



**Test Suite for the
CAX Implementor Forum
Round 18J**

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1.0 Introduction

This document describes the suite of test cases to be used for the eighteenth 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 iViP 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 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.
- 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
May 17, 2005 (Wed)	Test Suite available / 1st CAx Implementor Forum conference call
ASAP	Production Models released
July 7 (Fri)	Initial STEP files and native stats due
July 28 (Fri)	STEP files and native stats frozen
August 31 (Wed)	Target stats due / 2nd conference call
September 27 (Wed)	Target stats frozen
October 4 (Wed)	Pre-release of final stats / 3rd conference call
October 10 (Tue)	Review meeting for test round
October 11 – 12 (Wed – Thu)	CAx Implementor Forum meeting, Darmstadt, Germany

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 B4 : Data Transfer □entroi 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 Round18J 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 Round18J of Testing" (dated xx-05-2006).

2.1.3 Testing Instructions

The assembly should be exported as a single STEP file in either AP214-IS or AP203e2 format. Each system testing this model shall included the highest level of Geometric Validation Properties it supports on export to STEP.

2.1.3.1 Construction of the benchmark model

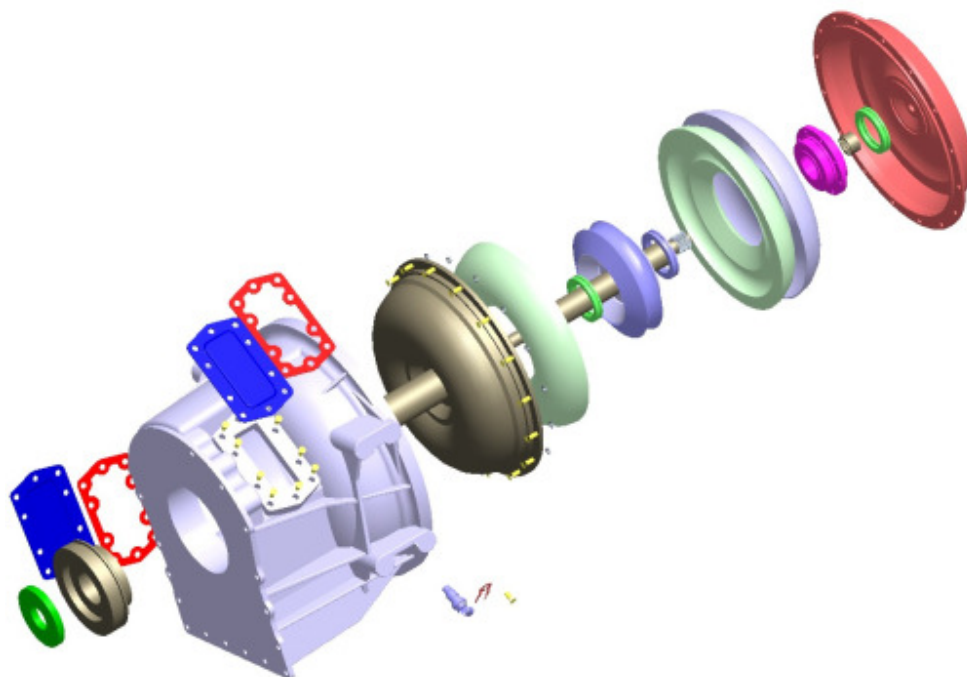


Figure 1: Exploded view of the B4 model (torque converter assembly)

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	<i>B4</i>
system_n	<i>Native system code</i>

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

2.2 Model IO1: Cloud Of PointS GVP

2.2.1 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.

2.2.2 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 Round18J of Testing” (dated xx-05-2006).

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

2.2.3 Testing instructions

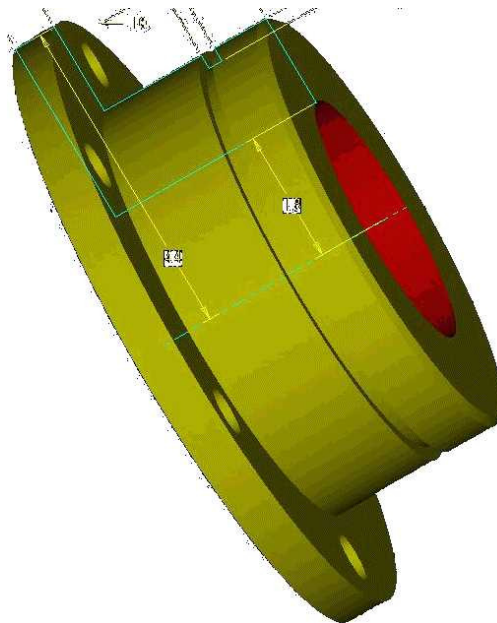


Figure 2: Shape of the io1 model (flange)

2.2.3.1 Model construction

Construct the flange as one solid. The modelling instructions can be found in the Annex of the Test Suite for Round9J, which can be found on the CAx-IF web sites under “Joint Testing Information”.

2.2.3.2 Statistics

With each STEP file submitted for the io1 model, vendors must include a text file with the stats in comma-delimited form (.CSV):

model	<i>io1</i>
system_n	<i>Native system code</i>
system_t	<i>Target system code (for native stats use 'stp' for system_t)</i>
unit	<i>Units</i>
volume	<i>Total volume of all solids</i>
validation_volume	<i>Total volume of all solids as received via the validation property capability.</i>
Valid_vol	<i>pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?</i>
Area	<i>Total surface area of all solids</i>
validation_area	<i>Total surface area of all solids (entire assembly) as received via the validation property capability.</i>
Valid_area	<i>pass/fail, is the instantiation of the validation property 'area' in the STEP file as per the recommended practices for validation properties?</i>
Cx cy cz	<i>Centroid of all solids</i>
validation_cx validation_cy validation_cz	<i>Centroid of all solids (entire assembly) as received via the validation property capability.</i>
Valid_cent	<i>pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?</i>
Cops_ok	<i>pass/fail, indicates whether the model passed comparison of the COPS GVP (i.e. no shape changes detected), or failed.</i>
Valid_cops	<i>pass/fail, indicates whether the target system considers the implementation of the Cloud of PointS information valid as per recommended practices.</i>
Date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

2.3 Model GD3: Geometric Dimensioning and Tolerancing

2.3.1 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

2.3.2 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”.

2.3.3 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].

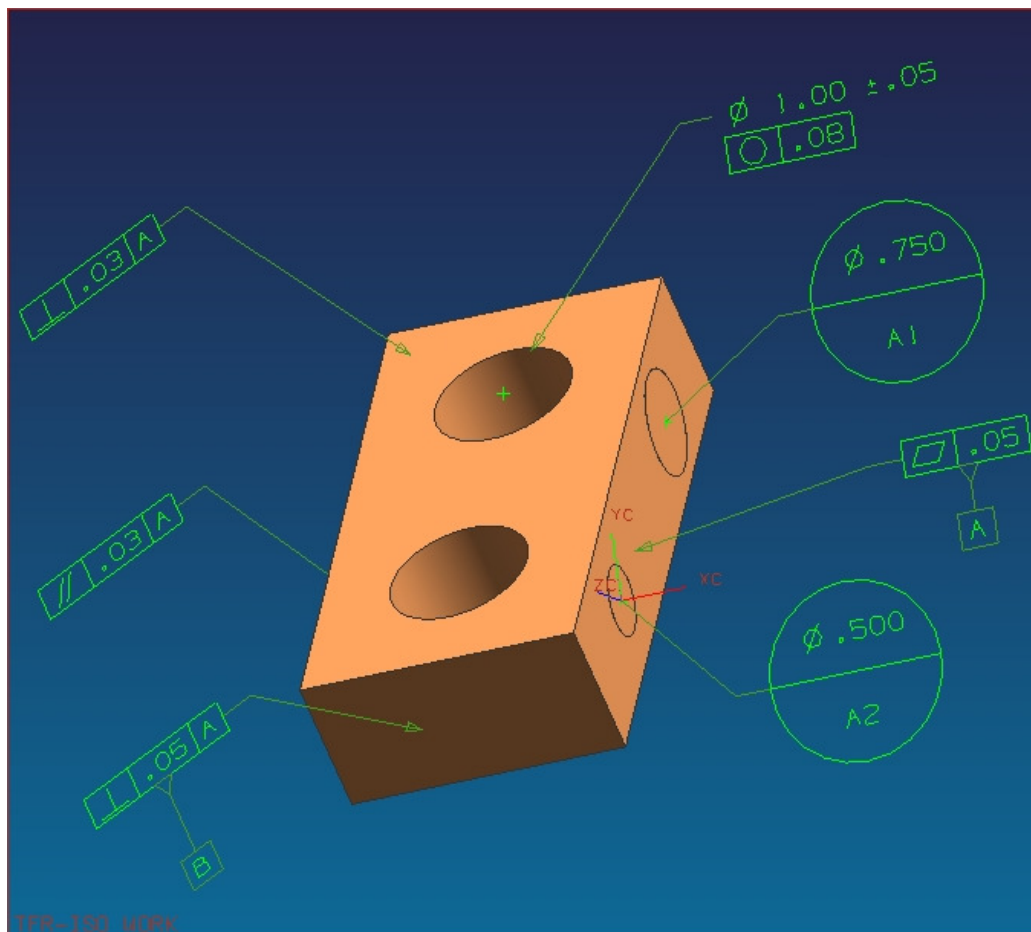


Figure 3: View of the GD3 model with GD&T information displayed

2.3.3.1 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	<i>gd2</i>
unit	<i>Units</i>
volume	<i>Total volume of all solids</i>
area	<i>Total surface area of all solids</i>
cx, cy, cz	<i>Centroid of all solids</i>
dim_found	<i>The number of dimensions processed.</i>
Datum_found	<i>The number of datums processed.</i>
Tol_processed	<i>The number of tolerances processed.</i>
Date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

2.4 Model C1 : Colors and 3D Annotation

2.4.1 Motivation

There are two main objectives for this test:

- 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 Round19J on
- Verification of color exchange: Several new systems have joined the CAx-IF recently and therefore never formally tested the colors functionality. This test offers them the chance to do so.

Since the focus of this test is on the functionalities mentioned above, a very simple test model will be used. It will contain a colored cube, including overriding color for the system supporting this functionality, plus a colored surface and curve.

2.4.2 Approach

2.4.2.1 Presentation colors

As defined in AP214, AP203e2 and the Colors and Layers extension to AP203e1.

2.4.2.2 Annotation

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/>.

2.4.3 Testing Instructions

2.4.3.1 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 with solid color (arbitrary dimensions).
- For systems supporting overriding colors:
 - An overriding face color on one side of the cube.
 - An overriding edge color on one edge of the cube. The edge should not belong to the colored surface.
- A separate surface with surface color.
- A separate curve with curve color.

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 two annotations in the model, one single-line text and one multi-line text.
- 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

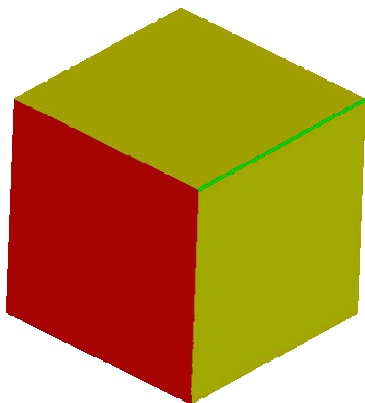


Figure 4: The cube with solid colour (yellow), overriding face colour (red) and overriding edge colour (green).

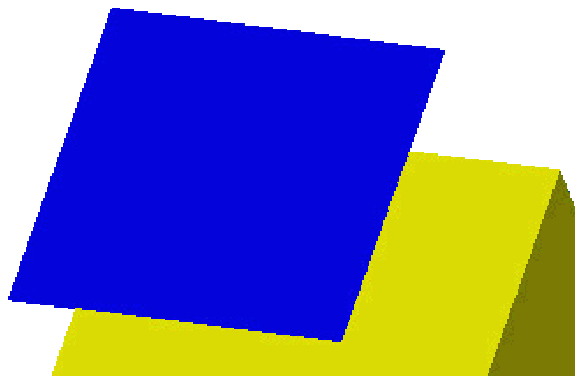


Figure 5: In addition to the cube, the test case shall contain a simple surface (blue).

Note: Overriding colours are not mandatory, but recommended for systems supporting this functionality. The colours don't necessarily need to be as shown on the figures above.

2.4.3.2 Statistics & Screenshots

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

model	<i>c1</i>
system_t	<i>Native system code</i>
system_n	<i>Target system code (for native stats use 'stp' for system_t)</i>
color_sd	<i>all/partial/none – if solid colours in the model are totally correct, partially correct, or lost completely. Note: na indicates vendor is not testing solid colour</i>
color_f	<i>all/partial/none – if overriding face colour in the model is totally correct, partially correct, or lost completely. Note: na indicates vendor is not testing overriding face colour</i>
color_e	<i>all/partial/none – if overriding edge colour in the model is totally correct, partially correct, or lost completely. Note: na indicates vendor is not testing overriding edge colour</i>
color_surf	<i>all/partial/none – if the colour of the extra surface in the model is totally correct, partially correct, or lost completely.</i>
Color_curve	<i>all/partial/none – if the colour of the extra curve in the model is totally correct, partially correct, or lost completely.</i>
Color_t1	<i>Text colour used for the single-line text.</i>

Color_t2	<i>Text colour used for the multi-line text.</i>
Valid_txt	<i>all/partial/none – whether the specified texts appear in the model Note: na indicates vendor is not testing associative text</i>
valid_txt_- assoc	<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>
date	<i>Date submitted</i>
issues	<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. 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).

2.5 BV1: BREP with Voids

2.5.1 Motivation

Although the applicability of a Brep with Voids in the “real world” is questionable (from a manufacturability point of view), it is evident that this type of geometry occurs every so often in production models. A Round17J Production Model test case turned out to be one of those.

The `brep_with_voids` capability was tested in the early days of STEP data exchange, in the PDES, Inc. StepNet and ProSTEP Roundtable activities. Since then, the CAD system landscape has changes significantly, and a number of current systems have never tested this.

This test is designed to update and verify the exchange of Breps with Voids.

2.5.2 Approach

No special approach is used in this test. Syntax and structure (i.e. shell orientation) shall be implemented as defined in the STEP standard (Part 42).

2.5.3 Testing Instructions

2.5.3.1 Model Construction

A quite simple model will be used for this test. The following composition is recommended:

- A cube or block with arbitrary dimensions
- Inside, construct two rectangular voids. The volume of each void shall at least be 10% of the volume of the main body.

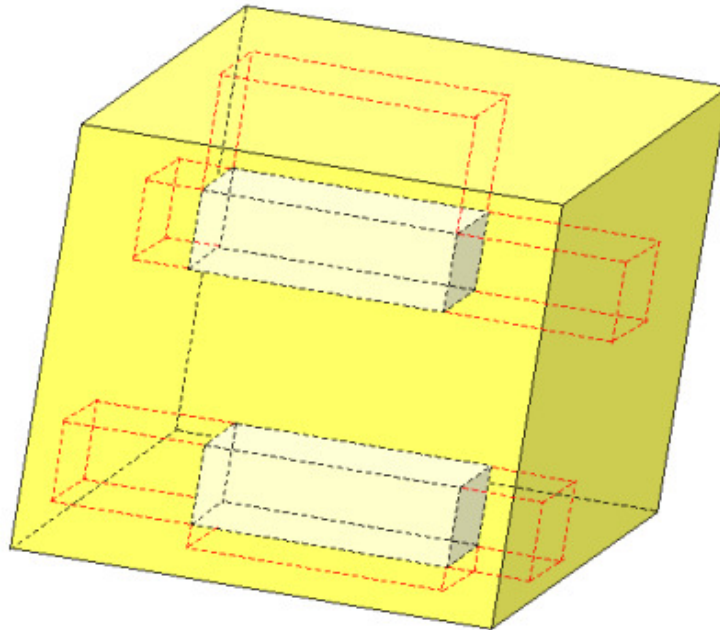


Figure 6: Sketched layout of the BV1 test case

2.5.3.2 Statistics

With each STEP file submitted for BV1, vendors must include a text file with the stats in comma-delimited form (.csv):

model	<i>bv1</i>
unit	<i>Units</i>
volume	<i>Total volume of all solids</i>
area	<i>Total surface area of all solids</i>
cx, cy, cz	<i>Centroid of all solids</i>
date	<i>Date submitted</i>
issues	<i>Short description of issues</i>

2.6 Import of Antique Files

2.6.1 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.

2.6.2 Testing Instructions

In Round18J, Production Model STEP files from Round3J will be re-tested. For these files in AP203e1 and AP214-DIS format, both a syntax check (STEPcheck) and a quality check (CADIQ) are documented. The native models for these files unfortunately are no longer available, but this does not impact the scenario, since the basic assumption of long-term archival is that the original native model is not accessible anyway.

The old STEP files will be included in the regular Production Model test cycle, see section 3.

3.0 Production models: PM16

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, from Round18J on, the native and target statistics will include ValProps.

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
Cylinder Head	I-DEAS MS 8	214-DIS	pm1-id-214.stp	Round3J
Harddrive	Microstation/J 7	214-DIS	pm1-ms-214.stp	Round3J
Boombox	Pro/E 2000i	203+	pm1-pe_b-203.stp	Round3J
Boombox	Pro/E 2000i	214-DIS	pm1-pe_b-214.stp	Round3J
Chassis	Pro/E 2000i	203+	pm1-pe_c-203.stp	Round3J
Chassis	Pro/E 2000i	214-DIS	pm1-pe_c-214.stp	Round3J
Dynacom Test Stand	CATIA V5	214-IS	pm16-c5-214.stp	New Model
Plate rotor			pm16-.stp	New Model
Pump	PTC CADD5	203	pm16-pc-203.stp	New Model

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):

model	<i>pm1 / pm16</i>
system_n	<i>Native system code</i>
system_t	<i>Target system code (for native stats use 'stp' for system_t)</i>
unit	<i>Units</i>
volume	<i>Total volume of all solids</i>
validation_volume	<i>Total volume of all solids as received via the validation property capability.</i>
valid_vol	<i>pass/fail, is the instantiation of the validation property 'volume' in the STEP file as per the recommended practices for validation properties?</i>
area	<i>Total surface area of all solids</i>
validation_area	<i>Total surface area of all solids (entire assembly) as received via the validation property capability.</i>
valid_area	<i>pass/fail, is the instantiation of the validation property 'area' in the STEP file as per the recommended practices for validation properties?</i>

cx cy cz	<i>Centroid of all solids</i>
validation_cx validation_cy validation_cz	<i>Centroid of all solids (entire assembly) as received via the validation property capability.</i>
valid_cent	<i>pass/fail, is the instantiation of the validation property 'centroid' in the STEP file as per the recommended practices for validation properties?</i>
shoveit_ok	<i>pass/fail, indicates whether the model passed comparison of the Extended GVP (i.e. no parts/subassemblies misplaced), or failed.</i>
valid_shoveit	<i>pass/fail, indicates whether the target system considers the implementation of the instance information valid as per recommended practices.</i>
date	<i>Date submitted</i>
issues	<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).