
**Industrial automation systems and
integration — Product data
representation and exchange —**

**Part 218:
Application protocol: Ship structures**

*Systèmes d'automatisation industrielle et intégration — Représentation
et échange de données de produits —*

Partie 218: Protocole d'application: Structures de navires



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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/ IEC Directives, Part 2.

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

Attention is drawn to the possibility that some of the elements of this part of ISO 10303 may be the subject of patent rights. ISO is not to be held responsible for identifying any or all such patent rights.

ISO 10303-218 was prepared by Technical Committee ISO TC 184, *Industrial automation systems and integration*, Subcommittee SC 4, *Industrial data*.

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

Each part of ISO 10303 is a member of one of the following series: description methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, application protocols, abstract test suites, application interpreted constructs, and application modules. This part is a member of the application protocol series.

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

`<http://www.tc184-sc4.org/titles/>`

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation of product information and for the exchange of product data. The objective is to provide a neutral mechanism capable of describing products throughout their life cycle. This mechanism is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases, and as a basis for archiving.

This part of ISO 10303 is a member of the application protocol series. This part of ISO 10303 specifies an application protocol (AP) for the definition of ship structures and its related data.

This application protocol defines the context, scope and information requirements for the communication of ship structural data and specifies the integrated resources necessary to satisfy these requirements. This part of ISO 10303 is one of a series of ship building application protocols, that together aim to provide an integrated computer interpretable product model for ships.

The series of shipbuilding industry application protocols assumes that the ship product model can be divided into separate ship systems; each covering a key element of the ship for its whole life cycle. These key elements are:

- ship arrangements;
- ship moulded forms;
- ship distribution systems.

NOTE 1 Distribution systems include piping, heating, ventilation and air conditioning, hydraulics, pneumatics, electrical, and cable way.

- ship structures;
- ship mechanical systems.

NOTE 2 Mechanical systems include cargo handling, machinery and propulsion.

- ship outfit and furnishings;
- combat systems;
- communication;
- navigation;
- operation.

Each separate system is described by one or more different application protocols. The full series of shipbuilding application protocols is depicted in Figure 1. Those aspects of the ship product model that are common to each ship application protocol are described consistently and identically in each application protocol. Within the series of shipbuilding application protocols this part of ISO 10303 details the key element of ship structures.

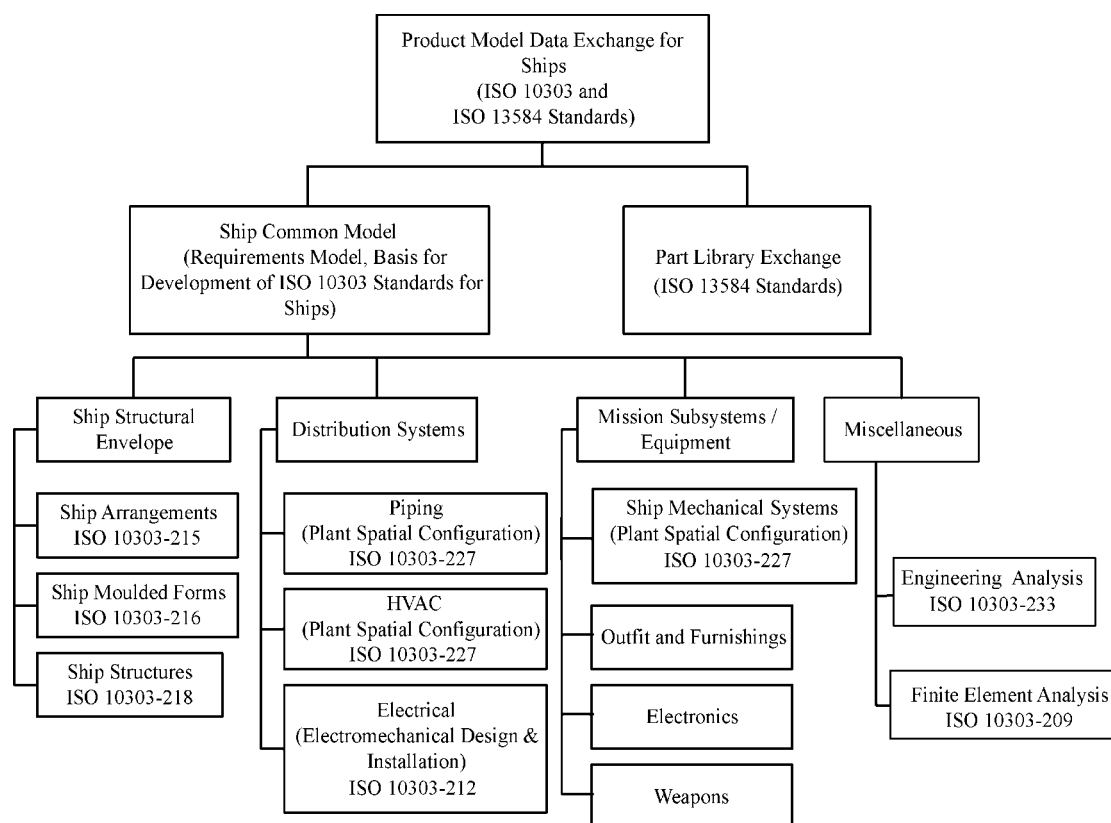


Figure 1 — Shipbuilding application protocols

This part of ISO 10303 specifies an application protocol for the exchange of product data representing a ship structures information. These data may needed to be exchanged or shared between different organizations. Such organizations include ship owners, ship classification societies, design agencies and fabricators. This AP has been developed to support the shipbuilding activities and computer applications associated with the pre-design, the main design, the manufacturing, the maintenance (repair), and the inspection and survey during operation life cycle phases for commercial or naval ships.

Figure 2 illustrates how the ship structures information may be grouped under the following:

- ship common model;
- ship common utilities;
- ship structures;

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- manufacturing of ship structures;
- class approvals;
- shape representations.

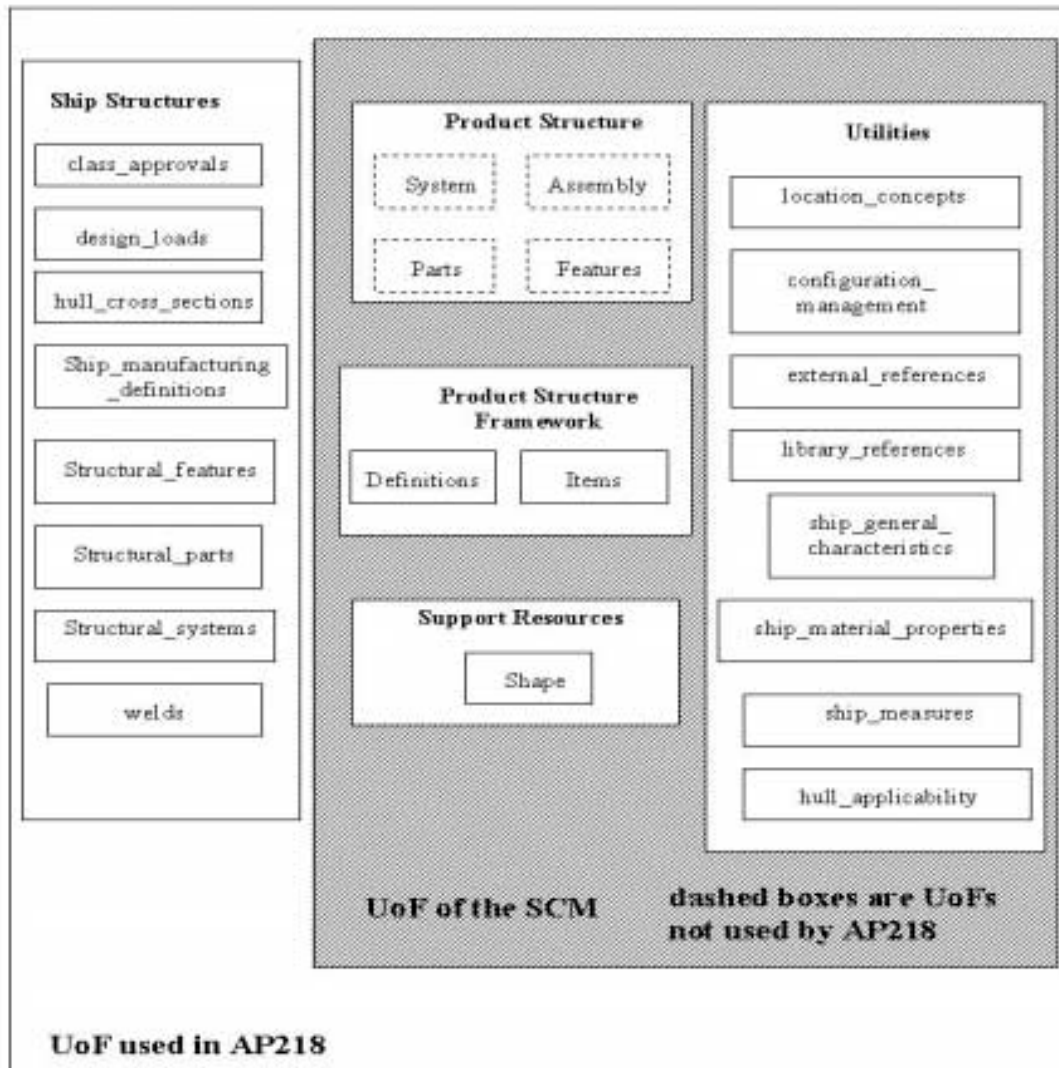


Figure 2 — Data planning model

The unit of functionality (UoF) for ship common model (SCM) specifies the shipbuilding common model which is used for all ship building APs (currently for AP215, AP216, and AP218). The SCM is considered to present the framework of Shipbuilding application protocols. The ship common model UoFs are the basis for the design and manufacturing of ship structures.

The group of UoFs labeled utilities provides the information for configuration management, location concepts, basic geometry and others, which is used by all shipbuilding application protocols.

The group of UoFs labeled ship structures describes the design definition of ship structures during the pre-design and design phase of a ship, the manufacturing definitions of ship structures during the manufacturing phase of a ship, and approvals of the structural parts and hull cross-sections of the ship.

The group of UoFs labeled product definition framework provides the key part of the Ship Common Model and provides general concepts of how to relate things, how to define their properties and how to represent them.

The group of UoFs labeled product structure provides different levels of structuring a product mainly by space, by assembly or by system in a general manner.

The group of UoFs labeled support resources provides all the STEP integrated resources (ISO 10303-41, 42, 43, 44, and 45) used in shipbuilding APs.

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

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

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

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Industrial automation systems and integration — Product data representation and exchange — Part 218: Application protocol: Ship structures

1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for the exchange of product definition data and its configuration and approval status information for ship structural systems. Configuration in this context pertains to data specific to revision tracking and change history of selected ship structural entities within the product model. Approval pertains to the company internal approval and the classification society approval. This Application Protocol supports the shipbuilding activities and applications associated with the design phase and the manufacturing phase.

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

NOTE 2 The detailed technical discussion in annex L provides details that define the basis for the definition of the scope of this part of ISO 10303 and details that define the basis of harmonization with other parts of ISO 10303 for product exchange of data for ships.

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

- product definition data pertaining to the ship structure which includes hull structure, superstructure and all other internal structures of commercial and naval ships;
- product definition data pertaining to the ship structure;
- product definition data pertaining to the pre-design phase of the ship structure;
- product definition data pertaining to the main design phase of the ship structure;
- product definition data pertaining to the manufacturing phase of the ship structure;
- product definition data pertaining to the product structuring of ships, including the structuring by system and by assemblies within the ship;
- product definition data identifying the ship general characteristics which are relevant to the design of the ship structure.

NOTE The general characteristics include ship main dimensions, designations and principle characteristics, as well as the rules, regulations and standards applicable to the ship. It also includes lightships weight distribution and free-board characteristics for the purpose of design and design approvals.

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- product definition data pertaining to the ship global coordinate system, local coordinate systems and spacing grids, which are used for defining the geometry of the ship structure;
- product definition data pertaining to the geometrical representation of the ship structure parts and assemblies;
- product definition data pertaining to the hull plating and the stiffener profiles, and the definition of structural features, which comprise the ship structure parts and assemblies, including functional descriptions.

EXAMPLE Edge, corner and interior cut-outs are examples of structural features.

- product definition data pertaining to the design of the welded connections and joints of ship structure parts and assemblies, including edge preparations and weld type and size;
- product definition data pertaining to the specification of transverse cross-sections through the ship structure for the purpose of approval of strength;
- product definition data pertaining to ship design loads, including shear forces and bending moments acting on the ship structure, for the purpose of determining the longitudinal strength of the ship;
- product definition data pertaining to the weights and centres of gravity of the ship structure parts and assemblies;
- product definition data pertaining to the materials of ship structure, required to manufacture the ship or a part of it;
- product definition data pertaining to the configuration management of the ship structure, including approval, versioning and change administration;
- product definition data pertaining to external references, technical documentation and other supporting concepts which are necessary and pertinent to the design and manufacture of the ship structure parts and assemblies.

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

- product definition data pertaining to the ship structure at the operation and de-commissioning phases of the ship life cycle;
- business data for the management of a ship development project, such as budgets, schedules and resource requirements;
- product definition data pertaining to the direct calculation of ship structure in the design stage;
- product definition data pertaining to the coating of structural parts as well as the production tolerances;
- product definition data pertaining to the ship subdivision;
- product definition data pertaining to the ship distribution systems;

EXAMPLE The electrical, piping and HVAC systems.

- product definition data pertaining to the ship machinery and propulsion systems;
- product definition data pertaining to the ship outfit and furnishing;

EXAMPLE Ladders, some foundations, pre-assembled hull outfit items, doors, and the like.

- product definition data pertaining to ship hull structure parts which are manufactured by forging or casting.

EXAMPLE Stern frames, rudder horns and propeller shaft brackets.

2 Normative references

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

ISO 657-19 *Hot-rolled steel sections — Part 19: Bulb flats (metric series) - Dimensions, sectional properties and tolerances*

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

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

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

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

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

ISO 10303-28 *Industrial automation systems and integration — Product data representation and exchange — Part 28: Implementation methods: XML representations of EXPRESS schemas and data.*

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

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

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

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

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

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

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

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

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

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

ISO 13584-26 *Industrial automation systems and integration — Parts library — Part 26: Logical resource: Information supplier identification*

ISO 13584-42 *Industrial automation systems and integration — Parts library — Part 42: Description methodology: Methodology for structuring part families*

3 Terms, definitions and abbreviated terms

3.1 Terms defined in ISO 10303-1

For the purposes of this document, the following terms defined in ISO 10303-1 apply.

- abstract test suite (ATS);
- application;
- application activity model (AAM);
- application context;
- application interpreted model (AIM);
- application object;
- application protocol (AP);
- application reference model (ARM);
- computer aided design (CAD);
- computer aided manufacture (CAM);
- conformance class;
- conformance requirement;
- data;
- data exchange;
- generic resource;
- information;
- integrated generic resource;
- integrated resource;
- interpretation;
- model;
- PICS proforma;

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- product;
- product data;
- product information model;
- resource construct;
- test purpose;
- unit of functionality (UoF);
- validation.

3.2 Terms defined in ISO 10303-21

For the purposes of this document, the following term defined in ISO 10303-21 applies.

- implementation method.

3.3 Terms defined in ISO 10303-31

For the purposes of this document, the following terms defined in ISO 10303-31 apply.

- conformance testing;
- postprocessor;
- preprocessor.

3.4 Terms defined in ISO 10303-41

For the purposes of this document, the following terms defined in ISO 10303-41 apply.

- address;
- approval status;
- area measure;
- date and time;
- derived unit;
- identifier;
- label;
- length measure;

- mass measure;
- named unit;
- organization;
- person;
- person and organization;
- plane angle measure;
- positive length measure;
- ratio measure;
- shape representation;
- text;
- time measure;
- unit;
- volume measure.

3.5 Terms defined in ISO 10303-42

For the purposes of this document, the following terms defined in ISO 10303-42 apply.

- axis2 placement 3d;
- boundary;
- bounded curve;
- bounded surface;
- box domain;
- cartesian point;
- circle;
- closed curve;
- connected;

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- curve;
- curve on surface;
- curve replica;
- edge;
- edge curve;
- fixed reference swept surface;
- geometric representation context;
- line;
- offset surface
- open curve;
- orientable;
- placement;
- point;
- surface;
- surface curve swept surface;
- vector;
- vertex.

3.6 Terms defined in ISO 10303-43

For the purposes of this document, the following terms defined in ISO 10303-43 apply.

- representation;
- representation context;
- representation item;
- representation relationship.

3.7 Terms defined in ISO 10303-216

For the purposes of this document, the following terms defined in ISO 10303-216 apply.

- after perpendicular;
- aft perpendicular;
- amidships;
- baseline;
- breadth;
- buttock line;
- camber;
- centreline;
- centreplane;
- classification;
- configuration management;
- deck;
- depth;
- forward perpendicular;
- frame;
- furnishings;
- hullform;
- hydrodynamic;
- hydrostatic;
- knuckle;
- length between perpendiculars;
- longitudinal;
- midship;

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- moulded form;
- offset;
- outfit;
- sheer;
- station;
- superstructure;
- waterline.

3.8 Other terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.8.1

assembly

a hierarchical building block view of individual structural parts comprising a ship

NOTE Parts are joined together to form successively larger building blocks. These interim products are referred to as assemblies.

3.8.2

bill of material (BOM)

a list of all raw material stock required to fabricate the product

NOTE The BOM may be for an individual part, for an aggregation of parts (EXAMPLE an assembly), or for a selected volumetric region (EXAMPLE a zone) of the ship.

3.8.3

bracket; gusset

a steel plate connecting two structural parts that strengthens the connection

EXAMPLE a bracket may be a short piece of flanged plate, a tee bar, an angle bar, or a piece of flat plate

3.8.4

builder

the company that built the ship

NOTE The builder may be further categorized as either the lead yard builder (that has constructed the first ship in a series or class) or a follow yard builder.

3.8.5

builder hull number

the unique serial number assigned to the ship by the shipbuilder indicating where this ship stands with respect to all the hulls built by this yard

NOTE The first hull would be 1, the tenth would be 10, etc. This hull number also serves as a reference to the design information generated during the design and construction processes.

3.8.6

bulkhead

A term applied to any of the partition walls used for subdividing the interior of the ship into various compartments

NOTE 1 Adapted from ISO 10303-216

NOTE 2 A longitudinal bulkhead may extend over one, several, or all decks. Likewise it may extend over the complete length of a ship or only between certain transverse bulkheads.

NOTE 3 A transverse bulkhead may extend from bottom to top of the ship, or only between certain decks. Likewise it may extend over the complete width of the ship or only between certain longitudinal bulkheads. Bulkheads are often designated by their location, use, kind of material, tightness, or method of fabrication.

3.8.7

centroid

the center of an item, area or volume measured with respect to some defined location

NOTE 1 Adapted from ISO 10303-216

NOTE 2 Within shipbuilding, centroid is expressed as a vertical component measured above the baseline, a transverse component measured from the centerline, and a longitudinal component measured from either amidships or the forward perpendicular.

3.8.8

chine

the intersection of the bottom and the sides of a flat or V-bottomed ship

3.8.9

combat systems

systems on board naval ships used for Communication and Battle

NOTE Communication is carried out for detection of targets, disturbing enemy communication signals and with weapon systems on board the ship. Battle systems are the weapon systems on board the ship.

3.8.10

compartments

the spatial partitioning of the interior volume of a ship

EXAMPLE Physical subdivision of space for segregating dry and liquid cargo, rooms, passengers, crew, machinery, and equipment

NOTE A compartment is a closed bounded volume that is defined by hull form elements, such as longitudinal and transverse bulkheads, decks, hull shell, or non structural joiner bulkheads.

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3.8.11

connections and joints

the connectivity between structural parts and other structural parts where the geometry and topology of the connection is static and does not change as a result of the connection

NOTE A connection represents a requirement that two parts be joined and may decompose into lower level connection requirements. Eventually, a connection requirement is fulfilled by a joint that represents a physical realization of the connection requirement.

3.8.12

coordinate system; co_ordinate_system; co ordinate system:

a reference system that associates a unique set of n parameters with each point in an n -dimensional space.

3.8.13

deadrise

the linear distance measured vertical from the ship keel to the turn of the bilge

NOTE A X deadrise would mean that the bottom of the ship would be X mm higher at the outboard location than at the centreline. It is sometimes expressed as a slope, such as X mm per Y m.

3.8.14

deadweight

the difference between the lightship weight and loaded displacement

EXAMPLE The weight of cargo plus weights of fuel, stores, water ballast, fresh water, crew and passengers, and baggage.

3.8.15

declination

a property of the stiffener indicating that it is tilted with respect to the surface, i.e. the web is not perpendicular to the surface. The angle between the web and surface normal is called the declination

3.8.16

definition geometry

a designation for geometry that defines the shape representation of an item

NOTE There is a contractual implication with respect to guaranteed accuracy associated with this type of geometry.

3.8.17

design change process

the processing of a formal request for change to one or more configuration items during the design phase

3.8.18

design load

the load that the ship is designed to carry or to withstand

NOTE It is used to present the design displacement or design strength.

3.8.19

design phase

stage within the ship life-cycle when the ship is being designed

NOTE A design phase can be subdivided into preliminary design, detailed design, and production design.

3.8.20

design zone

an abstract boundary, identifying a region, of a ship with unique requirements or characteristics that must be treated special in the design phase

EXAMPLE These zones carry designations such as Fire Zone, CPS Zone, Subsafe Zone, and Ship Work Authorization Boundary Zone.

3.8.21

diagonal

an auxiliary plane that cuts the hull in a plane perpendicular to the stations and inclined to the longitudinal centreplane of the ship

EXAMPLE a hull form element used to represent the intersection of the hull surface with longitudinally oriented plane, inclined to both the vertical and transverse global coordinate system axes

3.8.22

engineering parts

pipng parts, HVAC parts, discrete parts, outfit and furnishing parts

3.8.23

explicit shape

the collection of geometry, conforming to a specific geometric modelling representation defining the shape of a structural part

EXAMPLE such as CSG or B-rep

NOTE There may be more than one explicit shape for a single part. The explicit shape may have embedded in it the geometry associated with the part's features.

3.8.24

flare

the transverse measurement indicating how much greater a waterline's half-breadth is compared to the half-breadth of the design waterline, measured at the same longitudinal reference

NOTE A X mm flare are for a waterline means that the moulded hullform is 2xX mm wider at that waterline than it is at the design waterline.

3.8.25

freeboard

the distance between the waterline and the main deck or weather deck of a ship or between the level of the water and the upper edge of the side of a small boat

3.8.26

functional structural element

a classification of ship structure associated with a particular system view of the ship

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3.8.27

geometry of the ship hull

the collection of geometry elements that define the shape of the watertight envelope of the ship

NOTE This includes the underwater shell, the uppermost watertight deck or decks, and the internal watertight transverse and longitudinal bulkheads.

3.8.28

hogging

the situation of a vessel in still water as well as in a seaway, in which a vessel is bending along the longitudinal axis

NOTE The deck of the ship will be in tension, the bottom of the ship will be in compression.

3.8.29

hold

the space allocated for the stowage of cargo

3.8.30

hull number

a number assigned to the ship for its life.

NOTE When combined with a naval ship type abbreviation, it identifies the vessel.

3.8.31

hull shell

a hull form element that represents the outermost watertight envelope of a hull form section

NOTE Depending on the context of hull form section the hull shell may represent such things as the outer boundary of the ship itself, the rudder, and sonar dome.

3.8.32

hull form sections

an indicator as to whether or not the hull form section has been faired

NOTE If the section is faired, then all hull form elements contained in the section are assumed to be faired. A complete moulded hull form is fair if all its hull form sections are fair.

3.8.33

implicit shape definition

the specification of the shape of a plate or stiffener part that is independent of any specific geometric modelling representation

NOTE It is defined by a minimal set of geometry elements and attributes such that an explicit shape could be derived from it.

3.8.34

interference shape

a collection of geometry defining the shape of a structural part for performing interference analysis

NOTE This shape may include allowances for access and removal, insulation and shock clearances.

3.8.35

lightship

a ship with no cargo, stores, or personal

NOTE a ship that is complete in every respect, including operation fluids up to the required operating levels, but without any cargo, crew or their effects or any consumables.

3.8.36

main machinery

a characteristic that classifies equipment elements belonging to primary systems

EXAMPLE Such as propulsion, steering and diving.

3.8.37

maintenance phase

the operational stage of the ship when maintenance is required

3.8.38

manufacturer

a company or organization that fabricates, constructs, assembles, or delivers parts or material for the ship

3.8.39

opening

an opening in a structural part to allow penetration by another structural part, penetration of a distribution system part, passage of air or liquid, access through a structural part, lightening of a structural part to improve structural efficiency, or clearance between joined structural parts

3.8.40

predesign phase

the lifecycle phase when a first estimation of main characteristics for the ship are established

NOTE Often based on previous designs

3.8.41

production engineering

the stage within the ship life-cycle when the ship is being built, based on the production design

3.8.42

propulsion system

the system used to move the ship through the water

NOTE This can either be in a longitudinal (like the main propeller) or in a transverse (like bow thruster) direction or a combination of both.

3.8.43

ratholes

the results of removing a portions of a structural part

NOTE The ratholes are often in the shape of a semi-circle along one of its edges, in order to provide clearance

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between the part and a seam weld on an abutting part.

3.8.44

raw material stock

the plate and structural shape material that is purchased from either a steel mill or distributor, from which structural parts are cut

NOTE Typically, catalogues identify the range of sizes and cross-sectional shapes that can be selected. This raw material stock may be associated with a specific certification, heat treatment and chemical composition by the mill at the time of its manufacture.

3.8.45

reference geometry

a hull form element representing information symbolically defined in the hull form model and not intended to be an exact or complete geometric definition

NOTE Reference geometry may be used when the relationship between product model components is being highlighted, not the geometric description.

EXAMPLE The outline of the propeller blade or the shaft centerline for a moulded hull form.

3.8.46

rule length

the distance on the estimated summer load line, from the fore side of the stem to the after side of the rudder post or sternpost; where there is no rudder post or sternpost, the length is the distance to the centerline of the rudder stock. The rule length is not to be less than 96% and need not be greater than 97% of the length on the summer load line. The forward end of the rule length is to coincide with the fore side of the stem on the waterline on which the rule length is measured.

3.8.47

sagging

the situation of a vessel in still water as well as in a seaway, in which a vessel is bending along the longitudinal axis: the bottom of the ship would be in tension, the deck will be in compression

NOTE This is a reverse form of hogging with excess weight amidships.

3.8.48

ship class

the grouping of multiple ships built from a single design, identified as similar by the use of a class name

3.8.49

ship offset

a point used as a coordinate for a location on a ship hull form, appendage, or deck

3.8.50

ship range

a measure of a ship ability to remain at sea in order to perform a mission

NOTE It typically refers to a combination of distance and speed.

3.8.51

sight edge

a line that lies on the hull surface and defines the longitudinal seam between adjacent plates

NOTE These shapes are controlled, to a great extent, by appearance and aesthetic appeal.

3.8.52

special ship parts

ship parts that are formed by forging or casting processes

3.8.53

system penetrations

the intersection of piping, HVAC, or outfitting part with a structural part is a non-structural system penetration or the intersection of one structural part with another structural part is a structural system penetration

NOTE Depending on the location, compensation may be required to be added to the structural part being penetrated to compensate for lost material.

3.8.54

tanks

Compartments for liquids or gases

NOTE They may be formed by the ship structure as double bottom tanks, peak tanks, deep tanks, etc., or may be independent of ship structure and installed on special supports.

3.8.55

tumblehome

the decreasing of a vessel's beam above the water line as it approaches the rail

NOTE Tumblehome is opposite of flare.

3.8.56

weight of steel

the total weight of the structural steel parts that make up the ship

NOTE During the various life cycle phases this may vary from an estimated value during the design phase to a measured value after construction is completed.

3.9 Abbreviated terms

2D	two dimensional
3D	three dimensional
AAM	application activity model
AIC	application interpreted construct

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AIM	application interpreted model
ARM	application reference model
AP	application protocol
B-rep	boundary representation solid model
BSU	basic semantical unit
CAD	computer aided design
CAM	computer aided manufacture
CSG	constructive solid geometry
CPS	collective protective systems
FR	frame
GUID	globally unambiguous identifier
HVAC	heating, ventilation and air conditioning
ICLL	IMO load line conversion
ID	identification
IMO	international maritime organization
LFR	longitudinal frame
m	metre
MARPOL	marine pollution
mm	millimetre
NC	Numerical Control
PICS	protocol implementation conformance statement
SI	système international
SOLAS	safety of life at sea
SWBM	still water bending moment
SWSF	still water shear force

TFR	transversal frame
WF	webframe
X [n]	The nth logical element in the list X. This notation may be used to reference implicit values in the list
UoF	units of functionality

4 Information requirements

This clause specifies the information required for ship structures. The information requirements are specified as a set of units of functionality, application objects, and application assertions. These assertions pertain to individual application objects and to relationships between application objects. The information requirements are defined using the terminology of the subject area of this application protocol.

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

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

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

4.1 Units of functionality

This subclause specifies the units of functionality for the Ship Structures application protocol. This part of ISO 10303 specifies the following units of functionality:

- class_approvals;
- configuration_management;
- definitions;
- design_loads;
- external_references;
- hull_class_applicability;
- hull_cross_sections;
- items;
- library_reference;
- location_concepts;

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- product_structures;
- shapes;
- ship_general_characteristics;
- ship_manufacturing_definitions;
- ship_material_properties;
- ship_measures;
- structural_features;
- structural_parts;
- structural_systems;
- welds.

The units of functionality and a description of the functions that each UoF supports are given below. The application objects included in the UoFs are defined in 4.2.

4.1.1 class_approvals

The class_approvals UoF specifies the Definition for classification approval of structural parts, systems, plates, profiles, and hull cross sections.

NOTE Definition objects may have a class approval status attached. Subtypes of a Definition object indicate the approval status.

The following application objects are used by the class_approvals UoF:

- Corrugated_part_approval;
- Corrugated_part_rejection;
- Hull_cross_section_approval;
- Hull_cross_section_rejection;
- Hull_cross_section_result;
- Plate_approval;
- Plate_rejection;
- Plate_renewal_definition;
- Profile_approval;

- Profile_rejection;
- Profile_renewal_definition;
- Reason_for_decision;
- Structural_class_approval;
- Structural_class_approval_result;
- Structural_class_conditional_approval;
- Structural_class_rejection.

4.1.2 configuration_management

The configuration_management UoF covers the characterization of a definition under these principal aspects: its approval, its controlled changes, and the identity and the relationship of different versions within a version history.

The approval information provide when, who and what has been approved and to what level of approval, as well as how approvals are related to each other. The controlled changes information describes when and who modified what definition. Also it describes the impact of the change in terms of whether or not other definitions are created, modified or deleted.

Versions describe what definition is subject to versioning and how different versions are related to each other to provide a version history.

The following application objects are used by the configuration management UoF:

- Alternative_version_relationship;
- Approval_event;
- Approval_history;
- Change;
- Change_definition;
- Change_impact;
- Change_plan;
- Change_realization;
- Change_request;

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- Check;
- Envisaged_version_creation;
- Event;
- Revision;
- Revision_with_context;
- Version_creation;
- Version_deletion;
- Version_history;
- Version_modification;
- Version_relationship;
- Versionable_object_change_event.

4.1.3 definitions

The definitions UoF describes the abstract concept for the definition of items, item structures and item relationships.

The following application objects are used by the definitions UoF:

- Definition;
- Design_definition;
- Functional_definition;
- General_characteristics_definition;
- Library_definition;
- Library_design_definition;
- Library_manufacturing_definition;
- Manufacturing_definition.

4.1.4 design_loads

The design_loads UoF provides documentation on loads that are applied to ship structures to prove their strength. Both actual loads and loads required by classification rules may be specified.

EXAMPLE Bending moments and shear forces in still water or wave conditions are typical design loads.

NOTE A corresponding approval is normally based on artificial load cases that are the basis for strength calculations.

The following application objects are used by the design_loads UoF:

- Bending_moment;
- Design_load;
- Design_still_water_bending_moment;
- Design_still_water_shear_force;
- Design_swsf_values;
- Design_vertical_wave_bending_moment;
- Design_vertical_wave_shear_force;
- Maximum_permissible_still_water_bending_moment;
- Maximum_permissible_swbm_values;
- Maximum_permissible_still_water_shear_force;
- Maximum_permissible_swsf_values;
- Shear_force.

4.1.5 external_references

The external_references UoF provides the capability and mechanisms by which references can be made to information in other product model data set or refer to information outside a given data exchange or data sharing context, and defines constructs for the identification and reference of standards and documents defined in external libraries or outside of the scope of ISO 10303.

The following application objects are used by the external_references UoF:

- Document;
- Document_portion;

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- Document_reference;
- Document_reference_with_address;
- External_instance_reference;
- External_reference;
- External_storage;
- Universal_resource_locator.

4.1.6 hull_class_applicability

In a class design, all elements are related to the ship class. By default, an element is applicable to all hulls in the class. Hull specific changes result in elements that are applicable to specific hulls. These changes may be applied at the item level or may be applied at the definition level.

EXAMPLE 1 Types of hull applicability at the item level would be adding a new system, compartment, or equipment.

EXAMPLE 2 Types of hull applicability at the definition level would be different revisions are used to call out hull-specific changes to properties or geometry.

The following application objects are used by the hull_class_applicability UoF:

- Hull_applicability.

4.1.7 hull_cross_sections

The hull_cross_sections UoF specifies the two-dimensional (transverse) view of the hull at any longitudinal position on the ship, which is relevant to longitudinal strength.

EXAMPLE The ship is viewed as a structural beam with a length of about the length between the perpendiculars with cross sectional properties varying over this length.

The structural steel works, making up the transverse cross section, are defined in terms of hull structural elements. A hull structural element is a plate area, possibly stiffened and possibly with cutouts, constrained by an underlying geometry, to fulfill structural or other functional roles.

The following application objects are used by the hull_cross_sections UoF:

- Flare_area;
- Hull_cross_section;
- Hull_cross_section_design_definition.

4.1.8 items

The items UoF deals with the generic product structures of a ship, reflected by the concept of items, as well as by the concept of item structures, and item relationships in which instances of items are collected and related to each other in a well defined way.

The following application objects are used by the items UoF:

- Definable_object;
- Global_id;
- Item;
- Item_relationship;
- Item_structure;
- Ship;
- Versionable_object.

4.1.9 library_reference

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

EXAMPLE A supplier library of part information is a type of library that may be referenced.

The following application objects are used by the library_reference UoF:

- Boolean_property_value;
- Bsu;
- Class_bsu;
- Integer_property_value;
- Library_element_reference;
- Logical_property_value;
- Number_property_value;
- Property_bsu;
- Property_value;

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- Real_property_value;
- String_property_value;
- Supplier_bsu.

4.1.10 location_concepts

The location_concepts UoF specifies the information to locate a ship, or any part of it, in a right-handed 3D cartesian axis system. Also, it specifies the information required to subdivide any axis into intervals so that they form the reference basis for points in the axis system.

NOTE A coordinate system is either the one and only global coordinate system of the product description and root in the hierarchy, or a local coordinate system. Any number of local coordinate systems may exist. Spacing positions may be defined for any of the three global coordinate system axes. If the underlying coordinate system is the global coordinate system, the local origin may be defined with reference to spacing positions.

The following application objects are used by the location concept UoF:

- Buttock_table;
- Frame_table;
- Global_axis_placement;
- Local_co_ordinate_system;
- Local_co_ordinate_system_with_position_reference;
- Longitudinal_position;
- Longitudinal_table;
- Spacing_position;
- Spacing_position_with_offset;
- Spacing_table;
- Station_table;
- Transversal_position;
- Transversal_table;
- Vertical_position;
- Vertical_table;
- Waterline_table.

4.1.11 product_structures

The product_structures UoF describes the product structures of a ship from different points of view. It includes the assembly view of the ship, necessary for both production purposes and block oriented design.

Also, this UoF represents the functional view on a ship in order to highlight the specific aspects on each system type, used in the early design and detail design stages, and also intensively used during classification of a ship. This UoF provides a hierarchical definition of the assemblies and systems representing any number of levels.

The following application objects are used by the product_structures UoF:

- Assembly;
- Assembly_relationship;
- Composite_feature;
- Explicit_feature_design_definition;
- Feature;
- Feature_design_definition;
- Feature_relationship;
- Part;
- Part_relationship;
- System;
- System_design_definition;
- System_relationship.

4.1.12 shapes

The shapes UoF specifies the geometric information that describes the form, contour, and configuration of the ship.

The following application objects are used by the shapes UoF:

- Advanced_brep_shape;
- Edge_based_wireframe_shape;

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- Geometrically_bounded_wireframe_shape;
- Non_manifold_surface_shape.

4.1.13 ship_general_characteristics

The ship_general_characteristics UoF specifies the basic information that details the ship dimension and identification. This information is independent of any geometric context. This information includes scalar values for principal dimensions of a ship, designation information for ship related companies, ship class notation and all relevant rules and regulations. Also the information about the lightships weight distribution and free-board characteristics is included in this UoF.

The following application objects are used by the ship_general_characteristics UoF:

- Carrier;
- Class_and_statutory_designation;
- Class_notation;
- Class_parameters;
- Freeboard_characteristics;
- Lightship_definition;
- Lightship_weight_item;
- Loadline;
- Moment_3d;
- Navy_ship;
- Owner_designation;
- Principal_characteristics;
- Regulation;
- Research_ship;
- Ship_designation;
- Shiptype;
- Shipyard_designation;

- Weight_and_centre_of_gravity,
- Working_ship.

4.1.14 ship_manufacturing_definitions

The ship_manufacturing_definitions UoF specifies modifications to the detailed design geometry to account for part edge stock, part edge preparation, the addition of layout and marking information, and, in the case of curved or bent plate and structural shape parts, flat pattern development. The part geometries are associated with the raw material stock from which they will be cut. Constructs are provided for the use of manual or Numeric Control (NC) methods for laying out and cutting the parts from their raw stock and NC attributes are associated with the layout and marking information. Any production templates necessary for fabricating the parts are also identified.

Also, this UoF specifies the definitions needed by the assembly manufacturing process. The definitions are associated with the assembly orientation, assembly bounding box and footprint, or the weight and the centre of gravity of an assembly. The mechanisms specified by the weld manufacturing definition will be executed during the manufacturing life cycle.

The following application objects are used by the ship_manufacturing_definitions UoF:

- Assembly_bounding_box;
- Assembly_manufacturing_position;
- Assembly_manufacturing_definition;
- Plate_manufacturing_definition;
- Profile_manufacturing_definition;
- Structural_added_material_boundary_relationship;
- Structural_added_material_feature;
- Structural_added_material_feature_design_definition;
- Structural_manufacturing_feature;
- Structural_part_manufacturing_definition;
- Structural_weld_shrinkage_allowance_feature;
- Structural_weld_shrinkage_allowance_feature_design_definition;
- Weld_manufacturing_definition;

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- Weld_testing;
- Welding_sequence.

4.1.15 ship_material_properties

The ship_material_properties UoF describes the materials used for building a ship structure or structural parts. It specifies raw materials by physical properties, not a material that is a product which may contain many raw materials. The ship materials include composite materials and homogeneous materials.

The following application objects are used by the ship_material_properties UoF:

- Homogeneous_ship_material_property;
- Ship_material_property.

4.1.16 ship_measures

The ship_measures UoF the information for representing measures for physical quantities.

The following application objects are used by the ship measures UoF:

- Centre_location;
- Derived_unit;
- Named_unit;
- Precision.

Some attributes of application objects in this part of ISO 10303 specify relationships to types of measures. The appropriate unit corresponding to each measure is defined globally in the units attribute of the Ship object (see 4.2.204), or locally in the local_units attribute of the Definition object (see 4.2.56). Units are to be instantiable in either SI units or other systems of units.

NOTE A table specifying the units to be used in the Application Interpreted Model corresponding to each measure type is provided in annex L, section 5.

4.1.17 structural_features

The structural_features UoF describes product items covering definitions of structural cutouts. The structural cutouts specify the nature of cutouts, that is the removal of material from a structural part or a composite structural object, such as panels and assemblies.

NOTE Cutouts are distinguished by the number of part boundaries that they effect into: edge cutouts, 1 boundary effected corner cutouts, at least 2 boundaries effected and interior cutouts (holes), no boundary effected.

The following application objects are used by the structural_features UoF:

- Bevel_design_definition;
- Circular_cutout_design_definition;
- Corner_cutout;
- Corner_cutout_boundary_relationship;
- Corner_cutout_design_definition;
- Drain_hole_cutout_design_definition;
- Edge_cutout;
- Edge_cutout_functional_definition;
- Edge_feature;
- Edge_feature_functional_definition;
- Elliptical_cutout_design_definition;
- Elongated_oval_cutout_design_definition;
- Free_form_interior_cutout_design_definition;
- Interior_cutout;
- Interior_cutout_design_definition;
- Interior_cutout_functional_definition;
- Inward_round_corner_design_definition;
- Outward_round_corner_design_definition;
- Part_edge_cutout_design_definition;
- Position_feature;
- Position_feature_design_definition;
- Position_feature_relationship;
- Rectangular_cutback_corner_design_definition;
- Rectangular_cutout_design_definition;
- Round_corner_design_definition;

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- Round_corner_rectangular_cutout_design_definition;
- Round_edge_rectangular_cutout_design_definition;
- Seam;
- Seam_curve_relationship;
- Seam_design_definition;
- Shear_bevel_design_definition;
- Structural_cutout;
- Structural_cutout_boundary_relationship;
- Structural_feature;
- Structural_feature_relationship;
- Structural_part_penetration_relationship;
- Structural_system_penetration_relationship;
- Triangular_cutout_design_definition.

4.1.18 structural_parts

The structural_parts UoF describes ship parts used in a steel structure. A structural part is the generalization of piece parts in a steel structure.

EXAMPLE Types of structural parts are plates and profiles, stiffeners and beams.

A structural part may be a part of many different product structures such as assemblies, boundary topology relations, connections and functional decomposition. Each structural part has mass and material properties defined. Plates are specializations of structural parts and a plate is a part of the realization of the hull. Profiles are specializations of structural parts with a bounding surface defined along a path perpendicular to the surface of the cross section.

The following application objects are used by the structural_parts UoF:

- Angle_bar_cross_section;
- Angle_profile_cross_section;
- Bar_profile_cross_section;
- Bulbflat_cross_section;

- Channel_cross_section;
- Channel_profile_cross_section;
- Circular_hollow_profile_cross_section;
- Corrugated_part;
- Corrugated_part_design_definition;
- Corrugation;
- Explicit_profile_cross_section;
- Flanged_plate_cross_section;
- Flanged_profile_cross_section;
- Flat_bar_cross_section;
- Library_profile_cross_section;
- Non_circular_hollow_profile_cross_section;
- Parametric_profile_cross_section;
- Plate;
- Plate_boundary_relationship;
- Plate_design_definition;
- Plate_functional_definition;
- Plate_relationship;
- Profile;
- Profile_boundary_relationship;
- Profile_cross_section;
- Profile_curve_trace_line;
- Profile_design_definition;
- Profile_functional_definition;
- Profile_relationship;

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- Profile_trace_line_relationship;
- Proprietary_profile_cross_section;
- Round_bar_cross_section;
- Section_properties;
- Square_tube_cross_section;
- Structural_part;
- Structural_part_design_definition;
- Structural_part_functional_definition;
- Structural_part_relationship;
- Structural_part_symmetry_relationship;
- T_bar_cross_section;
- Twist_location;
- W_shape_cross_section.

4.1.19 structural_systems

The structural_systems UoF describes the properties and types of structural systems.

EXAMPLE 1 A hull element can be different types of bulkheads, tanks, decks, and bottoms.

EXAMPLE 2 A panel can be defined as a stiffened plate area defined on a surface, and constrained by a closed bounding curve. The curve may be modified by features such as cutouts, and the inner structure can be affected by holes.

This UoF contains definitions not only for a predefined breakdown into commonly used abstractions, but also allows the possibility for more shipyard specific abstractions.

The following application objects are used by the structural_systems UoF:

- Built_profile;
- Corrugated_structure;
- Corrugated_structure_design_definition;
- Corrugated_structure_boundary_relationship;
- Corrugated_structure_functional_definition;

- Corrugated_structure_relationship;
- Panel_system;
- Panel_system_boundary_relationship;
- Panel_system_curve_boundary;
- Panel_system_design_definition;
- Panel_system_functional_definition;
- Panel_system_plane_boundary;
- Panel_system_relationship;
- Plate_strake;
- Plate_strake_functional_definition;
- Structural_system;
- Structural_system_adjacency_relationship;
- Structural_system_design_definition;
- Structural_system_functional_definition;
- Structural_system_relationship;
- Structural_system_symmetry_relationship.

4.1.20 welds

The welds UoF contains the information requirements necessary to present the welded connectivity between structural parts. When two or more parts are joined together, these requirements are fulfilled by structural parts connection implementation which represents a physical realization of the connection.

The definitions of this UoF consist of weld design definition and welded joint design definition. The design definitions indicate the design requirements of the welds and welded joint to ensure that they satisfy the requirements of the manufacturing process.

The following application objects are used by the welds UoF:

- Beveled_groove_weld;
- Butt_groove_weld;

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- Continuous_fillet_weld;
- Electrode_chemical_composition;
- Fillet_weld;
- Groove_weld;
- Intermittent_fillet_weld;
- Spot_seam_weld;
- Structural_part_connection_implementation;
- Structural_part_joint;
- Structural_part_joint_design_definition;
- Weld;
- Weld_design_definition;
- Weld_filler_material;
- Welded_joint;
- Welded_joint_design_definition.

4.2 Application objects

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

NOTE Those attributes inherited from supertype application objects in the Application Reference Model are not repeated in the subtype application object definitions in this subclause. Refer to the appropriate supertype application object definition for the specification of these inherited attributes.

4.2.1 Advanced_brep_shape

An Advanced_brep_shape is a shape representation that is described in ISO 10303-514.

4.2.2 Alternative_version_relationship

An Alternative_version_relationship is a relationship between two Versionable_object objects (see 4.2.263) of the same type. Each Versionable_object is an alternative to the other Versionable_object.