Test Suite for the
CAx Implementor Forum
Round 17J

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Contents:

1.0 <u>Introduction</u>

This document describes the suite of test cases to be used for the seventeenth 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 long-term archiving.

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.

- Validation of data transfer quality: Based on the "Torque Converter" assembly from the 8th ProSTEP Benchmark, 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 3rd party quality checker are used.

- Geometric Validation Properties will be tested in three different occurrences:

  o 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.

  o Surface Model VP aim for the validation of the transfer of surface models, and focus on fixing issues previously found in the recommended practices.

  o 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.

- Long Term Archiving relates to importing native models and corresponding STEP files that are as old as possible. These files are taken from the archives of the CAx-IF and its preceding working groups. The intention is to see if native models and STEP files ten years and older still can be imported into the current system versions, and how they compare.

- In addition to synthetic models for the above capabilities, production models are included in this round of testing.

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 v1.4, dated December 2004.

1.3 Preliminary testing schedule

Date	Action
December 7, 2005 **(Wed)**	**Test Suite available /** **1st CAx Implementor Forum conference call**
ASAP	**Production Models released**
January 9, 2006 (Mon)	**Initial STEP files and native stats due**
January 27 (Fri)	**STEP files and native stats frozen**
February 20 (Mon)	**Target stats due / 2nd conference call**
March 6 (Mon)	**Target stats frozen**
March 21 (Tue)	**Pre-release of final stats / 3rd conference call**
March 28 (Tue)	**Review meeting for test round**
March 29 – 30 **(Wed – Thu)**	**CAx Implementor Forum meeting,** **Asheville, NC**

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 <u>Synthetic test case specifications</u>

2.1 Model B4 : Data Transfer Quality Validation

2.1.1 Motivation

The intention for this test case is the tracking of model quality before, during and after the exchange via STEP. The assembly model ('torque converter') from the 8th ProSTEP Benchmark is used since it's an established test suite available to all CAx-IF participants.

The data quality is checked on either end of the data exchange chain by a third party tool, namely CADIQ. Therefore, the native and target models need to be provided in addition to the usual STEP files and statistics. This type of quality check goes beyond mere geometric validation and also captures design defects.

In addition, in Round17J this model will be tested including (Extended) Geometric Validation Properties to observe correlations between the GVP results and CADIQ findings.

2.1.2 Approach

(Extended) Geometric 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 Round16J of Testing" (dated 05-02-2005).

2.1.3 Testing Instructions

The assembly should be exported as a single STEP file in either AP214-IS or AP203e2 format. Geometric Validation Properties shall be included by every system supporting them on export to STEP; on top of that, every processor supporting Extended GVP shall include those also.

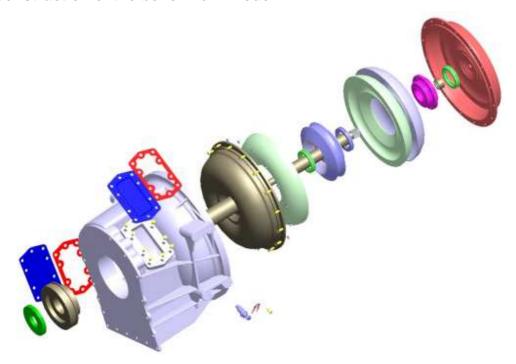**2.1.3.1 Construction of the benchmark model**

Figure 1: Exploded view of the B4 model (torque converter assembly)

Those vendors who participated in the ProSTEP iViP benchmark should re-use the torque converter assembly model which has been constructed for that purpose.

If vendors who wish to participate in this test but do not have a native model of the assembly, please contact jochen.boy@prostep.com for modeling instructions.

2.1.3.2 Results

For each STEP file imported for the B4 model, vendors need to submit at least one of the following:

- 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).

  If the resulting target model is submitted, no .CSV needs to be provided, since the results calculation can be done by CADIQ.

- A text file with the statistics in comma-delimited form (.CSV):

model	B4
system_n	Native system code

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

2.2 Model GD3: 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

The model is the same as GD2 (see Test Suite for Round16J), but the GD&T is different. The two Datum Targets have a circular target area, one is 0.5 in diameter, the other is 0.754 in diameter. They are centred on at [X2.0 Y0.5 Z1.0], and [X2.0 Y0.5 Z3.0.].
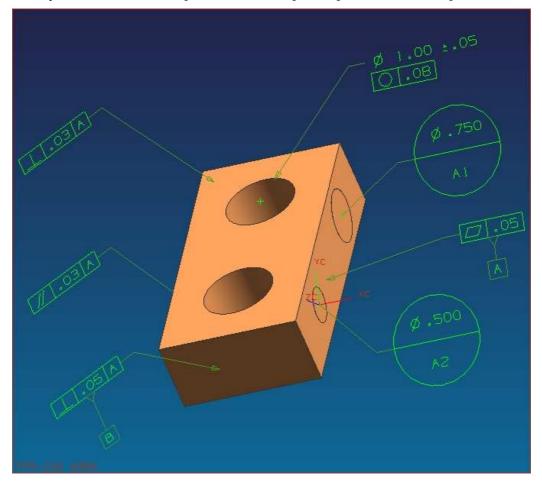

Figure 2: View of the GD3 model with GD&T information displayed

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):

model	gd2
unit	Units
volume	Total volume of all solids
area	Total surface area of all solids
cx, cy, cz	Centroid of all solids
dim_found	The number of dimensions processed.
datum_found	The number of datums processed.
tol_processed	The number of tolerances processed.
date	Date submitted
issues	Short description of issues

2.3 Model S1: 3D Associative Text

2.3.1 Motivation

This synthetic model (a slightly abstracted version of an "Überraschungsei"-toy) is a model already known from previous testing activities of the CAx-IF. The model is re-used to test 3D text annotation/text associativity. This test case has been defined in Round5J with a slightly extended scope.

The intention for testing this capability is preparation for the upcoming GD&T presentation functionality. Hence, all vendors should be given the chance to validate the 3D Annotation support in their STEP processors.
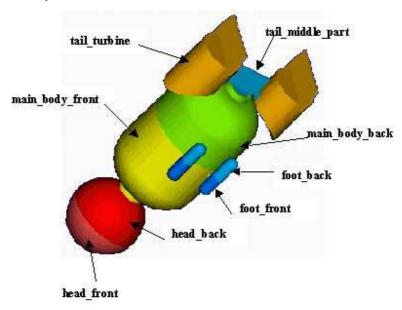

Figure 3: Annotated Shape of Space Ship s1.

2.3.2 Approach

See the approach described in the CAx Implementor Forum Recommended Practices for *3D Associative Text* (see http://www.cax-if.org/public/ or http://www.cax-if.de/public/), dated 01-13-2000.

Since AP203e1 is no longer tested in the CAx-IF, and the corresponding sections in AP203e2 still have some harmonization issues pending and will be changed, all vendors testing this capability are asked to provide their files in AP214-IS format.

2.3.3 Testing instructions

2.3.3.1 Construction of S1 "space ship"

This test case has been used in a number of previous CAx-IF test rounds, therefore the modeling instructions are not repeated here. If a vendors would like to participate in this test case and does not yet have the model, the construction information can be found e.g. in the Test Suite for Round5J, available in the "Joint Testing Information" area of the CAx-IF web site.

2.3.3.2 Presentation

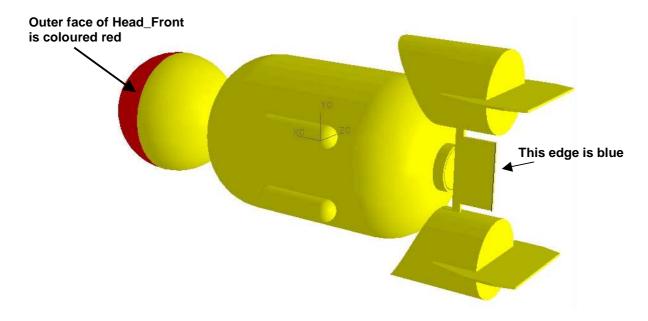The following 3D Annotations shall be included in the test model:

Figure 4: S1 Text Annotation Assignment

Annotations

Text is as shown in Figure 5. The following basic regulations are defined:

- style the two texts with an arbitrary colour

- associate the text "Outer face ..." to the outer face of the 'head_front'.

- associate the text "This edge ..." to the edge of the 'tail_middle_part'

- define the text "Outer face ..." as a multi-line text

- select an arbitrary placement of the text

2.3.3.3 Statistics

With each STEP file submitted for model S1 vendors must include a text file with the stats in comma-delimited form (.csv):

model	s1
system_n	*native system code*
system_t	*target system code (for native statistics use 'stp' for system_t)*
unit	*units*
volume	*total volume of all solids*
area	*total surface area of all solids*
cx cy cz	*Centroid of all solids*
color_t1	*Text color used for the annotation text "Outer face…"*
color_t2	*Text color used for the annotation text "This edge…"*
valid_txt	*all/partial/none – whether the specified texts appear in the model*
valid_txt_assoc	*all/partial/none – whether the association of the text to the elements of the geometric model as described above is correct*
date	*date submitted*
issues	*short description of issues*

Note: In case a vendor (native/target) is not testing a particular functionality, *'na'* must be used as code for that statistic.

2.4 Model K1 : Surface Model with Validation Properties

2.4.1 Motivation

Previous findings indicated that the exchange of surface models may need some enhancement. To take into account the latest issue resolution processes in the CAx-IF, and to give new participants a chance to measure their improvements, this model is tested again in Round 17J.

2.4.2 Approach

The STEP files should be exported in **AP203e2** format, including Geometric Validation Properties for Surface Models as described in the draft updated Recommended Practices for GVP, which are available in the "Member Area" of the CAx-IF internet homepages.

The reason for this test is that inconsistencies have been found in the definition of where to attach the GVP information to surface models, since there are several ways to do it. For details please the draft Recommended Practices mentioned above.

2.4.3 Testing Instructions
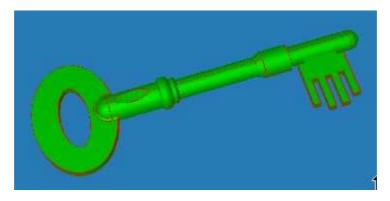
2.4.3.1 Model construction

Figure 5 : Shape of the K1 model.

The detailed modeling instructions are available as a PDF document from the member areas of the CAx-IF web sites, http://www.cax.if.de/secure/ and http://www.cax-if.org/secure/ , under 'Information on Round4J of Testing'. It has been agreed that only topologically bounded surface models shall be exchanged

There are several degrees of freedom when implementing this test case:

- The first point is how two construct the model according to Theorem's test suite. There are two approaches (sweeping/revolving vs. union/intersection). Vendors may choose the approach which fits best with their system capabilities, the model should be constructed only once.

- The next point is how to downgrade the model. It has been agreed that any number of shells is allowed. The information on how many shells are used will be collected with the native stats, but will not be an exchange success criteria.

2.4.3.2 Statistics

With each STEP file submitted for K1, vendors must include a text file with the stats in comma-delimited form (.csv):

model	k1
system_n	Native system code
system_t	Target system code (for native stats use 'stp' for system_t)
unit	Units
shells	Number of shells in the model (not a success criteria).
area	Total surface area (wetted)
validation_area	Total surface area as received via the GVP capability
valid_area	pass/fail – if the instantiation of the 'area' property is conforming the GVP Recommended Practices
cx, cy, cz	Center of area
validation_cx, validation_cy, validation_cz	Center of area as received via the GVP capability
valid_cent	pass/fail – if the instantiation of the 'center of area' property is conforming the GVP Recommended Practices
date	Date submitted
issues	Short description of issues

2.5 Import of old STEP and Native Files

2.5.1 Motivation

In the light of the Long-Term Archiving (LOTAR / LTDR) efforts, the goal is to get an idea of how old CAD models behave when they are being imported into the current versions of the respective systems. The CAx-IF with its extensive file archives, which, including preceding activities, reach back as far as ten years, offers the chance to import both the native model and the STEP file originally created from it.

2.5.2 Testing Instructions

All participating vendors are asked to import the old STEP files provided in the file vault in the member area of the CAx-IF homepage, and report their findings. The basic set of target statistics (see Production Models, section 3.3.2, below) is welcome.

All vendors maintaining STEP processors for the originating system of the old native model are asked to try and import the old part into their system and report their findings.

3.0 Production models: PM15

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 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. Vendors are encouraged to include (extended) validation properties as far as supported. The file format should be either AP214-IS or AP203e2.

All source system native models and STEP files will 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

3.3.2 Results

For each STEP file imported for the Production Models, vendors need to submit at least one of the following:

- 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).

If the resulting target model is submitted, no .CSV file is needed, since these results can be generated by CADIQ.

- A text file with the statistics in comma-delimited form (.CSV):

model	*pm15*
unit	*Units*
volume	*Total volume of all solids*
area	*Total surface area of all solids*
cx, cy, cz	*Centroid of all solids*
date	*Date submitted*
issues	*Short description of issues*