_algorithm: an indication that one or more tear streams are specified and the convergence algorithm method and values are supplied. If insufficient tear streams are specified the module will chose the remainder.

4.2.375.2.8 system_default: an indication that the module chooses which variable to converge on, which algorithm to use, and the calculation sequence.

4.2.375.3 stream_convergence_block_type

A stream_convergence_block_type specifies the convergence or optimization algorithm used by the Stream_convergence_block.

4.2.375.4 tolerance_method

A tolerance_method specifies the how the error that the tolerance is compared with is calculated.

4.2.375.5 tolerance_value

A tolerance_value specifies the criteria used by the convergence test to determine if a variable has converged.

4.2.376 Stream_reference_time

A Stream_reference_time is a snapshot of a Stream (see 4.2.374) at a specified point in time.

4.2.377 Stream_separation_specification

A Stream_separation_specification is a collection of values defining the separation for one Substance (see 4.2.381) in the inlet Stream(s) (see 4.2.374) of a Uo_substance_splitter (see 4.2.475).

The data associated with Stream_separation_specification are the following:

- separation_fraction;
- separation_mass_flow;
- separation_mole_flow;
- separation_residual_fraction;
- separation_standard_volume_flow.

4.2.377.1 separation_fraction

A separation_fraction specifies the fraction of the Substance (see 4.2.381) in the inlet that is present in the outlet.

NOTE - If no inlet is given then it is for all inlets to the unit operation.

4.2.377.2 separation_mass_flow

A separation_mass_flow specifies the mass flow of the Substance (see 4.2.381) in the outlet.

4.2.377.3 separation_mole_flow

A separation_mole_flow specifies the mole flow the Substance (see 4.2.381) in the outlet.

4.2.377.4 separation_residual_fraction

A separation_residual_fraction specifies the fraction in the outlet of all of the Substance (see 4.2.381) which is not elsewhere specified.

4.2.377.5 separation_standard_volume_flow

A separation_standard_volume_flow specifies the volumetric flow of the Substance (see 4.2.381) in the outlet at a Reference_state (see 4.2.300).

4.2.378 Stream_split_specification

A Stream_split_specification is the specification of the split of an inlet Stream (see 4.2.374) into an outlet Stream for a stream splitter.

NOTE - If no inlet Stream (see 4.2.374) is given, then the total of all inlet Streams to the unit operation is used.

The data associated with Stream_split_specification are the following:

— stream_split_fraction;

— stream_split_mass_flow;

— stream_split_mole_flow;

— stream_split_residual_fraction;

— stream_split_standard_volume_flow;

— stream_split_volume_flow.

4.2.378.1 stream_split_fraction

A stream_split_fraction specifies the fraction of the inlet split to the outlet in the Stream_split_-specification.

4.2.378.2 stream_split_mass_flow

A stream_split_mass_flow specifies the mass flow of the outlet of the Stream (see 4.2.374) split.

4.2.378.3 stream_split_mole_flow

A stream_split_mole_flow specifies the mole flow of the outlet of the Stream (see 4.2.374) split.

4.2.378.4 stream_split_residual_fraction

A stream_split_residual_fraction specifies the fraction of the outlet of anything that is not elsewhere specified.

4.2.378.5 stream_split_standard_volume_flow

A stream_split_standard_volume_flow specifies the volume flow of the outlet of the Stream (see 4.2.374) split at a Reference_state (see 4.2.300).

4.2.378.6 stream_split_volume_flow

A stream_split_volume_flow specifies the volume flow of the outlet of the Stream (see 4.2.374) split.

4.2.379 Structural_group

A Structural_group is a molecular or functional group defined for a given group contribution method for a property estimation.

The data associated with Structural_group are the following:

— structural_group_category;

— structural_group_description;

— structural_group_name;

— structural_group_type.

4.2.379.1 structural_group_category

A structural_group_category specifies the functional category for the Structural_group.

4.2.379.2 structural_group_description

A structural_group_description specifies the molecular structure of the Structural_group.

4.2.379.3 structural_group_name

A structural_group_name specifies a unique name for the Structural_group.

4.2.379.4 structural_group_type

A structural_group_type specifies the type of group contribution method the Structural_group is defined for.

4.2.380 Sub_plant_relationship

A Sub_plant_relationship is the relationship between Plant (see 4.2.236) objects and sub-plants and defines their relative locations.

The data associated with Sub_plant_relationship are the following:

— location_and_orientation.

A location_and_orientation specifies the relative position and orientation of the sub-plant within the Plant.

4.2.381 Substance

A Substance is any chemical substance. Each Substance may be one of the following: an Amorphous_solid (see 4.2.8), a Chemical_component (see 4.2.56), or a Mixture (see 4.2.192).

The data associated with Substance are the following:

— substance_identifier.

A substance_identifier specifies a unique name for the Substance.

4.2.382 Substance_name

A Substance_name is a common or specific label given to a Substance (see 4.2.381).

NOTE - More than one Substance_name may be associated with a given Substance and a given Substance_name may not always refer to the same Substance.

The data associated with Substance_name are the following:

— name_of_substance.

A name_of_substance specifies a label for the Substance_name.

4.2.383 Thermal_stream

A Thermal_stream is an Energy_stream (see 4.2.122) which is the flow of heat.

The data associated with Thermal_stream are the following:

— temperature_level.

A temperature_level specifies the effective temperature level for the Stream (see 4.2.374).

4.2.384 Thermo_property_method

A Thermo_property_method is a named set of related thermodynamic or transport property models used by a Process_simulation (see 4.2.271).

The data associated with Thermo_property_method are the following:

— method_description;

— method_name;

— method_phase.

4.2.384.1 method_description

A method_description specifies a short textual description that summarizes key aspects about the Thermo_property_method.

4.2.384.2 method_name

A method_name specifies a label that identifies the Thermo_property_method.

4.2.384.3 method_phase

A method_phase specifies that the Thermo_property_method applies only to a specific physical phase.

4.2.385 Thermo_property_option

A Thermo_property_option is a thermodynamic property option in the simulation.

The data associated with Thermo_property_option are the following:

— default;

— name;

— value.

4.2.385.1 default

A default specifies whether or not the Thermo_property_option is a default option.

4.2.385.2 name

A name specifies a label assigned to the Thermo_property_option in the simulation.

4.2.385.3 value

A value specifies the value of the Thermo_property_option in the simulation.

4.2.386 Thermodynamic_conditions

A Thermodynamic_conditions specifies the thermodynamic state for a Material_amount (see 4.2.179), Material_stream (see 4.2.186), or Specific_phase (see 4.2.367) or specifies the independent variables for a Process_material_property_curve_point (see 4.2.269).

The data associated with Thermodynamic_conditions are the following:

— enthalpy;

— description;

— pressure;

— temperature.

4.2.386.1 enthalpy

An enthalpy specifies the sum of the internal energy and the product of pressure and volume for any given portion of a fluid.

4.2.386.2 description

A description specifies additional information about the Thermodynamic_conditions in addition to temperature and pressure.

4.2.386.3 pressure

A pressure specifies the amount of force per unit area that any portion of a Material (see 4.2.178) exerts on its surroundings at the thermodynamic state.

4.2.386.4 temperature

A temperature specifies the temperature of a Material (see 4.2.178) at the thermodynamic state measured in one of the common scales of thermodynamic or thermometric temperature.

4.2.387 Thermodynamic_properties

A Thermodynamic_properties is a collection of properties loosely classified as thermodynamic properties for a Material (see 4.2.178) at a given thermodynamic state.

The data associated with Thermodynamic_properties are the following:

- heat_capacity_constant_pressure_mass_basis;
- heat_capacity_constant_pressure_mole_basis;
- heat_capacity_ratio;
- specific_enthalpy_mass_basis;
- specific_enthalpy_mole_basis;
- specific_entropy_mass_basis;
- specific_entropy_mole_basis;
- specific_gibbs_free_energy_mass_basis;
- specific_gibbs_free_energy_mole_basis;
- specific_helmholtz_free_energy_mass_basis;
- specific_helmholtz_free_energy_mole_basis.

4.2.387.1 heat_capacity_constant_pressure_mass_basis

A heat_capacity_constant_pressure_mass_basis specifies the instantaneous rate of change of the internal energy with respect to changes in temperature at constant pressure for any given portion of a Material (see 4.2.178) at the thermodynamic state per unit mass.

4.2.387.2 heat_capacity_constant_pressure_mole_basis

A heat_capacity_constant_pressure_mole_basis specifies the instantaneous rate of change of the internal energy with respect to changes in temperature at constant pressure for any given portion of a Material (see 4.2.178) at the thermodynamic state per mole.

4.2.387.3 heat_capacity_ratio

A heat_capacity_ratio specifies the ratio of heat capacity at constant pressure either mass or mole base divided by heat capacity at constant volume either mass or mole base.

4.2.387.4 specific_enthalpy_mass_basis

A specific_enthalpy_mass_basis specifies the enthalpy, the sum of the internal energy and the product of pressure and volume, per unit mass for any given portion of Material (see 4.2.178) at the thermodynamic state.

4.2.387.5 specific_enthalpy_mole_basis

A specific_enthalpy_mole_basis specifies the enthalpy, the sum of the internal energy and the product of pressure and volume, per mole for any given portion of a Material (see 4.2.178) at the thermodynamic state.

4.2.387.6 specific_entropy_mass_basis

A specific_entropy_mass_basis specifies the entropy per unit mass for any given portion of a Material (see 4.2.178) at the thermodynamic state.

4.2.387.7 specific_entropy_mole_basis

A specific_entropy_mole_basis specifies the entropy per mole for any given portion of a Material (see 4.2.178) at the thermodynamic state.

4.2.387.8 specific_gibbs_free_energy_mass_basis

A specific_gibbs_free_energy_mass_basis specifies the Gibbs free energy of a Substance (see 4.2.381) per unit mass. Gibbs free energy is the specific_enthalpy_mass_basis minus the product of the absolute temperature and the specific_entropy_mass_basis.

4.2.387.9 specific_gibbs_free_energy_mole_basis

A specific_gibbs_free_energy_mole_basis specifies the Gibbs free energy of a Substance (see 4.2.381) per mole. Gibbs free energy is the specific_enthalpy_mole_basis minus the product of the absolute temperature and the specific_entropy_mole_basis.

4.2.387.10 specific_helmholtz_free_energy_mass_basis

A specific_helmholtz_free_energy_mass_basis specifies the Helmholz free energy of a Substance (see 4.2.381) per unit mass. The Helmholz energy is the internal energy per unit mass minus the product of the absolute temperature and the specific_entropy_mass_basis.

4.2.387.11 specific_helmholtz_free_energy_mole_basis

A specific_helmholtz_free_energy_mole_basis specifies the Helmholz free energy of a Substance (see 4.2.381) per mole. The Helmholz energy is the internal energy per mole minus the product of the absolute temperature and the specific_entropy_mole_basis.

4.2.388 Thermophysical_point_property

A Thermophysical_point_property is a property which has a specific value for a Substance (see 4.2.381). Thermophysical_point_properties may be either constants or common properties which are expressed with respect to a standard state. Each Thermophysical_point_property may be a Defined_point_property (see 4.2.97).

> NOTE - A Thermophysical_point_property inherits a variable name. A number of these are reserved and defined.

4.2.389 Threaded

A Threaded is a type of Piping_connector (see 4.2.235) where the two pipes are connected by screw-type threading.

The data associated with Threaded are the following:

— thread_type.

A thread_type specifies an enumerated attribute that specifies the type of Threading. The value of the thread_type attribute shall be one of the following:

— iso_tapered;

— normal_course;

— normal_fine;

— normal_pipe;

— unknown.

4.2.389.0.1 iso_tapered: an indication which specifies the type of Threaded as ISO tapered thread.

4.2.389.0.2 normal_course: an indication which specifies the type of Threaded as normal coarse thread.

4.2.389.0.3 normal_fine: an indication which specifies the type of Threaded as normal fine thread.

4.2.389.0.4 normal_pipe: an indication which specifies the type of Threaded as normal pipe thread.

4.2.389.0.5 unknown: an indication which specifies the type of Threaded as unknown or unspecified.

4.2.390 Thrust_bearing

A Thrust_bearing is a type of Bearing (see 4.2.16) that is used to take up the axial force produced by a Shaft (see 4.2.325) driven machine. The Thrust_bearing acts as a pad at the end of the Shaft.

The data associated with Thrust_bearing are the following:

- thrust_bearing_bal_piston_comp_load;
- thrust_bearing_coupling_coeff_friction;
- thrust_bearing_coupling_gear_pitch;
- thrust_bearing_coupling_slip_load;
- thrust_bearing_gas_loading;
- thrust_bearing_location.

4.2.390.1 thrust_bearing_bal_piston_comp_load

A thrust_bearing_bal_piston_comp_load specifies the load the balance piston takes up from the impellers which relieves the Thrust_bearing of some of the burden and the Shaft (see 4.2.325).

4.2.390.2 thrust_bearing_coupling_coeff_friction

A thrust_bearing_coupling_coeff_friction specifies the coefficient of friction of the Thrust_bearing Coupling (see 4.2.84).

4.2.390.3 thrust_bearing_coupling_gear_pitch

A thrust_bearing_coupling_gear_pitch specifies the angle between the Thrust_bearing Coupling (see 4.2.84) and the gear.

4.2.390.4 thrust_bearing_coupling_slip_load

A thrust_bearing_coupling_slip_load specifies the load necessary to cause a slip in the position of the Thrust_bearing.

4.2.390.5 thrust_bearing_gas_loading

A thrust_bearing_gas_loading specifies the gas loading required to maintain normal Thrust_bearing operation with no slip.

4.2.390.6 thrust_bearing_location

A thrust_bearing_location specifies where on the Shaft (see 4.2.325) the Thrust_bearing is located.

4.2.391 Tie_rod

A Tie_rod is a device to hold the baffles in place.

> NOTE - One of several rods located at various points around the periphery of the bundle which run from the front tubesheet to the last baffle. They tie the baffles together and with the spacers hold the baffles in position.

The data associated with Tie_rod are the following:

— diameter;

— horiz_dist_from_tubesheet_centre;

— length;

— number_of_spacers;

— vert_dist_from_tubesheet_centre.

4.2.391.1 diameter

A diameter specifies the diameter of the Tie_rod.

4.2.391.2 horiz_dist_from_tubesheet_centre

A horiz_dist_from_tubesheet_centre specifies the horizontal distance from the vertical centreline of the tubesheet to the centre of the Tie_rod.

4.2.391.3 length

A length specifies the length of the Tie_rod.

4.2.391.4 number_of_spacers

A number_of_spacers specifies the number of Tie_rod_spacers (see 4.2.392) on the Tie_rod.

NOTE - Tie_rod_spacers are tube or pipe material with an inside diameter greater than the Tie_rod diameter and an outside diameter greater than the baffle Tie_rod holes. The spacers slide over the Tie_rods and act as spacers to hold the baffles in position.

4.2.391.5 vert_dist_from_tubesheet_centre

A vert_dist_from_tubesheet_centre specifies the vertical distance from the horizontal centreline of the tubesheet to the centre of the Tie_rod.

4.2.392 Tie_rod_spacer

A Tie_rod_spacer is a device made of pipe or tube which is placed over a Tie_rod (see 4.2.391) to maintain a space between adjacent baffles.

The data associated with Tie_rod_spacer are the following:

— distance_from_front_face;

— inside_diameter;

— length;

— outside_diameter.

4.2.392.1 distance_from_front_face

A distance_from_front_face specifies the distance from the front face of the front tubesheet of the heat exchanger to the spacer.

4.2.392.2 inside_diameter

An inside_diameter specifies the inside diameter of the spacer.

4.2.392.3 length

A length specifies the length of the spacer.

4.2.392.4 outside_diameter

An outside_diameter specifies the outside diameter of the spacer.

4.2.393 Time_reference

A Time_reference is either an absolute or relative time to be applied to an item in the plant design for the assignment of a temporal context.

The data associated with Time_reference are the following:

- description;
- time_id.

4.2.393.1 description

A description specifies a summary of key aspects of the Time_reference.

4.2.393.2 time_id

A time_id specifies a unique identifier for a Time_reference.

4.2.394 Torispherical_head

A Torispherical_head is a type of head for the Cylindrical_pv_head_section (see 4.2.92) with torispherical geometry.

The data associated with Torispherical_head are the following:

- torispherical_head_inside_diameter;
- torispherical_head_knuckle_radius;
- torispherical_head_outside_diameter.

4.2.394.1 torispherical_head_inside_diameter

A torispherical_head_inside_diameter specifies the inside diameter of the Torispherical_head.

4.2.394.2 torispherical_head_knuckle_radius

A torispherical_head_knuckle_radius specifies the knuckle radius of the Torispherical_head.

4.2.394.3 torispherical_head_outside_diameter

A torispherical_head_outside_diameter specifies the outside diameter of the Torispherical_head.

4.2.395 Trace_component_specification

A Trace_component_specification is the criteria that a Stream_convergence_block (see 4.2.375) may use in order to determine which components are present only in trace amounts and should be ignored in the convergence testing.

The data associated with Trace_component_specification are the following:

— applies_to;

— in_phases;

— minimum_fraction.

4.2.395.1 applies_to

An applies_to specifies whether the Trace_component_specification applies to all or only specified Substances (see 4.2.381) that may be present in the tear Stream (see 4.2.374) or Simulation_block (see 4.2.331) being converged. The value of the applies_to attribute shall be one of the following:

— all_components;

— specified_components.

4.2.395.1.1 all_components: an indication that the Trace_component_specification should be applied to all Substances (see 4.2.381) being converged.

4.2.395.1.2 specified_components: an indication that the Trace_component_specification is applied to one or more specified Substances (see 4.2.381).

4.2.395.2 in_phases

An in_phases specifies whether the Trace_component_specification applies to all or only specified Phases (see 4.2.230) that may be present in the tear Stream (see 4.2.374) or Simulation_block (see 4.2.331) being converged. The value of the in_phase attribute shall be one of the following:

— all_phases;

— specified_phases.

4.2.395.2.1 all_phases: an indication that the Trace_component_specification should be applied to all Phases (see 4.2.230) being converged.

4.2.395.2.2 specified_phases: an indication that the Trace_component_specification is applied to one or more specified Phases (see 4.2.230).

4.2.395.3 minimum_fraction

A minimum_fraction specifies the mole fraction below which a Substance (see 4.2.381) is considered to be a trace component and is ignored by the convergence test.

4.2.396 Transport_properties

A Transport_properties is a collection of properties loosely classified as transport properties for a bulk fluid or for one Phase (see 4.2.230) of a Mixture (see 4.2.192).

The data associated with Transport_properties are the following:

— thermal_conductivity;

— viscosity.

4.2.396.1 thermal_conductivity

A thermal_conductivity specifies the amount of thermal energy per unit time, per unit length, and per unit temperature that a Mixture (see 4.2.192) will transport by conduction.

4.2.396.2 viscosity

A viscosity specifies the ratio of the shearing stress per unit area for a given portion of a Mixture (see 4.2.192) to the velocity gradient necessary to produce that stress.

4.2.397 Tray_and_tray_stack

A Tray_and_tray_stack is the object class name given to the link attributes between Separation_tray (see 4.2.316) and Separation_tray_stack (see 4.2.322).

The data associated with Tray_and_tray_stack are the following:

— tray_number_from_bottom_of_stack;

— tray_number_from_top_of_stack.

4.2.397.1 tray_number_from_bottom_of_stack

A tray_number_from_bottom_of_stack specifies the Separation_tray (see 4.2.316) number when counting from the bottom to the top of the Separation_tray_stack (see 4.2.322).

4.2.397.2 tray_number_from_top_of_stack

A tray_number_from_top_of_stack specifies the Separation_tray (see 4.2.316) number when counting from the top to the bottom of the Separation_tray_stack (see 4.2.322).

4.2.398 Tray_cascade

A Tray_cascade is an abrupt vertical decline in the liquid flow path. A Separation_tray (see 4.2.316) may have zero or more Tray_cascades.

The data associated with Tray_cascade are the following:

— cascade_number;

— vertical_drop.

4.2.398.1 cascade_number

A cascade_number specifies the identification number for each Tray_cascade.

4.2.398.2 vertical_drop

A vertical_drop specifies the vertical distance that the liquid flow path declines at the Tray_cascade.

4.2.399 Tray_panel

A Tray_panel is part of a Separation_tray (see 4.2.316) that usually has vertical perforations for the passage of the vapour Phase (see 4.2.230).

NOTE - Typically, Tray_panels are horizontal and constructed from flat plates, but occasionally they are sloped and corrugated. The Tray_panel may also have tray slots that are designed to create a horizontal vapour jet in the liquid on top of the Tray_panel.

4.2.400 Tray_panel_and_perforation_shape

A Tray_panel_and_perforation_shape is the object class name assigned to the link attributes between the Tray_panel_shape (see 4.2.403) and the Perforation_shape (see 4.2.211).

The data associated with Tray_panel_and_perforation_shape are the following:

- hole_area;
- number_of_perforations.

4.2.400.1 hole_area

A hole_area specifies the total perforation area for each Tray_panel (see 4.2.399).

4.2.400.2 number_of_perforations

A number_of_perforations specifies the numeric quantity of hole perforations for each Tray_panel (see 4.2.399).

4.2.401 Tray_panel_and_slot_shape

A Tray_panel_and_slot_shape is the object class name assigned to the link attributes between the Tray_-panel_shape (see 4.2.403) and the Tray_slot_shape (see 4.2.404).

The data associated with Tray_panel_and_slot_shape are the following:

- number_of_slots;
- slot_area.

4.2.401.1 number_of_slots

A number_of_slots specifies the numeric quantity of tray slots on each Tray_panel (see 4.2.399).

4.2.401.2 slot_area

A slot_area specifies the total area of tray slots for that particular Tray_slot_shape (see 4.2.404).

4.2.402 Tray_panel_hydraulics

A Tray_panel_hydraulics is a description of the hydraulic features for each Tray_panel (see 4.2.399).

The data associated with Tray_panel_hydraulics are the following:

— jet_vapour_flood_at_constant_liquid;

— jet_vapour_flood_at_constant_molar_level;

— percentage_jet_flood_at_constant_liquid;

— percentage_jet_flood_at_constant_molar_overflow;

— vapour_load_limit.

4.2.402.1 jet_vapour_flood_at_constant_liquid

A jet_vapour_flood_at_constant_liquid specifies the vapour flood rate at a constant liquid height on a Tray_panel (see 4.2.399).

4.2.402.2 jet_vapour_flood_at_constant_molar_level

A jet_vapour_flood_at_constant_molar_level specifies the vapour flood rate at a constant molar liquid flow on a Tray_panel (see 4.2.399).

4.2.402.3 percentage_jet_flood_at_constant_liquid

A percentage_jet_flood_at_constant_liquid specifies the design vapour rate as a percent of jet flooding at a particular liquid height on a Tray_panel (see 4.2.399).

4.2.402.4 percentage_jet_flood_at_constant_molar_overflow

A percentage_jet_flood_at_constant_molar_overflow specifies the design vapour rate as a percent of jet flooding at a particular molar liquid flow on a Tray_panel (see 4.2.399).

4.2.402.5 vapour_load_limit

A vapour_load_limit specifies the actual vapour load that can be passed through a particular Tray_panel (see 4.2.399).

4.2.403 Tray_panel_shape

A Tray_panel_shape is a set of geometric features used to describe a Tray_panel (see 4.2.399).

The data associated with Tray_panel_shape are the following:

— hole_area;

— number_of_active_areas;

— number_of_perforation_geometries;

— percentage_hole_area;

— slope.

4.2.403.1 hole_area

A hole_area specifies the percentage of each Tray_panel (see 4.2.399) that has perforations.

4.2.403.2 number_of_active_areas

A number_of_active_areas specifies the number of active areas on each Tray_panel (see 4.2.399).

NOTE - The active areas need not be contiguous.

4.2.403.3 number_of_perforation_geometries

A number_of_perforation_geometries specifies the number of Perforation_shapes (see 4.2.211) on each Tray_panel (see 4.2.399).

4.2.403.4 percentage_hole_area

A percentage_hole_area specifies the fraction of total Tray_panel (see 4.2.399) area that has active hole areas.

4.2.403.5 slope

A slope specifies the change in vertical elevation for a Tray_panel (see 4.2.399).

4.2.404 Tray_slot_shape

A Tray_slot_shape is the geometric description, including Perimeter (see 4.2.216), that specifies a slot shape for each Tray_panel (see 4.2.399).

4.2.405 Tray_support

A Tray_support is generally that part of the Cylindrical_pressure_vessel (see 4.2.87) that is used to support each Separation_tray (see 4.2.316).

4.2.406 Tray_support_shape

A Tray_support_shape is the geometric description of the Tray_support (see 4.2.405).

NOTE - This description is usually of a ring welded to the inside of the Cylindrical_pressure_-vessel (see 4.2.87).

4.2.407 Trigger

A Trigger is a Process_definition (see 4.2.253) that is a Control_logic_condition (see 4.2.77), the execution status of which contributes to the Control_logic (see 4.2.76) that governs the execution of a Control_-event_or_adjustment (see 4.2.75) or an Event_sequence (see 4.2.128).

The data associated with Trigger are the following:

— status.

A status specifies the execution state of the Trigger.

4.2.408 Tube_external_characteristics

A Tube_external_characteristics is the type and dimensions of an external enhancement for tubes in a heat exchanger.

The data associated with Tube_external_characteristics are the following:

— base_thickness;

— bond_resistances;

— distance_unfinned_under_baffle;

— fin_pitch;

— finned_section_wall_thickness;

— height;

— outer_diameter;

— outside_area_per_unit_length;

— root_diameter;

— thermal_conductivity;

— tip_thickness;

— type;

— unfinned_under_baffles;

— width.

4.2.408.1 base_thickness

A base_thickness specifies the base thickness of the fin for an external finned tube.

4.2.408.2 bond_resistances

A bond_resistances specifies the thermal resistance across the bond between the fin and the tube.

4.2.408.3 distance_unfinned_under_baffle

A distance_unfinned_under_baffle specifies the length of one unfinned section of tube underneath the baffle.

4.2.408.4 fin_pitch

A fin_pitch specifies the distance between adjacent fins, centre to centre.

4.2.408.5 finned_section_wall_thickness

A finned_section_wall_thickness specifies the actual tube wall thickness underneath the external fin.

4.2.408.6 height

A height specifies the height of the fin for an externally finned tube.

4.2.408.7 outer_diameter

An outer_diameter specifies the outer diameter of the fin for an external finned tube.

4.2.408.8 outside_area_per_unit_length

An outside_area_per_unit_length specifies the actual outside area of the tube plus external device surface area per unit length of the tube.

4.2.408.9 root_diameter

A root_diameter specifies the outside diameter of the tube at the base of the fin for an external finned tube.

4.2.408.10 thermal_conductivity

A thermal_conductivity specifies the thermal conductivity of the tube external enhancement.

4.2.408.11 tip_thickness

A tip_thickness specifies the fin tip thickness for an external finned tube.

4.2.408.12 type

A type specifies an enumerated attribute indicating the type of external tube enhancement as corrugated, enhanced boiling, longitudinal fin, plain, sintered, spiral fin, or unspecified.

4.2.408.13 unfinned_under_baffles

An unfinned_under_baffles specifies the length of one unfinned section of tube located under the baffle.

4.2.408.14 width

A width specifies the width of a fin segment for segmented external finned tubes.

4.2.409 Tube_internal_characteristics

A Tube_internal_characteristics is the type and dimensions of an internal enhancement for tubes in a heat exchanger.

The data associated with Tube_internal_characteristics are the following:

- base_thickness;
- diameter;
- height;
- inside_area_per_unit_length;
- inside_cross_section;
- internal_hydraulic_diameter;

— length;

— number_internal_fins;

— spiral_fin_helix_angle;

— thermal_conductivity;

— tip_thickness;

— twisted_tape_pitch;

— twisted_tape_thickness;

— type;

— width.

4.2.409.1 base_thickness

A base_thickness specifies the thickness of the internal fin at its base.

4.2.409.2 diameter

A diameter specifies the diameter of the tube internal plug or wire loop device.

4.2.409.3 height

A height specifies the height of the internal tube fin.

4.2.409.4 inside_area_per_unit_length

An inside_area_per_unit_length specifies the actual inside area of the tube per unit length of tube.

4.2.409.5 inside_cross_section

An inside_cross_section specifies the actual inside cross sectional area of the tube with the internal device.

4.2.409.6 internal_hydraulic_diameter

An internal_hydraulic_diameter specifies the equivalent hydraulic diameter of the heat exchanger tube with an internal device.

4.2.409.7 length

A length specifies the length of the tube internal plug, twisted tape, or wire loop device.

4.2.409.8 number_internal_fins

A number_internal_fins specifies the number of internal fins around the inside circumference of the tubes.

4.2.409.9 spiral_fin_helix_angle

A spiral_fin_helix_angle specifies the helical angle of the spiral fin relative to the tube axis.

4.2.409.10 thermal_conductivity

A thermal_conductivity specifies the thermal conductivity of the tube internal device.

4.2.409.11 tip_thickness

A tip_thickness specifies the thickness of the internal fin at its tip.

4.2.409.12 twisted_tape_pitch

A twisted_tape_pitch specifies the distance between corresponding twists for the twisted tape internal device.

4.2.409.13 twisted_tape_thickness

A twisted_tape_thickness specifies the thickness of the twisted tape internal device.

4.2.409.14 type

A type specifies an enumerated attribute giving the type of internal tube enhancement as corrugated, longitudinal fin, plain, plug, spiral fin, twisted tape, wire loop, or unspecified.

4.2.409.15 width

A width specifies the width of the tube internal twisted tape device.

4.2.410 Tube_type

A Tube_type is the type, dimensions, and configuration of the tube.

The data associated with Tube_type are the following:

— effective_length;

— elastic_modulus;

— fin_area_per_unit_length;

— finned_length;

— heated_length;

— inside_diameter;

— outside_diameter;

— straight_length;

— tapered_ends;

— thermal_conductivity;

— thermal_resistance;

— total_length;

— tube_construction;

— tube_material_density;

— wall_specification;

— wall_thickness.

4.2.410.1 effective_length

An effective_length specifies the effective heat transfer length of the heat exchanger tubes.

NOTE - This normally does not include the tube length projecting from the tubesheet into the heads or the tube length contained inside the tubesheet(s).

4.2.410.2 elastic_modulus

An elastic_modulus specifies the modulus of elasticity for the heat exchanger tube material.

4.2.410.3 fin_area_per_unit_length

A fin_area_per_unit_length specifies the fin surface area per unit length of the heat exchanger tube.

4.2.410.4 finned_length

A finned_length specifies the total length of the heat exchanger tube that is finned.

4.2.410.5 heated_length

A heated_length specifies the length of the heat exchanger tube after it is heated to the operating temperature.

4.2.410.6 inside_diameter

An inside_diameter specifies the inside diameter of the heat exchanger tube.

4.2.410.7 outside_diameter

An outside_diameter specifies the outside diameter of the heat exchanger tube.

4.2.410.8 straight_length

A straight_length specifies the total straight length of the heat exchanger tubes.

NOTE - For U-tubes, the straight length is terminated at the tangent line of the U-bend.

4.2.410.9 tapered_ends

A tapered_ends specifies whether tapered tube ends are present, not present, or unspecified.

NOTE - Tapered tubes are tubes that are extended from the face of the tubesheet and cut at an angle (tapered).

4.2.410.10 thermal_conductivity

A thermal_conductivity specifies the thermal conductivity of the heat exchanger tube. The heat flow across a surface per unit area per unit time, divided by the negative of the rate of change of temperature with distance in a direction perpendicular to the surface.

4.2.410.11 thermal_resistance

A thermal_resistance specifies the thermal resistance of the heat exchanger tube. A measure of a body's ability to prevent heat from flowing through it, equal to the difference between the temperatures of opposite faces of the body divided by the rate of heat flow.

4.2.410.12 total_length

A total_length specifies the total length for the heat exchanger tube.

NOTE - For U-tubes the total length is the straight length.

4.2.410.13 tube_construction

A tube_construction specifies whether the tube is made to be seamless, welded, or its construction is not specified.

4.2.410.14 tube_material_density

A tube_material_density specifies the density of the heat exchanger tube material.

4.2.410.15 wall_specification

A wall_specification specifies an enumerated attribute giving the tube wall thickness specification to be used in ordering the tubes. The value of the wall_specification attributes shall be one of the following:

— average;

— minimum;

— unspecified.

4.2.410.15.1 average: an indication that the average tube wall thickness must meet the specified thickness.

4.2.410.15.2 minimum: an indication that the minimum tube wall thickness must meet the specified thickness.

4.2.410.15.3 unspecified: an indication that the wall thickness is not specified.

4.2.410.16 wall_thickness

A wall_thickness specifies the wall thickness of the tube.

4.2.411 Tubesheet

A Tubesheet is a sheet of material located between the heads and the shell to maintain separation of the shell and tube side fluids. The Tubesheet is perforated with tubes to permit passage of the tube side fluid through the shell.

The data associated with Tubesheet are the following:

— centreline_offset_from_shell_centreline;

— degree_of_symmetry;

— elastic_modulus;

— location;

— longitudinal_tube_pitch;

— number_of_tie_rods;

— number_tubes_removed;

— number_tubes_removed_under_nozzles;

— outside_diameter;

— thermal_conductivity;

— thickness;

— transverse_tube_pitch;

— tube_alignment;

— tube_pass_layout_type;

— tube_pattern;

— tube_to_tubesheet_joint;

— tubes_per_pass_deviation;

— tubesheet_extension_od;

— type.

4.2.411.1 centreline_offset_from_shell_centreline

A centreline_offset_from_shell_centreline specifies the distance from the horizontal centreline of the Tubesheet to the horizontal centreline of the kettle cylinder (kettle only).

4.2.411.2 degree_of_symmetry

A degree_of_symmetry specifies an enumerated attribute giving the degree of symmetry of the tube layout with respect to the tube rows on or next to the horizontal centreline of the Tubesheet as non-symmetrical to centreline, symmetrical to centreline, or unspecified.

4.2.411.3 elastic_modulus

An elastic_modulus specifies the modulus of elasticity for the Tubesheet material.

4.2.411.4 location

A location specifies an enumerated attribute giving the location of the Tubesheet. The value of the location attribute shall by one of the following:

— front;

— rear;

— unspecified.

4.2.411.4.1 front: an indication the location of the Tubesheet is at the front head or top of the heat exchanger if vertical.

4.2.411.4.2 rear: an indication the location of the Tubesheet is at the read head or bottom of heat exchanger if vertical.

4.2.411.4.3 unspecified: an indication the location of the Tubesheet is not specified.

4.2.411.5 longitudinal_tube_pitch

A longitudinal_tube_pitch specifies the shortest tube centre to centre distance between adjacent tubes within the tube_pattern.

4.2.411.6 number_of_tie_rods

A number_of_tie_rods specifies the number of Tie_rods (see 4.2.391) used to hold the baffles in position.

4.2.411.7 number_tubes_removed

A number_tubes_removed specifies the number of tubes removed from the Tubesheet.

4.2.411.8 number_tubes_removed_under_nozzles

A number_tubes_removed_under_nozzles specifies the number of tubes removed from the Tubesheet layout under the nozzles.

4.2.411.9 outside_diameter

An outside_diameter specifies the diameter of the heat exchanger Tubesheet.

4.2.411.10 thermal_conductivity

A thermal_conductivity specifies the thermal conductivity of the Tubesheet material.

4.2.411.11 thickness

A thickness specifies the thickness of the heat exchanger Tubesheet.

4.2.411.12 transverse_tube_pitch

A transverse_tube_pitch specifies the distance between the tube row centrelines in a direction perpendicular to the shell side fluid flow direction.

4.2.411.13 tube_alignment

A tube_alignment specifies an enumerated attribute giving the degree of tube alignment between tube passes. The value of the tube_alignment attribute shall be one of the following:

— full_alignment;

— none;

— semi_alignment;

— u_tube;

— unspecified.

4.2.411.13.1 full_alignment: an indication the alignment of tube lattices is preserved in all directions between passes, in the direction of the flow, perpendicular to the flow and diagonally.

NOTE - In order to do this pass lanes are adjusted.

4.2.411.13.2 none: an indication tube lattices are not aligned at all between passes.

NOTE - This gives the most tubes in shell.

4.2.411.13.3 semi_alignment: an indication that alignment of the tube lattice between passes is preserved only in the direction of the flow and perpendicular to the flow.

4.2.411.13.4 u_tube: an indication the pass partition lanes are adjusted to give the minimum tube bend radius allowed.

4.2.411.13.5 unspecified: an indication the tube_alignment is not specified.

4.2.411.14 tube_pass_layout_type

A tube_pass_layout_type specifies an enumerated attribute giving the type of tube pass layout as mixed or H-banded, quadrant, ribbon, or unspecified.

4.2.411.15 tube_pattern

A tube_pattern specifies an enumerated attribute giving the layout of the tubes in relation to the direction of the shell side crossflow. The value of the tube_pattern attribute shall be one of the following:

— rotated_square;

— rotated_triangular;

— square;

— triangular;

— unspecified.

4.2.411.15.1 rotated_square: an indication that the tube_pattern is rotated 45 degrees with respect to flow direction (see item 4 in the Figure 6).

4.2.411.15.2 rotated_triangular: an indication that the tube_pattern is rotated 60 degrees with respect to flow direction (see item 2 in Figure 6).

4.2.411.15.3 square: an indication that the tube_pattern is 90 degrees with respect to the flow direction (see item 3 in Figure 6).

4.2.411.15.4 triangular: an indication that the tube_pattern is 30 degrees with respect to the flow direction (see item 1 in Figure 6).

4.2.411.15.5 unspecified: an indication that the tube_pattern is not specified.

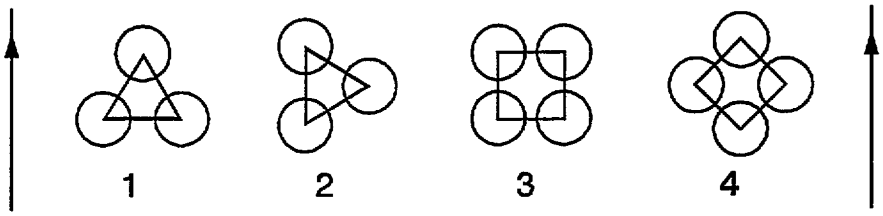


Figure 6 - Tube Pattern

4.2.411.16 tube_to_tubesheet_joint

A tube_to_tubesheet_joint specifies an enumerated attribute specifying the type of tube to Tubesheet joint used in fabrication of the Tubesheet. The value of the tube_to_tubesheet_joint shall be one of the following:

— expanded_only;

— expanded_and_seal_welded;

— expanded_and_strength_welded;

— seal_welded_only;

— strength_welded_only;

— unspecified.

4.2.411.16.1 expanded_only: an indication that the tube_to_tubesheet_joint is only expanded (see items 1, 2, and 3 in Figure 7) for no groove, one groove, and two groove expansion, respectively.

4.2.411.16.2 expanded_and_seal_welded: an indication that the tube_to_tubesheet_joint is expanded and seal welded (see items 6, 7, and 8 in Figure 7) for no groove, one groove, and two groove expansion, respectively.

4.2.411.16.3 expanded_and_strength_welded: an indication that the tube_to_tubesheet_joint is expanded and strength welded (see item 9 in Figure 7).

4.2.411.16.4 seal_welded_only: an indication that the tube_to_tubesheet_joint is seal welded (see item 4 in Figure 7).

4.2.411.16.5 strength_welded_only: an indication that the tube_to_tubesheet_joint is strength welded (see item 5 in Figure 7).

4.2.411.16.6 unspecified: an indication that the tube to Tubesheet joint type is not specified.

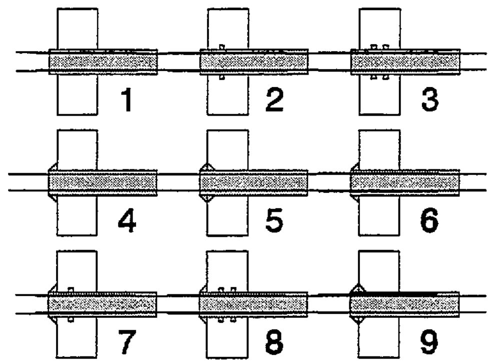


Figure 7 - Tube to Tubesheet Joint Types

4.2.411.17 tubes_per_pass_deviation

A tubes_per_pass_deviation specifies the highest percent deviation from the median number of tubes per pass.

4.2.411.18 tubesheet_extension_od

A tubesheet_extension_od specifies an enumerated attribute giving the type of extension of Tubesheet diameter as to shell outside diameter (N type head only), to gasket outside diameter (not bolted through), to flange outside diameter (bolted through), or integral with shell (bolted through).

4.2.411.19 type

A type specifies an enumerated attribute giving the type of Tubesheet. The value of the type attribute shall be one of the following:

— double_integral;

— double_with_gap;

— single;

— unspecified.

4.2.411.19.1 double_integral: an indication the Exchanger_tubesheet is a single plate with an internal space where a leaking fluid can flow out (see item 3 in Figure 8).

4.2.411.19.2 double_with_gap: an indication the Exchanger_tubesheet consists of two tubesheets at an end with a gap between them (see item 2 in Figure 8).

4.2.411.19.3 single: an indication the Exchanger_tubesheet is one tubesheet at an end (see item 1 in Figure 8).

4.2.411.19.4 unspecified: an indication the Exchanger_tubesheet type is not specified.

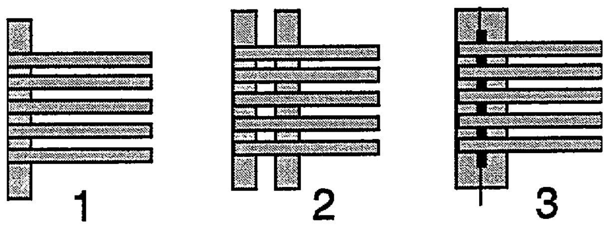


Figure 8 - Tubesheet Types

4.2.412 Tubeside_design

A Tubeside_design is the design criteria on the tube side.

The data associated with Tubeside_design are the following:

- allowable_pressure_drop;
- allowable_tubesheet_stress;
- coefficient_method;
- corrosion_allowance;
- design_degree_of_symmetry;
- design_pressure;
- design_temperature;
- design_tube_alignment;
- film_coefficient;
- film_coefficient_multiplier;

— maximum_deviation_tubes_per_pass;

— maximum_tube_length;

— maximum_tube_passes;

— maximum_velocity;

— minimum_tube_length;

— minimum_tube_passes;

— minimum_ubend_diameter;

— minimum_velocity;

— pressure_drop_multiplier;

— test_pressure;

— tube_length_increment;

— tube_pass_increment;

— vacuum_service_design_pressure.

4.2.412.1 allowable_pressure_drop

An allowable_pressure_drop specifies the maximum allowable pressure drop on the tube side of the heat exchanger.

4.2.412.2 allowable_tubesheet_stress

An allowable_tubesheet_stress specifies the allowable Tubesheet (see 4.2.411) material stress for the heat exchanger.

4.2.412.3 coefficient_method

A coefficient_method specifies whether the Heat_transfer_coefficient (see 4.2.159) used in the tube side design is based on clean, dirty, or service conditions.

4.2.412.4 corrosion_allowance

A corrosion_allowance specifies the allowable corrosive thickness of the tube side material.

4.2.412.5 design_degree_of_symmetry

A design_degree_of_symmetry specifies an indicator of design degree of symmetry to centreline of the Tubesheet (see 4.2.411). The value of the design_degree_of_symmetry attribute shall be one of the following:

— non_symmetrical_to_centreline;

— symmetrical_to_centreline;

— unspecified.

4.2.412.5.1 non_symmetrical_to_centreline: an indication the Tubesheet (see 4.2.411) design is non-symmetrical to the centreline of the Tubesheet.

4.2.412.5.2 symmetrical_to_centreline: an indication the Tubesheet (see 4.2.411) design is symmetrical to the centreline of the Tubesheet.

4.2.412.5.3 unspecified: an indication the Tubesheet (see 4.2.411) design is not specified.

4.2.412.6 design_pressure

A design_pressure specifies the design pressure of the tube side of the heat exchanger.

4.2.412.7 design_temperature

A design_temperature specifies the design temperature of the tube side of the heat exchanger.

4.2.412.8 design_tube_alignment

A design_tube_alignment specifies an enumerated attribute indicating the type of tube alignment in the heat exchanger design. The value of the design_tube_alignment attribute shall be one of the following:

— full_alignment;

— none;

— semi_alignment;

— u_tube;

— unspecified.

4.2.412.8.1 full_alignment: an indication that the alignment of tube lattices is preserved in all directions between passes; in direction of flow, perpendicular to flow; and diagonally.

NOTE - In order to do this pass lanes are adjusted.

4.2.412.8.2 none: an indication that tube lattices are not aligned at all between passes.

NOTE - This gives the most tubes in shell.

4.2.412.8.3 semi_alignment: an indication that alignment of the tube lattice between passes is preserved only in the direction of flow and perpendicular flow.

4.2.412.8.4 u_tube: an indication that pass partition lanes are adjusted to give the minimum tube bend radius allowed.

4.2.412.8.5 unspecified: an indication that tube alignment is not specified.

4.2.412.9 film_coefficient

A film_coefficient specifies the film Heat_transfer_coefficient (see 4.2.159).

4.2.412.10 film_coefficient_multiplier

A film_coefficient_multiplier specifies the multiplier for the film coefficient of the tube side of the heat exchanger.

4.2.412.11 maximum_deviation_tubes_per_pass

A maximum_deviation_tubes_per_pass specifies the maximum percent deviation of tubes per pass.

4.2.412.12 maximum_tube_length

A maximum_tube_length specifies the maximum tube length of the heat exchanger.

4.2.412.13 maximum_tube_passes

A maximum_tube_passes specifies the maximum number of tube passes of the heat exchanger.

4.2.412.14 maximum_velocity

An maximum_velocity specifies the maximum limit for liquid or vapour velocity anywhere within the tube side of the heat exchanger.

4.2.412.15 minimum_tube_length

A minimum_tube_length specifies the minimum tube length of the heat exchanger.

4.2.412.16 minimum_tube_passes

A minimum_tube_passes specifies the minimum number of tube passes of the heat exchanger.

4.2.412.17 minimum_ubend_diameter

A minimum_ubend_diameter specifies the minimum U-bend diameter of the heat exchanger.

4.2.412.18 minimum_velocity

A minimum_velocity specifies the minimum limit for liquid or vapour velocity anywhere within the tube side of the heat exchanger.

4.2.412.19 pressure_drop_multiplier

A pressure_drop_multiplier specifies a multiplier applied to the calculated tube side pressure drop excluding the pressure drop through the Nozzles (see 4.2.194).

4.2.412.20 test_pressure

A test_pressure specifies the test pressure at which the tube side of the heat exchanger is hydrotested.

4.2.412.21 tube_length_increment

A tube_length_increment specifies the increment by which the tube length can be changed.

4.2.412.22 tube_pass_increment

A tube_pass_increment specifies an enumerated attribute indicating the type of increment for tube passes of the heat exchanger as any (odd or even), even, odd, or unspecified.

4.2.412.23 vacuum_service_design_pressure

A vacuum_service_design_pressure specifies the vacuum service design pressure for the tube side of the heat exchanger.

4.2.413 Tubeside_performance

A Tubeside_performance is the overall tube side performance of the heat exchanger.

The data associated with Tubeside_performance are the following:

— average_skin_temperature;

— bulk_film_coefficient;

— clean_pressure_drop;

— dirty_pressure_drop;

— fouling_resistance;

— fouling_thickness;

— inlet_velocity;

— midpoint_velocity;

— outlet_temperature;

— outlet_velocity;

— thermal_resistance;

— wall_film_coefficient;

— wall_temperature.

4.2.413.1 average_skin_temperature

An average_skin_temperature specifies the temperature of the tube inside fouling layer in tube side of a heat exchanger.

4.2.413.2 bulk_film_coefficient

A bulk_film_coefficient specifies the Heat_transfer_coefficient (see 4.2.159) between the bulk fluid and the fluid film for the tube side of a heat exchanger.

4.2.413.3 clean_pressure_drop

A clean_pressure_drop specifies the pressure drop of the clean tube side heat exchanger.

4.2.413.4 dirty_pressure_drop

A dirty_pressure_drop specifies the pressure drop of the dirty tube side heat exchanger.

4.2.413.5 fouling_resistance

A fouling_resistance specifies the thermal resistance of fouling layers on the tube side of the heat exchanger.

4.2.413.6 fouling_thickness

A fouling_thickness specifies the thickness of fouling layers on the tube side of the heat exchanger.

4.2.413.7 inlet_velocity

An inlet_velocity specifies the fluid velocity at the inlet of the heat exchanger.

4.2.413.8 midpoint_velocity

A midpoint_velocity specifies the velocity associated with the midpoint of the tube side of a heat exchanger.

4.2.413.9 outlet_temperature

An outlet_temperature specifies the outlet temperature of the tube side of the heat exchanger.

4.2.413.10 outlet_velocity

An outlet_velocity specifies the fluid velocity at the exit of the heat exchanger.

4.2.413.11 thermal_resistance

A thermal_resistance specifies the thermal resistance of the tube side of the heat exchanger.

4.2.413.12 wall_film_coefficient

A wall_film_coefficient specifies the value of the convective Heat_transfer_coefficient (see 4.2.159) at the tube wall on the tube side of a heat exchanger.

4.2.413.13 wall_temperature

A wall_temperature specifies the inside wall temperature of the tube on the tube side of a heat exchanger.

4.2.414 U_bend_support

A U_bend_support is the support plates or grids which are used to give additional support to the tubes at the U-bend.

The data associated with U_bend_support are the following:

- angle;
- type.

4.2.414.1 angle

An angle specifies the angle of the U_bend_support to the axis of the U-bend.

4.2.414.2 type

A type specifies an enumerated attribute giving the type of U-bend support as full support, none, two supports with vertical cut windows, vibration support, or unspecified.

> NOTE - A vibration support is a support made of pieces for each tube row which are fitted in the U-bends during construction.

4.2.415 Uo_air_cooled_heat_exchanger

A Uo_air_cooled_heat_exchanger is a type of Process_unit_operation (see 4.2.275) that provides the capability to exchange heat between two Material_streams (see 4.2.186). One Material_stream flows through a tube bundle that is open to the atmosphere. Air is passed by the tube bundle by means of a fan.

4.2.416 Uo_centrifugal_compressor

A Uo_centrifugal_compressor is a type of Uo_compressor (see 4.2.420) that represents the operation of a Centrifugal_compressor (see 4.2.52).

The data associated with Uo_centrifugal_compressor are the following:

- radial_frequency.

A radial_frequency specifies the rotational speed of the Uo_centrifugal_compressor.

4.2.417 Uo_centrifugal_compressor_stage

A Uo_centrifugal_compressor_stage is a type of Uo_compressor_stage (see 4.2.421) that represents the operation of a single stage for a Centrifugal_compressor (see 4.2.52).

The data associated with Uo_centrifugal_compressor_stage are the following:

— design_flowrate;

— design_head;

— design_speed;

— isentropic_efficiency;

— stage_number.

4.2.417.1 design_flowrate

A design_flowrate specifies the volumetric flowrate for the compressor at the design_speed.

4.2.417.2 design_head

A design_head specifies the head developed for the compressor at the design_speed.

4.2.417.3 design_speed

A design_speed specifies the design rotational speed (radial_frequency) of the compressor.

4.2.417.4 isentropic_efficiency

An isentropic_efficiency specifies the isentropic efficiency of the Uo_centrifugal_compressor_stage associated with the unit operation.

4.2.417.5 stage_number

A stage_number specifies the stage number of the Uo_centrifugal_compressor (see 4.2.416).

4.2.418 Uo_centrifuge

A Uo_centrifuge is a type of Uo_liquid_solid_separator (see 4.2.448) that is a centrifuge unit operation. It uses mechanical energy to create a spinning motion that separates solids from liquids.

The data associated with Uo_centrifuge are the following:

— cake_surface_radius;

— diameter;

— filter_cake_compressibility_factor;

— filter_cake_particle_diameter;

— filter_cake_particle_sphericity;

— filter_cake_percent_solid;

— filter_cake_porosity;

— filter_cake_specific_resistance;

— filter_cloth_resistance;

— frequency;

— height;

— liquid_surface_radius.

4.2.418.1 cake_surface_radius

A cake_surface_radius specifies the inside radius of the surface of the solids caked, or pressed against, the rotating side of the centrifuge.

4.2.418.2 diameter

A diameter specifies the diameter associated with the unit operation, of the Uo_centrifuge.

4.2.418.3 filter_cake_compressibility_factor

A filter_cake_compressibility_factor specifies the compressibility factor of the filter cake layer associated with the unit operation, Uo_centrifuge.

4.2.418.4 filter_cake_particle_diameter

A filter_cake_particle_diameter specifies the average diameter of particles in the cake associated with the unit operation, of the Uo_centrifuge.

4.2.418.5 filter_cake_particle_sphericity

A filter_cake_particle_sphericity specifies the sphericity of the particles of solids associated with the unit operation, of the Uo_centrifuge.

4.2.418.6 filter_cake_percent_solid

A filter_cake_percent_solid specifies the ratio of the amount of solids in the filter cake to the total amount of filter cake for the unit operation, of the Uo_centrifuge.

4.2.418.7 filter_cake_porosity

A filter_cake_porosity specifies the ratio of void volume to total volume of the filter cake associated with the unit operation, of the Uo_centrifuge.

4.2.418.8 filter_cake_specific_resistance

A filter_cake_specific_resistance specifies the specific resistance associated with the Uo_centrifuge.

4.2.418.9 filter_cloth_resistance

A filter_cloth_resistance specifies the resistance of the cloth for the Uo_centrifuge.

4.2.418.10 frequency

A frequency specifies the frequency of the spinning element for the Uo_centrifuge.

4.2.418.11 height

A height specifies the height of the centrifuge for the Uo_centrifuge.

4.2.418.12 liquid_surface_radius

A liquid_surface_radius specifies the radius of the liquid layer.

4.2.419 Uo_complex_distillation

A Uo_complex_distillation is a type of Process_unit_operation (see 4.2.275) that is two or more interconnected Uo_distillation (see 4.2.428) unit operations.

4.2.420 Uo_compressor

A Uo_compressor is a type of Uo_pressure_changer (see 4.2.460) that represents the operation of equipment that mechanically compresses a gas Stream (see 4.2.374). Each Uo_compressor may be one of the following: a Uo_centrifugal_compressor (see 4.2.416), a Simulation_polytropic_compressor (see 4.2.348), or a Uo_positive_displacement_compressor (see 4.2.458).

The data associated with Uo_compressor are the following:

— cooler_dp;

— cooler_temp;

— number_of_stages;

— overall_isentropic_efficiency;

— overall_polytropic_efficiency.

4.2.420.1 cooler_dp

A cooler_dp specifies the pressure drop across the compressor after cooler.

4.2.420.2 cooler_temp

A cooler_temp specifies the outlet temperature for the compressor after cooler.

4.2.420.3 number_of_stages

A number_of_stages specifies the number of stages in the Uo_compressor.

4.2.420.4 overall_isentropic_efficiency

An overall_isentropic_efficiency specifies the overall isentropic efficiency for the compressor.

4.2.420.5 overall_polytropic_efficiency

An overall_polytropic_efficiency specifies the overall polytropic efficiency for the compressor.

4.2.421 Uo_compressor_stage

A Uo_compressor_stage is a type of Uo_pressure_changer (see 4.2.460) that represents one of a series of mechanical gas compression stages in a Uo_compressor (see 4.2.420) unit operation. Each Uo_-compressor_stage may be one of the following: a Uo_centrifugal_compressor_stage (see 4.2.417), a

Simulation_polytropic_compressor_stage (see 4.2.349), or a Uo_positive_displacement_compressor_stage (see 4.2.459).

The data associated with Uo_compressor_stage are the following:

- cooler_dp;
- cooler_temp.

4.2.421.1 cooler_dp

A cooler_dp specifies the pressure drop across the compressor stage after cooler.

4.2.421.2 cooler_temp

A cooler_temp specifies the outlet temperature for the compressor stage after cooler.

4.2.422 Uo_countercurrent_solids_decanter

A Uo_countercurrent_solids_decanter is a type of Uo_liquid_solid_separator (see 4.2.448) where the unit operation represents the separation of solids from a liquid Stream (see 4.2.374) by a series of decanters in which the liquids and solids move from decanter to decanter in opposite directions.

The data associated with Uo_countercurrent_solids_decanter are the following:

- heavy_key_recovery;
- light_key_recovery;
- stages.

4.2.422.1 heavy_key_recovery

A heavy_key_recovery specifies the recovery of one selected solid Chemical_component (see 4.2.56), the ratio of the amount of Chemical_component in the slurry feed Stream (see 4.2.374) to the amount of the Chemical_component in the solid outlet Stream, for the Countercurrent_decanter.

4.2.422.2 light_key_recovery

A light_key_recovery specifies the recovery of one selected liquid Chemical_component (see 4.2.56), the ratio of the amount of Chemical_component in the slurry feed Stream (see 4.2.374) to the amount of the Chemical_component in the liquid outlet Stream, for the Countercurrent_decanter.

4.2.422.3 stages

A stages specifies the number of identical countercurrent stages in the decanter.

4.2.423 Uo_crusher

A Uo_crusher is a type of Process_unit_operation (see 4.2.275) that is a crusher unit operation. It grinds a solid into smaller particles.

The data associated with Uo_crusher are the following:

— crusher_type;

— operating_mode;

— outlet_diameter.

4.2.423.1 crusher_type

A crusher_type specifies the type of crusher of the Uo_crusher. The value of the crusher_type attribute shall be one of the following:

— cage_mill;

— gyratory/jaw;

— multiple_roll;

— single_roll.

4.2.423.1.1 cage_mill: an indication the crusher is a cage mill type for the Uo_crusher.

4.2.423.1.2 gyratory/jaw: an indication that the crusher is a gyratory or jaw type for the Uo_crusher.

4.2.423.1.3 multiple_roll: an indication the crusher is a multiple roller type for the Uo_crusher.

4.2.423.1.4 single_roll: an indication that the crusher is a single roller type for the Uo_crusher.

4.2.423.2 operating_mode

An operating_mode specifies an enumerated attribute indicating whether the Uo_crusher is a primary or secondary crusher. The value of the operating_mode attribute shall be one of the following:

— primary;

— secondary.

4.2.423.2.1 primary: an indication that the crusher is operating as a primary crusher for the Uo_crusher.

4.2.423.2.2 secondary: an indication that the crusher is operating as a secondary crusher for the Uo_-crusher.

4.2.423.3 outlet_diameter

An outlet_diameter specifies the outlet diameter of the solids associated with the unit operation, of the Uo_crusher.

4.2.424 Uo_crystallizer

A Uo_crystallizer is a type of Uo_liquid_solid_separator (see 4.2.448) that is the representation of separation of a dissolved solid from a liquid Stream (see 4.2.374) by crystallization.

NOTE - Crystallization is used in industrial processes for the manufacturing of organics, inorganics, fertilizers, biochemicals, and polymers.

The data associated with Uo_crystallizer are the following:

— duty;

— exchanger_delta_temperature;

— fraction;

— magma_density;

— outlet_pressure;

— pressure_drop;

— rate;

— recirculation_flow_rate;

— saturation_ratio;

— solute;

— solute_recovery;

— solvent;

— solvent_loss;

— temperature;

— volume.

4.2.424.1 duty

A duty specifies the heat removed from the Uo_crystallizer by its heat exchanger.

4.2.424.2 exchanger_delta_temperature

An exchanger_delta_temperature specifies the temperature difference across the heat exchanger for the Crystallizer.

4.2.424.3 fraction

A fraction specifies the mole fraction of dissolved key solid component in the feed that is recovered in the crystallized bottom product Stream (see 4.2.374).

4.2.424.4 magma_density

A magma_density specifies the required density of the bottoms product Stream (see 4.2.374).

4.2.424.5 outlet_pressure

An outlet_pressure specifies the pressure at the outlet of the Uo_crystallizer.

4.2.424.6 pressure_drop

A pressure_drop specifies the difference between the inlet pressure and the outlet pressure of the Uo_-crystallizer.

4.2.424.7 rate

A rate specifies the rate of crystal formation in the crystallizer.

4.2.424.8 recirculation_flow_rate

A recirculation_flow_rate specifies the amount of saturated magma that is recirculated from the outlet of the Uo_crystallizer to the inlet.

4.2.424.9 saturation_ratio

A saturation_ratio specifies the supersaturation ratio of the key solid component in the bulk liquid of the crystallizer, that difference in the mole fraction of the key solid component in the bulk liquid and the equilibrium mole fraction of the key component divided by that equilibrium mole fraction.

4.2.424.10 solute

A solute specifies the component name for the crystal solute.

4.2.424.11 solute_recovery

A solute_recovery specifies the ratio of the amount of solute crystallized to the amount of solute dissolved in the feed.

4.2.424.12 solvent

A solvent specifies the component name for the predominant solvent component.

4.2.424.13 solvent_loss

A solvent_loss specifies the difference between the amount of solvent in the feed to the amount of solvent in the liquid portion of the outlet of the Uo_crystallizer.

4.2.424.14 temperature

A temperature specifies the operating temperature of the Uo_crystallizer.

4.2.424.15 volume

A volume specifies the internal volume of the Uo_crystallizer.

4.2.425 Uo_cst_reactor

A Uo_cst_reactor is a type of Uo_reactor (see 4.2.462) that represents a completely (ideal) stirred reactor unit operation.

The data associated with Uo_cst_reactor are the following:

- charge;
- maximum_volume;
- residence_time;

— volume.

4.2.425.1 charge

A charge specifies the amount of non-volatile material in the reactor.

EXAMPLE 27 - For example, a catalyst in the reactor.

4.2.425.2 maximum_volume

A maximum_volume specifies the maximum reaction phase volume.

NOTE - This is used to calculate the volume of a boiling pot reactor.

4.2.425.3 residence_time

A residence_time specifies the residence time associated with the unit operation of the Uo_cst_reactor.

4.2.425.4 volume

A volume specifies the reactor volume associated with the unit operation, of the Uo_cst_reactor.

4.2.426 Uo_cyclone

A Uo_cyclone is a type of Uo_gas_solid_separator (see 4.2.441) that is a cyclone unit operation. It derives centrifugal force from the inlet gas pressure causing solids to accumulate in the base.

The data associated with Uo_cyclone are the following:

— cone_length;

— cyclone_type;

— diameter;

— inlet_height;

— inlet_width;

— length;

— number_of_gas_turns;

— number_of_parallel_cyclones;

— overflow_diameter;

— overflow_length;

— underflow_diameter;

— vane_constant.

4.2.426.1 cone_length

A cone_length specifies the length of the cone associated with the unit operation of the Uo_cyclone.

4.2.426.2 cyclone_type

A cyclone_type specifies the type of the Uo_cyclone.

4.2.426.3 diameter

A diameter specifies the inside diameter of the entrance section(s) for the Uo_cyclone.

4.2.426.4 inlet_height

An inlet_height specifies the height of the inlet gas duct for the Uo_cyclone.

4.2.426.5 inlet_width

An inlet_width specifies the width of the inlet gas duct for the Uo_cyclone.

4.2.426.6 length

A length specifies the overall length for the Uo_cyclone.

4.2.426.7 number_of_gas_turns

A number_of_gas_turns specifies the number of turns in the Uo_cyclone.

4.2.426.8 number_of_parallel_cyclones

A number_of_parallel_cyclones specifies the number of parallel stages in the Uo_cyclone.

4.2.426.9 overflow_diameter

An overflow_diameter specifies the inside diameter of the cyclone at the overflow outlet for the Uo_-cyclone.

4.2.426.10 overflow_length

An overflow_length specifies the length of the cyclone at the overflow outlet for the Uo_cyclone.

4.2.426.11 underflow_diameter

An underflow_diameter specifies the inside diameter of the cyclone at the underflow outlet for the Uo_-cyclone.

4.2.426.12 vane_constant

A vane_constant specifies the parameter for the effect of the gas vanes present in the Uo_cyclone.

4.2.427 Uo_dissolver

A Uo_dissolver is a type of Uo_liquid_solid_separator (see 4.2.448) that represents a part of a solid Stream (see 4.2.374) preferentially dissolving into a solvent Stream.

The data associated with Uo_dissolver are the following:

— dissolution_fraction;

— dissolution_rate;

— duty;

— outlet_pressure;

— pressure_drop;

— solute;

— solute_recovery;

— solvent;

— solvent_loss;

— temperature;

— temperature_change_outlet_to_inlet;

— volume.

4.2.427.1 dissolution_fraction

A dissolution_fraction specifies the fraction of the total solute in the combined feeds that is to be dissolved.

4.2.427.2 dissolution_rate

A dissolution_rate specifies the rate at which the solid dissolves in the solvent for the Uo_dissolver.

4.2.427.3 duty

A duty specifies the amount of heat supplied to or removed from the Uo_dissolver.

4.2.427.4 outlet_pressure

An outlet_pressure specifies the pressure at the outlet of the Uo_dissolver.

4.2.427.5 pressure_drop

A pressure_drop specifies the difference between the outlet pressure and the inlet pressure for the Uo_-dissolver.

4.2.427.6 solute

A solute specifies the component name for the crystal solute.

4.2.427.7 solute_recovery

A solute_recovery specifies the ratio of the amount of the solute dissolved in the outlet solvent Stream (see 4.2.374) to the amount present in the inlet solid Stream for the Uo_dissolver.

4.2.427.8 solvent

A solvent specifies the component name for the predominant solvent component.

4.2.427.9 solvent_loss

A solvent_loss specifies the difference between the amount of solvent in the outlet Stream (see 4.2.374) to the amount of solvent supplied in the inlet solvent Stream for the Uo_dissolver.

4.2.427.10 temperature

A temperature specifies the temperature of the Uo_dissolver.

4.2.427.11 temperature_change_outlet_to_inlet

A temperature_change_outlet_to_inlet specifies the temperature change between outlet and inlet of the Uo_dissolver.

4.2.427.12 volume

A volume specifies the volume of the Uo_dissolver.

4.2.428 Uo_distillation

A Uo_distillation is a type of Process_unit_operation (see 4.2.275) that represents the separation of a liquid inlet Stream (see 4.2.374) into a lighter overhead liquid, a heavier bottoms liquid, and a possible overhead vapour Stream using distillation.

The data associated with Uo_distillation are the following:

— condenser_duty;

— condenser_subcooling;

— condenser_temperature;

— distillation_bottom_pressure;

— distillation_to_feed_ratio;

— distillation_top_pressure;

— distillation_type;

— feed_stage_number;

— feed_quality;

— heavy_key_recovery;

— height_equiv_to_theoretical_plate;

— light_key_recovery;

— number_of_stages;

— reboiler_baffle;

— reboiler_duty;

— reboiler_type;

— reflux_ratio;

— stage_numbering_convention;

— total_or_partial_condenser.

4.2.428.1 condenser_duty

A condenser_duty specifies the heat removed by the overhead condenser heat exchanger associated with the unit operation, of the Uo_distillation.

4.2.428.2 condenser_subcooling

A condenser_subcooling specifies the degrees of subcooling of the reflux Stream (see 4.2.374) in the rigorous distillation input.

4.2.428.3 condenser_temperature

A condenser_temperature specifies the temperature in the condenser in the rigorous distillation input.

4.2.428.4 distillation_bottom_pressure

A distillation_bottom_pressure specifies the pressure of the bottom tray or stage of the unit operation, Uo_distillation.

4.2.428.5 distillation_to_feed_ratio

A distillation_to_feed_ratio specifies the ratio of the distillate to the feed in the Uo_distillation.

4.2.428.6 distillation_top_pressure

A distillation_top_pressure specifies the condenser pressure associated with the unit operation, of the Uo_-distillation.

4.2.428.7 distillation_type

A distillation_type specifies an enumerated attribute for the type of distillation in the Uo_distillation. The value of the distillation_type attribute shall be one of the following:

— absorber;

— extractor;

— fractionator;

— stripper.

4.2.428.7.1 absorber: an indication that the distillation is an absorber.

4.2.428.7.2 extractor: an indication that the distillation is an extractor.

4.2.428.7.3 fractionator: an indication that the distillation is a fractionator.

4.2.428.7.4 stripper: an indication that the distillation is a stripper.

4.2.428.8 feed_stage_number

A feed_stage_number specifies the number of the feed stage for the Uo_distillation.

4.2.428.9 feed_quality

A feed_quality specifies the thermal quality of the feed Stream (see 4.2.374). The thermal quality is the ratio between the amount of energy required to convert the feed to a saturated vapour and the amount of energy required to convert a saturated liquid of the same composition as the feed to a saturated vapour.

4.2.428.10 heavy_key_recovery

A heavy_key_recovery specifies the heavy key recovery from the Uo_distillation. It is the moles of heavy key in the bottoms per mole of heavy key recovery in the feed.

4.2.428.11 height_equiv_to_theoretical_plate

A height_equiv_to_theoretical_plate specifies the height of continuous counter-current contact of vapour and liquid to that which provides the same separation as one ideal distillation stage for the Uo_distillation.

4.2.428.12 light_key_recovery

A light_key_recovery specifies the light key recovery from the Uo_distillation. It is the moles of light key in the overhead per mole of light key in the feed.

4.2.428.13 number_of_stages

A number_of_stages specifies either the number of theoretical stages or the number of actual stages in the Uo_distillation.

4.2.428.14 reboiler_baffle

A reboiler_baffle specifies the height of the liquid sump overflow baffle in the reboiler.

4.2.428.15 reboiler_duty

A reboiler_duty specifies the amount of heat transferred to the reboiler of the Uo_distillation.

4.2.428.16 reboiler_type

A reboiler_type specifies an enumerated attribute that specifies the type of reboiler that is attached to the Uo_distillation. The value of reboiler_type shall be one of the following:

— forced_circulation;

— kettle;

— none;

— thermosyphon.

4.2.428.16.1 forced_circulation: an indication that the Uo_distillation column is equipped with a reboiler circuit that uses forced circulation.

4.2.428.16.2 kettle: an indication that the Uo_distillation column reboiler is a kettle type reboiler.

4.2.428.16.3 none: an indication that the Uo_distillation column does not have a reboiler.

4.2.428.16.4 thermosyphon: an indication that the Uo_distillation column reboiler is a thermosyphon type reboiler.

4.2.428.17 reflux_ratio

A reflux_ratio specifies the ratio of the amount of liquid returned from the condenser to the top tray, reflux, to the amount of liquid removed as product from the condenser, distillate, for the Uo_distillation.

4.2.428.18 total_or_partial_condenser

A total_or_partial_condenser specifies whether or not a total condenser is used in the Uo_distillation.

4.2.428.19 stage_numbering_conversion

A stage_numbering_conversion specifies an enumerated attribute describing the stage numbering convention for the Uo_distillation. The value of the stage_numbering_convention attribute shall be one of the following:

— bottom_up;

— top_down.

4.2.428.19.1 bottom_up: an indication the stages are numbered from bottom to the top in the Uo_-distillation.

4.2.428.19.2 top_down: an indication the stages are numbered from top to bottom in the Uo_distillation.

4.2.429 Uo_distillation_stage

A Uo_distillation_stage is a type of Process_definition (see 4.2.253) that represents the contact and subsequent disengagement of a condensing vapour Stream (see 4.2.374) and a boiling liquid Stream in a distillation column. The Uo_distillation_stage may be the representation of a real or ideal stage. A Uo_-distillation_stage may represent a tray in a distillation column, the condenser in a column, or the reboiler in a column.

NOTE - A distillation tower that uses physical trays is composed of one or more internal trays. A distillation tower that uses packing typically does not contain a stage.

The data associated with Uo_distillation_stage are the following:

— condenser_stage;

— distillation_stage_number;

— distillation_stage_pressure;

— distillation_stage_temperature;

— external_heat_exchanger_duty;

— hole_diameter;

— number_of_holes;

— reboiler_stage;

— stage_area;

— stage_type;

— volume_liquid;

— volume_vapour;

— weir_height;

— weir_length.

4.2.429.1 condenser_stage

A condenser_stage specifies that the Uo_distillation_stage represents a vapour condenser at the top of the distillation column.

NOTE - A condenser_stage is the first stage in a distillation tower. The typical convention is that the condenser_stage is numbered 1.

4.2.429.2 distillation_stage_number

The distillation_stage_number specifies the relative position of the Uo_distillation_stage in a Uo_-distillation (see 4.2.428).

NOTE - The typical convention is to number the stages starting from the top of the distillation tower. However, if a condenser is present, the first stage is specified as number 2 rather than 1.

4.2.429.3 distillation_stage_pressure

A distillation_stage_pressure specifies the operating pressure of the Uo_distillation_stage.

4.2.429.4 distillation_stage_temperature

A distillation_stage_temperature specifies the average operating temperature of the liquid on the Uo_-distillation_stage.

4.2.429.5 external_heat_exchanger_duty

An external_heat_exchanger_duty specifies the amount of heat supplied or removed from the Uo_-distillation_stage by an external heat exchanger.

NOTE - To accomplish this, one side of a heat exchanger is attached to an internal tray.

4.2.429.6 hole_diameter

A hole_diameter specifies the size of a single vapour opening onto the stage.

NOTE - The typical types of holes are valve, sieve, or bubble cap.

4.2.429.7 number_of_holes

A number_of_holes specifies how many vapour openings are present on the stage.

4.2.429.8 reboiler_stage

A reboiler_stage specifies an indication that the Uo_distillation_stage represents the distillation column's bottom liquid reboiler.

NOTE - The typical convention is that the reboiler_stage is numbered n where n is the total number of stages in the tower.

4.2.429.9 stage_area

A stage_area specifies the surface area of the contacting portion of the stage.

NOTE - The stage_area is typically close to the cross sectional area of the distillation unit taking into account the seals between the trays and the inside of the tower.

4.2.429.10 stage_type

A stage_type specifies an enumerated attribute that specifies the mechanism by which the vapour is brought into contact on the Uo_distillation_stage. A stage_type may also specify the type of actual tray the stage represents. The value of the stage_type attribute shall be one of the following:

— bubble_cap;

— ideal_tray;

— packed;

— sieve_tray;

— valve_tray.

4.2.429.10.1 bubble_cap: an indication that the stage represents a tray equipped with risers and bubble caps.

4.2.429.10.2 ideal_tray: an indication that the stage represents a generic distillation tray that operates under complete phase equilibrium conditions.

4.2.429.10.3 packed: an indication that the stage represents a volume of tower packing.

4.2.429.10.4 sieve_tray: an indication that the stage represents a sieve type distillation tray.

4.2.429.10.5 valve_tray: an indication that the stage represents a tray equipped with vapour valves.

4.2.429.11 volume_liquid

A volume_liquid specifies the total liquid volumetric holdup on the stage.

NOTE - This value can be expressed on either a mole or mass basis. For example, the stage contains 25 kilograms of liquid material on the stage.

4.2.429.12 volume_vapour

A volume_vapour specifies the total vapour volumetric holdup on the stage.

NOTE - This value can be expressed on either a mole or mass basis. For example, the stage contains 0.1 kilograms of vapour material above the stage.

4.2.429.13 weir_height

A weir_height specifies the height of the weir for the Uo_distillation_stage.

NOTE - The weir is a lip above the tray next to the downcomer that is used to maintain a liquid volume on the stage.

4.2.429.14 weir_length

A weir_length specifies the distance through which flow proceeds down the downcomer to the stage below.

NOTE - For a single pass tray, the weir_length is the distance from the wall of the tower to the edge of the weir. Specification of the weir_length for trays that have multiple flow paths is a little more difficult. One needs to know the distance between the weirs. Based on the location of the weir on the stage and the length, the weir_length can be determined.

4.2.430 Uo_distillation_stage_phase_pump_around

A Uo_distillation_stage_phase_pump_around is a type of Process_definition_relationship (see 4.2.255) that represents the transfer or pumping of some of the liquid Stream (see 4.2.374) on one stage or tray to a second tray or stage. A Uo_distillation_stage_phase_pump_around may pass through a heat exchanger before being returned to the second stage.

> NOTE - The relating definition specifies the previous stage and the related definition specifies the subsequent stage.

The data associated with Uo_distillation_stage_phase_pump_around are the following:

- heat_duty;
- liquid_fraction;
- mass_flow_rate;
- mole_flow_rate;
- on_or_above_stage;
- pressure;
- temperature.

4.2.430.1 heat_duty

A heat_duty specifies the amount of heat removed from the pump around between the two stages.

4.2.430.2 liquid_fraction

A liquid_fraction specifies the ratio of the amount of liquid to the total amount of fluid in the pump around at the return to the distillation column.

4.2.430.3 mass_flow_rate

A mass_flow_rate specifies the amount of material being transferred by the pump around on a mass basis.

4.2.430.4 mole_flow_rate

A mole_flow_rate specifies the amount of material being transferred by the pump around on a molar basis.

4.2.430.5 on_or_above_stage

An on_or_above_stage specifies an enumerated attribute indicating where the pump around returns to as on stage or above stage.

4.2.430.6 pressure

A pressure specifies the pressure of the pump-around at the return to the distillation column.

4.2.430.7 temperature

A temperature specifies the temperature at which the pump-around returns to the distillation column.

4.2.431 Uo_double_pipe_heat_exchanger

A Uo_double_pipe_heat_exchanger is a type of Process_unit_operation (see 4.2.275) that provides the capability to exchange heat between two Material_streams (see 4.2.186). One Material_stream flows through a tube that is contained within a larger tube where the other Material_stream flows.

4.2.432 Uo_electrostatic_precipitator

A Uo_electrostatic_precipitator is a type of Uo_gas_solid_separator (see 4.2.441) that is an electrostatic precipitator. It generates an electrical charge to attract solids from the inlet gas.

The data associated with Uo_electrostatic_precipitator are the following:

— breakage_voltage;

— gas_velocity_maximum;

— gas_velocity_minimum;

— number_of_plates;

— plate_height;

— plate_height_maximum;

— plate_length;

— plate_length_maximum;

— plate_length_minimum;

— plate_to_wire_distance;

— plate_width_maximum;

— wire_diameter;

— wire_roughness.

4.2.432.1 breakage_voltage

A breakage_voltage specifies the breakage voltage for the Uo_electrostatic_precipitator.

4.2.432.2 gas_velocity_maximum

A gas_velocity_maximum specifies the maximum gas velocity associated with the Uo_electrostatic_-precipitator.

4.2.432.3 gas_velocity_minimum

A gas_velocity_minimum specifies the minimum gas velocity for a Uo_electrostatic_precipitator.

4.2.432.4 number_of_plates

A number_of_plates specifies the number of plates in the Uo_electrostatic_precipitator.

4.2.432.5 plate_height

A plate_height specifies the plate height associated with the Uo_electrostatic_precipitator.

4.2.432.6 plate_height_maximum

A plate_height_maximum specifies the maximum plate height for the Uo_electrostatic_precipitator.

4.2.432.7 plate_length

A plate_length specifies the plate length for the Uo_electrostatic_precipitator.

4.2.432.8 plate_length_maximum

A plate_length_maximum specifies the maximum plate length of the Uo_electrostatic_precipitator.

4.2.432.9 plate_length_minimum

A plate_length_minimum specifies the minimum plate length of the Uo_electrostatic_precipitator.

4.2.432.10 plate_to_wire_distance

A plate_to_wire_distance specifies the plate to wire distance associated with the Uo_electrostatic_-precipitator.

4.2.432.11 plate_width_maximum

A plate_width_maximum specifies the maximum plate width of the Uo_electrostatic_precipitator.

4.2.432.12 wire_diameter

A wire_diameter specifies the diameter of the wire associated with the unit operation, of the Uo_-electrostatic_precipitator.

4.2.432.13 wire_roughness

A wire_roughness specifies the wire roughness associated with the Uo_electrostatic_precipitator.

4.2.433 Uo_expander

A Uo_expander is a type of Uo_fluid_transfer (see 4.2.440) that represents the production of mechanical energy by the expansion of a gas, typically across a turbine.

The data associated with Uo_expander are the following:

- design_flowrate;
- design_head;
- design_speed;
- pressure_design;
- radial_frequency.

4.2.433.1 design_flowrate

A design_flowrate specifies the volumetric flow to the inlet of the expander.

4.2.433.2 design_head

A design_head specifies the head developed for the expander at the design_speed.

4.2.433.3 design_speed

A design_speed specifies the design rotational speed (i.e., rotational_frequency) of the expander.

4.2.433.4 pressure_design

A pressure_design specifies the outlet pressure of the Uo_expander.

4.2.433.5 radial_frequency

A radial_frequency specifies the speed at which the Uo_expander rotates.

4.2.434 Uo_extent_specified_reactor

A Uo_extent_specified_reactor is a type of Uo_reactor (see 4.2.462) that specifies a type of reactor unit operations other than CSTR reactor unit operation, plug flow reactor unit operation, or a specified yield reactor unit operation.

The data associated with Uo_extent_specified_reactor are the following:

— reactor_type.

A reactor_type specifies an enumerated attribute which sets the type of Uo_extent_specified_reactor. The value of the reactor_type attribute shall be one of the following:

— gibbs;

— stoichiometric;

— equilibrium.

4.2.434.0.1 gibbs: an indication that the unit operation uses minimum Gibbs free energy calculations.

4.2.434.0.2 stoichiometric: an indication that the unit operation uses stoichiometric calculations.

4.2.434.0.3 equilibrium: an indication that the unit operation uses equilibrium calculations.

4.2.435 Uo_extractor

A Uo_extractor is a type of Process_unit_operation (see 4.2.275) that provides the capability for separating Chemical_components (see 4.2.56) in solution by their distribution between two immiscible liquid Phases (see 4.2.230). The process involves the transfer of mass from one liquid Phase into a second liquid immiscible liquid Phase.

4.2.436 Uo_fabric_filter

A Uo_fabric_filter is a type of Uo_gas_solid_separator (see 4.2.441) that is a fabric filter unit operation. It passes gas through a series of bags with fine pores to remove solids.

The data associated with Uo_fabric_filter are the following:

— bag_area;

— bag_cleaning_time;

— bag_diameter;

— dust_resistance;

— filtration_time;

— gas_velocity_maximum;

— gas_velocity_minimum;

— number_of_bags_per_cell;

— number_of_cells;

— number_of_cells_cleaned;

— pressure_drop_clean_bag;

— pressure_drop_maximum.

4.2.436.1 bag_area

A bag_area specifies the surface area of a bag, associated with the unit operation, of the Uo_fabric_filter.

4.2.436.2 bag_cleaning_time

A bag_cleaning_time specifies the cleaning time for a bag.

4.2.436.3 bag_diameter

A bag_diameter specifies the diameter of a bag associated with the unit operation, of the Uo_fabric_filter.

4.2.436.4 dust_resistance

A dust_resistance specifies the dust resistance associated with the unit operation, of the Uo_fabric_filter.

4.2.436.5 filtration_time

A filtration_time specifies the filtering time associated with the unit operation, of the Uo_fabric_filter.

4.2.436.6 gas_velocity_maximum

A gas_velocity_maximum specifies the maximum velocity for a fabric filter.

4.2.436.7 gas_velocity_minimum

A gas_velocity_minimum specifies the minimum velocity for the Uo_fabric_filter.

4.2.436.8 number_of_bags_per_cell

A number_of_bags_per_cell specifies the number of bags per cell of the Uo_fabric_filter.

4.2.436.9 number_of_cells

A number_of_cells specifies the number of cells of a Uo_fabric_filter.

4.2.436.10 number_of_cells_cleaned

A number_of_cells_cleaned specifies the number of cells cleaned of the Uo_fabric_filter.

4.2.436.11 pressure_drop_clean_bag

A pressure_drop_clean_bag specifies the difference between the bag inlet and outlet pressures when the bag is clean.

4.2.436.12 pressure_drop_maximum

A pressure_drop_maximum specifies the maximum difference between the bag inlet and outlet pressures associated with the unit operation, for the Uo_fabric_filter.

4.2.437 Uo_fired_heater

A Uo_fired_heater is a type of Process_unit_operation (see 4.2.275) that is a heater unit operation. A fired heater increases the temperature of a process Stream (see 4.2.374) by combustion of fuel.

The data associated with Uo_fired_heater are the following:

— duty;

— fuel_efficiency;

— fuel_heating_value;

— outlet_temperature;

— pressure_drop.

4.2.437.1 duty

A duty specifies the amount of heat transferred to the process Stream (see 4.2.374) by the Uo_fired_heater.

4.2.437.2 fuel_efficiency

A fuel_efficiency specifies the fuel efficiency associated with the unit operation, of the Uo_fired_heater.

4.2.437.3 fuel_heating_value

A fuel_heating_value specifies the fuel heating value associated with the unit operation, of the Uo_fired_-heater.

4.2.437.4 outlet_temperature

An outlet_temperature specifies the outlet temperature attribute of the Uo_fired_heater.

4.2.437.5 pressure_drop

A pressure_drop specifies the difference between the fired heater inlet and outlet pressures associated with the unit operation of the Uo_fired_heater.

4.2.438 Uo_fired_reactor

A Uo_fired_reactor is a type of Uo_reactor (see 4.2.462) where the energy required to drive the reaction is supplied by a combustion process.

4.2.439 Uo_flash

A Uo_flash is a type of Process_unit_operation (see 4.2.275) that is the separation of an inlet Stream (see 4.2.374) into one or more outlet Streams by an equilibrium phase split. A Uo_flash may be one of the following: a Uo_multi_phase_flash (see 4.2.452), or a Uo_single_phase_flash (see 4.2.468).

NOTE - It may occur when a Stream (see 4.2.374) is throttled across a valve with the resulting pressure drop causing vapourization.

The data associated with Uo_flash are the following:

— duty;

— overhead_to_feed_mole_ratio;

— pressure;

— pressure_drop;

— spec;

— temperature.

4.2.439.1 duty

A duty specifies the heat to be supplied or removed from the Uo_flash to meet the flash specification. The duty may be a result or a specification.

4.2.439.2 overhead_to_feed_mole_ratio

An overhead_to_feed_mole_ratio specifies the total number of moles in the vapour overhead Stream (see 4.2.374) to the total number of moles in the feed Stream of the Uo_flash.

4.2.439.3 pressure

A pressure specifies the pressure at which the equilibrium separation is performed for the Uo_flash. The pressure is equal to the outlet pressure.

4.2.439.4 pressure_drop

A pressure_drop specifies the difference between outlet pressure and inlet pressure for the Uo_flash.

4.2.439.5 spec

A spec specifies which variables are used as inputs to specify the performance of the Uo_flash. Thermodynamic relationships constrain the solution of a Uo_flash to only certain possible combinations of input variables. The value of the spec attribute shall be one of the following:

— pq_flash;

— pvfrac_flash;

— tp_flash;

— tq_flash;

— tvfrac_flash;

— unknown.

4.2.439.5.1 pq_flash: an indication that the flash is a pressure and duty specified flash.

4.2.439.5.2 pvfrac_flash: an indication that the flash is a pressure and volume fraction specified flash.

4.2.439.5.3 tp_flash: an indication that the flash is a temperature and pressure specified flash.

4.2.439.5.4 tq_flash: an indication that the flash is a temperature and duty specified flash.

4.2.439.5.5 tvfrac_flash: an indication that the flash is a temperature and volume fraction specified flash.

4.2.439.5.6 unknown: an indication that the type of flash to be preformed is unknown or unspecified.

4.2.439.6 temperature

A temperature specifies the temperature of the Uo_flash.

4.2.440 Uo_fluid_transfer

A Uo_fluid_transfer is a category of Process_unit_operation (see 4.2.275) that provides the capability of producing fluid flow through a conduit or channel by the transfer of energy.

> NOTE - The means employed to cause fluids to flow are gravity, displacement, centrifugal force, electromagnetic force, transfer of momentum, mechanical impulse, and combinations of these six basic means. Aside from gravity, the means most commonly employed is centrifugal force.

4.2.441 Uo_gas_solid_separator

A Uo_gas_solid_separator is a type of Process_unit_operation (see 4.2.275) that represents equipment that separate solid particles from a gas Stream (see 4.2.374). Each Uo_gas_solid_separator may be one of the following: a Uo_cyclone (see 4.2.426), a Uo_electrostatic_precipitator (see 4.2.432), a Uo_fabric_filter (see 4.2.436), or a Uo_venturi_scrubber (see 4.2.478).

The data associated with Uo_gas_solid_separator are the following:

— gas_solid_separator_gas_velocity;

— gas_solid_separator_pressure_drop;

— separation_efficiency.

4.2.441.1 gas_solid_separator_gas_velocity

A gas_solid_separator_gas_velocity specifies the gas velocity associated with the unit operation, of the Uo_gas_solid_separator.

4.2.441.2 gas_solid_separator_pressure_drop

A gas_solid_separator_pressure_drop specifies the difference between outlet pressure and inlet pressure for the Uo_gas_solid_separator.

4.2.441.3 separation_efficiency

A separation_efficiency specifies ratio of the amount of solids removed from the gas Stream (see 4.2.374) to the amount of solids present in the inlet gas Stream.

4.2.442 Uo_heat_exchanger

A Uo_heat_exchanger is a type of Process_unit_operation (see 4.2.275) that may be used to heat or cool a single process Stream (see 4.2.374), exchange heat between two process Streams, or exchange heat between a process Stream and a Utility_stream (see 4.2.485).

The data associated with Uo_heat_exchanger are the following:

— duty;

— flow_direction;

— ft;

- minimum_approach_temperature;
- number_shell_passes;
- number_tube_passes;
- overall_heat_transfer_coefficient;
- shell_pass;
- shell_volume;
- surface_area;
- tube_pass;
- tube_volume.

4.2.442.1 duty

A duty specifies the amount of heat transferred from the hot Stream (see 4.2.374) to the cold Stream by the Uo_heat exchanger.

4.2.442.2 flow_direction

A flow_direction specifies an enumerated attribute indicating the relative fluid flow direction between shell side and the first tube side pass. The value of the flow_direction attribute shall be one of the following:

- cocurrent;
- countercurrent;
- unspecified.

4.2.442.2.1 cocurrent: an indication that the flow of shell and tube side fluids are in the same direction.

4.2.442.2.2 countercurrent: an indication that the flow of shell and tube side fluids are in opposite directions.

4.2.442.2.3 unspecified: an indication that the flow directions of shell and tube side fluids are not specified.

4.2.442.3 ft

A ft specifies the log mean temperature difference correction factor used in a two-sided heat exchanger.

4.2.442.4 minimum_approach_temperature

A minimum_approach_temperature specifies the minimum local difference in temperature between the shell side fluid and the tube side fluid at all points of contact in the Uo_heat_exchanger.

4.2.442.5 number_shell_passes

A number_shell_passes specifies the number of times the flow path of the shell side fluid is directed across the tube bundle for the Uo_heat_exchanger.

4.2.442.6 number_tube_passes

A number_tube_passes specifies the number of times the flow path of the tube side fluid is routed through the shell for the Uo_heat_exchanger.

4.2.442.7 overall_heat_transfer_coefficient

An overall_heat_transfer_coefficient specifies the overall rate at which heat is transferred from the hot fluid on one side of the heat exchanger to the cold fluid on the other side. This parameter relates the total amount of heat transferred by the Uo_heat_exchanger to its heat transfer surface_area and the driving temperature differences.

4.2.442.8 shell_pass

A shell_pass specifies the number of paths the fluid takes across the shell side of the Uo_heat_exchanger.

4 2.442.9 shell_volume

A shell_volume specifies the total volume available for Material (see 4.2.178) flow in the shell.

4.2.442.10 surface_area

A surface_area specifies the surface area of the heat transfer surface of the Uo_heat_exchanger.

4.2.442.11 tube_pass

A tube_pass specifies the number of paths the fluid takes across the tube side of the Uo_heat_exchanger.

4.2.442.12 tube_volume

A tube_volume specifies the total volume available for Material (see 4.2.178) flow in the tubes.

4.2.443 Uo_heat_exchanger_fluid

A Uo_heat_exchanger_fluid is a fluid flowing through a Uo_heat_exchanger_side (see 4.2.444).

The data associated with Uo_heat_exchanger_fluid are the following:

— heat_exchanger_shell_or_tube.

A heat_exchanger_shell_or_tube specifies an enumerated attribute indicating whether the fluid is on the shell side or the tube side. The value of the heat_exchanger_shell_or_tube attribute shall be one of the following:

— shell;

— tube.

4.2.443.0.1 shell: an indication that the fluid is on the shell side.

4.2.443.0.2 tube: an indication that the fluid is on the tube side.

4.2.444 Uo_heat_exchanger_side

A Uo_heat_exchanger_side is a type of Process_definition (see 4.2.253) that is either a hot side or a cold side of a Uo_heat_exchanger (see 4.2.442) and is characterized by pressure drop and temperature information.

The data associated with Uo_heat_exchanger_side are the following:

— heat_exchanger_side_delta_temperature;

— heat_exchanger_side_id;

— heat_exchanger_side_outlet_temperature;

— heat_exchanger_side_pressure_drop;

— hot_or_cold.

4.2.444.1 heat_exchanger_side_delta_temperature

A heat_exchanger_side_delta_temperature specifies the temperature across the Uo_heat_exchanger_side.

4.2.444.2 heat_exchanger_side_id

A heat_exchanger_side_id specifies a unique identifier for the Uo_heat_exchanger_side.

4.2.444.3 heat_exchanger_side_outlet_temperature

A heat_exchanger_side_outlet_temperature specifies the outlet temperature associated with the Uo_heat_-exchanger_side.

4.2.444.4 heat_exchanger_side_pressure_drop

A heat_exchanger_side_pressure_drop specifies the pressure drop across the Uo_heat_exchanger_side.

4.2.444.5 hot_or_cold

A hot_or_cold specifies whether the Uo_heat_exchanger_side specified is the hot or cold side.

4.2.445 Uo_hydrocyclone

A Uo_hydrocyclone is a type of Uo_liquid_solid_separator (see 4.2.448) that separates suspended solids from a liquid inlet Stream (see 4.2.374) by the action a liquid vortex. A hydrocyclone throttles an incoming Stream to achieve separation.

The data associated with Uo_hydrocyclone are the following:

- diameter;
- diameter_maximum;
- inlet_nozzle_diameter;
- length;
- number_of_parallel_hydrocyclones;
- overflow_nozzle_diameter;
- pressure_drop_maximum;
- separation_efficiency;

— underflow_nozzle_diameter;

— vortex_finder_diameter;

— vortex_finder_length.

4.2.445.1 diameter

A diameter specifies the diameter of the entrance section of the Uo_hydrocyclone.

4.2.445.2 diameter_maximum

A diameter_maximum specifies the maximum diameter of the entrance section allowed in a sizing calculation for the Uo_hydrocyclone.

4.2.445.3 inlet_nozzle_diameter

An inlet_nozzle_diameter specifies the diameter of the inlet Nozzle (see 4.2.194) for the Uo_hydrocyclone.

4.2.445.4 length

A length specifies the overall length associated with the Uo_hydrocyclone.

4.2.445.5 number_of_parallel_hydrocyclones

A number_of_parallel_hydrocyclones specifies the number of parallel hydrocyclones in the Uo_-hydrocyclone.

4.2.445.6 overflow_nozzle_diameter

An overflow_nozzle_diameter specifies the diameter of the overflow Nozzle (see 4.2.194)in the Uo_-hydrocyclone.

4.2.445.7 pressure_drop_maximum

A pressure_drop_maximum specifies the maximum difference between the inlet and outlet pressures of the Uo_hydrocyclone.

4.2.445.8 separation_efficiency

A separation_efficiency specifies the ratio of the amount of solids removed from the inlet to the amount of solids in the inlet for the Uo_hydrocyclone.

4.2.445.9 underflow_nozzle_diameter

An underflow_nozzle_diameter specifies the diameter of the underflow Nozzle (see 4.2.194) in the Uo_-hydrocyclone.

4.2.445.10 vortex_finder_diameter

A vortex_finder_diameter specifies the diameter of the vortex finder in the Uo_hydrocyclone.

4.2.445.11 vortex_finder_length

A vortex_finder_length specifies the length of the vortex finder in the Uo_hydrocyclone.

4.2.446 Uo_jet_ejector

A Uo_jet_ejector is a type of Process_unit_operation (see 4.2.275) that provides the capability in which the kinetic energy of one fluid is used to pump another fluid.

4.2.447 Uo_liquid_liquid_flash

A Uo_liquid_liquid_flash is a type of Uo_multi_phase_flash (see 4.2.452) where the inlet Stream (see 4.2.374) splits into two equilibrium liquid outlet Streams.

4.2.448 Uo_liquid_solid_separator

A Uo_liquid_solid_separator is a type of Process_unit_operation (see 4.2.275) that involves the separation of solids from a liquid Stream (see 4.2.374) or the transfer of entrained liquids from a solid Stream to a liquid or vapour Stream. A Uo_liquid_solid_separator may be one of the following: a Uo_centrifuge (see 4.2.418), a Uo_countercurrent_solids_decanter (see 4.2.422), a Uo_crystallizer (see 4.2.424), a Uo_-dissolver (see 4.2.427), a Uo_hydrocyclone (see 4.2.445), a Uo_rotary_filter (see 4.2.463), a Uo_solids_-decanter_stage (see 4.2.470), or a Uo_solids_dryer (see 4.2.471).

4.2.449 Uo_liquid_vapour_flash

A Uo_liquid_vapour_flash is a type of Uo_multi_phase_flash (see 4.2.452) where the inlet Stream (see 4.2.374) splits into a vapour Stream and a single liquid Stream.

4.2.450 Uo_melter

A Uo_melter is a type of Process_unit_operation (see 4.2.275) that provides the capability to melt a solid to transform it into the liquid Phase (see 4.2.230) and freeze a liquid to transform it into the solid phase.

4.2.451 Uo_mixer

A Uo_mixer is a mixer unit operation. A mixer combines multiple input Streams (see 4.2.374) into one output Stream.

The data associated with Uo_mixer are the following:

— pressure_drop;

— pressure_out.

4.2.451.1 pressure_drop

A pressure_drop specifies the difference between the inlet and outlet pressures for a Uo_mixer.

4.2.451.2 pressure_out

A pressure_out specifies the outlet pressure associated with the unit operation, of the Uo_mixer.

4.2.452 Uo_multi_phase_flash

A Uo_multi_phase_flash is a type of Uo_flash (see 4.2.439) that has more than two equilibrium liquid outlet Streams (see 4.2.374) or involves equilibrium solids. A Uo_multi_phase_flash may be one of the following: a Uo_liquid_liquid_flash (see 4.2.447), a Uo_liquid_vapour_flash (see 4.2.449), or a Uo_-separator_three_phase_flash (see 4.2.466).

The data associated with a Uo_multi_phase_flash are the following:

— diameter;

— entrained_fraction;

— entrainment_fraction;

— entrainment_from;

— entrainment_rate;

— entrainment_to;

— height_above_grade;

— length.

4.2.452.1 diameter

A diameter specifies the diameter of the separation drum in which the Uo_multi_phase_flash occurs.

4.2.452.2 entrained_fraction

An entrained_fraction specifies the ratio of the amount of an outlet Stream (see 4.2.374) that is entrained in another outlet Stream to the total amount of the first outlet Stream that would be present with no entrainment.

4.2.452.3 entrainment_fraction

An entrainment_fraction specifies the ratio of the amount of entrained material to the amount of entraining material in the outlet Stream (see 4.2.374).

4.2.452.4 entrainment_from

An entrainment_from specifies the outlet Stream (see 4.2.374) that is the source of the entrained material.

4.2.452.5 entrainment_rate

An entrainment_rate specifies the flow rate of the entrained material in the entraining outlet Stream (see 4.2.374).

4.2.452.6 entrainment_to

An entrainment_to specifies the outlet Stream (see 4.2.374) that is entraining the entrained material.

4.2.452.7 height_above_grade

A height_above_grade specifies the height above some datum of the liquid outlet for the separation drum in which the Uo_multi_phase_flash occurs.

4.2.452.8 length

A length specifies the length of the separation drum in which the multi_phase_flash occurs.

4.2.453 Uo_phase_changer

A Uo_phase_changer is a category of Process_unit_operation (see 4.2.275) that provides the capability to change the Phase (see 4.2.230) of a Material_stream (see 4.2.186) or a Chemical_component (see 4.2.56) in a Material_stream.

EXAMPLE 28 - For example, Chemical_component A in a Material_stream is changed from a solid to liquid.

The data associated with Uo_phase_changer are the following:

— duty.

A duty specifies the quantity of heat put into or taken out of the unit.

4.2.454 Uo_pipeline

A Uo_pipeline is a type of Process_unit_operation (see 4.2.275) that is a pipeline unit operation. It can simulate flow through a hollow pipe or an annular space.

The data associated with Uo_pipeline are the following:

— diameter.

A diameter specifies the actual or nominal diameter of the pipe segments in the Uo_pipeline.

4.2.455 Uo_pipeline_node

A Uo_pipeline_node is a type of Process_unit_operation (see 4.2.275) that is a location of a point along a Uo_pipeline (see 4.2.454). A Uo_pipeline_node forms the end of one or more Uo_pipeline_segments (see 4.2.456).

The data associated with Uo_pipeline_node are the following:

— ambient_temperature;

— duty;

— number;

— pressure;

— temperature;

— x_position;

— y_position;

— z_position.

4.2.455.1 ambient_temperature

An ambient_temperature specifies the ambient temperature at the node.

4.2.455.2 duty

A duty specifies the overall duty for the Uo_pipeline_node.

4.2.455.3 number

A number specifies the number for the Uo_pipeline_node that is unique within the Uo_pipeline (see 4.2.454) associated with it.

4.2.455.4 pressure

A pressure specifies the pressure at the Uo_pipeline_node.

4.2.455.5 temperature

A temperature specifies the temperature of the Uo_pipeline_node.

4.2.455.6 x_position

A x_position specifies the x_position of the Uo_pipeline_node.

NOTE - The origin is arbitrary, but consistent for all nodes belonging to a Uo_pipeline.

4.2.455.7 y_position

A y_position specifies the y_position of the Uo_pipeline_node.

NOTE - The origin is arbitrary, but consistent for all nodes belonging to a Uo_pipeline.

4.2.455.8 z_position

A z_position specifies the z_position of the Uo_pipeline_node.

NOTE - The origin is arbitrary, but consistent for all nodes belonging to a Uo_pipeline.

4.2.456 Uo_pipeline_segment

A Uo_pipeline_segment is a type of Process_unit_operation (see 4.2.275) that is a non-branching transfer of Material (see 4.2.178) between two Uo_pipeline_nodes (see 4.2.455) in a Uo_pipeline (see 4.2.454).

NOTE - A Uo_pipeline_segment may represent the flow of fluid in a hollow or annular pipe. The pipe may be a straight segment or have a number of bends, but cannot have any tees.

The data associated with Uo_pipeline_segment are the following:

— inner_diameter_of_outer_pipe;

— outer_diameter_of_inner_pipe;

— overall_heat_transfer_coeff;

— pipe_efficiency_factor;

— pipe_roughness;

— pressure_drop;

— segment_number.

4.2.456.1 inner_diameter_of_outer_pipe

An inner_diameter_of_outer_pipe specifies the inner diameter of the outer pipe for the Uo_pipeline_segment.

4.2.456.2 outer_diameter_of_inner_pipe

An outer_diameter_of_inner_pipe specifies the outer diameter of inner pipe for the Uo_pipeline_segment.

4.2.456.3 overall_heat_transfer_coeff

An overall_heat_transfer_coeff specifies the overall Heat_transfer_coefficient (see 4.2.159) for the Uo_pipeline_segment.

4.2.456.4 pipe_efficiency_factor

A pipe_efficiency_factor specifies an efficiency factor for the Uo_pipeline_segment.

4.2.456.5 pipe_roughness

A pipe_roughness specifies the pipe roughness for the Uo_pipeline_segment.

4.2.456.6 pressure_drop

A pressure_drop specifies the pressure difference between the inlet and outlet of the Uo_pipeline_segment.

4.2.456.7 segment_number

A segment_number specifies the segment number of the Uo_pipeline_segment that is unique within the Uo_pipeline (see 4.2.454).

4.2.457 Uo_plug_flow_reactor

A Uo_plug_flow_reactor is a type of Uo_reactor (see 4.2.462) that is a plug-flow reactor unit operation. A plug-flow reactor is an ideal reactor in which reactants and products pass through the reactor in an axial flow path with no back mixing. It calculates the extent of each reaction from kinetic equations.

The data associated with Uo_plug_flow_reactor are the following:

— coolant_flow_direction;

— diameter;

— length;

— overall_heat_transfer_coeff.

4.2.457.1 coolant_flow_direction

A coolant_flow_direction specifies an enumerated attribute giving the coolant flow direction for the Uo_-plug_flow_reactor. The value of the coolant_flow_direction attribute shall be one of the following:

— cocurrent;

— countercurrent.

4.2.457.1.1 cocurrent: an indication that the reactor coolant flow is cocurrent with the reactants.

4.2.457.1.2 countercurrent: an indication that the reactor coolant flow is countercurrent to the reactants.

4.2.457.2 diameter

A diameter specifies the diameter of the Uo_plug_flow_reactor.

4.2.457.3 length

A length specifies the length of the Uo_plug_flow_reactor.

4.2.457.4 overall_heat_transfer_coeff

An overall_heat_transfer_coeff specifies the overall Heat_transfer_coefficient (see 4.2.159) for the heat transfer to or from the walls of the Uo_plug_flow_reactor.

4.2.458 Uo_positive_displacement_compressor

A Uo_positive_displacement_compressor is a type of Uo_compressor (see 4.2.420) that represents a compressor that has a mechanism which prevents gas that has been displaced from the compressor from re-entering through the compressor outlet and gas that has entered the compressor from exiting through the compressor inlet. It is a Positive_displacement_compressor (see 4.2.248) unit operation. It can produce high compression ratios with small controlled flow rates.

4.2.459 Uo_positive_displacement_compressor_stage

A Uo_positive_displacement_compressor_stage is a type of Uo_compressor_stage (see 4.2.421) that is a Positive_displacement_compressor (see 4.2.248) stage unit operation. The stage has a mechanism which prevents gas the has been displaced from the stage from re-entering through the stage outlet and gas which has entered the stage from exiting through the stage inlet.

The data associated with Uo_positive_displacement_compressor_stage are the following:

— clearance_fraction;

— displacement;

— polytropic_efficiency;

— stage_number.

4.2.459.1 clearance_fraction

A clearance_fraction specifies the clearance fraction of the stage.

4.2.459.2 displacement

A displacement specifies the total displacement of the stage.

4.2.459.3 polytropic_efficiency

A polytropic_efficiency specifies the polytropic efficiency of the Uo_positive_displacement_compressor_-stage associated with the unit operation.

4.2.459.4 stage_number

A stage_number specifies the stage number associated with the Uo_positive_displacement_compressor_-stage.

4.2.460 Uo_pressure_changer

A Uo_pressure_changer is a type of Process_unit_operation (see 4.2.275) that is a pressure changer unit operation. It consumes energy to increase pressure or recovers energy from pressure letdown. Each Uo_-pressure_changer may be one of the following: a Uo_compressor (see 4.2.420), a Uo_compressor_stage (see 4.2.421), a Uo_expander (see 4.2.433), or a Uo_pump (see 4.2.461).

The data associated with Uo_pressure_changer are the following:

- brake_horsepower;
- differential_pressure;
- driver_power_quantity;
- driver_power_type;
- inlet_pressure;
- inlet_temperature;
- mechanical_efficiency;
- outlet_pressure;
- outlet_temperature;
- pressure_ratio.

4.2.460.1 brake_horsepower

A brake_horsepower specifies the power associated with the unit operation, supplied by the driver to the Uo_pressure_changer.

NOTE - In the case of a Uo_expander (see 4.2.433), brake_horsepower is the power supplied by the unit operation.

4.2.460.2 differential_pressure

A differential_pressure specifies the change in pressure between the inlet and the outlet of the Uo_-pressure_changer.

4.2.460.3 driver_power_quantity

A driver_power_quantity specifies the power required by the driver of the Uo_pressure_changer.

4.2.460.4 driver_power_type

A driver_power_type specifies an enumerated attribute giving the driver power type for the Uo_pressure_-changer. The value of the driver_power_type attribute shall be one of the following:

— electricity;

— fuel_gas;

— steam.

4.2.460.4.1 electricity: an indication that the driver is electric.

4.2.460.4.2 fuel_gas: an indication that the driver is fuel or gas driven.

4.2.460.4.3 steam: an indication that the driver is steam driven.

4.2.460.5 inlet_pressure

An inlet_pressure specifies the inlet pressure of the Uo_pressure_changer.

4.2.460.6 inlet_temperature

An inlet_temperature specifies the inlet temperature of the Uo_pressure_changer.

4.2.460.7 mechanical_efficiency

A mechanical_efficiency specifies the mechanical efficiency of the Uo_pressure_changer associated with the unit operation.

4.2.460.8 outlet_pressure

An outlet_pressure specifies the outlet pressure of the Uo_pressure_changer.

4.2.460.9 outlet_temperature

An outlet_temperature specifies the outlet temperature of the Uo_pressure_changer.

4.2.460.10 pressure_ratio

A pressure_ratio specifies the ratio of the outlet pressure to the inlet pressure for the Uo_pressure_changer.

4.2.461 Uo_pump

A Uo_pump is a type of Uo_pressure_changer (see 4.2.460) that is a pump unit operation. Pumps provide motive force for liquids.

The data associated with Uo_pump are the following:

- design_flowrate;
- design_head;
- design_speed;
- npsh;
- radial_frequency;
- uo_pump_type;
- volumetric_flow_rate.

4.2.461.1 design_flowrate

A design_flowrate specifies the volumetric flowrate for the pump at the design_speed.

4.2.461.2 design_head

A design_head specifies the head developed for the pump at the design_speed.

4.2.461.3 design_speed

A design_speed specifies the design rotational speed (i.e., radial_frequency) of the pump.

4.2.461.4 npsh

A npsh specifies the net positive suction head for the pump.

> NOTE - Typically, the pump manufacturer specifies the minimum value of NPSH which must exist at the pump suction.

4.2.461.5 radial_frequency

A radial_frequency specifies the radial frequency of the Uo_pump.

4.2.461.6 uo_pump_type

A uo_pump_type specifies the type of equipment that the Uo_pump represents.

4.2.461.7 volumetric_flow_rate

A volumetric_flow_rate specifies the volumetric flow rate at the inlet conditions for the Uo_pump.

4.2.462 Uo_reactor

A Uo_reactor is a type of Process_unit_operation (see 4.2.275) in which one or more chemical reactions occur. Each Uo_reactor is either a Uo_cst_reactor (see 4.2.425), a Uo_extent_specified_reactor (see 4.2.434), a Uo_plug_flow_reactor (see 4.2.457), or a Uo_specified_yield_reactor (see 4.2.472).

> NOTE - This is an abstract superclass of specialized types of reactors.

The data associated with Uo_reactor are the following:

- duty;
- outlet_pressure;
- outlet_temperature;
- outlet_vapour_fraction;
- pressure_drop.

4.2.462.1 duty

A duty specifies the heat supplied to or removed from the Uo_reactor.

4.2.462.2 outlet_pressure

An outlet_pressure specifies the outlet pressure of the Uo_reactor.

4.2.462.3 outlet_temperature

An outlet_temperature specifies the outlet temperature of the Uo_reactor.

4.2.462.4 outlet_vapour_fraction

An outlet_vapour_fraction specifies the vapour fraction of the outlet of the Uo_reactor.

4.2.462.5 pressure_drop

A pressure_drop specifies the difference between the inlet and outlet pressures in the Uo_reactor.

4.2.463 Uo_rotary_filter

A Uo_rotary_filter is a type of Uo_liquid_solid_separator (see 4.2.448) that is a filter stage unit operation. It applies a pressure differential across a filter to remove solids from liquids.

The data associated with Uo_rotary_filter are the following:

— cake_compressibility_factor;

— cake_particle_diameter;

— cake_particle_sphericity;

— cake_percent_solid;

— cake_porosity;

— cake_specific_resistance;

— cake_thickness;

— diameter;

— filtration_angle;

— frequency;

— width.

4.2.463.1 cake_compressibility_factor

A cake_compressibility_factor specifies the compressibility factor for the cake of the Uo_rotary_filter.

4.2.463.2 cake_particle_diameter

A cake_particle_diameter specifies the average diameter of particles in the filter cake associated with the unit operation, for the Uo_rotary_filter.

4.2.463.3 cake_particle_sphericity

A cake_particle_sphericity specifies the sphericity of the solids associated with the unit operation, for a Uo_rotary_filter.

4.2.463.4 cake_percent_solid

A cake_percent_solid specifies the percentage of solids in the inlet of the Uo_rotary_filter.

4.2.463.5 cake_porosity

A cake_porosity specifies the porosity of the cake associated with the unit operation, for the Uo_rotary_-filter.

4.2.463.6 cake_specific_resistance

A cake_specific_resistance specifies the specific resistance associated with the unit operation, for the Uo_-rotary_filter.

4.2.463.7 cake_thickness

A cake_thickness specifies the filter cake thickness of the Uo_rotary_filter.

4.2.463.8 diameter

A diameter specifies the diameter of the Uo_rotary_filter.

4.2.463.9 filtration_angle

A filtration_angle specifies the angle of tilt for the Uo_rotary_filter.

4.2.463.10 frequency

A frequency specifies the frequency for the Uo_rotary_filter.

4.2.463.11 width

A width specifies the filter width of the Uo_rotary_filter.

4.2.464 Uo_screen

A Uo_screen is a type of Process_unit_operation (see 4.2.275) that is a screen unit operation. A screen separates a Mixture (see 4.2.192) of solids on the basis of their size.

The data associated with Uo_screen are the following:

— opening_size;

— operating_level;

— operating_mode;

— separation_efficiency;

— separation_strength.

4.2.464.1 opening_size

An opening_size specifies the screen opening size associated with the unit operation, of the Uo_screen.

4.2.464.2 operating_level

An operating_level specifies an enumerated attribute indicating that the screen is operating as an upper or a lower screen for the Uo_screen. The value of the operating_level attribute shall be one of the following:

— lower;

— upper.

4.2.464.2.1 lower: an indication the Uo_screen is an lower screen.

4.2.464.2.2 upper: an indication the Uo_screen is an upper screen.

4.2.464.3 operating_mode

An operating_mode specifies an enumerated attribute indicating whether the Uo_screen operates as a wet or a dry screen. The value of the operating_mode attribute shall be one of the following:

— dry_screen;

— wet_screen.

4.2.464.3.1 dry_screen: an indication the Uo_screen operates dry.

4.2.464.3.2 wet_screen: an indication the Uo_screen operates wet.

4.2.464.4 separation_efficiency

A separation_efficiency specifies the separation efficiency with the unit operation, of the Uo_screen.

4.2.464.5 separation_strength

A separation_strength specifies the separation strength for the Uo_screen.

4.2.465 Uo_separator

A Uo_separator is a category of Process_unit_operation (see 4.2.275) that performs a physical separation of Chemical_components (see 4.2.56) in a feed Material_stream (see 4.2.186) into two or more outlet Material_streams.

4.2.466 Uo_separator_three_phase_flash

A Uo_separator_three_phase_flash is a type of Uo_multi_phase_flash (see 4.2.452) that is a calculation of the thermal conditions for a flash containing three outlet Streams (see 4.2.374). An inlet Stream to the flash is separated into three outlet Streams. The outlet Streams consist of a vapour and two liquid streams.

The data associated with Uo_separator_three_phase_flash are the following:

— weir_height;

— weir_length.

4.2.466.1 weir_height

A weir_height specifies the height of the weir that separates the division of the two liquid Phases (see 4.2.230) in the flash unit.

4.2.466.2 weir_length

A weir_length specifies the distance the weir is located from one end of the flash unit.

4.2.467 Uo_shell_and_tube_heat_exchanger

A Uo_shell_and_tube_heat_exchanger is a type of Process_unit_operation (see 4.2.275) that provides the capability to exchange heat between two Material_streams (see 4.2.186). One Material_stream flows through a tube bundle that is contained within a shell where the other Material_stream flows.

4.2.468 Uo_single_phase_flash

A Uo_single_phase_flash is a type of Uo_flash (see 4.2.439) that is a calculation of the thermal conditions for a single-phase Stream (see 4.2.374).

The data associated with Uo_single_phase_flash are the following:

— node_volume.

A node_volume specifies the total volume associated with the Uo_single_phase_flash.

4.2.469 Uo_solid_solid_separator

A Uo_solid_solid_separator is a category of Process_unit_operation (see 4.2.275) that represents equipment that separates solid particles from solid particles. Each Uo_solid_solid_separator may be one of the following: a Uo_crusher (see 4.2.423) or a Uo_screen (see 4.2.464).

4.2.470 Uo_solids_decanter_stage

A Uo_solids_decanter_stage is a type of Process_definition (see 4.2.253) that is the contacting of a solid Stream (see 4.2.374) and a liquid Stream followed by the separation of the leached solid and effluent liquid by settling and decanting.

The data associated with Uo_solids_decanter_stage are the following:

— decanter_stage_number;

— decanter_stage_outlet_pressure;

— decanter_stage_pressure_drop;

— flow_ratio_oflow_to_uflow;

— solids_conc_oflow_to_uflow.

4.2.470.1 decanter_stage_number

A decanter_stage_number specifies the stage number for the Uo_solids_decanter_stage in a Uo_-countercurrent_solids_decanter (see 4.2.422).

4.2.470.2 decanter_stage_outlet_pressure

A decanter_stage_outlet_pressure specifies the outlet pressure for the Uo_solids_decanter_stage.

4.2.470.3 decanter_stage_pressure_drop

A decanter_stage_pressure_drop specifies the difference between the inlet pressure and outlet pressure of the Uo_solids_decanter_stage.

4.2.470.4 flow_ratio_oflow_to_uflow

A flow_ratio_oflow_to_uflow specifies the ratio of over flow to under flow of the Uo_solids_decanter_-stage.

4.2.470.5 solids_conc_oflow_to_uflow

A solids_conc_oflow_to_uflow specifies the ratio of the solids concentration in the over flow to under flow for the Uo_solids_decanter_stage.

4.2.471 Uo_solids_dryer

A Uo_solids_dryer is a type of Process_unit_operation (see 4.2.275) that is the removal of moisture or an entrained liquid from a solids Stream (see 4.2.374). Heat input or pressure drop is used to remove the overhead Stream (see 4.2.374) from the residual solids in the bottoms Stream.

The data associated with Uo_solids_dryer are the following:

— duty;

— entrained_fraction;

— overhead_to_feed_mass_ratio;

— overhead_to_feed_mole_ratio;

— pressure;

— pressure_drop;

— temperature.

4.2.471.1 duty

A duty specifies the heat supplied to the Uo_solids_dryer.

4.2.471.2 entrained_fraction

An entrained_fraction specifies the mass fraction of the amount of solids leaving the Uo_solids_dryer in overhead vapor stream to the total amount of solids leaving the dryer.

4.2.471.3 overhead_to_feed_mass_ratio

An overhead_to_feed_mass_ratio specifies the ratio of the mass of the overhead to feed for the Uo_solids_dryer.

4.2.471.4 overhead_to_feed_mole_ratio

An overhead_to_feed_mole_ratio specifies the ratio of the mole flows of the overhead to the feed for the Uo_solids_dryer.

4.2.471.5 pressure

A pressure specifies the pressure of the Uo_solids_dryer.

4.2.471.6 pressure_drop

A pressure_drop specifies the difference between the inlet and outlet of the Uo_solids_dryer.

4.2.471.7 temperature

A temperature specifies the temperature of the Uo_solids_dryer.

4.2.472 Uo_specified_yield_reactor

A Uo_specified_yield_reactor is a type of Uo_reactor (see 4.2.462) whose performance is specified solely by the desired amount of one or more Chemical_components (see 4.2.56) in one or more Phases (see 4.2.230) of the reactor outlet.

4.2.473 Uo_splitter

A Uo_splitter is a type of Process_unit_operation (see 4.2.275) that specifies the separation of one or more inlet Streams (see 4.2.374) into two or more outlet Streams. Each Uo_splitter may be one of the following: a Uo_stream_splitter (see 4.2.474) or a Uo_substance_splitter (see 4.2.475).

> NOTE - No specification of the process or equipment that might achieve this separation is supplied.

The data associated with Uo_splitter are the following:

— differential_pressure;

— pressure.

4.2.473.1 differential_pressure

A differential_pressure specifies the difference between the inlet pressure and the outlet pressure for the Uo_splitter.

4.2.473.2 pressure

A pressure specifies the outlet pressure for the Uo_splitter.

4.2.474 Uo_stream_splitter

A Uo_stream_splitter is a type of Uo_splitter (see 4.2.473) whose performance is specified by setting the desired flows or fractions of individual Substances (see 4.2.381) in one or more outlet Streams (see 4.2.374) based on the amount of those Substances present in one or more inlet Streams.

4.2.475 Uo_substance_splitter

A Uo_substance_splitter is a type of Uo_splitter (see 4.2.473) that is a Substance (see 4.2.381) splitter unit operation.

4.2.476 Uo_valve

A Uo_valve is a type of Uo_pressure_changer (see 4.2.460) that represents the pressure drop imposed by a device that restricts or redirects the flow path in a process line.

The data associated with Uo_valve are the following:

— action;

— control_type;

— fail;

— valve_cv;

— valve_style;

— valve_type.

4.2.476.1 action

An action specifies an enumerated attribute that specifies whether the Uo_valve opens or closes with an increase in a control signal to the Uo_valve. The value of the action attribute shall be one of the following:

— close;

— open.

4.2.476.1.1 close: an indication the Uo_valve closes with an increasing control signal.

4.2.476.1.2 open: an indication the Uo_valve opens with an increasing control signal.

4.2.476.2 control_type

A control_type specifies the type of control signal or mechanism that is used to operate the Uo_valve.

4.2.476.3 fail

A fail specifies an enumerated attribute that specifies how the valve behaves on loss of control signal or power. The value of the fail attribute shall be one of the following:

— fail_close;

— fail_fixed;

— fail_open.

4.2.476.3.1 fail_close: an indication the Uo_valve shall close on the loss of its control signal.

4.2.476.3.2 fail_fixed: an indication the Uo_valve shall remain fixed in its last position on the loss of its control signal.

4.2.476.3.3 fail_open: an indication the Uo_valve shall open on the loss of its control signal.

4.2.476.4 valve_cv

A valve_cv specifies the coefficient of flow for the valve in its fully open position.

4.2.476.5 valve_style

A valve_style specifies the particular style of valve for a given manufacturer.

4.2.476.6 valve_type

A valve_type identifies the valve manufacturer.

NOTE - The value_type attribute determines the flow equation to be used. Typical valve manufacturers include: Masoneilan, Mokveld, Fisher, Introl, Valtek, and CCI Drag.

4.2.477 Uo_vapourizer

A Uo_vapourizer is a type of Process_unit_operation (see 4.2.275) that provides the capability to vapourize part or all of a liquid Material_stream (see 4.2.186) by introducing heat.

4.2.478 Uo_venturi_scrubber

A Uo_venturi_scrubber is a type of Uo_gas_solid_separator (see 4.2.441) that is a venturi scrubber unit operation. A venturi scrubber uses a liquid to scrub solid particles from a gas.

The data associated with Uo_venturi_scrubber are the following:

— gas_velocity_maximum;

— gas_velocity_minimum;

— liquid_throat_velocity;

— liquid_to_gas_volume_ratio_maximum;

— liquid_to_gas_volume_ratio_minimum;

— throat_diameter;

— throat_diameter_maximum;

— throat_diameter_minimum;

— throat_length.

4.2.478.1 gas_velocity_maximum

A gas_velocity_maximum specifies the maximum gas velocity for the Uo_venturi_scrubber.

4.2.478.2 gas_velocity_minimum

A gas_velocity_minimum specifies the minimum gas velocity for the Uo_venturi_scrubber.

4.2.478.3 liquid_throat_velocity

A liquid_throat_velocity specifies the liquid velocity in the throat of the Uo_venturi_scrubber.

4.2.478.4 liquid_to_gas_volume_ratio_maximum

A liquid_to_gas_volume_ratio_maximum specifies the maximum volume ratio of liquid flow to gas flow of the Uo_venturi_scrubber.

4.2.478.5 liquid_to_gas_volume_ratio_minimum

A liquid_to_gas_volume_ratio_minimum specifies the minimum volume ratio of liquid flow to gas flow of the Uo_venturi_scrubber.

4.2.478.6 throat_diameter

A throat_diameter specifies the diameter of the throat associated with the unit operation, of the Uo_-venturi_scrubber.

4.2.478.7 throat_diameter_maximum

A throat_diameter_maximum specifies the maximum diameter of the throat associated with the unit operation, of the Uo_venturi_scrubber.

4.2.478.8 throat_diameter_minimum

A throat_diameter_minimum specifies the minimum diameter of the throat associated with the unit operation, of the Uo_venturi_scrubber.

4.2.478.9 throat_length

A throat_length specifies the length of the throat associated with the unit operation, of the Uo_venturi_-scrubber.

4.2.479 User_defined_simulation_property

A User_defined_simulation_property is a property for a simulation that is not defined in the standard. Support for the information described in a User_defined_simulation_property is not a requirement of applications which conform to this standard.

The data associated with User_defined_simulation_property are the following:

— simulation_property_method_name.

A simulation_property_method_name specifies a name which in conjunction with a Process_simulation (see 4.2.271) uniquely identifies the User_defined_simulation_property.

4.2.480 User_defined_simulation_value

A User_defined_simulation_value is the value of a User_defined_simulation_property (see 4.2.479).

The data associated with User_defined_simulation_value are the following:

— simulation_value;

— simulation_value_id.

4.2.480.1 simulation_value

A simulation_value specifies the value of User_defined_unit_operation_value (see 4.2.482) in the simulation.

4.2.480.2 simulation_value_id

A simulation_value_id specifies a unique identifier for a User_defined_simulation_value.

4.2.481 User_defined_unit_operation_property

A User_defined_unit_operation_property is the attributes of user defined unit operations are metadata that are stored as data by the User_defined_unit_operation_property.

The data associated with User_defined_unit_operation_property are the following:

— uo_property_method_name.

A uo_property_method_name specifies a label which in conjunction with a Process_simulation (see 4.2.271) uniquely identifies the User_defined_unit_operation_property.

4.2.482 User_defined_unit_operation_value

A User_defined_unit_operation_value is a value for each property of each Process_unit_operation (see 4.2.275).

The data associated with User_defined_unit_operation_value are the following:

— unit_operation_value;

— unit_operation_value_id.

4.2.482.1 unit_operation_value

A unit_operation_value specifies the value of User_defined_unit_operation_value in the simulation.

4.2.482.2 unit_operation_value_id

A unit_operation_value_id specifies a unique identifier for a User_defined_unit_operation_value.

4.2.483 Utility_material_service

A Utility_material_service is a type of Site_utility_service (see 4.2.357) available at a Site (see 4.2.354) in which the service is a utility Material (see 4.2.178).

The data associated with Utility_material_service are the following:

— utility_material_category.

A utility_material_category specifies an enumerated attribute that indicates whether the Utility_material_-service is fuel, steam, water, or air. The value of the utility_material_category attribute shall be one of the following:

— air;

— fuel;

— steam;

— water.

4.2.483.0.1 air: an indication that the utility Material (see 4.2.178) is air.

4.2.483.0.2 fuel: an indication that the utility Material (see 4.2.178) is a fuel.

4.2.483.0.3 steam: an indication that the utility Material (see 4.2.178) is steam.

4.2.483.0.4 water: an indication that the utility Material (see 4.2.178) is water.

4.2.484 Utility_service_stream_demand

A Utility_service_stream_demand is a requirement by a Utility_material_service (see 4.2.483) for either a continuous or peak flow by a Stream (see 4.2.374).

The data associated with Utility_service_stream_demand are the following:

— demand_type.

A demand_type specifies whether the type of demand is continuous or peak.

4.2.485 Utility_stream

A Utility_stream is a type of Stream (see 4.2.374) that describes an energy source or sink available to the Process_unit_operation (see 4.2.275).

NOTE - Utility_stream represents common utility services such as cooling water, steam, and air.

The data associated with Utility_stream are the following:

— utility_flow;

— utility_name.

4.2.485.1 utility_flow

A utility_flow specifies either the flow rate or the consumption of the Utility_stream.

4.2.485.2 utility_name

A utility_name specifies what the utility service is in the Utility_stream.

4.2.486 Valve_cap

A Valve_cap is a type of Perforation_cover_shape (see 4.2.210).

4.2.487 Valve_cap_shape

A Valve_cap_shape is a description of the shape of the Valve_cap (see 4.2.486).

The data associated with Valve_cap_shape are the following:

— characteristic_size;

— type_code;

— type_name.

4.2.487.1 characteristic_size

A characteristic_size specifies the Valve_cap (see 4.2.486) size in terms of a numeric value or code.

4.2.487.2 type_code

A type_code specifies the particular code name for a Valve_cap (see 4.2.486).

4.2.487.3 type_name

A type_name specifies the particular Valve_cap (see 4.2.486) name that is used to characterize the Valve_-cap.

4.2.488 Vapour_belt

A Vapour_belt (see Figure 8, Figure 9) is a cylinder of larger diameter than the shell cylinder, centrally located two separate shell cylinders that aids in the distribution of a vapour into the shell side of a heat exchanger.

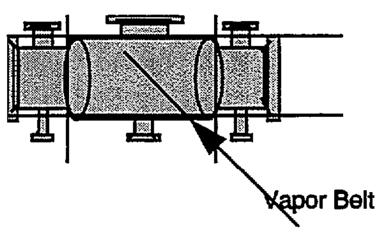


Figure 9 - Vapour Belt

The data associated with Vapour_belt are the following:

— inside_diameter;

— length;

— outside_diameter;

— radial_clearance;

— radial_clearance;

— slot_area.

4.2.488.1 inside_diameter

An inside_diameter specifies the inside diameter of the Vapour_belt cylinder.

4.2.488.2 length

A length specifies the overall length of the Vapour_belt cylinder.

4.2.488.3 outside_diameter

An outside_diameter specifies the outside diameter of the Vapour_belt cylinder.

4.2.488.4 radial_clearance

A radial_clearance specifies the radial clearance of the Vapour_belt inside diameter to the shell inside diameter.

4.2.488.5 slot_area

A slot_area specifies the total area of the distribution slots in the Vapour_belt.

4.2.489 Variable

A Variable is a variable for an equation, an Equation_group (see 4.2.124), a Reference_state (see 4.2.300), or a Property_data_set (see 4.2.278). Each Variable may be one of the following: a Thermophysical_point_property (see 4.2.388).

NOTE - Properties may be expressed as a Variable.

The data associated with Variable are the following:

— variable_name;

— variable_type.

4.2.489.1 variable_name

A variable_name specifies the label for the Variable.

4.2.489.2 variable_type

A variable_type specifies the name of the thermodynamic mathematical model or method associated with the value of the Variable.

NOTE 1 - The value of the variable_type may be one of a set of predefined values or may be user supplied.

The value of the variable_type attribute may be one of the following:

— BWR;

— BWRS;

— Chao-Seader;

— Lee-Kesler;

— Margules;

— NRTL;

— PR;

— SRK;

— UNIQUAC;

— Van Laar;

— Wilson.

4.2.489.2.1 BWR: Bennedict-Webb-Rubin equation of state.

4.2.489.2.2 BWRS: Bennedict-Webb-Rubin-Starling equation of state.

4.2.489.2.3 Chao-Seader: Chao-Seader method.

4.2.489.2.4 Lee-Kesler: Lee-Kessler method.

4.2.489.2.5 Margules: Margules excess Gibbs free energy method.

4.2.489.2.6 NRTL: Non-Random Two Liquid method.

4.2.489.2.7 PR: Peng-Robinson equation of state.

4.2.489.2.8 SRK: Soave-Redlich-Kwong equation of state.

4.2.489.2.9 UNIQUAC: Unified Quasi-chemical method.

4.2.489.2.10 Van Laar: Van Laar equation.

4.2.489.2.11 Wilson: Wilson's excess Gibbs free energy method.

4.2.490 Variable_approval_context

A Variable_approval_context is the suitability of a Variable_value (see 4.2.493) for use in an Equation_-group (see 4.2.124) or equations specified by an Equation_definition (see 4.2.123).

The data associated with Variable_approval_context are the following:

— approved_by;

— description.

4.2.490.1 approved_by

An approved_by specifies who or what body states the suitability of the Variable_value (see 4.2.493).

4.2.490.2 description

A description specifies key aspects about the Variable_approval_context.

4.2.491 Variable_convergence_block

A Variable_convergence_block is a Simulation_block (see 4.2.331) that varies the value of one or more Stream (see 4.2.374) variables or Process_unit_operation (see 4.2.275) variables to meet a desired objective for one or more other Stream or Process_unit_operation variables in the context of a Process_simulation (see 4.2.271).

4.2.492 Variable_convergence_specification

A Variable_convergence_specification is the specification of the criteria a Variable_convergence_block (see 4.2.491) uses to determine if a specific target variable has converged.

4.2.493 Variable_value

A Variable_value is a specific value of a Variable (see 4.2.489) for a Phase (see 4.2.230).

The data associated with Variable_value are the following:

— raw_or_approved;

— value;

— variable_value_type.

4.2.493.1 raw_or_approved

A raw_or_approved specifies whether the Variable_value is from raw data or from data that has been processed or evaluated for a particular use.

4.2.493.2 value

A value specifies the numerical value for a Variable_value.

4.2.493.3 variable_value_type

A variable_value_type specifies either a Point_property_value (see 4.2.246) or a Binary_property_value (see 4.2.20).

4.2.494 Weir

A Weir is a vertical barrier paced in the liquid flow so that the liquid will collect behind it and will overflow the top of the Weir.

4.2.495 Weir_and_disengaging_panel_intersection

A Weir_and_disengaging_panel_intersection is the layout of a Weir (see 4.2.494) in a Downcomer (see 4.2.109) disengaging panel and is described by a Curve (see 4.2.86) and a length.

The data associated with Weir_and_disengaging_panel_intersection are the following:

— length.

A length specifies the horizontal distance of the intersection between the Weir (see 4.2.494) and the Downcomer (see 4.2.109) disengaging panel.

4.2.496 Weir_and_seal_pan_intersection

A Weir_and_seal_pan_intersection is the layout of a Weir (see 4.2.494) on a Seal_pan (see 4.2.309) and can be described by a Curve (see 4.2.86) or length.

The data associated with Weir_and_seal_panel_intersection are the following:

— length.

A length specifies the horizontal distance of the intersection between the Weir (see 4.2.494) and the Seal_-pan (see 4.2.309).

4.2.497 Weir_and_tray_panel_intersection

A Weir_and_tray_panel_intersection is the layout of a Weir (see 4.2.494) on a Tray_panel (see 4.2.399) and can be described by a Curve (see 4.2.86) or length.

The data associated with Weir_and_tray_panel_intersection are the following:

— length.

A length specifies the horizontal distance of the intersection between the Weir (see 4.2.494) and the Tray_-panel (see 4.2.399).

4.2.498 Weir_shape

A Weir_shape is a description of the shape of the Weir (see 4.2.494).

NOTE - This shape is typically vertical with smooth top edges over which the liquid flows. However, they are occasionally swept back in the direction of the liquid flow or have serrated, notched, or curved top edges.

The data associated with Weir_shape are the following:

— angle_swept_back_in_direction_of_flow;

— attachment_method;

— disengaging_panel_intersection_length;

— seal_pan_intersection_length;

— tray_panel_intersection_length;

— vertical_height.

4.2.498.1 angle_swept_back_in_direction_of_flow

An angle_swept_back_in_direction_of_flow specifies Weirs (see 4.2.494) that are not vertical.

4.2.498.2 attachment_method

An attachment_method specifies how Weirs (see 4.2.494) are connected to the Separation_tray (see 4.2.316).

NOTE - Methods include welding, bolting, and extending between tray components.

4.2.498.3 disengaging_panel_intersection_length

A disengaging_panel_intersection_length specifies the horizontal distance between the Weir (see 4.2.494) and the Downcomer (see 4.2.109) disengaging panel intersection.

4.2.498.4 seal_pan_intersection_length

A seal_pan_intersection_length specifies the horizontal distance between the Weir (see 4.2.494) and the Seal_pan (see 4.2.309) intersection.

4.2.498.5 tray_panel_intersection_length

A tray_panel_intersection_length specifies the horizontal distance between the Weir (see 4.2.494) and the Tray_panel (see 4.2.399) intersection.

4.2.498.6 vertical_height

A vertical_height specifies the vertical distance from the Separation_tray (see 4.2.316) to the top of the Weir (see 4.2.494).

4.2.499 Work_stream

A Work_stream is a type of Energy_stream (see 4.2.122) that is the flow of work.

4.3 Application assertions

This subclause specifies the application assertions for the process plant engineering application protocol. Application assertions specify the relationships between application objects, the cardinality of the relationships, and the rules required for the integrity and validity of the application objects and UoFs. The application assertions and their definitions are given below.

4.3.1 Active_area_shape to Tray_panel_shape

Each Active_area_shape describes the active area for exactly one Tray_panel_shape. Each Tray_panel_-shape has as active area description zero, one, or many Active_area_shape objects.

4.3.2 Axial_position_detector to Centrifugal_compressor

Each Axial_position_detector is a component of exactly one Centrifugal_compressor. Each Centrifugal_-compressor has as a component zero, one, or many Axial_position_detector objects.

4.3.3 Baffle_and_disengaging_panel_intersection to Downcomer_disengaging_-panel_shape

Each Baffle_and_disengaging_panel_intersection is intersected by exactly one Downcomer_disengaging_-panel_shape. Each Downcomer_disengaging_panel_shape intersects zero, one, or many Baffle_and_-disengaging_panel_intersection objects.

4.3.4 Baffle_and_disengaging_panel_intersection to Separation_tray_baffle_-shape

Each Baffle_and_disengaging_panel_intersection is intersected by exactly one Separation_tray_baffle_-shape. Each Separation_tray_baffle_shape intersects zero or one Baffle_and_disengaging_panel_-intersection.

4.3.5 Baffle_and_seal_pan_intersection to Seal_pan_shape

Each Baffle_and_seal_pan_intersection is intersected exactly one by Seal_pan_shape. Each Seal_pan_-shape intersects zero, one, or many Baffle_and_seal_pan_intersection objects.

4.3.6 Baffle_and_seal_pan_intersection to Separation_tray_baffle_shape

Each Baffle_and_seal_pan_intersection is intersected by exactly one Separation_tray_baffle_shape. Each Separation_tray_baffle_shape intersects zero or one Baffle_and_seal_pan_intersection.

4.3.7 Baffle_and_tray_panel_intersection to Separation_tray_baffle_shape

Each Baffle_and_tray_panel_intersection is intersected by exactly one Separation_tray_baffle_shape. Each Separation_tray_baffle_shape intersects zero or one Baffle_and_tray_panel_intersection.

4.3.8 Baffle_and_tray_panel_intersection to Tray_panel_shape

Each Baffle_and_tray_panel_intersection is intersected by exactly one Tray_panel_shape. Each Tray_-panel_shape intersects zero, one, or many Baffle_and_tray_panel_intersection objects.

4.3.9 Balance to Process_simulation

Each Balance is a result for exactly one Process_simulation. Each Process_simulation has as a result of zero, one, or many Balance objects.

4.3.10 Baseplates_and_soleplates to Fluid_transfer_machine

Each Baseplates_and_soleplates is a component of exactly one Fluid_transfer_machine. Each Fluid_-transfer_machine has as a component exactly one Baseplates_and_soleplates.

4.3.11 Bearing to Bearing_housing

Each Bearing is part of exactly one Bearing_housing. Each Bearing_housing contains one or more Bearing objects.

4.3.12 Bearing to Fluid_transfer_machine

Each Bearing may be a component of exactly one Fluid_transfer_machine. Each Fluid_transfer_machine has as a component zero, one, or many Bearing objects.

4.3.13 Bearing_housing to Fluid_transfer_machine

Each Bearing_housing is a component of exactly one Fluid_transfer_machine. Each Fluid_transfer_-machine has as a component zero or one Bearing_housing.

4.3.14 Bin_section to Bounded_curve

Each Bin_section has lower cross section of exactly one Bounded_curve. Each Bounded_curve is lower cross section for zero, one, or many Bin_section objects.

Each Bin_section has upper cross section of exactly one Bounded_curve. Each Bounded_curve is upper cross section for zero, one, or many Bin_section objects.

4.3.15 Bin_section to Construction_material

Each Bin_section may be made from exactly one Construction_material. Each Construction_material is used to make zero, one, or many Bin_section objects.

4.3.16 Bin_section to External_treatment

Each Bin_section may be the treatment for exactly one External_treatment. Each External_treatment is treatment for zero, one, or many Bin_section objects.

4.3.17 Bin_section to Solids_storage_bin

Each Bin_section is a component exactly one Solids_storage_bin. Each Solids_storage_bin has as ordered components of one or more Bin_section objects.

4.3.18 Binary_property_value to Substance

Each Binary_property_value may be a property value of exactly one Substance. Each Substance has property value of zero, one, or many Binary_property_value objects.

4.3.19 Blinding_strip to Blinding_strip_shape

Each Blinding_strip may be described by exactly one Blinding_strip_shape. Each Blinding_strip_shape describes zero, one, or many Blinding_strip objects.

4.3.20 Blinding_strip_shape to Separation_tray_shape

Each Blinding_strip_shape composes exactly one Separation_tray_shape. Each Separation_tray_shape consists of zero, one, or many Blinding_strip_shape objects.

4.3.21 Boot to Cylindrical_pressure_vessel_section

Each Boot is attached to exactly one Cylindrical_pressure_vessel_section. Each Cylindrical_pressure_-vessel_section has attached zero, one, or many Boot objects.

4.3.22 Boot_location_on_cyl_section to Boot

Each Boot_location_on_cyl_section has child boot of exactly one Boot. Each Boot is child boot for zero or one Boot_location_on_cyl_section.

4.3.23 Boot_location_on_cyl_section to Cylindrical_pv_cylinder_section

Each Boot_location_on_cyl_section is an attachment of exactly one Cylindrical_pv_cylinder_section. Each Cylindrical_pv_cylinder_section has as attachments zero, one, or many Boot_location_on_cyl_section objects.

4.3.24 Boot_location_on_head_section to Boot

Each Boot_location_on_head_section has child boot of exactly one Boot. Each Boot is child boot for zero or one Boot_location_on_head_section.

4.3.25 Boot_location_on_head_section to Cylindrical_pv_head_section

Each Boot_location_on_head_section is attachment of exactly one Cylindrical_pv_head_section. Each Cylindrical_pv_head_section has as attachments zero, one, or many Boot_location_on_head_section objects.

4.3.26 Boot_section_relationship to Boot

Each Boot_section_relationship has as ordered sections exactly one Boot. Each Boot has as ordered sections exactly two Boot_section_relationship objects.

4.3.27 Boot_section_relationship to Cylindrical_pressure_vessel_section

Each Boot_section_relationship has section of exactly one Cylindrical_pressure_vessel_section. Each Cylindrical_pressure_vessel_section is sections of zero or one Boot_section_relationship.

4.3.28 Bulk_thermodynamic_properties to Bulk_thermophysical_properties

Each Bulk_thermodynamic_properties is property of exactly one Bulk_thermophysical_properties. Each Bulk_thermophysical_properties has properties of zero or one Bulk_thermodynamic_properties.

4.3.29 Bulk_thermodynamic_properties to Reference_state

Each Bulk_thermodynamic_properties may have reference state provided by exactly one Reference_state. Each Reference_state provides reference state for zero, one, or many Bulk_thermodynamic_properties objects.

4.3.30 Bulk_thermophysical_properties to Material_amount

Each Bulk_thermophysical_properties may be a property of exactly one Material_amount. Each Material_-amount has composite properties of zero or one Bulk_thermophysical_properties.

4.3.31 Bulk_thermophysical_properties to Material_stream

Each Bulk_thermophysical_properties may be property of exactly one Material_stream. Each Material_-stream has composite properties of zero or one Bulk_thermophysical_properties.

4.3.32 Bulk_thermophysical_properties to Mixture

Each Bulk_thermophysical_properties may be composition data of exactly one Mixture. Each Mixture has composition data of zero or one Bulk_thermophysical_properties.

4.3.33 Bulk_thermophysical_properties to Reference_state

Each Bulk_thermophysical_properties may have a reference state provided by exactly one Reference_state. Each Reference_state provides reference state for zero, one, or many Bulk_thermophysical_properties objects.

4.3.34 Bulk_thermophysical_properties to Referenced_object

Each Bulk_thermophysical_properties is zero or one Referenced_object. Each Referenced_object may be exactly one Bulk_thermophysical_properties.

4.3.35 Bulk_thermophysical_properties to Specific_phase

Each Bulk_thermophysical_properties may be a property of exactly one Specific_phase. Each Specific_-phase has composite properties zero or one Bulk_thermophysical_properties.

4.3.36 Bulk_vle_properties to Bulk_thermophysical_properties

Each Bulk_vle_properties is property of exactly one Bulk_thermophysical_properties. Each Bulk_-thermophysical_properties has properties of zero or one Bulk_vle_properties.

4.3.37 Cap_shape to Bubble_cap_shape

Each Cap_shape composes exactly one Bubble_cap_shape. Each Bubble_cap_shape consists of exactly one Cap_shape.

4.3.38 Cap_shape to Curve

Each Cap_shape may have bottom edge described by exactly one Curve. Each Curve describes the bottom edge of zero or one Cap_shape.

4.3.39 Cap_shape to Bubble_slot_shape

Each Cap_shape may have slot described by exactly one Bubble_slot_shape. Each Bubble_slot_shape describes the slot for zero, one, or many Cap_shape objects.

4.3.40 Cartesian_point to Tray_panel_and_perforation_shape

Each Cartesian_point may be the perforation location for exactly one Tray_panel_and_perforation_shape. Each Tray_panel_and_perforation_shape has as the perforation location zero, one, or many Cartesian_point objects.

4.3.41 Cartesian_point to Tray_panel_and_slot_shape

Each Cartesian_point may be the slot location for exactly one Tray_panel_and_slot_shape. Each Tray_-panel_and_slot_shape has as the slot location zero, one, or many Cartesian_point objects.

4.3.42 Casing_nozzle to Fluid_transfer_machine

Each Casing_nozzle is a component of exactly one Fluid_transfer_machine. Each Fluid_transfer_machine has as a component zero, one, or many Casing_nozzle objects.

4.3.43 Cc_balance_piston to Centrifugal_compressor

Each Cc_balance_piston is a component of exactly one Centrifugal_compressor. Each Centrifugal_-compressor has as a component zero or one Cc_balance_piston.

4.3.44 Cc_casing to Centrifugal_compressor

Each Cc_casing is a component of exactly one Centrifugal_compressor. Each Centrifugal_compressor has as a component exactly one Cc_casing.

4.3.45 Cc_diaphragm to Centrifugal_compressor

Each Cc_diaphragm is a component of exactly one Centrifugal_compressor. Each Centrifugal_compressor has as a component zero, one, or many Cc_diaphragm objects.

4.3.46 Cc_impeller to Centrifugal_compressor_stage

Each Cc_impeller is part of exactly one Centrifugal_compressor_stage. Each Centrifugal_compressor_stage has zero, one, or many Cc_impeller objects.

4.3.47 Cc_impeller to Centrifugal_compressor

Each Cc_impeller is a component of exactly one Centrifugal_compressor. Each Centrifugal_compressor has as a component zero, one, or many Cc_impeller objects.

4.3.48 Cc_labyrinth to Centrifugal_compressor

Each Cc_labyrinth is a component of exactly one Centrifugal_compressor. Each Centrifugal_compressor has as a component zero, one, or many Cc_labyrinth objects.

4.3.49 Cc_lateral_critical_speed to Centrifugal_compressor

Each Cc_lateral_critical_speed is part of exactly one Centrifugal_compressor. Each Centrifugal_compressor has zero, one, or many Cc_lateral_critical_speed objects.

4.3.50 Cc_miscellaneous to Centrifugal_compressor

Each Cc_miscellaneous is part of exactly one Centrifugal_compressor. Each Centrifugal_compressor has zero or one Cc_miscellaneous.

4.3.51 Cc_shaft_sleeve to Centrifugal_compressor

Each Cc_shaft_sleeve is a component of exactly one Centrifugal_compressor. Each Centrifugal_compressor has as a component zero, one, or many Cc_shaft_sleeve objects.

4.3.52 Cc_speed_control_method to Centrifugal_compressor

Each Cc_speed_control_method is part of exactly one Centrifugal_compressor. Each Centrifugal_-compressor has zero, one, or many Cc_speed_control_method objects.

4.3.53 Cc_speed_control_signal to Centrifugal_compressor

Each Cc_speed_control_signal is part of exactly one Centrifugal_compressor. Each Centrifugal_compressor has zero, one, or many Cc_speed_control_signal objects.

4.3.54 Cc_torsional_critical_speed to Centrifugal_compressor

Each Cc_torsional_critical_speed is part of exactly one Centrifugal_compressor. Each Centrifugal_-compressor has zero, one, or many Cc_torsional_critical_speed objects.

4.3.55 Cc_weights to Centrifugal_compressor

Each Cc_weights is part of exactly one Centrifugal_compressor. Each Centrifugal_compressor has zero or one Cc_weights.

4.3.56 Centrifugal_compressor to Buffer_gas_system

Each Centrifugal_compressor is the shaft seal component for exactly one Buffer_gas_system. Each Buffer_gas_system has as the shaft seal component zero or one Centrifugal_compressor.

4.3.57 Centrifugal_compressor_stage to Centrifugal_compressor

Each Centrifugal_compressor_stage is the component stage for exactly one Centrifugal_compressor. Each Centrifugal_compressor has as component stages zero, one, or many Centrifugal_compressor_stage objects.

4.3.58 Centrifugal_pump to Mechanical_seal

Each Centrifugal_pump has a component of exactly one Mechanical_seal. Each Mechanical_seal is component of exactly one Centrifugal_pump.

4.3.59 Chemical_reaction to Process_design_property_value

Each Chemical_reaction has zero, one, or many Process_design_property_value objects. Each Process_-design_property_value defines property values of zero, one, or many Chemical_reaction objects.

4.3.60 Chemical_reaction to Referenced_object

Each Chemical_reaction is zero or one Referenced_object. Each Referenced_object may be exactly one Chemical_reaction.

4.3.61 Chemical_reaction to Uo_cst_reactor

Each Chemical_reaction is the chemical reaction for zero, one, or many Uo_cst_reactor objects. Each Uo_-cst_reactor has as a chemical reaction zero, one, or many Chemical_reaction objects.

4.3.62 Chemical_reaction to Uo_plug_flow_reactor

Each Chemical_reaction is the chemical reaction for zero, one, or many Uo_plug_flow_reactor objects. Each Uo_plug_flow_reactor has as a chemical reaction zero, one, or many Chemical_reaction objects.

4.3.63 Chemical_specie to Family

Each Chemical_specie is in family of zero, one, or many Family objects. Each Family specie is family of zero, one, or many Chemical_specie objects.

4.3.64 Chemical_specie_structural_group_relationship to Chemical_specie

Each Chemical_specie_structural_group_relationship has groups of exactly one Chemical_specie. Each Chemical_specie has groups zero, one, or many Chemical_specie_structural_group_relationship objects.

4.3.65 Chemical_specie_structural_group_relationship to Structural_group

Each Chemical_specie_structural_group_relationship has group of exactly one Structural_group. Each Structural_group is group in zero, one, or many Chemical_specie_structural_group_relationship objects.

4.3.66 Citation to Property_note

Each Citation has as a note zero, one, or many Property_note objects. Each Property_note is a note for zero, one, or many Citation objects.

4.3.67 Clock_time to Date

Each Clock_time has as the date exactly one Date. Each Date is the date for one or more Clock_time objects.

4.3.68 Coefficient_value to Specific_equation

Each Coefficient_value is value of exactly one Specific_equation. Each Specific_equation has value of zero, one, or many Coefficient_value objects.

4.3.69 Coefficient_value to Variable_value

Each Coefficient_value is value of exactly one Variable_value. Each Variable_value is value for zero, one, or many Coefficient_value objects.

4.3.70 Component_in_mixture_properties to Chemical_component

Each Component_in_mixture_properties is property of exactly one Chemical_component. Each Chemical_-component has properties zero, one, or many Component_in_mixture_properties objects.

4.3.71 Component_in_mixture_properties to Single_phase_thermophysical_-properties

Each Component_in_mixture_properties is property of exactly one Single_phase_thermophysical_-properties. Each Single_phase_thermophysical_properties has properties of zero, one, or many Component_in_mixture_properties objects.

4.3.72 Composition_relationship to Mixture

Each Composition_relationship is contained by exactly one Mixture. Each Mixture contains zero, one, or many Composition_relationship objects.

4.3.73 Composition_relationship to Referenced_object

Each Composition_relationship is zero or one Referenced_object. Each Referenced_object may be exactly one Composition_relationship.

4.3.74 Composition_relationship to Substance

Each Composition_relationship contains exactly one Substance. Each Substance is part of zero, one, or many Composition_relationship objects.

4.3.75 Compressor_performance_data_point to Uo_fluid_transfer

Each Compressor_performance_data_point is data point of exactly one Uo_fluid_transfer. Each Uo_fluid_-transfer has as data point zero, one, or many Compressor_performance_data_point objects.

4.3.76 Connected_equipment_port to Equipment_port

Each Connected_equipment_port is exactly one Equipment_port. Each Equipment_port is zero or one Connected_equipment_port.

4.3.77 Connected_equipment_port to Equipment_port_connection

Each Connected_equipment_port is connected by exactly one Equipment_port_connection. Each Equipment_port_connection connects exactly two Connected_equipment_port objects.

4.3.78 Connected_process_port to Process_port

Each Connected_process_port is exactly one Process_port. Each Process_port is the port for zero, one, or many Connected_process_port objects.

4.3.79 Connected_process_port to Process_port_connection

Each Connected_process_port is used in exactly one Process_port_connection. Each Process_port_-connection is the connection for exactly two Connected_process_port objects.

4.3.80 Construction_material to Plant_item

Each Construction_material is used in the construction of zero, one, or many Plant_item objects.
Each Plant_item is constructed of zero, one, or many Construction_material objects.

4.3.81 Control_element to Control_function

Each Control_element carries out zero, one, or many Control_function objects. Each Control_function is carried out by zero, one, or many Control_element objects.

4.3.82 Control_function to Control_logic

Each Control_function carries out exactly one Control_logic. Each Control_logic is carried out by zero, one, or many Control_function objects.

4.3.83 Control_function to Control_logic_condition

Each Control_function may be exactly one Control_logic_condition. Each Control_logic_condition is zero or one Control_function.

4.3.84 Control_function to Control_measurement_module

Each Control_function may have variables measured by exactly one Control_measurement_module. Each Control_measurement_module measures variables for zero, one, or many Control_function objects.

4.3.85 Control_function to Stream

Each Control_function is defined for zero, one, or many Stream objects. Each Stream is acted upon by zero, one, or many Control_function objects.

4.3.86 Control_logic to Control_algorithm

Each Control_logic employs exactly one Control_algorithm. Each Control_algorithm is employed by zero, one, or many Control_logic objects.

4.3.87 Control_logic to Control_logic_condition

Each Control_logic may have requirements defined by exactly one Control_logic_condition. Each Control_logic_condition defines requirements for zero, one, or many Control_logic objects.

4.3.88 Control_logic to Control_scheme

Each Control_logic results in exactly one Control_scheme. Each Control_scheme results from one or more Control_logic objects.

4.3.89 Control_measurement_module to Material_amount

Each Control_measurement_module measures properties of zero, one, or many Material_amount objects. Each Material_amount has properties measured by zero, one, or many Control_measurement_module objects.

4.3.90 Control_measurement_module to Plant_item

Each Control_measurement_module measures properties of zero, one, or many Plant_item objects. Each Plant_item has properties measured by zero, one, or many Control_measurement_module objects.

4.3.91 Control_measurement_module to Site

Each Control_measurement_module measures ambient conditions of zero, one, or many Site objects. Each Site has ambient conditions measured by zero, one, or many Control_measurement_module objects.

4.3.92 Control_measurement_module to Stream

Each Control_measurement_module measures properties of zero, one, or many Stream objects. Each Stream has properties measured by zero, one, or many Control_measurement_module objects.

4.3.93 Control_objective to Control_function

Each Control_objective is defined for zero, one, two, or three Control_function objects. Each Control_-objective is defined for zero, one, or many Control_function objects.

If there is more than one Control_function per Control_objective, each Control_function has a different value for mode.

4.3.94 Control_objective to Control_variable

Each Control_objective controls one or more Control_variable objects. Each Control_objective controls zero, one, or many Control_variable objects.

4.3.95 Control_scheme to Control_objective

Each Control_scheme provides the basis for one or more Control_objective objects. Each Control_scheme is based on zero, one, or many Control_objective objects.

4.3.96 Control_variable to Control_algorithm

Each Control_variable is the set point for exactly one Control_algorithm. Each Control_algorithm has set points of one or more Control_variable objects.

4.3.97 Control_variable to Control_measurement_module

Each Control_variable is measured by zero or one Control_measurement_module. Each Control_-measurement_module measures zero, one, or many Control_variable objects.

4.3.98 Convergence_block_property_value_usage to Process_design_property_-value

Each Convergence_block_property_value_usage has as value exactly one Process_design_property_value. Each Process_design_property_value is the value for zero, one, or many Convergence_block_property_-value_usage objects.

4.3.99 Convergence_block_property_value_usage to Stream_convergence_-block

Each Convergence_block_property_value_usage is the value for exactly one Stream_convergence_block. Each Stream_convergence_block uses values of zero, one, or many Convergence_block_property_value_-usage objects.

4.3.100 Corrugation to Tray_panel_shape

Each Corrugation may be the corrugation for exactly one Tray_panel_shape. Each Tray_panel_shape has as corrugation zero or one Corrugation.

4.3.101 Coupling to Fluid_transfer_machine

Each Coupling may be a component of exactly one Fluid_transfer_machine. Each Fluid_transfer_machine has as a component zero, one, or many Coupling objects.

4.3.102 Cross_baffle to Exchanger_bundle

Each Cross_baffle belongs to exactly one Exchanger_bundle. Each Exchanger_bundle has zero, one, or many Cross_baffle objects.

If there is more than one kind of Cross_baffle for a given Exchanger_bundle, each individual cross_baffle shall be specified. Otherwise, only one cross_baffle instance shall be specified, and the count shall be specified in the number_of_cross_baffles attribute.

4.3.103 Curve to Baffle_and_disengaging_panel_intersection

Each Curve may describe the intersection for exactly one Baffle_and_disengaging_panel_intersection. Each Baffle_and_disengaging_panel_intersection has an intersection description of zero or one Curve.

4.3.104 Curve to Baffle_and_seal_pan_intersection

Each Curve may describe the intersection for exactly one Baffle_and_seal_pan_intersection. Each Baffle_-and_seal_pan_intersection has an intersection description of zero or one Curve.

4.3.105 Curve to Baffle_and_tray_panel_intersection

Each Curve may describe the intersection for exactly one Baffle_and_tray_pan_intersection. Each Baffle_-and_tray_pan_intersection has an intersection description of zero or one Curve.

4.3.106 Curve to Downcomer_apron_section_shape

Each Curve may describe the bottom edge for exactly one Downcomer_apron_section_shape. Each Downcomer_apron_section_shape has the bottom edge described by zero or one Curve.

4.3.107 Curve to Weir_and_disengaging_panel_intersection

Each Curve may describe the intersection for exactly one Weir_and_disengaging_panel_intersection. Each Weir_and_disengaging_panel_intersection has the intersection described by zero or one Curve.

4.3.108 Curve to Weir_and_seal_pan_intersection

Each Curve may describe the intersection for exactly one Weir_and_seal_pan_intersection. Each Weir_-and_seal_pan_intersection has the intersection described by zero or one Curve.

4.3.109 Curve to Weir_and_tray_panel_intersection

Each Curve may describe the intersection for exactly one Weir_and_tray_pan_intersection. Each Weir_-and_tray_pan_intersection has the intersection described by zero or one Curve.

4.3.110 Curve to Weir_shape

Each Curve may describe the weir top edge for exactly one Weir_shape. Each Weir_shape has weir top edge described by zero or one Curve.

4.3.111 Curve to Corrugation

Each Curve may describe exactly one Corrugation. Each Corrugation is described by zero or one Curve.

4.3.112 Cylindrical_pressure_vessel to Separation_tower

Each Cylindrical_pressure_vessel may compose exactly one Separation_tower. Each Separation_tower is composed of one or more Cylindrical_pressure_vessel objects.

4.3.113 Cylindrical_pressure_vessel_section to Construction_material

Each Cylindrical_pressure_vessel_section may be made from exactly one Construction_material. Each Construction_material is used to make zero, one, or many Cylindrical_pressure_vessel_section objects.

4.3.114 Cylindrical_pressure_vessel_section to Cylindrical_pressure_vessel

Each Cylindrical_pressure_vessel_section may be ordered section of exactly one Cylindrical_pressure_vessel. Each Cylindrical_pressure_vessel has as ordered sections of zero, one, or many Cylindrical_pressure_vessel_section objects.

4.3.115 Cylindrical_pressure_vessel_section to Cylindrical_pressure_vessel_connection

Each Cylindrical_pressure_vessel_section is connected by zero, one, or many Cylindrical_pressure_vessel_connection objects. Each Cylindrical_pressure_vessel_connection connects exactly two Cylindrical_pressure_vessel_section.

4.3.116 Cylindrical_pressure_vessel_section to External_treatment

Each Cylindrical_pressure_vessel_section may have treatment of exactly one External_treatment. Each External_treatment is treatment for zero, one, or many Cylindrical_pressure_vessel_section objects.

4.3.117 Data_entry to Property_data_set

Each Data_entry is part of exactly one Property_data_set. Each Property_data_set has zero, one, or many Data_entry objects.

4.3.118 Demister_pad to Cylindrical_pressure_vessel

Each Demister_pad may be part of exactly one Cylindrical_pressure_vessel. Each Cylindrical_pressure_vessel has internally zero, one, or many Demister_pad objects.

4.3.119 Demister_pad to Cylindrical_pressure_vessel_section

Each Demister_pad is contained within zero, one, or many Cylindrical_pressure_vessel_section objects. Each Cylindrical_pressure_vessel_section contains zero, one, or many Demister_pad objects.

4.3.120 Demister_pad to Separation_tower

Each Demister_pad may be part of exactly one Separation_tower. Each Separation_tower has as part of it zero, one, or many Demister_pad objects.

4.3.121 Demister_pad_stack to Cylindrical_pressure_vessel

Each Demister_pad_stack may be part of exactly one Cylindrical_pressure_vessel. Each Cylindrical_-pressure_vessel has internally zero, one, or many Demister_pad_stack objects.

4.3.122 Demister_pad_stack to Cylindrical_pressure_vessel_section

Each Demister_pad_stack is contained within zero, one, or many Cylindrical_pressure_vessel_section objects. Each Cylindrical_pressure_vessel_section contains zero, one, or many Demister_pad_stack objects.

4.3.123 Demister_pad_stack to Separation_tower

Each Demister_pad_stack may be part of exactly one Separation_tower. Each Separation_tower has as part of it zero, one, or many Demister_pad_stack objects.

4.3.124 Density_properties to Bulk_thermophysical_properties

Each Density_properties may be property of exactly one Bulk_thermophysical_properties. Each Bulk_-thermophysical_properties has properties of zero or one Density_properties.

4.3.125 Density_properties to Single_phase_thermophysical_properties

Each Density_properties may be property of exactly one Single_phase_thermophysical_properties. Each Single_phase_thermophysical_properties has properties of zero or one Density_properties.

4.3.126 Density_properties to Transport_properties

Each Density_properties may be property of exactly one Transport_properties. Each Transport_properties has properties of zero or one Density_properties.

4.3.127 Design_project to PFD_title_block

Each Design_project is displayed on zero, one, or many PFD_title_block objects. Each PFD_title_block displays zero or one Design_project.

4.3.128 Design_project_assignment to Design_project

Each Design_project_assignment has performed in it exactly one Design_project. Each Design_project is performed in zero, one, or many Design_project_assignment objects.

4.3.129 Design_project_assignment to Plant_item

Each Design_project_assignment assigns exactly one Plant_item. Each Plant_item is assigned by zero, one, or many Design_project_assignment objects.

4.3.130 Detuning_plate to Exchanger_bundle

Each Detuning_plate belongs to exactly one Exchanger_bundle. Each Exchanger_bundle has zero or one Detuning_plate.

4.3.131 Disengaging_panel_opening_shape to Downcomer_apron_shape

Each Disengaging_panel_opening_shape describes the opening of exactly one Downcomer_apron_shape. Each Downcomer_apron_shape has the opening described by one or more Disengaging_panel_opening_shape objects.

4.3.132 Disengaging_panel_opening_shape to Downcomer_disengaging_panel_shape

Each Disengaging_panel_opening_shape describes the opening of exactly one Downcomer_disengaging_panel_shape. Each Downcomer_disengaging_panel_shape has the opening described by zero, one, or many Disengaging_panel_opening_shape objects.

4.3.133 Distillation_curve to Petroleum_mixture

Each Distillation_curve may be the curve for exactly one Petroleum_mixture. Each Petroleum_mixture has as a curve zero, one, or many Distillation_curve objects.

4.3.134 Distillation_curve to Pseudo_component

Each Distillation_curve may be the curve for exactly one Pseudo_component. Each Pseudo_component has as a curve zero, one, or many Distillation_curve objects.

4.3.135 Distillation_stage_phase to Uo_distillation_stage

Each Distillation_stage_phase is draw for exactly one Uo_distillation_stage. Each Uo_distillation_stage has as draw zero, one, or many Distillation_stage_phase objects.

4.3.136 Distillation_stage_phase to Uo_reactor

Each Distillation_stage_phase may have reactor of exactly one Uo_reactor. Each Uo_reactor is reactor for zero or one Distillation_stage_phase.

4.3.137 Distribution_belt to Exchanger_nozzle

Each Distribution_belt belongs to exactly one Exchanger_nozzle. Each Exchanger_nozzle has zero or one Distribution_belt.

4.3.138 Downcomer to Downcomer_shape

Each Downcomer may be described exactly one by Downcomer_shape. Each Downcomer_shape describes zero, one, or many Downcomer objects.

4.3.139 Downcomer to Downcomer_hydraulics

Each Downcomer may have as the hydraulics exactly one Downcomer_hydraulics. Each Downcomer_-hydraulics is the hydraulics of zero, one, or many Downcomer objects.

4.3.140 Downcomer_apron_section_shape to Downcomer_apron_shape

Each Downcomer_apron_section_shape is part of exactly one Downcomer_apron_shape. Each Downcomer_apron_shape consists of one or more Downcomer_apron_section_shape objects.

4.3.141 Downcomer_apron_shape to Downcomer_shape

Each Downcomer_apron_shape is part of exactly one Downcomer_shape. Each Downcomer_shape consists of zero, one, or many Downcomer_apron_shape objects.

4.3.142 Downcomer_disengaging_panel_shape to Downcomer_shape

Each Downcomer_disengaging_panel_shape is part of exactly one Downcomer_shape. Each Downcomer_-shape consists of exactly one Downcomer_disengaging_panel_shape.

4.3.143 Downcomer_liquid_flow_channel_shape to Downcomer_apron_section_shape

Each Downcomer_liquid_flow_channel_shape describes the flow channel for exactly one Downcomer_-apron_section_shape. Each Downcomer_apron_section_shape has the flow channel described by zero or one Downcomer_liquid_flow_channel_shape.

4.3.144 Downcomer_shape to Separation_tray_shape

Each Downcomer_shape is part of exactly one Separation_tray_shape. Each Separation_tray_shape consists of zero, one, or many Downcomer_shape objects.

4.3.145 Equation_definition to Equation_group

Each Equation_definition is a part of zero, one, or many Equation_group objects. Each Equation_group consists of zero, one, or many Equation_definition objects.

4.3.146 Equation_definition to Variable_approval_context

Each Equation_definition has is suitable value for zero, one, or many Variable_approval_context objects. Each Variable_approval_context has approval context for zero, one, or many Equation_definition objects.

4.3.147 Equation_group to Citation

Each Equation_group has as a reference exactly one Citation. Each Citation is a reference for zero, one, or many Equation_group objects.

4.3.148 Equation_group to Property_note

Each Equation_group is referenced in zero, one, or many Property_note objects. Each Property_note is about zero, one, or many Equation_group objects.

4.3.149 Equation_group to Variable_approval_context

Each Equation_group has approval context for zero, one, or many Variable_approval_context objects. Each Variable_approval_context is suitable value for zero, one, or many Equation_group objects.

4.3.150 Equipment_port to Plant_item

Each Equipment_port is the port for one or more Plant_item objects. Each Plant_item has ports of zero, one, or many Equipment_port objects.

4.3.151 Equipment_port to Process_design_property_value

Each Equipment_port has zero, one, or many Process_design_property_value objects. Each Process_-design_property_value defines property values of zero, one, or many Equipment_port objects.

4.3.152 Equipment_port to Referenced_object

Each Equipment_port is zero or one Referenced_object. Each Referenced_object may be exactly one Equipment_port.

4.3.153 Escape_area_shape to Downcomer_shape

Each Escape_area_shape describes the seal pan escape area for exactly one Downcomer_shape. Each Downcomer_shape has as seal pan escape area description zero or one Escape_area_shape.

4.3.154 Escape_area_shape to Seal_pan_shape

Each Escape_area_shape describes the downcomer escape area for exactly one Seal_pan_shape. Each Seal_pan_shape has as downcomer escape area description zero or one Escape_area_shape.

4.3.155 Excess_properties to Reference_state

Each Excess_properties may have reference state provided by exactly one Reference_state. Each Reference_state provides reference state for zero, one, or many Excess_properties objects.

4.3.156 Excess_properties to Single_phase_thermophysical_properties

Each Excess_properties is properties of exactly one Single_phase_thermophysical_properties. Each Single_phase_thermophysical_properties has properties of zero or one Excess_properties.

4.3.157 Exchanger_assembly to Shell_and_tube_heat_exchanger_unit

Each Exchanger_assembly belongs to exactly one Shell_and_tube_heat_exchanger_unit. Each Shell_and_tube_heat_exchanger_unit has one or more Exchanger_assembly objects.

If there is more than one kind of exchanger_assembly for a given shell_and_tube_heat_exchanger_unit, then each individual exchanger_assembly shall be specified. Otherwise, only one exchanger_assembly instance shall be specified.

4.3.158 Exchanger_bundle to Exchanger_assembly

Each Exchanger_bundle belongs to exactly one Exchanger_assembly. Each Exchanger_assembly has exactly one Exchanger_bundle.

4.3.159 Exchanger_bundle to Tube_type

Each Exchanger_bundle may have as the type exactly one Tube_type. Each Tube_type is the type of one or more Exchanger_bundle objects.

> NOTE - A tube_type has 1 or more exchanger_bundle due to the scope of the AP. With a different scope, the tube_type could be associated with more than just the exchanger_bundle, so the association would change.

4.3.160 Exchanger_design_criteria to Shellside_design

Each Exchanger_design_criteria has exactly one Shellside_design. Each Shellside_design is the shellside design for zero, one, or many Exchanger_design_criteria objects.

4.3.161 Exchanger_design_criteria to Tubeside_design

Each Exchanger_design_criteria has exactly one Tubeside_design. Each Tubeside_design is the tubeside design for zero, one, or many Exchanger_design_criteria objects.

4.3.162 Exchanger_end to End_partition_plate

Each Exchanger_end may have exactly one End_partition_plate. Each End_partition_plate belongs to zero, one, or many Exchanger_end objects.

4.3.163 Exchanger_end to Exchanger_assembly

Each Exchanger_end belongs to exactly one Exchanger_assembly. Each Exchanger_assembly has zero, one, or many Exchanger_end objects.

4.3.164 Exchanger_nozzle to Exchanger_assembly

Each Exchanger_nozzle belongs to exactly one Exchanger_assembly. Each Exchanger_assembly has zero, one, or many Exchanger_nozzle objects.

4.3.165 Exchanger_performance to Exchanger_assembly

Each Exchanger_performance may be the performance for exactly one Exchanger_assembly. Each Exchanger_assembly has as the performance zero or one Exchanger_performance.

4.3.166 Exchanger_shell to Exchanger_assembly

Each Exchanger_shell belongs to exactly one Exchanger_assembly. Each Exchanger_assembly has exactly one Exchanger_shell.

4.3.167 Exchanger_zone to Exchanger_performance

Each Exchanger_zone describes the location for exactly one Exchanger_performance. Each Exchanger_-performance is in zero, one, or many Exchanger_zone objects.

4.3.168 Expansion_joint to Exchanger_shell

Each Expansion_joint belongs to exactly one Exchanger_shell. Each Exchanger_shell has zero or one Expansion_joint.

4.3.169 Extents_specified_chemical_reaction to Chemical_reaction

Each Extents_specified_chemical_reaction is exactly one Chemical_reaction. Each Chemical_reaction is zero or one Extents_specified_chemical_reaction.

4.3.170 Extents_specified_chemical_reaction to Uo_extent_specified_reactor

Each Extents_specified_chemical_reaction is specified by exactly one Uo_extent_specified_reactor. Each Uo_extent_specified_reactor specifies one or more Extents_specified_chemical_reaction objects.

4.3.171 External_circuit_component to Reboiler_piping

Each External_circuit_component belongs to exactly one Reboiler_piping. Each Reboiler_piping has zero, one, or many External_circuit_component objects.

4.3.172 Flow_vibration_analysis to Exchanger_performance

Each Flow_vibration_analysis describes exactly one Exchanger_performance. Each Exchanger_performance has zero, one, or many Flow_vibration_analysis objects.

4.3.173 Functional_volume to Plant_item

Each Functional_volume is of exactly one Plant_item. Each Plant_item has functional volume zero, one, or many Functional_volume objects.

4.3.174 Functional_volume_service_case to Functional_volume

Each Functional_volume_service_case has capacity provided by exactly one Functional_volume. Each Functional_volume is the capacity for zero, one, or many Functional_volume_service_case objects.

4.3.175 Functional_volume_service_case to Material_amount

Each Functional_volume_service_case is specified by exactly one Material_amount. Each Material_amount provides specification for zero or one Functional_volume_service_case.

4.3.176 Functional_volume_service_case to Process_service

Each Functional_volume_service_case is serviced by exactly one Process_service. Each Process_service is service for zero, one, or many Functional_volume_service_case objects.

4.3.177 Gasket to Construction_material

Each Gasket may be the body material for exactly one Construction_material. Each Construction_material is body material for zero, one, or many Gasket objects.

Each Gasket may be the fill material for exactly one Construction_material. Each Construction_material is fill material for zero, one, or many Gasket objects.

4.3.178 Heat_exchanger_internal_data to Uo_heat_exchanger_side

Each Heat_exchanger_internal_data is internal data for exactly one Uo_heat_exchanger_side. Each Uo_-heat_exchanger_side has as internal data zero, one, or many Heat_exchanger_internal_data objects.

4.3.179 Heat_exchanger_internal_phase to Heat_exchanger_internal_data

Each Heat_exchanger_internal_phase is internal phase for exactly one Heat_exchanger_internal_data. Each Heat_exchanger_internal_data has as internal phase one or more Heat_exchanger_internal_phase objects.

4.3.180 Heat_release_curve to Shellside_design

Each Heat_release_curve may describe the heat characteristics for exactly one Shellside_design. Each Shellside_design has heat characteristics of zero, one, or many Heat_release_curve objects. The heat_-release_curve shall be associated with at least one of tubeside_design or shellside_design.

4.3.181 Heat_release_curve to Tubeside_design

Each Heat_release_curve may describe the heat characteristics for exactly one Tubeside_design. Each Tubeside_design has heat characteristics of zero, one, or many Heat_release_curve objects. The heat_-release_curve shall be associated with at least one of tubeside_design or shellside_design.

4.3.182 Heat_release_point to Heat_release_curve

Each Heat_release_point is a point in exactly one Heat_release_curve. Each Heat_release_curve has zero, one, or many Heat_release_point objects.

4.3.183 Heat_transfer_coefficient to Uo_heat_exchanger

Each Heat_transfer_coefficient is coefficient of exactly one Uo_heat_exchanger. Each Uo_heat_exchanger has as coefficient zero, one, or many Heat_transfer_coefficient objects.

4.3.184 Impingement_protection to Exchanger_nozzle

Each Impingement_protection belongs to exactly one Exchanger_nozzle. Each Exchanger_nozzle has zero or one Impingement_protection.

4.3.185 Inspection_and_tests to Plant_item

Each Inspection_and_tests is associated with exactly one Plant_item. Each Plant_item has zero or one Inspection_and_tests objects.

4.3.186 Internal_stream_phase to Site_standard_conditions

Each Internal_stream_phase may have as reference for standard volume exactly one Site_standard_-conditions. Each Site_standard_conditions is reference for standard volume for zero, one, or many Internal_stream_phase objects.

4.3.187 Interphase_chemical_reaction to Chemical_reaction

Each Interphase_chemical_reaction is exactly one Chemical_reaction. Each Chemical_reaction is zero or one Interphase_chemical_reaction.

4.3.188 Interphase_chemical_reaction to Specific_phase

Each Interphase_chemical_reaction has as the first phase exactly one Specific_phase. Each Specific_phase is the first phase of zero, one, or many Interphase_chemical_reaction objects.

Each Interphase_chemical_reaction has as the second phase exactly one Specific_phase. Each Specific_-phase is the second phase of zero, one, or many Interphase_chemical_reaction objects.

4.3.189 Interphase_thermophysical_properties to Specific_phase

Each Interphase_thermophysical_properties is associated with zero or two Specific_phase objects. Each Specific_phase has zero, one, or many Interphase_thermophysical_properties objects.

4.3.190 Item_property_reference to Referenced_object

Each Item_property_reference is described by exactly one Referenced_object. Each Referenced_object describes one or more Item_property_reference objects.

4.3.191 Location_conditions to Plant_item

Each Location_conditions is associated with exactly one Plant_item. Each Plant_item has zero or one Location_conditions.

4.3.192 Location_in_plant to Plant

Each Location_in_plant is located in zero, one, or many Plant objects. Each Plant contains zero, one, or many Location_in_plant objects.

4.3.193 Location_in_site to Site

Each Location_in_site has as the reference frame for exactly one Site. Each Site is a reference frame for zero, one, or many Location_in_site objects.

4.3.194 Logical_operation to Control_logic_condition

Each Logical_operation has as the first operand exactly one Control_logic_condition. Each Control_logic_-condition is the first operand zero, one, or many Logical_operation objects.

Each Logical_operation has as the second operand exactly one Control_logic_condition. Each Control_-logic_condition is the second operand zero, one, or many Logical_operation objects.

4.3.195 Longitudinal_baffle to Exchanger_bundle

Each Longitudinal_baffle belongs to exactly one Exchanger_bundle. Each Exchanger_bundle has zero, one, or many Longitudinal_baffle objects.

NOTE - If the type of Exchanger_bundle is Tema-H shell, the number of Longitudinal_baffles is 2, if it is a Tema-G shell, the number is 1, otherwise there are none.

4.3.196 Matched_perimeter_segments to Perimeter_segment

Each Matched_perimeter_segments has as the first match exactly one Perimeter_segment. Each Perimeter_-segment is the first match in zero or one Matched_perimeter_segments.

Each Matched_perimeter_segments has as the second match exactly ne Perimeter_segment. Each Perimeter_segment is the second match in zero or one Matched_perimeter_segments.

4.3.197 Material to Process_design_property_value

Each Material has zero, one, or many Process_design_property_value objects. Each Process_design_-property_value defines property values of zero, one, or many Material objects.

4.3.198 Material to Referenced_object

Each Material is zero or one Referenced_object. Each Referenced_object may be exactly one Material.

4.3.199 Material_amount to Process_simulation

Each Material_amount may be part of inventory of zero or one Process_simulation. Each Process_-simulation contains inventory of zero, one, or many Material_amount objects.

4.3.200 Material_amount to Process_unit_operation

Each Material_amount may be part of inventory of exactly one Process_unit_operation. Each Process_-unit_operation contains inventory of zero, one, or many Material_amount objects.

4.3.201 Material_amount_phase to Material_amount

Each Material_amount_phase is phase of exactly one Material_amount. Each Material_amount has as phase zero, one, or many Material_amount_phase objects.

4.3.202 Material_amount_reference_time to Material_amount

Each Material_amount_reference_time is the time reference for exactly one Material_amount. Each Material_amount has time reference of zero, one, or many Material_amount_reference_time objects.

4.3.203 Material_amount_reference_time to Process_design_property_value

Each Material_amount_reference_time has property of zero, one, or many Process_design_property_value objects. Each Process_design_property_value is applicable at zero or one Material_amount_reference_time.

4.3.204 Material_amount_reference_time to Time_reference

Each Material_amount_reference_time has assigned exactly one Time_reference. Each Time_reference is assigned to zero, one, or many Material_amount_reference_time objects.

4.3.205 Material_characterization to Process_material

Each Material_characterization characterizes exactly one Process_material. Each Process_material is characterized by zero, one, or many Material_characterization objects.

4.3.206 Material_characterization to Substance

Each Material_characterization is characterized by exactly one Substance. Each Substance characterizes zero or one Material_characterization.

4.3.207 Material_cost to Process_material

Each Material_cost is cost point of exactly one Process_material. Each Process_material has as cost point zero, one, or many Material_cost objects.

4.3.208 Material_cost to Site

Each Material_cost has as the location exactly one Site. Each Site is the location for zero, one, or many Material_cost objects.

4.3.209 Material_cost to Site_standard_conditions

Each Material_cost may have as the reference condition exactly one Site_standard_conditions. Each Site_-standard_conditions is the reference condition for zero, one, or many Material_cost objects.

4.3.210 Material_cost to Thermodynamic_conditions

Each Material_cost may have temperature and pressure of exactly one Thermodynamic_conditions. Each Thermodynamic_conditions is temperature and pressure for zero, one, or many Material_cost objects.

4.3.211 Material_reference_time to Material

Each Material_reference_time is the time reference for exactly one Material. Each Material has time reference of zero, one, or many Material_reference_time objects.

4.3.212 Material_reference_time to Process_design_property_value

Each Material_reference_time has property of zero, one, or many Process_design_property_value objects. Each Process_design_property_value is applicable at zero or one Material_reference_time.

4.3.213 Material_reference_time to Time_reference

Each Material_reference_time has assigned exactly one Time_reference. Each Time_reference is assigned to zero, one, or many Material_reference_time objects.

4.3.214 Material_stream to Distillation_stage_phase

Each Material_stream may be feed of exactly one Distillation_stage_phase. Each Distillation_stage_phase has as feed zero, one, or many Material_stream objects.

4.3.215 Material_stream to Site_standard_conditions

Each Material_stream may have as reference for standard volume exactly one Site_standard_conditions. Each Site_standard_conditions is reference for standard volume for zero or one Material_stream.

4.3.216 Material_stream to Uo_distillation_stage

Each Material_stream may be the feed of exactly one Uo_distillation_stage. Each Uo_distillation_stage has as feed zero, one, or many Material_stream objects.

4.3.217 Material_stream_phase to Material_stream

Each Material_stream_phase is a phase of exactly one Material_stream. Each Material_stream has as a phase of zero, one, or many Material_stream_phase objects.

4.3.218 Mechanical_seal to Centrifugal_pump

Each Mechanical_seal is a component of exactly one Centrifugal_pump. Each Centrifugal_pump has as a component exactly one Mechanical_seal.

4.3.219 Mechanical_seal to Fluid_transfer_machine

Each Mechanical_seal is the shaft seal component for exactly one Fluid_transfer_machine. Each Fluid_-transfer_machine has as the shaft seal component zero, one, or many Mechanical_seal objects.

4.3.220 Noise_specification to Plant_item

Each Noise_specification is associated with exactly one Plant_item. Each Plant_item has zero or one Noise_specification.

4.3.221 Nozzle to Material_port

Each Nozzle is a nozzle for exactly one Material_port. Each Material_port has zero or one Nozzle.

4.3.222 Nozzle_dome to Exchanger_nozzle

Each Nozzle_dome belongs to exactly one Exchanger_nozzle. Each Exchanger_nozzle exactly one Nozzle_dome.

4.3.223 Nozzle_location_for_pv_cyl_section to Cylindrical_pv_cylinder_section

Each Nozzle_location_for_pv_cyl_section is attachment of exactly one Cylindrical_pv_cylinder_section. Each Cylindrical_pv_cylinder_section has as attachments of zero, one, or many Nozzle_location_for_pv_-cyl_section objects.

4.3.224 Nozzle_location_for_pv_cyl_section to Nozzle_section

Each Nozzle_location_for_pv_cyl_section has as child part exactly one Nozzle_section. Each Nozzle_section is child part for zero or one Nozzle_location_for_pv_cyl_section.

4.3.225 Nozzle_location_for_pv_head_section to Cylindrical_pv_head_section

Each Nozzle_location_for_pv_head_section is attachment of exactly one Cylindrical_pv_head_section. Each Cylindrical_pv_head_section has as attachments of zero, one, or many Nozzle_location_for_pv_head_section objects.

4.3.226 Nozzle_location_for_pv_head_section to Nozzle_section

Each Nozzle_location_for_pv_head_section has as child part exactly one Nozzle_section. Each Nozzle_section is child part for zero or one Nozzle_location_for_pv_head_section.

4.3.227 Nozzle_performance to Exchanger_nozzle

Each Nozzle_performance may be the performance for exactly one Exchanger_nozzle. Each Exchanger_nozzle has performance of zero or one Nozzle_performance.

4.3.228 Nozzle_performance to Exchanger_performance

Each Nozzle_performance describes exactly one Exchanger_performance. Each Exchanger_performance has zero, one, or many Nozzle_performance objects.

4.3.229 Nozzle_section to Construction_material

Each Nozzle_section may be made from exactly one Construction_material. Each Construction_material is used to make zero, one, or many Nozzle_section objects.

4.3.230 Nozzle_section to External_treatment

Each Nozzle_section may have as treatment exactly one External_treatment. Each External_treatment is treatment for zero, one, or many Nozzle_section objects.

4.3.231 Nozzle_section to Nozzle

Each Nozzle_section may be ordered component for exactly one Nozzle. Each Nozzle has as ordered components zero, one, or many Nozzle_section objects.

4.3.232 Nozzle_section to Nozzle_section_connection

Each Nozzle_section is a section for zero, one, or many Nozzle_section_connection objects. Each Nozzle_-section_connection has as section exactly two Nozzle_section objects.

4.3.233 Nozzle_section_connection to Gasket

Each Nozzle_section_connection may contain exactly one Gasket. Each Gasket is part of zero, one, or many Nozzle_section_connection objects.

4.3.234 Packaging to Plant_item

Each Packaging is associated with exactly one Plant_item. Each Plant_item has zero or one Packaging.

4.3.235 Pad_and_pad_stack to Demister_pad

Each Pad_and_pad_stack is the stack for exactly one Demister_pad. Each Demister_pad is in the stack of zero or one Pad_and_pad_stack.

4.3.236 Pad_and_pad_stack to Demister_pad_stack

Each Pad_and_pad_stack is the pads for exactly one Demister_pad_stack. Each Demister_pad_stack has as pads one or more Pad_and_pad_stack objects.

4.3.237 Particle_fraction to Psd_values

Each Particle_fraction is part of ordered distribution of exactly one Psd_values. Each Psd_values has ordered distribution of zero, one, or many Particle_fraction objects.

4.3.238 Particle_size to Particle_size_distribution

Each Particle_size specifies ordered intervals of exactly one Particle_size_distribution. Each Particle_size_-distribution has ordered intervals specified by one or more Particle_size objects.

4.3.239 Passlane to Exchanger_bundle

Each Passlane belongs to exactly one Exchanger_bundle. Each Exchanger_bundle has zero or one Passlane.

4.3.240 Pattern to Perforation_shape

Each Pattern is the pattern for one or more Perforation_shape objects. Each Perforation_shape describes the perforations for zero, one, or many Pattern objects.

4.3.241 Perforation_cover to Perforation_cover_shape

Each Perforation_cover may be described by exactly one Perforation_cover_shape. Each Perforation_-cover_shape describes zero, one, or many Perforation_cover objects.

4.3.242 Perforation_cover_shape to Active_area_shape

Each Perforation_cover_shape describes the cover for exactly one Active_area_shape. Each Active_area_-shape has as the cover description zero, one, or many Perforation_cover_shape objects.

4.3.243 Performance_curve to Plant_item

Each Performance_curve may be of exactly one Plant_item. Each Plant_item has as curve zero, one, or many Performance_curve objects.

4.3.244 Performance_curve to Process_service

Each Performance_curve may be the curve for exactly one Process_service. Each Process_service has as a curve zero, one, or many Performance_curve objects.

4.3.245 Performance_curve to Process_unit_operation

Each Performance_curve may be for exactly one Process_unit_operation. Each Process_unit_operation has as curve zero, one, or many Performance_curve objects.

4.3.246 Performance_map_curve to Performance_curve

Each Performance_map_curve is family of exactly one Performance_curve. Each Performance_curve is part of dependent curve family of zero or one Performance_map_curve.

4.3.247 Performance_map_curve to Performance_map

Each Performance_map_curve is part of exactly one Performance_map. Each Performance_map consists of zero, one, or many Performance_map_curve objects.

4.3.248 Performance_map_curve to Process_design_property_value_usage

Each Performance_map_curve uses exactly one Process_design_property_value_usage. Each Process_-design_property_value_usage may be used by exactly one Performance_map_curve.

4.3.249 Performance_point to Process_design_property_value_usage

Each Performance_point uses one or more Process_design_property_value_usage objects. Each Process_-design_property_value_usage may be used by exactly one Performance_map_curve. For each Performance_point, exactly one of the Process_design_property_value_usage objects is an independent value and all of the others are dependent values.

4.3.250 Performance_point to Simple_performance_curve

Each Performance_point is part of exactly one Simple_performance_curve. Each Simple_performance_-curve consists of zero, one, or many Performance_point objects.

4.3.251 Perimeter to Active_area_shape

Each Perimeter may bound exactly one Active_area_shape. Each Active_area_shape is bounded by zero or one Perimeter.

4.3.252 Perimeter to Blinding_strip_shape

Each Perimeter may bound exactly one Blinding_strip_shape. Each Blinding_strip_shape is bounded by zero or one Perimeter.

4.3.253 Perimeter to Bubble_slot_shape

Each Perimeter may bound exactly one Bubble_slot_shape. Each Bubble_slot_shape is bounded by zero or one Perimeter.

4.3.254 Perimeter to Cap_shape

Each Perimeter may bound the cap base of exactly one Cap_shape. Each Cap_shape has the cap base bounded by zero or one Perimeter.

4.3.255 Perimeter to Disengaging_panel_opening_shape

Each Perimeter may bound exactly one Disengaging_panel_opening_shape. Each Disengaging_panel_-opening_shape is bounded by zero or one Perimeter.

4.3.256 Perimeter to Downcomer_disengaging_panel_shape

Each Perimeter may bound exactly one Downcomer_disengaging_panel_shape. Each Downcomer_-disengaging_panel_shape is bounded by zero or one Perimeter.

4.3.257 Perimeter to Downcomer_liquid_flow_channel_shape

Each Perimeter may bound the bottom of the channel of exactly one Downcomer_liquid_flow_channel_-shape. Each Downcomer_liquid_flow_channel_shape has the bottom of the channel bounded by zero or one Perimeter.

Each Perimeter may bound the top of the channel of exactly one Downcomer_liquid_flow_channel_shape. Each Downcomer_liquid_flow_channel_shape has the top of the channel bounded by zero or one Perimeter.

4.3.258 Perimeter to Escape_area_shape

Each Perimeter may bound exactly one Escape_area_shape. Each scape_area_shape is bounded by zero or one Perimeter.

4.3.259 Perimeter to Perforation_shape

Each Perimeter may bound exactly one Perforation_shape. Each Perforation_shape is bounded by zero or one Perimeter.

4.3.260 Perimeter to Pressure_equalization_channel_shape

Each Perimeter may describe the cross section of exactly one Pressure_equalization_channel_shape. Each Pressure_equalization_channel_shape has the cross section described by zero or one Perimeter.

4.3.261 Perimeter to Riser_shape

Each Perimeter may bound the riser flow channel of exactly one Riser_shape. Each Riser_shape has the riser flow channel bounded by zero or one Perimeter.

Each Perimeter may bound the riser base of exactly one Riser_shape. Each Riser_shape has the riser base bounded by zero or one Perimeter.

4.3.262 Perimeter to Seal_pan_recess_shape

Each Perimeter may bound exactly one Seal_pan_recess_shape. Each Seal_pan_recess_shape is bounded by zero or one Perimeter.

4.3.263 Perimeter to Seal_pan_shape

Each Perimeter may bound exactly one Seal_pan_shape. Each Seal_pan_shape is bounded by zero or one Perimeter.

4.3.264 Perimeter to Separation_tray_shape

Each Perimeter may bound exactly one Separation_tray_shape. Each Separation_tray_shape is bounded by zero or one Perimeter.

4.3.265 Perimeter to Tray_panel_shape

Each Perimeter may bound exactly one Tray_panel_shape. Each Tray_panel_shape is bounded by zero or one Perimeter.

4.3.266 Perimeter to Tray_slot_shape

Each Perimeter may be the horizontal projection for exactly one Tray_slot_shape. Each Tray_slot_shape has as the horizontal projection zero or one Perimeter.

Each Perimeter may be the slot opening for exactly one ray_slot_shape. Each Tray_slot_shape has as the slot opening zero or one Perimeter.

4.3.267 Perimeter_segment to Curve

Each Perimeter_segment has the perimeter described by exactly one Curve. Each Curve describes the perimeter of zero, one, or many Perimeter_segment objects.

4.3.268 Perimeter_segment to Perimeter

Each Perimeter_segment is part of exactly one Perimeter. Each Perimeter consists of one or more Perimeter_segment objects.

4.3.269 PFD to Process_definition

Each Process_definition is represented by zero, one, or many PFD objects. Each PFD represents one or more Process_definition objects.

4.3.270 PFD_element to Control_element

Each PFD_element depicts zero, one, or many Control_element objects. Each Control_elements depicted by zero, one, or many PFD_element objects.

4.3.271 PFD_element to Equipment_port

Each PFD_element depicts zero, one, or many Equipment_port objects. Each Equipment_port is depicted by zero, one, or many PFD_element objects.

4.3.272 PFD_element to Item_property_reference

Each PFD_element depicts zero, one, or many Item_property_reference objects. Each Item_property_-reference is depicted by zero, one, or many PFD_element objects.

4.3.273 PFD_element to PFD_presentation_component

Each PFD_element is organized by exactly one PFD_presentation_component. Each PFD_presentation_-component organizes zero, one, or many PFD_element objects.

4.3.274 PFD_element to Process_design_property_value

Each PFD_element depicts zero, one, or many Process_design_property_value objects. Each Process_-design_property_value is depicted by zero, one, or many PFD_element objects.

4.3.275 PFD_element to Process_equipment

Each PFD_element depicts zero, one, or many Process_equipment objects. Each Process_equipment is depicted by zero, one, or many PFD_element objects.

4.3.276 PFD_element to Process_port

Each PFD_element depicts zero, one, or many Process_port objects. Each Process_port is depicted by zero, one, or many PFD_element objects.

4.3.277 PFD_element to Process_unit_operation

Each PFD_element depicts zero, one, or many Process_unit_operation objects. Each Process_unit_-operation is depicted by zero, one, or many PFD_element objects.

4.3.278 PFD_element to Stream

Each PFD_element depicts zero, one, or many Stream objects. Each Stream is depicted by zero, one, or many PFD_element objects.

4.3.279 PFD_presentation_component to PFD

Each PFD_presentation_component is part of exactly one PFD. Each PFD is comprised of one or more PFD_presentation_component objects.

4.3.280 PFD_presentation_component_composition to PFD_presentation_component

Each PFD_presentation_component_composition has as the child exactly one PFD_presentation_component. Each PFD_presentation_component is the child in zero, one, or many PFD_presentation_component_composition objects.

Each PFD_presentation_component_composition has as the parent exactly one PFD_presentation_component. Each PFD_presentation_component is the parent in zero, one, or many PFD_presentation_component_composition objects.

4.3.281 PFD_reference_time to PFD

Each PFD_reference_time is the time reference for exactly one PFD. Each PFD has time reference of zero, one, or many PFD_reference_time objects.

4.3.282 PFD_reference_time to Process_design_property_value

Each PFD_reference_time has property of zero, one, or many Process_design_property_value objects. Each Process_design_property_value is applicable at zero or one PFD_reference_time.

4.3.283 PFD_reference_time to Time_reference

Each PFD_reference_time has assigned exactly one Time_reference. Each Time_reference is assigned to zero, one, or many PFD_reference_time objects.

4.3.284 PFD_symbol_definition to PFD_curve

Each PFD_symbol_definition has zero, one, or many PFD_curve objects. Each PFD_curve is an element of zero, one, or many PFD_symbol_definition objects.

4.3.285 PFD_symbol_definition to PFD_point

Each PFD_symbol_definition has zero, one, or many PFD_point objects. Each PFD_point is an element of zero, one, or many PFD_symbol_definition objects.

4.3.286 PFD_symbol_definition to PFD_symbol_occurrence

Each PFD_symbol_definition has zero, one, or many PFD_symbol_occurrence objects. Each PFD_symbol_occurrence is an element of zero, one, or many PFD_symbol_definition objects.

4.3.287 PFD_symbol_definition to PFD_text

Each PFD_symbol_definition has zero, one, or many PFD_text objects. Each PFD_text is an element of zero, one, or many PFD_symbol_definition objects.

4.3.288 PFD_symbol_occurrence to PFD_symbol_definition

Each PFD_symbol_occurrence may be the placement of exactly one PFD_symbol_definition. Each PFD_-symbol_definition is placed on the pfd as zero, one, or many PFD_symbol_occurrence objects.

4.3.289 PFD_title_block to PFD

Each PFD_title_block defines the title information for exactly one PFD. Each PFD has title information defined in zero, one, or many PFD_title_block objects.

4.3.290 Phase to Chemical_reaction

Each Phase allows to take place zero, one, or many Chemical_reaction objects. Each Chemical_reaction may occur in zero, one, or many Phase objects.

4.3.291 Phase to Psd_values

Each Phase may be particle limiting phase for exactly one Psd_values. Each Psd_values is particle limiting phase for zero, one, or many Phase objects.

4.3.292 Phase to Process_design_property_value

Each Phase has zero, one, or many Process_design_property_value objects. Each Process_design_-property_value defines property values of zero, one, or many Phase objects.

4.3.293 Phase to Referenced_object

Each Phase is zero or one Referenced_object. Each Referenced_object may be exactly one Phase.

4.3.294 Phase to Trace_component_specification

Each Phase is applicable by zero, one, or many Trace_component_specification objects. Each Trace_-component_specification applies to zero, one, or many Phase objects.

4.3.295 Phase_distribution_coefficient to Chemical_component

Each Phase_distribution_coefficient is distribution for exactly one Chemical_component. Each Chemical_-component has distribution of zero, one, or many Phase_distribution_coefficient objects.

4.3.296 Phase_distribution_coefficient to Specific_phase

Each Phase_distribution_coefficient has heavy phase of exactly one Specific_phase. Each Specific_phase is heavy phase for zero, one, or many Phase_distribution_coefficient objects.

Each Phase_distribution_coefficient has light phase of exactly one Specific_phase. Each Specific_phase is light phase for zero, one, or many Phase_distribution_coefficient objects.

4.3.297 Phase_fraction to Bulk_thermophysical_properties

Each Phase_fraction is part of exactly one Bulk_thermophysical_properties. Each Bulk_thermophysical_-properties has as parts of zero, one, or many Phase_fraction objects.

4.3.298 Phase_fraction to Single_phase_thermophysical_properties

Each Phase_fraction has as part exactly one Single_phase_thermophysical_properties. Each Single_phase_-thermophysical_properties is part of zero, one, or many Phase_fraction objects.

4.3.299 Phase_properties to Heat_release_point

Each Phase_properties provides properties for exactly one Heat_release_point. Each Heat_release_point has zero, one, or many Phase_properties objects.

4.3.300 Phase_region to Phase

Each Phase_region may have a physical state of exactly one Phase. Each Phase is the physical state for zero, one, or many Phase_region objects.

4.3.301 Phase_region to Process_property_curve

Each Phase_region contains properties of zero, one, or many Process_property_curve objects. Each Process_property_curve has properties within zero, one, or many Phase_region objects.

4.3.302 Piping_connector to Construction_material

Each Piping_connector may be made of exactly one Construction_material. Each Construction_material is used to make zero, one, or many Piping_connector objects.

4.3.303 Plant to Process_definition

Each Plant has as definition zero, one, or many Process_definition objects. Each Process_definition defines zero, one, or many Plant objects.

4.3.304 Plant to Process_design_property_value

Each Plant has zero, one, or many Process_design_property_value objects. Each Process_design_property_-value defines property values of zero, one, or many Plant objects.

4.3.305 Plant_item to Process_definition

Each Plant_item carries out zero, one, or many Process_definition objects. Each Process_definition is carried out by zero, one, or many Plant_item objects.

4.3.306 Plant_item to Process_design_property_value

Each Plant_item has zero, one, or many Process_design_property_value objects. Each Process_design_-property_value defines property values of zero, one, or many Plant_item objects.

4.3.307 Plant_item to Referenced_object

Each Plant_item is zero or one Referenced_object. Each Referenced_object may be exactly one Plant_-item.

4.3.308 Plant_item_connector to Plant_item

Each Plant_item_connector is connector for zero, one, or many Plant_item objects. Each Plant_item has as ordered connectors of zero, one, or many Plant_item_connector objects.

4.3.309 Plant_item_group_relationship to Plant_item

Each Plant_item_group_relationship is exactly one Plant_item. Each Plant_item is a group of zero, one, or many Plant_item_group_relationship objects.

Each Plant_item_group_relationship is of exactly one Plant_item. Each Plant_item is an element in zero, one, or many Plant_item_group_relationship objects.

4.3.310 Plant_item_location to Plant_item

Each Plant_item_location locates exactly one Plant_item. Each Plant_item is located by zero, one, or many Plant_item_location objects.

4.3.311 Plant_item_reference_time to Plant_item

Each Plant_item_reference_time is the time reference for exactly one Plant_item. Each Plant_item has time reference of zero, one, or many Plant_item_reference_time objects.

4.3.312 Plant_item_reference_time to Process_design_property_value

Each Plant_item_reference_time has property of zero, one, or many Process_design_property_value objects. Each Process_design_property_value is applicable at zero or one Plant_item_reference_time.

4.3.313 Plant_item_reference_time to Time_reference

Each Plant_item_reference_time has assigned exactly one Time_reference. Each Time_reference is assigned to zero, one, or many Plant_item_reference_time objects.

4.3.314 Plant_system to Plant

Each Plant_system is part of exactly one Plant. Each Plant consists of zero, one, or many Plant_system objects.

4.3.315 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.

4.3.316 Plant_system to Process_design_property_value

Each Plant_system has zero, one, or many Process_design_property_value objects. Each Process_design_-property_value defines property values of zero, one, or many Plant_system objects.

4.3.317 Plant_system to Referenced_object

Each Plant_system is zero or one Referenced_object. Each Referenced_object may be exactly one Plant_-system.

4.3.318 Plant_system_assembly to Plant_system

Each Plant_system_assembly has as the sub-system exactly one Plant_system. Each Plant_system is the sub-system in zero, one, or many Plant_system_assembly objects.

Each Plant_system_assembly has as the super-system exactly one Plant_system. Each Plant_system is the super-system in zero, one, or many Plant_system_assembly objects.

4.3.319 Port_service_case to Equipment_port

Each Port_service_case has flow point provided by exactly one Equipment_port. Each Equipment_port is the flow point for zero, one, or many Port_service_case objects.

4.3.320 Port_service_case to Process_design_case

Each Port_service_case is part of zero, one, or many Process_design_case objects. Each Process_design_case consists of zero, one, or many Port_service_case objects.

4.3.321 Port_service_case to Process_service

Each Port_service_case is serviced by exactly one Process_service. Each Process_service is service for zero, one, or many Port_service_case objects.

4.3.322 Port_service_case to Stream

Each Port_service_case specified by exactly one Stream. Each Stream provides the specification for zero or one Port_service_case.

4.3.323 Pressure_equalization_channel_shape to Downcomer_apron_section_shape

Each Pressure_equalization_channel_shape describes the pressure equalization channel for zero, one, or many Downcomer_apron_section_shape objects. Each Downcomer_apron_section_shape has pressure equalization channel described by exactly one Pressure_equalization_channel_shape.

4.3.324 Process_control_unit to Process_train

Each Process_control_unit is part of exactly one Process_train. Each Process_train contains zero, one, or many Process_control_unit objects.

4.3.325 Process_definition to Plant_item

Each Process_definition is carried out by zero, one, or many Plant_item objects. Each Plant_item carries out zero, one, or many Process_definition objects.

4.3.326 Process_definition_reference_time to Process_definition

Each Process_definition_reference_time is the time reference for exactly one Process_definition. Each Process_definition has time reference of zero, one, or many Process_definition_reference_time objects.

4.3.327 Process_definition_reference_time to Process_design_property_value

Each Process_definition_reference_time has property of zero, one, or many Process_design_property_value objects. Each Process_design_property_value is applicable at zero or one Process_definition_reference_time.

4.3.328 Process_definition_reference_time to Time_reference

Each Process_definition_reference_time has assigned exactly one Time_reference. Each Time_reference is assigned to zero, one, or many Process_definition_reference_time objects.

4.3.329 Process_definition_relationship to Process_definition

Each Process_definition_relationship has as the related process definition exactly one Process_definition. Each Process_definition is the related process definition in zero, one, or many Process_definition_-relationship objects.

Each Process_definition_relationship has as the relating process definition exactly one Process_definition. Each Process_definition is the relating process definition in zero, one, or many Process_definition_-relationship objects.

4.3.330 Process_design_case to Conditional_property

Each Process_design_case is part of zero, one, or many Conditional_property objects. Each Conditional_-property consists of zero, one, or many Process_design_case objects.

4.3.331 Process_design_case to Conditional_property_value

Each Process_design_case is a part of zero, one, or many Conditional_property_value objects. Each Conditional_property_value consists of zero, one, or many Process_design_case objects.

4.3.332 Process_design_case to Plant_item

Each Process_design_case may be the design condition of exactly one Plant_item. Each Plant_item has design condition of zero, one, or many Process_design_case objects.

4.3.333 Process_design_case to Process_definition

Each Process_design_case may be the design condition for exactly one Process_definition. Each Process_-definition has design condition of zero, one, or many Process_design_case objects.

4.3.334 Process_design_property_curve_point_usage to Item_property_reference

Each Process_design_property_curve_point_usage may use exactly one Item_property_reference. Each Item_property_reference is used in zero, one, or many Process_design_property_curve_point_usage objects.

4.3.335 Process_design_property_curve_point_usage to Process_design_property_value

Each Process_design_property_curve_point_usage may use exactly one Process_design_property_value. Each Process_design_property_value is used in zero, one, or many Process_design_property_curve_point_usage objects.

4.3.336 Process_design_property_curve_point_usage to Process_property_curve_point

Each Process_design_property_curve_point_usage is used by exactly one Process_property_curve_point. Each Process_property_curve_point uses one or more Process_design_property_curve_point_usage objects.

4.3.337 Process_design_property_value_usage to Process_design_property_value

Each Process_design_property_value_usage uses exactly one Process_design_property_value. Each Process_design_property_value is used in zero, one, or many Process_design_property_value_usage objects.

4.3.338 Process_level to Bin_section

Each Process_level may be associated with exactly one Bin_section. Each Bin_section has zero, one, or many Process_level objects.

4.3.339 Process_level to Boot

Each Process_level may be associated with exactly one Boot. Each Boot has zero, one, or many Process_level objects.

4.3.340 Process_level to Cylindrical_pressure_vessel_section

Each Process_level may be associated with exactly one Cylindrical_pressure_vessel_section. Each Cylindrical_pressure_vessel_section has zero, one, or many Process_level objects.

4.3.341 Process_level to Process_vessel

Each Process_level may be associated with exactly one Process_vessel. Each Process_vessel has zero, one, or many Process_level objects.

4.3.342 Process_material to Material_amount

Each Process_material may be used to make exactly one Material_amount. Each Material_amount is made of exactly one Process_material.

4.3.343 Process_material to Material_stream

Each Process_material may be used to make exactly one Material_stream. Each Material_stream is made of exactly one Process_material.

4.3.344 Process_material to Specific_phase

Each Process_material may be made from exactly one Specific_phase. Each Specific_phase is made of exactly one Process_material.

4.3.345 Process_port to Equipment_port

Each Process_port has physical requirements fulfilled by zero, one, or many Equipment_port objects. Each Equipment_port fulfills physical requirements for zero, one, or many Process_port objects.

4.3.346 Process_port to Process_definition

Each Process_port is the port for one or more Process_definition objects. Each Process_definition has as a port zero, one, or many Process_port objects.

4.3.347 Process_port_connection_case to Process_port_connection

Each Process_port_connection_case is contained by exactly one Process_port_connection. Each Process_-port_connection contains one or more Process_port_connection_case objects.

4.3.348 Process_port_connection_case to Stream

Each Process_port_connection_case is exactly one Stream. Each Stream is zero or one Process_port_-connection_case objects.

4.3.349 Process_port_stream_case to Process_port

Each Process_port_stream_case is contained by exactly one Process_port. Each Process_port contains zero, one, or many Process_port_stream_case objects.

4.3.350 Process_port_stream_case to Stream

Each Process_port_stream_case is exactly one Stream. Each Stream is zero or one Process_port_stream_-case objects.

4.3.351 Process_property_curve to Material_stream

Each Process_property_curve may be curve for exactly one Material_stream. Each Material_stream has curves of zero, one, or many Process_property_curve objects.

4.3.352 Process_property_curve to Process_material

Each Process_property_curve may be curve exactly one Process_material. Each Process_material has curves of zero, one, or many Process_property_curve objects.

4.3.353 Process_property_curve to Process_unit_operation

Each Process_property_curve may be curve for exactly one Process_unit_operation. Each Process_unit_-operation has curves of zero, one, or many Process_property_curve objects.

4.3.354 Process_property_curve to Uo_heat_exchanger_fluid

Each Process_property_curve may be heating cooling curve of exactly one Uo_heat_exchanger_fluid. Each Uo_heat_exchanger_fluid has as heating cooling curve zero or one Process_property_curve.

4.3.355 Process_simulation to Algorithm_type_parameter

Each Process_simulation has parameters of zero, one, or many Algorithm_type_parameter objects. Each Algorithm_type_parameter is parameter for one or more Process_simulation objects.

4.3.356 Process_simulation to Process_definition

Each Process_simulation simulates one or more Process_definition objects. Each Process_definition is simulated by zero, one, or many Process_simulation objects. A Simulation_centrifuge shall simulate a Uo_centrifuge. A Simulation_compressor shall simulate a Uo_compressor. A Simulation_countercurrent_-solids_decanter shall simulate a Uo_countercurrent_solids_decanter. A Simulation_crystallizer shall simulate a Uo_crystallizer. A Simulation_dissolver shall simulate a Uo_dissolver. A Simulation_-distillation_stage shall simulate a Uo_distillation_stage. A Simulation_distillation shall simulate a Uo_-distillation. A Simulation_electrostatic_precipitator shall simulate a Uo_electrostatic_precipitator. A Simulation_fabric_filter shall simulate a Uo_fabric_filter. A Simulation_flash shall simulate a Uo_flash. A Simulation_gas_solid_separator shall simulate a Uo_gas_solid_separator. A Simulation_heat_exchanger shall simulate a Uo_heat_exchanger. A Simulation_hydrocyclone shall simulate a Uo_hydrocyclone. A Simulation_liquid_solid_separator shall simulate a Uo_liquid_solid_separator. A Simulation_pipeline_node shall simulate a Uo_pipeline_node. A Simulation_pipeline shall simulate a Uo_pipeline. A Simulation_-

polytropic_compressor shall simulate a Uo_compressor. A Simulation_polytropic_compressor_stage shall simulate a Uo_compressor_stage. A Simulation_rotary_filter shall simulate a Uo_rotary_filter. A Simulation_unit_operation shall simulate a Process_unit_operation.

4.3.357 Process_simulation_reference_time to Process_design_property_value

Each Process_simulation_reference_time has property of zero, one, or many Process_design_property_-value objects. Each Process_design_property_value is applicable at zero or one Process_simulation_-reference_time.

4.3.358 Process_simulation_reference_time to Process_simulation

Each Process_simulation_reference_time is the time reference for exactly one Process_simulation. Each Process_simulation has time reference of zero, one, or many Process_simulation_reference_time objects.

4.3.359 Process_simulation_reference_time to Time_reference

Each Process_simulation_reference_time has assigned exactly one Time_reference. Each Time_reference is assigned to zero, one, or many Process_simulation_reference_time objects.

4.3.360 Process_simulation_relationship to Process_simulation

Each Process_simulation_relationship has a related simulation of exactly one Process_simulation. Each Process_simulation is the related simulation in zero, one, or many Process_simulation_relationship objects.

Each Process_simulation_relationship has a relating simulation of exactly one Process_simulation. Each Process_simulation is the relating simulation in zero, one, or many Process_simulation_relationship objects.

4.3.361 Process_vessel to External_treatment

Each Process_vessel may have as treatment exactly one External_treatment. Each External_treatment is treatment for zero, one, or many Process_vessel objects.

4.3.362 Property_data_group to Property_data_set

Each Property_data_group contains one or more Property_data_set objects. Each Property_data_set is contained in zero, one, or many Property_data_group objects.

4.3.363 Property_data_set to Citation

Each Property_data_set may have as a reference exactly one Citation. Each Citation is a reference for zero, one, or many Property_data_set objects.

4.3.364 Property_data_set to Specific_equation_group

Each Property_data_set may be generated by exactly one Specific_equation_group. Each Specific_-equation_group generates zero, one, or many Property_data_set objects.

4.3.365 Psd_values to Material_amount

Each Psd_values may be psd values of exactly one Material_amount. Each Material_amount has psd values of zero, one, or many Psd_values objects.

4.3.366 Psd_values to Material_stream

Each Psd_values may be psd values of exactly one Material_stream. Each Material_stream has psd values of zero, one, or many Psd_values objects.

4.3.367 Psd_values to Particle_size_distribution

Each Psd_values has intervals specified by exactly one Particle_size_distribution. Each Particle_size_-distribution specifies intervals for zero, one, or many Psd_values objects.

4.3.368 Pump_casing to Centrifugal_pump

Each Pump_casing is a component of exactly one Centrifugal_pump. Each Centrifugal_pump has as a component exactly one Pump_casing.

4.3.369 Pump_casing_test to Pump_casing

Each Pump_casing_test is the casing test for exactly one Pump_casing. Each Pump_casing has zero, one, or many Pump_casing_test objects.

4.3.370 Pump_gland to Centrifugal_pump

Each Pump_gland is component of exactly one Centrifugal_pump. Each Centrifugal_pump has as a component exactly one Pump_gland.

4.3.371 Pump_gland_taps to Pump_gland

Each Pump_gland_taps is part of exactly one Pump_gland. Each Pump_gland has zero, one, or many Pump_gland_taps objects.

4.3.372 Pump_impeller to Centrifugal_pump

Each Pump_impeller is a component of exactly one Centrifugal_pump. Each Centrifugal_pump has as a component exactly one Pump_impeller.

4.3.373 Pump_packing to Centrifugal_pump

Each Pump_packing is a component of exactly one Centrifugal_pump. Each Centrifugal_pump is a component of exactly one Pump_packing.

4.3.374 Radial_bearing to Fluid_transfer_machine

Each Radial_bearing is a component of exactly one Fluid_transfer_machine. Each Fluid_transfer_machine has as a component zero, one, or many Radial_bearing objects.

4.3.375 Reaction_parametric_data to Chemical_reaction

Each Reaction_parametric_data is the data set for exactly one Chemical_reaction. Each Chemical_reaction has as a data set zero, one, or many Reaction_parametric_data objects.

4.3.376 Reaction_rate to Chemical_reaction

Each Reaction_rate is the rate for exactly one Chemical_reaction. Each Chemical_reaction has as a rate zero, one, or many Reaction_rate objects.

4.3.377 Reaction_rate to Phase

Each Reaction_rate is the rate for exactly one Phase. Each Phase has a rate defined by zero, one, or many Reaction_rate objects.

4.3.378 Reaction_rate to Process_design_property_value

Each Reaction_rate has zero, one, or many Process_design_property_value objects. Each Process_design_-property_value defines property values of zero, one, or many Reaction_rate objects.

4.3.379 Reaction_rate to Referenced_object

Each Reaction_rate is zero or one Referenced_object. Each Referenced_object may be exactly one Reaction_rate.

4.3.380 Reaction_rate to Substance

Each Reaction_rate has as key component exactly one Substance. Each Substance is the key component for zero, one, or many Reaction_rate objects.

4.3.381 Reactor_yield to Phase

Each Reactor_yield is rate for exactly one Phase. Each Phase has rate of zero, one, or many Reactor_yield objects.

4.3.382 Reactor_yield to Substance

Each Reactor_yield has substance exactly one Substance. Each Substance is substance for zero, one, or many Reactor_yield objects.

4.3.383 Reactor_yield to Uo_specified_yield_reactor

Each Reactor_yield is yield for exactly one Uo_specified_yield_reactor. Each Uo_specified_yield_reactor has as yield zero, one, or many Reactor_yield objects.

4.3.384 Reboiler_piping to Exchanger_assembly

Each Reboiler_piping belongs to exactly one Exchanger_assembly. Each Exchanger_assembly has zero or one Reboiler_piping.

4.3.385 Reciprocating_compressor_stage to Reciprocating_compressor

Each Reciprocating_compressor_stage is a component stage for exactly one Reciprocating_compressor. Each Reciprocating_compressor has as a component stage zero, one, or many Reciprocating_compressor_-stage objects.

4.3.386 Reference_state_variable_relationship to Variable

Each Reference_state_variable_relationship is defined by exactly one Variable. Each Variable defines zero, one, or many Reference_state_variable_relationship objects.

4.3.387 Reference_state_variable_relationship to Reference_state

Each Reference_state_variable_relationship is variable of exactly one Reference_state. Each Reference_-state has variables of zero, one, or many Reference_state_variable_relationship objects.

4.3.388 Reference_time_relationship to Time_reference

Each Reference_time_relationship has as the preceding time exactly one Time_reference. Each Time_-reference is the preceding time in zero, one, or many Reference_time_relationship objects.

Each Reference_time_relationship has as the succeeding time exactly one Time_reference. Each Time_-reference is the succeeding time in zero, one, or many Reference_time_relationship objects.

4.3.389 Relative_time_reference to Absolute_time_reference

Each Relative_time_reference may have as the basis exactly one Absolute_time_reference. Each Absolute_time_reference is the basis for zero, one, or many Relative_time_reference objects.

4.3.390 Riser_and_tray_panel_shape to Riser_shape

Each Riser_and_tray_panel_shape has the riser described by exactly one Riser_shape. Each Riser_shape describes the riser for one or more Riser_and_tray_panel_shape objects.

4.3.391 Riser_and_tray_panel_shape to Tray_panel_shape

Each Riser_and_tray_panel_shape describes the riser for exactly one Tray_panel_shape. Each Tray_panel_-shape has as the riser description zero or one Riser_and_tray_panel_shape.

4.3.392 Riser_shape to Bubble_cap_shape

Each Riser_shape is part of exactly one Bubble_cap_shape. Each Bubble_cap_shape consists of exactly one Riser_shape.

4.3.393 Seal_pan to Seal_pan_shape

Each Seal_pan may be described by exactly one Seal_pan_shape. Each Seal_pan_shape describes zero, one, or many Seal_pan objects.

4.3.394 Seal_pan_recess_shape to Seal_pan_shape

Each Seal_pan_recess_shape describes the recess for exactly one Seal_pan_shape. Each Seal_pan_shape has recess described by zero, one, or many Seal_pan_recess_shape objects.

4.3.395 Seal_pan_shape to Separation_tray_shape

Each Seal_pan_shape is part of exactly one Separation_tray_shape. Each Separation_tray_shape consists of zero, one, or many Seal_pan_shape objects.

4.3.396 Stream_separation_specification to Site_standard_conditions

Each Stream_separation_specification may have as reference for standard volume exactly one Site_-standard_conditions. Each Site_standard_conditions is reference for standard volume for zero or one Stream_separation_specification.

4.3.397 Separation_tower_internal to Cylindrical_pressure_vessel

Each Separation_tower_internal may be part of exactly one Cylindrical_pressure_vessel. Each Cylindrical_-pressure_vessel has internally zero, one, or many Separation_tower_internal objects.

4.3.398 Separation_tower_internal to Cylindrical_pressure_vessel_section

Each Separation_tower_internal is contained within zero, one, or many Cylindrical_pressure_vessel_section objects. Each Cylindrical_pressure_vessel_section contains zero or one Separation_tower_internal.

4.3.399 Separation_tower_internal to Separation_tower

Each Separation_tower_internal may be part of exactly one Separation_tower. Each Separation_tower has as part of it zero, one, or many Separation_tower_internal objects.

4.3.400 Separation_tray to Separation_efficiency

Each Separation_tray may have as the efficiency exactly one Separation_efficiency. Each Separation_-efficiency is the efficiency for zero, one, or many Separation_tray objects.

4.3.401 Separation_tray to Separation_tray_hydraulics

Each Separation_tray may have as the hydraulics exactly one Separation_tray_hydraulics. Each Separation_tray_hydraulics is the hydraulics for zero, one, or many Separation_tray objects.

4.3.402 Separation_tray to Separation_tray_shape

Each Separation_tray may be described by exactly one Separation_tray_shape. Each Separation_tray_shape describes zero, one, or many Separation_tray objects.

4.3.403 Separation_tray_baffle to Separation_tray_baffle_shape

Each Separation_tray_baffle may be described by exactly one Separation_tray_baffle_shape. Each Separation_tray_baffle_shape describes zero, one, or many Separation_tray_baffle objects.

4.3.404 Separation_tray_baffle_shape to Separation_tray_shape

Each Separation_tray_baffle_shape is part of exactly one Separation_tray_shape. Each Separation_tray_-shape consists of zero, one, or many Separation_tray_baffle_shape objects.

4.3.405 Separation_tray_component to Separation_tray

Each Separation_tray_component is a component of exactly one Separation_tray. Each Separation_tray has as components one or more Separation_tray_component objects.

4.3.406 Separation_tray_structural_component to Separation_tray

Each Separation_tray_structural_component is part of exactly one Separation_tray. Each Separation_tray contains zero, one, or many Separation_tray_structural_component objects.

4.3.407 Service_connections to Fluid_transfer_machine

Each Service_connections is a component of exactly one Fluid_transfer_machine. Each Fluid_transfer_-machine has as a component exactly one Service_connections.

4.3.408 Shaft to Fluid_transfer_machine

Each Shaft is a component of exactly one Fluid_transfer_machine. Each Fluid_transfer_machine has as a component exactly one Shaft.

4.3.409 Shell_and_tube_heat_exchanger_unit to Exchanger_design_criteria

Each Shell_and_tube_heat_exchanger_unit has exactly one Exchanger_design_criteria. Each Exchanger_-design_criteria is the criteria for zero, one, or many Shell_and_tube_heat_exchanger_unit objects.

4.3.410 Shell_and_tube_heat_exchanger_unit to Exchanger_performance

Each Shell_and_tube_heat_exchanger_unit has zero, one, or many Exchanger_performance objects. Each Exchanger_performance is the performance for zero, one, or many Shell_and_tube_heat_exchanger_unit.

4.3.411 Shellside_performance to Exchanger_performance

Each Shellside_performance describes exactly one Exchanger_performance. Each Exchanger_performance has exactly one Shellside_performance.

4.3.412 Simulation_polytropic_compressor_stage to Simulation_polytropic_-compressor

Each Simulation_polytropic_compressor_stage is stage of exactly one Simulation_polytropic_compressor. Each Simulation_polytropic_compressor has as stages zero, one, or many Simulation_polytropic_-compressor_stage objects.

4.3.413 Single_phase_thermophysical_properties to Material_amount

Each Single_phase_thermophysical_properties may be phase property of exactly one Material_amount. Each Material_amount has phase properties of zero, one, or many Single_phase_thermophysical_properties objects.

4.3.414 Single_phase_thermophysical_properties to Material_stream

Each Single_phase_thermophysical_properties may be phase property of exactly one Material_stream. Each Material_stream has phase properties zero, one, or many Single_phase_thermophysical_properties objects.

4.3.415 Single_phase_thermophysical_properties to Mixture

Each Single_phase_thermophysical_properties may be composition data of exactly one Mixture. Each Mixture has composition data of zero, one, or many Single_phase_thermophysical_properties objects.

4.3.416 Single_phase_thermophysical_properties to Phase

Each Single_phase_thermophysical_properties has phase of exactly one Phase. Each Phase is phase of zero, one, or many Single_phase_thermophysical_properties objects.

4.3.417 Single_phase_thermophysical_properties to Specific_phase

Each Single_phase_thermophysical_properties may be phase property of exactly one Specific_phase. Each Specific_phase has phase properties of zero, one, or many Single_phase_thermophysical_properties objects.

4.3.418 Site to Process_design_property_value

Each Site has zero, one, or many Process_design_property_value objects. Each Process_design_property_-value defines property values of zero, one, or many Site objects.

4.3.419 Site to Referenced_object

Each Site is zero or one Referenced_object. Each Referenced_object may be exactly one Site.

4.3.420 Site_ambient_condition to Control_measurement_module

Each Site_ambient_condition is measured by zero, one, or many Control_measurement_module objects. Each Control_measurement_module measures zero, one, or many Site_ambient_condition objects.

4.3.421 Site_ambient_condition to Site

Each Site_ambient_condition is the condition for exactly one Site. Each Site has conditions of zero, one, or many Site_ambient_condition objects.

4.3.422 Site_standard_conditions to Site

Each Site_standard_conditions has as custody transfer exactly one Site. Each Site is the custody transfer for zero, one, or many Site_standard_conditions objects.

4.3.423 Site_utility_service to Site

Each Site_utility_service is the utility services for exactly one Site. Each Site has utility services of zero, one, or many Site_utility_service objects.

4.3.424 Sited_plant to Plant

Each Sited_plant is exactly one Plant. Each Plant is used as zero, one, or many Sited_plant objects.

4.3.425 Sited_plant to Site

Each Sited_plant is located on exactly one Site. Each Site has located on it one or more Sited_plant objects.

4.3.426 Space_requirements to Plant_item

Each Space_requirements is for exactly one Plant_item. Each Plant_item has zero, one, or many Space_-requirements objects.

4.3.427 Spare_item_relationship to Plant_item

Each Spare_item_relationship is in-service for exactly one Plant_item. Each Plant_item is in-service item for zero, one, or many Spare_item_relationship objects.

Each Spare_item_relationship is space for exactly one Plant_item. Each Plant_item is spare item for zero, one, or many Spare_item_relationship objects.

4.3.428 Specific_equation to Citation

Each Specific_equation has as a reference exactly one Citation. Each Citation is a reference for zero, one, or many Specific_equation objects.

4.3.429 Specific_equation to Equation_definition

Each Specific_equation is defined by exactly one Equation_definition. Each Equation_definition defines zero, one, or many Specific_equation objects.

4.3.430 Specific_equation to Phase

Each Specific_equation is equation for exactly one Phase. Each Phase has equation of zero, one, or many Specific_equation objects.

4.3.431 Specific_equation to Specific_equation_group

Each Specific_equation is a part of zero, one, or many Specific_equation_group objects. Each Specific_-equation_group consists of zero, one, or many Specific_equation objects.

4.3.432 Specific_equation_group to Equation_group

Each Specific_equation_group is part of exactly one Equation_group. Each Equation_group has as part zero, one, or many Specific_equation_group objects.

4.3.433 Specific_phase to Phase

Each Specific_phase may have physical state of exactly one Phase. Each Phase is physical state for zero, one, or many Specific_phase objects.

4.3.434 Specific_phase to Phase_equilibrium_relationship

Each Specific_phase may be in equilibrium in exactly one Phase_equilibrium_relationship. Each Phase_-equilibrium_relationship has as phases in equilibrium zero, one, or many Specific_phase objects.

4.3.435 Specific_phase to Phase_region

Each Specific_phase may contain points of exactly one Phase_region. Each Phase_region has points within zero, one, or many Specific_phase objects.

4.3.436 Specific_phase to Process_design_property_value

Each Specific_phase has zero, one, or many Process_design_property_value objects. Each Process_-design_property_value defines property values of zero, one, or many Specific_phase objects.

4.3.437 Specific_phase to Process_material

Each Specific_phase is made from exactly one Process_material. Each Process_material is used to make zero or one Specific_phase.

4.3.438 Specific_phase to Referenced_object

Each Specific_phase is zero or one Referenced_object. Each Referenced_object may be exactly one Specific_phase.

4.3.439 Spheroidal_pressure_vessel to Bounded_curve

Each Spheroidal_pressure_vessel has outside shape of exactly one Bounded_curve. Each Bounded_curve is outside shape of zero, one, or many Spheroidal_pressure_vessel objects.

4.3.440 Stage_column_section to Uo_distillation

Each Stage_column_section is section of exactly one Uo_distillation. Each Uo_distillation has as sections zero, one, or many Stage_column_section objects.

4.3.441 Stoichiometry to Chemical_reaction

Each Stoichiometry is the stoichiometry for exactly one Chemical_reaction. Each Chemical_reaction has zero, one, or many Stoichiometry objects.

4.3.442 Stoichiometry to Substance

Each Stoichiometry is the stoichiometry for exactly one Substance. Each Substance has as a stoichiometry zero, one, or many Stoichiometry objects.

4.3.443 Stream to Process_design_property_value

Each Stream has zero, one, or many Process_design_property_value objects. Each Process_design_-property_value defines property values of zero, one, or many Stream objects.

4.3.444 Stream to Process_simulation

Each Stream may be simulated by exactly one Process_simulation.
Each Process_simulation simulates zero, one, or many Stream objects.

4.3.445 Stream to Referenced_object

Each Stream is zero or one Referenced_object. Each Referenced_object may be exactly one Stream.

4.3.446 Stream to Stream_convergence_block

Each Stream is affected by zero, one, or many Stream_convergence_block objects. Each Stream_-convergence_block affects zero, one, or many Stream objects.

Each Stream is tear stream for zero, one, or many Stream_convergence_block objects. Each Stream_-convergence_block has tear streams of zero, one, or many Stream objects.

4.3.447 Stream to Variable_convergence_block

Each Stream is affected by zero, one, or many Variable_convergence_block objects. Each Variable_-convergence_block affects zero, one, or many Stream objects.

4.3.448 Stream_convergence_block to Simulation_block

Each Stream_convergence_block has ordered block sequence of zero, one, or many Simulation_block objects. Each Simulation_block is in block sequence for zero, one, or many Stream_convergence_block objects.

4.3.449 Stream_reference_time to Process_design_property_value

Each Stream_reference_time has property of zero, one, or many Process_design_property_value objects. Each Process_design_property_value is applicable at zero or one Stream_reference_time.

4.3.450 Stream_reference_time to Stream

Each Stream_reference_time is the time reference for exactly one Stream. Each Stream has time reference of zero, one, or many Stream_reference_time objects.

4.3.451 Stream_reference_time to Time_reference

Each Stream_reference_time has assigned exactly one Time_reference. Each Time_reference is assigned to zero, one, or many Stream_reference_time objects.

4.3.452 Stream_separation_specification to Material_stream

Each Stream_separation_specification may have inlet of exactly one Material_stream. Each Material_-stream is inlet for zero, one, or many Stream_separation_specification objects.

4.3.453 Stream_separation_specification to Material_stream_phase

Each Stream_separation_specification may have outlet of exactly one Material_stream_phase.
Each Material_stream_phase is outlet for zero, one, or many Stream_separation_specification objects.

4.3.454 Stream_separation_specification to Site_standard_conditions

Each Stream_separation_specification may have reference of exactly one Site_standard_conditions. Each Site_standard_conditions is reference for standard volume zero, one, or many Stream_separation_-specification objects.

4.3.455 Stream_separation_specification to Substance

Each Stream_separation_specification specifies exactly one Substance. Each Substance is substance for zero, one, or many Stream_separation_specification objects.

4.3.456 Stream_separation_specification to Uo_substance_splitter

Each Stream_separation_specification is specification for exactly one Uo_substance_splitter. Each Uo_-substance_splitter has as specification zero, one, or many Stream_separation_specification objects.

4.3.457 Stream_split_specification to Material_stream

Each Stream_split_specification may have inlet of exactly one Material_stream. Each Material_stream is inlet for zero, one, or many Stream_split_specification objects.

Each Stream_split_specification has outlet of exactly one Material_stream. Each Material_stream is outlet for zero, one, or many Stream_split_specification objects.

4.3.458 Stream_split_specification to Site_standard_conditions

Each Stream_split_specification may have as reference for standard volume exactly one Site_standard_-conditions. Each Site_standard_conditions is reference for standard volume for zero or one Stream_split_-specification.

4.3.459 Stream_split_specification to Uo_stream_splitter

Each Stream_split_specification is specification for exactly one Uo_stream_splitter. Each Uo_stream_-splitter has as specification zero, one, or many Stream_split_specification objects.

4.3.460 Sub_plant_relationship to Plant

Each Sub_plant_relationship is contained within exactly one Plant. Each Plant contains zero, one, or many Sub_plant_relationship objects.

Each Sub_plant_relationship has as the sub-plant exactly one Plant. Each Plant is used in zero, one, or many Sub_plant_relationship objects.

4.3.461 Substance to Particle_size_distribution

Each Substance has psd of zero, one, or many Particle_size_distribution objects. Each Particle_size_-distribution is psd for one or more Substance objects.

4.3.462 Substance to Process_design_property_value

Each Substance has zero, one, or many Process_design_property_value objects. Each Process_design_-property_value defines property values of zero, one, or many Substance objects.

4.3.463 Substance to Referenced_object

Each Substance is zero or one Referenced_object. Each Referenced_object may be exactly one Substance.

4.3.464 Substance to Trace_component_specification

Each Substance is considered by zero, one, or many Trace_component_specification objects. Each Trace_-component_specification considers zero, one, or many Substance objects.

4.3.465 Substance_name to Substance

Each Substance_name is alias for zero, one, or many Substance objects. Each Substance has as alias zero, one, or many Substance_name objects.

4.3.466 Thermo_property_option to Process_simulation

Each Thermo_property_option may be a default value of exactly one Process_simulation. Each Process_-simulation has default values of one or more Thermo_property_option objects.

4.3.467 Thermo_property_option to Thermo_property_method

Each Thermo_property_option has method of exactly one Thermo_property_method. Each Thermo_property_method is method for zero, one, or many Thermo_property_option objects.

4.3.468 Thermodynamic_condition to Material_amount

Each Thermodynamic_condition may be for exactly one Material_amount. Each Material_amount is at exactly one Thermodynamic_condition.

4.3.469 Thermodynamic_condition to Material_stream

Each Thermodynamic_condition may be for exactly one Material_stream. Each Material_stream is at exactly one Thermodynamic_condition.

4.3.470 Thermodynamic_condition to Process_design_property_value

Each Thermodynamic_condition has zero, one, or many Process_design_property_value objects. Each Process_design_property_value defines property values of zero, one, or many Thermodynamic_condition objects.

4.3.471 Thermodynamic_condition to Process_property_curve

Each Thermodynamic_condition may be fixed TPH value for exactly one Process_property_curve. Each Process_property_curve has as fixed TPH values of zero or one Thermodynamic_condition.

4.3.472 Thermodynamic_condition to Referenced_object

Each Thermodynamic_condition is zero or one Referenced_object. Each Referenced_object may be exactly one Thermodynamic_condition.

4.3.473 Thermodynamic_condition to Specific_phase

Each Thermodynamic_condition may be of exactly one Specific_phase. Each Specific_phase is at exactly one Thermodynamic_condition.

4.3.474 Thermodynamic_properties to Heat_release_point

Each Thermodynamic_properties describes exactly one Heat_release_point. Each Heat_release_point has exactly one Thermodynamic_properties.

4.3.475 Thermodynamic_properties to Reference_state

Each Thermodynamic_properties may have reference state provided by exactly one Reference_state. Each Reference_state provides reference state for zero, one, or many Thermodynamic_properties objects.

4.3.476 Thermodynamic_properties to Single_phase_thermophysical_properties

Each Thermodynamic_properties is property of exactly one Single_phase_thermophysical_properties. Each Single_phase_thermophysical_properties has properties of zero, one, or many Thermodynamic_properties objects.

4.3.477 Thermophysical_point_property to Reference_state

Each Thermophysical_point_property may have reference state provided by exactly one Reference_state. Each Reference_state provides reference state for zero, one, or many Thermophysical_point_property objects.

4.3.478 Thrust_bearing to Fluid_transfer_machine

Each Thrust_bearing is a component of exactly one Fluid_transfer_machine. Each Fluid_transfer_machine has as a component zero or one Thrust_bearing.

4.3.479 Tie_rod to Tubesheet

Each Tie_rod belongs to exactly one Tubesheet. Each Tubesheet has zero, one, or many Tie_rod objects.

If there is more than one kind of tie_rod for a given tubesheet, each individual tie_rod shall be specified. Otherwise, only one tie_rod instance shall be specified, and the count shall be specified in the number_of_tie_rods attribute.

4.3.480 Tie_rod_spacer to Tie_rod

Each Tie_rod_spacer belongs to exactly one Tie_rod. Each Tie_rod has zero, one, or many Tie_rod_spacer objects.

If there is more than one kind of Tie_rod_spacer for a given Tie_rod, each individual Tie_rod_spacer shall be specified. Otherwise, only one Tie_rod_spacer instance shall be specified, and the count shall be specified in the number_of_spacers attribute.

4.3.481 Time_reference to Clock_time

Each Time_reference may have assigned exactly one Clock_time. Each Clock_time is assigned to zero, one, or many Time_reference objects.

4.3.482 Trace_component_specification to Stream_convergence_block

Each Trace_component_specification is trace component spec for zero, one, or many Stream_-convergence_block objects. Each Stream_convergence_block has trace component spec of zero, one, or many Trace_component_specification objects.

4.3.483 Transport_properties to Bulk_thermophysical_properties

Each Transport_properties is property of exactly one Bulk_thermophysical_properties. Each Bulk_-thermophysical_properties has properties of zero or one Transport_properties.

4.3.484 Transport_properties to Single_phase_thermophysical_properties

Each Transport_properties is property of exactly one Single_phase_thermophysical_properties. Each Single_phase_thermophysical_properties has properties of zero or one Transport_properties.

4.3.485 Tray_and_tray_stack to Separation_tray

Each Tray_and_tray_stack has as the tray exactly one Separation_tray. Each Separation_tray is the tray in zero or one Tray_and_tray_stack.

4.3.486 Tray_and_tray_stack to Separation_tray_stack

Each Tray_and_tray_stack is the trays for exactly one Separation_tray_stack. Each Separation_tray_stack has as trays one or more Tray_and_tray_stack objects.

4.3.487 Tray_cascade to Curve

Each Tray_cascade may be described by exactly one Curve. Each Curve describes zero or one Tray_-cascade.

4.3.488 Tray_cascade to Separation_tray_shape

Each Tray_cascade is the cascade for exactly one Separation_tray_shape. Each Separation_tray_shape has as the cascade zero, one, or many Tray_cascade objects.

4.3.489 Tray_panel to Separation_efficiency

Each Tray_panel may have as the efficiency exactly one Separation_efficiency. Each Separation_efficiency is efficiency for zero, one, or many Tray_panel objects.

4.3.490 Tray_panel to Tray_panel_hydraulics

Each Tray_panel may have as the hydraulics exactly one Tray_panel_hydraulics. Each Tray_panel_-hydraulics is the hydraulics of zero, one, or many Tray_panel objects.

4.3.491 Tray_panel to Tray_panel_shape

Each Tray_panel may be described by exactly one Tray_panel_shape. Each Tray_panel_shape describes zero, one, or many Tray_panel objects.

4.3.492 Tray_panel_and_perforation_shape to Perforation_shape

Each Tray_panel_and_perforation_shape has the perforation described by exactly one Perforation_shape. Each Perforation_shape describes the perforation for zero, one, or many Tray_panel_and_perforation_shape objects.

4.3.493 Tray_panel_and_perforation_shape to Tray_panel_shape

Each Tray_panel_and_perforation_shape describes the perforation for exactly one Tray_panel_shape. Each Tray_panel_shape has as the perforation description zero, one, or many Tray_panel_and_perforation_shape objects.

4.3.494 Tray_panel_and_slot_shape to Tray_panel_shape

Each Tray_panel_and_slot_shape describes the slot for exactly one Tray_panel_shape. Each Tray_panel_-shape has as the slot description zero, one, or many Tray_panel_and_slot_shape objects.

4.3.495 Tray_panel_and_slot_shape to Tray_slot_shape

Each Tray_panel_and_slot_shape has the slot described by exactly one Tray_slot_shape. Each Tray_slot_-shape describes the slot for zero, one, or many one or more Tray_panel_and_slot_shape objects.

4.3.496 Tray_panel_shape to Separation_tray_shape

Each Tray_panel_shape is part of exactly one Separation_tray_shape. Each Separation_tray_shape consists of one or more Tray_panel_shape objects.

4.3.497 Tray_support to Cylindrical_pv_cylinder_section

Each Tray_support has exactly one Cylindrical_pv_cylinder_section. Each Cylindrical_pv_cylinder_section is part of zero, one, or many Tray_support objects.

4.3.498 Tray_support to Separation_tray

Each Tray_support supports exactly one Separation_tray. Each Separation_tray is supported by zero, one, or many Tray_support objects.

4.3.499 Tray_support to Tray_support_shape

Each Tray_support may be described by exactly one Tray_support_shape. Each Tray_support_shape describes zero, one, or many Tray_support objects.

4.3.500 Tube_external_characteristics to Tube_type

Each Tube_external_characteristics describes exactly one Tube_type. Each Tube_type has zero or one Tube_external_characteristics.

4.3.501 Tube_internal_characteristics to Tube_type

Each Tube_internal_characteristics describes exactly one Tube_type. Each Tube_type has zero or one Tube_internal_characteristics.

4.3.502 Tubesheet to Exchanger_bundle

Each Tubesheet belongs to exactly one Exchanger_bundle. Each Exchanger_bundle has zero, one, or many Tubesheet objects.

4.3.503 Tubesheet to Partition_seal_rod

Each Tubesheet may have exactly one Partition_seal_rod. Each Partition_seal_rod is part of zero, one, or many Tubesheet objects.

4.3.504 Tubeside_performance to Exchanger_performance

Each Tubeside_performance describes exactly one Exchanger_performance. Each Exchanger_performance has exactly one Tubeside_performance.

4.3.505 U_bend_support to Exchanger_bundle

Each U_bend_support belongs to exactly one Exchanger_bundle. Each Exchanger_bundle has zero or one U_bend_support.

4.3.506 Uo_centrifugal_compressor_stage to Uo_centrifugal_compressor

Each Uo_centrifugal_compressor_stage is stage of exactly one Uo_centrifugal_compressor. Each Uo_-centrifugal_compressor has as stage zero, one, or many Uo_centrifugal_compressor_stage objects.

4.3.507 Uo_distillation to Substance

Each Uo_distillation may have heavy key of exactly one Substance. Each Substance is heavy key for zero, one, or many Uo_distillation objects.

Each Uo_distillation may have light key of exactly one Substance. Each Substance is light key for zero, one, or many Uo_distillation objects.

4.3.508 Uo_distillation to Uo_complex_distillation

Each Uo_distillation may be a component of exactly one Uo_complex_distillation. Each Uo_complex_-distillation is composed of zero, one, or many Uo_distillation objects.

4.3.509 Uo_distillation_stage to Stage_column_section

Each Uo_distillation_stage may have section of exactly one Stage_column_section. Each Stage_column_-section is section for zero, one, or many Uo_distillation_stage objects.

4.3.510 Uo_distillation_stage to Uo_distillation

Each Uo_distillation_stage is a stage of exactly one Uo_distillation. Each Uo_distillation has as a stage zero, one, or many Uo_distillation_stage objects.

4.3.511 Uo_distillation_stage to Uo_heat_exchanger

Each Uo_distillation_stage may have external heat transfer provided by exactly one Uo_heat_exchanger. Each Uo_heat_exchanger provides external heat transfer for zero or one Uo_distillation_stage.

4.3.512 Uo_heat_exchanger_fluid to Stream

Each Uo_heat_exchanger_fluid has material or utility stream of exactly one Stream. Each Stream is the material or utility stream for zero or one Uo_heat_exchanger_fluid.

4.3.513 Uo_heat_exchanger_side to Uo_heat_exchanger

Each Uo_heat_exchanger_side is a side for exactly one Uo_heat_exchanger. Each Uo_heat_exchanger has as sides two or more Uo_heat_exchanger_side objects. Each Uo_heat_exchanger has at least one cold side and at least one hot side.

4.3.514 Uo_heat_exchanger_side to Uo_heat_exchanger_fluid

Each Heat_exchanger_side has one or more Uo_heat_exchanger_fluid objects. Each Uo_heat_exchanger_-fluid is fluid for exactly one Heat_exchanger_side.

4.3.515 Uo_pipeline_node to Uo_pipeline

Each Uo_pipeline_node is node of exactly one Uo_pipeline.
Each Uo_pipeline has as node zero, one, or many Uo_pipeline_node objects.

4.3.516 Uo_pipeline_node to Uo_pipeline_segment

Each Uo_pipeline_node may have in node exactly one Uo_pipeline_segment.
Each Uo_pipeline_segment has as in node exactly one Uo_pipeline_node.

Each Uo_pipeline_node may have as out node exactly one Uo_pipeline_segment.
Each Uo_pipeline_segment has as out node exactly one Uo_pipeline_node.

4.3.517 Uo_pipeline_segment to Uo_pipeline

Each Uo_pipeline_segment is segment of exactly one Uo_pipeline. Each Uo_pipeline has as segment zero, one, or many Uo_pipeline_segment objects.

4.3.518 Uo_positive_displacement_compressor_stage to Uo_positive_displacement_compressor

Each Uo_positive_displacement_compressor_stage is stage of exactly one Uo_positive_displacement_-compressor. Each uo_positive_displacement_compressor has as stage zero, one, or many Uo_positive_-displacement_compressor_stage objects.

4.3.519 Uo_separator to Separation_efficiency

Each Uo_separator may have as the efficiency exactly one Separation_efficiency. Each Separation_-efficiency is efficiency for zero, one, or many Uo_separator objects.

4.3.520 Uo_countercurrent_solids_decanter to Substance

Each Uo_countercurrent_solids_decanter may have heavy key of exactly one Substance. Each Substance is heavy key for zero, one, or many Uo_countercurrent_solids_decanter objects.

Each Uo_countercurrent_solids_decanter may have light key of exactly one Substance. Each Substance is light key for zero, one, or many Uo_countercurrent_solids_decanter objects.

4.3.521 Uo_solids_decanter_stage to Uo_countercurrent_solids_decanter

Each Uo_solids_decanter_stage is stage of exactly one Uo_countercurrent_solids_decanter.
Each Uo_countercurrent_solids_decanter has as stages zero, one, or many Uo_solids_decanter_stage objects.

4.3.522 User_defined_simulation_value to Process_simulation

Each User_defined_simulation_value is value for exactly one Process_simulation. Each Process_simulation has values of zero, one, or many User_defined_simulation_value objects.

4.3.523 User_defined_simulation_value to User_defined_simulation_property

Each User_defined_simulation_value is value of exactly one User_defined_simulation_property. Each User_defined_simulation_property has values of one or more User_defined_simulation_value objects.

4.3.524 User_defined_unit_operation_value to Process_unit_operation

Each User_defined_unit_operation_value is value of exactly one Process_unit_operation. Each Process_unit_operation has values of zero, one, or many User_defined_unit_operation_value objects.

4.3.525 User_defined_unit_operation_value to User_defined_unit_operation_property

Each User_defined_unit_operation_value is value of exactly one User_defined_unit_operation_property. Each User_defined_unit_operation_property has values of one or more User_defined_unit_operation_value objects.

4.3.526 Utility_service_stream_demand to Stream

Each Utility_service_stream_demand demands exactly one Stream. Each Stream is demanded by zero, one, or two Utility_service_stream_demand objects.

4.3.527 Utility_service_stream_demand to Utility_material_service

Each Utility_service_stream_demand is demanded by exactly one Utility_material_service. Each Utility_material_service has demands of zero, one, or two Utility_service_stream_demand objects.

4.3.528 Vapor_belt to Exchanger_shell

Each Vapor_belt belongs to exactly one Exchanger_shell. Each Exchanger_shell has zero or one Vapor_belt.

4.3.529 Variable_convergence_specification to Variable_convergence_block

Each Variable_convergence_specification is a specification for exactly one Variable_convergence_block. Each Variable_convergence_block has as specification of zero, one, or many Variable_convergence_specification objects.

4.3.530 Variable_value to Citation

Each Variable_value may have as a reference exactly one Citation. Each Citation is a reference for zero, one, or many Variable_value objects.

4.3.531 Variable_value to Data_entry

Each Variable_value may be the dependent variable value for exactly one Data_entry. Each Data_entry has as dependent variable values zero, one, or many Variable_value objects.

Each Variable_value may be the independent variable value for exactly one Data_entry. Each Data_entry has as independent variable values zero, one, or many Variable_value objects.

4.3.532 Variable_value to Data_quality

Each Variable_value may have quality of exactly one Data_quality. Each Data_quality is quality of zero, one, or many Variable_value objects.

4.3.533 Variable_value to Data_source

Each Variable_value may have source of exactly one Data_source. Each Data_source is source of zero, one, or many Variable_value objects.

4.3.534 Variable_value to Phase

Each Variable_value may have context of exactly one Phase. Each Phase is context for zero, one, or many Variable_value objects.

4.3.535 Variable_value to Property_note

Each Variable_value has as a note zero, one, or many Property_note objects. Each Property_note is a note for zero, one, or many Variable_value objects.

4.3.536 Variable_value to Substance

Each Variable_value has property value of exactly one Substance. Each Substance has property value zero, one, or many Variable_value objects.

4.3.537 Variable_value to Variable

Each Variable_value is value of exactly one Variable. Each Variable has values of zero, one, or many Variable_value objects.

4.3.538 Variable_value to Variable_approval_context

Each Variable_value has approval context of zero, one, or many Variable_approval_context objects. Each Variable_approval_context is context for zero, one, or many Variable_value objects.

4.3.539 Vibration_detector to Centrifugal_compressor

Each Vibration_detector may be a component of exactly one Centrifugal_compressor. Each Centrifugal_-compressor has as a component zero or one Vibration_detector.

4.3.540 Weir to Weir_shape

Each Weir may be described by exactly one Weir_shape. Each Weir_shape describes zero, one, or many Weir objects.

4.3.541 Weir_and_disengaging_panel_intersection to Downcomer_disengaging_panel_shape

Each Weir_and_disengaging_panel_intersection is intersected by exactly one Downcomer_disengaging_-panel_shape. Each Downcomer_disengaging_panel_shape intersects zero, one, or many Weir_and_-disengaging_panel_intersection objects.

4.3.542 Weir_and_disengaging_panel_intersection to Weir_shape

Each Weir_and_disengaging_panel_intersection is intersected by exactly one Weir_shape. Each Weir_-shape intersects zero or one Weir_and_disengaging_panel_intersection.

4.3.543 Weir_and_seal_pan_intersection to Seal_pan_shape

Each Weir_and_seal_pan_intersection is intersected by exactly one Seal_pan_shape. Each Seal_pan_shape intersects zero, one, or many Weir_and_seal_pan_intersection objects.

4.3.544 Weir_and_seal_pan_intersection to Weir_shape

Each Weir_and_seal_pan_intersection is intersected by exactly one Weir_shape. Each Weir_shape intersects zero or one Weir_and_seal_pan_intersection.

4.3.545 Weir_and_tray_panel_intersection to Tray_panel_shape

Each Weir_and_tray_panel_intersection is intersected by exactly one Tray_panel_shape. Each Tray_panel_-shape intersects zero, one, or many Weir_and_tray_panel_intersection objects.

4.3.546 Weir_and_tray_panel_intersection to Weir_shape

Each Weir_and_tray_panel_intersection is intersected by exactly one Weir_shape. Each Weir_shape intersects zero or one Weir_and_tray_panel_intersection.

4.3.547 Weir_shape to Separation_tray_shape

Each Weir_shape is part of exactly one Separation_tray_shape. Each Separation_tray_shape consists of zero, one, or many Weir_shape objects.

5 Application interpreted model (later)

5.1 Mapping table (later)

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).

5.2 AIM EXPRESS short listing (later)

This clause specifies the EXPRESS schema that uses elements from the integrated resources and the application interpreted constructs (AICs) and contains the types, entity specializations, rules and functions that are specific to this part of ISO 10303. This clause also specifies modifications to the textual material for constructs that are imported from the integrated resources and the AICs. The definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes which are not imported into the AIM. Requirements stated in the integrated resources which refer to such items and subtypes apply exclusively to those items which are imported into the AIM.

6 Conformance requirements

Conformance to this part of ISO 10303 includes satisfying the requirements stated in this part, the requirements of the implementation methods 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 are specified in annex C.

The protocol information conformance statement (PICS) proforma lists the conformance classes and any conformance options that may be included in the conformance statement and subsequent testing. The PICS proforma is provided in annex D.

NOTE 1 - ISO 10303-331:—[1] defines the abstract test suite to be used in the assessment of conformance. ISO 10303-32:—[1] describes the conformance assessment process.

This part of ISO 10303 specifies 10 conformance classes that may be supported by an implementation. Table 1 defines the units of functionality within each conformance class.

Conformance to a particular class requires that all AIM elements defined as part of that class be supported. Table (later) defines the classes to which each AIM element belongs. The conformance classes are characterized as follows:

Class 1: Process Overview - This class includes stream information. It is related to the following data flows between the AAM activities:

— A2111 to A2112.

Class 2: Chemical Reaction Data, Physical Property Data and Models - This class includes physical property information and chemical reaction information. It is related to the following data flows between the AAM activities:

— A2111 to A2112;

— A211212.

[1]To be published.

Class 3: Process Simulation - This class includes chemical reaction information and design models including those data elements which are required to calculate the performance of the process. It is related to the following data flows within the AAM activity:

— A21122.

Class 4: Quantities Flowsheet Information - This class includes process definition, stream, and unit_-operation information. This class is suitable to express the numeric quantities of materials in the flow stream. It is related to the following data flows between the AAM activities:

— A21122 to A21123;

— A21122 to A21124;

— A21122 to A21125;

— A21122 to A21126.

Class 5: Equipment Design Information - This class includes process material information and design information for process equipment and plant items. This includes all the data to be transferred from the simulator into the equipment design program and data produced in the equipment design program to be transferred onto equipment datasheets. It is related to the following data flows between the AAM activities:

— A21122 to A21123;

— A21123 to A21124;

— A21123 to A21125.

Class 6: Control Concept - This class includes the control requirements of the process and information on the stream and process definition. It is suitable for expressing the needed control to be designed and shown in the P&I diagrams. It is related to the following data flows between the AAM activities:

— A21125 to A22.

Classes 7: Process Flow Diagram - This class includes the association between process engineering information and the symbols on the process flow diagram and the presentation of these symbols on schematics. (Note: This class requires further definition.)

It is related to the following data flows between the AAM activities:

— A21126 to A22.

Class 8: Process Engineering Information Package - This class includes all of the UoFs specified in this part of ISO 10303. This class is suitable for transfer of the complete process design and process equipment design information from one organization to another, excluding the process flow diagrams. It is related to all in scope data flows between the AAM activities.

Table 1 - Conformance Classes

Unit of functionality	Class							
	1	2	3	4	5	6	7	8
chemical_reaction_data		X	X					X
control_strategy						X		X
heat_transfer_equipment					X			X
major_process_equipment					X			X
mass_transfer_equipment					X			X
material_data		X	X		X			X
material_transfer_equipment					X			X
plant_context				X		P		X
plant_item_definition					X	P	X	X
plant_system_definition							P	X
process_description	X		X	X		P		X
process_flow_diagram							X	
process_simulation_data			X					X
process_vessel_equipment					X			X
stream_data	X		X	X	P	P	P	X
substance_experimental_data		X						X
substance_model_data	X	X	X	X				X
unit_operation			X	X		X	P	X

KEY: X = Full coverage
P = Partial coverage

Annex A
(normative)

AIM EXPRESS expanded listing (later)

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.

Annex B
(normative)

AIM short names (later)

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.

Annex C
(normative)

Implementation method specific requirements (later)

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 (later).

Annex D
(normative)

Protocol Information Conformance Statement (PICS) proforma (later)

The PICS proforma is supplied for completion by the person or organization (the client) requesting conformance testing. Its purpose is to ascertain the scope of claimed conformance to a particular application protocol by an implementation under test (IUT) using a defined implementation method. Through the completion of this form, the PICS Proforma becomes a PICS.

The information contained in the PICS is used to configure an appropriate executable test suite for use by the client.

Ten 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 ISO 10303-231 AIM constructs. These classes are detailed in clause 6 of ISO 10303-231.

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:_______________

   — Class 5:_______________

   — Class 6:_______________

— Class 7:_______________

— Class 8:_______________

Annex E
(normative)

Information object registration (later)

E.1 Document identification

In order to provide for unambiguous identification of an information object in an open system, the object identifier

{ iso standard 10303 part(231) version(-1) }

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

E.2 Schema identification

In order to provide for unambiguous identification of the schema specifications given in this application protocol in an open information system, object identifiers are assigned as follows:

{ iso standard 10303 part(231) version(-1) object(1) (1) }

is assigned to the (later) expanded schema (see annex A).

{ iso standard 10303 part(231) version(-1) object(1) (2) }

is assigned to the (later) 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. The viewpoint of the AAM is the users of process engineering information, including process engineers and process engineering management.

F.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.

F.1.1 AIChE Equipment Test Procedures: * A set of procedures backed by the American Institute of Chemical Engineers (AIChE) describing industry standard methods for testing packed distillation columns, fired heaters, spray driers, impeller mixing equipment, tray distillation columns, direct heat rotary driers, centrifugal pumps, centrifuges, particle size classifiers, evaporators, solids mixing equipment, and rotary positive displacement pumps.

F.1.2 Automation Tools: * The collection of software and hardware tools used to assist the activities involved in the life cycle of a process plant.

F.1.3 Basic Laws: * Those elements of natural and human laws affecting any activity in the life cycle of a process plant. These may include operating rules and guidelines as established by 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.1.4 Business Requirements: Documents that specify constraints on the design of the plant due to corporate business practices.

F.1.5 Changes in Plant Requirements: Changes in plant requirements determined during the definition of operation and information requirements, the conceptual facility design, or the development of an appropriations request.

F.1.6 Chemical Kinetic Data and Models: Data or models describing the rate of chemical reactions within a process.

F.1.7 Chemical Reaction Information: All chemical information associated with a chemical reaction including stoichiometry, operating conditions (temperature, pressure, catalyst, concentration), conversion, kinetic data, or reaction model.

F.1.8 Chemical Species Information: All information associated with a chemical compound or mixtures of chemical compounds including physical and transport property data or models, materials compatibility, and environmental impact information, such as material safety datasheets (MSDS).

F.1.9 Commissioned Plant: * A plant that has been proven to be operational through commissioning procedures.

F.1.10 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.1.11 Company Standards and Policies: Documents that specify constraints on the design of the plant due to company business practices and the selected site.

F.1.12 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 is procured as needed (such as scaffolding). 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 which meets the testing procedures defined in the project control and approval documentation.

F.1.13 Construction Documentation: * All documentation related to the construction of the process plant including 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.1.14 Control Concept: A document describing the conceptual control strategies to be implemented for process control, unit supervision, and safety protection.

F.1.15 Control Objective: A project control and approval document that defines the functional objectives of the control and information systems (C&IS).

F.1.16 Cost, Safety, and Environmental Engineering Personnel: * Individuals who, in conjunction with process engineers, are responsible for analyzing process design specifications, recommending process engineering changes, and producing and engineering design specification. These activities include site selection, hazards analysis, environmental impact assessment, definition of major control functions, generation of start-up and acceptance procedures, preliminary estimation of profitability, optimization studies, design validation, and report generation (including the appropriation request and the engineering design specifications).

F.1.17 Costing Estimation Automation Tools: * Tools, typically commercial or proprietary software products, that are used to automate the development of capital and operating cost estimates for a process alternative.

F.1.18 Create Process Flow Diagram (AAM A21126): The activities associated with collecting the technical information displayed on the PFD and creating the PFD.

F.1.19 Data Requirements: A selection of the types of data required to complete the material and energy balances for a process alternative.

F.1.20 Decide on Data Requirements (AAM A211211): Activities that select the data or models needed to complete a material and energy balance for the process as defined in the quantities flowsheet and by the process design specifications.

F.1.21 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.1.22 Define Operation and Information Requirements (AAM A212): The activities that select the level of automation for the C&IS and specify the operating strategies and requirements (both steady-state and transitional) for the equipment/technologies/sub-processes that comprise the process plant/retrofit.

F.1.23 Define Plant Requirements (AAM 21): The activities that define process plant requirements for: 1) the process technology, 2) the process operation and control systems and procedures, and 3) the physical three-dimensional facility structure and layout. The result is an appropriation request that is expected to be within 30% of the actual cost of the project.

F.1.24 Design and Rate Chemical Reactors (AAM A2112324): All activities associated with the design and rating of chemical reactors. These devices include stirred-tank, tubular-flow, gas-liquid, fixed bed, fluidized bed. and kiln reactors.

F.1.25 Design and Rate Fluid Transport Equipment (AAM A2112321): All activities associated with the design and rating of fluid transport equipment. Such devices include equipment for the point-to-point transfer of liquids, such as pumps, or of gases, such as fans, blowers, compressors, expanders, and vacuum equipment, within a chemical process or within a piping network. These activities include selecting appropriate transport equipment, determining design details to meet the design specifications, and specifying primary control elements.

F.1.26 Design and Rate Heat Transfer Equipment (AAM A2112322): All activities associated with the design and rating of heat transfer equipment. Such devices include equipment for the exchange of energy between two fluid streams without allowing interchange of the two fluids, such as shell-and-tube exchangers, reboilers and condensers, evaporators, and fired heaters. These activities include selecting appropriate equipment items, determining design details including the specification of internal components to meet the design specifications, and specifying primary control elements.

F.1.27 Design and Rate Major Processing Equipment (AAM A211232): All activities associated with the design or rating of fluid transport equipment, heat transfer equipment, stills, extractors and absorbers, reactors, mixers and agitators, and process vessels. The result of these activities is a specific equipment datasheet for each equipment item that is included in the process design specifications package. In-house testing and sizing is generally performed on these equipment items prior to specification and vendor selection.

F.1.28 Design and Rate Mixers and Agitators (AAM A2112325): All activities associated with the design and rating of mixers and agitators.

F.1.29 Design and Rate Process Vessels (AAM A2112326): All activities associated with the design and rating of process vessels and tanks.

F.1.30 Design and Rate Stills, Extractors, and Absorbers (AAM A2112323): All activities associated with the design and rating of stills, absorbers, and extractors. These devices include multi-component distillation columns for petroleum fractionation and for extractive and azeotropic distillation, gas absorption and gas stripping devices, and equipment for the transfer of components between two liquid phases. Such equipment may utilize various types of tray or packing materials for interphase contacting.

F.1.31 Design and Rate Vendor-Proprietary Equipment (AAM A211233): All activities associated with the design or rating of equipment whose performance is guaranteed by the vendor. These may include gas-solid separators, solids washers, solid-liquid separators, crushers, screens, critical pipe segments, and other specialized items. The result of these activities is a specific equipment datasheet included in the process design specifications package. The majority of the equipment items in this classification are designed by first selecting a vendor who performs testing and sizing of the item, frequently on a proprietary basis.

F.1.32 Design Changes: Requests for different equipment selections or minor changes to the process plant to improve process performance or economics.

F.1.33 Design Models and Performance Data: The mathematical models and correlations, performance data, or heuristic rules selected as the design methodologies for use in the process design.

F.1.34 Design 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. The appropriation request is submitted to company management for approval. Upon approval, the construction design specification is generated.

F.1.35 Design Task Estimate Results: * Documentation assessing the feasibility or estimating the requirements of the various tasks in the final plant design. Included is a preliminary layout, civil engineering, electrical, and utilities requirements, evaluations of materials of construction, fabrication feasibility, safety, environmental impact, operability, reliability, and controllability, and an estimated schedule and budget.

F.1.36 Design, Model, and Process Design Changes: Changes to the process topology, models, or equipment in a process alternative.

F.1.37 Designate and Rate Process Equipment (AAM A21123): All activities associated with selecting, designing, or rating of equipment items specified in the PFD.

F.1.38 Detailed Quantities Flowsheet(s): A set of graphical documents indicating the unit operations and their topology for a process alternative including a detailed listing of component flows, total energy content, and condition of each stream in the process topology. This information may include a "base case" alternative as well as several "off-design cases" for a particular process.

F.1.39 Develop Control Concept (AAM A21125): The activity of generating the document describing the conceptual control strategies to be implemented for process control, unit supervision, and safety protection.

F.1.40 Develop Material and Energy Balances (AAM A21122): The calculation of material and energy flows for all streams and unit operations in the quantities flowsheet.

F.1.41 Disassembled Plant: * All equipment items remaining after the disposal of a process plant.

F.1.42 Discipline Experts: * Those personnel with considerable training, knowledge, or experience in a given field of science or engineering.

F.1.43 Disposal Documentation: * All documentation 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.1.44 Energy: * All utilities required in the production of useful products through the operation of a process plant.

F.1.45 Engineering Design Changes: Changes to the process design arising from analyses performed in the engineering design phase.

F.1.46 Engineering Design Specifications: A document stating the final process topology, material and energy balance information, the type and size of equipment, equipment datasheets and specifications, utilities requirements, the top level C&IS architecture, sizes of major piping components, materials of construction, hazards and operability analysis, start-up procedures, initial site selection information, general pre-commissioning guidelines, equipment testing procedures, and acceptance methods. This document is the established basis from which the final plant design is produced.

F.1.47 Engineering Design, Construction, and Operation Changes: Changes to the design of the plant arising from analyses performed during design, construction, and operation.

F.1.48 Equipment Data: All of the equipment data on a process flow diagram should be obtained from the equipment datasheets.

F.1.49 Equipment Datasheets: A collection of documents for each equipment item in the process flow diagram that contains sufficient information to submit to an engineering design and construction (E&C) firm. Typically, this would include an equipment list and a set of equipment datasheets for submission with the engineering design specifications.

F.1.50 Equipment Design and Rating Automation Tools: * Tools, typically commercial or proprietary software products, that are used to automate the design and rating of process equipment.

F.1.51 Equipment Information Databases: An archive of information relating to the performance, operation, maintenance, and cost of manufactured/fabricated equipment.

F.1.52 Estimate Detailed Design Tasks (AAM A211243): An assessment of the feasibility or estimating the requirements of the various tasks in the final plant design. Included is a preliminary layout, civil engineering, electrical, and utilities requirements, evaluations of materials of construction, fabrication feasibility, safety, environmental impact, operability, reliability, and controllability, and an estimated schedule and budget.

F.1.53 Final Design Documentation: * All documents pertaining to the design of the plant including the design methodologies used, acceptance and testing procedures for construction and pre-commissioning, the C&IS as designed, detailed plant layout, final hazards and operability analysis, a final estimate of the capital and operating costs with an expected accuracy of 10%, documentation of regulatory compliance, and preliminary operating procedures.

F.1.54 Generate a Study Cost Estimate (AAM A211242): For each remaining process alternative, the PFD, utilities summary, and equipment specifications are used to generate a factored estimate (or study cost estimate as defined by the American Association of Cost Engineers (AACE)) of the capital and manufacturing costs. The cost estimate is typically within 30% of the actual cost and is generally used to compare the remaining alternatives to eliminate all but one from further consideration.

F.1.55 Generate Additional and Compare All Process Alternatives (AAM A211241): Activities associated with the analysis of the set of existing process alternatives to determine new alternatives with the potential for improved technical or economical performance. These new alternatives feedback as "changes," perhaps as far as the process synthesis activity. All process alternatives are compared with each other and with the project design requirements. All infeasible or inferior process alternatives are discarded.

F.1.56 Generate Specifications and Documentation (AAM A211244): The equipment specifications, utilities summary, and PFD are combined with statements of general design performance criteria to form a set of process design specifications.

F.1.57 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.1.58 Initial Information: Any knowledge available at the start of the process to build or modify a process plant. This includes information about the site, regulatory agreements, owner requirements, approved suppliers, etc.

F.1.59 Innovation: New ideas and concepts generated internally or through the public domain to solve problems or to enhance the quality of work. Some ideas and concepts may become goods, services, and systems for which there is a societal requirement. 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.1.60 Licensed Technologies: Patented or proprietary processes or design information purchased or licensed from an outside source, such as a process processor, vendor, or fabricator. Such technology may range from laboratory synthesis data through unit operation process data to complete, detailed plant designs or equipment items and modules.

F.1.61 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.1.62 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.1.63 Mixture Data and Models: Data or models describing the thermodynamic condition and transport properties of mixtures of pure components within a chemical process.

F.1.64 Model Changes: Requests for updated design or physical property models or performance data.

F.1.65 Obtain Kinetic Data and Models (AAM A211213): All activities associated with determining appropriate kinetic data and models for all chemical reactions occurring in a process.

F.1.66 Obtain Mixture Information (AAM A2112122): All activities associated with the development of thermodynamic and transport property information for mixtures of pure components within a chemical process.

F.1.67 Obtain Physical Property Data and Models (AAM A211212): All activities associated with development of the thermodynamic and transport property information for the chemical substances within a chemical process. These substances include pure components, mixtures of pure components, and pseudo-components.

F.1.68 Obtain Pseudocomponent and Assay Information (AAM A2112123): All activities associated with the description of complex substances as a mixture of pseudocomponents with specified thermodynamic and transport properties.

F.1.69 Obtain Pure Component Information (AAM A2112121): All activities associated with the development of thermodynamic and transport property information for pure components within a chemical process.

F.1.70 Obtain Transport Rate Data and Models (AAM A211214): All activities associated with determining transport rates within unit operations of a chemical process. Such data may include correlations for mass and heat transfer coefficients, tray efficiencies, bubble dynamics, radiative transport, and drying rates.

F.1.71 Obtain Unit Performance Data (AAM A211215): Unit performance data are a quantitative description of the quantity and quality of a product produced by the plant usually stated as "units of product/unit time". Certain unit operations, such as crystallization, fiber drawing, and injection molding, are not easily described by models or correlations derived from fundamental principles. Performance data for these types of operations must be supplied by direct laboratory measurements or from vendors.

F.1.72 Obtain Vendor/Fabricator Equipment Data (AAM A211231): All activities associated with contacting vendors or fabricators of certain types of equipment and obtaining information necessary for the design of the equipment.

F.1.73 Other Discipline Personnel: * Civil, Mechanical, Safety and Health, Operations, Electrical and Control, and Project and Construction discipline personnel.

F.1.74 P&ID, Approved for Design: * A schematic diagram which shows engineering details of the equipment, instruments, pipes, valves, and their connectivity and sequence. When a P&ID is Approved for Design (AFD), it is an indication that the process definition is firm and that it needs instrumentation.

F.1.75 Perform Conceptual Facility Design (AAM A213): The activity of extending the conceptual process design into a preliminary plant spatial arrangement.

F.1.76 Perform Design Analysis and Cost Optimization (AAM A21124): Additional process alternatives are created by making modifications to existing process alternatives that may reduce costs, increase profitability, or improve operability, maintainability, controllability, or constructability. The new process alternatives may require additional or more accurate design models or performance data. If a new process alternative is radically different from any existing alternative, it will feedback through the design activities, perhaps as far as the process synthesis activities. Inferior alternatives are identified and discarded.

F.1.77 Perform Process Design (AAM A2112): All activities associated with the development of a finalized PFD. These activities include refining the required physical property and kinetic data or models, collecting the required equipment performance data, calculating detailed material and energy balances, sizing or rating equipment items, compiling utility requirements, estimating capital and operating costs and producing the PFD. Some optimization of the design is performed to satisfy profitability criteria.

F.1.78 Perform Process Design and Engineering (AAM A211): The activities associated with selecting, sizing, and determining requirements for the equipment/technologies that comprise a retrofit/process plant.

F.1.79 Perform Process Engineering Analysis (AAM A2113): All activities involved in converting the PFD, equipment specification, material and energy balances, and utility requirements into an engineering design specification. These activities include site selection, hazards analysis, environmental impact assessment, definition of major control functions, generation of start-up and acceptance procedures, preliminary estimation of profitability, optimization studies, design validation, and report generation (including the appropriation request and the engineering design specifications).

F.1.80 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. These tasks may include: conception, research, design, construction, operation, maintenance, retrofit, and disposal. Major outputs are contractual documents, regulatory compliance information and data retained beyond the life time of the plant, all useful products generated by the operation of the plant and all residual materials remaining in the environment upon completion of the plant life cycle including waste products generated while producing useful product and the disassembled plant.

F.1.81 Perform Process Synthesis (AAM A2111): Process alternatives, that differ in production rate, raw materials, process topology, or process equipment/technologies, are generated, their technical and economical feasibility is verified, and socio-economical comparisons are made to determine a small set for which to perform preliminary designs. Unit operations are selected for modeling the major equipment/technologies, basic chemical and reaction information is determined, and preliminary material and energy balances are performed for each alternative.

F.1.82 Personnel: * The individuals responsible for the life cycle of the process plant. These may include discipline experts, skilled workers, and laborers.

F.1.83 Physical Property Data and Models: Data or models describing the thermodynamic condition and transport properties of substances within a chemical process.

F.1.84 Plant Design Documentation: * All documents related to the process of designing the process plant including 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, vendor performance data, capital and operating cost estimates, and appropriations requests.

F.1.85 Plant Items: An item or piece of equipment that may be used as a component of the plant.

F.1.86 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. This includes all data retained past the end of the plant life cycle.

F.1.87 Plant Operation/Maintenance Documentation: * The collection of all documents relating to the operation and maintenance of process plant. This includes 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.1.88 Preliminary Cost Estimate: * A factored (study cost estimate as defined by the AACE) estimate of the capital and operating costs of the plant. The estimate is expected to be within 30% of the actual costs of the plant.

F.1.89 Preliminary Design Documentation: * The collection of all documents relating to the preliminary design of the plant. This includes process design and engineering documentation, P&IDs that are approved for design, a preliminary cost estimate.

F.1.90 Preliminary Facility Design: * Documentation describing the preliminary plant spatial arrangement. This includes C&IS, piping, civil, mechanical, and electrical systems.

F.1.91 Preliminary Plant Layout: * A graphical document describing the spatial arrangement of the major equipment or process units.

F.1.92 Preliminary Process Design Specifications: A document containing a list of specifications that the preliminary design must meet or exceed, recommended correlations and their parameter values, site-specific information that will impact the design, and other associated information to be used in the course of the preliminary design.

F.1.93 Previous Designs: * Information acquired from historical archives of previous designs that can be reused.

F.1.94 Process Design and Engineering Documentation: * All documents related to the process of designing the process plant including 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, vendor performance data, capital and operating cost estimates, and appropriations requests.

F.1.95 Process Design and Engineering Information: * Knowledge about the practice of process design and engineering gained through experience with previous design activities.

F.1.96 Process Design Changes: Requests for change to the quantities flowsheet or the chemical species or chemical reaction information.

F.1.97 Process Design Documentation: * All documents pertaining to the methodologies used in the process design activities.

F.1.98 Process Design Specifications: A document containing a list of specifications that the process design must meet or exceed, equipment datasheets and specifications, utility load summaries, stream definitions, and the models, correlations, and performance data used in the process design.

F.1.99 Process Engineering Analysis Documentation: * All documents pertaining to the methodologies used in the process engineering analysis activity.

F.1.100 Process Engineering Changes: Requests for change to the process flow diagram or process design specifications.

F.1.101 Process Engineering Personnel: * Individuals responsible for performing process designs of process alternatives, recommending process design changes, and assisting in process engineering analysis.

F.1.102 Process Flow Diagram: A graphical 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.1.103 Process Flow Diagram Automation Tools: * Tools, typically commercial software products, that are used to automate the creation of PFDs for a process alternative.

F.1.104 Process Operation Definition: * The design documentation that defines the decomposition of the plant into process cells and process units (as defined by ISA-S88.01-1995 [1]) and the interconnecting flows of material, energy, and information. Each cell and unit is described in terms of its operating states and associated operation strategies within the states. The operation strategy defines the requirements to operate and control the cell or unit during an operating state. This includes routine/special operator tasks, control/manipulated variables, performance variables, and state transition methods. The process operation definition (POD) contains cell or unit flow diagrams, state diagrams, and descriptions of the operation strategy for each state. The POD is used to help develop the plant human organization and the C&IS architecture. The POD is also used as a guide in designing operator displays, alarm management, process cell/unit coordination control, and C&IS component distribution strategies.

F.1.105 Process Simulator Automation Tools: * Tools, typically commercial software products, that are used to automate the development of material and energy balances, the design and rating of process equipment, or the creation of PFDs for a process alternative.

F.1.106 Procure Components (AAM A3): The process by which needed parts, equipment, or services are purchased or acquired.

F.1.107 Produce + or - 30% Appropriations Request (AAM A214): Prepare a preliminary budget and schedule, supported by technical information, as an appropriation request package for management review.

F.1.108 Produce Final Plant Design (AAM A22): The activities required to generate a construction design specification from the process plant requirements. The activities may include designing the mechanical, electrical, and civil engineering systems of the process, designing the detailed instrumentation systems, producing P&IDs and detailed equipment layout through isometric drawings or three-dimensional computer-aided design (CAD) models.

F.1.109 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 constraints include financial limitations, accounting, legal and regulatory restrictions, socio-economic factors, and business practices throughout the plant life cycle. The documents indicate how all activities are to be implemented and approved and identify all constraints that must be met.

F.1.110 Project Design Requirements: * A document that defines the requirements that the design for the project must meet or exceed.

F.1.111 Project Financial Requirements: * A document that defines the financial requirements that the cost estimate for the project must meet or exceed. The requirements may impose limitations on capital and operating costs, measures of profitability, or price of raw materials and products.

F.1.112 Pseudocomponent Data and Models: Data or models describing the thermodynamic condition and transport properties of pseudocomponents within a chemical process.

F.1.113 Pure Component Data and Models: Data or models describing the thermodynamic condition and transport properties of pure components within a chemical process.

F.1.114 Quantities Flowsheet: A document indicating the unit operations and their topology and a preliminary estimate of the material and energy flows for the major process streams in a process alternative.

F.1.115 Regulatory Requirements: * Federal, state, or local laws, codes, or standards that impact various activities related to the process plant. Regulatory requirements may apply to, but are not limited to, permitting, engineering, construction, operations and decommissioning.

F.1.116 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. Approval requests may, at times, include a request that the company appropriate monies for a particular activity.

F.1.117 Research and Development Scientific and Engineering Personnel: * Individuals responsible for developing or analyzing process alternatives to verify technical and economical feasibility.

F.1.118 Residual Materials: * All chemicals and equipment remaining in the environment at the end of the plant life cycle, but excluding useful products.

F.1.119 Retained Process Alternatives: Those process alternatives that are technically, economically, or commercially superior when compared to the set of process alternatives.

F.1.120 Select Models and Obtain Performance Data (AAM A21121): The process of collecting the required physical property and kinetics data and developing the necessary correlations for use in the process design. The appropriate design methodology is chosen for each unit operation in the preliminary design specification and the quantities flowsheet. Such methodologies may include a heuristic, model, or performance data. These items may be generated in-house or may be licensed or purchased from vendors and other outside sources.

F.1.121 Societal Requirements: * The expressed need or demand for products, services, or processes by society on either a local, national, or global scale. 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.1.122 Spreadsheet Automation Tools: * Tools, typically commercial software products, that are used to automate the development of material and energy balances for a process alternative.

F.1.123 Starting Materials: * All necessary equipment components or consumable goods necessary to construct and operate the process plant for the production of useful products.

F.1.124 Transport Rate Data and Models: Data or models describing transport rates within the unit operations of a chemical process.

F.1.125 Unit Performance Data: Data or models describing the operation and performance of unit operations in a chemical process.

F.1.126 Useful Products: * The materials or energy generated through the operation of the process plant that are sold to customers for a profit.

F.1.127 Utilities Summary: A compilation of the total annual consumption and peak rates of consumption for each utility in the preliminary design.

F.1.128 Vendor Documentation: Documentation received from a vendor concerning procured items, usually in the form of drawings, manuals, or calculations, which provides information concerning design details or performance of the procured items.

Kinds of vendor documentation include:

— Preliminary: in process design information;

— Certified: information from the supplier of equipment or other components which is warranted to correctly describe the as-delivered functional or physical data;

— released for fabrication/construction.

F.2 Application activity model diagrams

The application activity model diagrams are given in figures F.2 through F.12. 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.

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 engineering information.

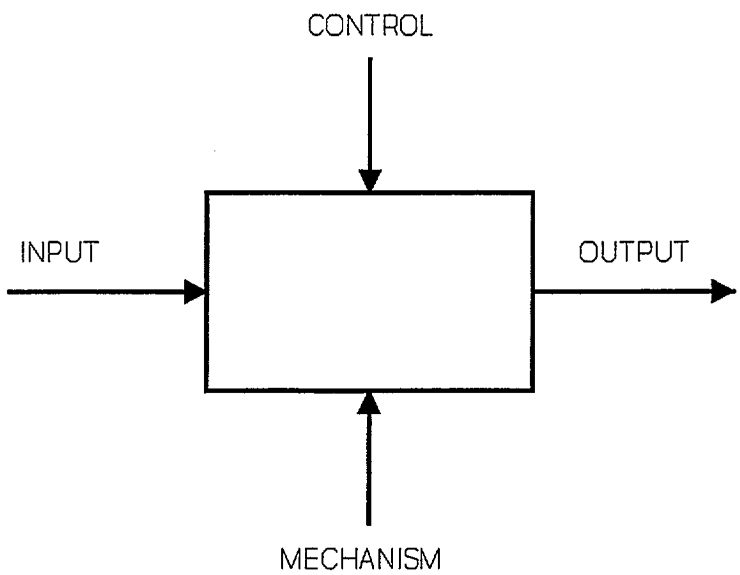
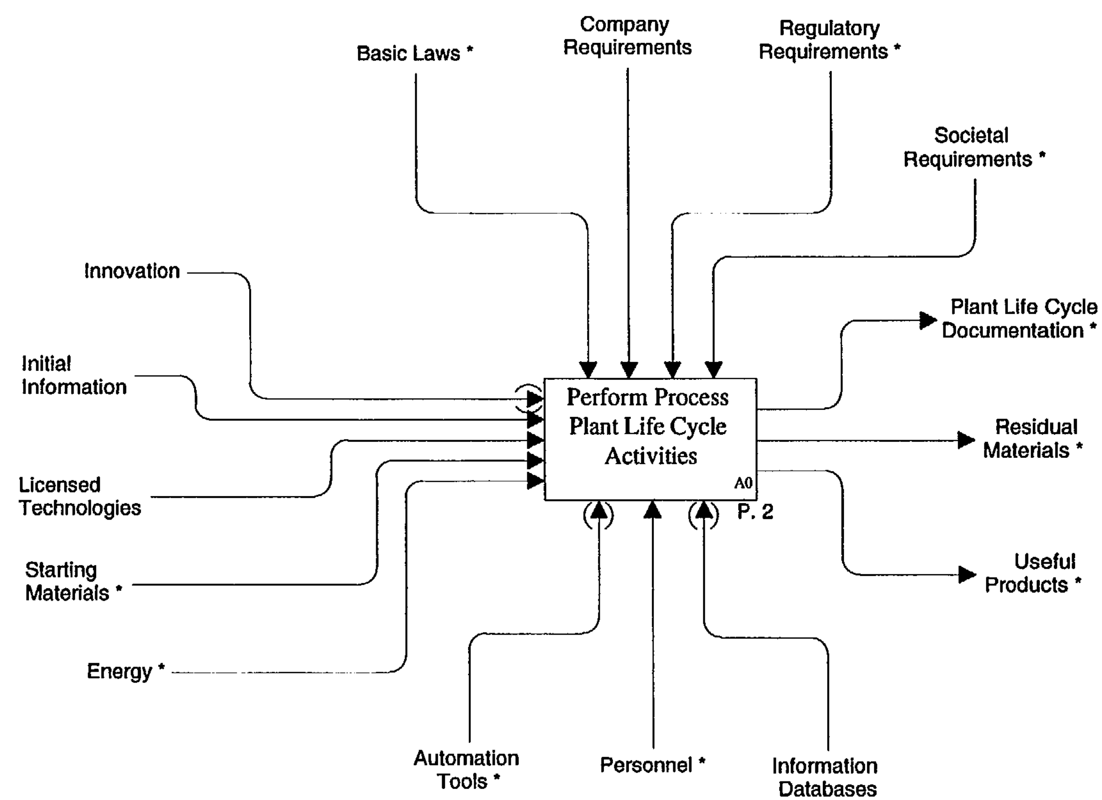


Figure F.1 - IDEF0 basic notation

USED AT:	AUTHOR: Steven W. Kline PROJECT: Activity Model for AP 231 Project NOTES: 1 2 3 4 5 6 7 8 9 10	DATE: 08/25/96 REV: 0.4.1	x	WORKING	READER	DATE	CONTEXT: Top
				DRAFT			
				RECOMMENDED			
				PUBLICATION			



Purpose: Identify the activities in the life cycle of a process plant that generate process engineering data.
Viewpoint: A process engineer or a member of process engineering management.

Notes: 1. An * after the Activity or ICOM (Input, Control, Output, Mechanism) name indicates that it is out of scope.

NODE: A-0	TITLE:	NUMBER: P. 1

Figure F.2 - A-0: Process Engineering

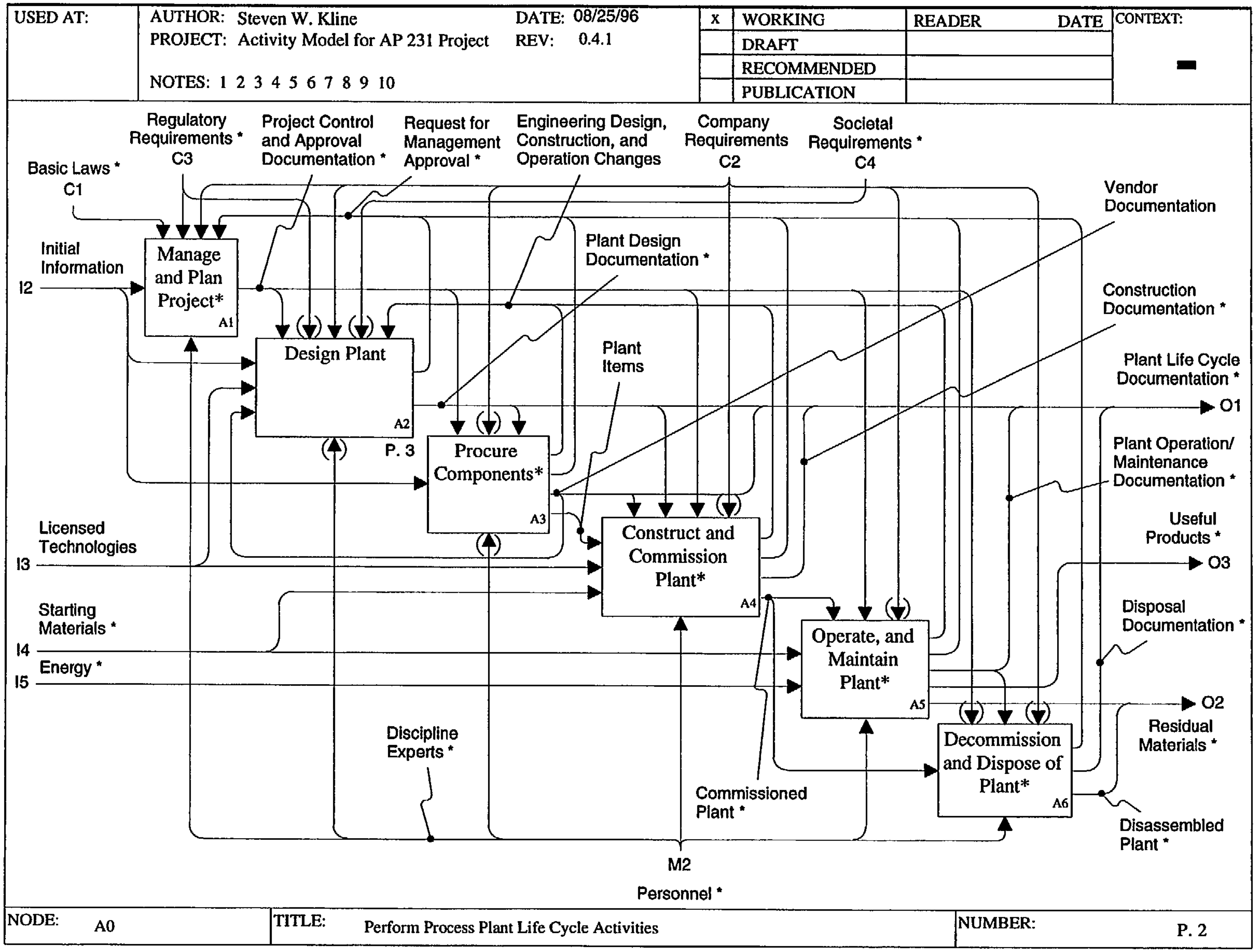


Figure F.3 - A0: Perform Process Plant Life Cycle Activities

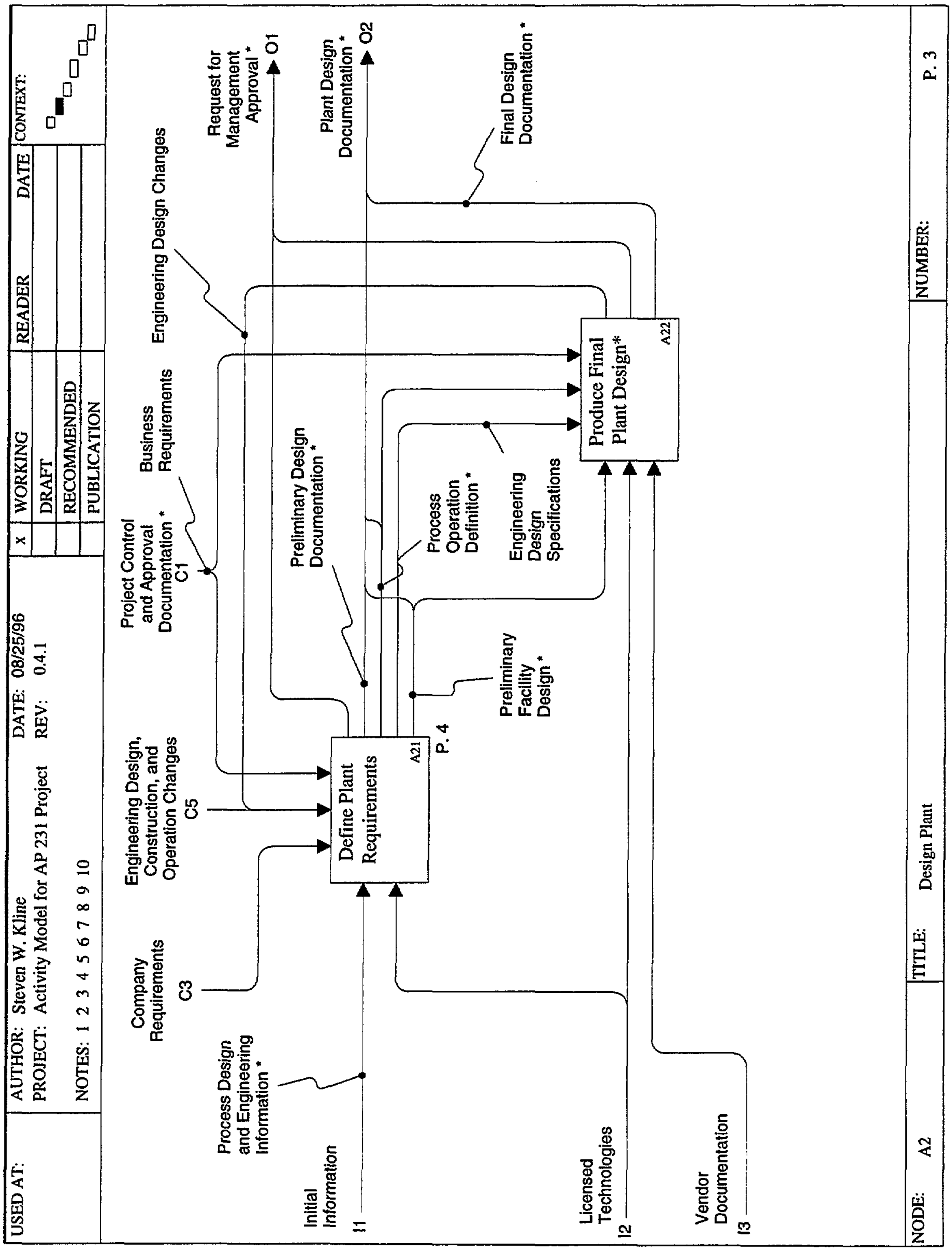


Figure F.4 - A2: Design Plant

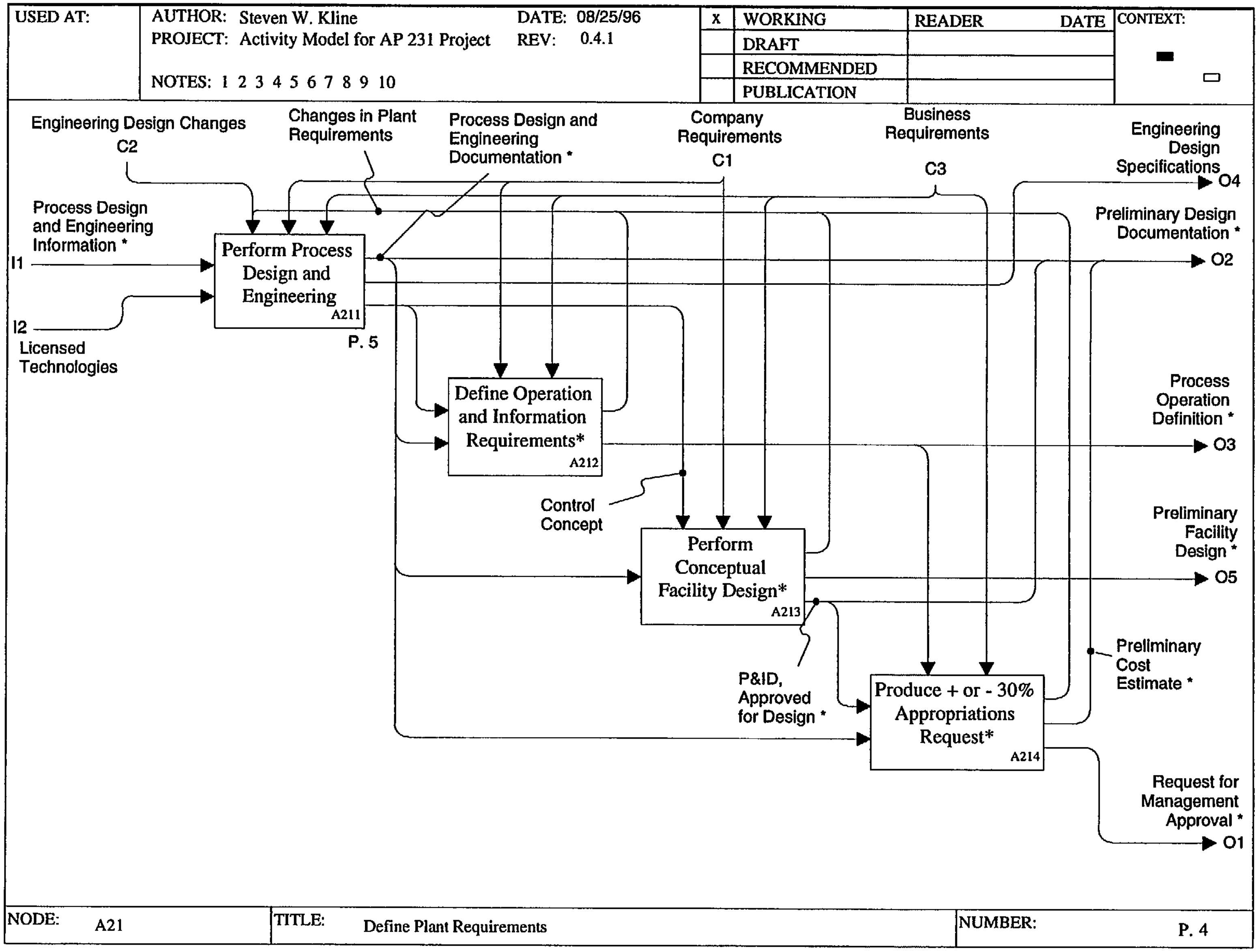


Figure F.5 - A21: Define Plant Requirements

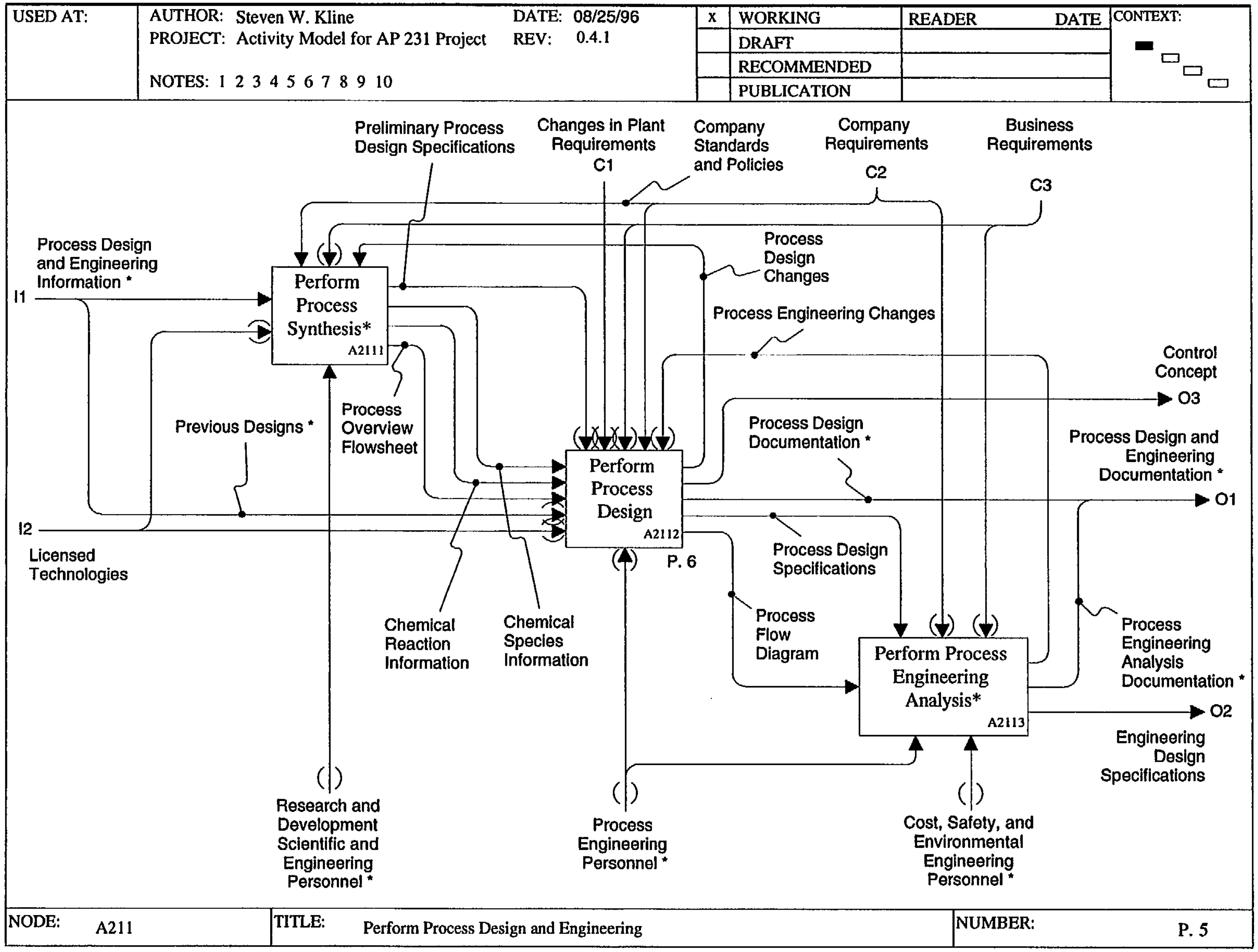


Figure F.6 - A211: Perform Process Design and Engineering

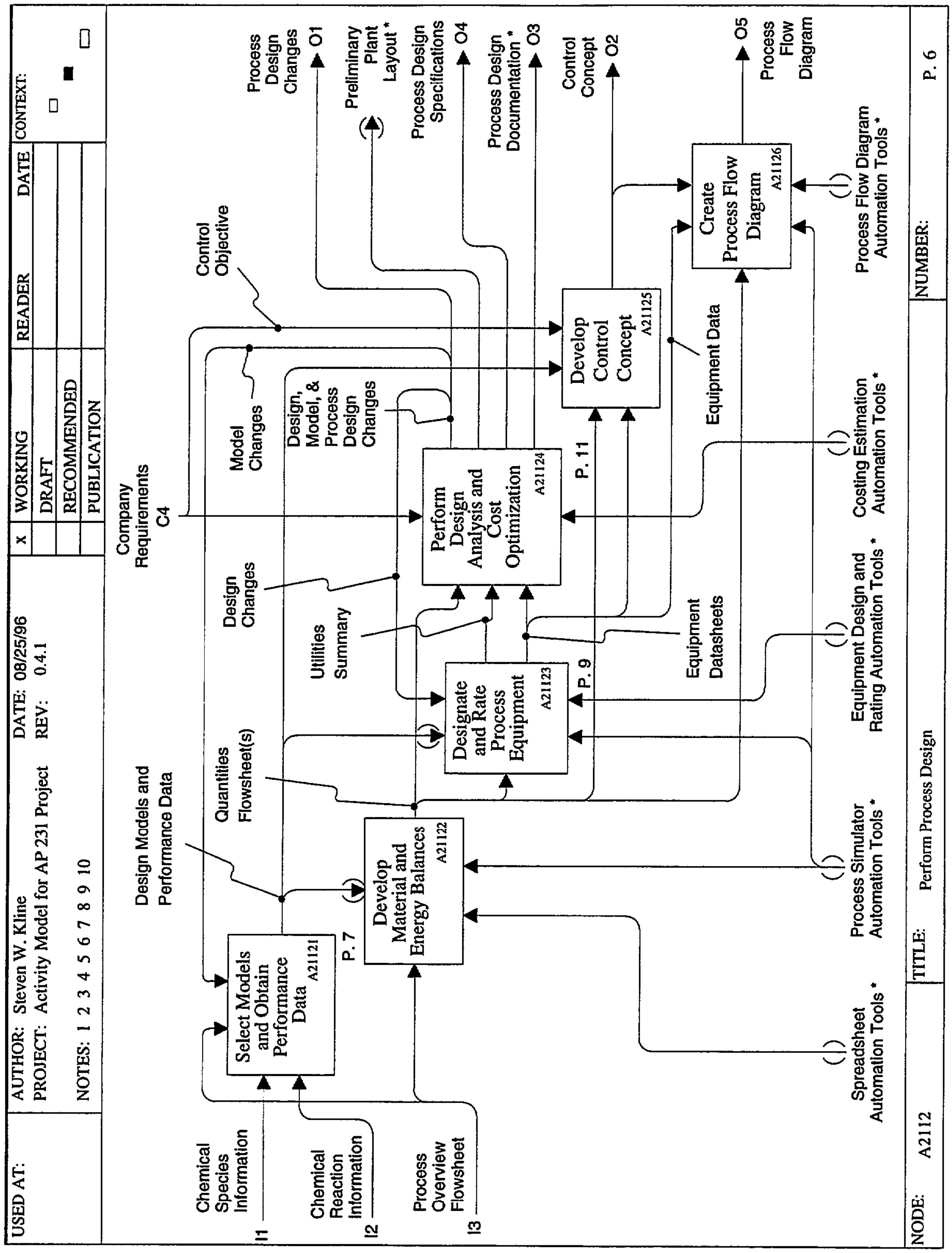


Figure F.7 - A2112: Perform Process Design

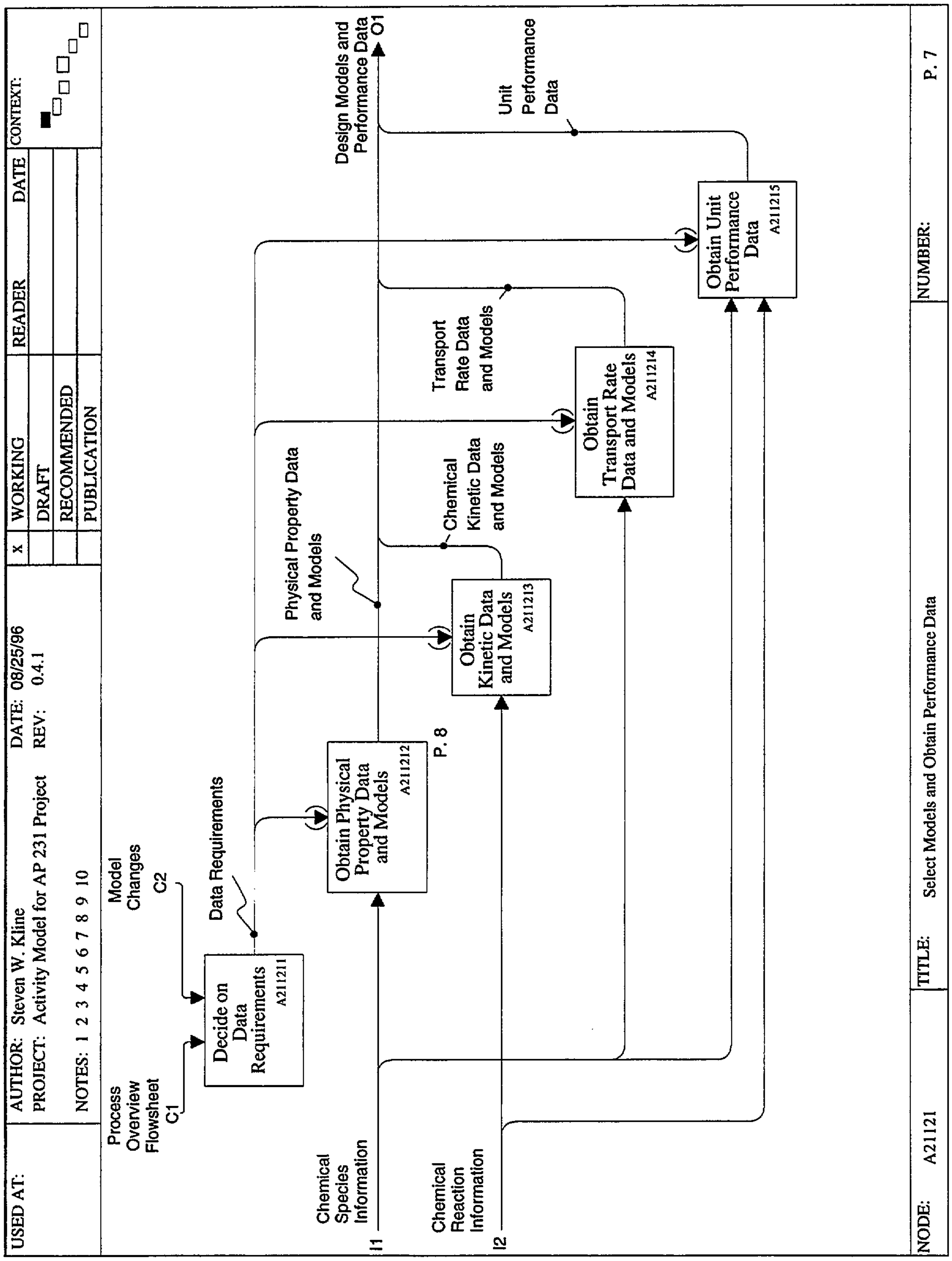


Figure F.8 - A21121: Select Models and Obtain Performance Data

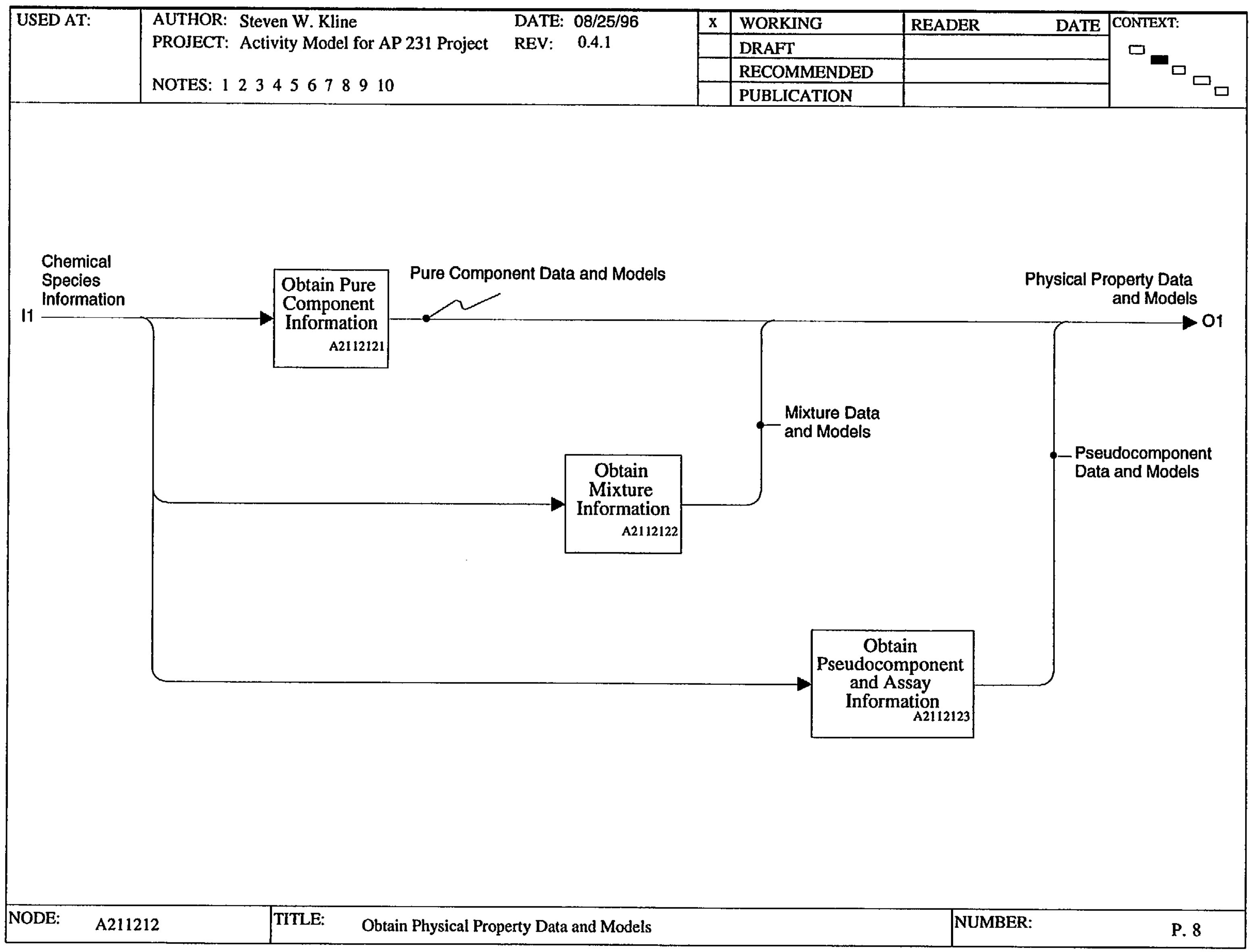


Figure F.9 - A211212: Obtain Physical Property Data and Models

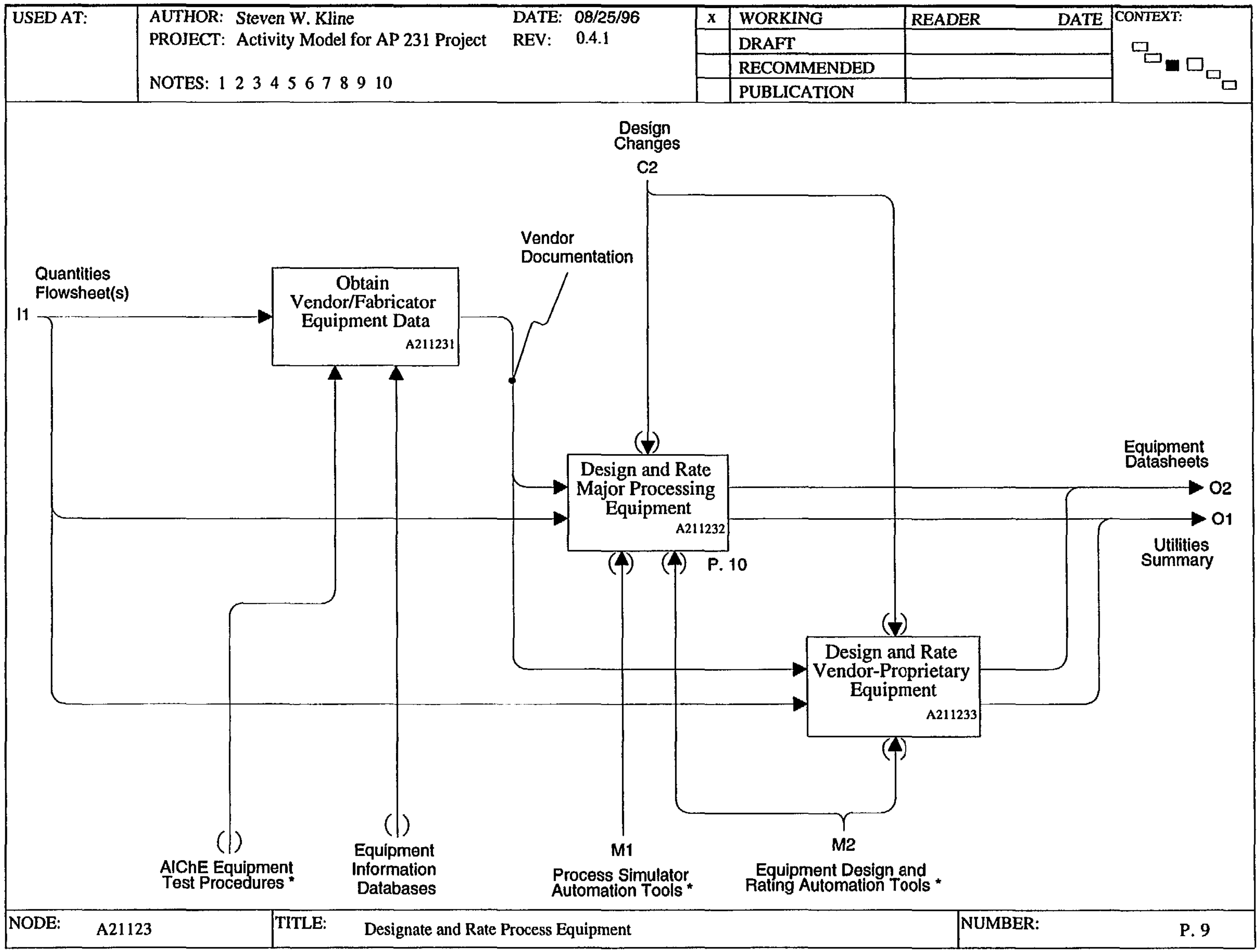


Figure F.10 - A21123: Designate and Rate Process Equipment

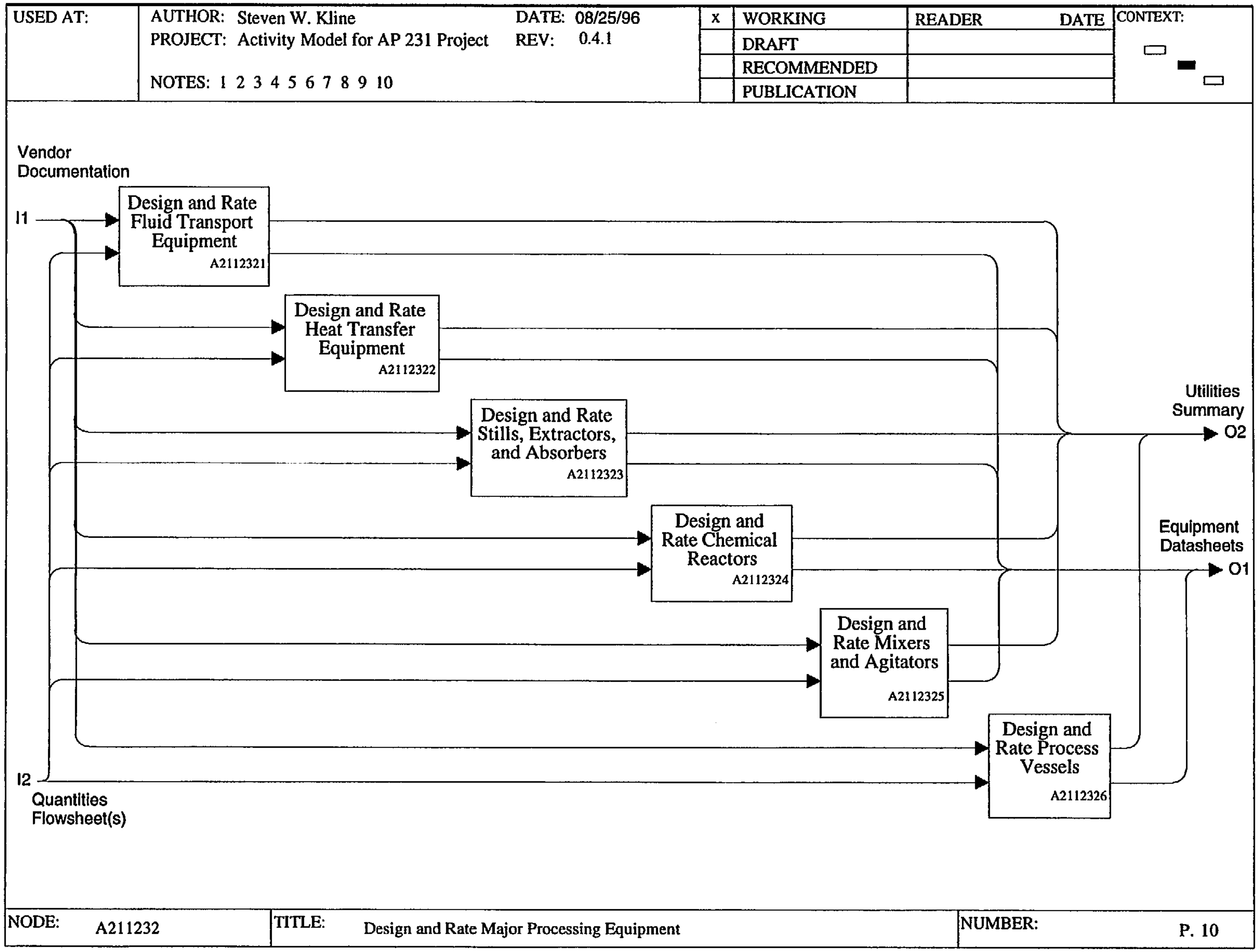


Figure F.11 - A211232: Design and Rate Major Processing Equipment

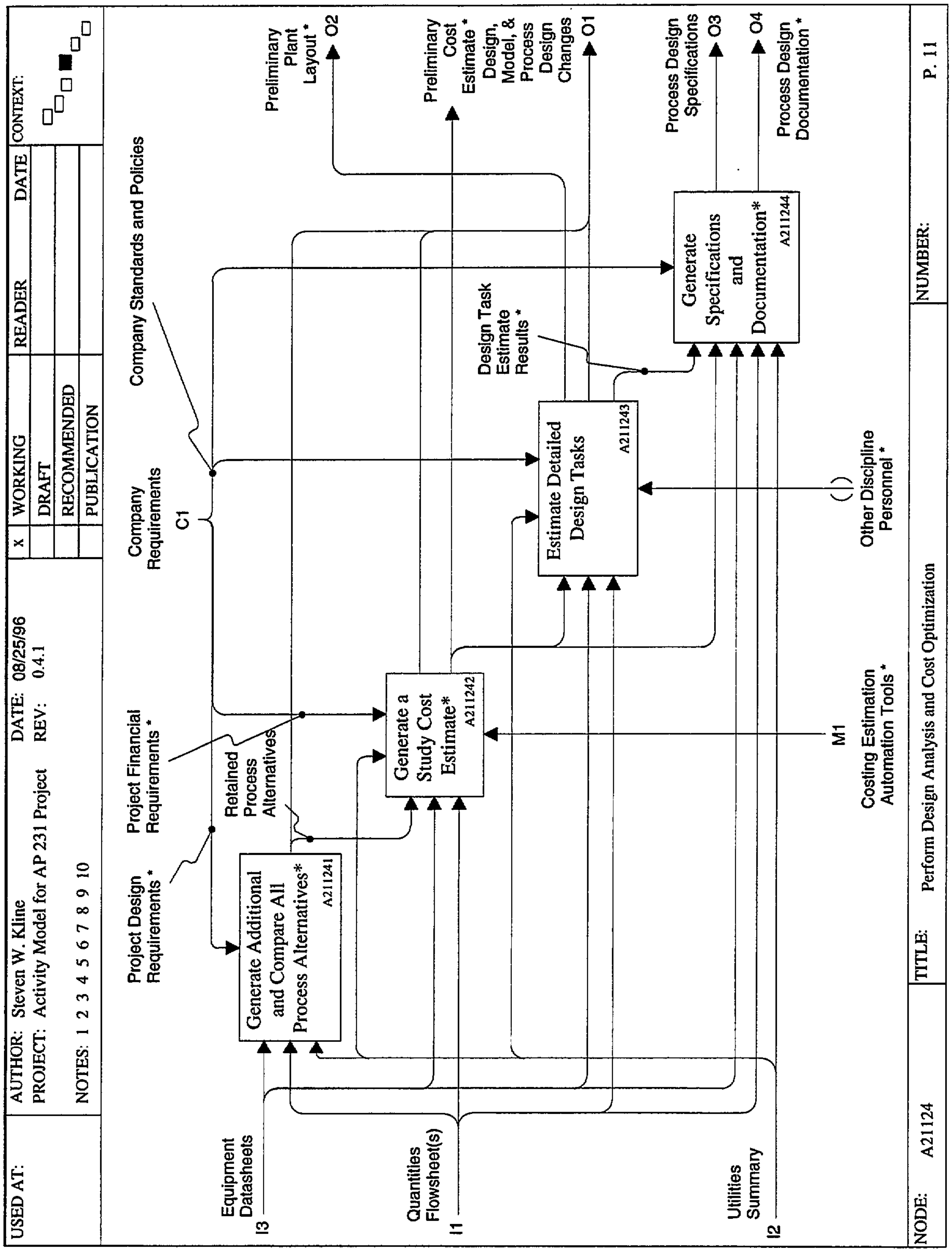


Figure F.12 - A21124: Perform Design Analysis and Cost Optimization

Annex G
(informative)

Application reference model wallpaper version

This annex provides the application reference model for this part of ISO 10303 and is given in Figures G.1 through G.53. 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 the IDEF1X modelling language. The application reference model is independent of any implementation method.

NOTE - The application reference model is presented in a tiled diagram format. The application reference model has been broken up into several smaller groupings that correspond to the UoFs detailed in clause 4.1. Each UoF grouping may be assembled according to the templates shown in Table G.1.

Table G.1 - ARM UoF Templates

Chemical_reaction_data UoF		
Figure G.1		
Control_strategy UoF		
Figure G.2		
Heat_transfer_equipment UoF		
Figure G.3	Figure G.4	
Figure G.5	Figure G.6	
Major_process_equipment UoF		
Figure G.7	Figure G.8	

Table G.1 - ARM UoF Templates (continued)

Mass_transfer_equipment UoF		
Figure G.9	Figure G.10	
Figure G.11	Figure G.12	
Figure G.13	Figure G.14	
Material_data UoF		
Figure G.15	Figure G.16	
Figure G.17	Figure G.18	
Material_transfer_equipment UoF		
Figure G.19	Figure G.20	
Figure G.21	Figure G.22	
Plant_context UoF		
Figure G.23		
Figure G.24	Figure G.25	
Plant_item_definition UoF		
Figure G.26	Figure G.27	
Figure G.28	Figure G.29	
Figure G.30	Figure G.31	
Plant_system_definition UoF		
Figure G.32		
Process_description UoF		
Figure G.33		

Table G.1 - ARM UoF Templates (concluded)

Process_flow_diagram UoF		
Figure G.34		
Process_simulation_data UoF		
Figure G.35		
Figure G.36		
Process_vessel_equipment UoF		
Figure G.37	Figure G.38	
Figure G.39	Figure G.40	
Stream_data UoF		
Figure G.41	Figure G.42	
	Figure G.43	
Substance_experimental_data UoF		
Figure G.44		
Substance_model_data UoF		
Figure G.45	Figure G.46	
Figure G.47		
Unit_operation UoF		
Figure G.48	Figure G.49	Figure G.50
Figure G.51	Figure G.52	Figure G.53

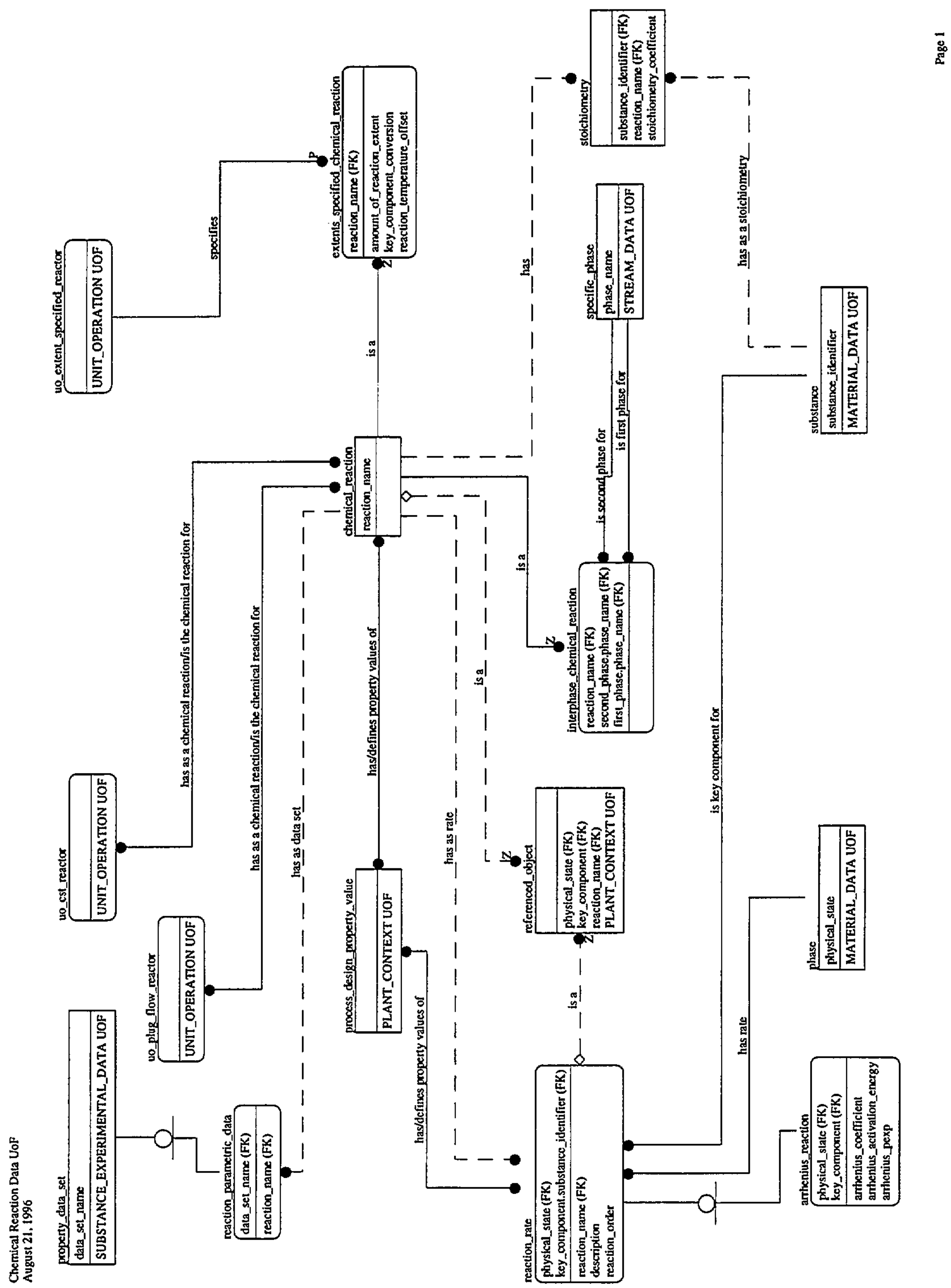


Figure G.1 - ARM Chemical_reaction_data UoF diagram 1 of 1

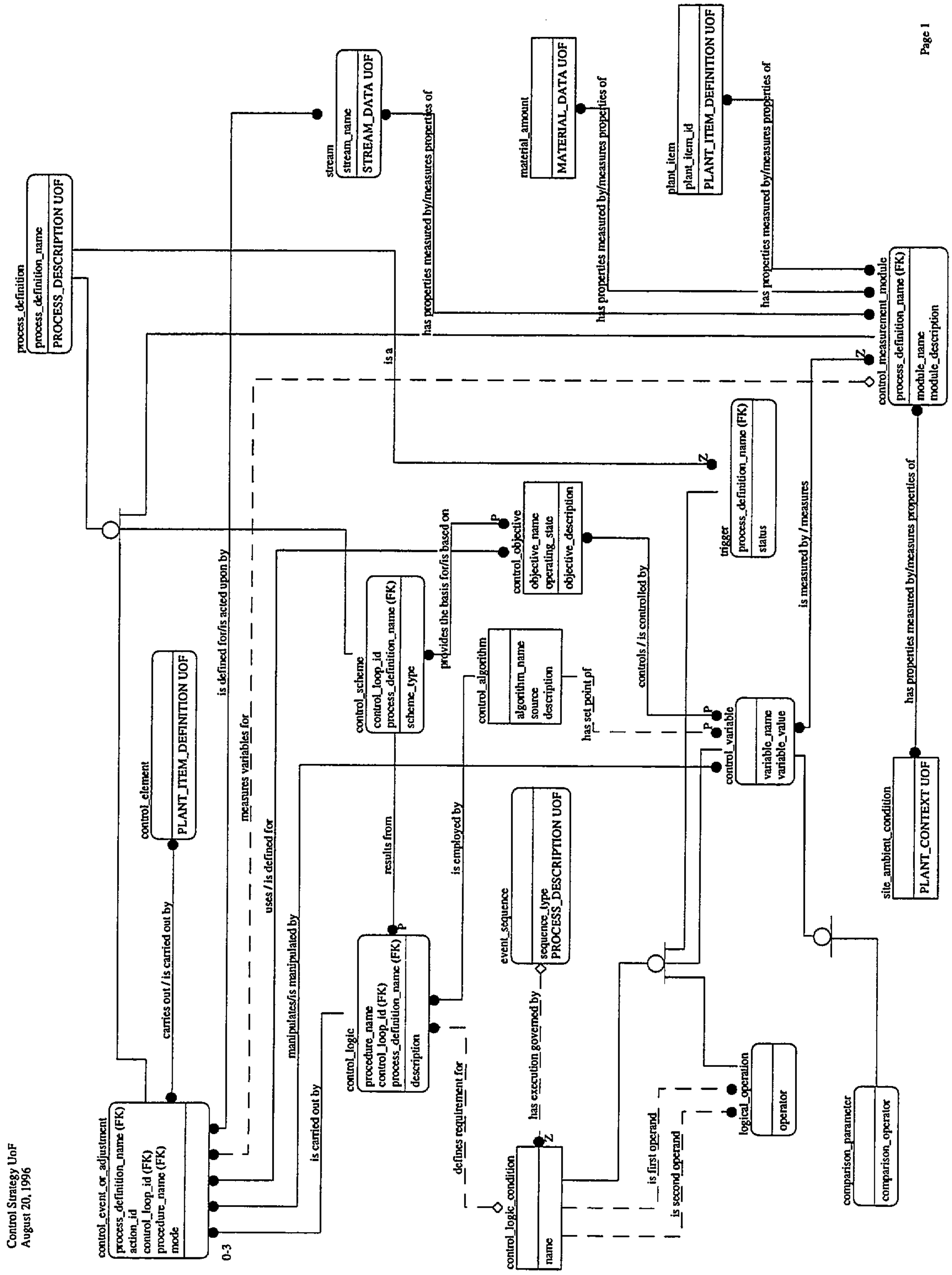


Figure G.2 - ARM Control_strategy UoF diagram 1 of 1

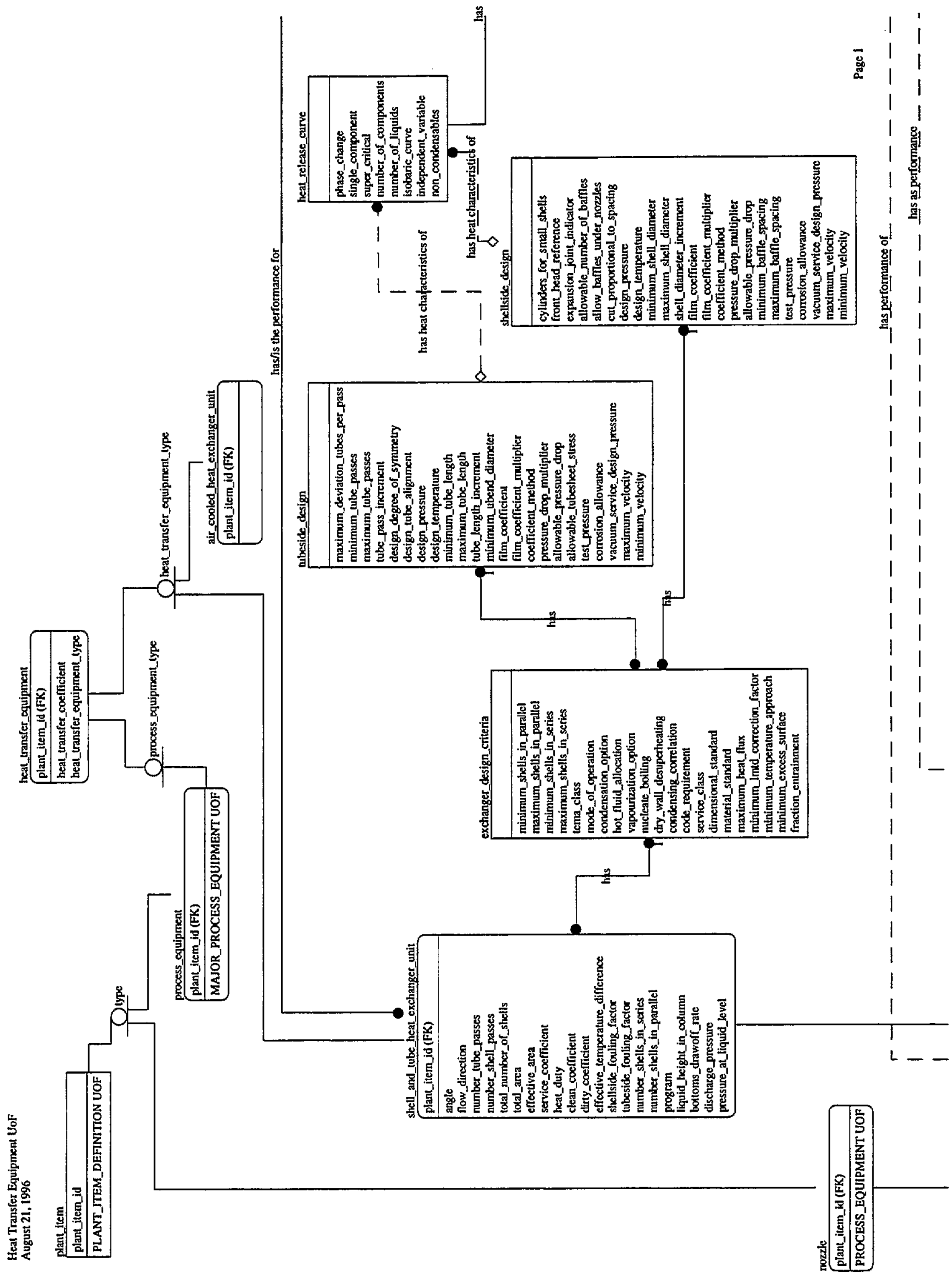


Figure G.3 - ARM Heat_transfer_equipment UoF diagram 1 of 4

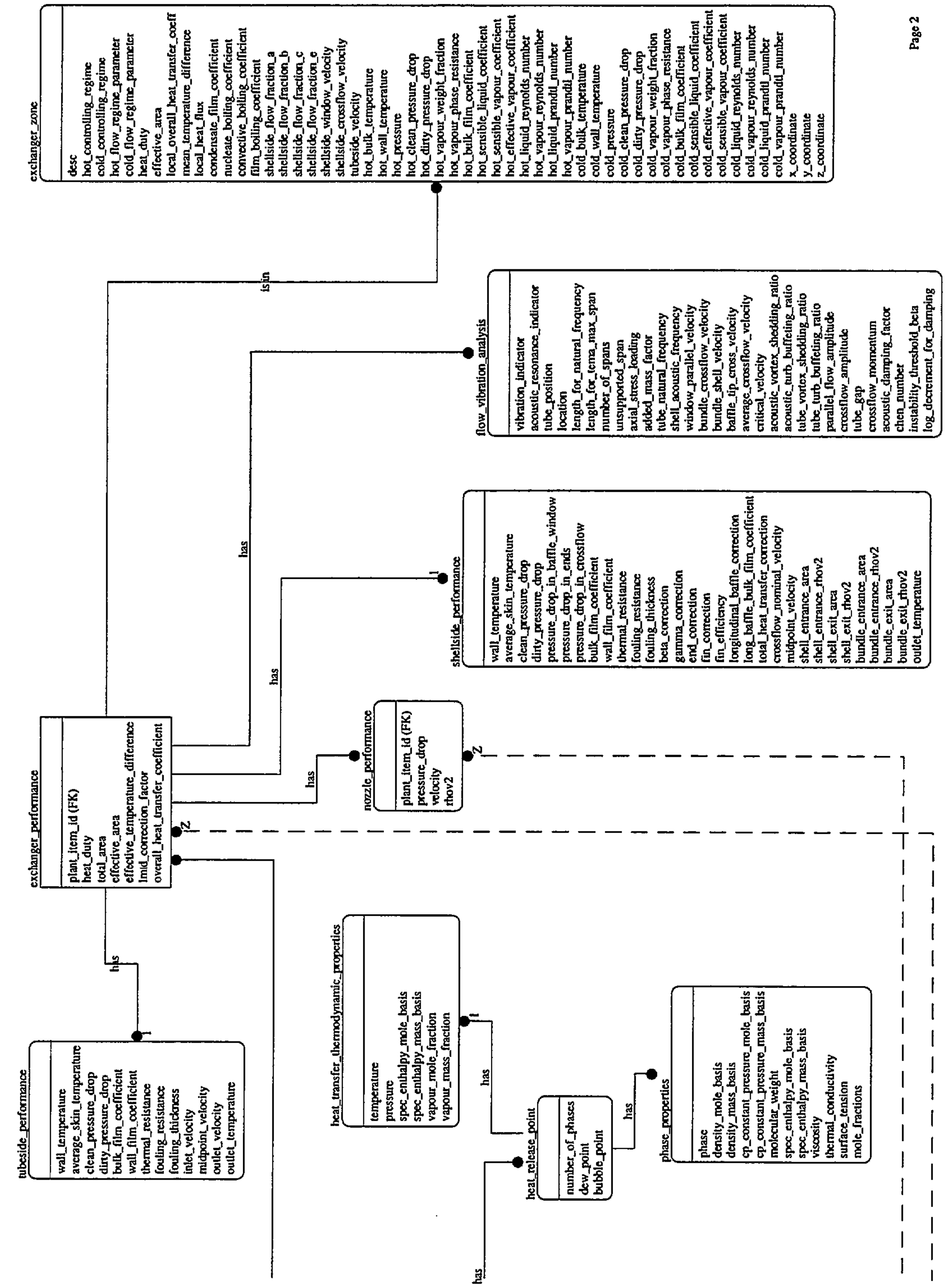


Figure G.4 - ARM Heat_transfer_equipment UoF diagram 2 of 4

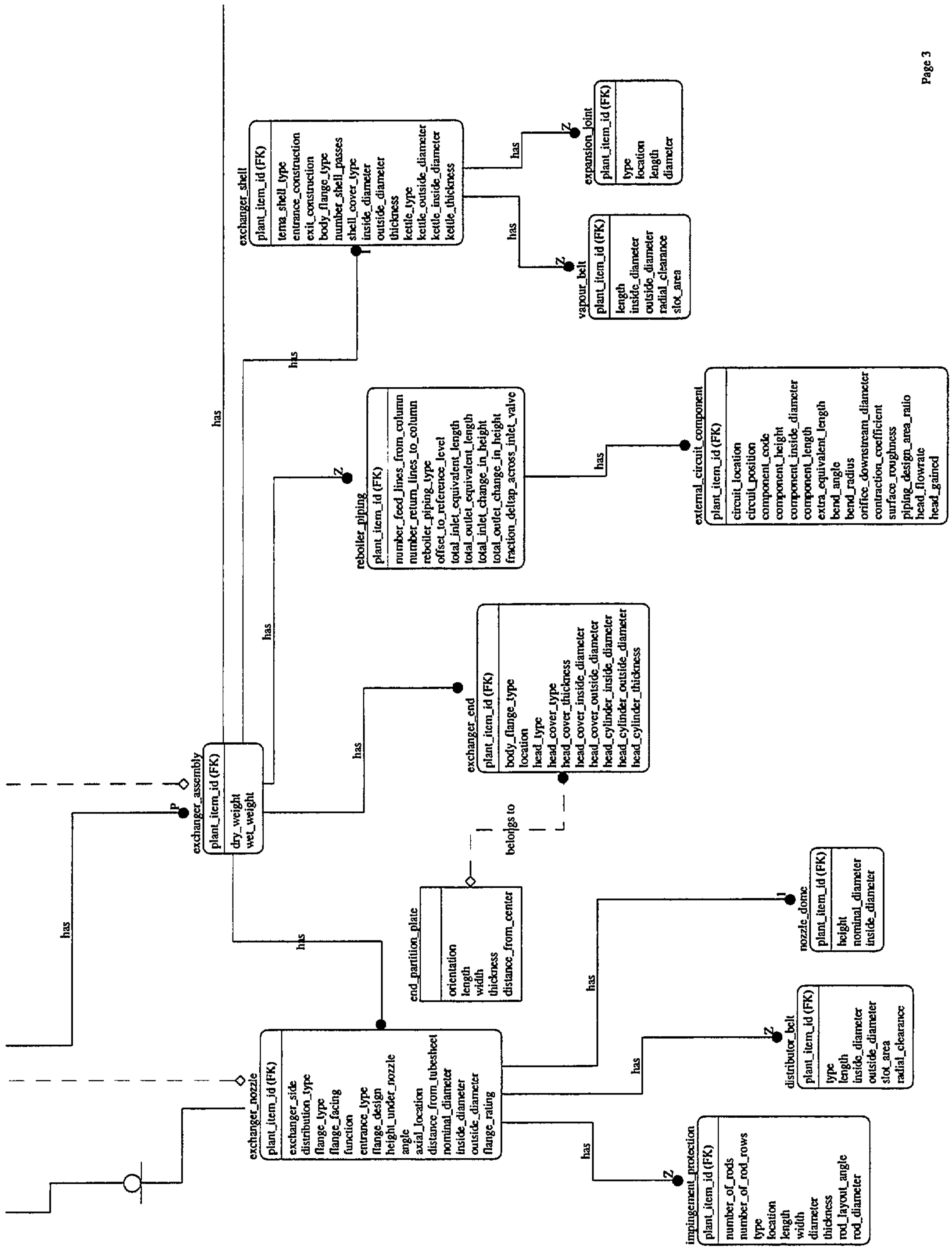


Figure G.5 - ARM Heat_transfer_equipment UoF diagram 3 of 4

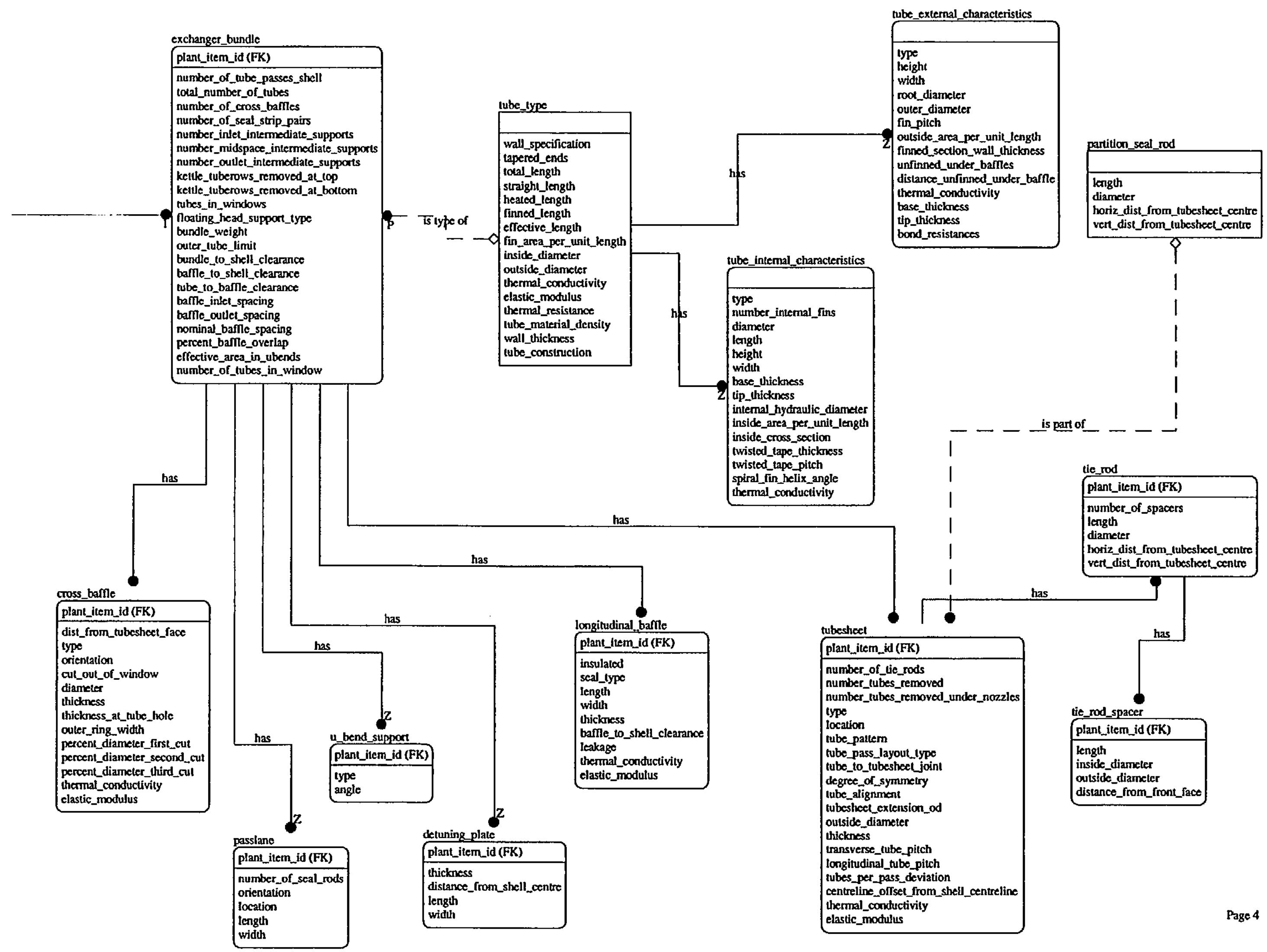


Figure G.6 - ARM Heat_transfer_equipment UoF diagram 4 of 4

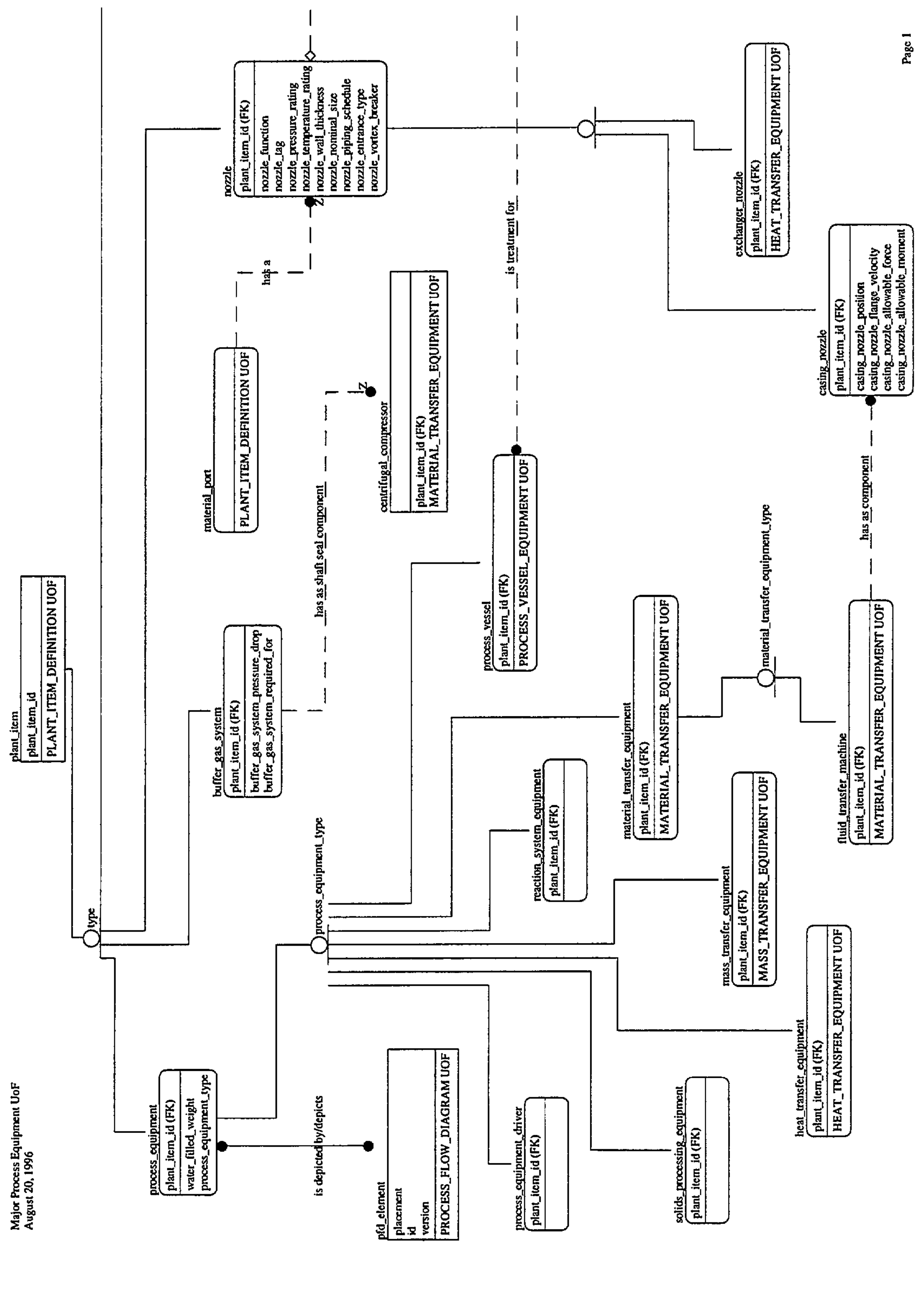


Figure G.7 - ARM Major_process_equipment UoF diagram 1 of 2

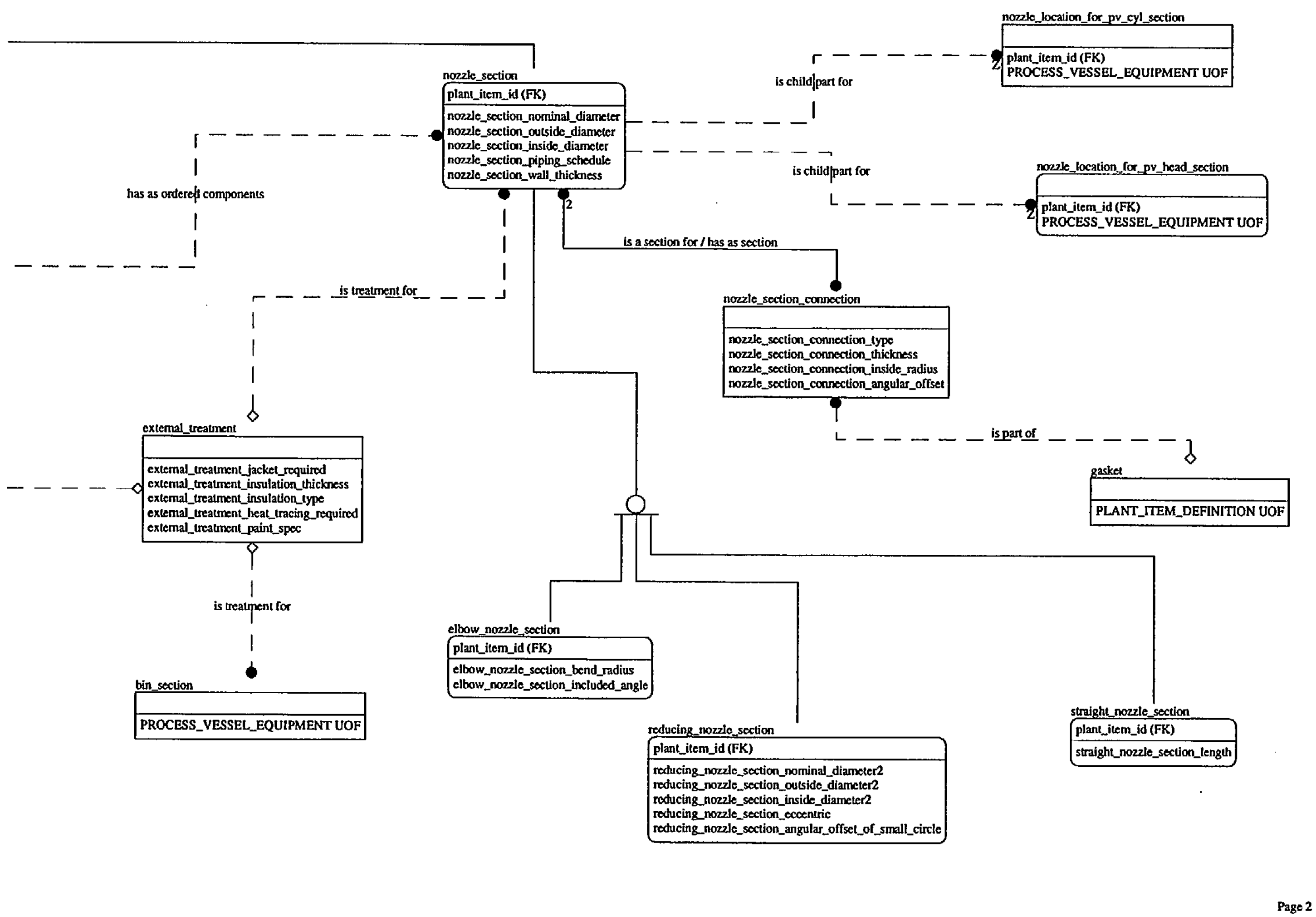


Figure G.8 - ARM Major_process_equipment UoF diagram 2 of 2

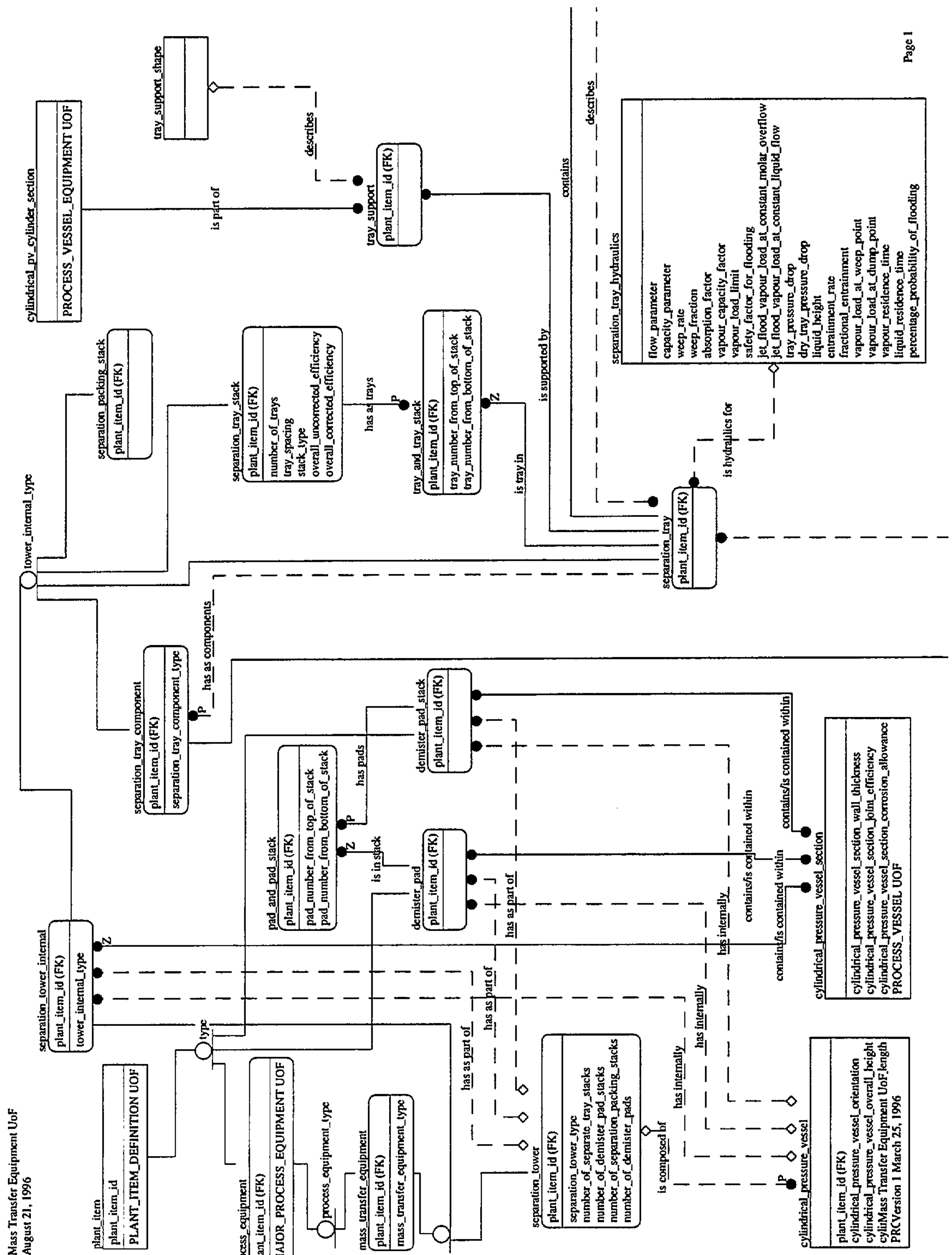


Figure G.9 - ARM Mass_transfer_equipment UoF diagram 1 of 6

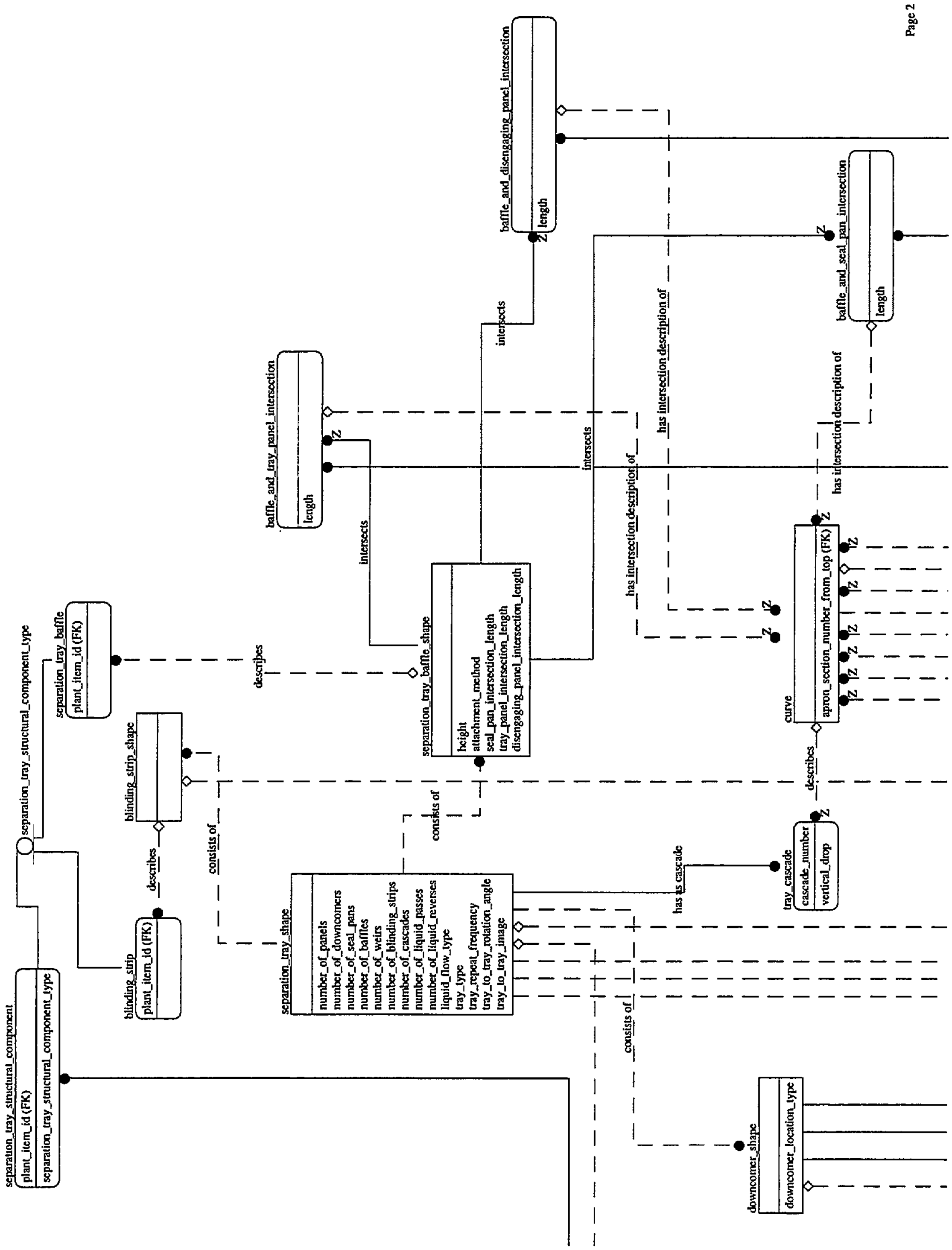


Figure G.10 - ARM Mass_transfer_equipment UoF diagram 2 of 6

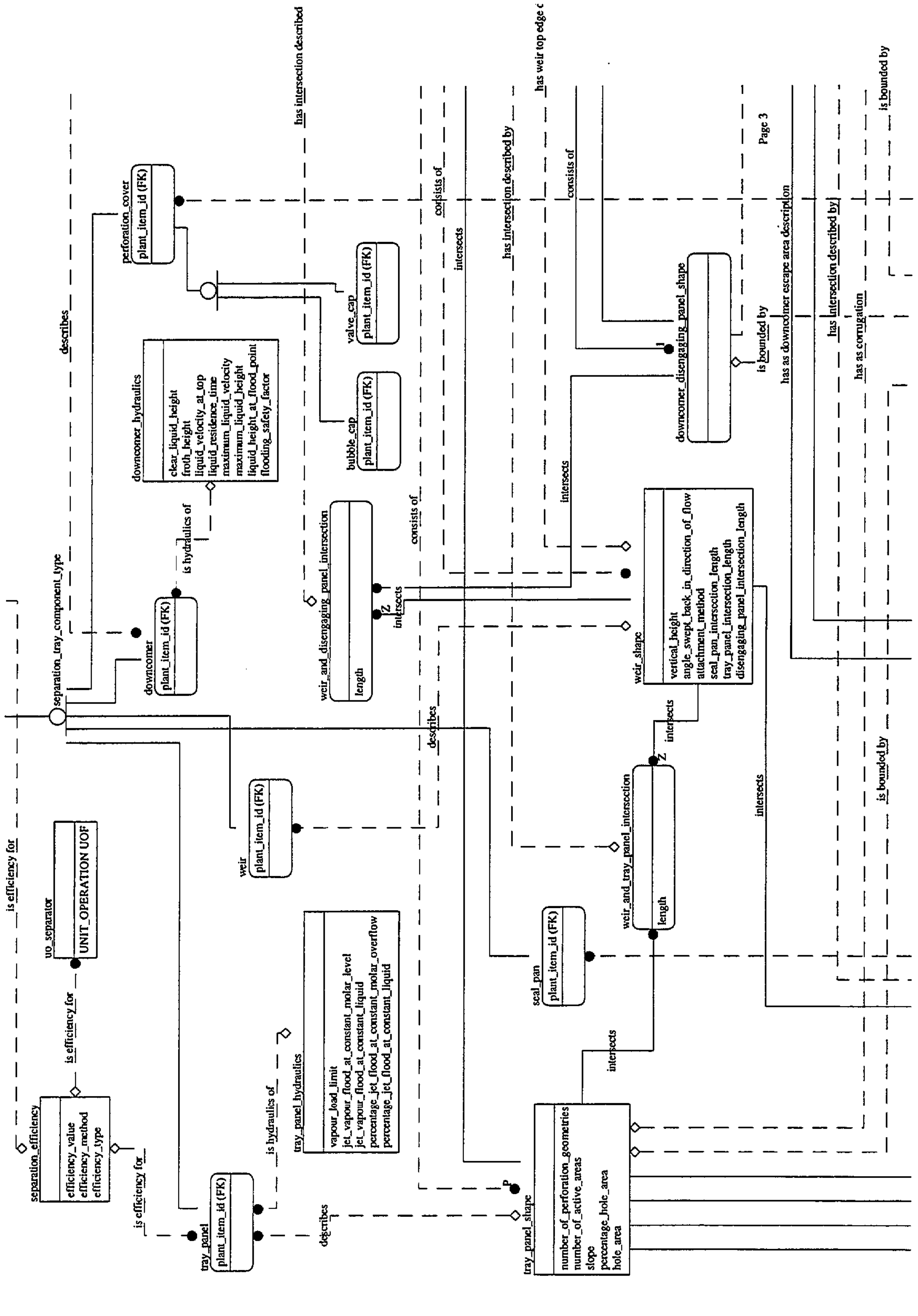


Figure G.11 - ARM Mass_transfer_equipment UoF diagram 3 of 6

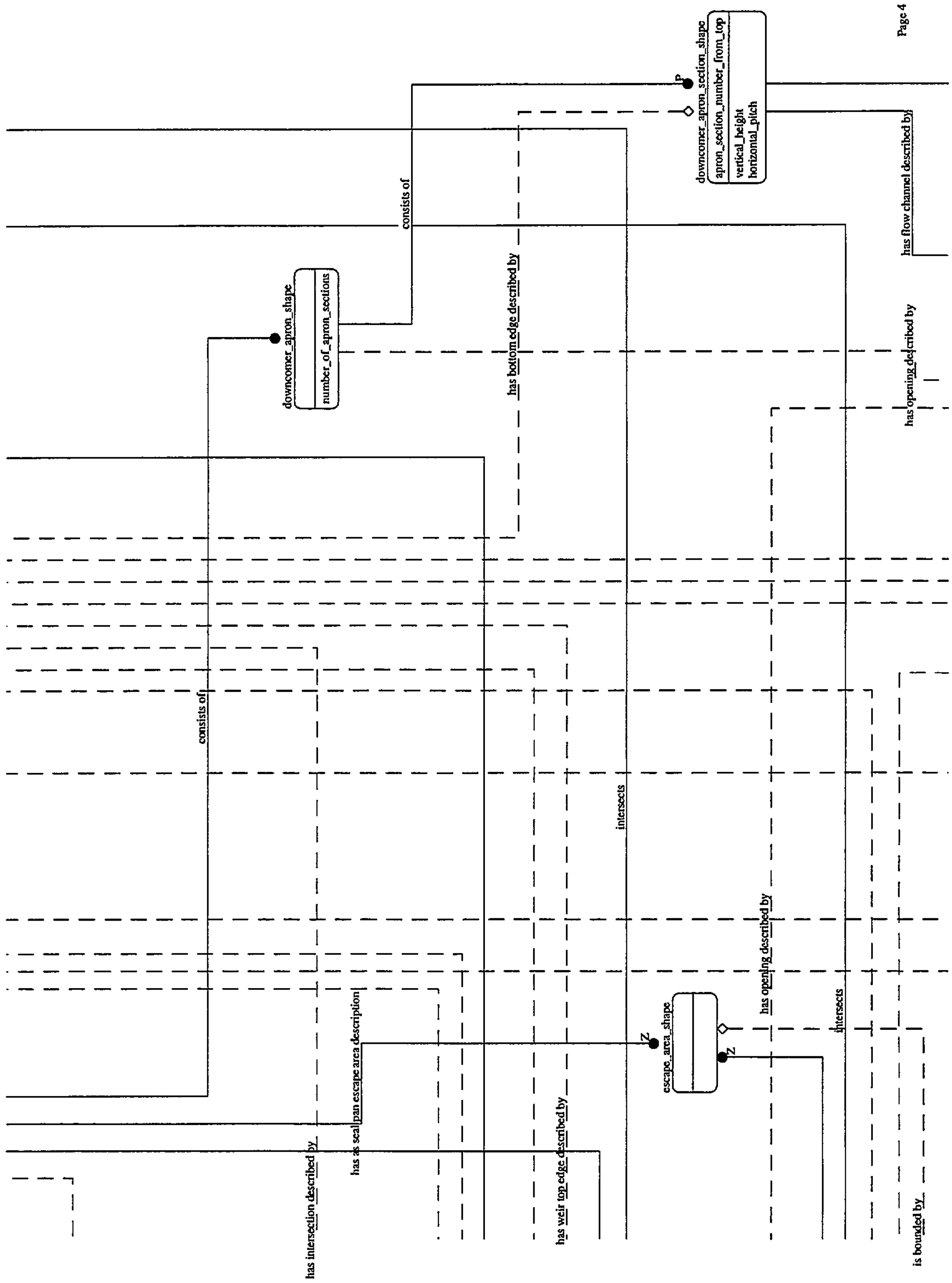


Figure G.12 - ARM Mass_transfer_equipment UoF diagram 4 of 6

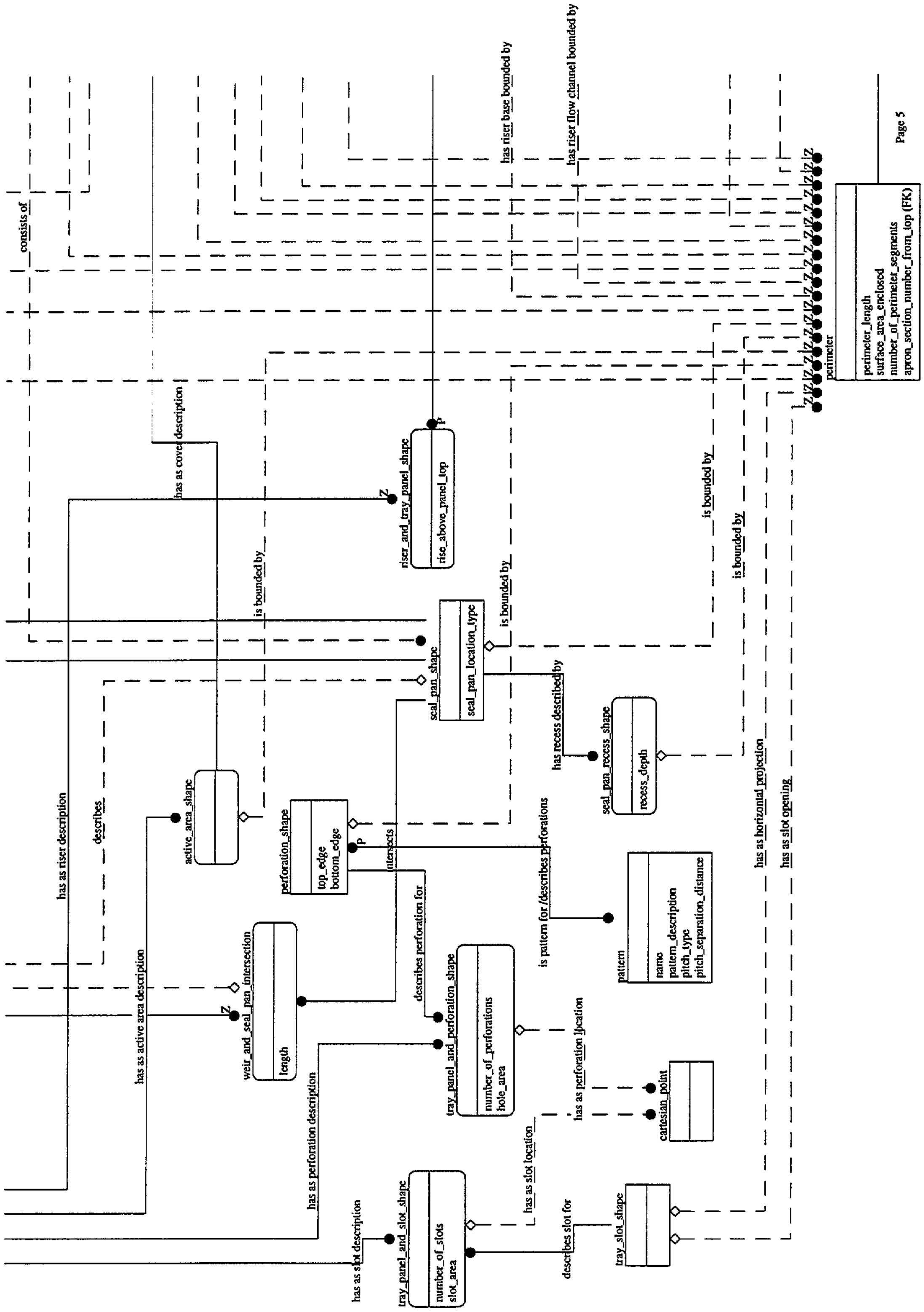


Figure G.13 - ARM Mass_transfer_equipment UoF diagram 5 of 6

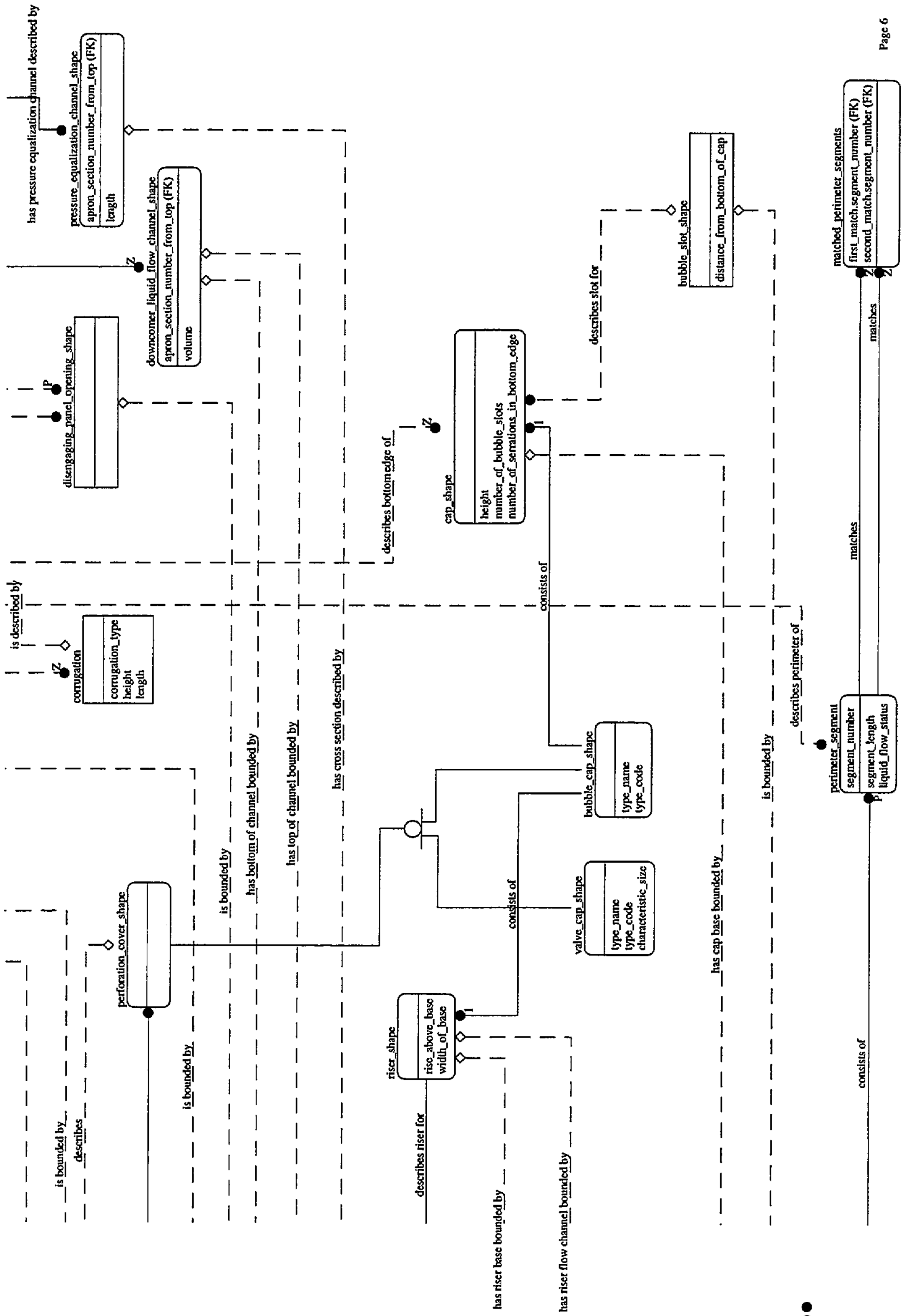


Figure G.14 - ARM Mass_transfer_equipment UoF diagram 6 of 6

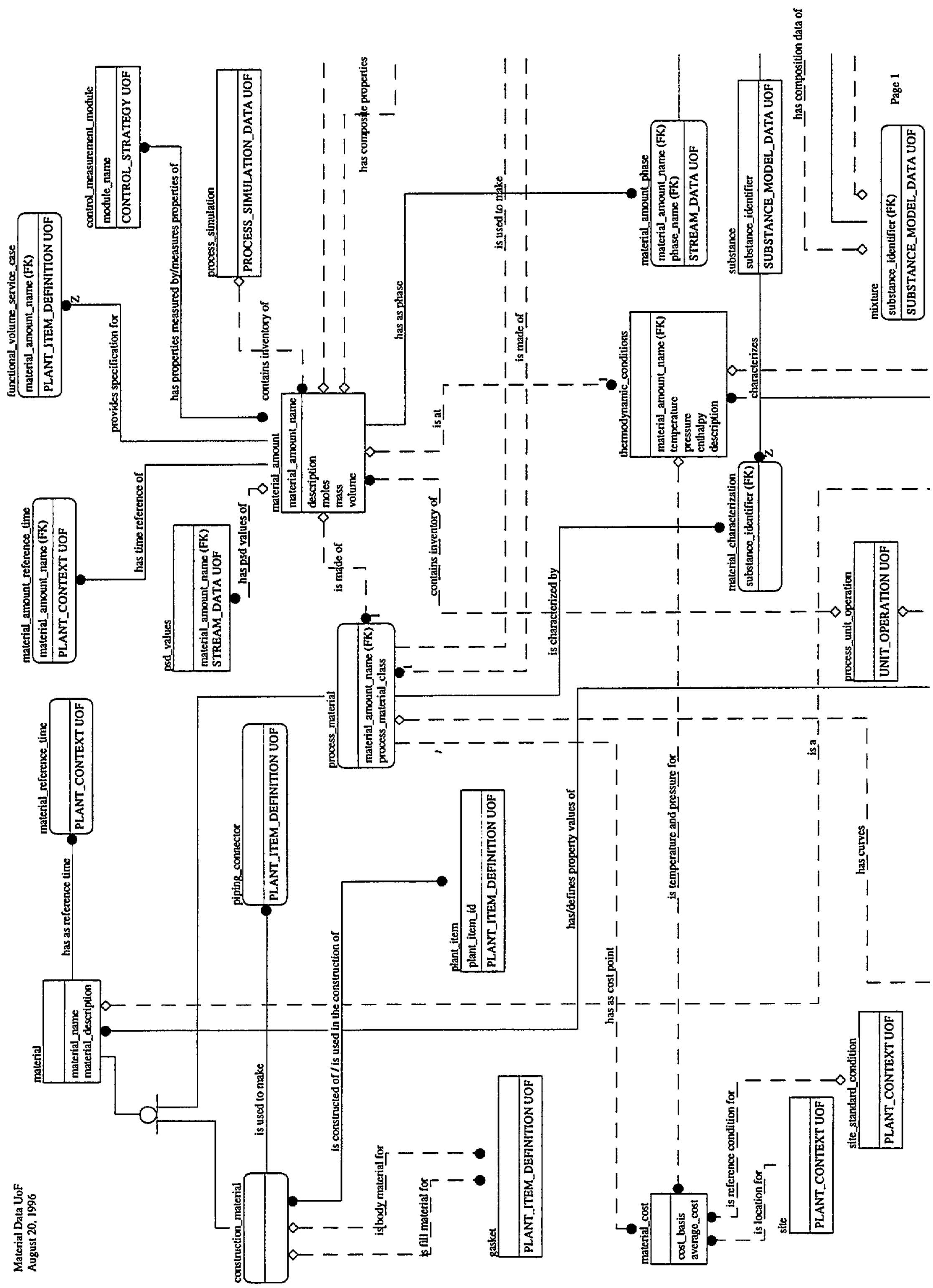


Figure G.15 - ARM Material_data UoF diagram 1 of 4

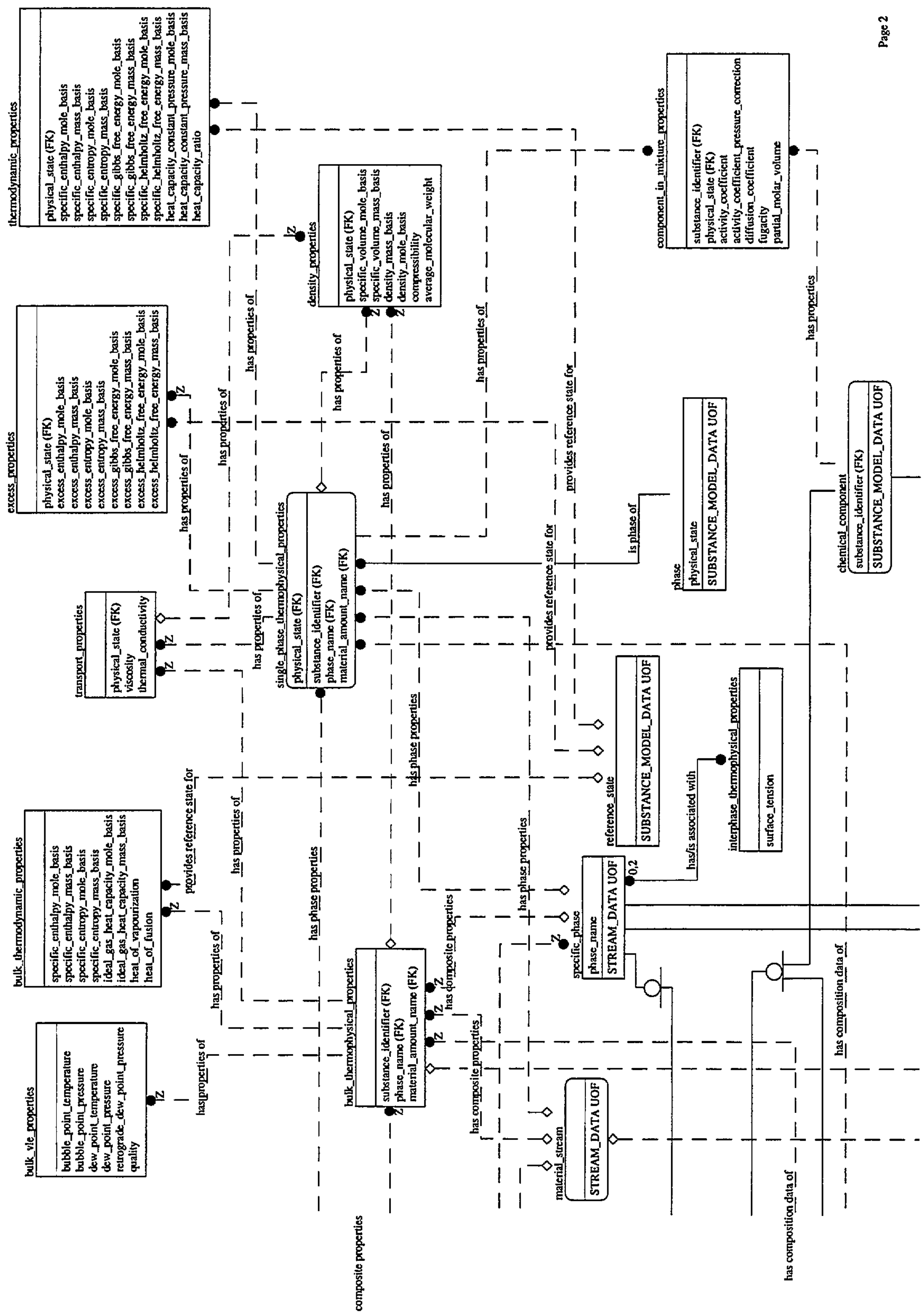


Figure G.16 - ARM Material_data UoF diagram 2 of 4

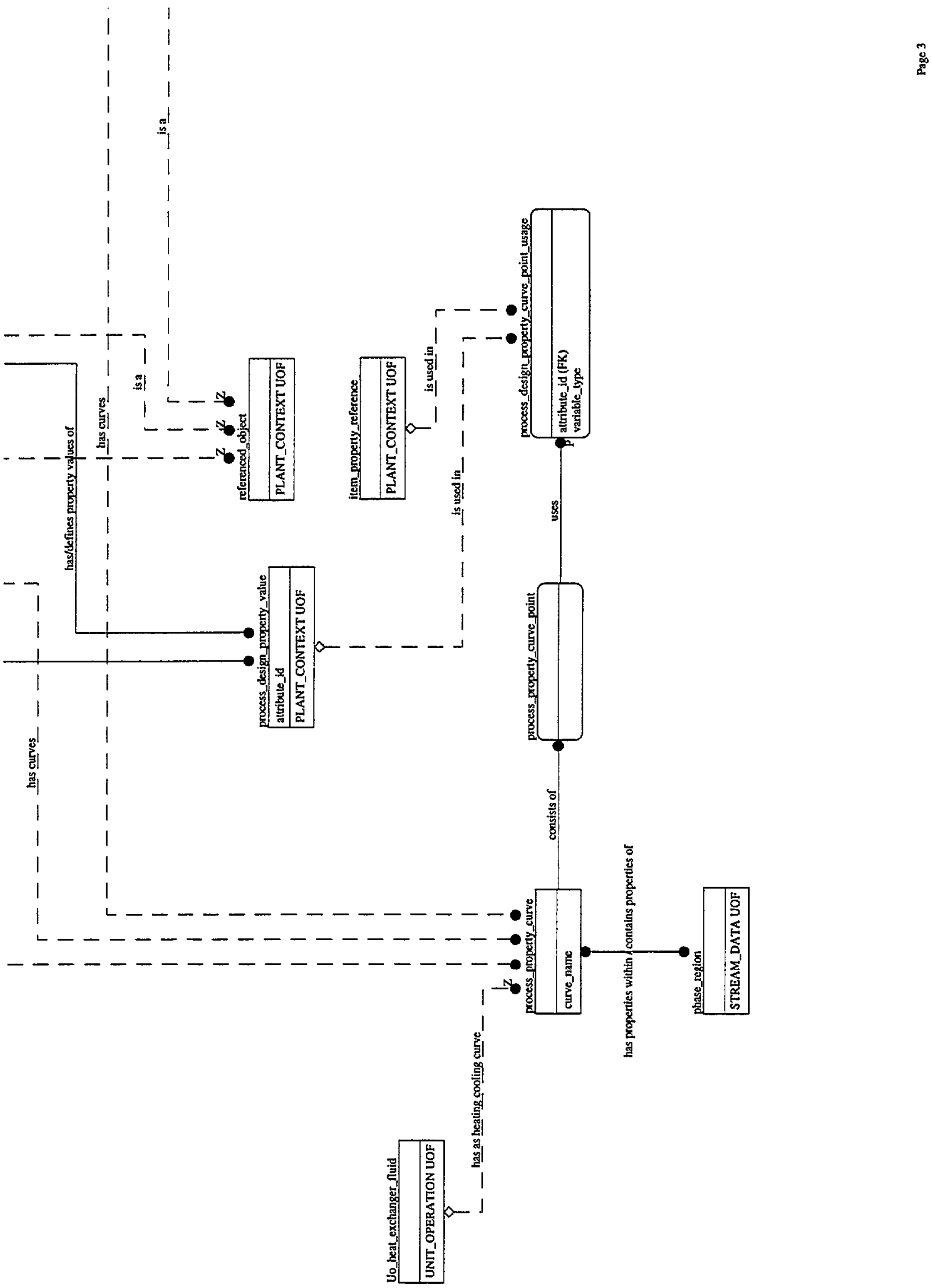


Figure G.17 - ARM Material_data UoF diagram 3 of 4

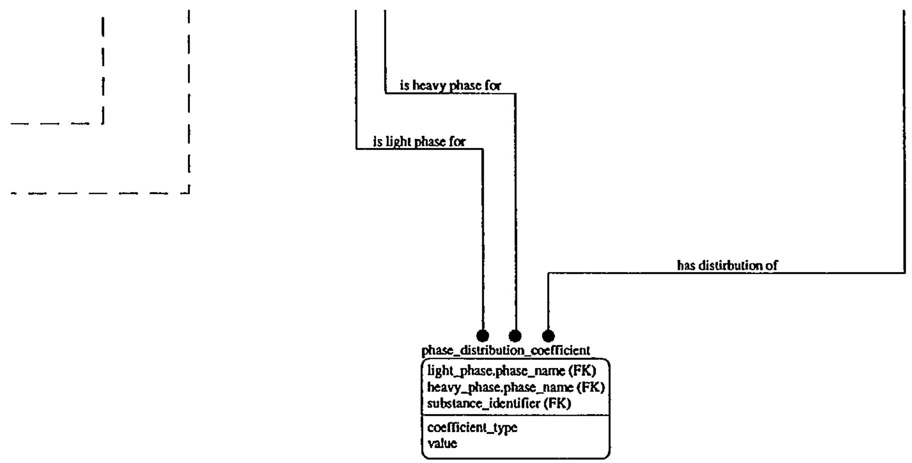


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Figure G.18 - ARM Material_data UoF diagram 4 of 4

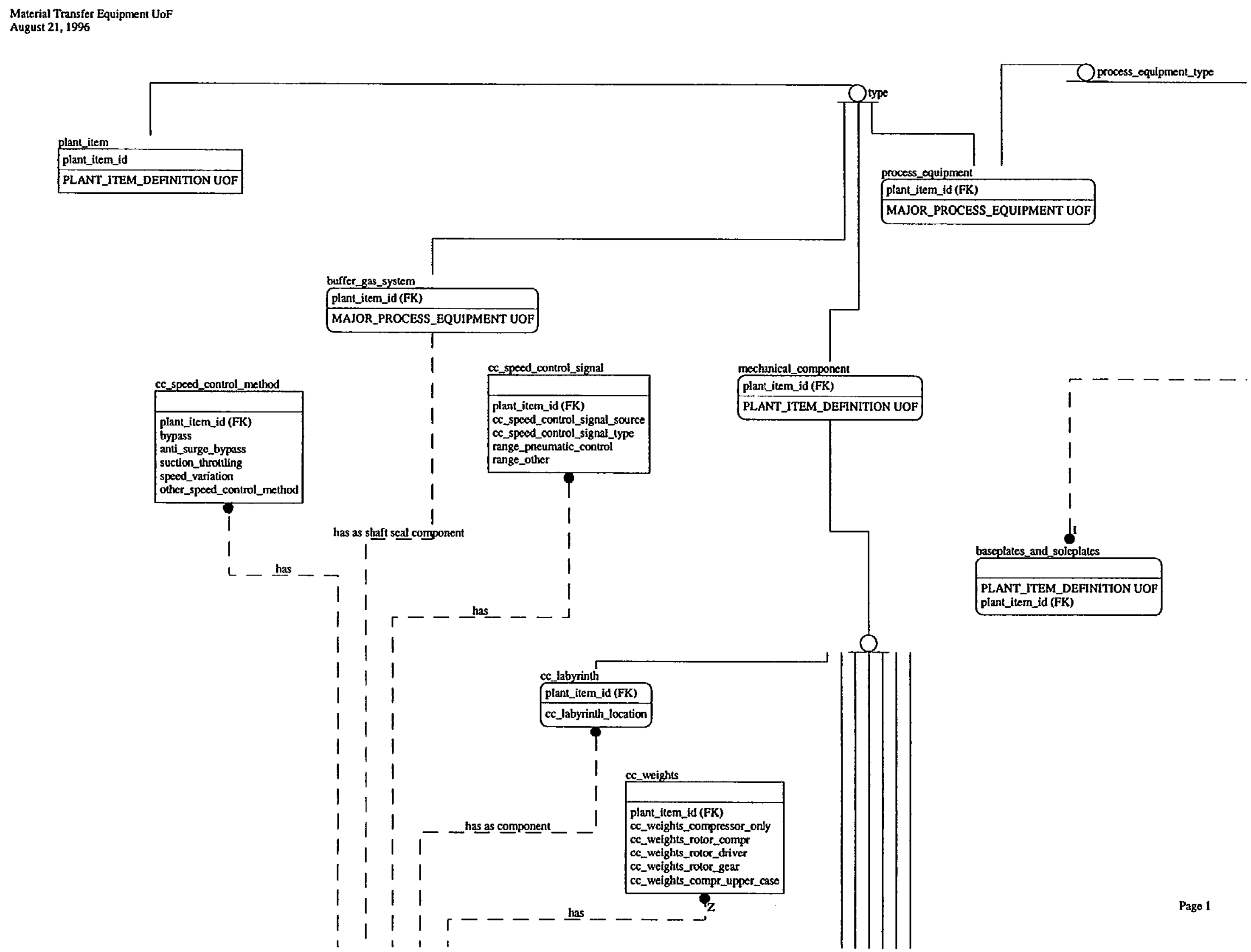

Figure G.19 - ARM Material_transfer_equipment UoF diagram 1 of 4

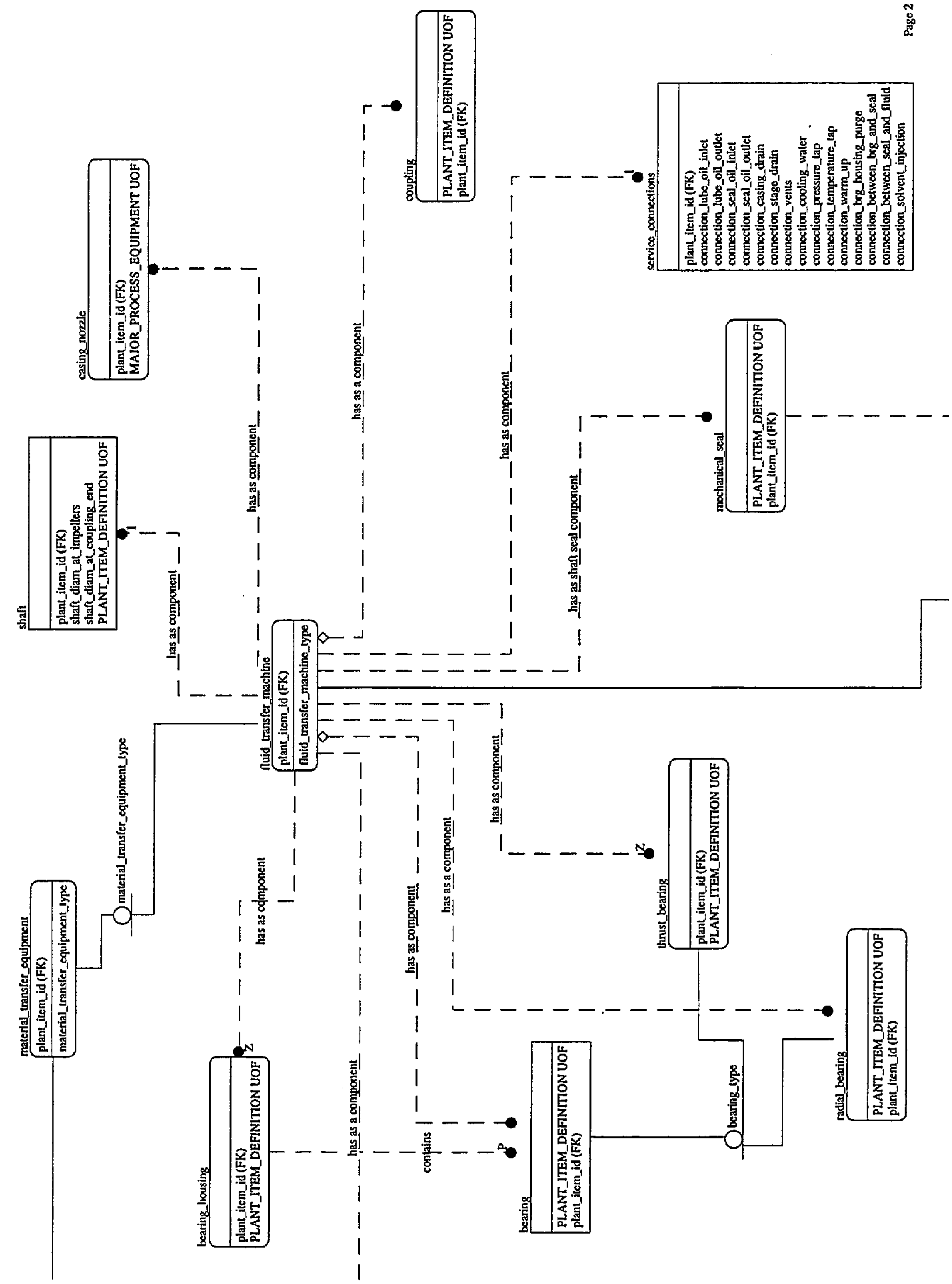

Figure G.20 - ARM Material_transfer_equipment UoF diagram 2 of 4

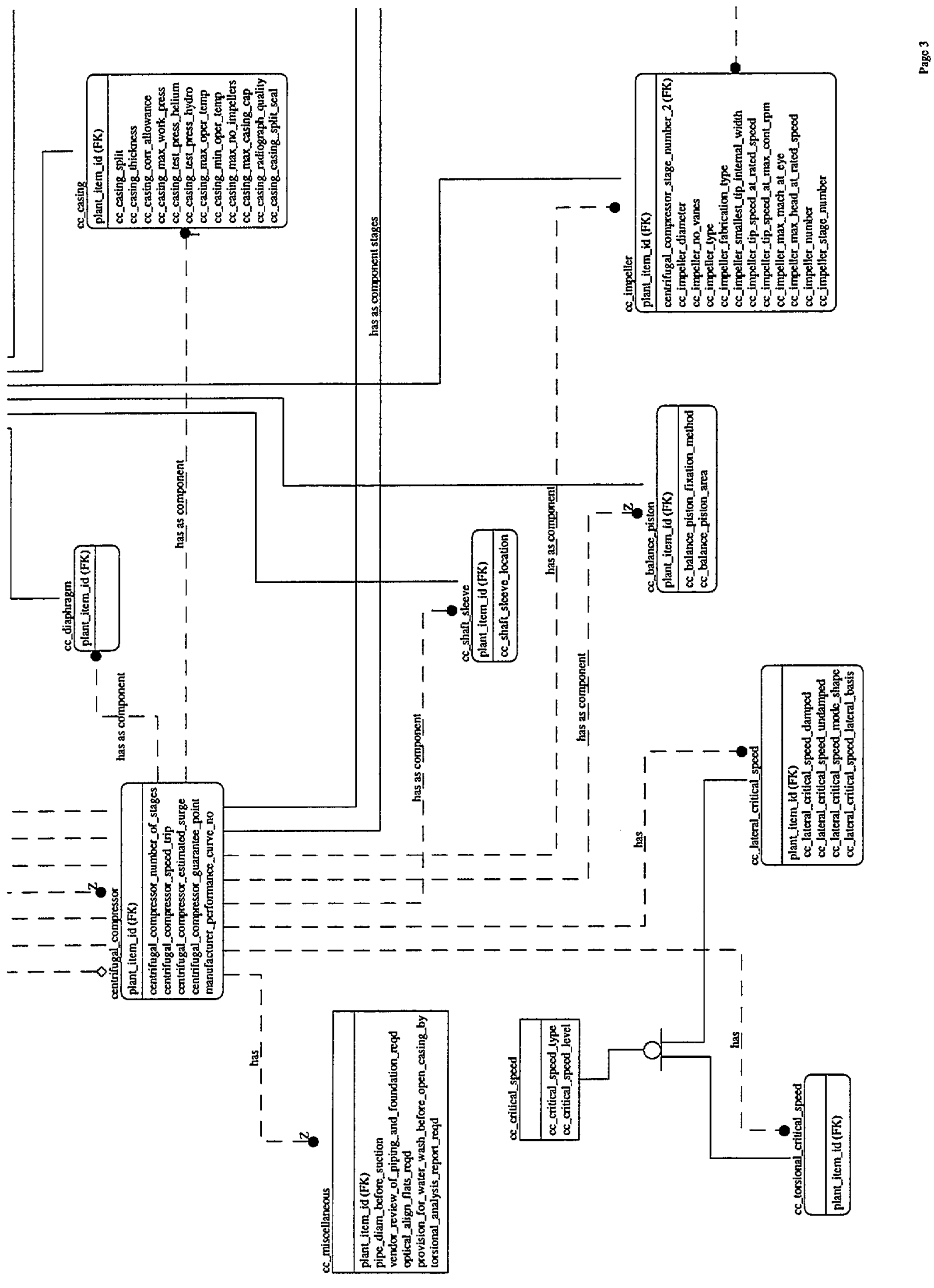

Figure G.21 - ARM Material transfer_equipment UoF diagram 3 of 4

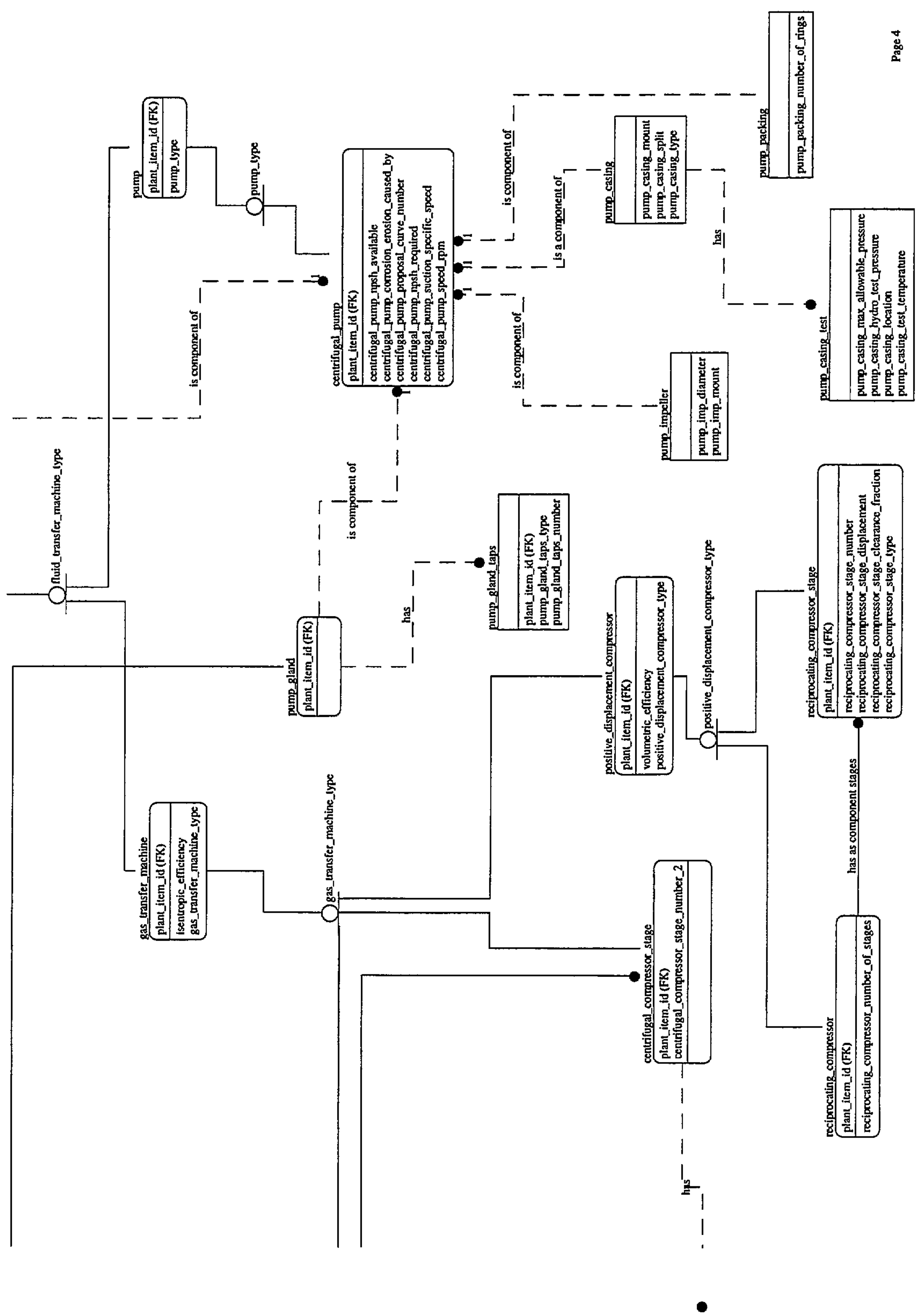

Figure G.22 - ARM Material_transfer_equipment UoF diagram 4 of 4

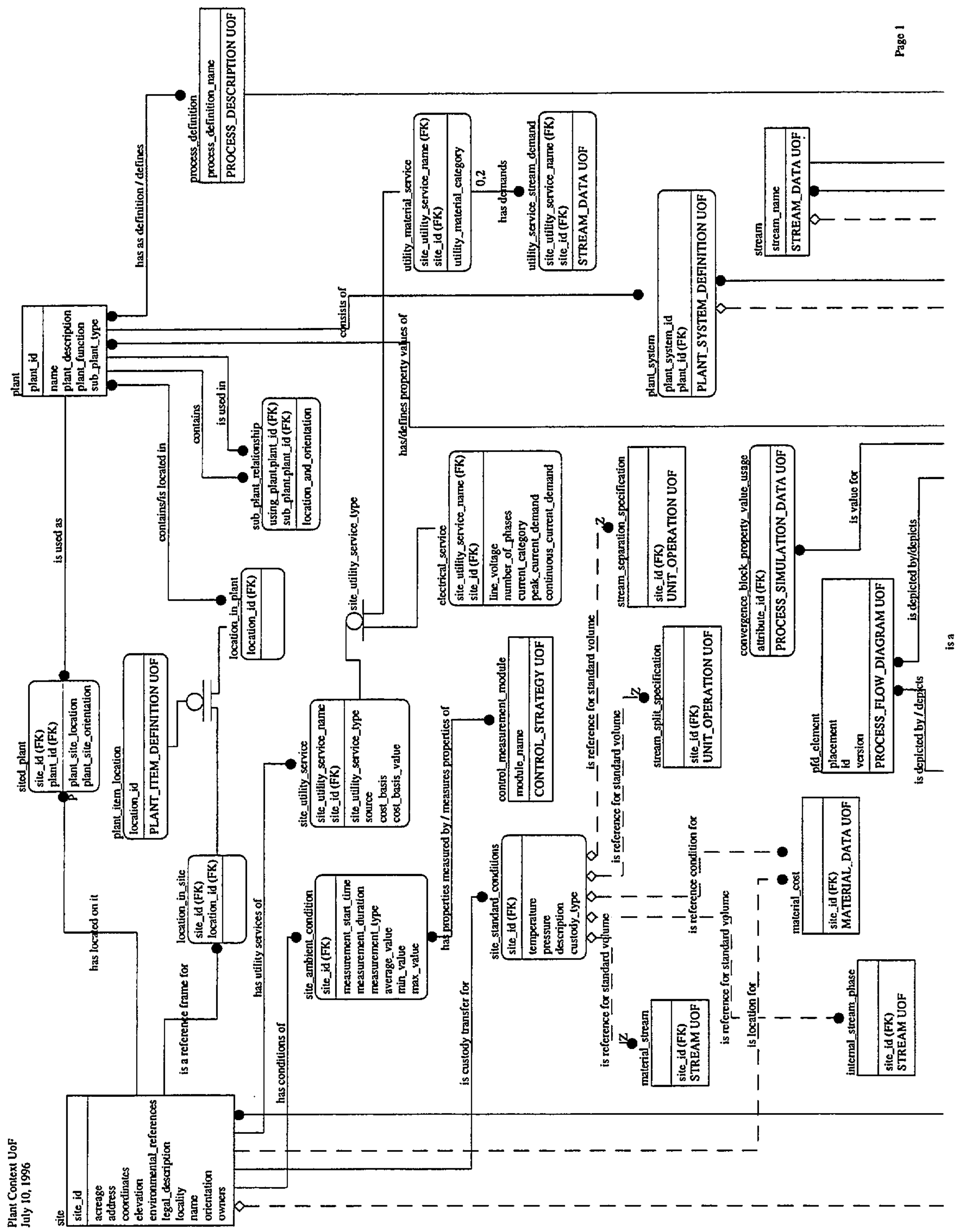

Figure G.23 - ARM Plant_context UoF diagram 1 of 3

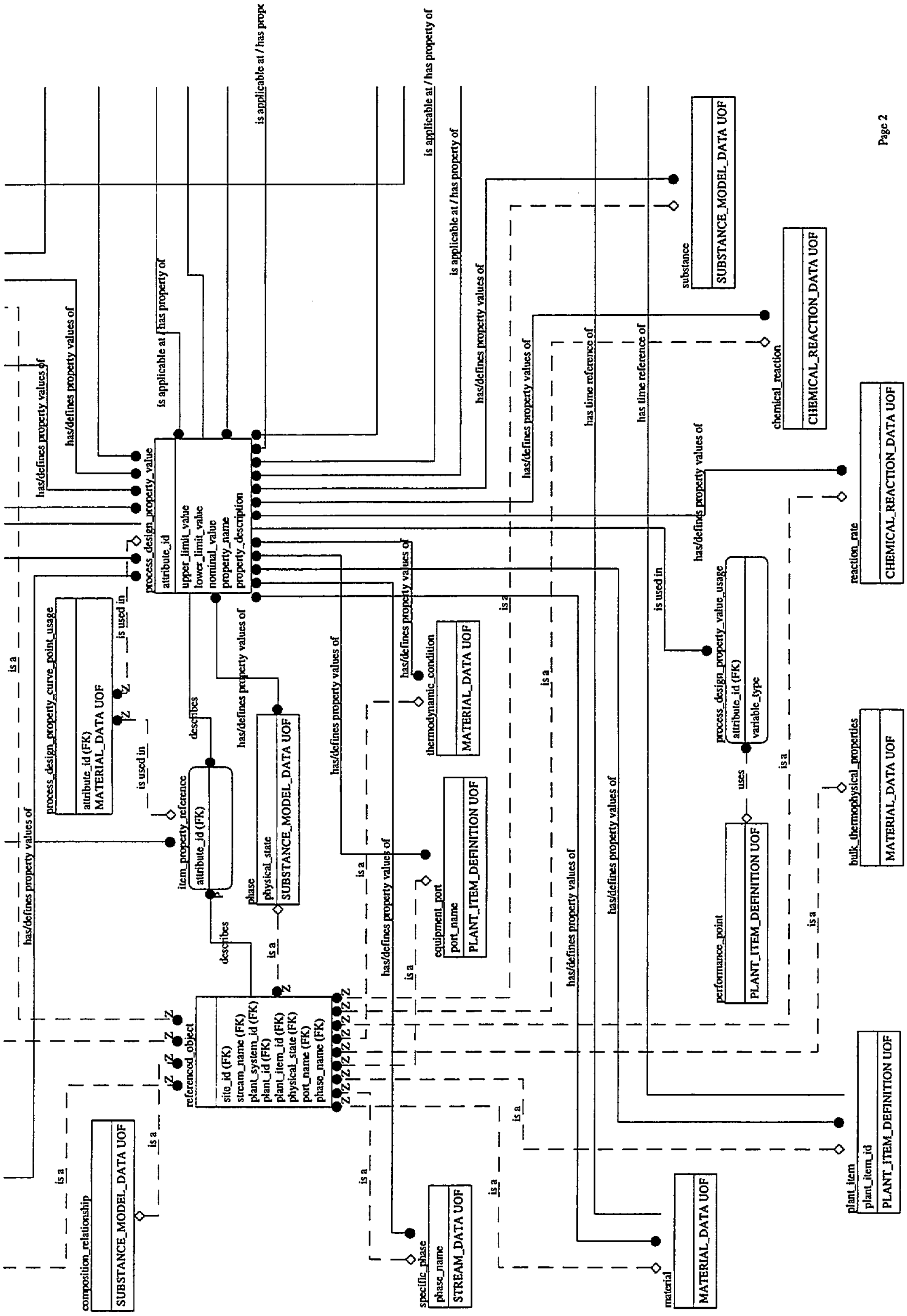

Figure G.24 - ARM Plant_context UoF diagram 2 of 3

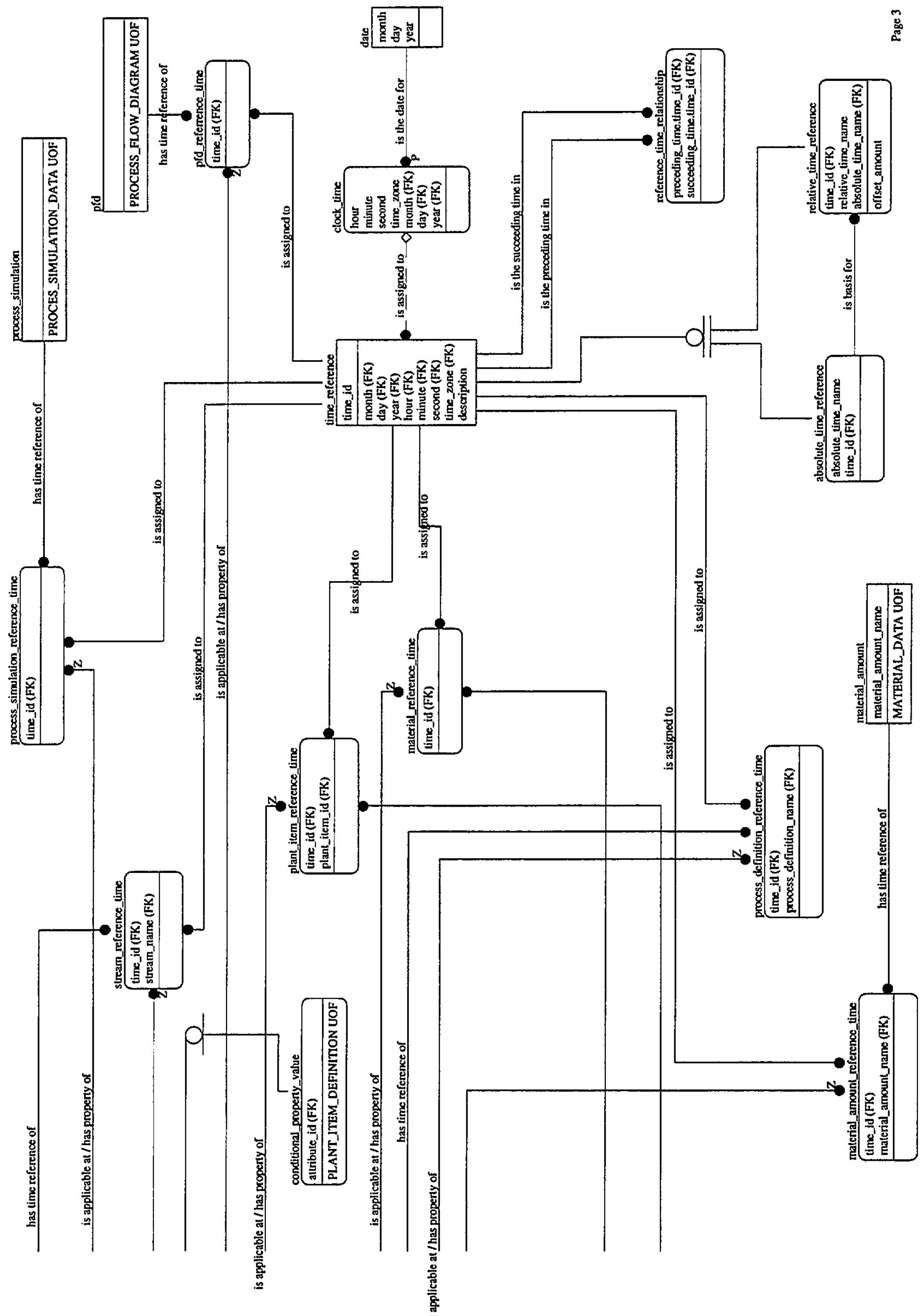

Figure G.25 - ARM Plant_context UoF diagram 3 of 3

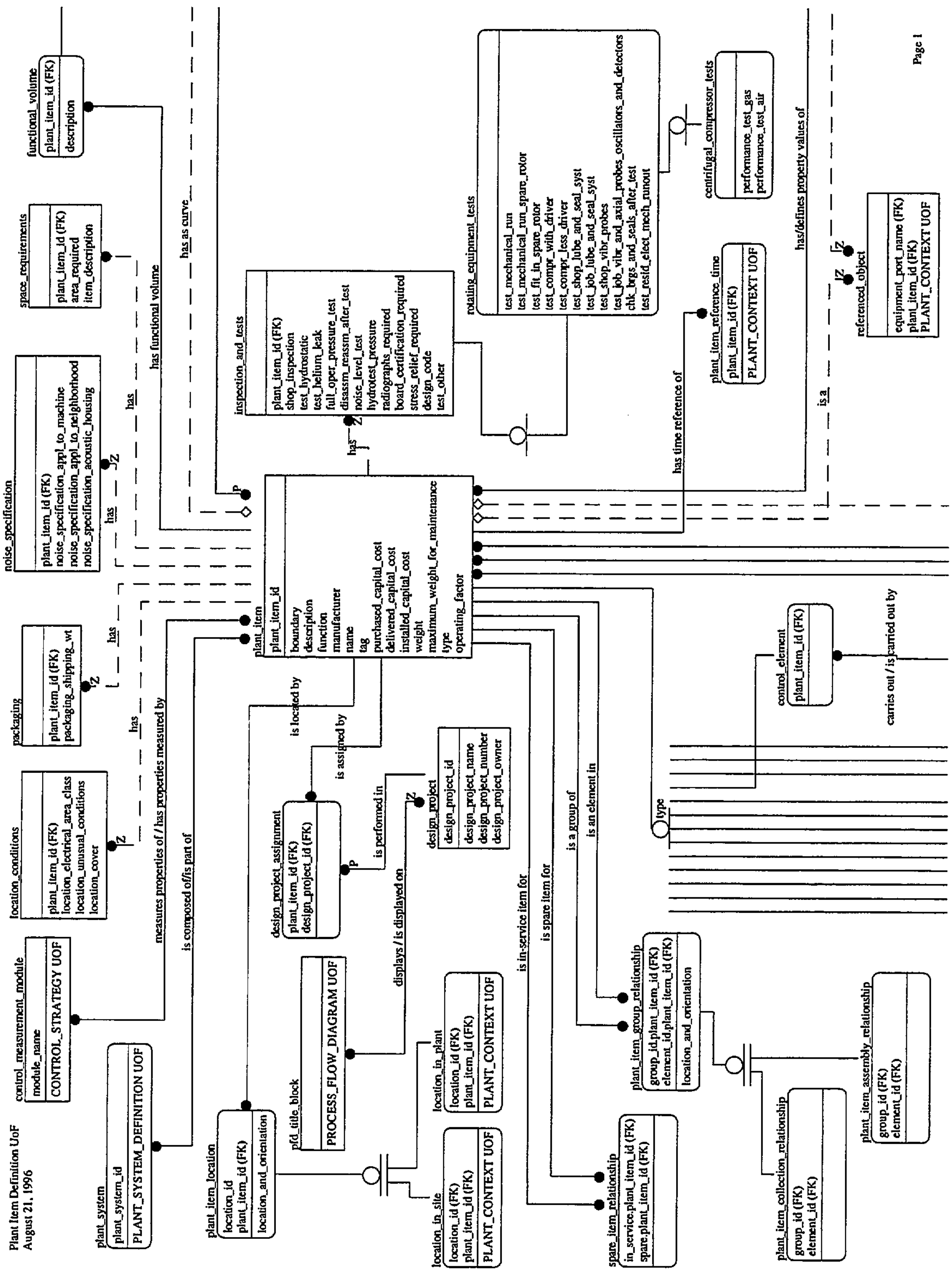

Figure G.26 - ARM Plant_item_definition UoF diagram 1 of 6

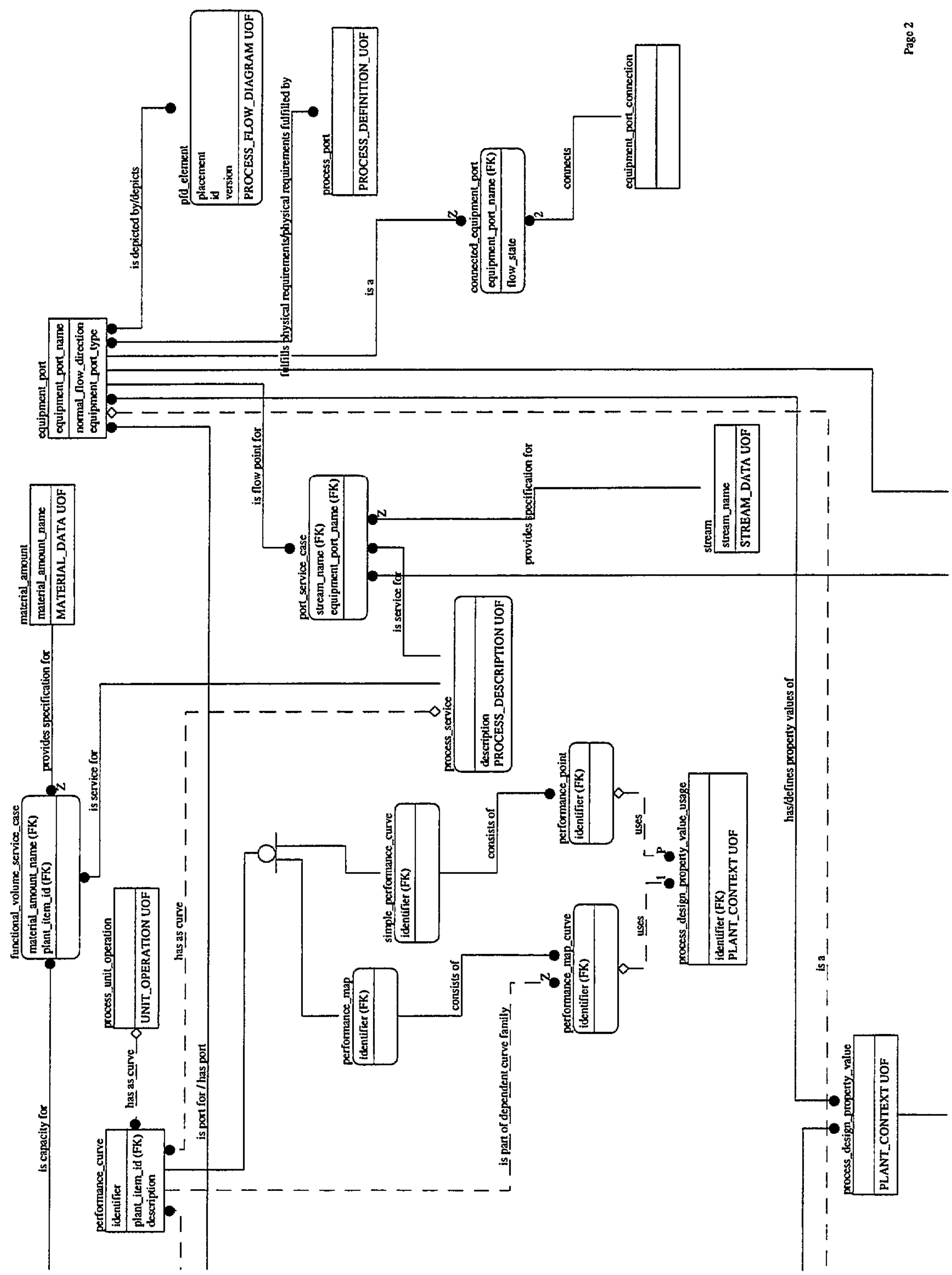

Figure G.27 - ARM Plant_item_definition UoF diagram 2 of 6

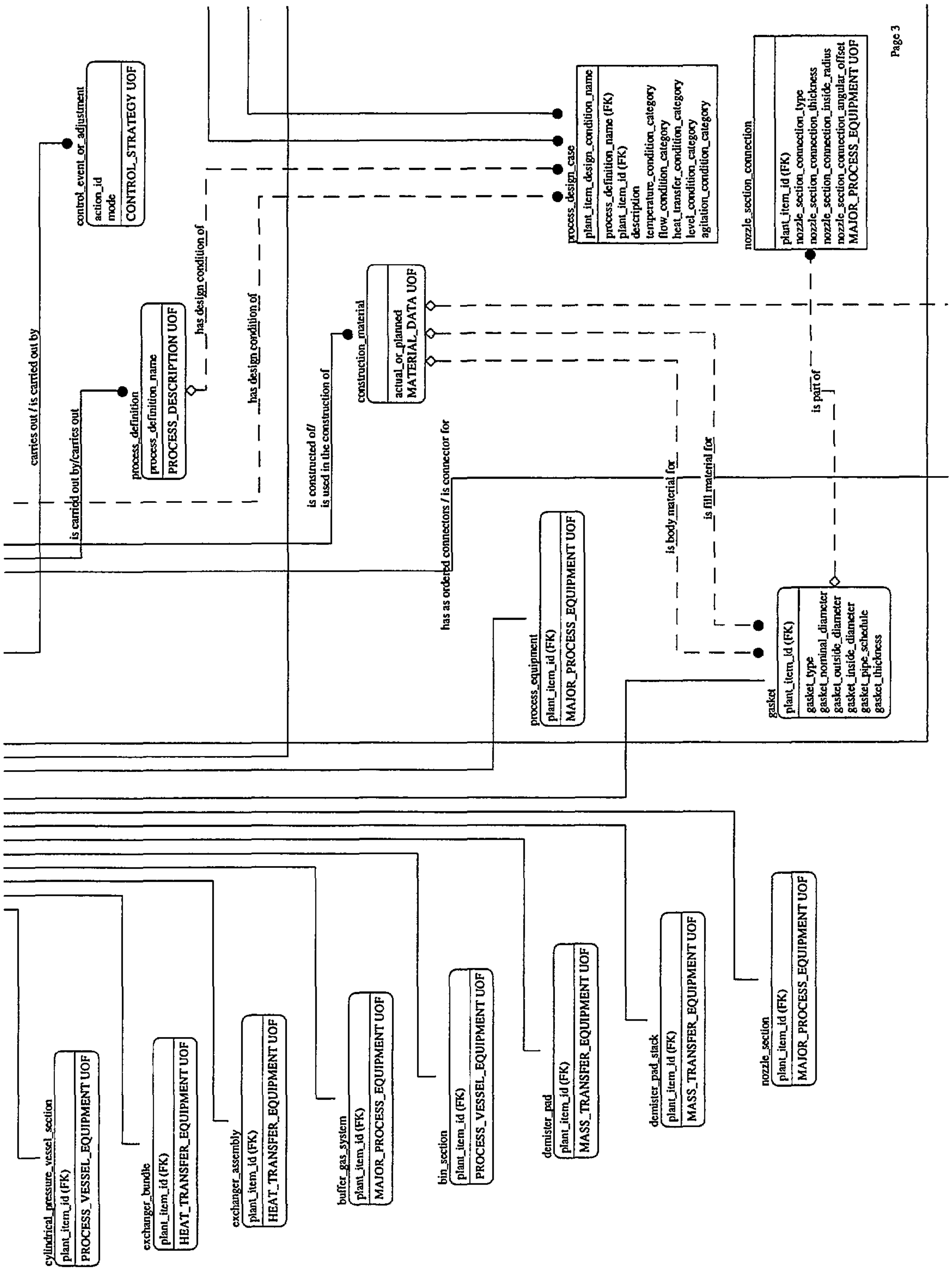

Figure G.28 - ARM Plant_item_definition UoF diagram 3 of 6

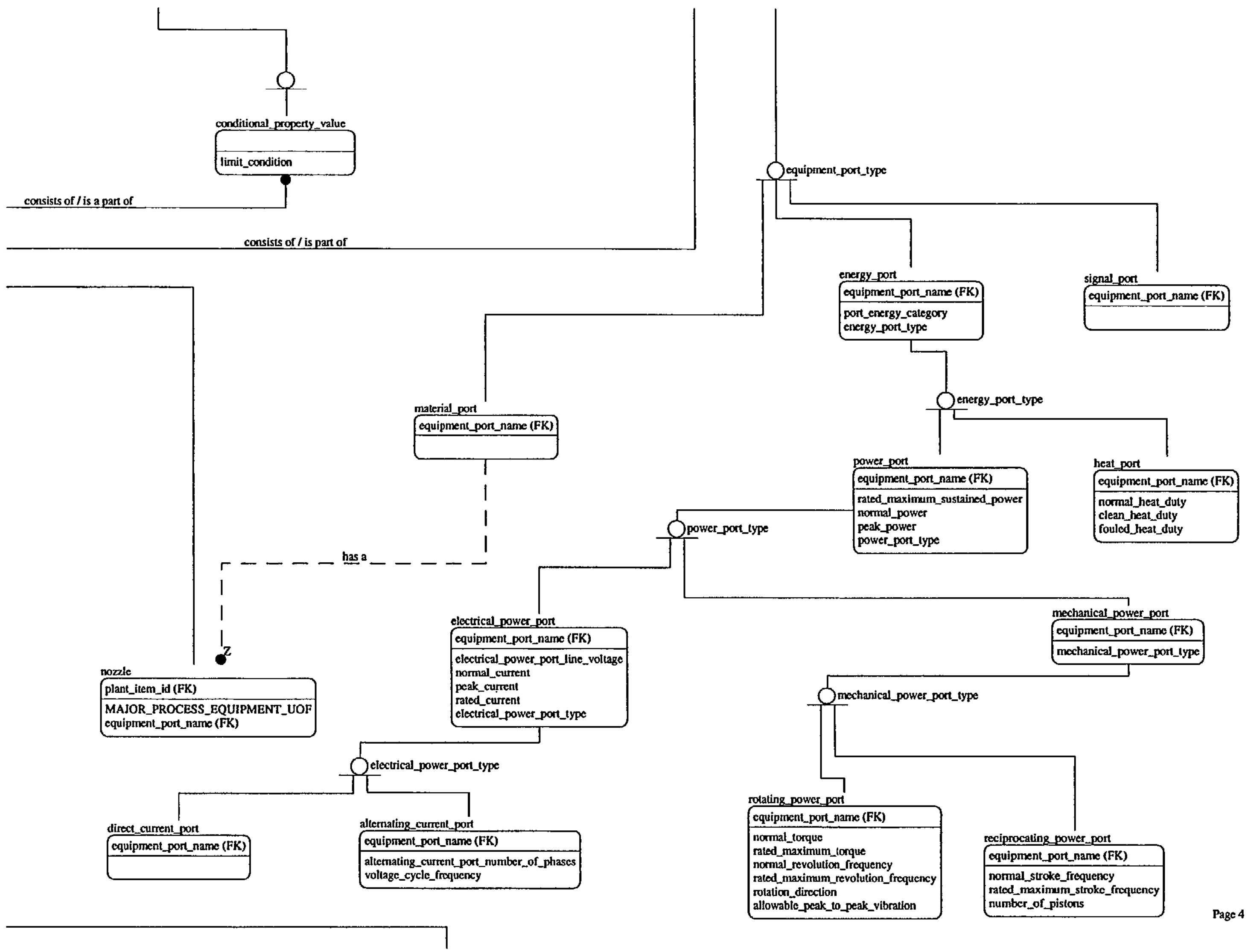

Figure G.29 - ARM Plant_item_definition UoF diagram 4 of 6

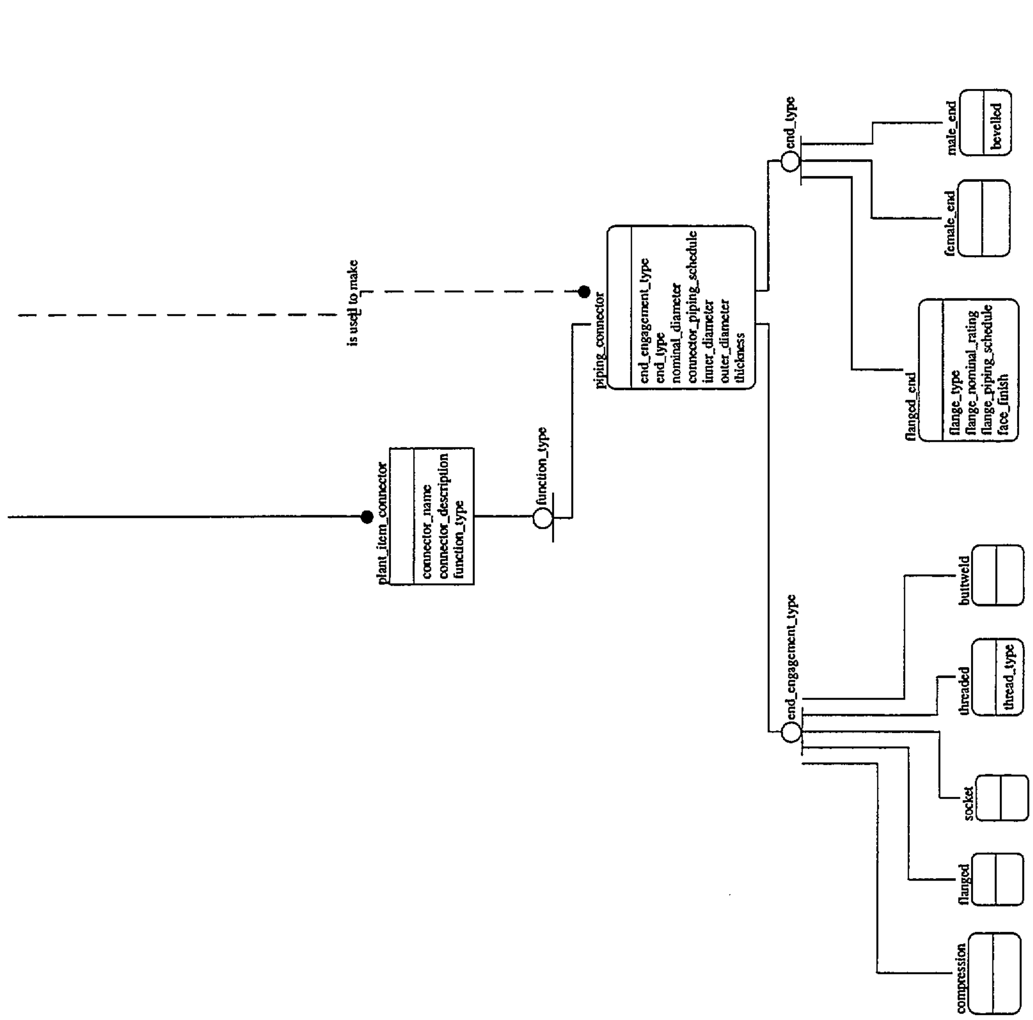

Figure G.30 - ARM Plant_item_definition UoF diagram 5 of 6

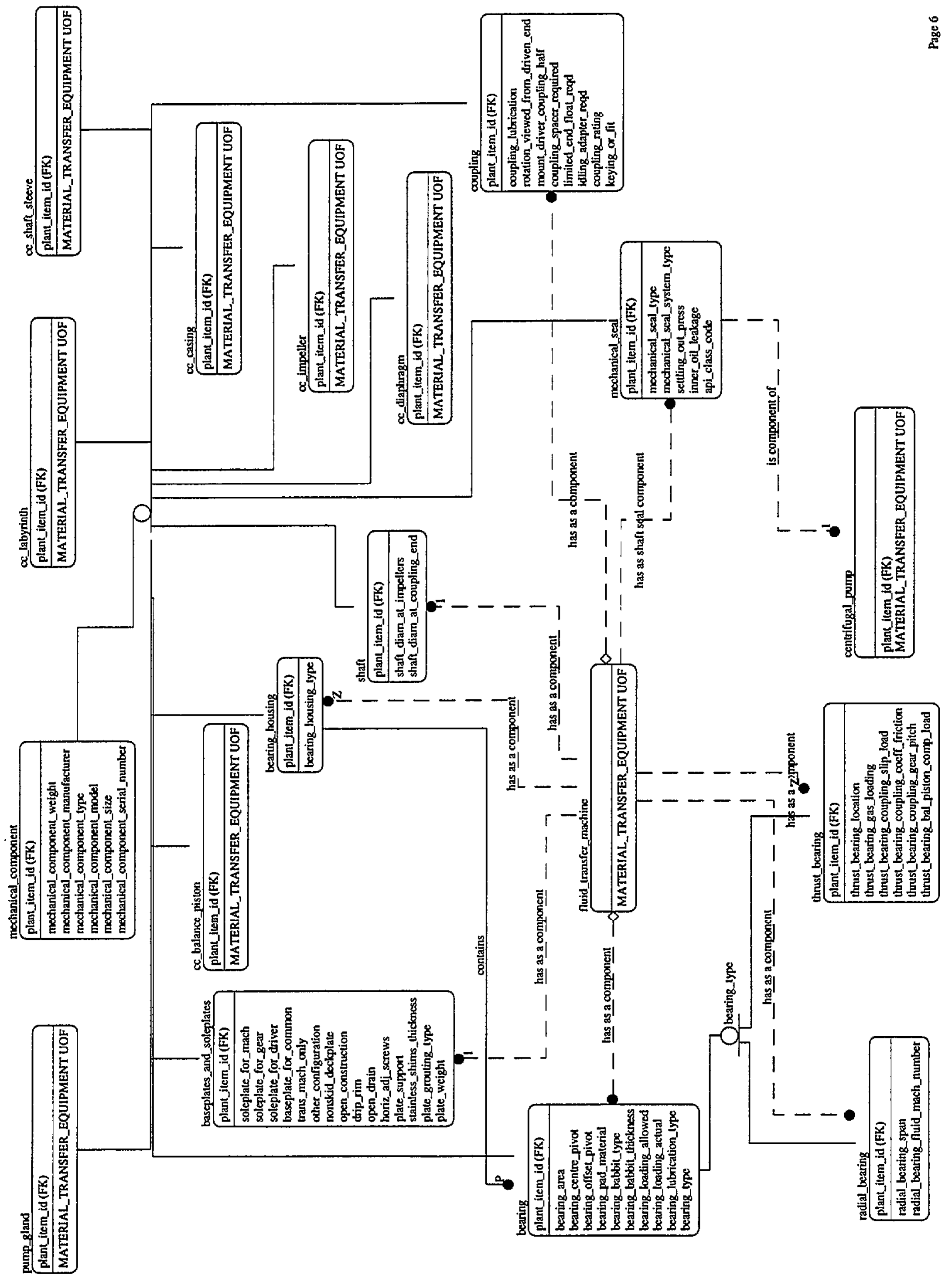

Figure G.31 - ARM Plant_item_definition UoF diagram 6 of 6

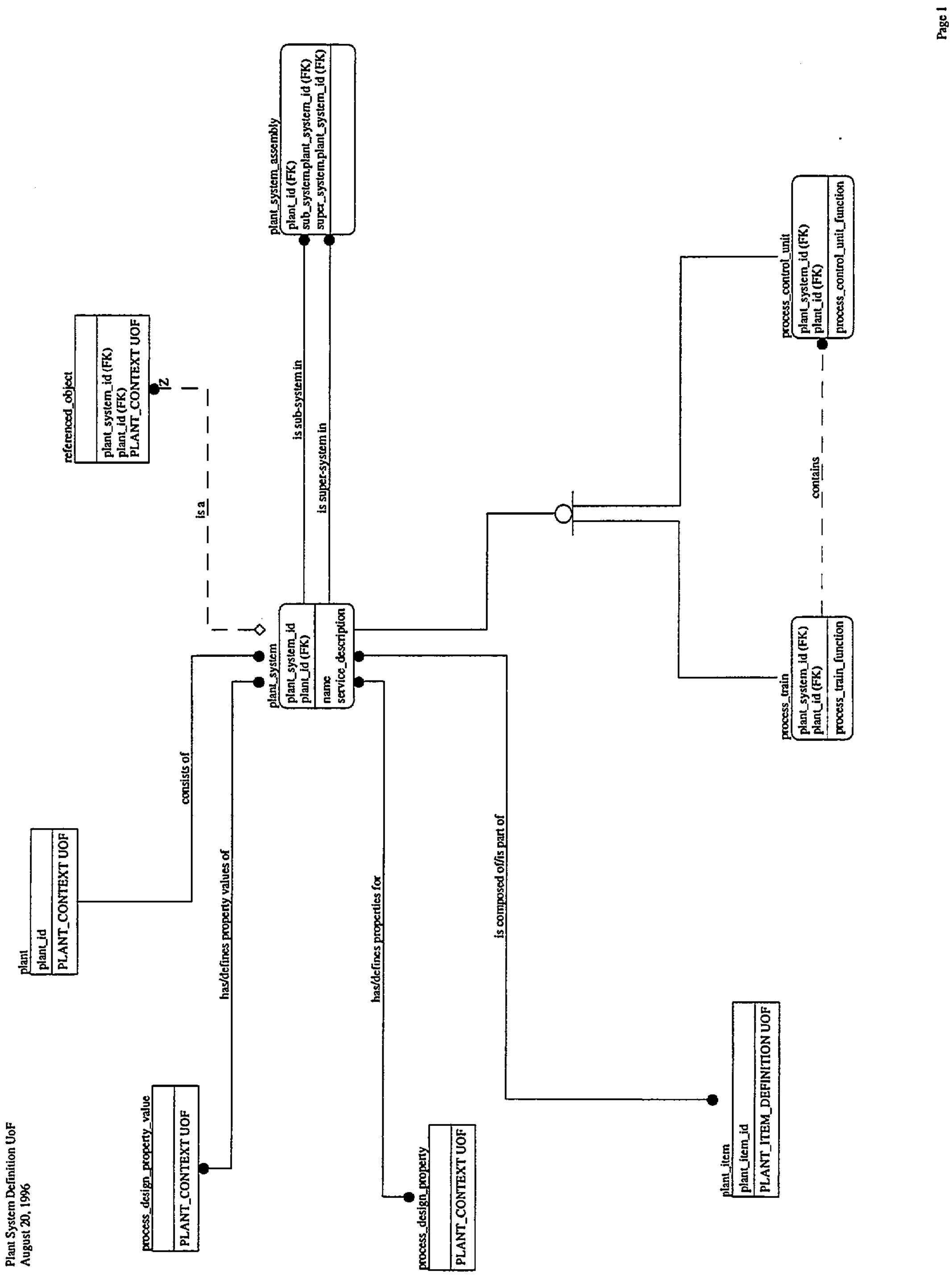

Figure G.32 - ARM Plant_system_definition UoF diagram 1 of 1

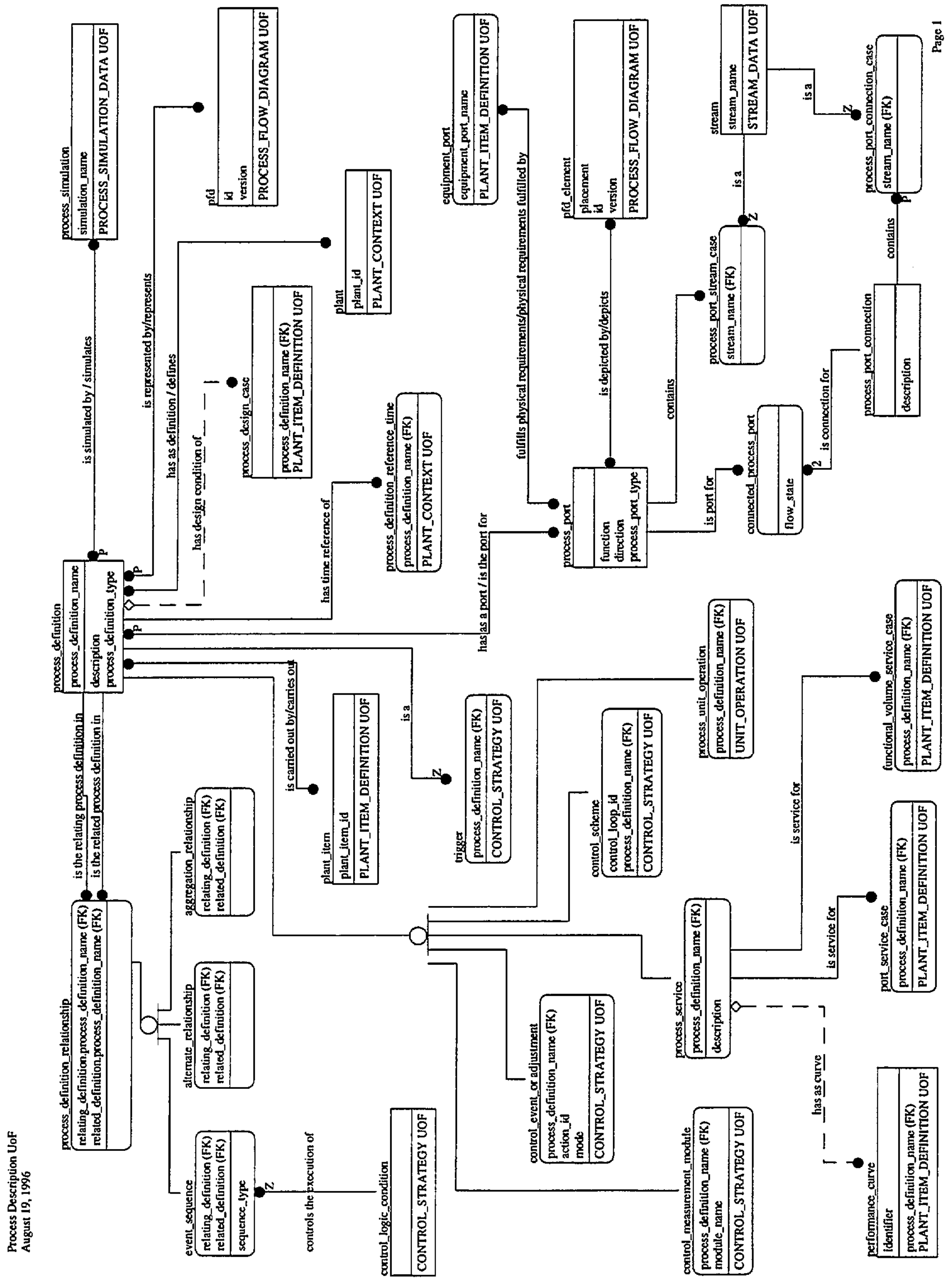

Figure G.33 - ARM Process_description UoF diagram 1 of 1

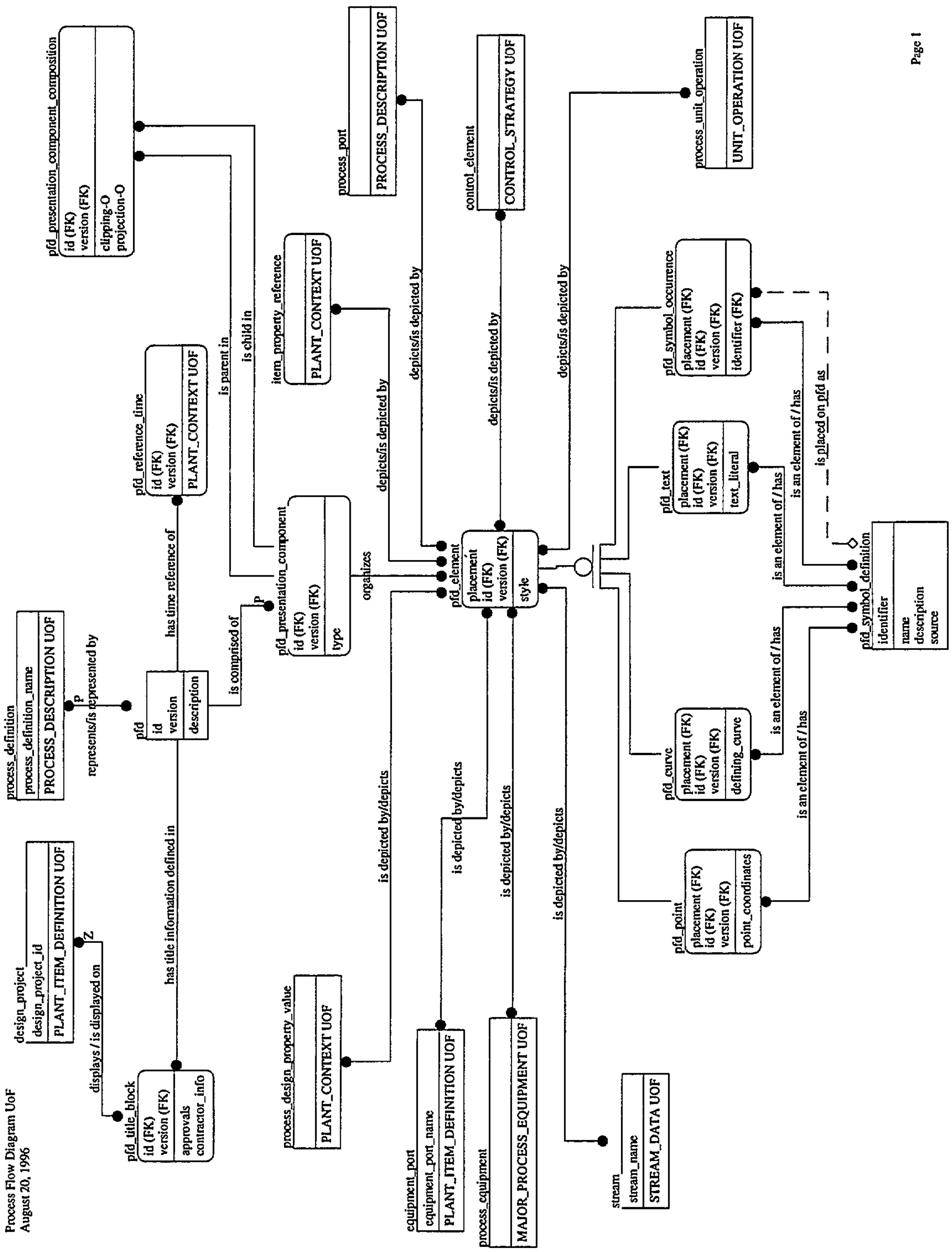

Figure G.34 - ARM Process_flow_diagram UoF diagram 1 of 1

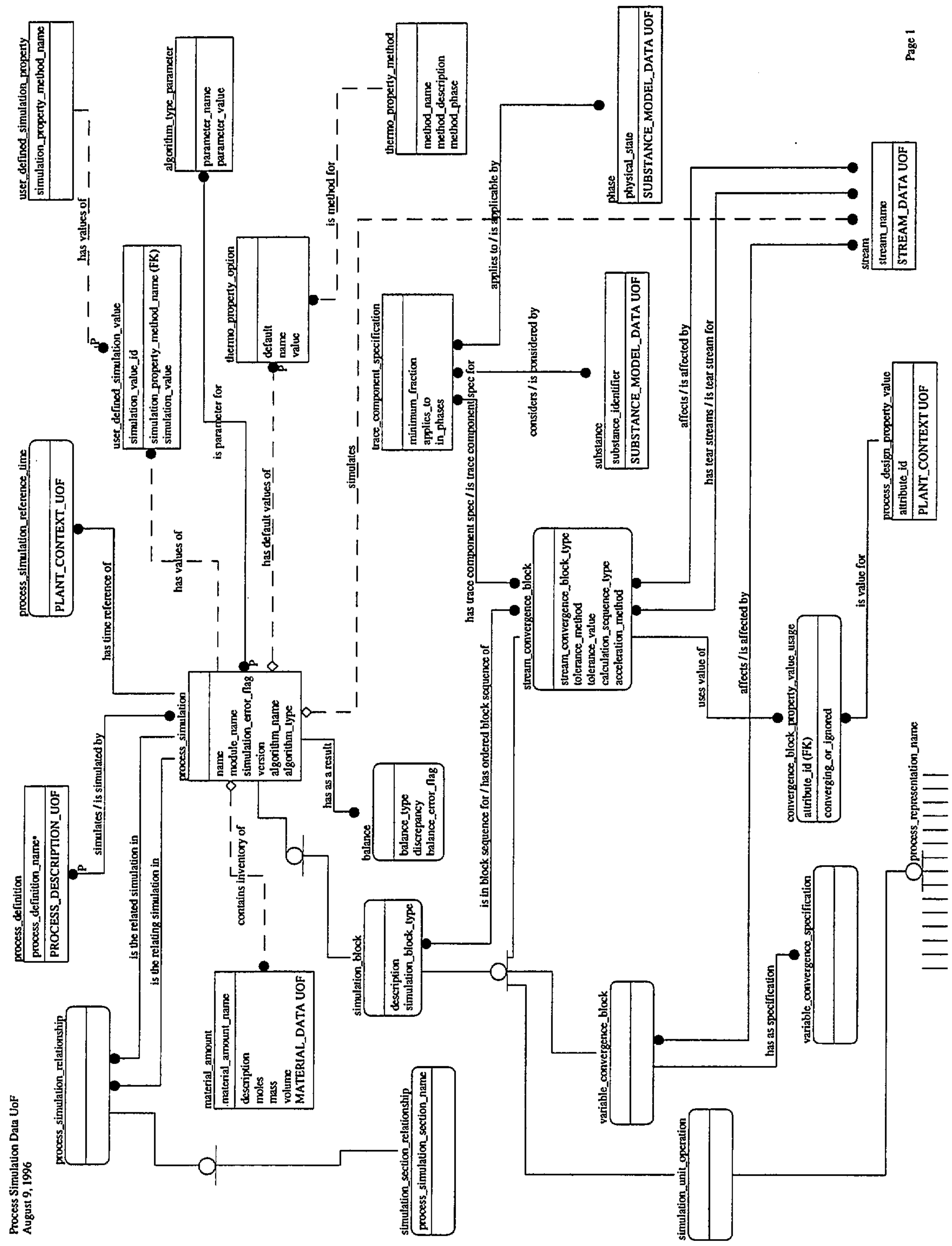

Figure G.35 - ARM Process_simulation_data UoF diagram 1 of 2

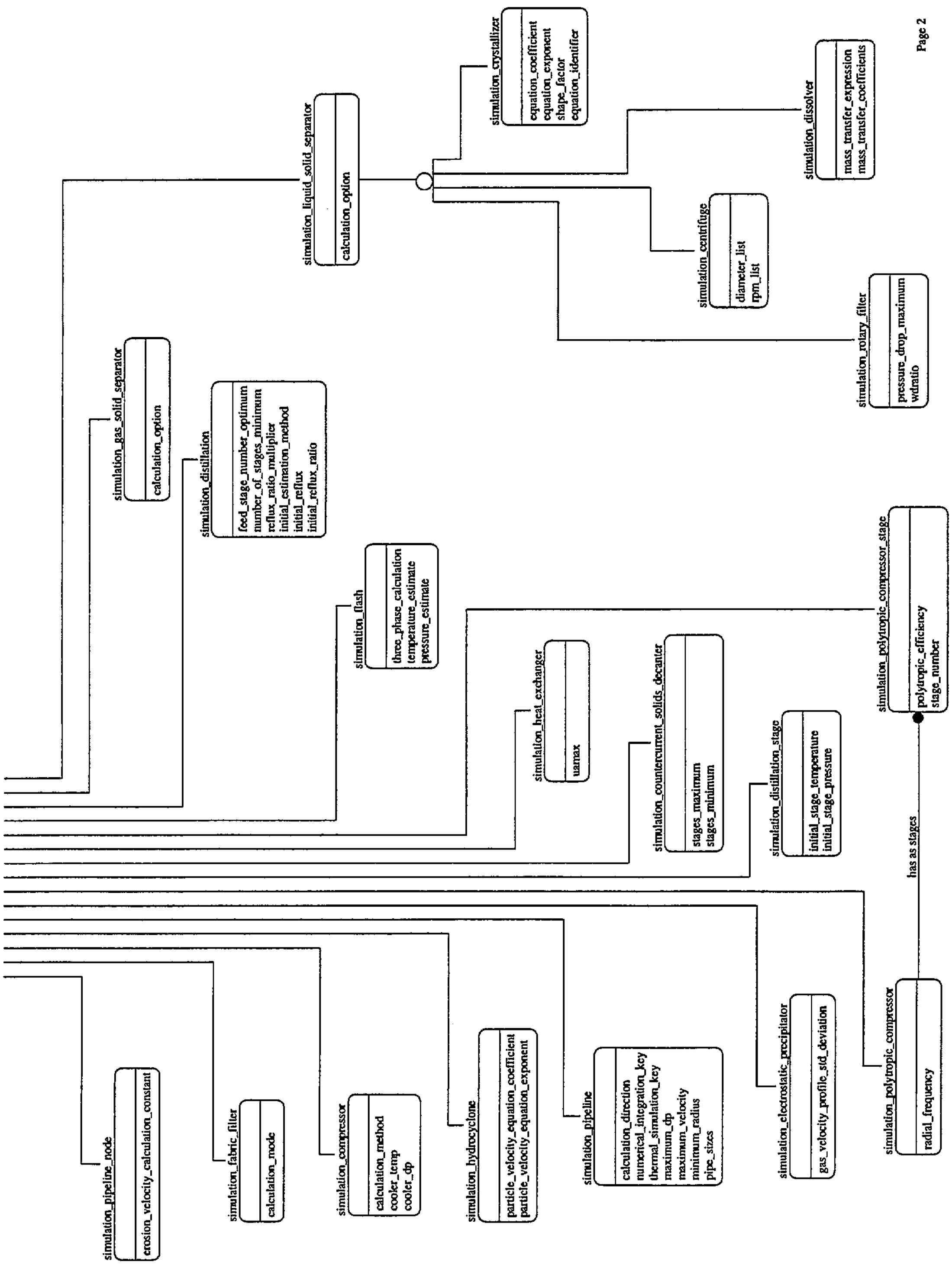

Figure G.36 - ARM Process_simulation_data UoF diagram 2 of 2

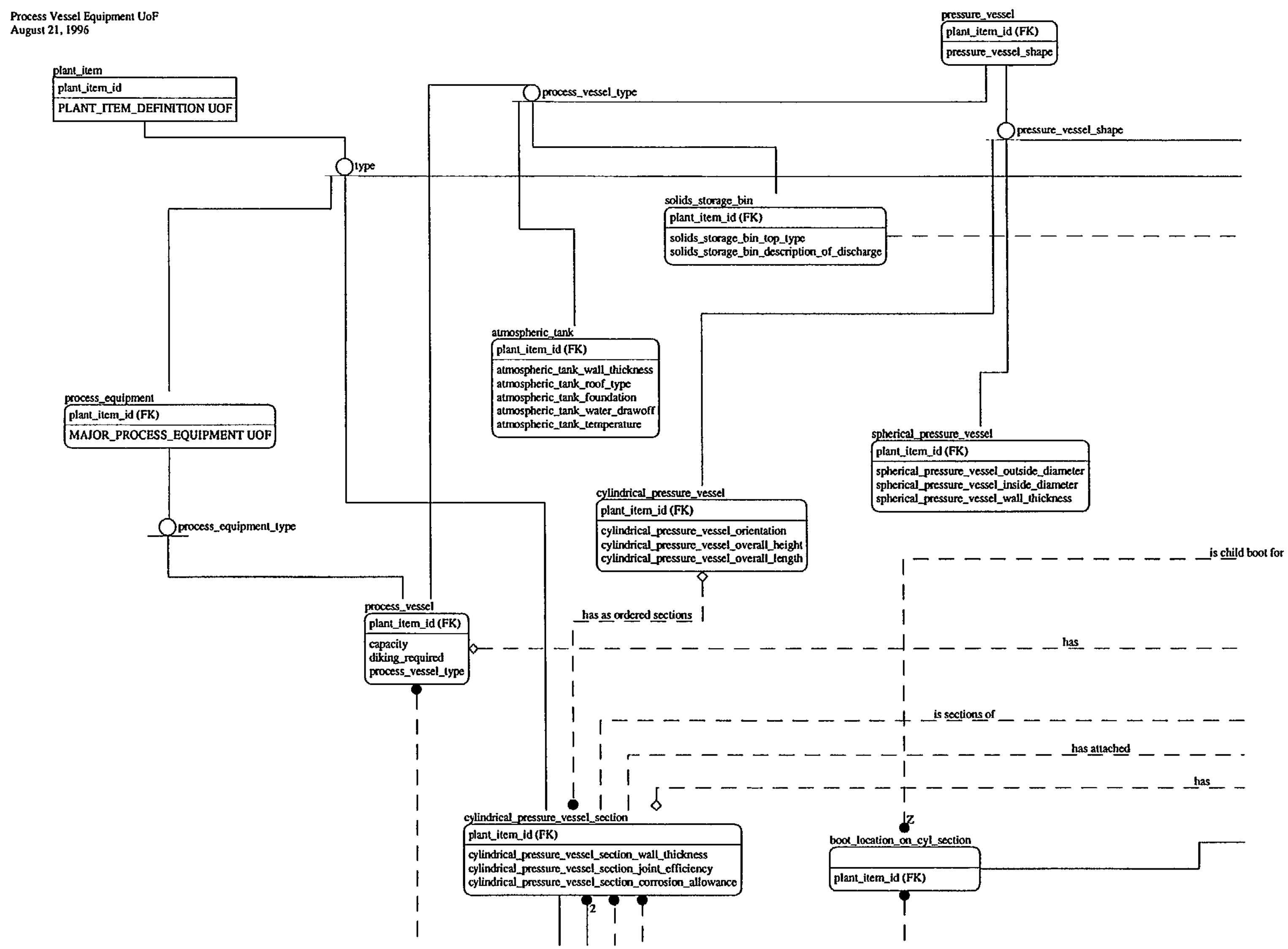

Figure G.37 - ARM Process_vessel_equipment UoF diagram 1 of 4

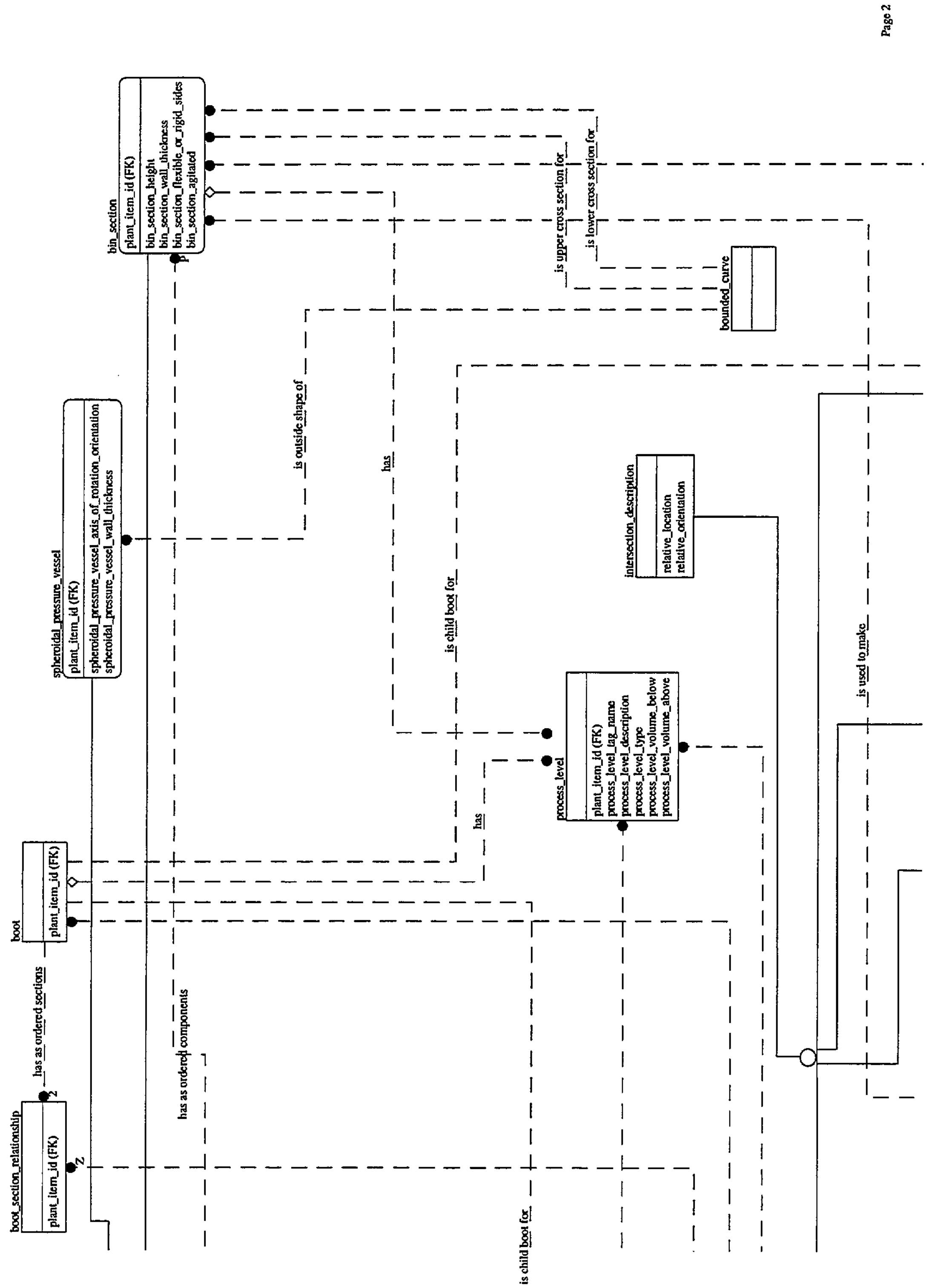

Figure G.38 - ARM Process_vessel_equipment UoF diagram 2 of 4

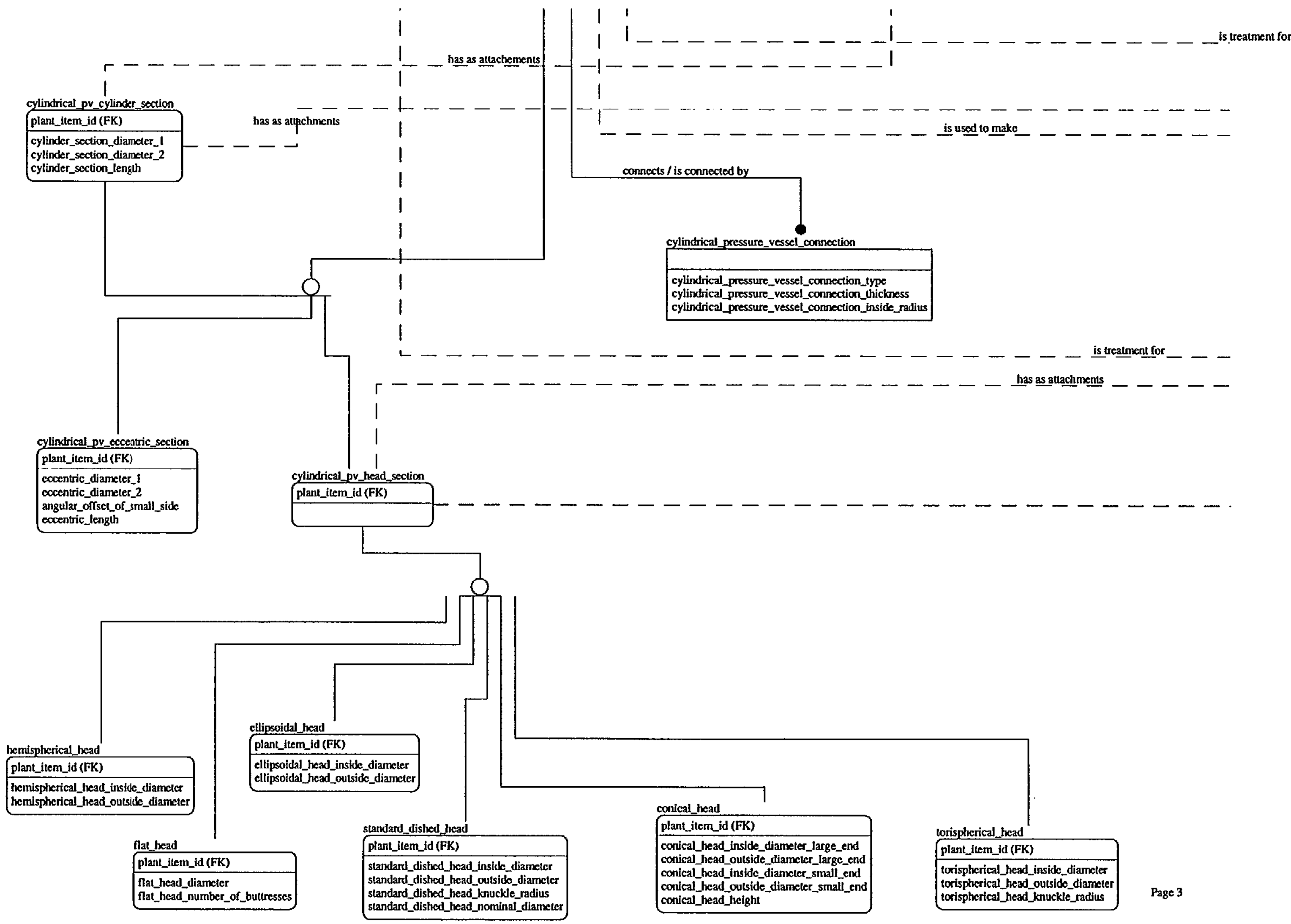

Figure G.39 - ARM Process_vessel_equipment UoF diagram 3 of 4

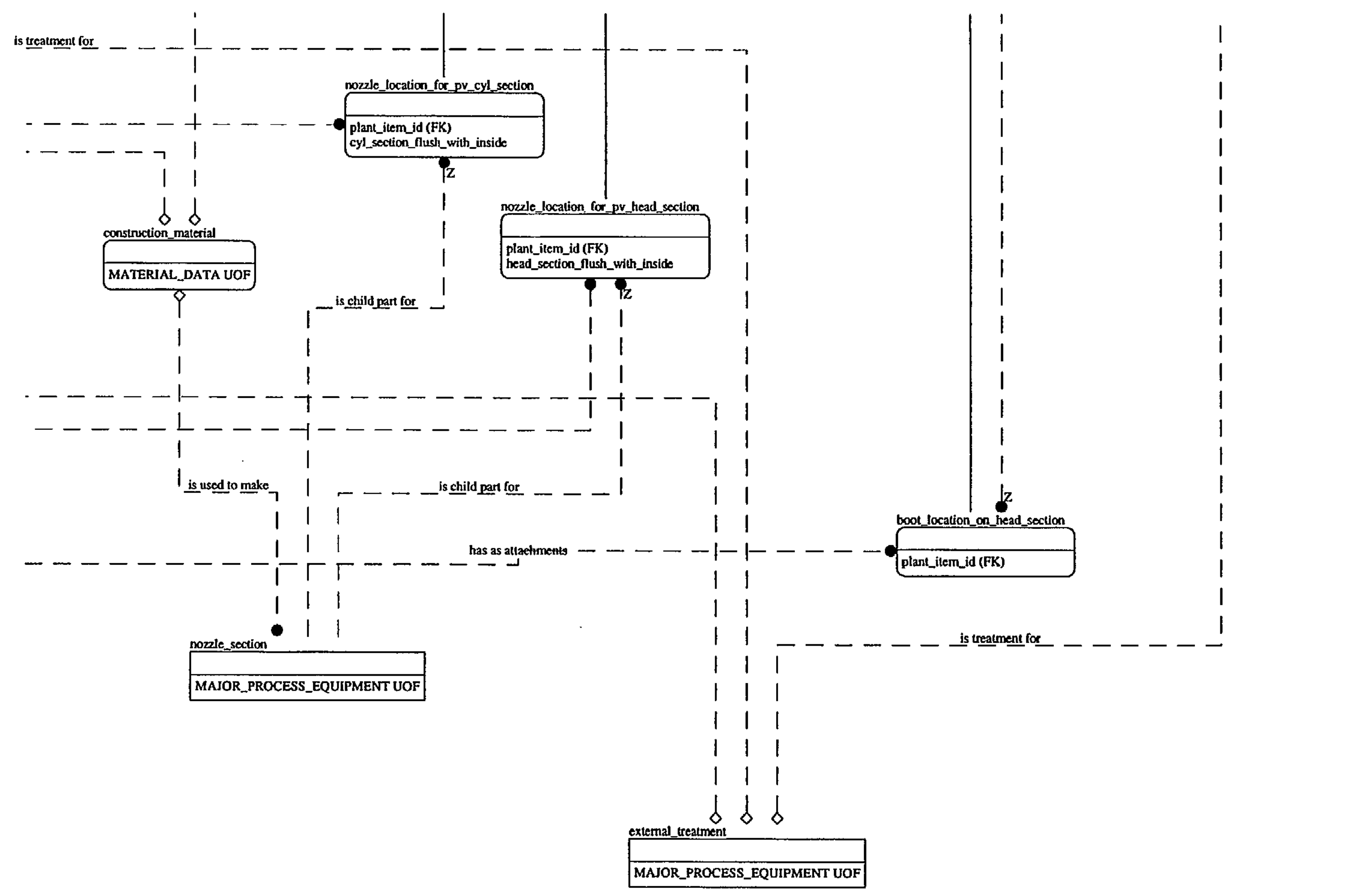

Figure G.40 - ARM Process_vessel_equipment UoF diagram 4 of 4

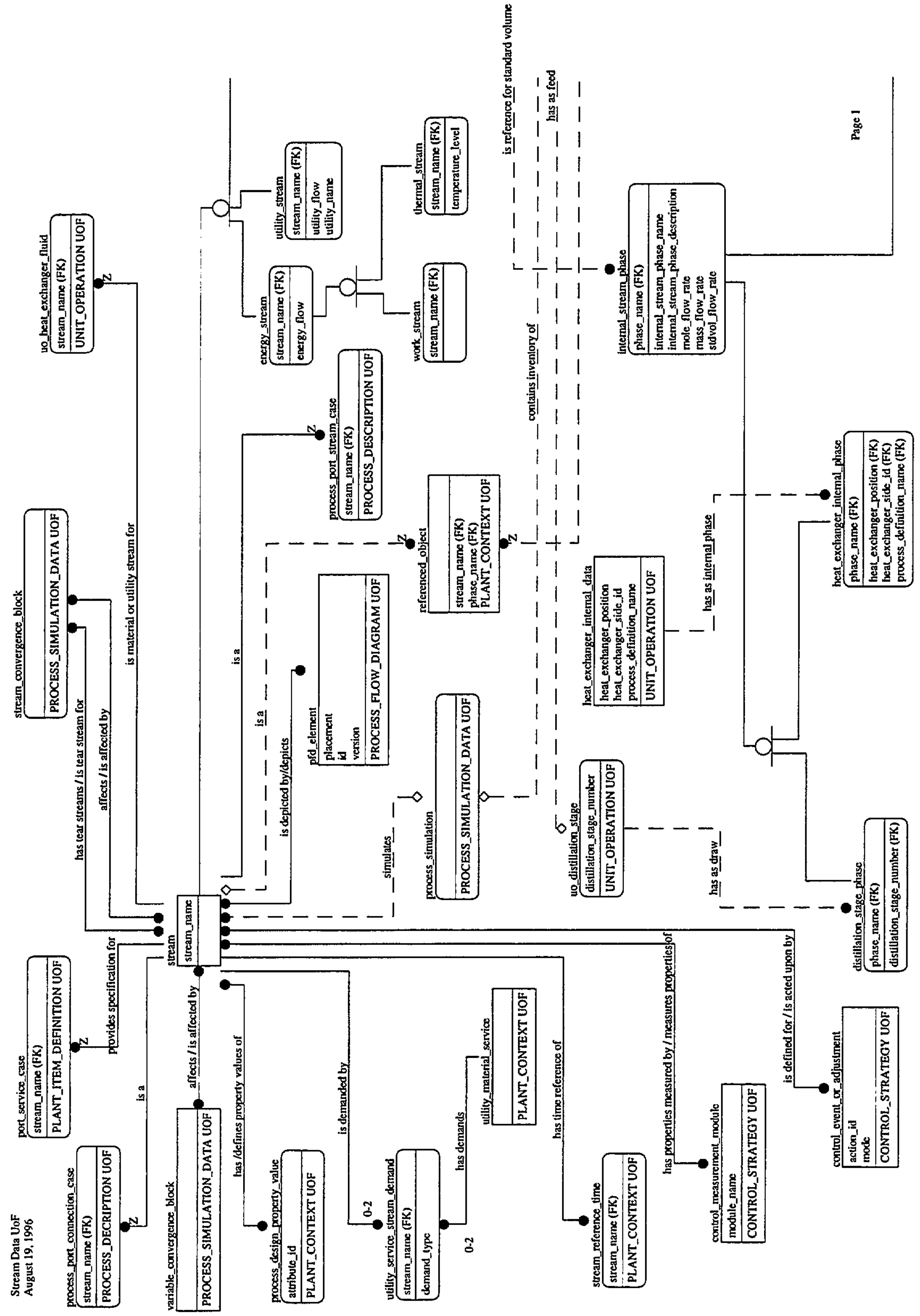

Figure G.41 - ARM Stream_data UoF diagram 1 of 3

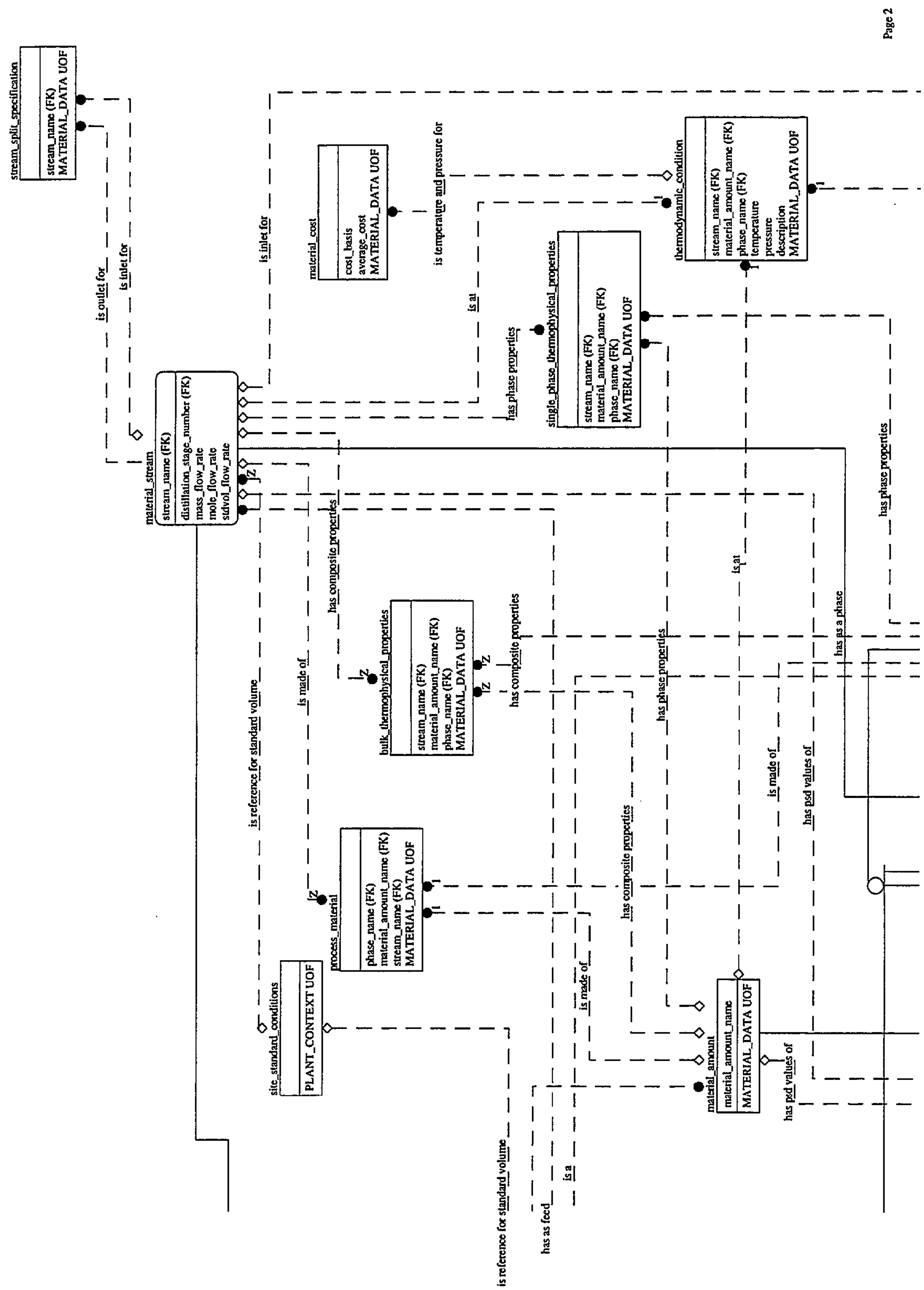

Figure G.42 - ARM Stream_data UoF diagram 2 of 3

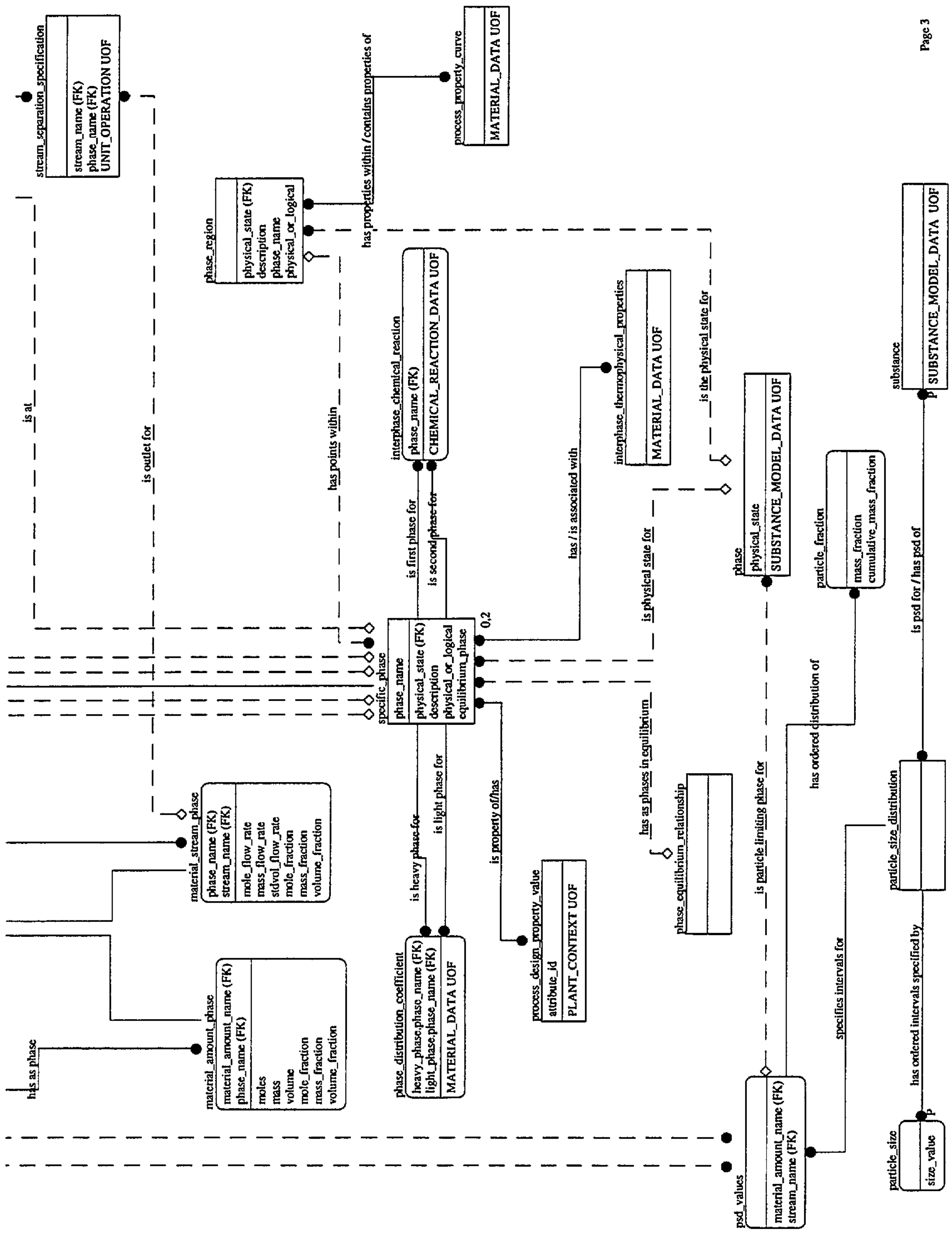

Figure G.43 - ARM Stream_data UoF diagram 3 of 3

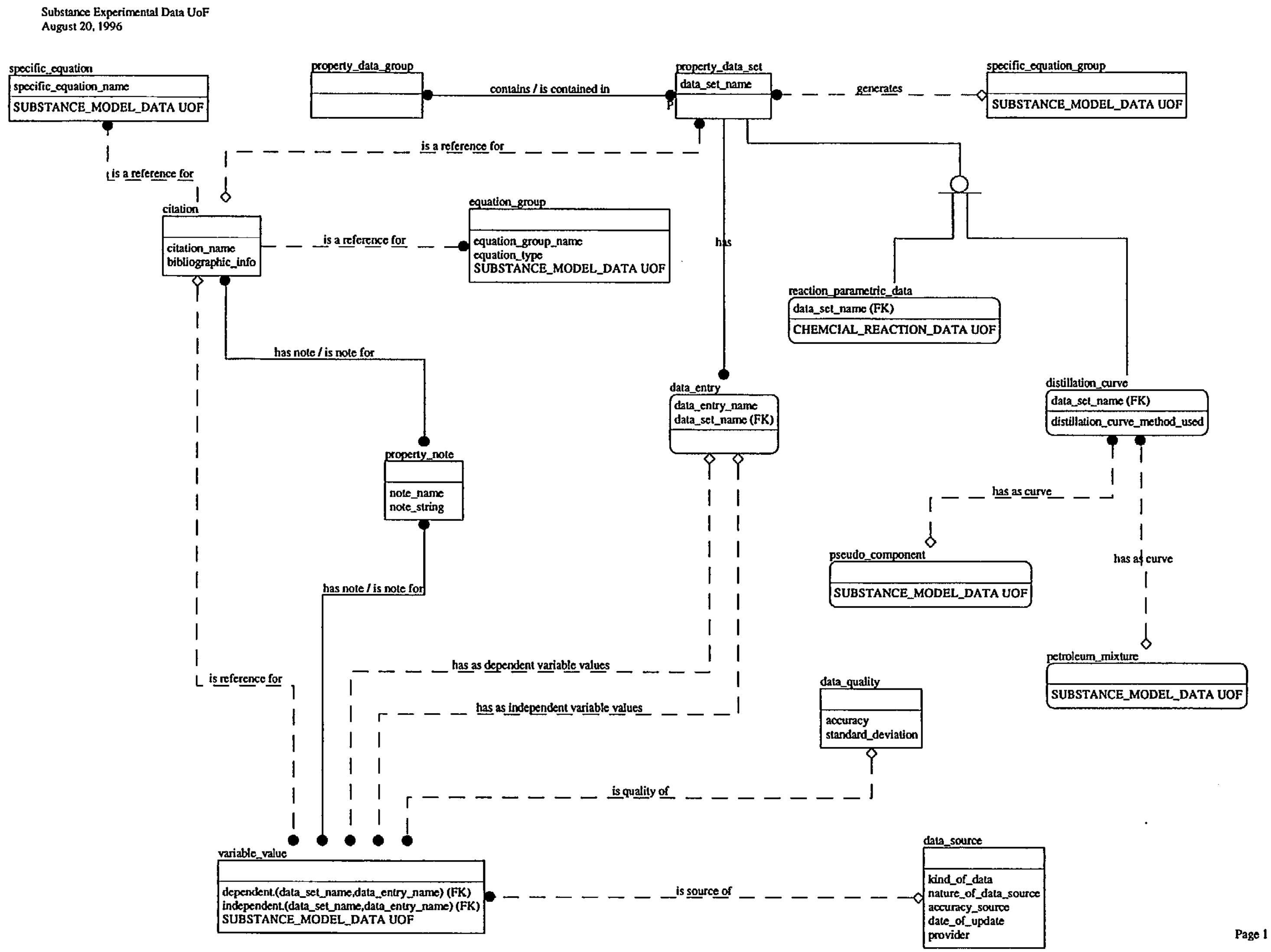

Figure G.44 - ARM Substance_experimental_data UoF diagram 1 of 1

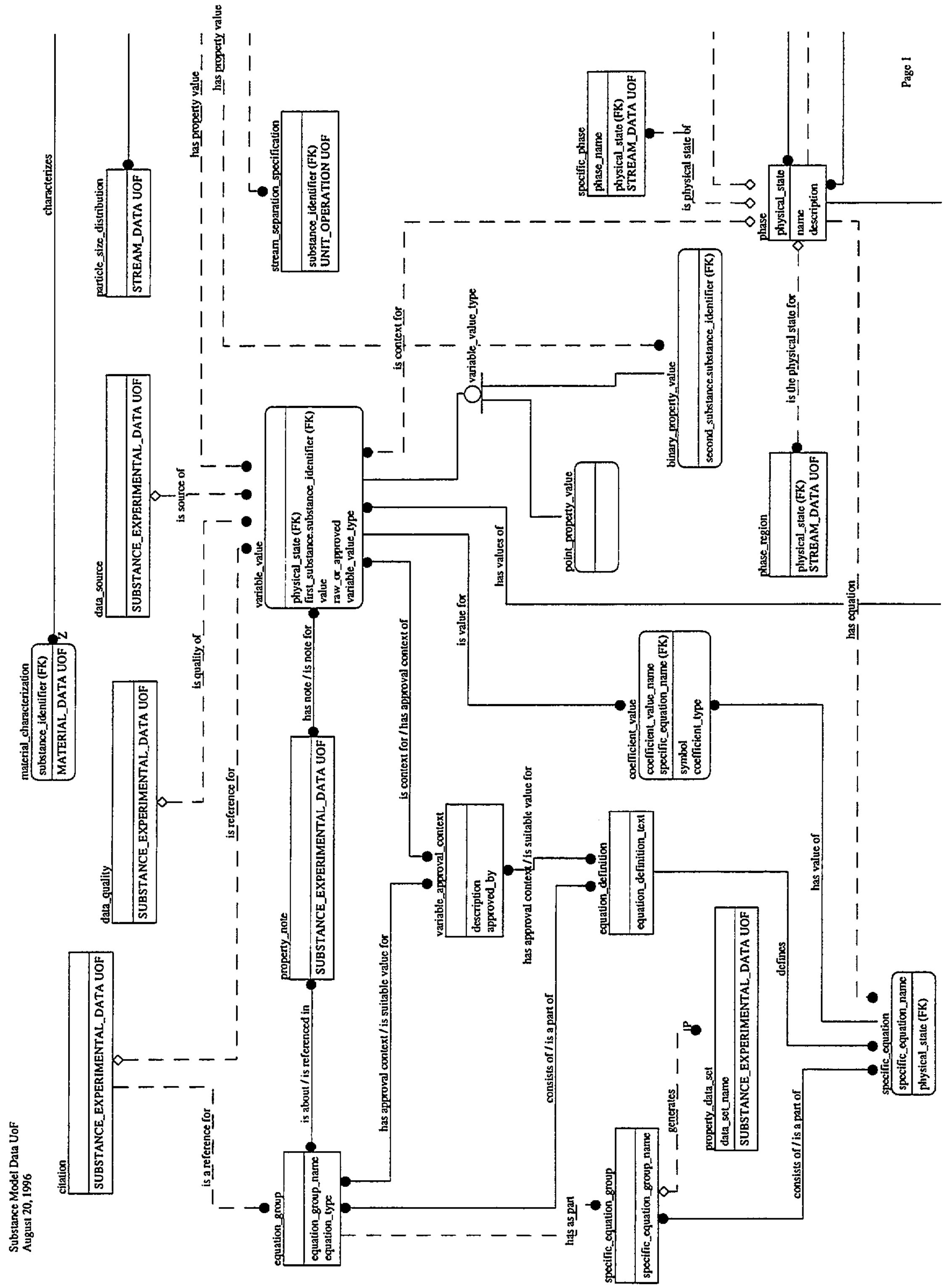

Figure G.45 - ARM Substance_model_data UoF diagram 1 of 3

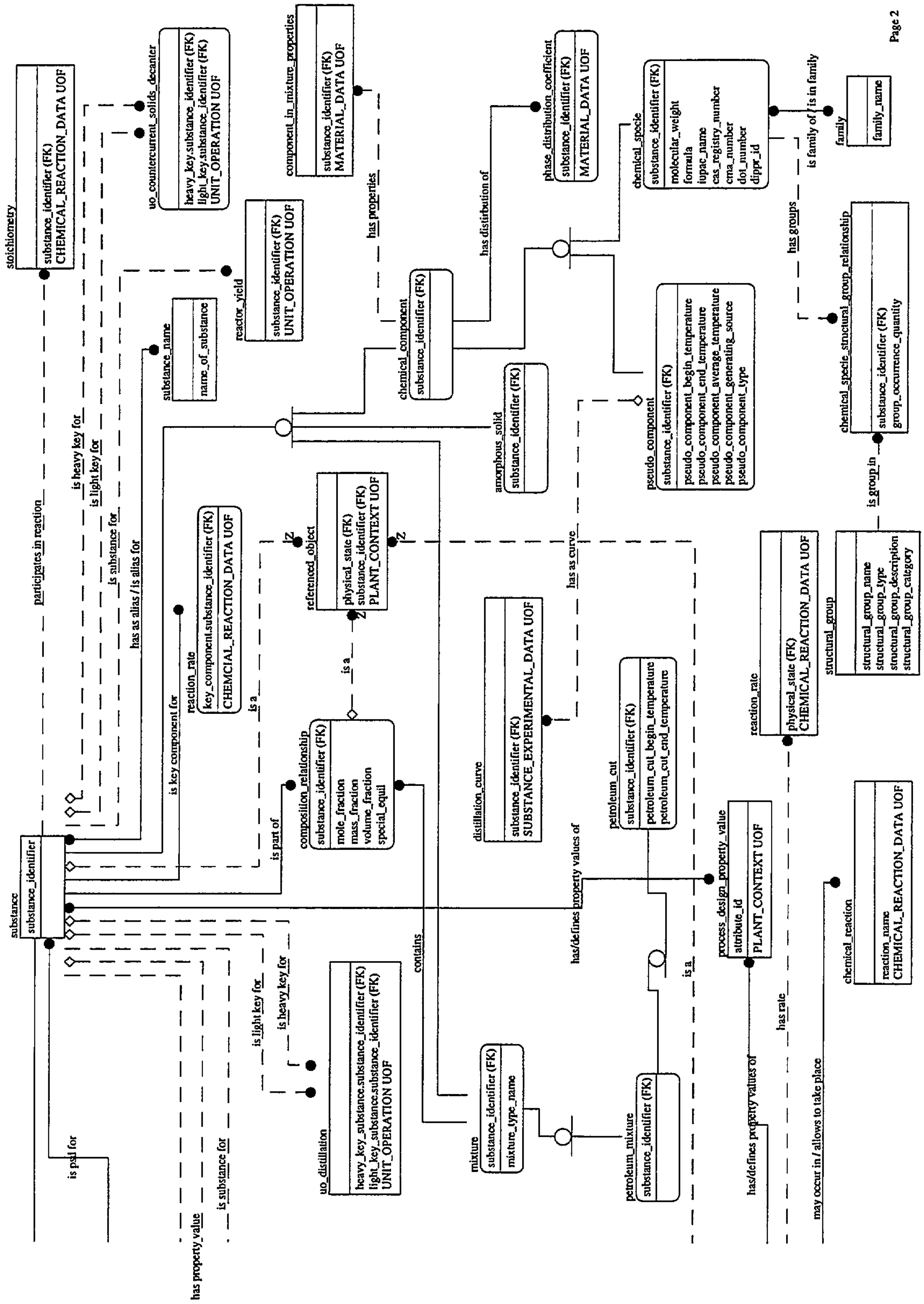

Figure G.46 - ARM Substance_model_data UoF diagram 2 of 3

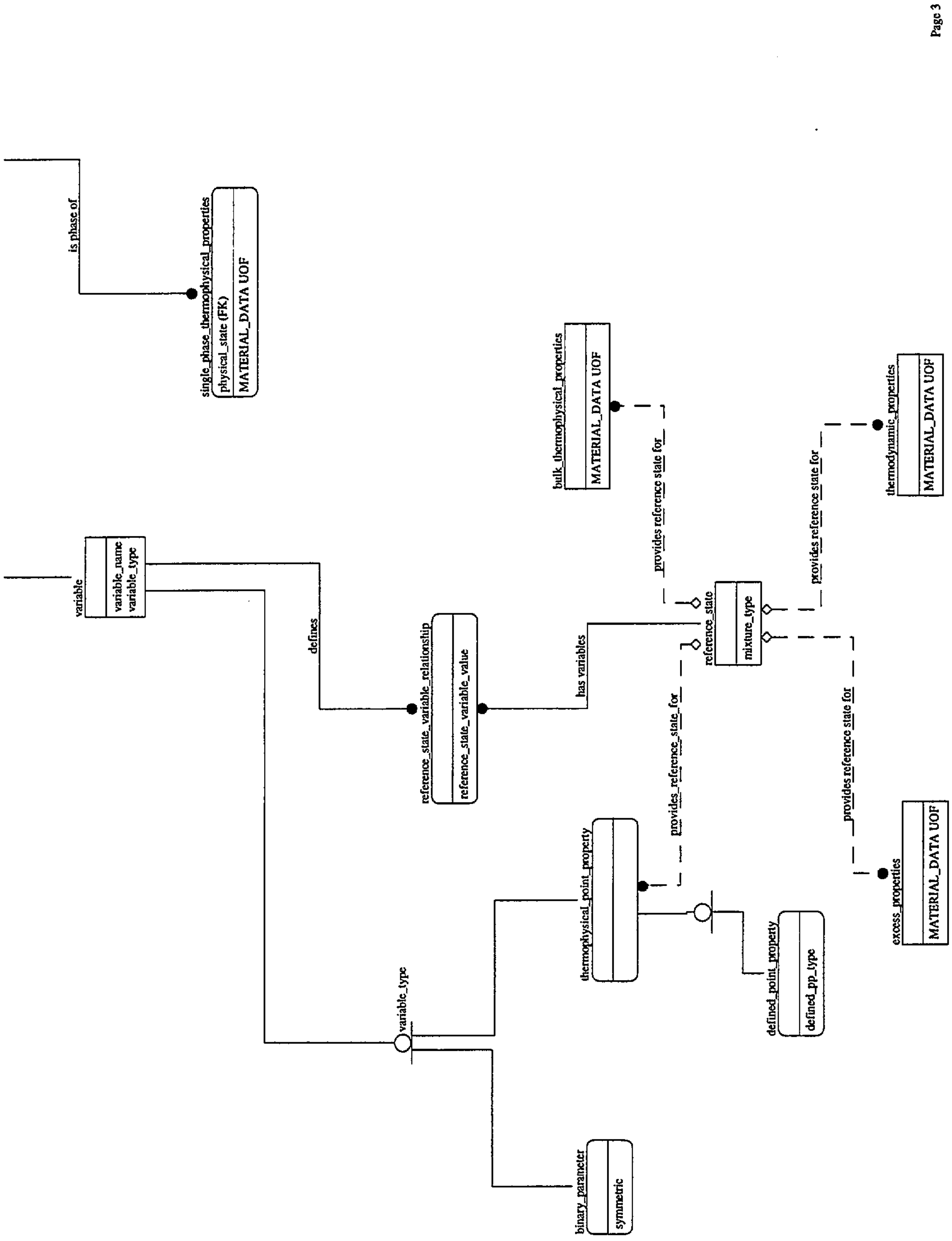

Figure G.47 - ARM Substance_model_data UoF diagram 3 of 3

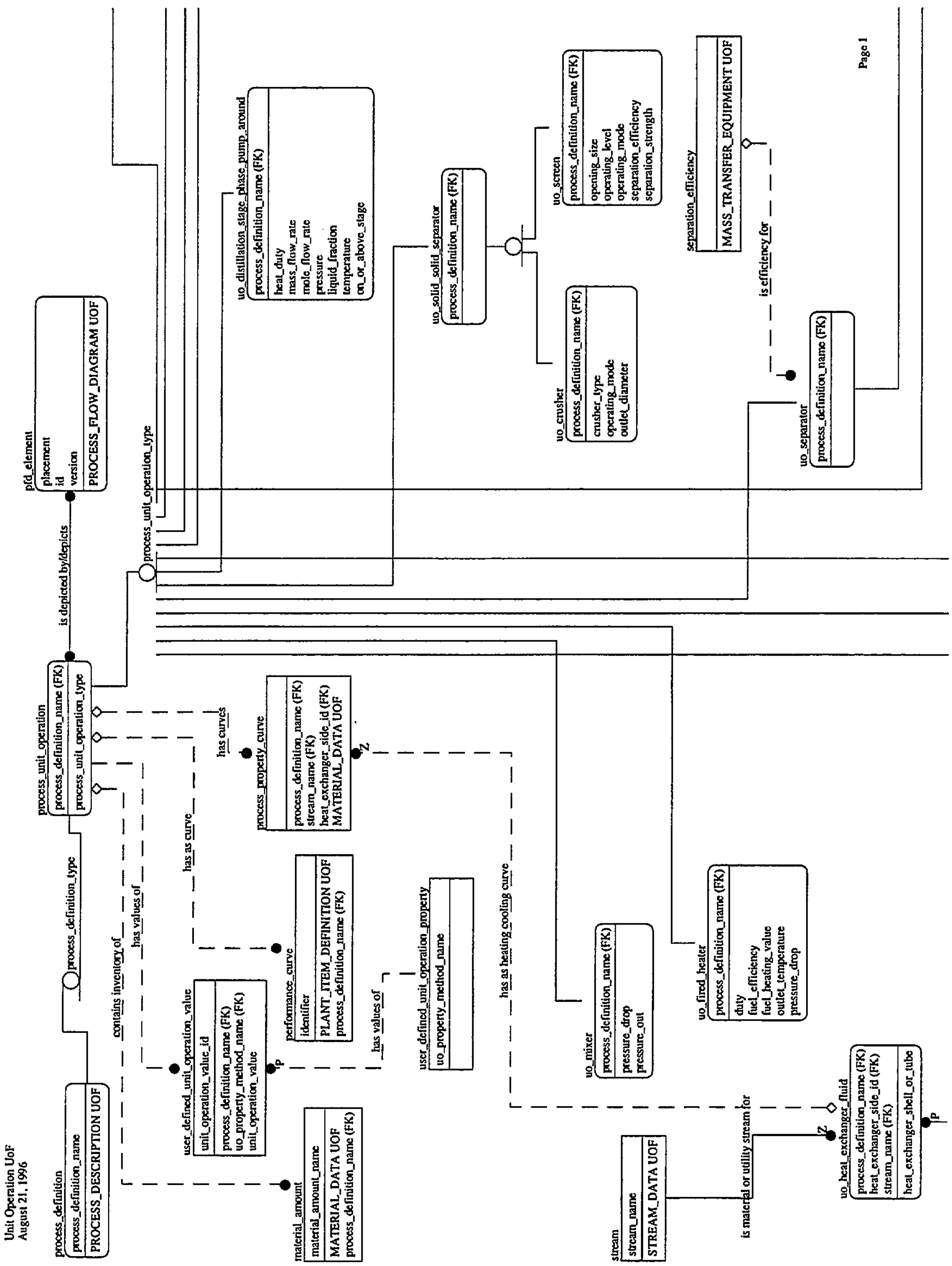

Figure G.48 - ARM Unit_operation UoF diagram 1 of 6

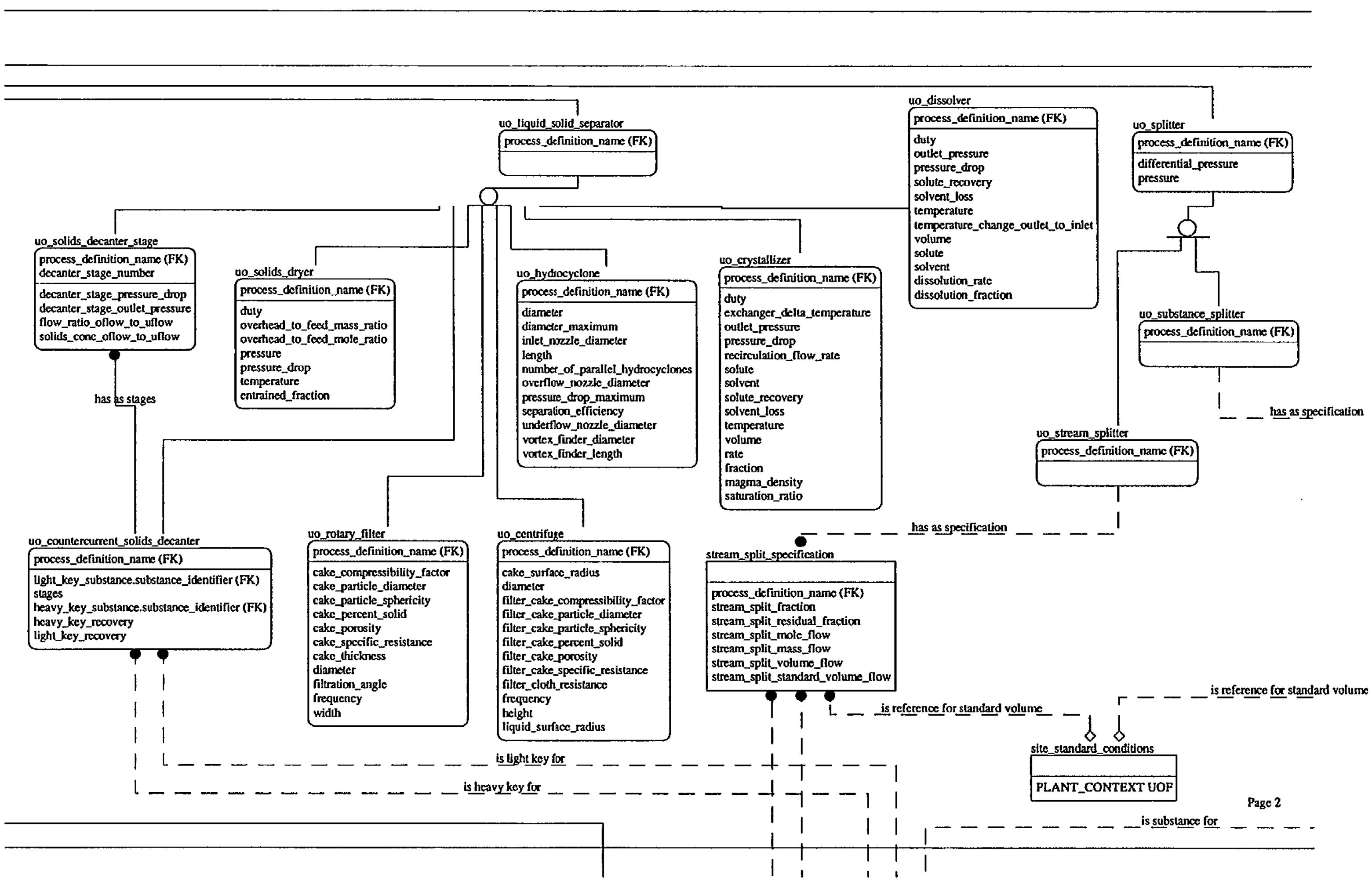

Figure G.49 - ARM Unit_operation UoF diagram 2 of 6

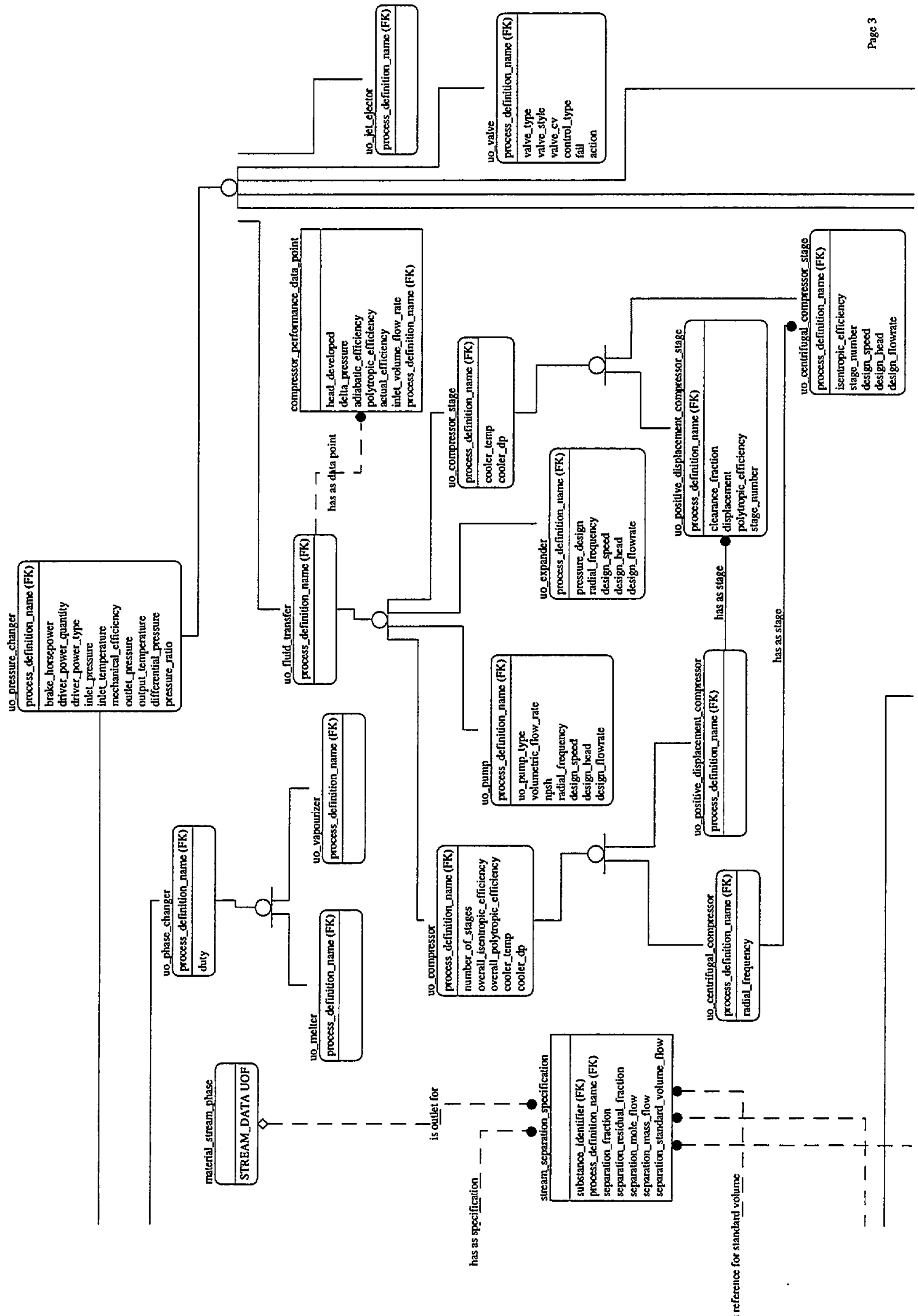

Figure G.50 - ARM Unit_operation UoF diagram 3 of 6

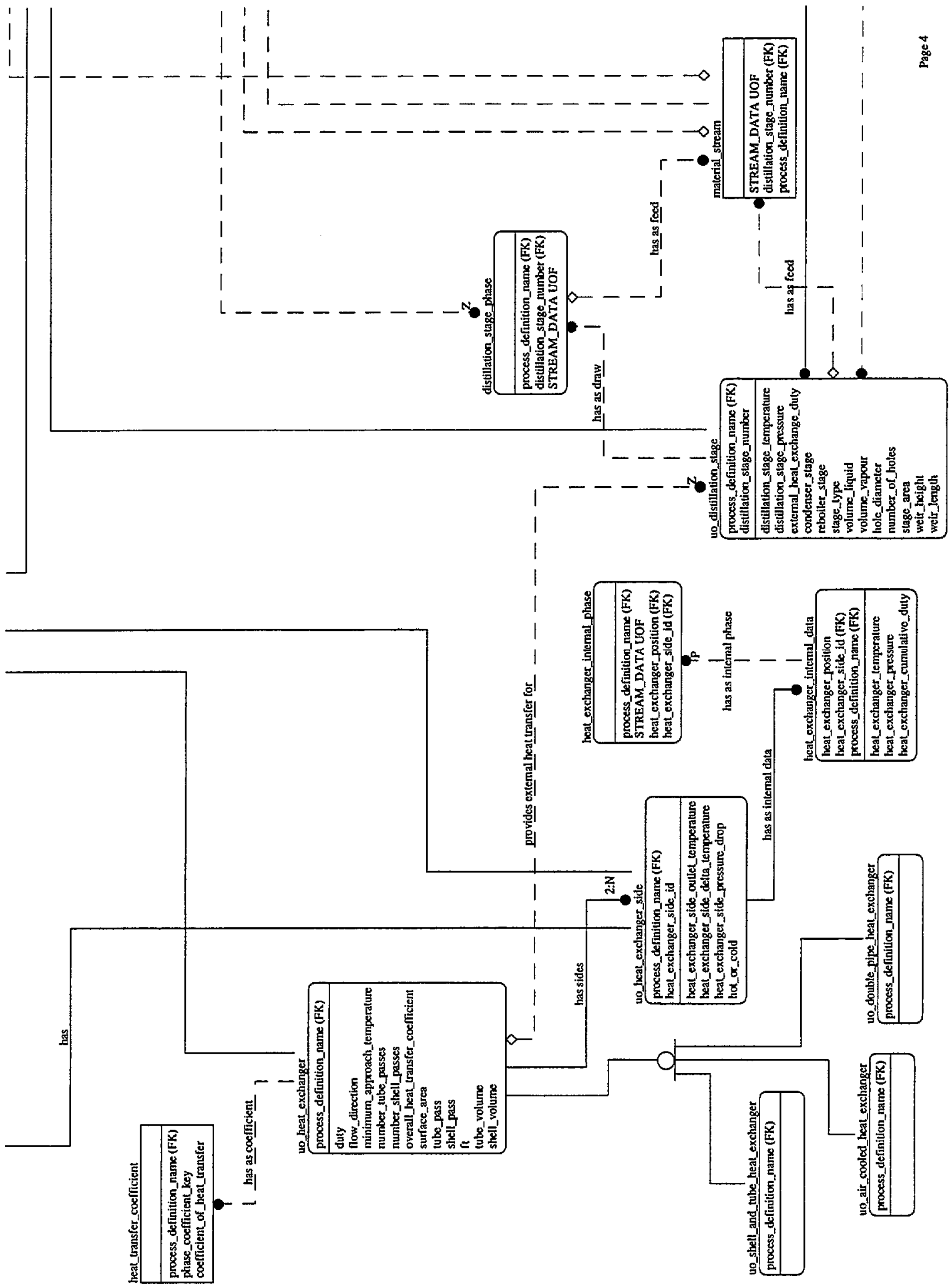

Figure G.51 - ARM Unit_operation UoF diagram 4 of 6

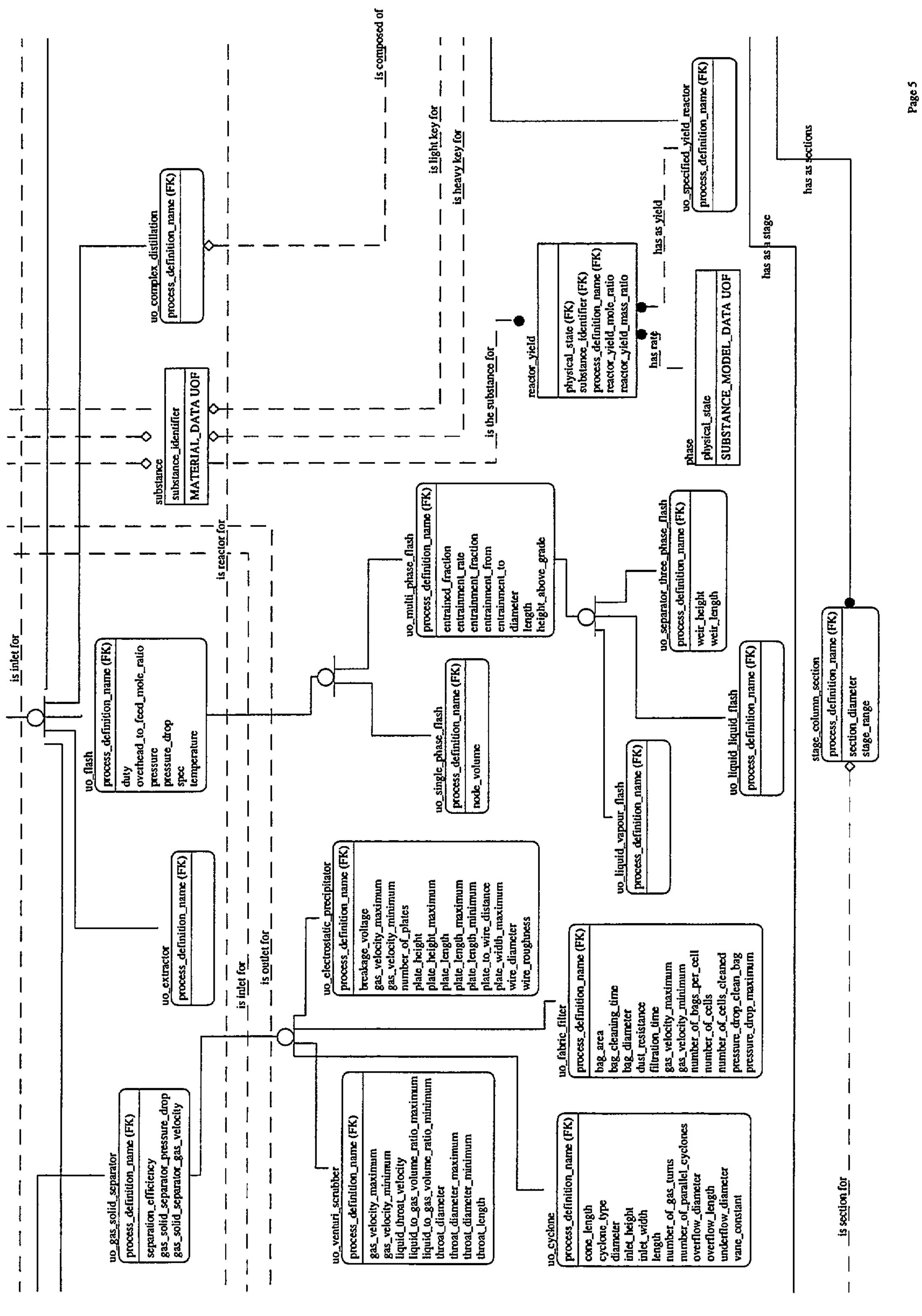

Figure G.52 - ARM Unit_operation UoF diagram 5 of 6

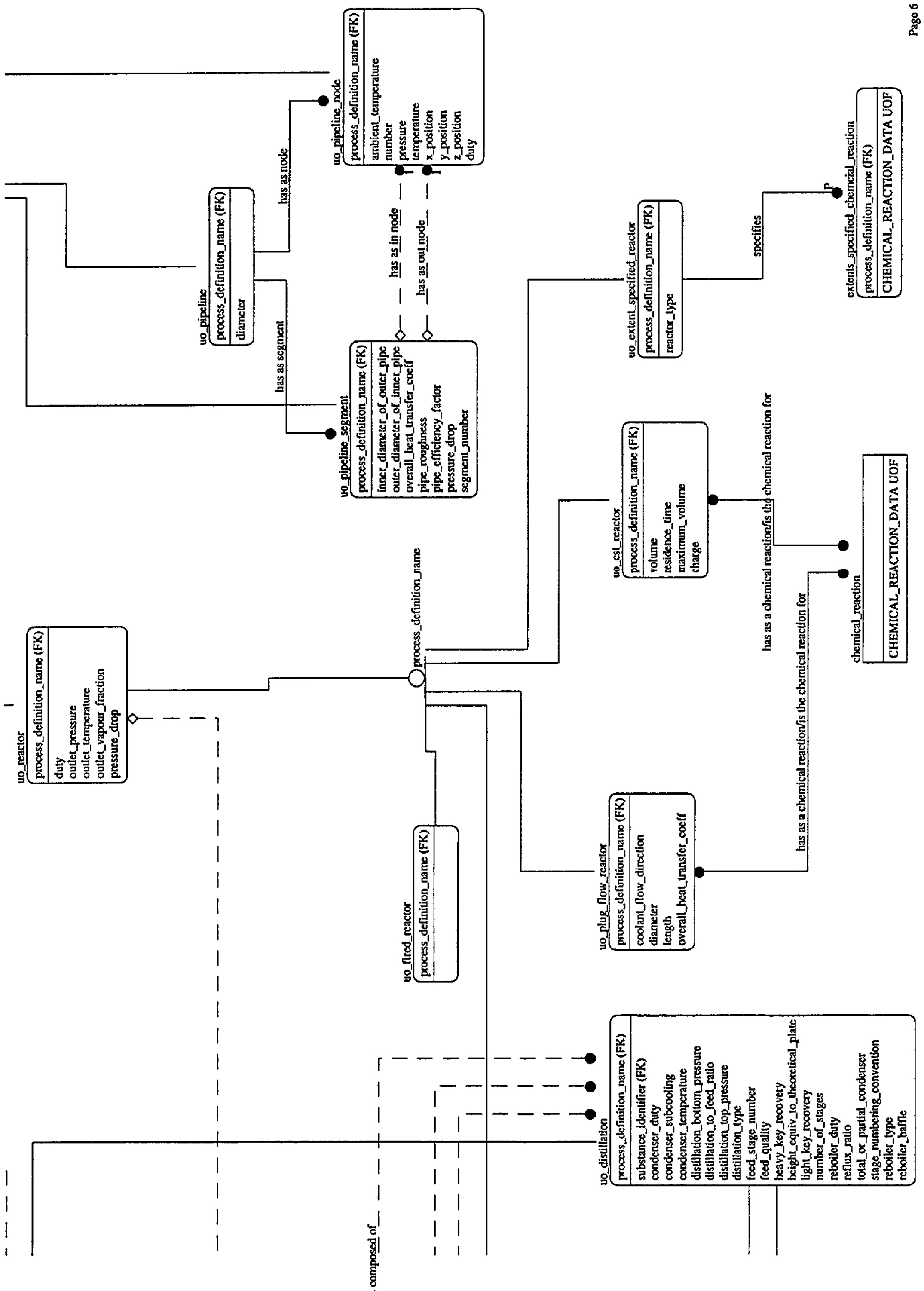

Figure G.53 - ARM Unit_operation UoF diagram 6 of 6

Annex H
(informative)

AIM EXPRESS-G (later)

Figures H.1 through H.(later) 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.

Annex J
(informative)

AIM EXPRESS listing (later)

This annex provides 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)

Bibliography

[1] *Batch Control, Part 1: Models and Terminology*, ISA-S88.01-1995, The International Society for Measurement and Control, 28 February 1995.

[2] *Federal Information Processing Standards Publication 183, Integration Definition for Function Modeling (IDEF0)*, FIPS PUB 183, National Institute of Standards and Technology, December 1993.

[3] *Federal Information Processing Standards Publication 184, Integration Definition for Information Modeling (IDEF1X)*, FIPS PUB 184, National Institute of Standards and Technology, December 1993.

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