



**Test Suite for the  
CAX Implementor Forum  
Round 19J**

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**Contents:**

1.0	Introduction .....	5
1.1	Functionality tested in this round .....	5
1.2	General test instructions for this round .....	6
1.3	Preliminary testing schedule .....	6
1.4	Copyrights on test cases.....	6
2.0	Synthetic test case specifications .....	7
2.1	Model T1: Cloud Of PointS GVP .....	7
2.1.1	Motivation .....	7
2.1.2	Approach .....	7
2.1.3	Testing instructions .....	8
2.1.3.1	Model construction.....	8
2.1.3.2	Statistics .....	8
2.2	Model GD4: Geometric Dimensioning and Tolerancing.....	9
2.2.1	Motivation .....	9
2.2.2	Approach .....	9
2.2.3	Testing Instructions.....	10
2.2.3.1	Statistics .....	10
2.3	Model C1 : Colors and 3D Annotation .....	11
2.3.1	Motivation .....	11
2.3.2	Approach .....	11
2.3.3	Testing Instructions.....	11
2.3.3.1	Model construction.....	11
2.3.3.2	Statistics & Screenshots .....	12
2.4	Model AS1: External References.....	13
2.4.1	Motivation .....	13
2.4.2	Approach .....	13
2.4.3	Testing Instructions.....	13
2.4.3.1	Construction of the AS1 model .....	14
2.4.3.2	Statistics .....	15
2.5	Model U1: Unicode Character Encoding.....	15
2.5.1	Motivation .....	15

2.5.2	Approach .....	16
2.5.3	Testing Instructions.....	16
2.5.3.1	Construction of the U1 model .....	16
2.5.3.2	Statistics .....	16
3.0	Production models: PM17.....	17
3.1	Motivation .....	17
3.2	Approach .....	17
3.3	Testing Instructions.....	17
3.3.1	List of available models .....	17
3.3.2	Results.....	17

## **1.0 Introduction**

This document describes the suite of test cases to be used for the nineteenth round of testing of the CAx Implementor Forum (CAx-IF). The CAx-IF is a joint testing forum organized by PDES, Inc. and the ProSTEP iViP Association. The test rounds of the CAx-IF concentrate primarily on testing the interoperability and conformance of STEP processors based on AP 203 and AP 214.

The test rounds in general combine testing of synthetic and production models. Production models will in most cases be provided by the member companies of the organizations PDES, Inc. and ProSTEP iViP. When production models are not available from the member companies, “production-like” models will be solicited from the various CAx-IF participants.

This test suite includes synthetic models for testing the following capabilities: validation of data transfer quality, geometric validation properties, geometric and dimensional tolerances (GD&T), 3d annotations, and Unicode character encoding.

Production models are provided for assemblies and piece parts. The basis for the production test cases is native CAD models. Each test case therefore originates from a single CAD system, and the set of test cases to be pre-processed (converted to STEP files) is unique for each CAD system. After pre-processing, the resulting STEP files are then to be imported/post-processed/read in by the rest of the participants.

### **1.1 Functionality tested in this round**

Functionality tested in this round relates to: validation of data transfer quality, geometric validation properties, geometric and dimensional tolerances (GD&T), 3d annotations, and long-term archiving.

- Geometric Validation Properties will be tested in two different occurrences:
  - Solid Model VP aim for the validation of the transfer of solid models and assemblies (Extended GVP). These will tested in conjunction with the data transfer quality testing.
  - Cloud Of Points (COPs) VP is a new kind of validation properties intended to detect shape changes encountered during the data transfer.
- The goal for GD&T is the ability to exchange tolerances for dimensions and geometry to drive downstream applications such as coordinate measuring and manufacturing.
- 3D Annotations is related to the functionality to display notes in the 3d model space. These notes are typically associated with a geometric element of the model (Associative Text). This test is intended as preparation for GD&T presentation.
- In addition to synthetic models for the above capabilities, production models are included in this round of testing.
- Validation of data transfer quality: Based on the production models, this test focuses on the data quality before, during and after the data exchange via STEP. For validation purposes, both the (Extended) Geometric Validation Properties as well as a 3<sup>rd</sup> party quality checker are used.

- Unicode character encoding: With the growing number of trans-national projects and the closing of the gap between CAD and PDM systems, the need to transfer special characters, such as German umlauts, French accents or Asian characters in geometry STEP files is growing. Since Part21 allows only the basic ASCII set, these characters have to be encoded in the STEP files.

## 1.2 General test instructions for this round

The general procedures for communication of models and statistics are outlined in a separate document 'General Testing Instructions'. The general instructions can be retrieved from CAx Implementor Forum web sites. The latest version is v1.5, dated December 2006.

## 1.3 Preliminary testing schedule

The following schedule has been agreed on for Round19J:

Date	Action
<b>December 5, 2006</b> (Tue)	<b>Test Suite available / 1<sup>st</sup> CAx Implementor Forum conference call</b>
<b>ASAP</b>	<b>Production Models released</b>
<b>January 3, 2007</b> (Wed)	<b>Initial STEP files and native stats due</b>
<b>January 24</b> (Wed)	<b>STEP files and native stats frozen</b>
<b>February 5</b> (Mon)	<b>Target stats due / 2<sup>nd</sup> conference call</b>
<b>February 22</b> (Fri)	<b>Target stats frozen</b>
<b>February 28</b> (Wed)	<b>Pre-release of final stats / 3<sup>rd</sup> conference call</b>
<b>March 5</b> (Mon)	<b>Review meeting for test round</b>
<b>March 6 – 7</b> (Tue – Wed)	<b>CAx Implementor Forum meeting, Asheville, NC - USA</b>

The CAx-IF will take place in conjunction with the PDES, Inc. offsite meeting. Please note that because of the embedding of the CAx-IF agenda, the meeting will me Monday through Wednesday instead of Tuesday through Thursday, as would be usual.

## 1.4 Copyrights on test cases

Not all of the production test cases which were provided by the PDES, Inc. and ProSTEP iViP member companies are fully released for any purpose. The least common denominator is that the test cases can be freely distributed among the ProSTEP iViP / PDES, Inc. Round Table participants and can be used for any purposes that are related to CAx-IF testing (i.e.

testing, documentation of testing efforts), as long as a reference to the originating company is made.

The test cases must not be used for any purposes other than the CAx-IF testing or outside of PDES, Inc. and ProSTEP iViP.

## **2.0 Synthetic test case specifications**

### **2.1 Model T1: Cloud Of PointS GVP**

#### **2.1.1 Motivation**

The “Cloud Of PointS” (COPS) is a new kind of validation properties, intended to validate the actual shape of the model. The mechanism is based on sampling points, which are created exactly on each surface by the exporting CAD system and written into the STEP file as cartesian points. The importing system measures the distances between those sampling points and the faces and boundaries of the created geometry in order to detect any shape changes.

In case a face gets lost during translation, the sampling points can also be used as a guideline to re-create the face.

The goal is to extend the STEP file to be a self-validating archive, since in addition to the geometry it also stores the information for its validation. The main application scenario for this is long-term archiving.

#### **2.1.2 Approach**

The COPS Validation Properties will be tested according to the current Draft Recommended Practices available in the member area of the CAx-IF web sites, under “Information on Round19J of Testing” (dated 12-06-2006).

A more detailed presentation on this functionality provided by ITI will also be made available.

### 2.1.3 Testing instructions

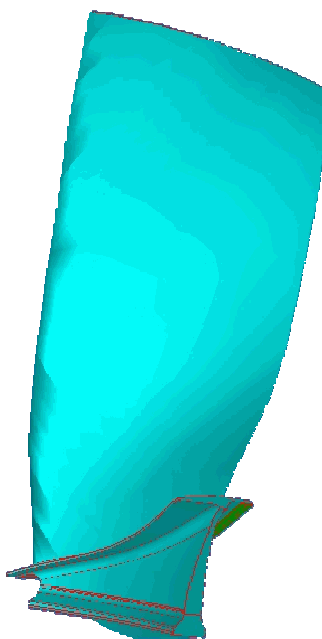


Figure 1: Shape of the T1 model (turbine blade)

#### 2.1.3.1 Model construction

The turbine blade was originally used as a production model in Round12J. It has been provided by Pratt&Whitney as a UG assembly. The native models and a STEP file will be made available in the member area of the CAx-IF web site.

Participants with a UG processor should export T1 model based on the native model, all others based on the STEP file. In any case, the highest level of validation properties supported by the exporting system shall be included in the STEP file.

#### 2.1.3.2 Statistics

With each STEP file submitted for the T1 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

<b>model</b>	<i>t1</i>
<b>system_n</b>	<i>Native system code</i>
<b>system_t</b>	<i>Target system code (for native stats use 'stp' for system_t)</i>
<b>unit</b>	<i>Units</i>
<b>volume</b>	<i>Total volume of all solids</i>
<b>validation_ volume</b>	<i>Total volume of all solids as received via the validation property capability.</i>

<b>Valid_vol</b>	<i>pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?</i>
<b>Area</b>	<i>Total surface area of all solids</i>
<b>validation_area</b>	<i>Total surface area of all solids (entire assembly) as received via the validation property capability.</i>
<b>Valid_area</b>	<i>pass/fail, is the instantiation of the validation property 'area' in the STEP file as per the recommended practices for validation properties?</i>
<b>Cx cy cz</b>	<i>Centroid of all solids</i>
<b>validation_cx validation_cy validation_cz</b>	<i>Centroid of all solids (entire assembly) as received via the validation property capability.</i>
<b>Valid_cent</b>	<i>pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?</i>
<b>Cops_ok</b>	<i>pass/fail, indicates whether the model passed comparison of the COPS GVP (i.e. no shape changes detected), or failed.</i>
<b>Valid_cops</b>	<i>pass/fail, indicates whether the target system considers the implementation of the Cloud of PointS information valid as per recommended practices.</i>
<b>Date</b>	<i>Date submitted</i>
<b>issues</b>	<i>Short description of issues</i>

## 2.2 Model GD4: Geometric Dimensioning and Tolerancing

### 2.2.1 Motivation

Geometric and Dimensional Tolerances are required for a number of business use cases in the context of STEP data exchange. Among others, they are a prerequisite for long-term data archiving, the way the aircraft industry plans to use it. In addition, the GD&T data can be used to drive downstream applications such as coordinate measuring and manufacturing

### 2.2.2 Approach

The functionality tested with this model is based on the harmonized approach for GD&T, described in detail in the updated GD&T Usage Guide (Version 2), which is available from the CAx-IF homepages under "Joint Testing Information".



### 2.2.3 Testing Instructions

Note: A more detailed description of this test case will be added in the next release of this document.

This round, a suite of models will be tested for GD&T in order to cover the complete scope of GD&T representation currently covered by the respective Recommended Practices.

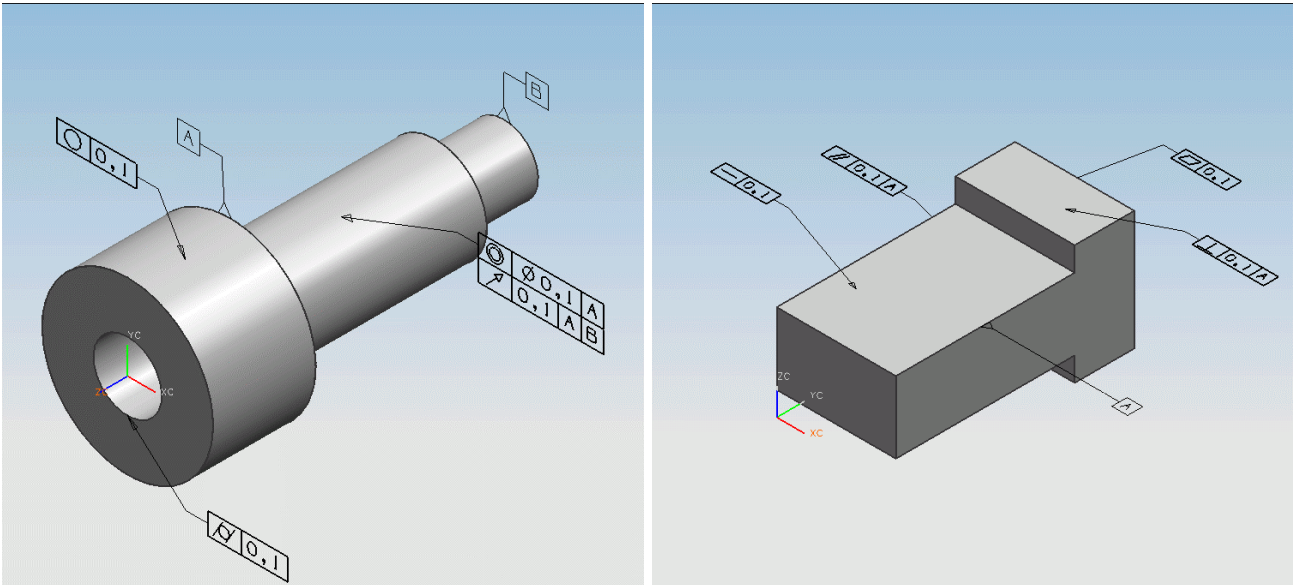


Figure 4: Views of the GD4 models a (left) and b (right) with GD&T information displayed

#### 2.2.3.1 Statistics

With each STEP file processed for the GD&T model, vendors must include a text file with the statistics in comma-delimited form (.CSV):

<b>model</b>	<i>gd4a / gd4b</i>
<b>unit</b>	<i>Units</i>
<b>volume</b>	<i>Total volume of all solids</i>
<b>area</b>	<i>Total surface area of all solids</i>
<b>cx, cy, cz</b>	<i>Centroid of all solids</i>
<b>dim_found</b>	<i>The number of dimensions processed.</i>
<b>Datum_found</b>	<i>The number of datums processed.</i>
<b>Tol_processed</b>	<i>The number of tolerances processed.</i>
<b>Date</b>	<i>Date submitted</i>
<b>issues</b>	<i>Short description of issues</i>

## 2.3 Model C1 : Colors and 3D Annotation

### 2.3.1 Motivation

The main objectives for this test is the preparation for GD&T Presentation: Since the 3D Annotation tests in Round17J revealed some issues with the existing implementations, it was agreed to further test this functionality to give all vendors supporting 3D Test a chance to update and verify their implementations in this area. Since most of the 3D Annotation module will be re-used for GD&T Presentation, this test is also a preparation for that. GD&T Presentation will probably be tested from Round20J on.

Since the focus of this test is on the functionality mentioned above, a very simple test model will be used.

### 2.3.2 Approach

The systems' support for associative text is strongly varying. The approach studied with the Implementor Forum allows for:

- unstyled text in the model
- styled notes in the model
- associate notes to the model
- associativity of notes visually depicted by leader curves

The support for this functionality inside the systems varies considerably. Further variations are introduced by the target elements to which the notes can be associated in a system.

For the test of 3D Annotation, a scenario with a styled text associated to a face and a visual depiction of this associativity by a leader curve will be studied. Since the underlying STEP approach is modular, those systems that cannot exactly represent such a scenario are encouraged to use closest-fits, e.g. neglect the associativity when necessary.

The recommended practices for associative text are available on the CAx-IF web sites, <http://www.cax-if.org/> and <http://www.cax-if.de/>.

### 2.3.3 Testing Instructions

#### 2.3.3.1 Model construction

In order to test color and text exchange without any unwanted side-effects, a very simple geometry is used. It was originally defined in Round6J and should contain:

- A cube (arbitrary dimensions and colors).

This model is also used to test the exchange of 3D annotations, for systems supporting this functionality. Recommendations to set up the text in the model:

- Include three annotations in the model:
  - one single-line text

- one multi-line text
- one which includes an annotation symbol
- Style the two texts with an arbitrary color.
- The two annotations should be associated to portions of the cube, e.g. a surface and an edge.
- Select an arbitrary placement of the text



Figure 5: A section of the C1 model with a 3D Annotation

### 2.3.3.2 Statistics & Screenshots

With each STEP file submitted for C1, vendors must include a text file with the stats in comma-delimited form (.csv):

<b>model</b>	<i>c1</i>
<b>system_t</b>	<i>Native system code</i>
<b>system_n</b>	<i>Target system code (for native stats use 'stp' for system_t)</i>
<b>Valid_txt</b>	<i>all/partial/none – whether the specified texts appear in the model Note: na indicates vendor is not testing associative text</i>
<b>valid_txt_- assoc</b>	<i>all/partial/none – whether the association of the text to the elements of the geometric model as described above is correct Note: na indicates vendor is not testing associative text</i>
<b>date</b>	<i>Date submitted</i>
<b>issues</b>	<i>Short description of issues</i>

Please note that due to the simplicity of the test model, no geometry statistics (volume / area / centroid) will be collected.

In order to validate the color and annotation exchange on a visual basis, vendors are asked to send in a screenshot for their native model and one for each imported C1 to

[Jochen.boy@prostep.com](mailto:Jochen.boy@prostep.com). These pictures will then be published in the secure area of the CAx-IF web sites (<http://www.cax-if.de/secure/> and <http://www.cax-if.org/secure/>). The following naming convention is suggested:

c1-[nat]-[tgt].[type]

where [nat] is the native system code, [tgt] is the target system code (use 'native' for the screenshot of the native model), and [type] is the usual extension based on the file format (.jpg/.gif/.bmp).

## 2.4 Model AS1: External References

### 2.4.1 Motivation

External references and the related functionalities (e.g. document format properties, nested external references) have been tested several times before. Since an additional system now has implemented this scope and aims to prove its implementation, this will be tested again in the CAx-IF. All participants supporting external references are asked to actively participate in this test.

### 2.4.2 Approach

All STEP files submitted for this test case should be compliant to the AP203e2 longform schema, which is available from the CAx-IF web sites under 'Joint Testing Information'.

### 2.4.3 Testing Instructions

The following file structure is recommended for the AS1 test case:

- one PDM/structure file plus five single part geometry files
- Including Document format properties if supported
- According to the 2<sup>nd</sup> edition of the External References Rec. Pracs.

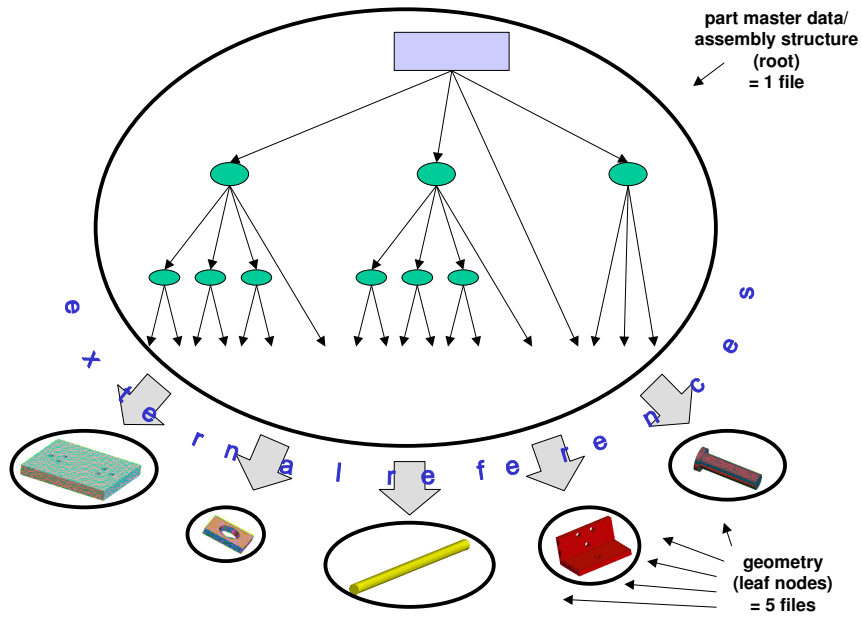


Figure 6: Relationships of the generated files

**2.4.3.1 Construction of the AS1 model**

The AS1 model is a well-known test case within the CAX-IF. Therefore, the modeling instructions will not be listed in detail here, since most of the participants already have this models available in their systems.

Detailed modeling instructions are included in older test suite documents. Should additional information be required, please contact the facilitators ([cax-test-admin-l@cax-if.org](mailto:cax-test-admin-l@cax-if.org)).

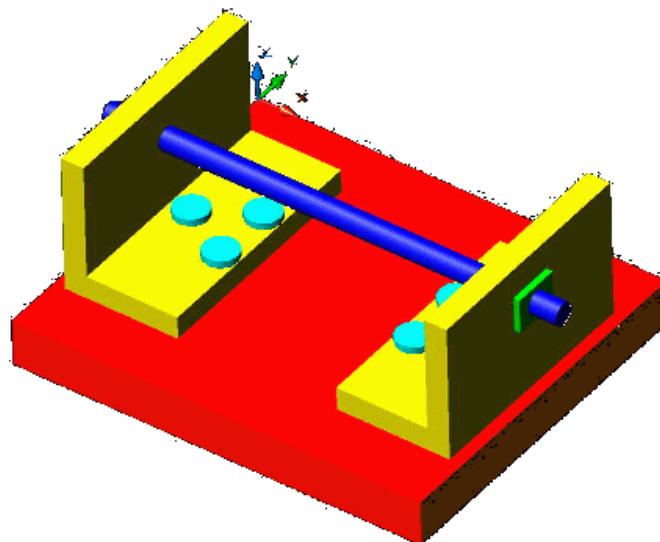


Figure 7: Shape of the AS1 model (toilet paper holder)

### 2.4.3.2 Statistics

With each STEP file submitted for the external reference model, vendors must include a text file with the stats in comma-delimited form (.CSV):

<b>model</b>	<i>as1</i>
<b>system_n</b>	<i>native system code</i>
<b>system_t</b>	<i>target system code (for native statistics use 'stp' for system_t)</i>
<b>fref_found</b>	<i>All – all file references for the external geometry can be found and the file node associations to model parts can be established</i> <i>Partial – some of the file references for the external geometry can be found and some of the file node association to model parts can be established</i> <i>None – no references found or associations can not be established</i>
<b>fref_processed</b>	<i>All – all referenced files can be processed to construct the overall model</i> <i>Partial - all referenced files can be processed to construct the overall model</i> <i>None – referenced files can not be processed</i>
<b>volume</b>	<i>total volume of all solids</i>
<b>area</b>	<i>total surface area of all solids</i>
<b>cx cy cz</b>	<i>Centroid of all solids</i>
<b>date</b>	<i>Date submitted</i>
<b>issues</b>	<i>Short description of issues</i>

## 2.5 Model U1: Unicode Character Encoding

### 2.5.1 Motivation

Due to the growing internationality of cooperations both within projects and between companies, a growing amount of CA-PDM data exchanged which contains international characters in certain strings, as for example a product's name or id.

Since the allowable characters within a Part 21 STEP file are limited to the basic alphabet, these special characters need to be encoded. Several levels of (Unicode-)encoding are available for the various European and Asian characters.

## 2.5.2 Approach

The approach how to represent Unicode-encoded characters within a STEP file is described within Part 21 itself, Section 6.3.3.1. For quick reference, the Part 21 PDF document will be made available in the member area of the CAx-IF web sites.

## 2.5.3 Testing Instructions

At the Round18J review meeting, it was agreed to start with the basic 'S-encoding'. A character table for this encoding is available at [http://en.wikipedia.org/wiki/ISO/IEC\\_8859-1](http://en.wikipedia.org/wiki/ISO/IEC_8859-1).

### 2.5.3.1 Construction of the U1 model

No shape will be pre-defined for the U1 test case. It is recommend though to use a single part with simple geometry. This part, however, shall contain strings with special, Unicode-encoded characters in mandatory attributes within the file structure, that have to be read by the target system. It was suggested to use the PRODUCT.name and PRODUCT.id name for this.

The allowed special characters can be seen in the table referenced in section 2.5.3. Vendors participating in this test should choose two arbitrary text strings (for name and id) which contain some special characters. When submitting a STEP file for this, the strings with the special characters (before encoding) should be included in the native stats. After importing, the string as imported into the target system (after decoding) should be reported in the target stats.

If the target system cannot display that special character, it should replace it with a placeholder, for example '\_' or '□'.

### 2.5.3.2 Statistics

With each STEP file submitted for the encoding test model, vendors must include a text file with the stats in comma-delimited form (.CSV):

<b>model</b>	<i>u1</i>
<b>system_n</b>	<i>native system code</i>
<b>system_t</b>	<i>target system code (for native statistics use 'stp' for system_t)</i>
<b>product.name</b>	<i>The string used for the product.name native stats: before encoding target stats: after decoding</i>
<b>product.id</b>	<i>The string used for the product.name native stats: before encoding target stats: after decoding</i>
<b>date</b>	<i>Date submitted</i>
<b>issues</b>	<i>Short description of issues</i>

## 3.0 Production models: PM17

### 3.1 Motivation

In an attempt to test the STEP processors on real world models, the CAx Implementor Forum will be testing production parts in this round and future rounds of CAx-IF testing. These production models are characteristic for components and assemblies that are encountered in the aerospace and automotive industries. PDES, Inc. and ProSTEP iViP member companies and vendors have supplied these models.

### 3.2 Approach

Testing of Production Models focuses mainly on data quality, not on specific functionalities. Assemblies should therefore be exported as a single STEP file. The file format should be either AP214-IS or AP203e2. In order to support quality validation of the Production Model exchange, all vendors shall include the maximum level of Validation Properties they support. In addition, since Round18J, the native and target statistics will include ValProps.

All source system native models and STEP files may be analyzed for data quality by the “CADIQ” developers. STEP syntax and structure will be checked by the CAx-IF facilitators. In order to enable an end-to-end analysis of the data exchange, all vendors importing Production Model STEP files are asked to submit the resulting target model from their system along with or instead of the target statistics.

### 3.3 Testing Instructions

#### 3.3.1 List of available models

Model name	Exporting System	AP	Filename	Remarks
Casing 1	Pro/E			
Casing 2	Pro/E			
Lid	Pro/E			
Ring	Pro/E			
Nose Landing Gear	CATIA V5			BREP with Voids

#### 3.3.2 Results

For each STEP file imported for the Production Models, vendors have to submit a text file with the statistics in comma-delimited form (.CSV):



<b>model</b>	<i>pm17</i>
<b>system_n</b>	<i>Native system code</i>
<b>system_t</b>	<i>Target system code (for native stats use 'stp' for system_t)</i>
<b>unit</b>	<i>Units</i>
<b>volume</b>	<i>Total volume of all solids</i>
<b>validation_volume</b>	<i>Total volume of all solids as received via the validation property capability.</i>
<b>valid_vol</b>	<i>pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?</i>
<b>area</b>	<i>Total surface area of all solids</i>
<b>validation_area</b>	<i>Total surface area of all solids (entire assembly) as received via the validation property capability.</i>
<b>valid_area</b>	<i>pass/fail, is the instantiation of the validation property 'area' in the STEP file as per the recommended practices for validation properties?</i>
<b>cx cy cz</b>	<i>Centroid of all solids</i>
<b>validation_cx validation_cy validation_cz</b>	<i>Centroid of all solids (entire assembly) as received via the validation property capability.</i>
<b>valid_cent</b>	<i>pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?</i>
<b>shoveit_ok</b>	<i>pass/fail, indicates whether the model passed comparison of the Extended GVP (i.e. no parts/subassemblies misplaced), or failed.</i>
<b>valid_shoveit</b>	<i>pass/fail, indicates whether the target system considers the implementation of the instance information valid as per recommended practices.</i>
<b>date</b>	<i>Date submitted</i>
<b>issues</b>	<i>Short description of issues</i>

In addition, it is recommended to submit the target model from their system created by importing the STEP file. This is required for an end-to-end analysis of the data exchange with the "CADIQ" tool. The file name should clearly point out the source system which created the STEP file.

**Note:** For collecting the target models, the File Upload Area at <http://collaboration.aticorp.org/pdt/caxif/> will be used (for further information see CAx-IF General Guidelines v1.5, section 3.3).