



Recommended Practices for Assembly Validation Properties

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1 Introduction

This document provides the technical specification for two additional validation properties for assembly data. These were developed as a part of the LOTAR part 115 project.

The existing validation properties for assembly data, known as “ValProps II” (see Recommended Practices for Geometric Validation Properties, 2nd Extension), provide a suitable mechanism where geometrical data is provided along with the product structure. However, for incremental exchange of STEP files, where the product structure might be included but the geometry of the component parts may be omitted, ValProps II is not applicable. Similarly, if the product structure is broken down into smaller sub-assemblies, the component data is not available in the sub-assembly files and so ValProps II is again not applicable.

The additional Assembly Validation Properties introduced in this document will provide a verification capability where geometry is not present. They will make it possible for the exchange of assembly data to be verified in two ways. The first will ensure that the number of instances found at each node is correct. The second will ensure that the position and orientation information for each instance is correct.

2 Scope

The following are within scope of this document

- Assignment of specific properties for the top node and intermediate nodes of a product structure, i.e. a collection of **products** with **product_definitions** related by **next_assembly_usage_occurrence** entities.
- Assignment of a numerical property to such nodes to define the number of child instances of that node.
- Assignment of a centroid type property to such nodes to simulate the existence of a pre-defined notional solid within each child instance node.

The following are outside the scope of this document

- Assignment of physical properties to any product.
- Assignment of properties where product structure is not defined.
- Support for other forms of product structure where **assembly_component_usage** entities or other subtypes are used to relate **product_definitions** instead of **next_assembly_usage_occurrence** entities.

Within this document, the following definitions apply:

- A **node** is a part within a product structure primarily represented by a **product_definition**, but also includes the associated **product_definition_formation** and **product** and can include any associated **product_definition_shape**.
- The **top node** of a product structure is referenced as the **relating_product_definition** by one or more **next_assembly_usage_occurrence** but is not referenced as a **related_product_definition** by any **next_assembly_usage_occurrence**.
- **Intermediate nodes** are those which are referenced as the **relating_product_definition** of one or more **next_assembly_usage_occurrences** and are referenced as the **related_product_definition** by one or more other **next_assembly_usage_occurrences**.

- A **leaf node** is referenced as the **related_product_definition** by one or more **next_assembly_usage_occurrence** but is not referenced as a **relating_product_definition** by any **next_assembly_usage_occurrence**.
- **Child instances** for a **product_definition** are those **next_assembly_usage_occurrence** entities which reference the **product_definition** as the **relating_product_definition**. In this case, the **product_definition** referenced by the **next_assembly_usage_occurrence** as the **related_product_definition** is the child node.
- **Parent instances** for a **product_definition** are those **next_assembly_usage_occurrence** entities which reference the **product_definition** as the **related_product_definition**. In this case, the **product_definition** referenced by the **next_assembly_usage_occurrence** as the **relating_product_definition** is a parent node.

3 Fundamental concepts

The following two concepts are defined:

3.1 Number of Children

The first of these allows the pattern of the product structure to be verified, i.e. each node has the correct number of instances or branches.

3.2 Notional Solids Centroid Position

The second of these allows the positional information for each instance in the product structure to be verified i.e. the coordinate systems for each child node is positioned and oriented correctly relative to its parent. Note that this condition is not mathematically guaranteed by this methodology, but the chance of an incorrect position and orientation combining to give the correct result is extremely small.

4 Assembly Validation Properties

4.1 Number of Children

Each node which is the parent node of at least one instance will have a property attached to enumerate the actual number of child instances of that node. This number will be defined by the sending system. On receipt of the data, the system which post-processes the STEP file will check that the translated assembly data has the correct number of child instances at each node.

This property will be defined by STEP entities in the following way:

- Where a **product_definition** entity is used as the **relating_product_definition** by one or more **next_assembly_usage_occurrence** entities, it will have a **property_definition** for which the **name** will be "assembly validation property".
- The **representation** linked to the **property_definition** by a **property_definition_representation** will have the **name** "number of children".
- The single **representation_item** for this **representation** will have the **name** "number of children".
- It will be a **value_representation_item** with a **value_component** which is a **measure_value**. The value defined will represent the number of **next_assembly_usage_occurrence** entities for which the **relating_product_definition** is the **product_definition** for which the property is defined.

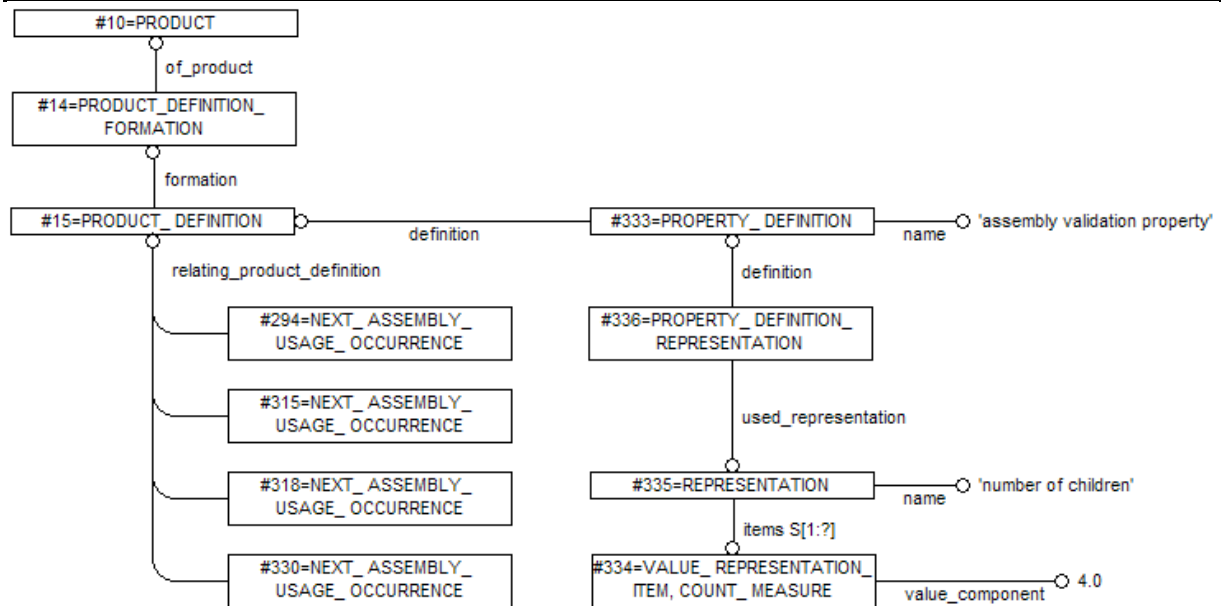


Figure 1 - Entities used for the "Number of Children" Assembly Validation Property

The following sample entity definitions are taken from the STEP file in section 5.1:

```
#10=PRODUCT('as1','as1',$, (#8));
#14=PRODUCT_DEFINITION_FORMATION('v0','v0 for as1',#10);
#15=PRODUCT_DEFINITION('design',$,#14,#9);

#333=PROPERTY_DEFINITION('assembly validation property','',#15);
#334=VALUE_REPRESENTATION_ITEM('number of children',COUNT_MEASURE(4));
#335=REPRESENTATION('number of children',(#334),#266);
#336=PROPERTY_DEFINITION_REPRESENTATION(#333,#335);
```

where the following instance definitions occur within the STEP file which have #15 as the **relating product definition**:

```
#294=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_PLATE','', 'PART44_PLATE',
#15,#21, 'PART44_PLATE');
#315=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_LBRACKASS_1','',
'PART44_LBRACKASS',#15,#51, 'PART44_LBRACKASS');
#318=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_LBRACKASS_2','',
'PART44_LBRACKASS',#15,#51, 'PART44_LBRACKASS');
#330=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_RODASS','', 'PART44_RODASS',
#15,#63, 'PART44_RODASS');
```

4.2 Notional Solids Centroid Position

This property is similar to the original Geometric Validation Properties in that a property analogous to a mass property for each sub-assembly is defined (in this case, a centroid). See the Recommended Practices for GVP, section 3.6, for details. However, in this case the property is not calculated based on any real geometry defined for that product.

For the top node and each intermediate node of a product structure, a notional solid is assumed within the child node of each child instance of that node. Using the positional and orientation relationship for each child instance, a centroid position can be calculated for the combined set of notional solids within the set of child instances.

The notional solid will be a cube of size 10 x 10 x 10. The notional solid will be positioned with its centroid at (10.0,10.0,10.0) of the co-ordinate system of the child node. Note that the actual size and shape of the notional solid will not, in fact, affect the overall result. The key data is the centroid position and the assumption that the volume of the notional solid in each child node is the same. Mathematically the calculated point is the mean of the set of points at (10.0,10.0,10.0) within the child nodes.

Note that in contrast to an actual solid centroid, the notional solid itself is not in the STEP file – it is just a convention. Thus, it has to be ensured that the correct geometrical context is used for the notional solids centroid position, in order to guarantee that the units are applied correctly.

The child node may be a leaf node of the overall assembly or another intermediate node within the sub-assembly. Each case is treated in the same way. Even though the child node might be an intermediate node with no actual geometry defined, a notional solid will be assumed for the purpose of this calculation.

The notional centroid for each sub-assembly is influenced only by the notional solid in each of its directly instanced child nodes.

This property will be defined by STEP entities in the following way:

- Where a **product_definition** entity is used as the **relating_product_definition** by one or more **next_assembly_usage_occurrence** entities, it will have a **property_definition** for which the **name** will be “assembly validation property”.
- The **property_definition_description** will be “notional solids centroid”.
- The **representation** linked to the **property_definition** by a **property_definition_representation** will have the **name** “notional solids centroid”.
- The single **representation_item** for this **representation** will have the **name** “centre point”. It will be a **cartesian_point** defining the calculated centroid for the notional solids assumed for each child node. The child nodes are those **product_definitions** defined as a **related_product_definition** in a **next_assembly_usage_occurrence** entity for which the **relating_product_definition** is the **product_definition** for which the property is defined.

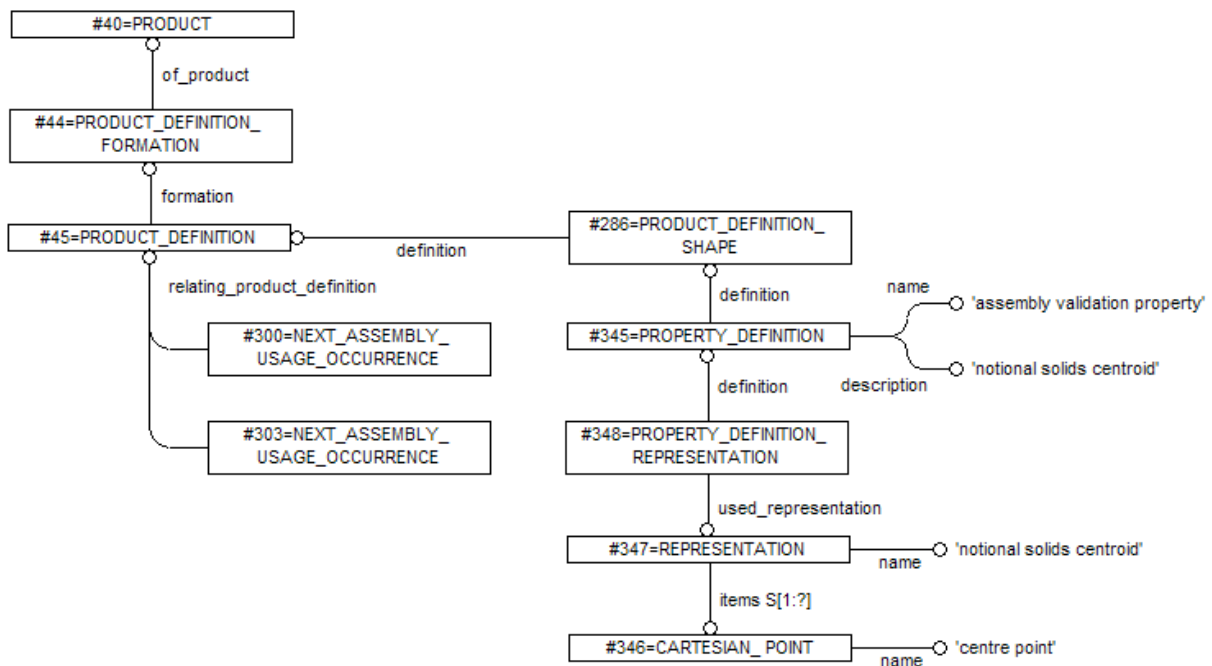


Figure 2 - Entities used for the "Notional Solids Centroid Position" Validation Property

The following sample entity definitions are taken from the STEP file in section 5.1:

```
#40=PRODUCT('part44_nutbolt','part44_nutbolt',$,(#8));
#44=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_nutbolt',#40);
#45=PRODUCT_DEFINITION('design',$,#44,#9);

#286=PRODUCT_DEFINITION_SHAPE('', $, #45);

#345=PROPERTY_DEFINITION('assembly validation property',
'notional solids centroid', #286);
#346=CARTESIAN_POINT('centre point', (10.,10.,12.));
#347=REPRESENTATION('notional solids centroid', (#346), #172);
#348=PROPERTY_DEFINITION_REPRESENTATION(#345, #347);
```

where the following instance definitions occur within the STEP file which have #45 as the **relating_product_definition**:

```
#300=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_BOLT', '', 'PART44_BOLT', #45,
#33, 'PART44_BOLT');
#303=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_NUT_1', '', 'PART44_NUT', #45,
#39, 'PART44_NUT');
```

5 Part21 File Example

The following example is the well known AS1 assembly. The assembly is made up with five actual parts. These are a plate, an L-bracket, a rod, a bolt and a nut. There are three sub-assemblies. These are as follows:

- The nut-bolt assembly consisting of a nut and bolt.
- The rod-assembly consisting of a rod and 2 nuts.
- The L-bracket assembly consisting of an L-bracket and 3 nut-bolt sub-assemblies.

The full assembly is made up of a plate, a rod-assembly and 2 L-bracket assemblies.

Schematically it is defined as shown in Figure 3. Pictorially it is shown in Figure 4.

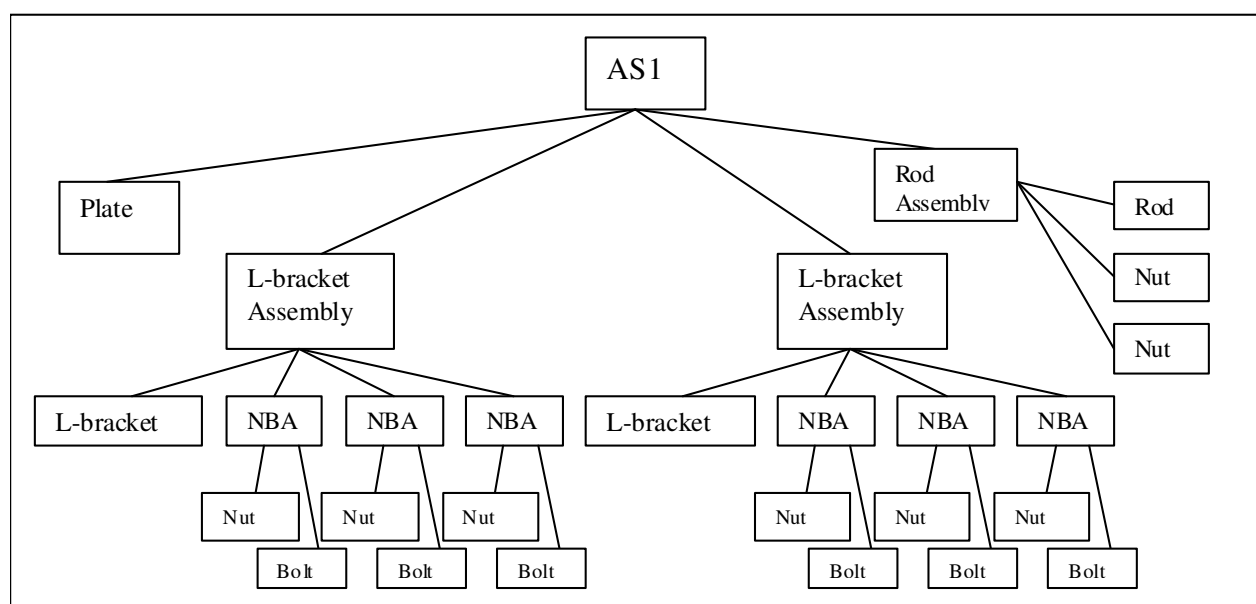


Figure 3 - Schematic diagram of exploded AS1 assembly

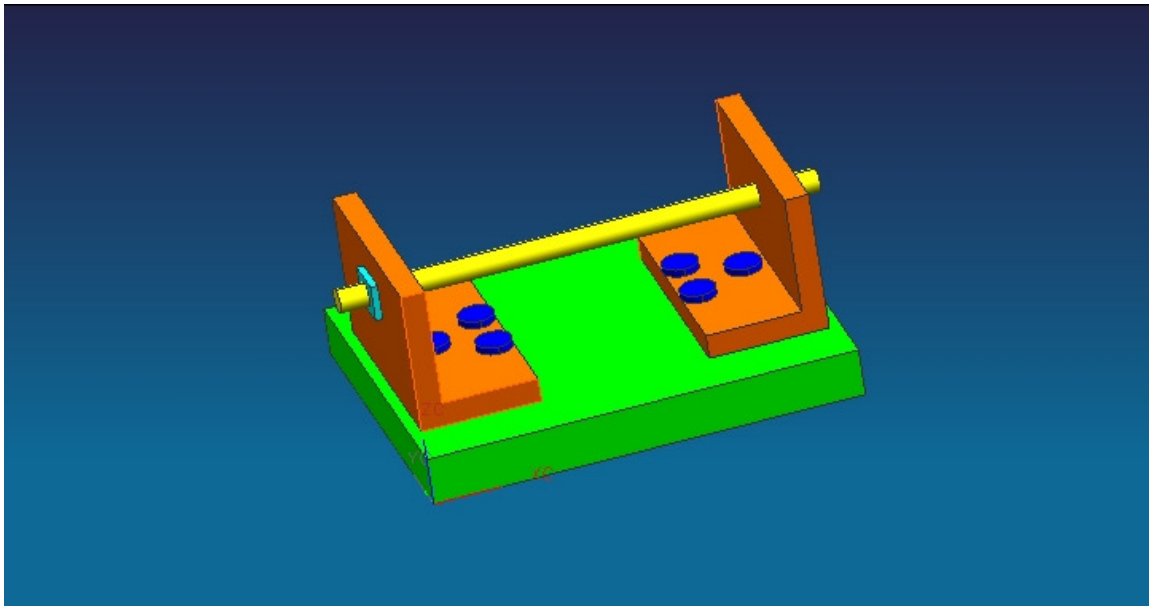


Figure 4 - Shaded image of AS1 assembly

5.1 Conforming to AP214 IS

This is an AP214 file defining the product structure of the full AS1 assembly with external references to the five files defining the geometry of the component parts. The new property definitions are defined by the entities #333 to #364, and are highlighted in blue.

```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION('', '2;1');
FILE_NAME('as1-extref.stp', '2007-02-26T15:40:58+00:00', (' '), (' '),
'THEOREM SOLUTIONS AP214 IS OUTPUT PROCESSOR 9.0.002', 'CADD/CAMU', ' ');
FILE_SCHEMA(('AUTOMOTIVE_DESIGN { 1 0 10303 214 1 1 1 1 } '));
ENDSEC;
DATA;
#1=DIMENSIONAL_EXPONENTS(1.0,0.0,0.0,0.0,0.0,0.0,0.0);
#2=DIMENSIONAL_EXPONENTS(0.0,0.0,0.0,0.0,0.0,0.0,0.0);
#3=(NAMED_UNIT(*)SI_UNIT($, .STERADIAN.) SOLID_ANGLE_UNIT());
#4=(LENGTH_UNIT()NAMED_UNIT(*)SI_UNIT(.MILLI., .METRE.));
#5=(NAMED_UNIT(*)PLANE_ANGLE_UNIT()SI_UNIT($, .RADIAN.));
#6=APPLICATION_CONTEXT(
'Core Data for Automotive Mechanical Design Process');
#7=APPLICATION_PROTOCOL_DEFINITION('international standard',
'automotive_design', 2001, #6);
#8=PRODUCT_CONTEXT('', #6, 'mechanical');
#9=PRODUCT_DEFINITION_CONTEXT('', #6, 'design');
#10=PRODUCT('as1', 'as1', $, (#8));
#11=PRODUCT_RELATED_PRODUCT_CATEGORY('detail', '', (#10));
#12=PRODUCT_RELATED_PRODUCT_CATEGORY('part', 'as1', (#10));
#13=PRODUCT_CATEGORY_RELATIONSHIP('', 'as1', #12, #11);
#14=PRODUCT_DEFINITION_FORMATION('v0', 'v0 for as1', #10);
#15=PRODUCT_DEFINITION('design', $, #14, #9);
#16=PRODUCT('part44_plate', 'part44_plate', $, (#8));
#17=PRODUCT_RELATED_PRODUCT_CATEGORY('detail', '', (#16));
#18=PRODUCT_RELATED_PRODUCT_CATEGORY('part', 'part44_plate', (#16));
#19=PRODUCT_CATEGORY_RELATIONSHIP('', 'part44_plate', #18, #17);
```

```
#20=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_plate',#16);
#21=PRODUCT_DEFINITION('design',$,#20,#9);
#22=PRODUCT('part44_l-bracket','part44_l-bracket',$,(#8));
#23=PRODUCT_RELATED_PRODUCT_CATEGORY('detail','',(#22));
#24=PRODUCT_RELATED_PRODUCT_CATEGORY('part','part44_l-bracket',(#22));
#25=PRODUCT_CATEGORY_RELATIONSHIP('','part44_l-bracket',#24,#23);
#26=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_l-bracket',#22);
#27=PRODUCT_DEFINITION('design',$,#26,#9);
#28=PRODUCT('part44_bolt','part44_bolt',$,(#8));
#29=PRODUCT_RELATED_PRODUCT_CATEGORY('detail','',(#28));
#30=PRODUCT_RELATED_PRODUCT_CATEGORY('part','part44_bolt',(#28));
#31=PRODUCT_CATEGORY_RELATIONSHIP('','part44_bolt',#30,#29);
#32=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_bolt',#28);
#33=PRODUCT_DEFINITION('design',$,#32,#9);
#34=PRODUCT('part44_nut','part44_nut',$,(#8));
#35=PRODUCT_RELATED_PRODUCT_CATEGORY('detail','',(#34));
#36=PRODUCT_RELATED_PRODUCT_CATEGORY('part','part44_nut',(#34));
#37=PRODUCT_CATEGORY_RELATIONSHIP('','part44_nut',#36,#35);
#38=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_nut',#34);
#39=PRODUCT_DEFINITION('design',$,#38,#9);
#40=PRODUCT('part44_nutbolt','part44_nutbolt',$,(#8));
#41=PRODUCT_RELATED_PRODUCT_CATEGORY('detail','',(#40));
#42=PRODUCT_RELATED_PRODUCT_CATEGORY('part','part44_nutbolt',(#40));
#43=PRODUCT_CATEGORY_RELATIONSHIP('','part44_nutbolt',#42,#41);
#44=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_nutbolt',#40);
#45=PRODUCT_DEFINITION('design',$,#44,#9);
#46=PRODUCT('part44_lbrackass','part44_lbrackass',$,(#8));
#47=PRODUCT_RELATED_PRODUCT_CATEGORY('detail','',(#46));
#48=PRODUCT_RELATED_PRODUCT_CATEGORY('part','part44_lbrackass',(#46));
#49=PRODUCT_CATEGORY_RELATIONSHIP('','part44_lbrackass',#48,#47);
#50=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_lbrackass',#46);
#51=PRODUCT_DEFINITION('design',$,#50,#9);
#52=PRODUCT('part44_rod','part44_rod',$,(#8));
#53=PRODUCT_RELATED_PRODUCT_CATEGORY('detail','',(#52));
#54=PRODUCT_RELATED_PRODUCT_CATEGORY('part','part44_rod',(#52));
#55=PRODUCT_CATEGORY_RELATIONSHIP('','part44_rod',#54,#53);
#56=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_rod',#52);
#57=PRODUCT_DEFINITION('design',$,#56,#9);
#58=PRODUCT('part44_rodass','part44_rodass',$,(#8));
#59=PRODUCT_RELATED_PRODUCT_CATEGORY('detail','',(#58));
#60=PRODUCT_RELATED_PRODUCT_CATEGORY('part','part44_rodass',(#58));
#61=PRODUCT_CATEGORY_RELATIONSHIP('','part44_rodass',#60,#59);
#62=PRODUCT_DEFINITION_FORMATION('v0','v0 for part44_rodass',#58);
#63=PRODUCT_DEFINITION('design',$,#62,#9);
#64=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4,#5,#3)REPRESENTATION_CONTEXT('part44_plate','external'));
#65=CARTESIAN_POINT('#65',(0.0,0.0,0.0));
#66=DIRECTION('#66',(1.0,0.0,0.0));
#67=DIRECTION('#67',(0.0,0.0,1.0));
#68=AXIS2_PLACEMENT_3D('#68',#65,#67,#66);
#69=SHAPE_REPRESENTATION('#69',(#68),#64);
#70=DOCUMENT_TYPE('geometry');
#71=DOCUMENT_FILE('part44_plate.stp',' ',' ',#70,'','');
#72=DOCUMENT_REPRESENTATION_TYPE('digital',#71);
#73=PROPERTY_DEFINITION('external definition',' ',#71);
#74=PROPERTY_DEFINITION_REPRESENTATION(#73,#69);
#75=REPRESENTATION_CONTEXT(' ','document parameters');
#76=DESCRIPTIVE_REPRESENTATION_ITEM('data format','STEP AP214');
#77=REPRESENTATION('document format',(#76),#75);
#78=PROPERTY_DEFINITION('document property',' ',#71);
#79=PROPERTY_DEFINITION_REPRESENTATION(#78,#77);
```

```
#80=IDENTIFICATION_ROLE('Technical Data Package','access context');
#81=EXTERNAL_SOURCE(IDENTIFIER(' '));
#82=APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT('part44_plate.stp',#80,
#81,(#71));
#83=OBJECT_ROLE('mandatory','');
#84=APPLIED_DOCUMENT_REFERENCE(#71,'',( #21));
#85=ROLE_ASSOCIATION(#83,#84);
#86=CARTESIAN_POINT('#86',(0.0,0.0,0.0));
#87=DIRECTION('#87',(1.0,0.0,0.0));
#88=DIRECTION('#88',(0.0,0.0,1.0));
#89=AXIS2_PLACEMENT_3D('#89',#86,#88,#87);
#90=ITEM_DEFINED_TRANSFORMATION('#89','MASTER : part44_plate',#68,#89);
#91=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4,#5,#3))REPRESENTATION_CONTEXT('part44_l-bracket','external'));
#92=CARTESIAN_POINT('#92',(0.0,0.0,0.0));
#93=DIRECTION('#93',(1.0,0.0,0.0));
#94=DIRECTION('#94',(0.0,0.0,1.0));
#95=AXIS2_PLACEMENT_3D('#95',#92,#94,#93);
#96=SHAPE_REPRESENTATION('#96',(#95),#91);
#97=DOCUMENT_TYPE('geometry');
#98=DOCUMENT_FILE('part44_l-bracket.stp',' ',' ',#97,'','');
#99=DOCUMENT_REPRESENTATION_TYPE('digital',#98);
#100=PROPERTY_DEFINITION('external definition',' ',#98);
#101=PROPERTY_DEFINITION_REPRESENTATION(#100,#96);
#102=REPRESENTATION_CONTEXT(' ','document parameters');
#103=DESCRIPTIVE_REPRESENTATION_ITEM('data format','STEP AP214');
#104=REPRESENTATION('document format',(#103),#102);
#105=PROPERTY_DEFINITION('document property',' ',#98);
#106=PROPERTY_DEFINITION_REPRESENTATION(#105,#104);
#107=IDENTIFICATION_ROLE('Technical Data Package','access context');
#108=EXTERNAL_SOURCE(IDENTIFIER(' '));
#109=APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT('part44_l-bracket.stp',
#107,#108,(#98));
#110=OBJECT_ROLE('mandatory','');
#111=APPLIED_DOCUMENT_REFERENCE(#98,'',( #27));
#112=ROLE_ASSOCIATION(#110,#111);
#113=CARTESIAN_POINT('#113',(0.0,0.0,0.0));
#114=DIRECTION('#114',(1.0,0.0,0.0));
#115=DIRECTION('#115',(0.0,-1.,0.0));
#116=AXIS2_PLACEMENT_3D('#116',#113,#115,#114);
#117=ITEM_DEFINED_TRANSFORMATION('#116',
'part44_lbrackass : part44_l-bracket',#95,#116);
#118=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4,#5,#3))REPRESENTATION_CONTEXT('part44_bolt','external'));
#119=CARTESIAN_POINT('#119',(0.0,0.0,0.0));
#120=DIRECTION('#120',(1.0,0.0,0.0));
#121=DIRECTION('#121',(0.0,0.0,1.0));
#122=AXIS2_PLACEMENT_3D('#122',#119,#121,#120);
#123=SHAPE_REPRESENTATION('#123',(#122),#118);
#124=DOCUMENT_TYPE('geometry');
#125=DOCUMENT_FILE('part44_bolt.stp',' ',' ',#124,'','');
#126=DOCUMENT_REPRESENTATION_TYPE('digital',#125);
#127=PROPERTY_DEFINITION('external definition',' ',#125);
#128=PROPERTY_DEFINITION_REPRESENTATION(#127,#123);
#129=REPRESENTATION_CONTEXT(' ','document parameters');
#130=DESCRIPTIVE_REPRESENTATION_ITEM('data format','STEP AP214');
#131=REPRESENTATION('document format',(#130),#129);
#132=PROPERTY_DEFINITION('document property',' ',#125);
#133=PROPERTY_DEFINITION_REPRESENTATION(#132,#131);
#134=IDENTIFICATION_ROLE('Technical Data Package','access context');
#135=EXTERNAL_SOURCE(IDENTIFIER(' '));
```

```
#136=APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT('part44_bolt.stp',#134,
#135, (#125));
#137=OBJECT_ROLE('mandatory','');
#138=APPLIED_DOCUMENT_REFERENCE(#125,' ',(#33));
#139=ROLE_ASSOCIATION(#137,#138);
#140=CARTESIAN_POINT('#140',(0.0,0.0,0.0));
#141=DIRECTION('#141',(1.0,0.0,0.0));
#142=DIRECTION('#142',(0.0,0.0,1.0));
#143=AXIS2_PLACEMENT_3D('#143',#140,#142,#141);
#144=ITEM_DEFINED_TRANSFORMATION('#143','part44_nutbolt : part44_bolt',
#122,#143);
#145=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4,#5,#3))REPRESENTATION_CONTEXT('part44_nut','external'));
#146=CARTESIAN_POINT('#146',(0.0,0.0,0.0));
#147=DIRECTION('#147',(1.0,0.0,0.0));
#148=DIRECTION('#148',(0.0,0.0,1.0));
#149=AXIS2_PLACEMENT_3D('#149',#146,#148,#147);
#150=SHAPE_REPRESENTATION('#150',(#149),#145);
#151=DOCUMENT_TYPE('geometry');
#152=DOCUMENT_FILE('part44_nut.stp',' ',' ',#151,'','');
#153=DOCUMENT_REPRESENTATION_TYPE('digital',#152);
#154=PROPERTY_DEFINITION('external definition',' ',#152);
#155=PROPERTY_DEFINITION_REPRESENTATION(#154,#150);
#156=REPRESENTATION_CONTEXT(' ','document parameters');
#157=DESCRIPTIVE_REPRESENTATION_ITEM('data format','STEP AP214');
#158=REPRESENTATION('document format',(#157),#156);
#159=PROPERTY_DEFINITION('document property',' ',#152);
#160=PROPERTY_DEFINITION_REPRESENTATION(#159,#158);
#161=IDENTIFICATION_ROLE('Technical Data Package','access context');
#162=EXTERNAL_SOURCE(IDENTIFIER(' '));
#163=APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT('part44_nut.stp',#161,
#162, (#152));
#164=OBJECT_ROLE('mandatory','');
#165=APPLIED_DOCUMENT_REFERENCE(#152,' ',(#39));
#166=ROLE_ASSOCIATION(#164,#165);
#167=CARTESIAN_POINT('#167',(0.0,0.0,4.0));
#168=DIRECTION('#168',(1.0,0.0,0.0));
#169=DIRECTION('#169',(0.0,0.0,1.0));
#170=AXIS2_PLACEMENT_3D('#170',#167,#169,#168);
#171=ITEM_DEFINED_TRANSFORMATION('#170','part44_nutbolt : part44_nut',
#149,#170);
#172=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4,#5,#3))REPRESENTATION_CONTEXT('part44_nutbolt','3D'));
#173=CARTESIAN_POINT('#173',(0.0,0.0,0.0));
#174=DIRECTION('#174',(1.0,0.0,0.0));
#175=DIRECTION('#175',(0.0,0.0,1.0));
#176=AXIS2_PLACEMENT_3D('#176',#173,#175,#174);
#177=SHAPE_REPRESENTATION('#177',(#176,#143,#170),#172);
#178=(REPRESENTATION_RELATIONSHIP('#178',
'part44_nutbolt : part44_bolt',#123,#177)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#144)
SHAPE_REPRESENTATION_RELATIONSHIP());
#179=(REPRESENTATION_RELATIONSHIP('#179','part44_nutbolt : part44_nut',
#150,#177)REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#171)
SHAPE_REPRESENTATION_RELATIONSHIP());
#180=CARTESIAN_POINT('#180',(7.5,-37.00961894,-27.));
#181=DIRECTION('#181',(0.0,1.0,0.0));
#182=DIRECTION('#182',(0.0,0.0,1.0));
#183=AXIS2_PLACEMENT_3D('#183',#180,#182,#181);
#184=ITEM_DEFINED_TRANSFORMATION('#183',
'part44_lbrackass : part44_nutbolt',#176,#183);
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#185=CARTESIAN_POINT('#185', (7.5, -62.99038106, -27.));
#186=DIRECTION('#186', (0.0, 1.0, 0.0));
#187=DIRECTION('#187', (0.0, 0.0, 1.0));
#188=AXIS2_PLACEMENT_3D('#188', #185, #187, #186);
#189=ITEM_DEFINED_TRANSFORMATION('#188',
'part44_lbrackass : part44_nutbolt', #176, #188);
#190=CARTESIAN_POINT('#190', (30., -50., -27.));
#191=DIRECTION('#191', (0.0, -1., 0.0));
#192=DIRECTION('#192', (0.0, 0.0, 1.0));
#193=AXIS2_PLACEMENT_3D('#193', #190, #192, #191);
#194=ITEM_DEFINED_TRANSFORMATION('#193',
'part44_lbrackass : part44_nutbolt', #176, #193);
#195=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4, #5, #3))REPRESENTATION_CONTEXT('part44_lbrackass', '3D'));
#196=CARTESIAN_POINT('#196', (0.0, 0.0, 0.0));
#197=DIRECTION('#197', (1.0, 0.0, 0.0));
#198=DIRECTION('#198', (0.0, 0.0, 1.0));
#199=AXIS2_PLACEMENT_3D('#199', #196, #198, #197);
#200=SHAPE_REPRESENTATION('#200', (#199, #116, #183, #188, #193), #195);
#201=(REPRESENTATION_RELATIONSHIP('#201',
'part44_lbrackass : part44_l-bracket', #96, #200)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#117)
SHAPE_REPRESENTATION_RELATIONSHIP());
#202=(REPRESENTATION_RELATIONSHIP('#202',
'part44_lbrackass : part44_nutbolt', #177, #200)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#184)
SHAPE_REPRESENTATION_RELATIONSHIP());
#203=(REPRESENTATION_RELATIONSHIP('#203',
'part44_lbrackass : part44_nutbolt', #177, #200)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#189)
SHAPE_REPRESENTATION_RELATIONSHIP());
#204=(REPRESENTATION_RELATIONSHIP('#204',
'part44_lbrackass : part44_nutbolt', #177, #200)
REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#194)
SHAPE_REPRESENTATION_RELATIONSHIP());
#205=CARTESIAN_POINT('#205', (125., 125., 20.));
#206=DIRECTION('#206', (1.0, 0.0, 0.0));
#207=DIRECTION('#207', (0.0, 0.0, 1.0));
#208=AXIS2_PLACEMENT_3D('#208', #205, #207, #206);
#209=ITEM_DEFINED_TRANSFORMATION('#208', 'MASTER : part44_lbrackass',
#199, #208);
#210=CARTESIAN_POINT('#210', (55., 25., 20.));
#211=DIRECTION('#211', (-1., 0.0, 0.0));
#212=DIRECTION('#212', (0.0, 0.0, 1.0));
#213=AXIS2_PLACEMENT_3D('#213', #210, #212, #211);
#214=ITEM_DEFINED_TRANSFORMATION('#213',
'MASTER : part44_lbrackass', #199, #213);
#215=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4, #5, #3))REPRESENTATION_CONTEXT('part44_rod', 'external'));
#216=CARTESIAN_POINT('#216', (0.0, 0.0, 0.0));
#217=DIRECTION('#217', (1.0, 0.0, 0.0));
#218=DIRECTION('#218', (0.0, 0.0, 1.0));
#219=AXIS2_PLACEMENT_3D('#219', #216, #218, #217);
#220=SHAPE_REPRESENTATION('#220', (#219), #215);
#221=DOCUMENT_TYPE('geometry');
#222=DOCUMENT_FILE('part44_rod.stp', ' ', ' ', #221, ' ', ' ');
#223=DOCUMENT_REPRESENTATION_TYPE('digital', #222);
#224=PROPERTY_DEFINITION('external definition', ' ', #222);
#225=PROPERTY_DEFINITION_REPRESENTATION(#224, #220);
#226=REPRESENTATION_CONTEXT(' ', 'document parameters');
#227=DESCRIPTIVE_REPRESENTATION_ITEM('data format', 'STEP AP214');
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#228=REPRESENTATION('document format',(#227),#226);
#229=PROPERTY_DEFINITION('document property',' ',#222);
#230=PROPERTY_DEFINITION_REPRESENTATION(#229,#228);
#231=IDENTIFICATION_ROLE('Technical Data Package','access context');
#232=EXTERNAL_SOURCE(IDENTIFIER(' '));
#233=APPLIED_EXTERNAL_IDENTIFICATION_ASSIGNMENT('part44_rod.stp',#231,
#232, (#222));
#234=OBJECT_ROLE('mandatory','');
#235=APPLIED_DOCUMENT_REFERENCE(#222,' ',(#57));
#236=ROLE_ASSOCIATION(#234,#235);
#237=CARTESIAN_POINT('#237', (0.0,0.0,0.0));
#238=DIRECTION('#238', (1.0,0.0,0.0));
#239=DIRECTION('#239', (0.0,0.0,1.0));
#240=AXIS2_PLACEMENT_3D('#240',#237,#239,#238);
#241=ITEM_DEFINED_TRANSFORMATION('#240','part44_rodass : part44_rod',
#219,#240);
#242=CARTESIAN_POINT('#242', (12.,0.0,0.0));
#243=DIRECTION('#243', (0.0,-1.,0.0));
#244=DIRECTION('#244', (1.0,0.0,0.0));
#245=AXIS2_PLACEMENT_3D('#245',#242,#244,#243);
#246=ITEM_DEFINED_TRANSFORMATION('#245','part44_rodass : part44_nut',
#149,#245);
#247=CARTESIAN_POINT('#247', (185.,0.0,0.0));
#248=DIRECTION('#248', (0.0,-1.,0.0));
#249=DIRECTION('#249', (1.0,0.0,0.0));
#250=AXIS2_PLACEMENT_3D('#250',#247,#249,#248);
#251=ITEM_DEFINED_TRANSFORMATION('#250','part44_rodass : part44_nut',
#149,#250);
#252=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4,#5,#3))REPRESENTATION_CONTEXT('part44_rodass','3D'));
#253=CARTESIAN_POINT('#253', (0.0,0.0,0.0));
#254=DIRECTION('#254', (1.0,0.0,0.0));
#255=DIRECTION('#255', (0.0,0.0,1.0));
#256=AXIS2_PLACEMENT_3D('#256',#253,#255,#254);
#257=SHAPE_REPRESENTATION('#257', (#256,#240,#245,#250),#252);
#258=(REPRESENTATION_RELATIONSHIP('#258','part44_rodass : part44_rod',
#220,#257)REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#241)
SHAPE_REPRESENTATION_RELATIONSHIP());
#259=(REPRESENTATION_RELATIONSHIP('#259','part44_rodass : part44_nut',
#150,#257)REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#246)
SHAPE_REPRESENTATION_RELATIONSHIP());
#260=(REPRESENTATION_RELATIONSHIP('#260','part44_rodass : part44_nut',
#150,#257)REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#251)
SHAPE_REPRESENTATION_RELATIONSHIP());
#261=CARTESIAN_POINT('#261', (-10.,75.,60.));
#262=DIRECTION('#262', (1.0,0.0,0.0));
#263=DIRECTION('#263', (0.0,0.0,1.0));
#264=AXIS2_PLACEMENT_3D('#264',#261,#263,#262);
#265=ITEM_DEFINED_TRANSFORMATION('#264','MASTER : part44_rodass',
#256,#264);
#266=(GEOMETRIC_REPRESENTATION_CONTEXT(3)GLOBAL_UNIT_ASSIGNED_CONTEXT((
#4,#5,#3))REPRESENTATION_CONTEXT('as1','3D'));
#267=CARTESIAN_POINT('#267', (0.0,0.0,0.0));
#268=DIRECTION('#268', (1.0,0.0,0.0));
#269=DIRECTION('#269', (0.0,0.0,1.0));
#270=AXIS2_PLACEMENT_3D('#270',#267,#269,#268);
#271=SHAPE_REPRESENTATION('#271', (#270,#89,#208,#213,#264),#266);
#272=(REPRESENTATION_RELATIONSHIP('#272','MASTER : part44_plate',#69,
#271)REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#90)
SHAPE_REPRESENTATION_RELATIONSHIP());
#273=(REPRESENTATION_RELATIONSHIP('#273','MASTER : part44_lbrackass',
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#200,#271)REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#209)
SHAPE_REPRESENTATION_RELATIONSHIP());
#274=(REPRESENTATION_RELATIONSHIP('#274','MASTER : part44_lbrackass',
#200,#271)REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#214)
SHAPE_REPRESENTATION_RELATIONSHIP());
#275=(REPRESENTATION_RELATIONSHIP('#275','MASTER : part44_rodass',#257,
#271)REPRESENTATION_RELATIONSHIP_WITH_TRANSFORMATION(#265)
SHAPE_REPRESENTATION_RELATIONSHIP());
#276=PRODUCT_DEFINITION_SHAPE('',$,#15);
#277=SHAPE_DEFINITION_REPRESENTATION(#276,#271);
#278=PRODUCT_DEFINITION_SHAPE('',$,#21);
#279=SHAPE_DEFINITION_REPRESENTATION(#278,#69);
#280=PRODUCT_DEFINITION_SHAPE('',$,#27);
#281=SHAPE_DEFINITION_REPRESENTATION(#280,#96);
#282=PRODUCT_DEFINITION_SHAPE('',$,#33);
#283=SHAPE_DEFINITION_REPRESENTATION(#282,#123);
#284=PRODUCT_DEFINITION_SHAPE('',$,#39);
#285=SHAPE_DEFINITION_REPRESENTATION(#284,#150);
#286=PRODUCT_DEFINITION_SHAPE('',$,#45);
#287=SHAPE_DEFINITION_REPRESENTATION(#286,#177);
#288=PRODUCT_DEFINITION_SHAPE('',$,#51);
#289=SHAPE_DEFINITION_REPRESENTATION(#288,#200);
#290=PRODUCT_DEFINITION_SHAPE('',$,#57);
#291=SHAPE_DEFINITION_REPRESENTATION(#290,#220);
#292=PRODUCT_DEFINITION_SHAPE('',$,#63);
#293=SHAPE_DEFINITION_REPRESENTATION(#292,#257);
#294=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_PLATE','','',
'PART44_PLATE',#15,#21,'PART44_PLATE');
#295=PRODUCT_DEFINITION_SHAPE('PART44_PLATE',$,#294);
#296=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#272,#295);
#297=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_L-BRACKET','','',
'PART44_L-BRACKET',#51,#27,'PART44_L-BRACKET');
#298=PRODUCT_DEFINITION_SHAPE('PART44_L-BRACKET',$,#297);
#299=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#201,#298);
#300=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_BOLT','','',
'PART44_BOLT',#45,
#33,'PART44_BOLT');
#301=PRODUCT_DEFINITION_SHAPE('PART44_BOLT',$,#300);
#302=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#178,#301);
#303=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_NUT_1','','',
'PART44_NUT',
#45,#39,'PART44_NUT');
#304=PRODUCT_DEFINITION_SHAPE('PART44_NUT',$,#303);
#305=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#179,#304);
#306=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_NUTBOLT_1','','',
'PART44_NUTBOLT',#51,#45,'PART44_NUTBOLT');
#307=PRODUCT_DEFINITION_SHAPE('PART44_NUTBOLT',$,#306);
#308=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#202,#307);
#309=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_NUTBOLT_2','','',
'PART44_NUTBOLT',#51,#45,'PART44_NUTBOLT');
#310=PRODUCT_DEFINITION_SHAPE('PART44_NUTBOLT',$,#309);
#311=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#203,#310);
#312=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_NUTBOLT_3','','',
'PART44_NUTBOLT',#51,#45,'PART44_NUTBOLT');
#313=PRODUCT_DEFINITION_SHAPE('PART44_NUTBOLT',$,#312);
#314=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#204,#313);
#315=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_LBRACKASS_1','','',
'PART44_LBRACKASS',#15,#51,'PART44_LBRACKASS');
#316=PRODUCT_DEFINITION_SHAPE('PART44_LBRACKASS',$,#315);
#317=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#273,#316);
#318=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_LBRACKASS_2','','',
'PART44_LBRACKASS',#15,#51,'PART44_LBRACKASS');
#319=PRODUCT_DEFINITION_SHAPE('PART44_LBRACKASS',$,#318);
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#320=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#274,#319);
#321=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_ROD','','PART44_ROD',#63,
#57,'PART44_ROD');
#322=PRODUCT_DEFINITION_SHAPE('PART44_ROD',$,#321);
#323=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#258,#322);
#324=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_NUT_2','','PART44_NUT',#63,
#39,'PART44_NUT');
#325=PRODUCT_DEFINITION_SHAPE('PART44_NUT',$,#324);
#326=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#259,#325);
#327=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_NUT_3','','PART44_NUT',#63,
#39,'PART44_NUT');
#328=PRODUCT_DEFINITION_SHAPE('PART44_NUT',$,#327);
#329=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#260,#328);
#330=NEXT_ASSEMBLY_USAGE_OCCURRENCE('PART44_RODASS','','PART44_RODASS',
#15,#63,'PART44_RODASS');
#331=PRODUCT_DEFINITION_SHAPE('PART44_RODASS',$,#330);
#332=CONTEXT_DEPENDENT_SHAPE_REPRESENTATION(#275,#331);
#333=PROPERTY_DEFINITION('assembly validation property','','#15);
#334=VALUE_REPRESENTATION_ITEM('number of children', COUNT_MEASURE(4.0));
#335=REPRESENTATION('number of children',(#334),#266);
#336=PROPERTY_DEFINITION_REPRESENTATION(#333,#335);
#337=PROPERTY_DEFINITION('assembly validation property',
'notional solids centroid',#276);
#338=CARTESIAN_POINT('centre point',(47.5,61.25,35.));
#339=REPRESENTATION('notional solids centroid',(#338),#266);
#340=PROPERTY_DEFINITION_REPRESENTATION(#337,#339);
#341=PROPERTY_DEFINITION('assembly validation property','','#45);
#342=VALUE_REPRESENTATION_ITEM('number of children', COUNT_MEASURE(2.0));
#343=REPRESENTATION('number of children',(#342),#172);
#344=PROPERTY_DEFINITION_REPRESENTATION(#341,#343);
#345=PROPERTY_DEFINITION('assembly validation property',
'notional solids centroid',#286);
#346=CARTESIAN_POINT('centre point',(10.,10.,12.));
#347=REPRESENTATION('notional solids centroid',(#346),#172);
#348=PROPERTY_DEFINITION_REPRESENTATION(#345,#347);
#349=PROPERTY_DEFINITION('assembly validation property','','#51);
#350=VALUE_REPRESENTATION_ITEM('number of children', COUNT_MEASURE(4.0));
#351=REPRESENTATION('number of children',(#350),#195);
#352=PROPERTY_DEFINITION_REPRESENTATION(#349,#351);
#353=PROPERTY_DEFINITION('assembly validation property',
'notional solids centroid',#288);
#354=CARTESIAN_POINT('centre point',(11.25,-37.5,-10.25));
#355=REPRESENTATION('notional solids centroid',(#354),#195);
#356=PROPERTY_DEFINITION_REPRESENTATION(#353,#355);
#357=PROPERTY_DEFINITION('assembly validation property','','#63);
#358=VALUE_REPRESENTATION_ITEM('number of children', COUNT_MEASURE(3.0));
#359=REPRESENTATION('number of children',(#358),#252);
#360=PROPERTY_DEFINITION_REPRESENTATION(#357,#359);
#361=PROPERTY_DEFINITION('assembly validation property',
'notional solids centroid',#292);
#362=CARTESIAN_POINT('centre point',(75.66666667,-3.33333333,
-3.33333333));
#363=REPRESENTATION('notional solids centroid',(#362),#252);
#364=PROPERTY_DEFINITION_REPRESENTATION(#361,#363);
ENDSEC;
END-ISO-10303-21;

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5.2 Conforming to AP203 Edition 2

In the scope covered by this document, there are notable differences in the data sections of an AP214 and an AP203 Ed.2 STEP file. Therefore, no AP203 example is given.

6 Availability of implementation schemas

6.1 AP214

The AP214 IS schema supports the implementation of the capabilities as described. The schema can be retrieved from the 'Joint Testing Information' section of the CAx-IF web site:

http://www.cax-if.de/documents/ap214_is_schema.zip

6.2 AP203 edition 2

The schema for the second edition of AP203 is still under development. The most current schema is available from

http://www.cax-if.de/joint_testing_info.html