



**Test Suite
for the 1st joint test round of
the CAX Implementor Forum
held May - July 1999**

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1 Introduction

This document describes the suite of test cases to be used for the first round of testing of the CAx implementor forum. The CAx implementor forum is a joint platform of the organisations and vendors previously engaged in the ProSTEP CAD Round Table and STEPnet.

The test rounds of the CAx Implementor Forum continue the tradition of the ProSTEP Test Rallies and the STEPnet test rounds in testing STEP processor conformance and interoperability.

The test rounds will in general combine testing of synthetic models and production models. Production models will in most cases be provided by the member companies of the organizations PDES and ProSTEP.

This test suite includes synthetic models for testing the capabilities model viewing & drawing organization, 3D annotation, validation properties, surface model as well as colours and layers.

Production models are provided for solid assemblies. The basis for the production test cases are native CAD models. Each test case is therefore originating from a single CAD system, and the set of test cases to be preprocessed (converted to STEP) is unique for each CAD system. After preprocessing, the resulting STEP files are then to be read in by all participants

1.1 Functionality tested in this round

Concerning new functionality to date untested the test round focuses on model viewing and drawing structure. This capability allows to exchange the projection of 3D model geometry onto planar views.

Functionality addressed before relates to 3D annotation/associative text, validation properties, surface models and colours and layers functionality.

Associative text is the capability to associate to text notes in 3D models space with portions of the model.

Validation properties (in AP214 named `shape_dependent_properties`) is a mechanism to allow the exchange of geometric properties and their assignment to geometric representations for the purposes of data exchange validation. Considered properties are volume, surface area and centroid.

Surface models are again tested because of previous findings that indicate that this exchange capability might still need some enhancement.

A colours and layers model is included in the test suite to study AP203 + extensions vs. AP214 interoperability. The colours and layers domain is chosen because this domain is seen as consolidated and completely harmonised between 203 and 214 based implementations. The objective of this testing is to study the interoperability be pre- and post-processing 203-based files with 214-based processors and vice versa without any file adjustment.

1.2 General test instructions for this round

The general procedures for communication of models and stats etc. are outlined in a separate document 'xxx'. See general instructions can be retrieved from ...

Specifically for this round of testing it is recommended for to in general write STEP files in respect to AP214 DIS.

1.3 Schedule

Date	Action
beginning of May	CAx Implementor Forum conference call
May 28 th	STEP files and native stats are communicated
June 11 th	vendors have communicated target stats and issues identified when processing models
June 25 th	issues resolved and documented. An overview of the issues is sent to the vendors
July 6 th	Review meeting for test round
July 7 th , 8 th	CAx Implementor Forum meeting

1.4 Copyrights on test cases

Not all of the production test cases which were provided by the PDES and ProSTEP member companies are fully released for any purpose. The least common denominator is that the test cases can be freely distributed among the ProSTEP/PDES Inc. Round Table participants and can be used for any purposes that are related to CAx Implementor Forum testing (i.e. testing, documentation of testing efforts), as long as a reference to the originating company is made.

If use of the test cases beyond the scope or outside the group described above is intended, please contact the facilitators of the CAx Implementor Forum so that we can try to obtain such permission from the originator.

2 Synthetic test case specifications

2.1 Model d1 'draughting of block'

2.1.1 Motivation

This synthetic model represents basic draughting capability. It involves the projection of a simple 3D solid onto a view which is then placed on a sheet. The sheet is organised in a drawing. As a first synthetic test for this new capability this test is kept deliberately simple.

2.1.2 Approach

See the approach described in the CAx Implementor Forum Recommended Practices for *Model Viewing and Drawing structure* (see <http://www.stepnet.org/secure/r13.html> or <ftp://ftp@ftp.prostep.de/pub/CAx-if/rec-prac/>).

2.1.3 Testing Instructions

Please note that systems vendors that do not support this basic draughting capability should not submit STEP files for this test case.

2.1.3.1 Model construction

The figures below indicate the construction of the draughting test case. The basic steps are:

1. construct the solid geometry. The dimensions for the solid are given in the figures below
2. define a views of the solid and place it onto a sheet. The projection related to the views can be extracted from the figure below.

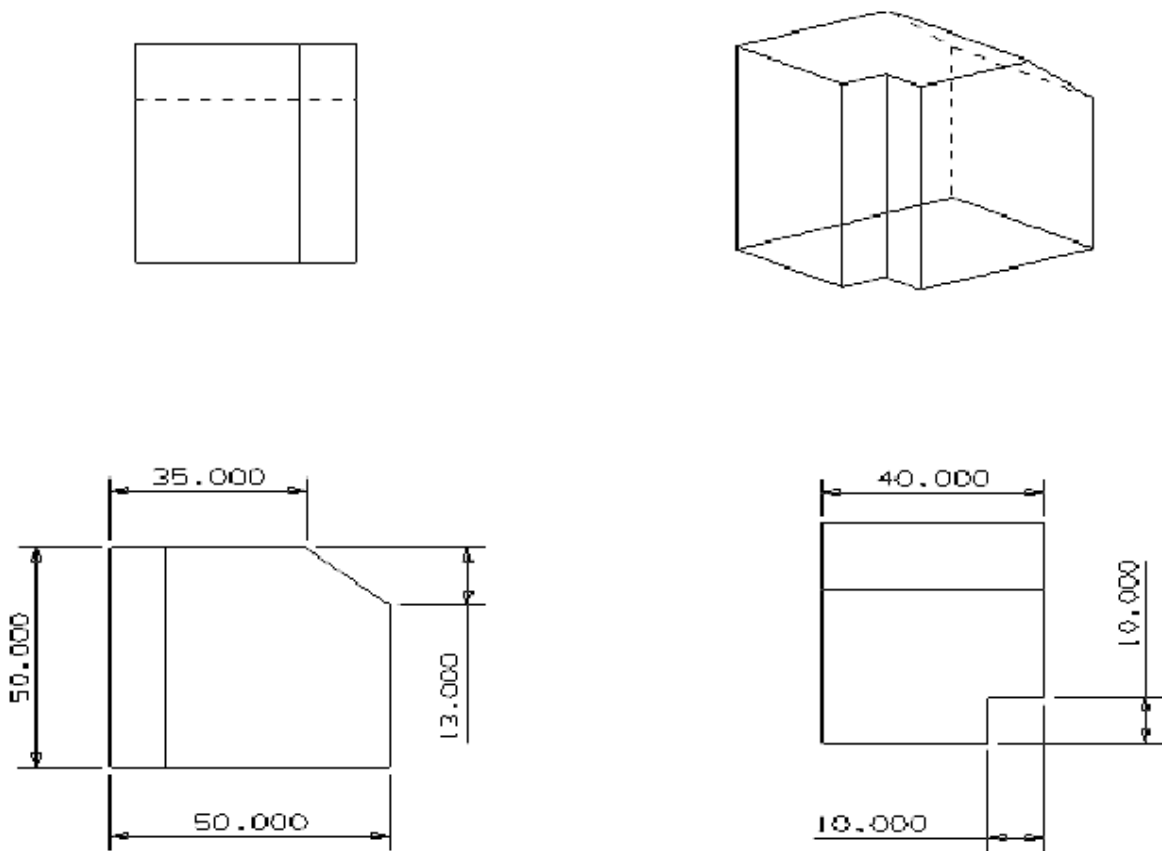


Figure: dimensions for solid for d1 (dimensions in mm)

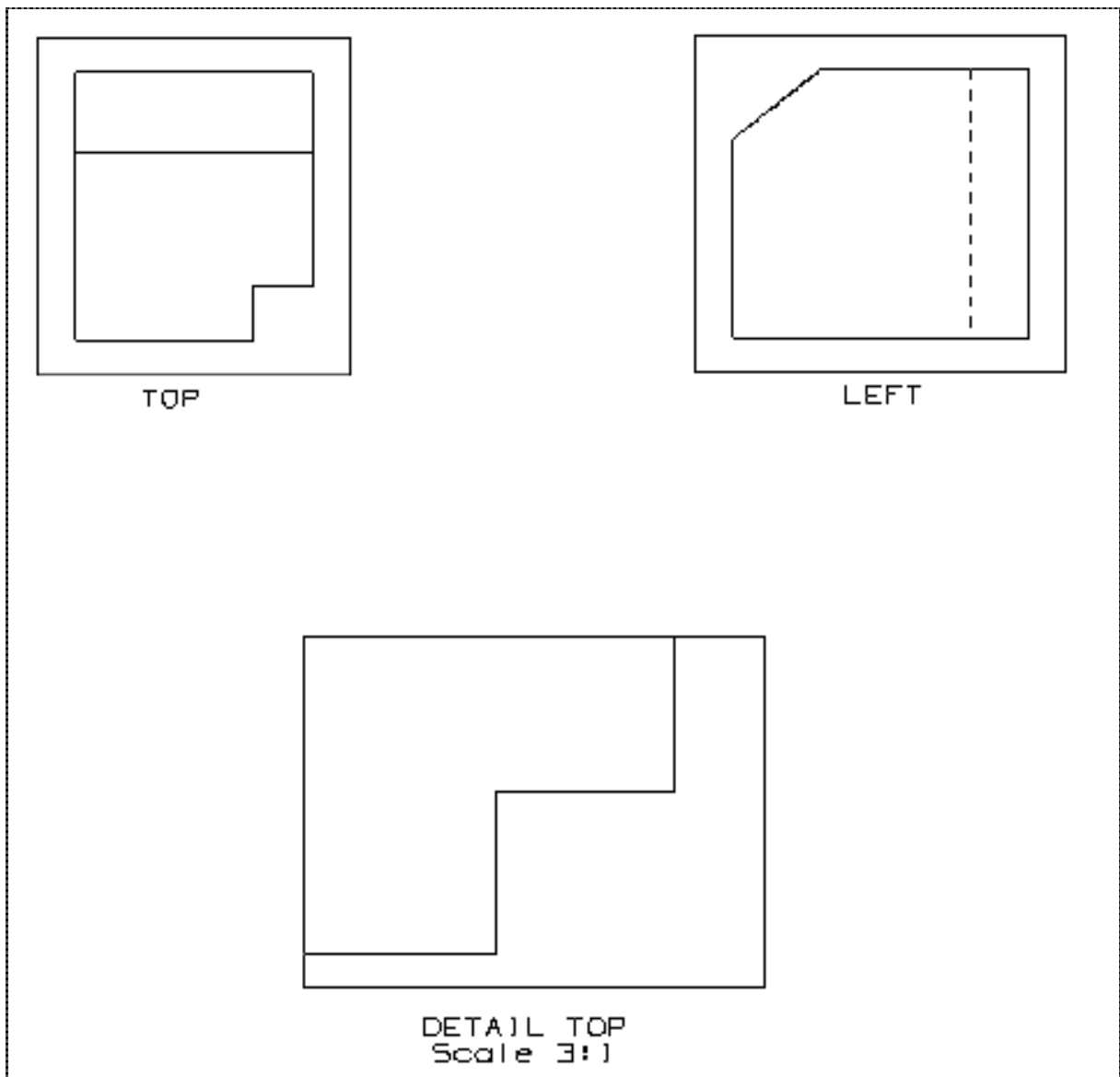


Figure: views on the drawing sheet

The layout of the views on the sheet should be as above indicated, i.e.:

- TOP and LEFT are horizontally aligned
- TOP and LEFT are placed on the top of the sheet
- the DETAIL TOP is horizontally centred
- DETAIL TOP is placed on the bottom of the sheet

2.1.3.2 Statistics

The statistics that must be associated with each STEP file submitted for the v1 test case are designed to represent the results for the following criteria and validations:

- check the views: placement on the sheet and orientation
- move the views on the sheet in order to test the association of the model to the view
- add any dimension to test the functionality of the drawing. A dimension shall be added in the target system in order to inspect the associativity between the shape and the presentation.

model	<i>model name</i>
system_t	<i>native system code</i>
system_n	<i>target system code</i>
views	<i>all/partial/none - whether the views appear on the sheet in the target system</i>
view_layout	<i>all/partial/none - whether the views appear with right placement and orientation in the target system</i>
valid_associativity	<i>pass/fail – whether modifications of the shape result in an appropriate update of the views (check with new dimension)</i>
valid_sm	<i>pass/fail - whether target system considers target model valid</i>
date	<i>date submitted</i>
issues	<i>short description of issues</i>

2.2 Surface model tm4

2.2.1 Motivation

Previous findings indicated that the exchange of surface models – geometrically bounded as well as topologically bounded – may need some enhancement. Possibly side effects with newly implemented functionality caused a regression in surface model exchange capability. To study this phenomena the capability tested with the model is limited to surface model exchange written as geometrically and as well as topologically bounded. The variants are called tm4_top for the model with topology and tm4_geo as the geometrically bounded variant.

2.2.2 Approach

No new capability involved.

2.2.3 Testing Instructions

2.2.3.1 Construction of the surface test case t4

This model has already been used in the Test Rally and STEPnet test activities. The following model construction guideline corresponds to those previously given.

The model is based on the following point coordinates (referenced by letters A-Z):

Name	X-Coordinate	Y-Coordinate	Z-Coordinate
O	0	0	0
A	500	0	0
B	1000	0	-500
C	1200	0	-500

D	0	-250	0
E	500	-250	0
F	1000	-250	-500
G	1200	-250	-500
H	0	500	0
J	0	1000	-500
K	0	1200	-500
L	700	600	-231.7567
M	600	700	-231.7567
N	600	600	-141.4918
P	0	0	600
Q	771.3891	771.3891	-599.5859
R	0	200	400
S	200	0	400
T	0	0	-1138.0711
U	292.8932	292.8932	585.7865
W	1025.0183	0	-566.1647
X	1165.8529	0	-575.2555
Y	0	1025.0183	-566.1647
Z	0	1165.8529	-575.2555

All geometric elements are labelled according to the points they connect.

For example, the line OA is the line running from (0, 0, 0) to (500, 0, 0) and so forth.

Create the following nine surfaces:

- Create a surface of revolution by rotating the line OA 90 degrees around the z-axis in the direction of positive y (OAH is a quarter of a circular die).
- Create a plane with equation $z = 0$ and trim it to $-250 \leq y \leq 0$ and $0 \leq x \leq 500$.
- BAEF: Create a surface of linear extrusion by extruding the quarter-of-a-circle with center at (500, 0, -500) lying on the plane $y = 0$ that connects A and B by -250 in the y-direction (BAEF is part of a cylinder)
- BCGF: Create a cylindrical surface with a radius of 100 from the line (1100, 0, -500) to (1100, -250, -500). Trim the cylinder by $-250 \leq y \leq 0$ and $z \leq -500$.
- BAHJ: Create, as auxiliary element, a toroidal surface whose major radius is 500 and lies in the plane $z = -500$ and whose minor radius is 250. Create BAHJ as offset surface from the auxiliary element with an offset of 250 (away from the major circle). Trim BAHJ by $x \geq 500$, $y \geq 500$, $x*x+y*y \geq 500$ and $z \geq -500$.
- BCKJ: Create a toroidal surface whose major radius is 1100 and lies in the plane $z = -500$ and whose minor radius is 100. Trim the torus by $x \geq 0$, $y \geq 0$, and $z \leq -500$.
- ASRH: Create a conical surface by sweeping the line AS around the z-axis. Trim the conus by $0 \leq x \leq 500$, $0 \leq y \leq 500$, and $0 \leq z \leq 400$.

- TAUH: Span a surface between the lines TA and UH. TAUH can be realized as a b-spline surface of degree 1 x 1.
- SRP: Create a sphere with center point (0, 0, 400) and radius 200. Trim the sphere by $x \geq 0$, $y \geq 0$, and $z \geq 400$.

Using these surfaces, the following faces are now to be created:

- BAHJF: A face defined on the surface BAHJ having three holes which are obtained as follows:
 - Create the cylinder parallel to the z-axis, running through the point (700, 300, 0), having a radius of 100. Its intersection with BAHJ defines the first hole (Note: This cylinder should be deleted after creation of the hole, as it is an auxiliary element).
 - Create the cylinder parallel to the z-axis, running through the point (300, 700, 0), having a radius of 100. Its intersection with BAHJ defines the second hole (Note: This cylinder should be deleted after creation of the hole, as it is an auxiliary element).
 - Create the intersection curves of the three planes $x + y = 1300$, $x = 600$ and $y = 600$ with BAHJ. These three intersection curves define a triangular area on BAHJ when trimmed against each other. This triangular area defines the third hole in BAHJF (Note: The planes should be deleted afterwards as well).
- BCKJF1-BCKJF4 : Create, as auxiliary elements, two circles. The first is defined as running through W, Q, and Z, the second runs through X, Q, and Y. These circles will be used to partition BCKJ into four faces. If the SUT requires a trimming curve to lie on the basis surface with high precision, choose one of the following methods of projection (listed in order of decreasing accuracy):
 - Project circles onto BCKJ using minimal distances
 - Project circles onto BCKJ in the direction orthogonal to the plane defined by W, Q, Z
 - Project circles onto BCKJ in z-direction
- Now, using these circles, define four faces on BCKJ as follows:
 - BCKJF1: With vertices B, J, Y, Q, and W
 - BCKJF2: With vertices W, Q, and X
 - BCKJF3: With vertices C, X, Q, Z, and K
 - BCKJF4: With vertices Y, Q, and Z
- ASRHF1 and ASRHF2: The intersection curve between TAUH and ASRH partitions ASRH into two parts (Note: This intersection curve is a hyperbola; it may also be obtained by intersecting ASRH with the plane $x + y = 500$). Define the following faces using the intersection curve:
 - ASRHF1: With vertices A and H
 - ASRHF2: With vertices A, S, R, and H
- TAUHF1 and TAUHF2: Create the intersection curve between TAUH and the plane $x + y - 0.75 z - 500 = 0$ (Note: this intersection curve is a parabola). Define the following faces:
 - TAUHF1: Between parabola and hyperbola (see ASRHFx). With vertices A and H

- TAUHF2: Between hyperbola and U. With vertices A, H, and U

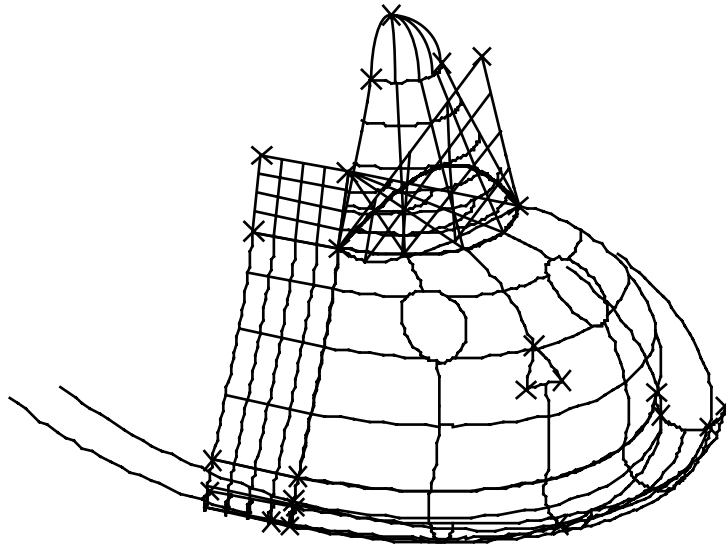


Figure: t4 model

2.2.3.2 Statistics

The model shall be pre-processed in two variants: topologically bounded (model: t4m_topo) and geometrically bounded (t4m_geo).

With each STEP file submitted for t4m_topo and t4m_geo vendors must include a text file with the stats in comma-delimited form:

model	<i>model name</i>
system_t	<i>native system code</i>
system_n	<i>target system code</i>
unit	<i>units</i>
area	<i>total surface area</i>
valid_sm	<i>pass/fail - whether target system considers target model valid</i>
valid_id	<i>pass/fail/na, element id is valid</i>
date	<i>date submitted</i>
issues	<i>short description of issues</i>

2.3 Assembly s1 "space ship"

2.3.1 Motivation

This synthetic model (a slightly abstracted version of an "Überraschungsei"-toy) is used to combine the testing of the capabilities solid assembly and validation properties.

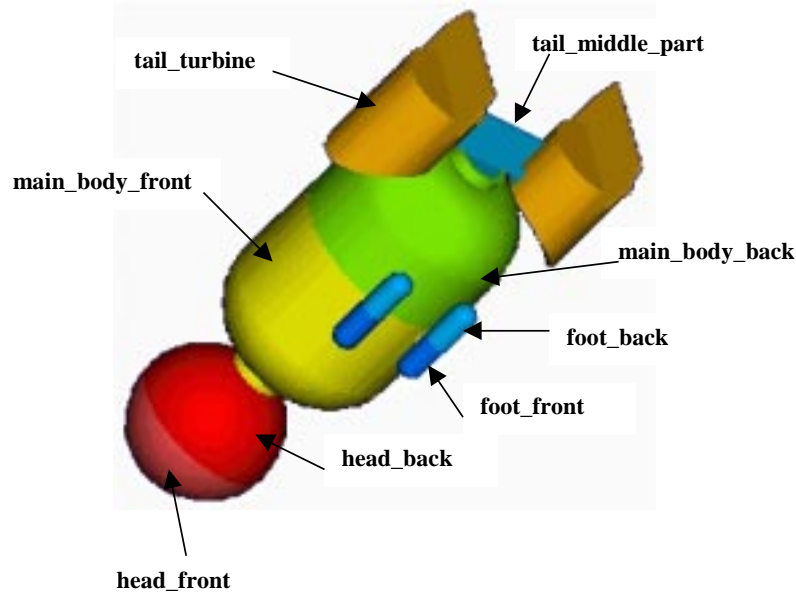


Figure: annotated shape of space ship s1.

REMARK: The annotation on the above figure is included to illustrate the part names for the description of the assembly structure. This is not a test case to exchange annotation in an assembly context!

2.3.2 Approach

2.3.2.1 Validation properties

See the approach described in the CAX Implementor Forum Recommended Practices for Validation Properties (see <http://www.stepnet.org/secure/r13.html> or <ftp://ftp.prostep.de/pub/CAX-if/rec-prac/>).

2.3.3 Testing instructions

2.3.3.1 Construction of s1 "spaceship"

Shape

see figures given in the annex

Assembly structure

The underlying assembly structure shall be (see figure above for part names):

Assembly	Component
<i>space_ship</i>	<i>mainbody</i> <i>2x foot</i> <i>tail</i>
<i>mainbody</i>	<i>mainbody_front</i> <i>mainbody_back</i>
<i>foot</i>	<i>foot_front</i> <i>foot_back</i>
<i>tail</i>	<i>2 x tail_turbine</i> <i>tail_middlepart</i>

Validation properties

The values for the overall volume of the assembly and its centroid as well as the total surface area of the main_body_front solid shall be computed and transferred via the STEP file. The statistics for target systems shall indicate whether these values match those computed in the target systems.

2.3.3.2 Statistics

With each STEP file submitted for model s1 vendors must include a text file with the stats in comma-delimited form:

model	<i>model name</i>
system_t	<i>native system code</i>
system_n	<i>target system code</i>
unit	<i>units</i>
solids	<i>number of solids</i>
volume	<i>total volume of all solids</i>
area	<i>total surface area of all solids</i>
mx my mz	<i>principle moment of inertia of all solids</i>
cx cy cz	<i>centroid of all solids</i>
valid_sm	<i>pass/fail – whether target system considers target model valid</i>
valid_ass_vol	<i>pass/fail, does the volume measure transferred in the STEP file correspond to the computed overall assembly volume in the target system?</i>
valid_area	<i>pass/fail, , does the area measure transferred in the STEP file correspond to the computed surface area of the main_body_front solid?</i>
valid_cent	<i>pass/fail, do cx, cy, cz transferred in the STEP file correspond to the computed centroid of the assembly in the target system?</i>
assem_struct	<i>does the received product structure reflect the described assembly structure?</i>
date	<i>date submitted</i>
issues	<i>short description of issues</i>

2.4 Model io1, Colours/Layers Interoperability test

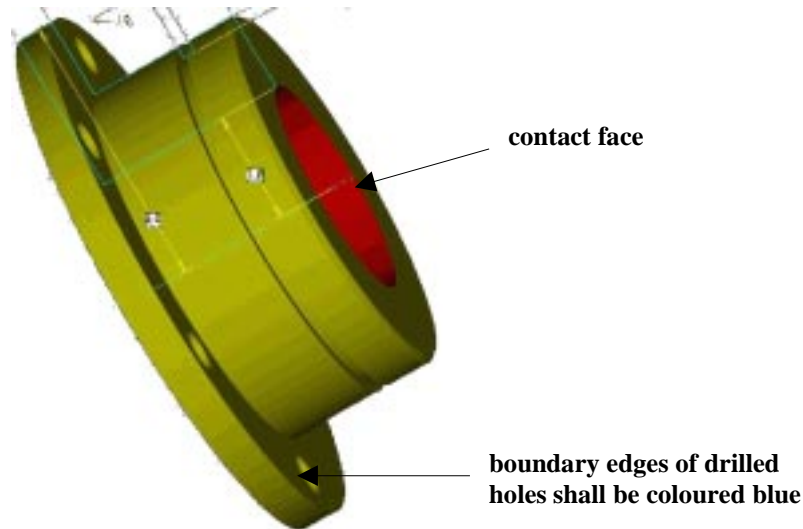


Figure: io1 test case

REMARK: the annotation is part of test case. The overriding colour for the edge on the hole boundaries is not shown here.

2.4.1 Motivation

The objective of this test case is to verify the direct interoperability between 214 and 203 with the colours/layers extension. The model is a hollow shaft with several drilled holes. In models of this type presentation color is used to identify the different contact faces.

The model is a non-assembled single solid model having a colour assigned to the solid, for the inner face of the hollow shaft an overriding face colour is specified and the edges limiting the drilled holes have another colour assigned.

This model – for the systems having implemented the annotation capability – is also used to transfer associative text. The associative text capability is fully harmonised between the AP 214 recommended practices and the corresponding AP 203 application extension and thus should also be interoperable.

2.4.2 Approach

2.4.2.1 Presentation colors

As defined in AP214 and the colours and layers extension to AP203.

2.4.2.2 Annotation

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

- unstyled text in the model

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

The support for this functionality inside the systems is strongly varying. 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 system that cannot exactly represent such a scenario are encouraged to use closes-fits, e.g. neglect the associativity when necessary.

The recommended practices for associative text are available at <http://www.stepnet.org/secure/r13.html> or via ftp://ftp.prostep.de/pub/CAx-if/rec-prac/

2.4.3 Testing Instructions

For purpose of testing schema interoperability the model shall be pre-processed depending on the individual vendor's choice either as a 214-based or a 203-based file. For post-processing every processor should take these files 'as is', i.e. without any editing and try to read them in.

2.4.3.1 Construction of io1

Shape

Construct the flange as one solid. For dimensions see figures in the annex.

Presentation

The following colours should be chosen:

- solid colour: yellow
- overriding colour for contact face: red
- overriding colour for profile boundaries: blue

Annotation

Due to the – as above discussed – big variation in annotation related capability of the systems only basic regulations are defined:

- style the two texts with an arbitrary colour
- associate the text "contact ..." to the inner face of the shaft
- associate the text "boundary edges ..." to the edge of an/the drilled hole profile
- define the text "boundary edges ..." as a multi-line text
- select an arbitrary placement of the text

As outlined above, systems not allowing one or the other of the above should try to find the closest work-around (e.g. associate to geomtry instead topology, omit associaty ...)

2.4.3.2 Statistics

With each STEP file submitted for io1 vendors must include a text file with the stats in comma-delimited form:

model	<i>model name</i>
system_t	<i>native system code</i>
system_n	<i>target system code</i>
unit	<i>units</i>
solids	<i>number of solids</i>
volume	<i>total volume of all solids</i>
area	<i>total surface area of all solids</i>
mx my mz	<i>principle moment of inertia of all solids</i>
cx cy cz	<i>centroid of all solids</i>
valid_sm	<i>pass/fail - whether target system considers target model valid</i>
color_t1	<i>text colour used for the annotation text "contact face"</i>
color_t2	<i>text colour used for the annotation text "boundary edges"</i>
color_sd	<i>all/partial/none - if solid colors in the model are totally correct, partially correct, or lost completely. Note: na indicates vendor is not testing solid color</i>
color_f	<i>all/partial/none - if overriding face color in the model is totally correct, partially correct, or lost completely. Note: na indicates vendor is not testing overriding face color</i>
color_e	<i>all/partial/none - if overriding edge color in the model is totally correct, partially correct, or lost completely. Note: na indicates vendor is not testing overriding edge color</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>

3 Production models

TO BE SPECIFIED LATER

Annex

Dimensions for s1 (space ship) shape

The following figures show the dimensions of the space ship design. Measures are given in centimetre.

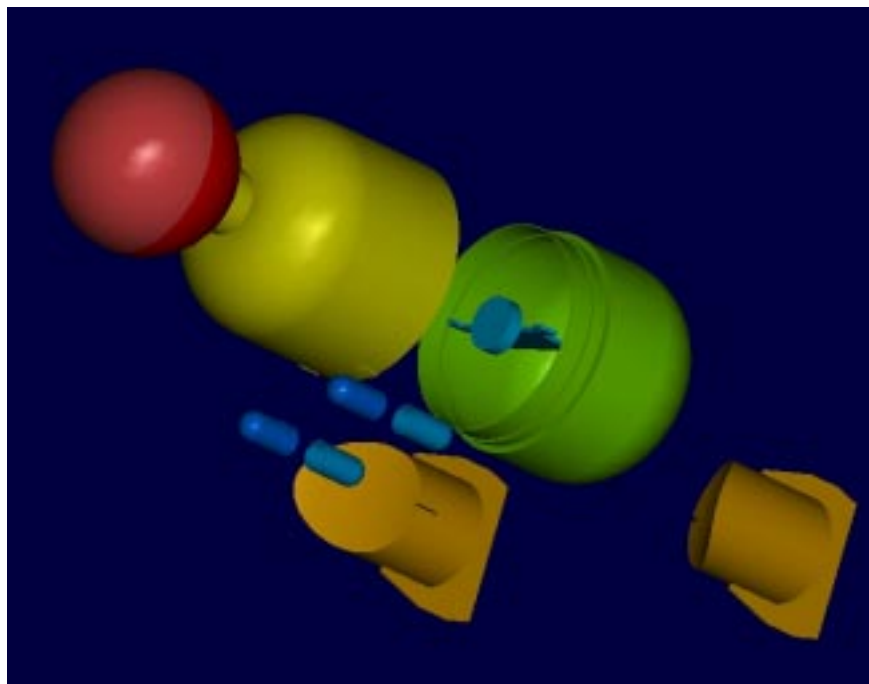


Figure: s1 - overview of parts of s1

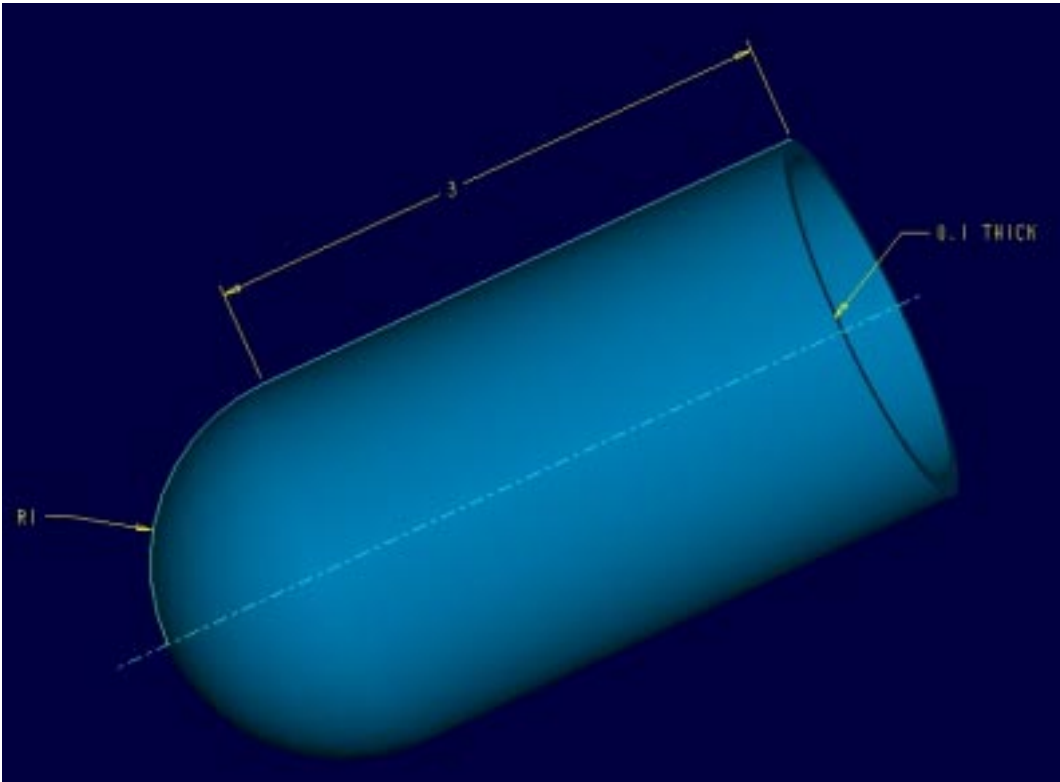


Figure: s1 - foot back

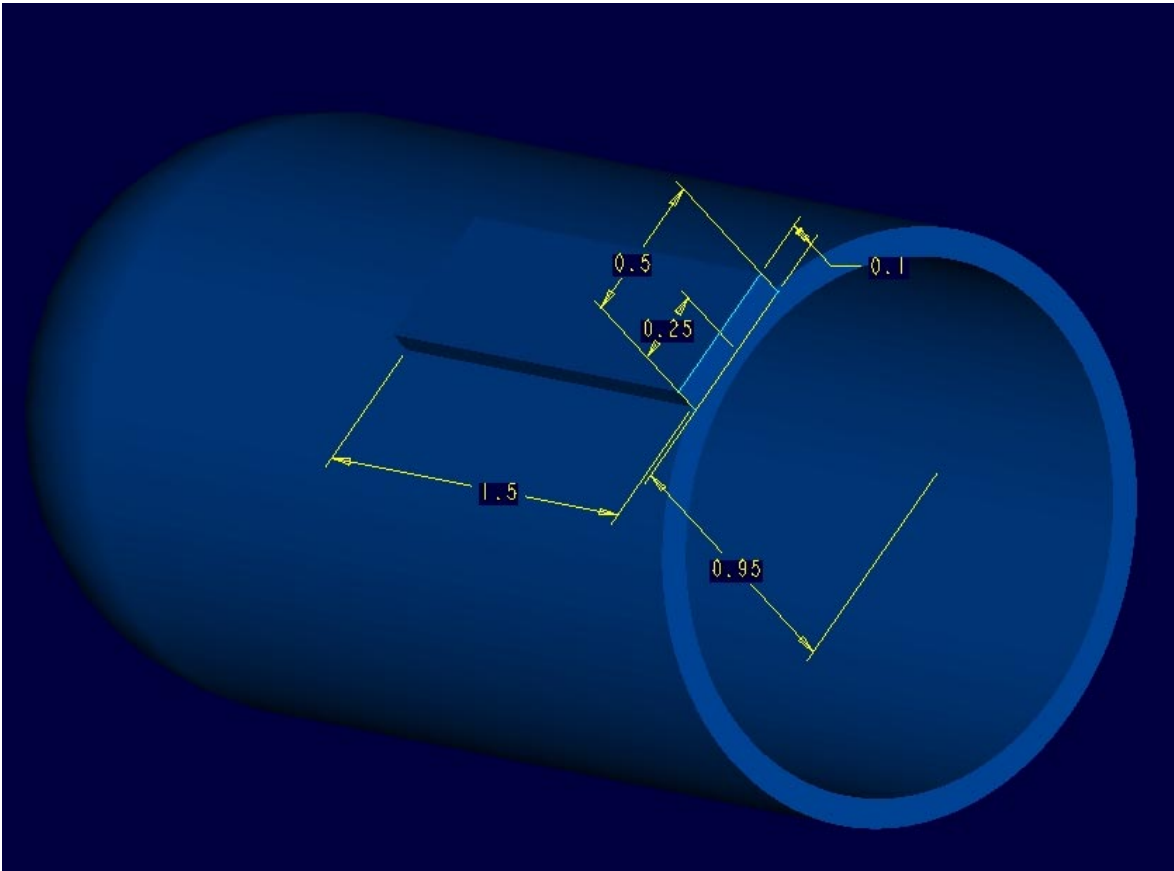


Figure: s1 - foot_front

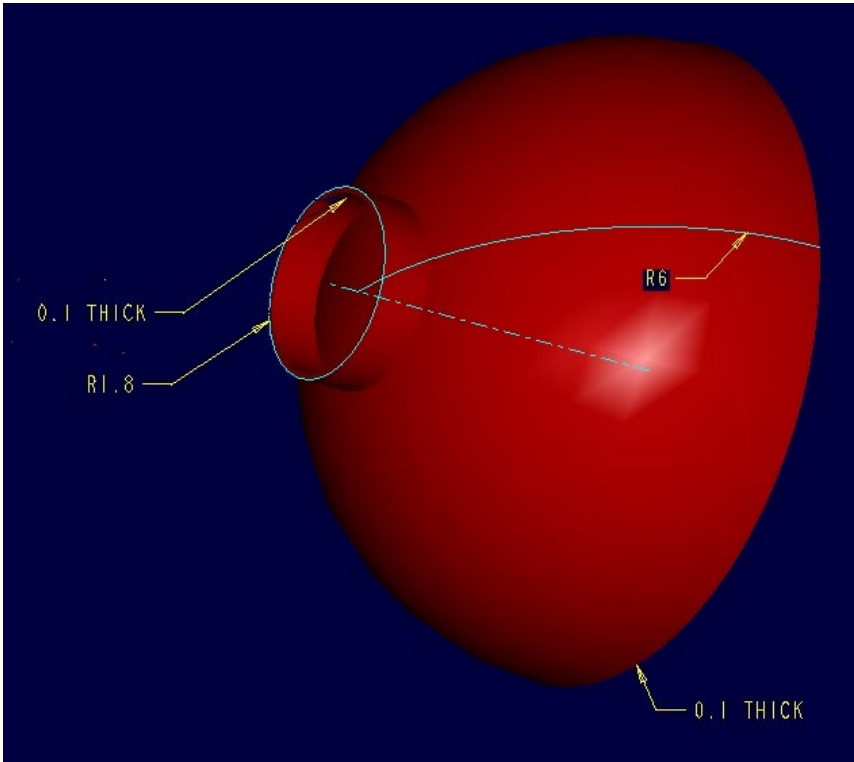


Figure: s1 - head_back

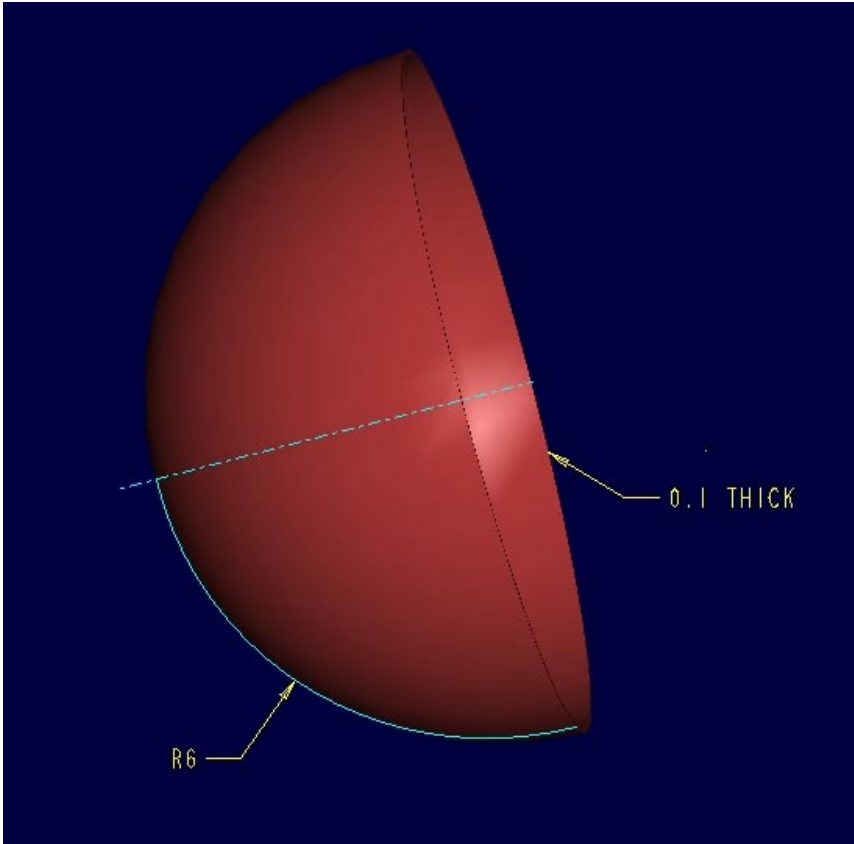


Figure: s1 - head_front

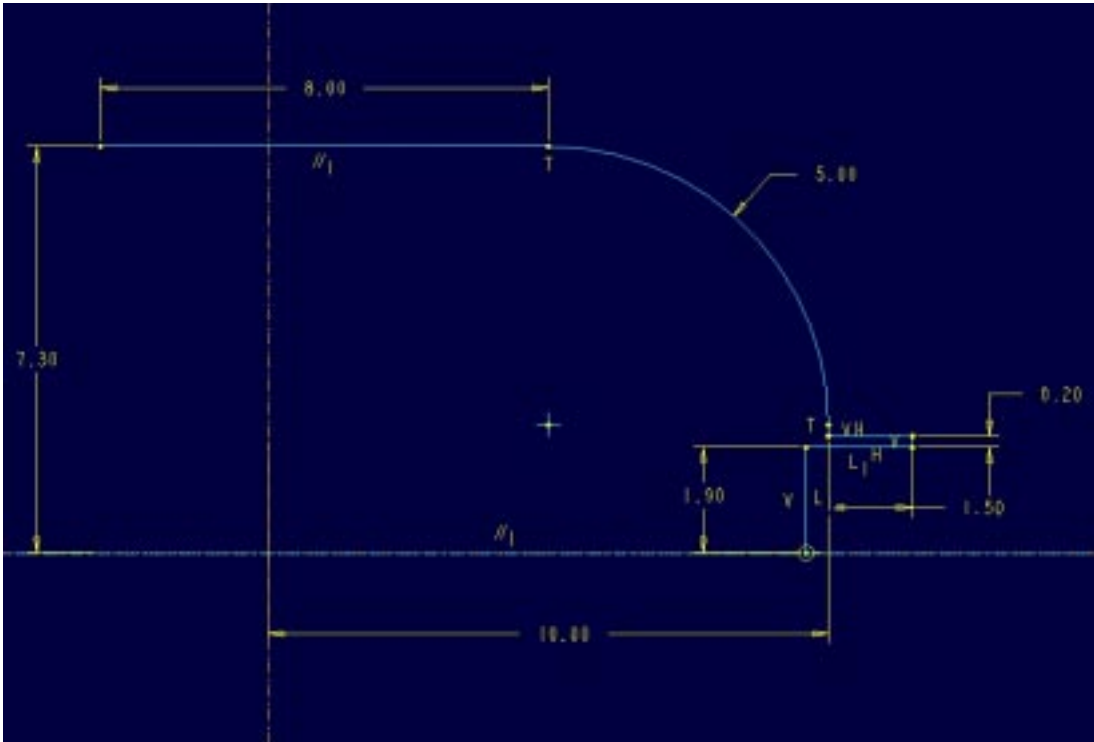


Figure: s1 - main_body_back

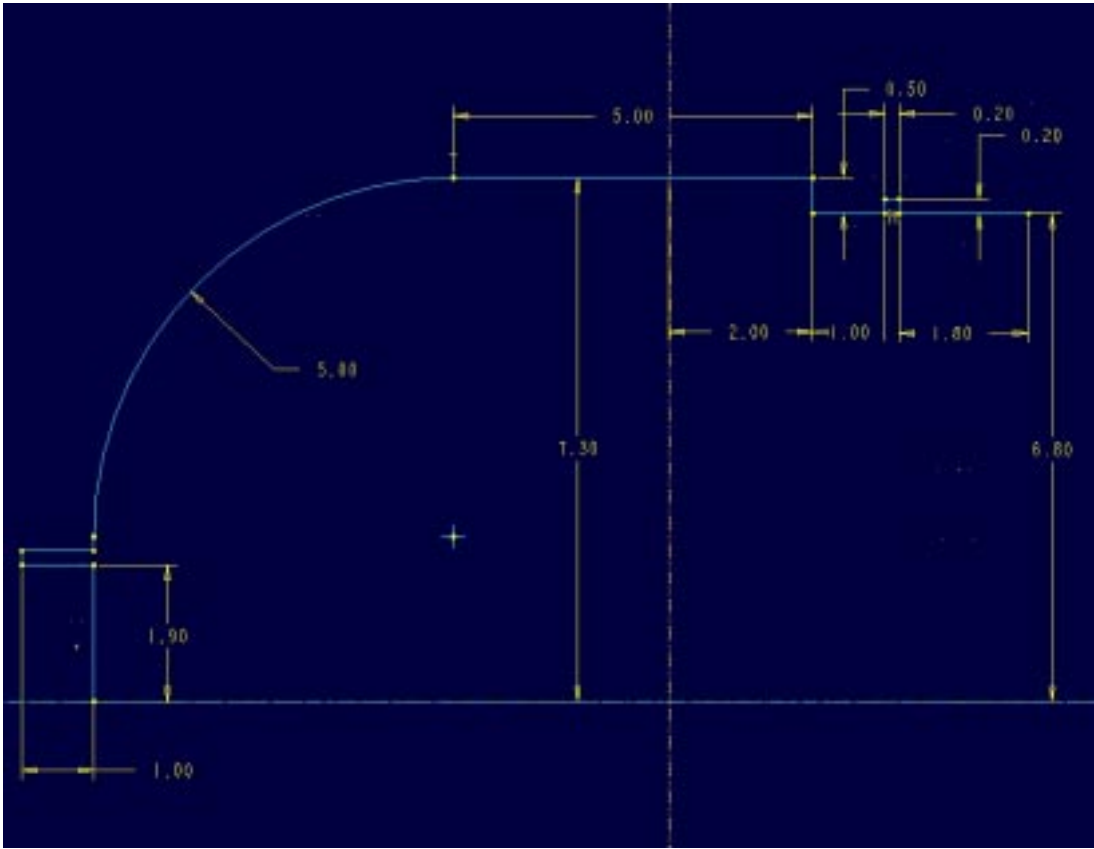


Figure: s1 - main_body_front

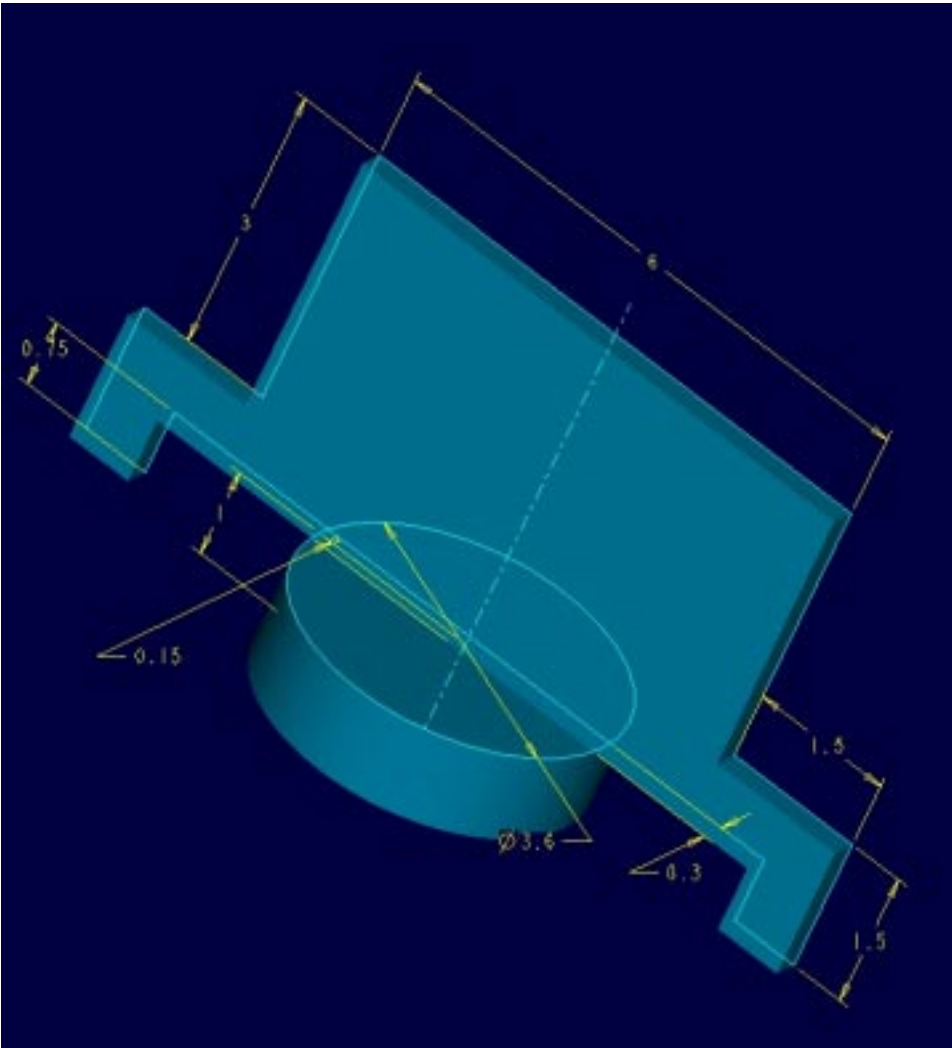


Figure: s1 - tail_middle

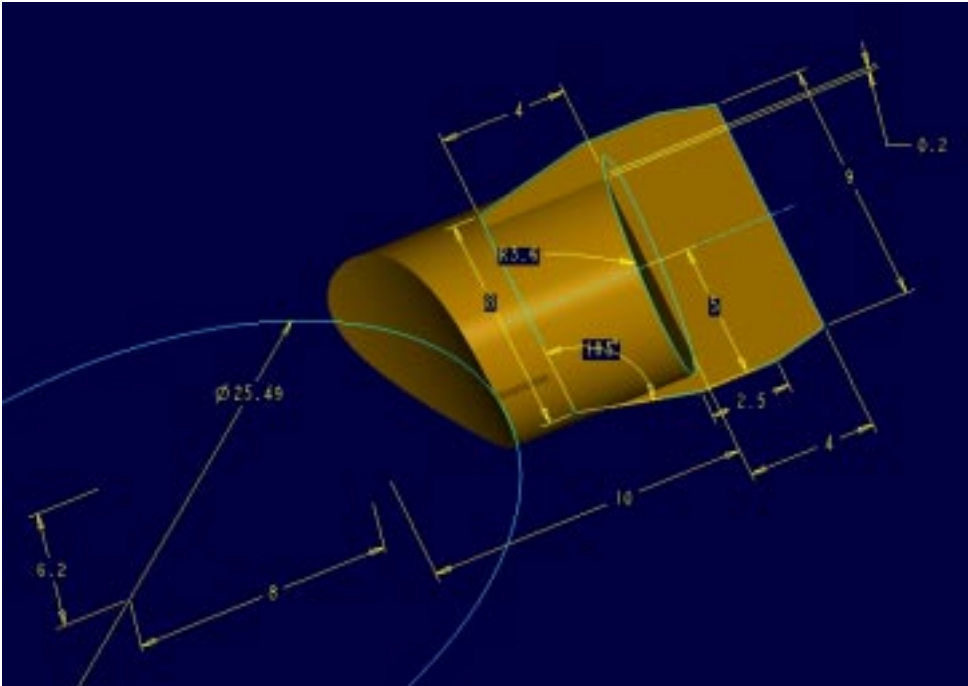


Figure: s1 - tail_turbine

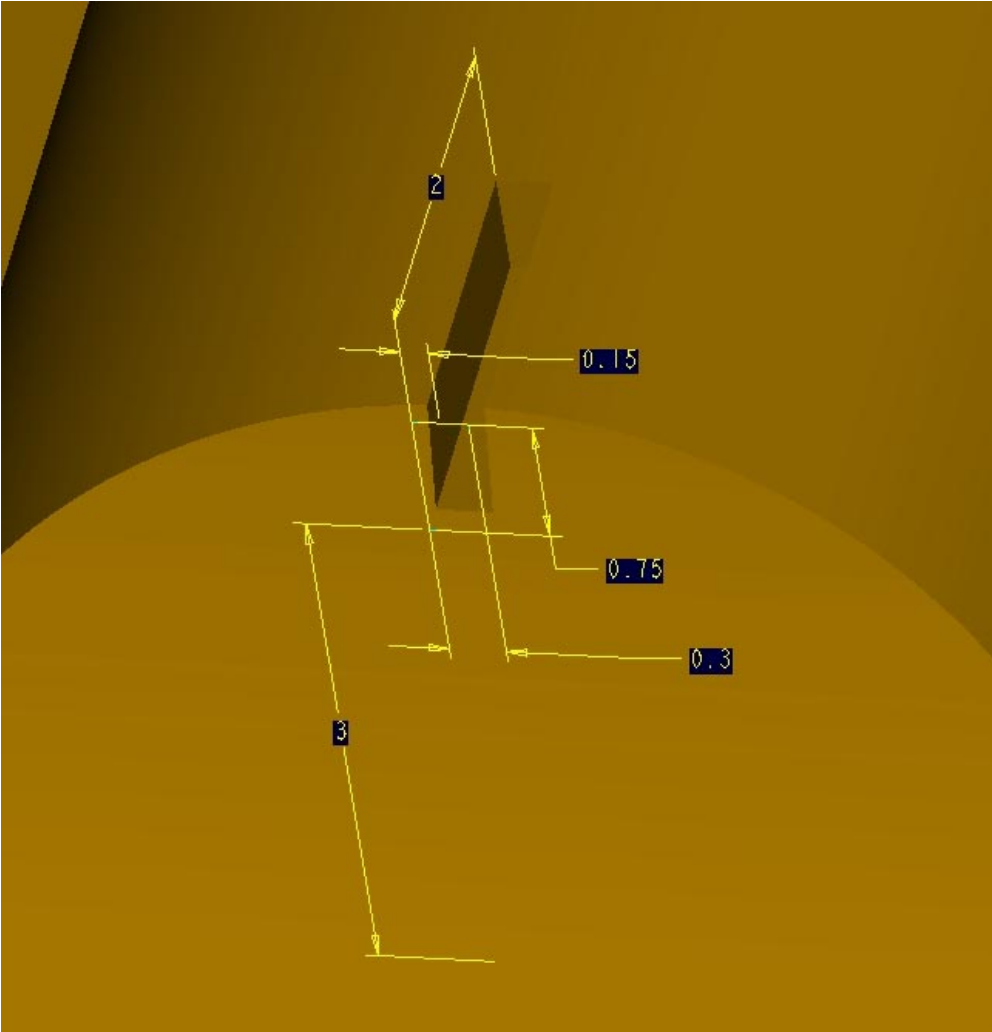


Figure: s1- detail nut of tail_turbine

Dimensions for io1 (flange) shape

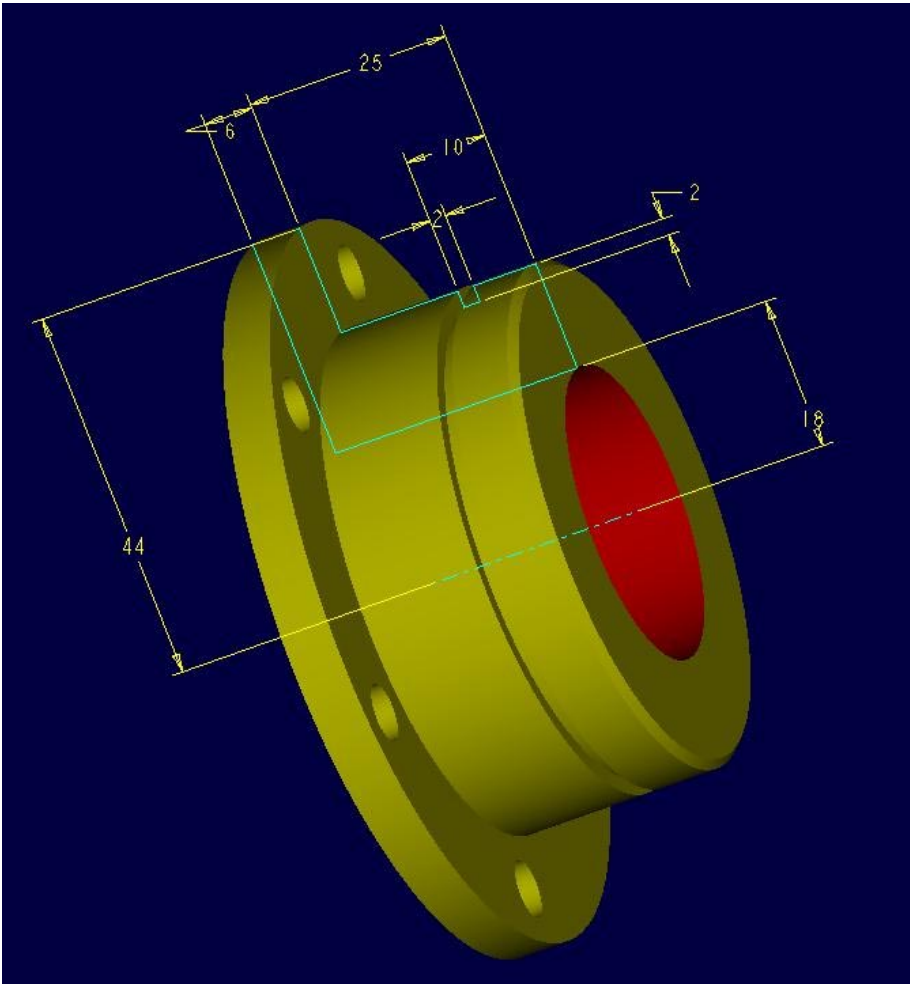


Figure: io1 shape

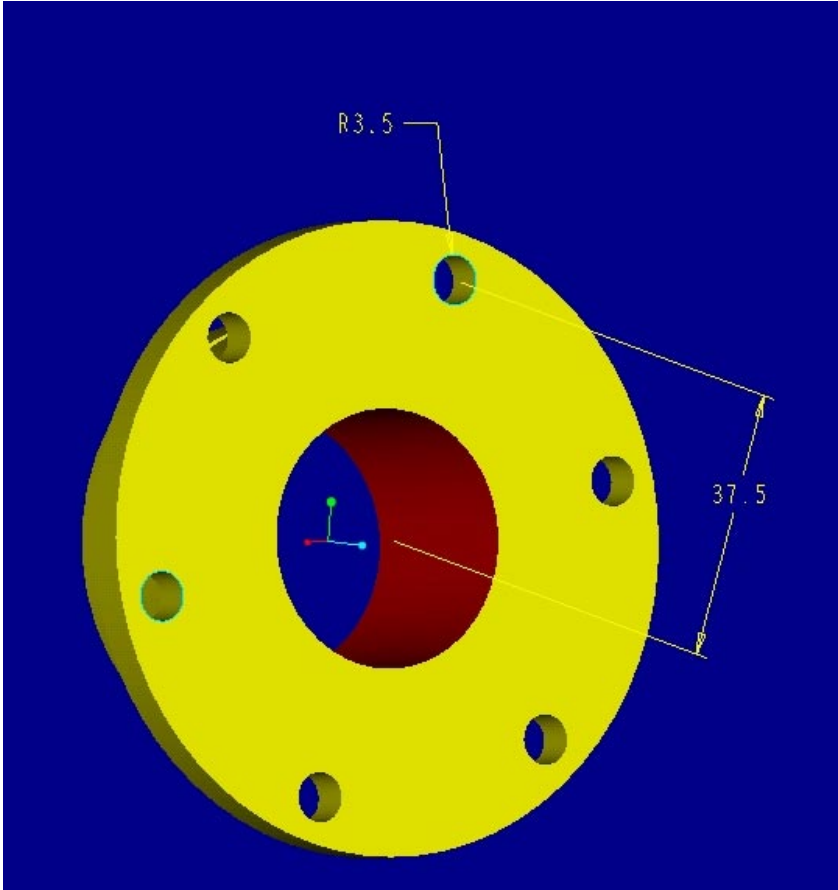


Figure: io1 – profile