BS 8541-3:2012

BSI Standards Publication

Library objects for architecture, engineering and construction –

Part 3: Shape and measurement – Code of practice

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Contents

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This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 16, an inside back cover and a back cover.

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Foreword

Publishing information

This part of BS 8541 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 September 2012. It was prepared by Technical Committee B/555, *Construction design, modelling and data exchange*. A list of organizations represented on this committee can be obtained on request to its secretary.

Relationship with other publications

BS 8541 comprises four parts as follows:

- Part 1, *Identification and classification*
- Part 2, *Recommended 2D symbols of building elements for use in building information modelling*
- Part 3 (this part), *Shape and measurement*
- Part 4, *Attributes for specification and assessment*

BS 8541-1, BS 8541-3 and BS 8541-4 document best practice for the development and application of construction library objects to support Building Information Modelling (BIM)-based design, standardization, specification and construction processes, see BS 8541-1:2012, **0.4** and Figure 1.

The IFC standard (ISO/PAS 16739) includes recommendations for the association of base quantities and geometry for objects. The use of the IFC standard can be supplemented by using UK-specific quantification recommendations. For further information on work within ISO, see BS 8541-1:2012, Clause **0**.

Use of this document

As a code of practice, this part of BS 8541 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this part of BS 8541 is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word "should" is used to express recommendations of this standard. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

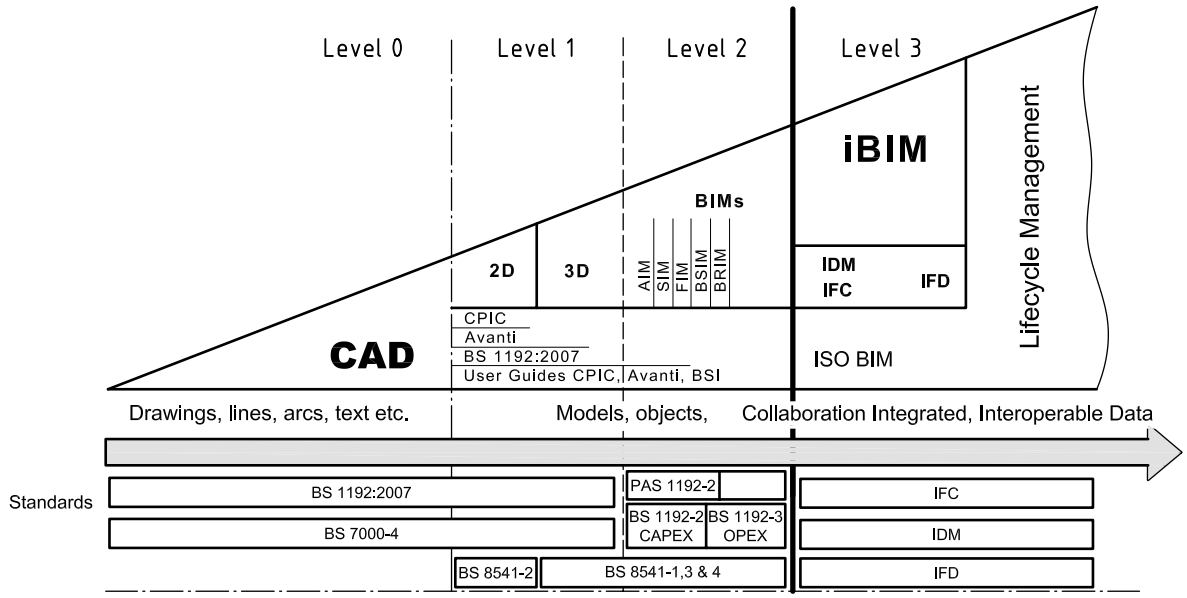
Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Figure 1 **Core maturity model**



NOTE 1 Reproduced with kind permission of Mark Bew and Mervyn Richards.

NOTE 2 The BIM reports and an updated Roadmap are maintained by BIS[1)]

[1)] Available at: http://www.bsigroup.com/en/sectorsandservices/Forms/BIM-reports/

1 Scope

This part of BS 8541 extends the recommendations in BS 8541-1 to cover purposes for characterizing the shape and measurement of construction library objects for use in the building construction and facility domain. It applies to the creation and use of generic objects and manufacturer's product objects.

NOTE Providers of generic and manufacturer's product objects can provide information to support additional purposes including measurement and spatial coordination.

It gives recommendations for the application of construction objects in integrated BIM working for spatial and construction coordination, quantity take-off and visualization. It defines the level of detail appropriate for specific uses and provides representations of measurements for characterizing the library object where geometric shape is not relevant.

Where a project is formally committed to integrated working, this British Standard may be adopted as a requirement on the design team and/or the procurement chain. For other situations, this British Standard gives recommendations of best practice.

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.

BS 8541-1:2012, *Library objects for architecture, engineering and construction – Part 1: Identification and classification – Code of practice*

3 Terms and definitions

For the purposes of this part of BS 8541, the terms and definitions given in BS 8541-1 and the following apply.

3.1 object

3.1.1 template object
type object intended to guide the production of generic objects and product objects by providing schedules of classification values and a minimum set of attributes

NOTE Typically the measurement type is specified, but the values are not.

3.1.2 generic object
type object intended for use in stages of design when the object is not resolved into a product

3.1.3 product object
type object intended to represent an obtainable product, either as a requirement or exemplar or as-built

3.1.4 type (library) object
representation of the common features of a product or group, including its classifications and properties

NOTE 1 It can be a template object, generic object or product object.

NOTE 2 It is independent of any occurrence, and has no placement in space. It can represent a template, generic or product object.

3.1.5 occurrence object
representation of an actual occurrence (instance) of an object in a building

3.2 level of detail
completeness and accuracy of a virtual shape representation compared to the physical and functional characteristics of the actual object

3.3 level of measurement
completeness and accuracy of a virtual measurement compared to the physical and functional characteristics of the actual object

4 Shape and measurement levels for construction library objects

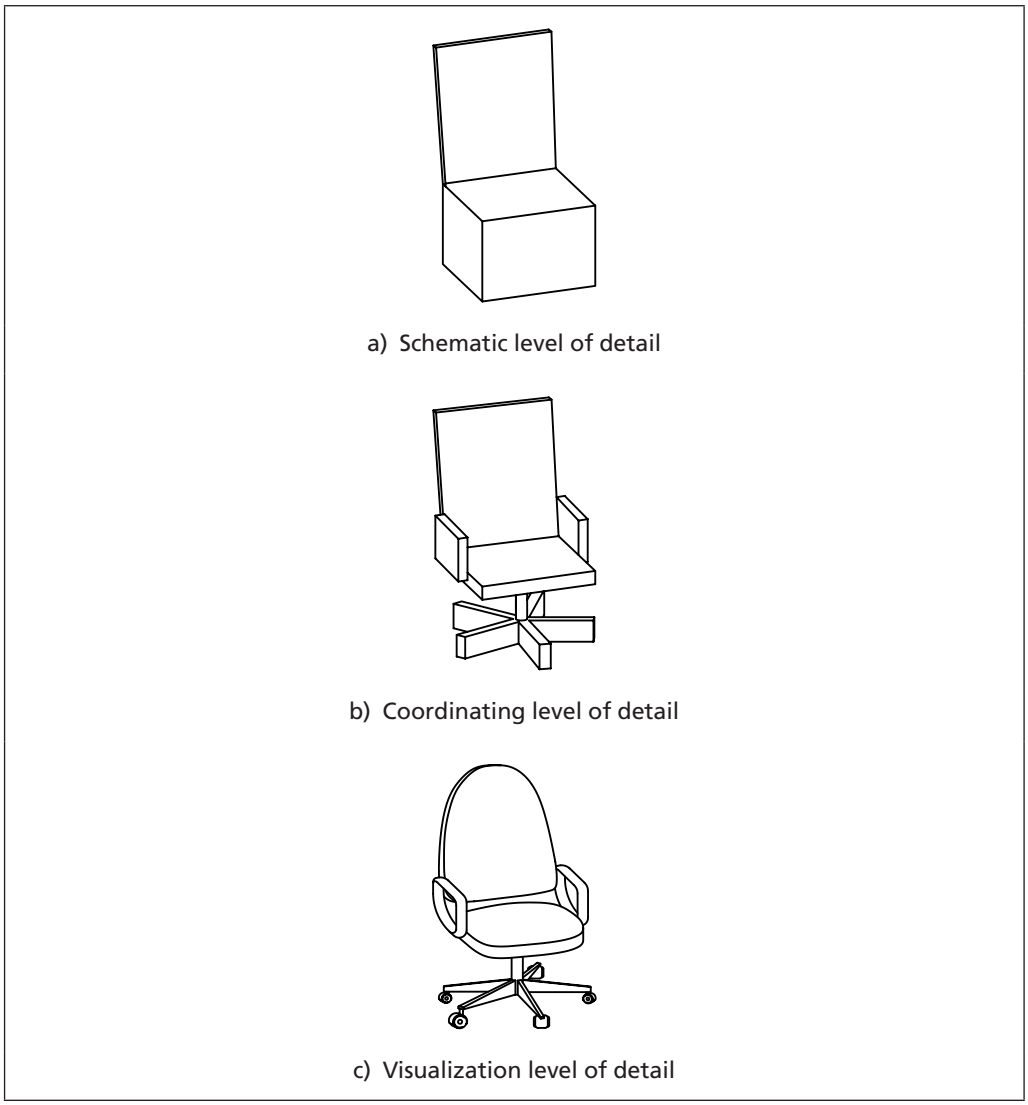
4.1 Level of detail and shape types

4.1.1 General

Library objects should be delivered with shape information appropriate to the intended uses, see Figure 2.

*NOTE Three levels of detail are defined in **4.1.2** to **4.1.4**.*

Figure 2 **Schematic, coordinating and visualization levels of detail**



a) Schematic level of detail

b) Coordinating level of detail

c) Visualization level of detail

4.1.2 Schematic level of detail

A library object should be characterized by its extent.

NOTE 1 A schematic level of detail can be used to represent the extent of the object and its connectivity. The extent of an object can be a 3D bounding box, so its location, size and adjacencies are visible.

A library object should be characterized by key connections and connectivity, using either a wire-line representation, or specific connection points.

NOTE 2 Schematic level of detail is broadly similar to the AIA Level of Development 200–300 [2].

4.1.3 Coordinating level of detail

For coordinating level of detail, a library object should also be characterized by more detailed shape sufficient to recognize the object and ensure that it has sufficient space allocated.

NOTE 1 The purposes for coordinating level of detail include object recognition, spatial allocation and coordination, and clash detection. This level of detail is also useful for the visualization of space use and construction processes.

NOTE 2 Coordinating level of detail is broadly similar to the AIA Level of Development 300 [2].

NOTE 3 *Excessive geometric detail in representations can be counterproductive and have an impact of model performance.*

4.1.4 Visualization level of detail

For visualization, a library object should be characterized by more detailed shape sufficient to create a recognizable image and to envisage its operation and use.

NOTE 1 The use-cases for visualization level of detail include detailed rendering, and visualization of the usability of equipment, including the simulation of connections on equipment through named ports.

NOTE 2 Visualization level of detail may be broadly similar to the AIA Level of Development 300 – 400 [2].

4.1.5 Insertion points

Insertion points should be consistent across all levels of detail and should usually be within the extent of the object.

4.2 Levels of measurement and measurement types

4.2.1 General

A library object should be characterized by its physical properties. Objects without specific sizing should be described at a unit size by volume, area, length or mass.

For construction object templates, the type of measurement (e.g. linear, area, mass, power etc.) should be defined. Any conventional preferences for particular units should be documented in the property description.

For generic objects and product objects, units should be defined for any numeric attribute. Units for angles, length, area, volume and mass should be used consistently across shape and measurement.

NOTE 1 BS ISO 80000-1 provides guidance on the naming of units of measure.

NOTE 2 ISO/PAS 16739 provides guidance on the naming of measurement types and units of measure.

*NOTE 3 Three levels of measurement are defined in **4.2.2** to **4.2.4**.*

Nominal sizes should not be documented as actual measurements.

4.2.2 Characteristic level of measurement

A library object should be characterized by its overall dimensions and mass.

4.2.3 Standard level of measurement representation of measurements derived from the level of detail available

To support generalized measurements, a library object should be characterized by its principal dimensions, areas and volume.

4.2.4 Method-based level of measurement

To support specific methods of measurement, a library object should additionally be characterized by method-based measures.

NOTE 1 Method-based measurements are typically made to a local or national methodology. The purposes for method-based level of measurement includes contractually required early stage elemental cost plans , quantity take-off reports, and Bills of Quantities prepared in accordance with standards such as RICS SMM7[3], NRM[4] or ICE CESMM4 [5].

A library object may also be characterized by its estimated or reference service life. Service lives should be given in years for passive objects and in hours for those objects whose service life depends on their use.

NOTE 2 See ISO 15686-4[2)]*.*

5 Use of level of detail and level of measurement

5.1 Use of level of detail

5.1.1 General

An object should be characterized by a 3D representation of its shape, with a level of detail appropriate to its intended uses. The representation should be associated to the type object.

*NOTE See **A.2**, **B.2** or **C.2** for representation examples.*

5.1.2 Library object types

Library templates should have a schematic level of detail.

Generic objects should have a coordination level of detail.

Products should have a coordination level of detail and may have a visualization level of detail.

NOTE See Table 1 for the expected levels of detail for construction library objects.

2) In preparation.

Table 1 **Expected levels of detail for construction library objects**

	Schematic	Coordination	Visualization
Template objects	required	optional	optional
Generic objects	optional	required	optional
Product objects	optional	required	optional

5.1.3 Domains

Library objects for architectural and planning objects should have at least a coordination level of detail.

Library objects for structural design in shared designs should have at least a coordination level of detail.

Library objects for mechanical, electrical and plumbing design should have at least a schematic level of detail.

NOTE 1 See Table 2 for the expected levels of detail for specific domains.

Table 2 **Expected levels of detail for specific domains**

	Schematic	Coordination	Visualization
Architecture and planning	optional	required	optional
Structural	optional	required	optional
Mechanical, electrical and plumbing	required	required	optional
Civil and infrastructure	required	required	optional

*NOTE 2 See **A.2**, **B.2** or **C.2** for examples.*

5.2 Use of levels of measurement

5.2.1 General

An object should be characterized by measurements, with a level of detail appropriate to its intended uses and domain.

The measurement should be associated to the type object.

*NOTE See **A.3**, **B.3** or **C.3** for measurement examples, including service life.*

5.2.2 Library object types

Library templates should have a characteristic level of measurement.

Generic library objects should have a characteristic and standard level of measurement.

Product objects should have a characteristic, standard and method-based level of measurement.

NOTE See Table 3 for the expected levels of measurement for construction library objects.

Table 3 **Expected levels of measurement for construction library objects**

	Characteristic	Standard	Method-based
Template objects	required	optional	optional
Generic objects	required	required	optional
Product objects	required	required	required

5.2.3 Domain types

Library templates and generic objects, irrespective of domain, should have at least a characteristic and standard level of measurement.

NOTE See Table 4 for the expected levels of detail for specific domains.

Table 4 **Expected levels of measurement for specific domains**

	Characteristic	Standard	Method-based
Architecture and planning	required	required	optional
Structural	required	required	optional
Mechanical, electrical and plumbing	required	required	optional
Civil and infrastructure	required	required	optional

5.3 Occurrence

Where an occurrence of a library object is provided, it should be given context by positioning it relative to a containing spatial object, e.g. a space, a building storey or a building. It should be referenced to the defining library object and may share its shape representation, see Figure 3.

*NOTE See **A.4, B.4** or **C.4** for placement examples.*

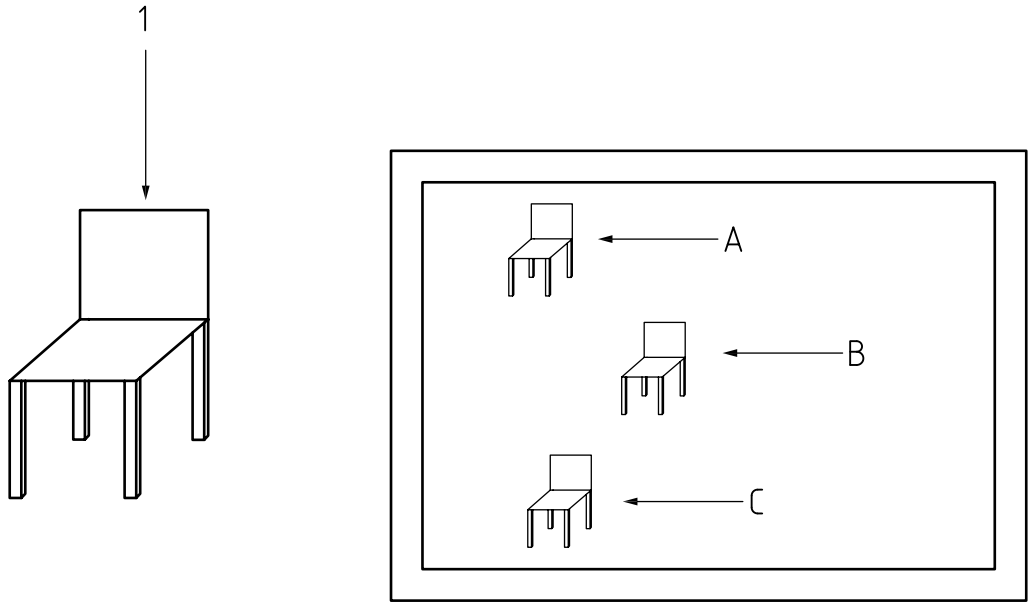
5.4 Compliance

The library object should be tested in accordance with:

- BS 8541-1; and
- the additional rules implied by the specific recommendations in **5.1** to **5.3**.

NOTE Compliance to this British Standard does not warrant the data transmitted.

Figure 3 **Relationship of type (library object and occurrence objects**



Key

1 Type (specification)

A Occurrence at a specific position and orientation

B Occurrence at another specific position and orientation

C Occurrence at another specific position and orientation

Annex A (informative) COBie 2.4 presentation

A.1 General

Table A.1 to Table A.3 give examples of the data required using the COBie representation, e.g. in a standard spreadsheet. See BS 8541-1:2012, Clause **0** for further information about COBie and BS 8541-1:2012, Annex A for examples covering identification and origination.

A.2 Shape examples

Table A.1 **COBie type sheet showing fields that relate to size-related columns**

Name	NominalLength	NominalWidth	NominalHeight	Shape	Size
MyCompany MC999 Basin 470w × 300d	470.0	300.0	455.0	shaped	470mm (W) × 455mm (H) × 300mm (D)

NOTE 1 Length is the primary or characteristic horizontal dimension.

NOTE 2 Width is the secondary horizontal dimension.

NOTE 3 Height is the characteristic vertical dimension.

A.3 Measurement

Table A.2 **COBie attribute sheet showing an example measure**

Name	CreatedBy (lookup)	CreatedOn	Category (lookup)	SheetName (lookup)	RowName (lookup)	Value	Unit
GrossWeight	sales@ MyCompany. co.uk	2012-02-11T18:31:28	Approved	Type	MyCompany MC999 Basin 470w × 300d	18	kg

A.4 Placement

Table A.3 **COBie coordinate sheet (showing component placement and extent**

Name	CreatedBy (lookup)	CreatedOn	Category (lookup)	StreetName (lookup)	RowName (lookup)	CoordinateXAxis	CoordinateYAxis	CoordinateZAxis
MyCompany MC999 Basin:470w × 300d:470w × 300d:211813 box-lowerleft	sales@ MyCompany. co.uk	2012-01-19T12:27:24	box-lowerleft	Component	MyCompany MC999 Basin:470w × 300d:470w × 300d:211813	0	0	0
MyCompany MC999 Basin:470w × 300d:470w × 300d:211813 box-upperright	sales@ MyCompany. co.uk	2012-01-19T12:27:24	box-upperright	Component	MyCompany MC999 Basin:470w × 300d:470w × 300d:211813	470	300	455

Annex B (informative) ISO 10303-28 "XML" format

B.1 General

Definitive information is contained in the current IFC documentation [6].

B.2 Shape examples

```
<IfcShapeRepresentation id="i100080">
       <ContextOfItems>
              <IfcGeometricRepresentationContext xsi:nil="true" ref="i100081"/>
       </ContextOfItems>
       <RepresentationIdentifier>Body</RepresentationIdentifier>
       <RepresentationType>SweptSolid</RepresentationType>
       <Items >
              <IfcExtrudedAreaSolid ">
                     <SweptArea>
```

IFC provides many forms of geometric representation, of which an extruded solid is one of the simplest. IFC recommends specific names for the representation identifier and type.

```
                        <IfcRectangleProfileDef >
                                <ProfileType>area</ProfileType>
                                <Position>
                                        <IfcAxis2Placement2D xsi:nil="true"
                                        ref="i100084"/>
                                </Position>
                                <XDim>400.</XDim>
                                <YDim>600.</YDim>
                        </IfcRectangleProfileDef>
                </SweptArea>
                <Position>
                        <IfcAxis2Placement3D xsi:nil="true" ref="i100079"/>
                </Position>
                <ExtrudedDirection>
                        <IfcDirection xsi:nil="true" ref="i100086"/>
                </ExtrudedDirection>
                <Depth>800.</Depth>
        </IfcExtrudedAreaSolid>
</Items>
</IfcShapeRepresentation>
```

B.3 Measurement examples

```
<IfcElementQuantity id="i100055">
        <GlobalId>1234567890123456789300</GlobalId>
        <OwnerHistory>
                <IfcOwnerHistory xsi:nil="true" ref="i100006"/>
        </OwnerHistory>
        <Name>BaseQuantities</Name>
        <Description>Base quantities that are common to the definition of all occurrences of walls.</
        Description>
        <Quantities>
                <IfcQuantityWeight>
                        <Name>Mass</Name>
                        <Description>Mass of the object</Description>
                        <MassValue>0.</MassValue>
```

<pre></IfcQuantityWeight>
<IfcQuantityVolume >
<Name>GrossVolume</Name>
<Description>Volume of the object</Description>
<VolumeValue>0.</VolumeValue>
</IfcQuantityVolume>
<IfcQuantityLength>
<Name>Length</Name>
<Description>Characteristic length of the object </Description>
<LengthValue>0.</LengthValue>
</IfcQuantityLength>
<IfcQuantityArea>
<Name>ProjectedArea</Name>
<Description>Characteristic Area of the object Description>
<AreaValue>0.</AreaValue>
</IfcQuantityArea>
 	
</Quantities>
</IfcElementQuantity></pre>	

<pre><IfcPropertySet id=”ps2”>
<GlobalId>2hfLRDZAz8$QVWSrY4eISL</GlobalId>
<OwnerHistory>
<IfcOwnerHistory xsi:nil=”true” ref=”oh1”/>
</OwnerHistory>
<Name>Pset_ServiceLife</Name>
<Description>
Captures the period of time that an artefact will last along with various factors that impact the expected service life.
</Description>
<HasProperties>
<IfcPropertyEnumeratedValue>.
<Name>ServiceLifeType</Name>
<Description>
ACTUALSERVICELIFE: The service life that an asset has given.
EXPECTEDSERVICELIFE: The service life that an artefact is expected to have under current operating conditions.
OPTIMISTICREFERENCESERVICELIFE: The best or most optimistic estimate of service life that is quoted for an artefact under reference operating conditions.</pre>
	IFC recommends a specific property set for documenting service life.


```
                PESSIMISTICREFERENCESERVICELIFE: The least or most pessimistic estimate of
                service life that is quoted for an artefact under reference operating conditions.
                REFERENCESERVICELIFE: The typical service life that is quoted for an artefact
                under reference operating conditions.
                </Description>
                <EnumerationValues>
                        <IfcLabel>REFERENCESERVICELIFE</IfcLabel>
                </EnumerationValues>
        </IfcPropertyEnumeratedValue>
                <IfcPropertySingleValue>
                        <Name>ServiceLifeDuration</Name>
                                <Description>The length or duration of a service life
                                </Description>
                        <NominalValue>
                                <IfcDurationMeasure>24</IfcDurationMeasure>
                        </NominalValue>
                </IfcPropertySingleValue>
                        <IfcPropertySingleValue>
                                <Name>QualityOfComponents</Name>
                                        <Description>
                                        Adjustment of the service life resulting from the effect
                                        of the quality of components used.
                                        </Description>
                                <NominalValue>
                                        <IfcPositiveRatioMeasure>1.1</PositiveRatioMeasure>
                                </NominalValue>
                        </IfcPropertySingleValue>
                                <IfcPropertySingleValue>
                                        <Name>Utilization</Name>
                                                <Description>
                                                The proportion of time that the facility or the
                                                product is expected to be utilized.
                                                </Description>
                                        <NominalValue>
                                                <IfcPositiveRatioMeasure>0.125</
                                                PositiveRatioMeasure>
                                        </NominalValue>
                                </IfcPropertySingleValue>
        </HasProperties>
</IfcPropertySet>
```

B.4 Placement

<IfcLightFixtureType id="i100005"> <GlobalId>123456789012345678900</GlobalId> <OwnerHistory> <IfcOwnerHistory xsi:nil="true" ref="i100006"/> </OwnerHistory> <Name>LightFixture_POINTSOURCE_LightFixture_UK</Name> <Description/> <HasPropertySets ex:cType="set"> <IfcPropertySet pos="0" xsi:nil="true" ref="i100007"/> </HasPropertySets> <RepresentationMaps ex:cType="list-unique"> <IfcRepresentationMap pos="0" xsi:nil="true" ref="i100078"/> </RepresentationMaps> <Tag>SPie Template Template</Tag> <ElementType/> <PredefinedType>pointsource</PredefinedType> </IfcLightFixtureType>	An Ifc*Type, e.g. an IfcLightFixtureType, has representations of shape but no position.
<IfcFlowTerminal id="i100087"> <GlobalId>37N4UypQzHIfXhrSJ8E8EP</GlobalId> <OwnerHistory> <IfcOwnerHistory xsi:nil="true" ref="i100006"/> </OwnerHistory> <Name>LightFixture_LightFixture_POINTSOURCE_LightFixture_UK_Instance</Name> <Description/> <ObjectType>COMPONENT</ObjectType> <ObjectPlacement> <IfcLocalPlacement xsi:nil="true" ref="i100088"/> </ObjectPlacement> <Representation> <IfcProductDefinitionShape xsi:nil="true" ref="i100094"/> </Representation> <Tag>element</Tag> </IfcFlowTerminal>	An Ifc occurrence object, e.g. an IfcFlowTerminal, has position and may have representations of shape.

Annex C (informative) BS ISO 10303-21 “STEP file” format

C.1 General

Definitive information is contained in the current IFC documentation [6].

C.2 Shape

#100474 = IFCSHAPEREPRESENTATION(#100000, ‘Body’, ‘SweptSolid’, (#100475));

#100475 = IFCEXTRUDEDAREASOLID(#100476, #100408, #100407, 3000.);

#100476 = IFCRECTANGLEPROFILEDEF(.AREA., $, #100477, 3000., 1000.);

NOTE See the IFC documentation [6] for a full discussion of shape representations.

C.3 Measurement

#946781=IFCQUANTITYAREA(‘GrossFootprintArea’,$,$,29779.38);

#100658 = IFCPROPERTYENUMERATEDVALUE(‘ServiceLifeType’, ‘The typical service life that is quoted for an artefact under reference operating conditions.’, (IFCLABEL(‘expectedservicelife’)), #100551);

#100659 = IFCPROPERTYSINGLEVALUE(‘ServiceLifeDuration’, ‘The length or duration of a service life.’, IFCREAL(35.00), $);

C.4 Placement

#100467 = IFCLOCALPLACEMENT(#100456, #100473);

#100489 = IFCLOCALPLACEMENT(#100467, #100633);

#100633 = IFCAXIS2PLACEMENT3D(#100639, #100407, #100405);

#100639 = IFCCARTESIANPOINT((0., 0., 0.));

#100407 = IFCDIRECTION((0., 0., 1.));

#100405 = IFCDIRECTION((1., 0., 0.));

NOTE See the IFC documentation [6] for a full discussion of placement.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

BS ISO 80000-1, *Quantities and units – Part 1: General*

ISO 10303-28, *Industrial automation systems and integration – Product data representation and exchange – Part 28: Implementation methods: XML representations of EXPRESS schema and data* [3)]

ISO/PAS 16739, *Industry foundation classes (IFC2x) platform specification*

ISO 15686-4, *Building Construction – Service Life Planning – Part 4: Service Life Planning using IFC based Building Information Modelling* [3)]

Other publications

[1] BSI, *Free reports on BIM and BI555 roadmap,* London, BSI 2012 [4)]

[2] AMERICAN INSTITUE OF ARCHITECTS, *E202–2008 BIM Protocol document*, Washington, AIA 2012 [5)]

[3] ROYAL INSTITUTION OF CHARTERED SURVEYORS, *SMM7 - Standard method of measurement for building works*, Coventry, RICS 2012

[4] ROYAL INSTITUTION OF CHARTERED SURVEYORS, *RICS New rules of measurement detailed measurement for building works*, Coventry, RICS 2012

[5] INSTITUTION OF CIVIL ENGINEERS, *CESMM4 Civil Engineering Standard Method of Measurement*, London, ICE, 2012

[6] BUIILDINGSMART INTERNATIONAL, *IFC Documentation* [6)]

Further reading

BUILDING COST INFORMATION SERVICES, *Elemental Standard Form of Cost Analysis: Principles, instructions, elements and definitions,* 4th (NRM) edition, London, BCIS, 2012

3) In preparation.

4) Available at http://www.bsigroup.com/en/sectorsandservices/Forms/BIM-reports/

5) Available at http://www.aia.org/contractdocs/training/bim/AIAS078742

6) Available at http://buildingsmart-tech.org/specifications/ifc-releases

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