ITI TranscenData

YOUR CENTRAL SOURCE FOR DATA EXCHANGE

# NIST MBE PMI Validation & Conformance Testing
# FTC Model Verification Results
# June 2015

Doug Cheney
CAD Validation Specialist
ITI TranscenData
Doug.Cheney@TranscenData.com

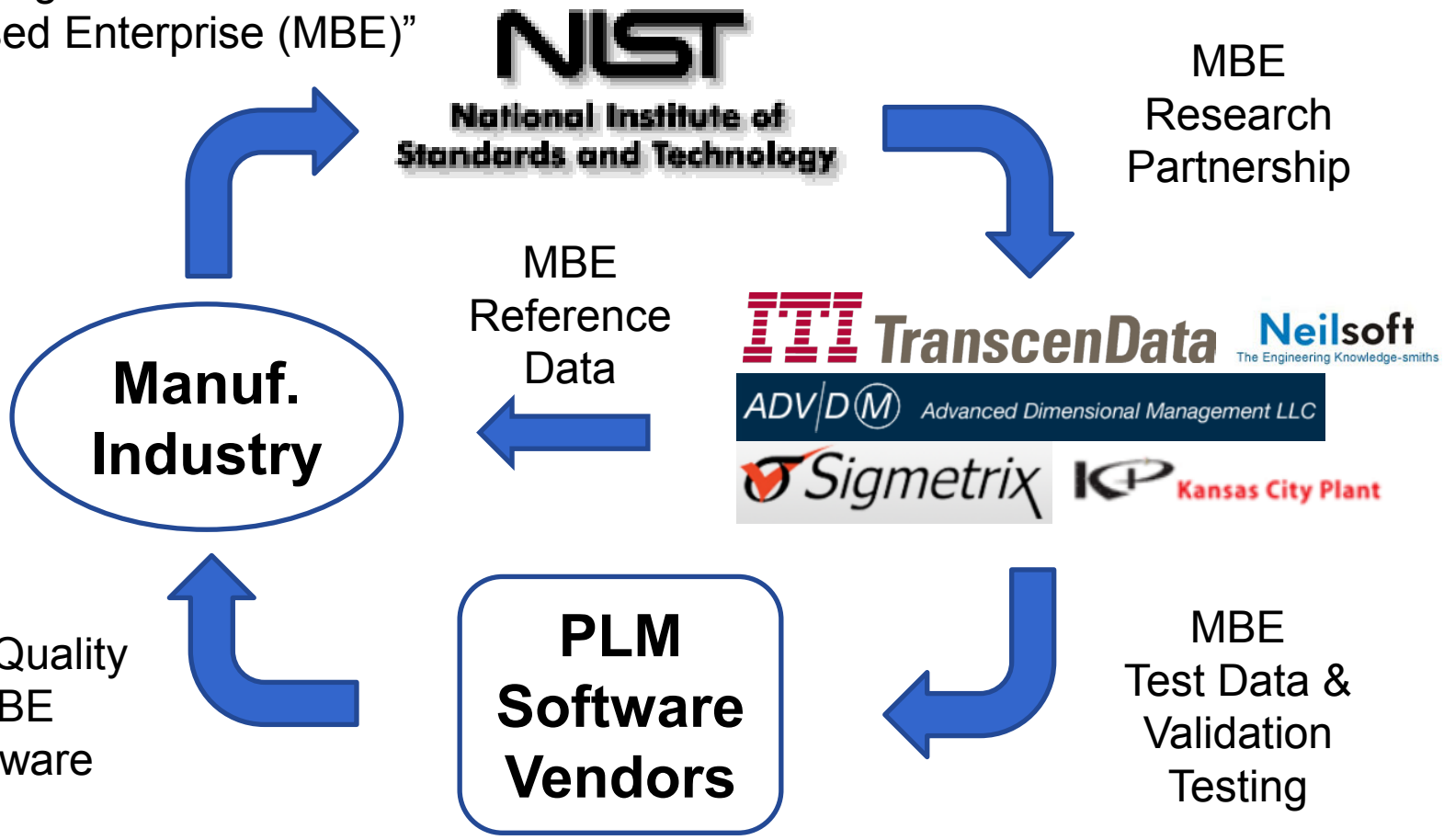
FOCUS INNOVATION CHALLENGE SOLUTION PARTNERSHIP INTEGRATION

www.TranscenData.com

Any mention of commercial products is for information only; it does not imply recommendation or endorsement by NIST.

# NIST is Supporting the Discrete Part Manufacturing Industry for Long-term Growth

"Our strategic direction is the Model-Based Enterprise (MBE)"



# NIST MBE PMI Validation and Conformance Testing Program Objectives

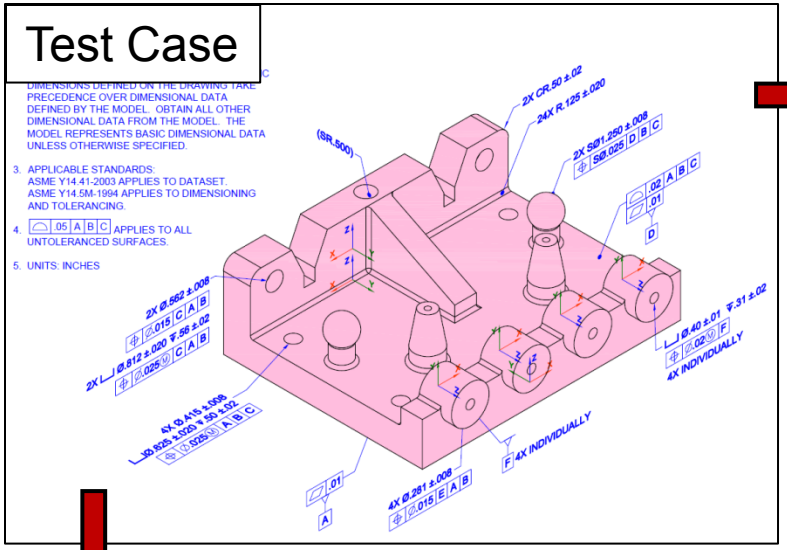
Develop **test cases**, **test models** and software **algorithms** sufficient to ***measure conformance*** of CAD systems to American Society of Mechanical Engineers (ASME) **standards** for Product and Manufacturing Information (PMI).

| | |
|---|---|
| ASME Y14.5 | Dimensioning and Tolerancing |
| ASME Y14.41 | Digital Product Data Definition Practices |

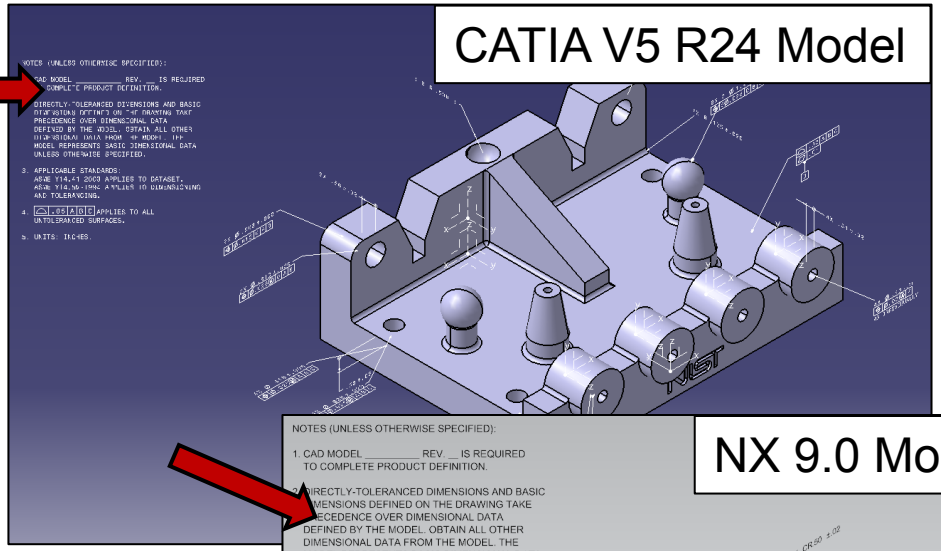
**Web site: http://go.usa.gov/mGVm**

# Example Fully-toleranced Test Case (FTC) and Test Models

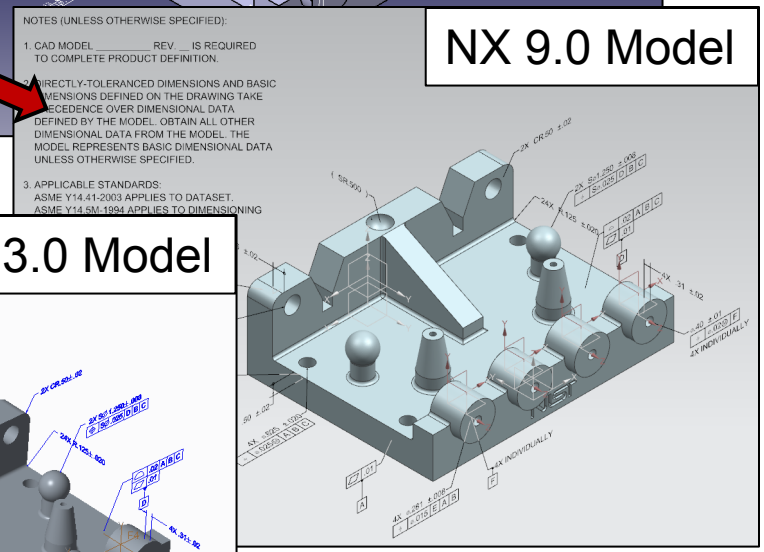
Test Case



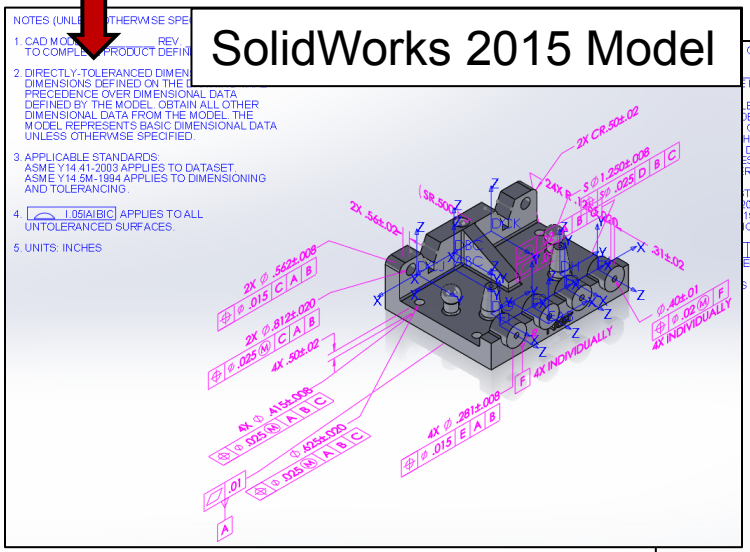
CATIA V5 R24 Model



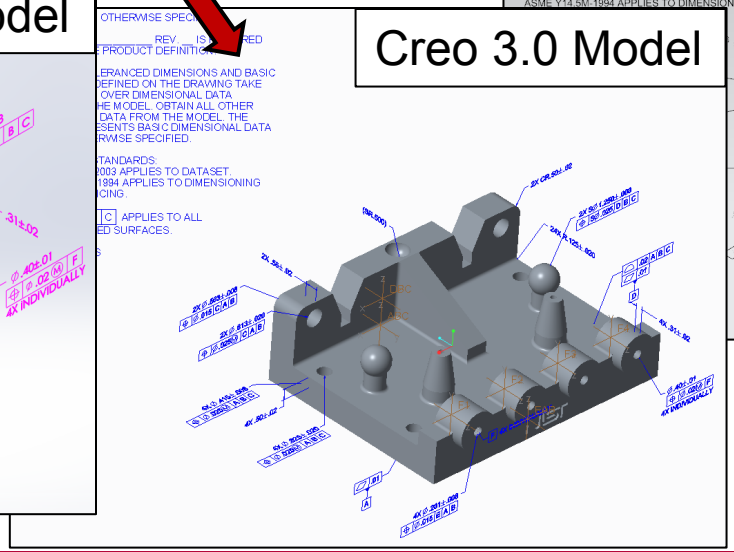
NX 9.0 Model



SolidWorks 2015 Model



Creo 3.0 Model



# Conformance Testing Terminology

PMI element: An annotation, coordinate system, supplemental geometry entity, or saved view

Presentation: What the human user sees (Visual consumption)

Representation: What the downstream software receives (Automated consumption)

Verification: How well each PMI element is modeled (CAD system capability)

Validation: How well each PMI element is translated (Translator capability)

# Fully-toleranced vs. Combined Test Cases

- Combined Test Case (CTC)
  - Combination of representative PMI constructs
  - Not intended to be realistic
- Fully-toleranced Test Case (FTC)
  - All geometric features are fully-toleranced in the context of the GD&T
  - Each tolerancing feature is adequately controlled and constrained by tolerances that comply with the applicable dimensioning, tolerancing, and modeling standards
  - Includes as many annotation types and constructs as needed to fully control and constrain each geometric feature relative to one or more datum reference frames
  - Accounts for the constraint requirements on the form, size, orientation, and location of features and hierarchical interrelationships between their tolerance zones and datum reference frames
  - Not intended to be functional

# Verification Testing Methodology

- The representation and presentation of each PMI element is compared to the test case specification
- Any differences, which cannot be resolved with an alternate modeling technique, are categorized as a:
  - Representation Limitation
  - Presentation Limitation
  - Style Difference (representation and presentation are correct but different between systems)
- Each limitation/difference is grouped by characteristic and type
- An example of each characteristic-type combination is documented in this presentation
- The following slide indexes (underlined) these examples

# Verification Characteristics (and index to examples)

Representation Limitation
- Annotation structure
- Annotation parameters
- Annotation geometry
- Coordinate system structure
- Coordinate system parameters
- Supplemental geometry structure
- Supplemental geometry parameters

Style Difference
- Annotation structure
- Annotation geometry
- Supplemental geometry structure
- Product geometry parameters

*If a characteristic is not underlined, no limitations were found in this dataset.*

Presentation Limitation
- Annotation visibility
- Annotation color
- Annotation name
- Annotation layout
- Annotation location
- Annotation orientation
- Annotation lines
- Annotation text
- Coordinate system visibility
- Coordinate system color
- Coordinate system name
- Coordinate system text
- Supplemental geometry visibility
- Supplemental geometry color
- Saved view structure
- Saved view name
- Saved view frustum

PMI Constructs  Test Case Drawings and Models

# Verification Capability Measurement Methodology

- Each PMI element limitation/difference is counted by category, characteristic, and type
- The subtotal per characteristic is divided by the subtotal of PMI elements to which it applies
  - Multiple limitations/differences of the same characteristic for the same PMI element are only counted once
- The total per category is divided by the total PMI elements
  - Multiple limitations/differences of the same category for the same PMI element are only counted once, with representation > presentation
- The following slides show these statistics for this dataset
- The name of each CAD system is generalized according to the overall results (“CAD A” better than “CAD B”…)

# Representation Limitation Counts by Characteristic and Type (across all systems)

| Representation Limitations | 133 |
|---|---|
| **Annotation structure** | **38** |
| FCF extension lines defined as separate DIM | 18 |
| FCF missing composite layout | 4 |
| FCF not defined | 1 |
| FCF projected tolerance zone defined as separate DIM | 2 |
| FCF text defined as separate note | 12 |
| FCF text duplicated | 1 |
| **Annotation parameters** | **51** |
| Chamfer DIM width not defined | 1 |
| DIM conic surfaces defined with encoded text | 4 |
| DIM controlled radius defined with encoded text | 2 |
| DIM missing dual dimension tolerance | 1 |
| DIM not defined as reference DIM | 3 |
| DIM origin not defined | 4 |
| DIM radius defined with encoded text | 1 |
| DIM slot radius defined with encoded text | 6 |
| DIM spherical diameter defined with encoded text | 3 |
| DIM spherical radius defined with encoded text | 4 |
| DIM tapered center defined with encoded text | 4 |
| FCF between-basis defined with encoded text | 4 |
| FCF diameter symbol not specified | 6 |
| FCF dual dimension defined with encoded text | 2 |
| FCF free state defined with encoded text | 1 |
| FCF missing all-around designation | 2 |
| FCF missing tangent plane modifier | 1 |
| FCF spherical diameter defined with encoded text | 2 |

| Annotation geometry | 44 |
|---|---|
| DFS not associated with complete set of faces | 5 |
| DIM associated with incorrect face | 1 |
| DIM not associated with complete set of faces | 5 |
| DIM not associated with edge | 2 |
| DIM not associated with face | 2 |
| DTS not associated with SG curve | 6 |
| FCF associated with incorrect face | 1 |
| FCF extension line DIM not associated with correct face | 3 |
| FCF not associated with complete set of faces | 2 |
| FCF not associated with SG curve | 17 |

| Abbrev | Definition |
|---|---|
| AN | Annotation |
| CS | Coordinate system |
| DFS | Datum feature symbol |
| DIM | Dimension |
| DRF | Datum reference frame |
| DTS | Datum target symbol |
| FCF | Feature control frame |
| PG | Product geometry |
| SG | Supplemental geometry |
| VW | View |

# Style Difference Counts by Characteristic and Type (across all systems)

| Style Differences | 36 |
|---|---|
| **Annotation structure** | **12** |
| DTS requires DFS to be defined | 12 |
| **Annotation geometry** | **20** |
| DFS edge association is extraneous | 2 |
| DIM edge association is extraneous | 8 |
| FCF edge association is extraneous | 10 |
| **Supplemental geometry structure** | **4** |
| FCF limited area is non-solid surface on solid face | 3 |
| FCF limited area is subdivided solid face | 1 |

| Abbrev | Definition |
|---|---|
| AN | Annotation |
| CS | Coordinate system |
| DFS | Datum feature symbol |
| DIM | Dimension |
| DRF | Datum reference frame |
| DTS | Datum target symbol |
| FCF | Feature control frame |
| PG | Product geometry |
| SG | Supplemental geometry |
| VW | View |

# Presentation Limitation Counts by Characteristic and Type (across all systems)

| Presentation Limitations | 198 |
|---|---|
| **Annotation visibility** | **4** |
| DFS is extraneous when DTS is defined | 4 |
| **Annotation layout** | **43** |
| Counterbore DIM defined as two separate DIM's | 12 |
| Countersink DIM defined as two separate DIM's | 3 |
| DIM dual dimension bracket size very small | 1 |
| DIM dual dimension position is incorrect | 1 |
| DIM not stacked correctly | 4 |
| DIM text misaligned | 2 |
| FCF defined separate from general note text | 2 |
| FCF instance count not in front | 2 |
| FCF modifiers reversed | 1 |
| FCF stack order reversed | 2 |
| Hole DIM defined as two separate DIM's | 8 |
| Slot DIM defined as two separate DIMs | 5 |
| **Annotation location** | **19** |
| DFS not attached to FCF | 17 |
| FCF not attached to DIM | 2 |
| **Annotation orientation** | **8** |
| DIM view plane rotated | 6 |
| FCF view plane rotated | 2 |
| **Annotation lines** | **15** |
| DFS missing extension line | 5 |
| DIM leader line is extraneous | 1 |
| FCF divider line cuts through symbol | 1 |
| FCF leader line passes through FCF | 1 |
| FCF missing dual leader lines | 4 |
| FCF radial extension lines defined as SG curves | 3 |

| | |
|---|---|
| **Annotation text** | **39** |
| DFS text is extraneous | 6 |
| DIM has extraneous space | 7 |
| DIM missing pattern text | 2 |
| DIM missing zero tolerance limit negative sign | 2 |
| DIM nominal value rounded incorrectly | 4 |
| DIM pattern text is extraneous | 1 |
| DIM pattern text is incorrect | 1 |
| FCF extension line DIM text is extraneous | 6 |
| FCF missing projected tolerance zone length | 2 |
| FCF pattern text is extraneous | 7 |
| FCF pattern text is incorrect | 1 |
| **Coordinate system visibility** | **19** |
| CS visible in wrong view | 19 |
| **Supplemental geometry visibility** | **29** |
| SG curve visible in wrong view | 16 |
| SG point visible in wrong view | 13 |
| **Saved view structure** | **11** |
| View cannot contain annotations on different planes | 11 |
| **Saved view frustum** | **11** |
| View camera position not defined | 11 |

| Abbrev | Definition |
|---|---|
| AN | Annotation |
| CS | Coordinate system |
| DFS | Datum feature symbol |
| DIM | Dimension |
| DRF | Datum reference frame |
| DTS | Datum target symbol |
| FCF | Feature control frame |
| PG | Product geometry |
| SG | Supplemental geometry |
| VW | View |

# Verification Percentages by Characteristic and System

| Representation Limitations | Element Count | CAD A | CAD B | CAD C | CAD D |
|---|---|---|---|---|---|
| Annotation structure | 182 | 97% | **89%** | 97% | 99% |
| Annotation parameters | 182 | 96% | 92% | 95% | 91% |
| Annotation geometry | 182 | 97% | 95% | 100% | **86%** |
| Coordinate system parameters | 33 | 100% | 100% | 100% | 100% |
| Supplemental geometry structure | 16 | 100% | 100% | 100% | 100% |
| Supplemental geometry parameters | 16 | 100% | 100% | 100% | 100% |

| Presentation Limitations | Element Count | CAD A | CAD B | CAD C | CAD D |
|---|---|---|---|---|---|
| Annotation visibility | 182 | 100% | 100% | 100% | 98% |
| Annotation color | 182 | 100% | 100% | 100% | 100% |
| Annotation name | 182 | 100% | 100% | 100% | 100% |
| Annotation layout | 182 | 96% | 91% | 96% | 94% |
| Annotation location | 182 | 100% | 99% | 92% | 98% |
| Annotation orientation | 182 | 99% | 98% | 99% | 99% |
| Annotation lines | 182 | 99% | 97% | 98% | 97% |
| Annotation text | 182 | 96% | 91% | 99% | 92% |
| Coordinate system visibility | 33 | 100% | 100% | 100% | **42%** |
| Coordinate system color | 33 | 100% | 100% | 100% | 100% |
| Coordinate system name | 33 | 100% | 100% | 100% | 100% |
| Coordinate system text | 33 | 100% | 100% | 100% | 100% |
| Supplemental geometry visibility | 16 | 100% | 100% | 100% | **0%** |
| Supplemental geometry color | 16 | 100% | 100% | 100% | 100% |
| Saved view structure | 11 | 100% | 100% | 100% | **0%** |
| Saved view name | 11 | 100% | 100% | 100% | 100% |
| Saved view frustum | 11 | 100% | 100% | 100% | **0%** |

| PMI Element | Element Count per Test Case 6 | 8 | 9 | Total |
|---|---|---|---|---|
| Annotation | 66 | 52 | 64 | 182 |
| Coordinate System | 15 | 9 | 9 | 33 |
| Supplemental Geometry Entity | 6 | 2 | 8 | 16 |
| Saved View | 3 | 4 | 4 | 11 |
| **Total:** | 90 | 67 | 85 | **242** |

Each percentage is calculated using this ratio:

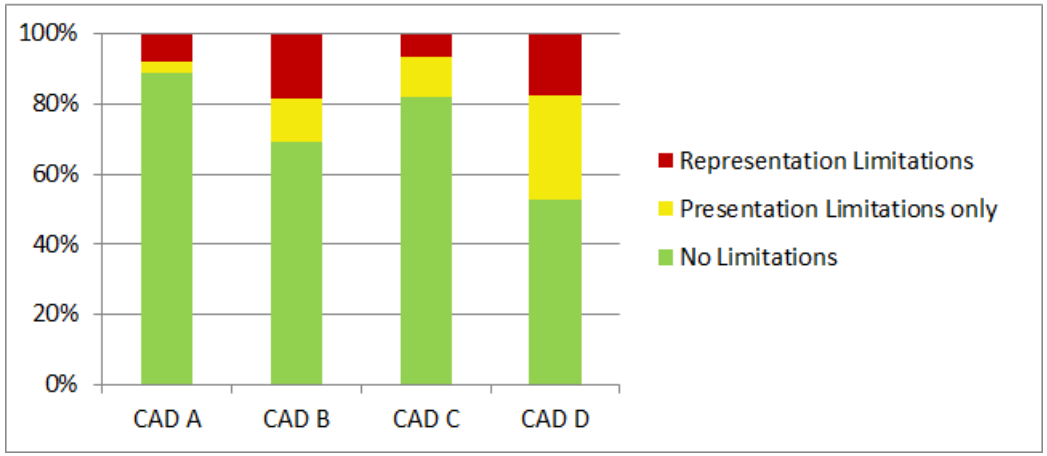
$$\frac{\text{(Element count – Limitation count)}}{\text{Element count}}$$

The limitation count excludes limitations with the same characteristic (but different types) on the same PMI element.

Percentages less than 90% are shown in **bold** font.

# Verification Percentages by System

| | CAD A | CAD B | CAD C | CAD D |
|---|---|---|---|---|
| **No Limitations** | 89% | 69% | 82% | 52% |
| **Presentation Limitations only** | 3% | 12% | 12% | 30% |
| **Representation Limitations** | 8% | 19% | 7% | 18% |
| **Representation Level** | 92% | 81% | 93% | 82% |




"No Limitations" measures the capability for both automated and visual consumption and is calculated as 100% less the other limitation percentages.

"Representation Level" measures the capability for automated consumption only and is calculated as 100% less the representation limitations percentage.

The presentation and representation limitation percentages are calculated using this ratio:

$$\frac{\text{Limitation count}}{\text{Element count}}$$

The "Presentation Limitation Only" count excludes presentation limitations that overlap with representation limitations on the same PMI element.

The "Element Count" includes all annotations, coordinate systems, supplemental geometry entities, and saved views specified in the test cases.

# Verification Summary

- The limitation characteristics and types are different for each system.
- All 4 CAD systems are able to **represent** more than 80% of the annotations, supplemental geometry entities, and saved views in this verification test.
- The systems vary significantly in their ability to visually **present** the PMI elements as specified in the test cases.
- None of the systems are able to present the complex dimensions (counterbore, countersink, hole, slot) as specified in the test case while representing the correct geometry associations for each component of the dimension.

# Verification Characteristics (and index to examples)

Representation Limitation
- Annotation structure
- Annotation parameters
- Annotation geometry
- Coordinate system structure
- Coordinate system parameters
- Supplemental geometry structure
- Supplemental geometry parameters

Style Difference
- Annotation structure
- Annotation geometry
- Supplemental geometry structure
- Product geometry parameters

*If a characteristic is not underlined, no limitations were found in this dataset.*

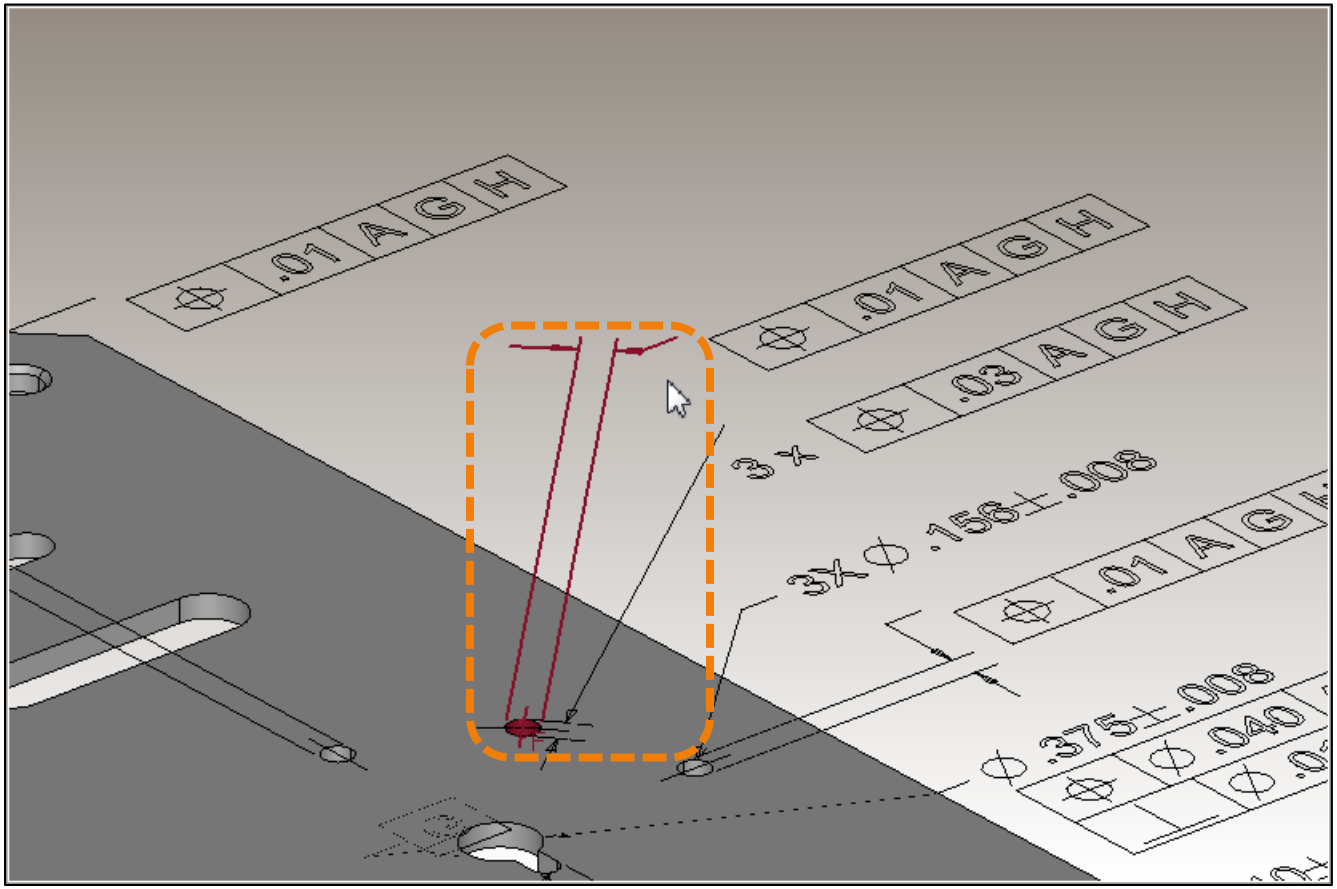
Presentation Limitation
- Annotation visibility
- Annotation color
- Annotation name
- Annotation layout
- Annotation location
- Annotation orientation
- Annotation lines
- Annotation text
- Coordinate system visibility
- Coordinate system color
- Coordinate system name
- Coordinate system text
- Supplemental geometry visibility
- Supplemental geometry color
- Saved view structure
- Saved view name
- Saved view frustum

PMI Constructs  Test Case Drawings and Models

# CAD System Representation Limitations for Annotation Structure

Return to Index

# Annotation Structure: FCF extension lines defined as separate DIM



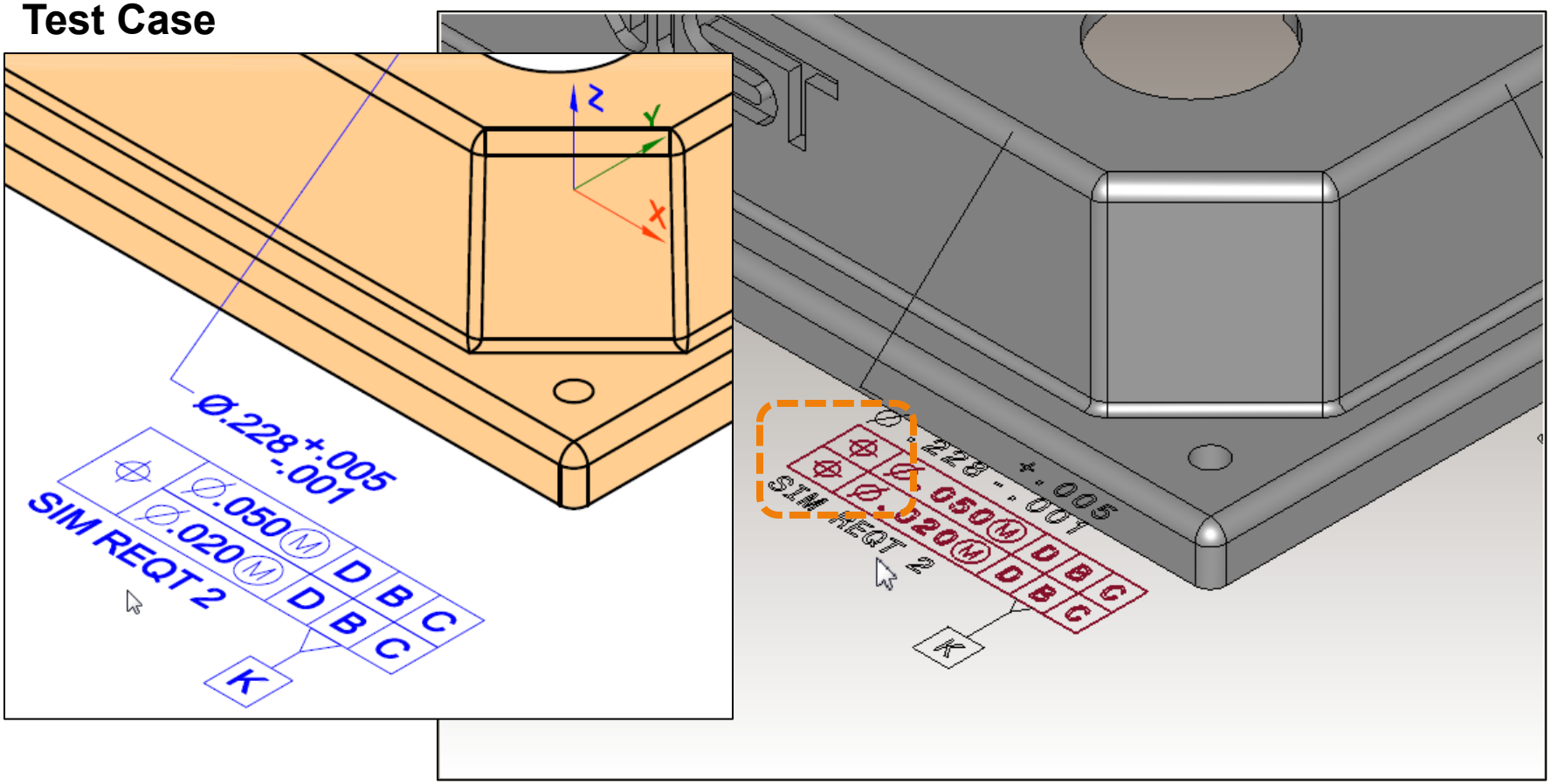

These extension lines are defined as a separate dimension that has no displayed value.

Return to Index

# Annotation Structure: FCF missing composite layout



**Test Case**



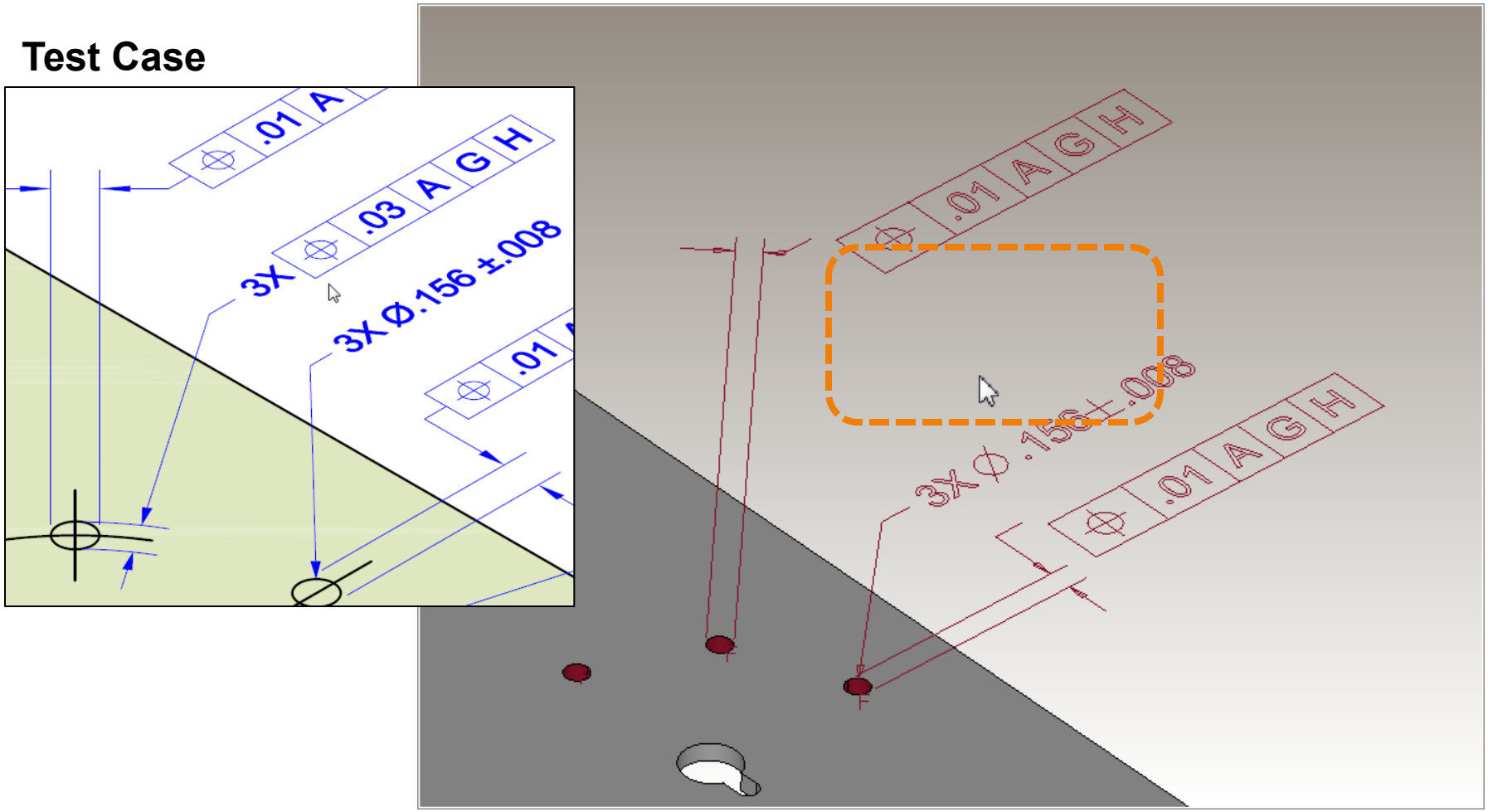

This feature control frame lacks the specified composite layout.

Return to Index

# Annotation Structure: FCF not defined



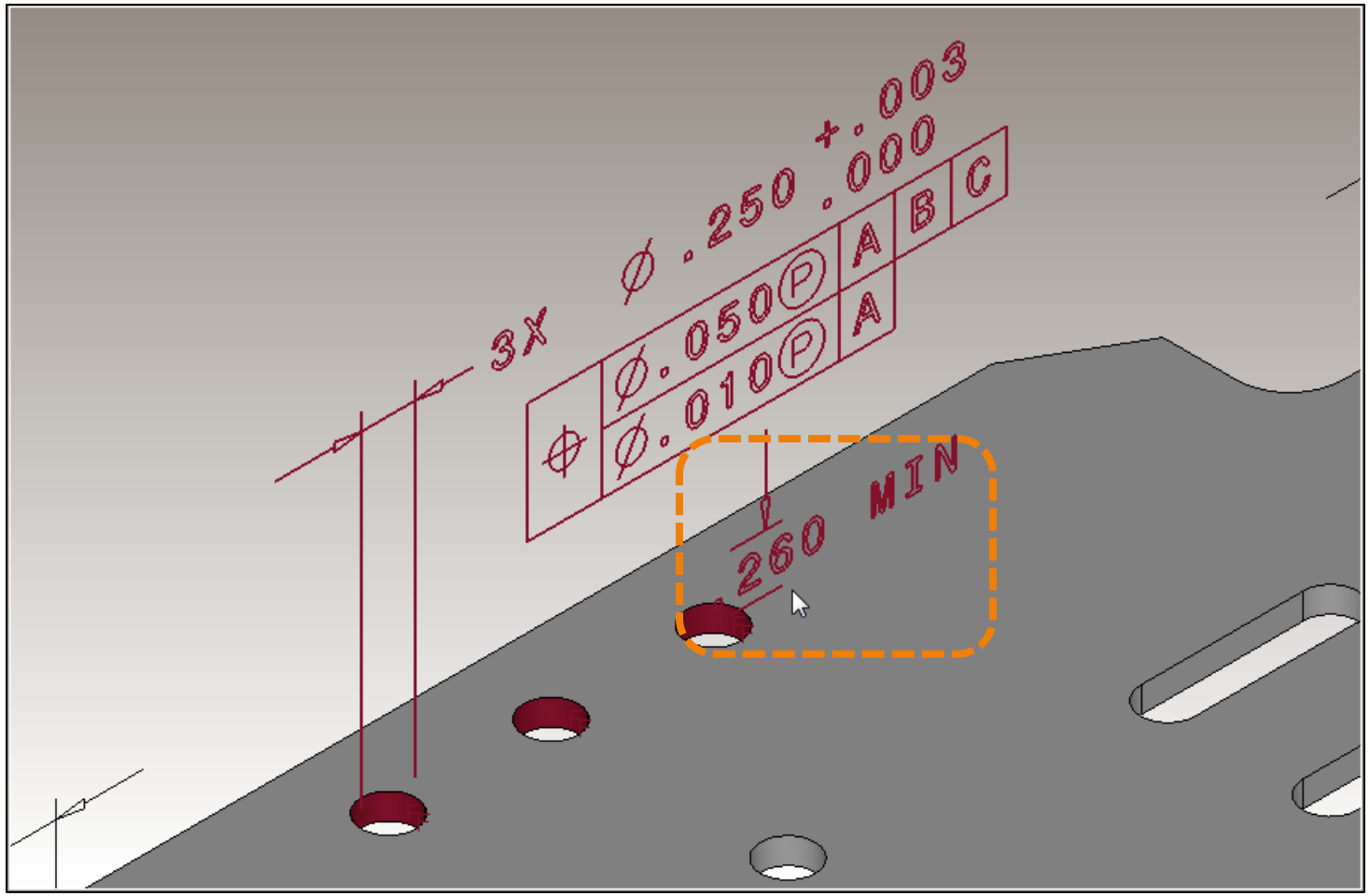
**Test Case**




This specified feature control frame is defined.

Return to Index

# Annotation Structure:
# FCF projected tolerance zone defined as separate DIM

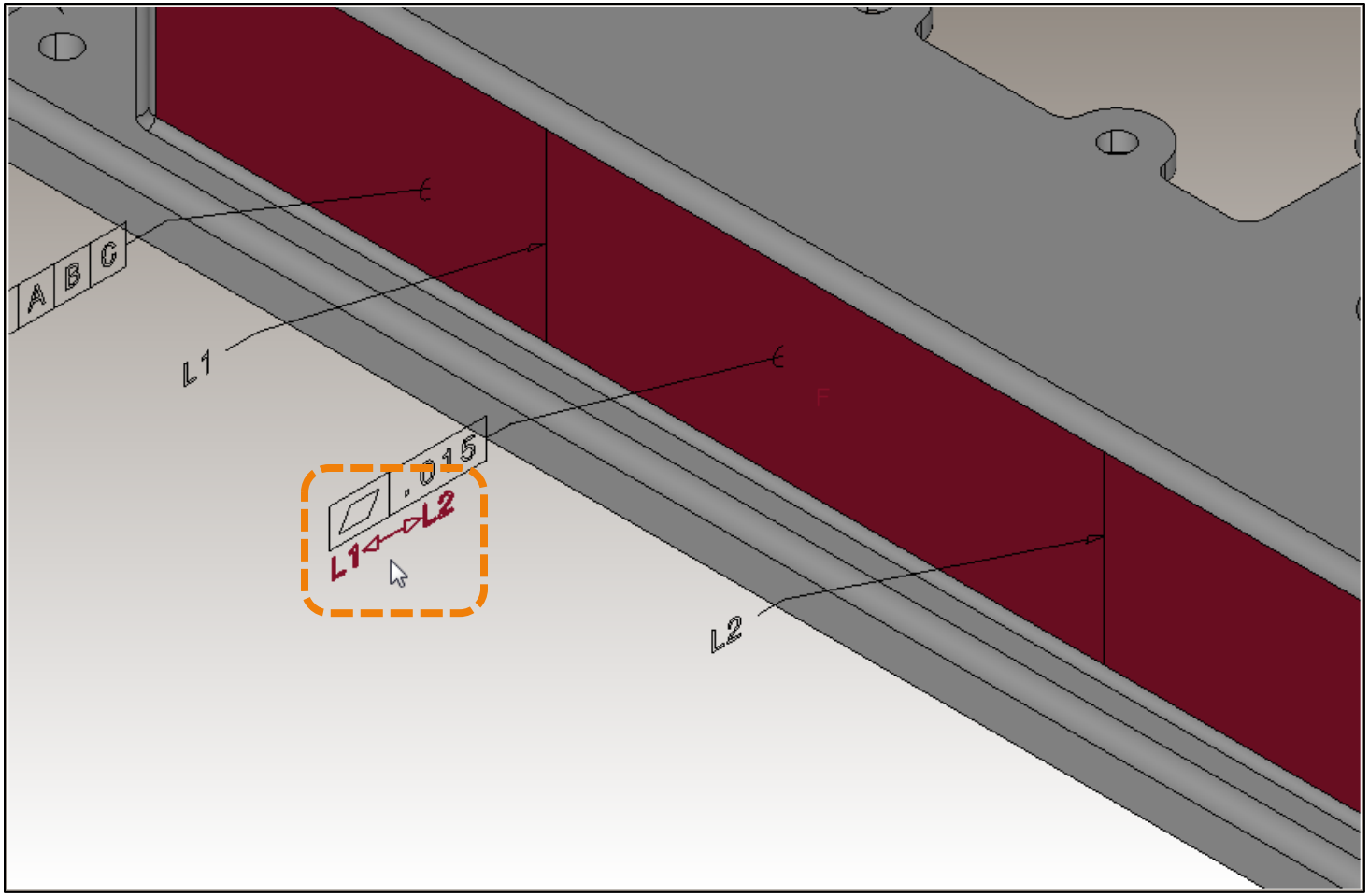



The length of the projected tolerance zone for this feature control frame is defined as a separate dimension.

Return to Index

# Annotation Structure: FCF text defined as separate note



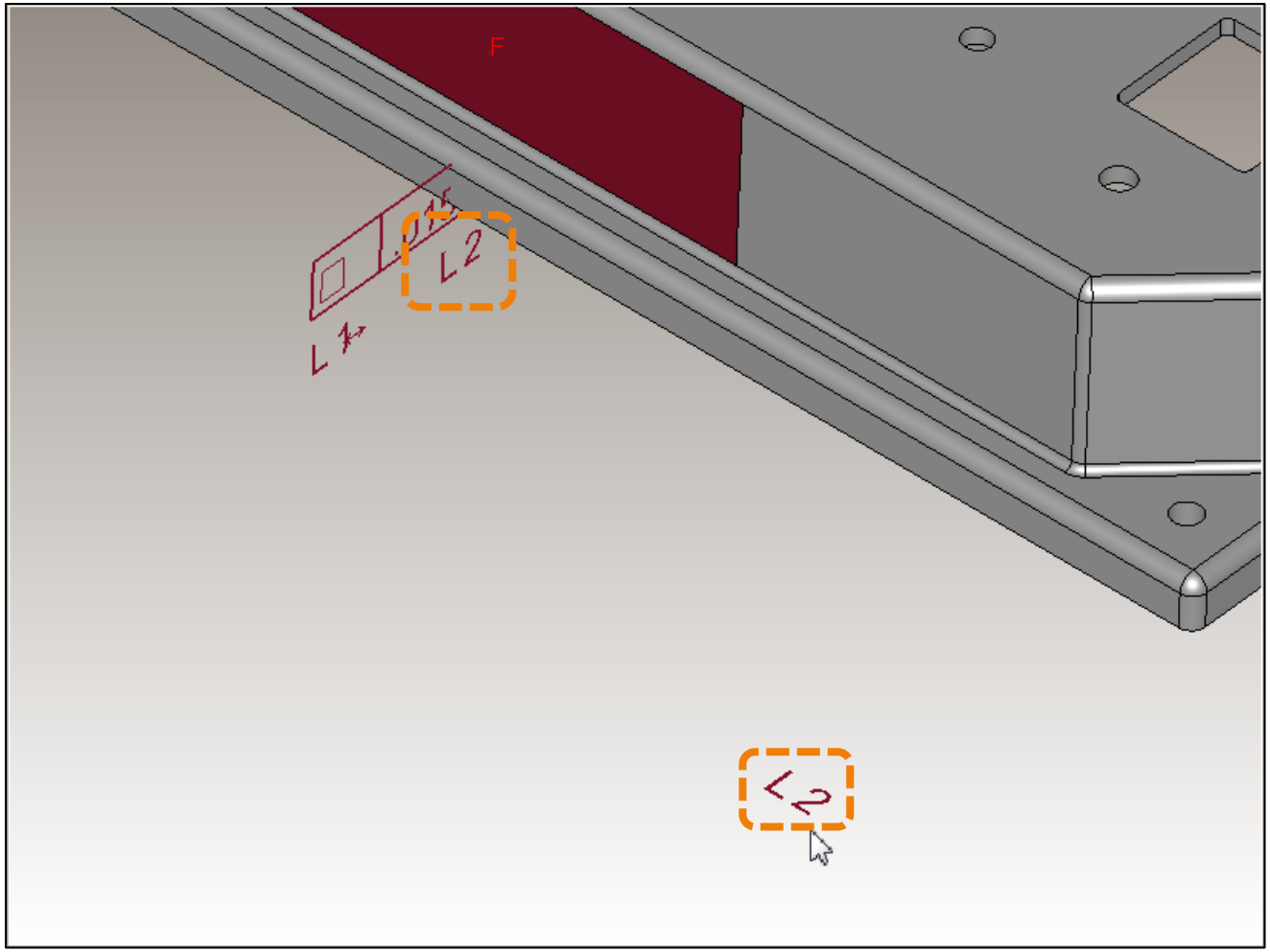



The text which defines the between-basis for this feature control frame is defined as a separate note annotation.

Return to Index

# Annotation Structure: FCF text duplicated






This annotation text is defined twice in the model.

Return to Index

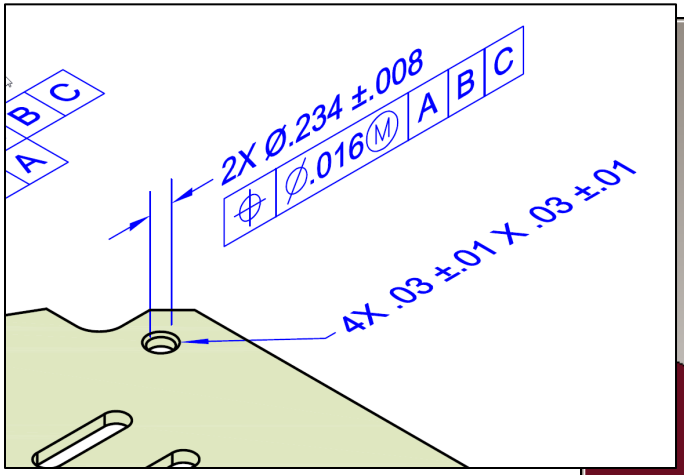
# CAD System Representation Limitations for Annotation Parameters

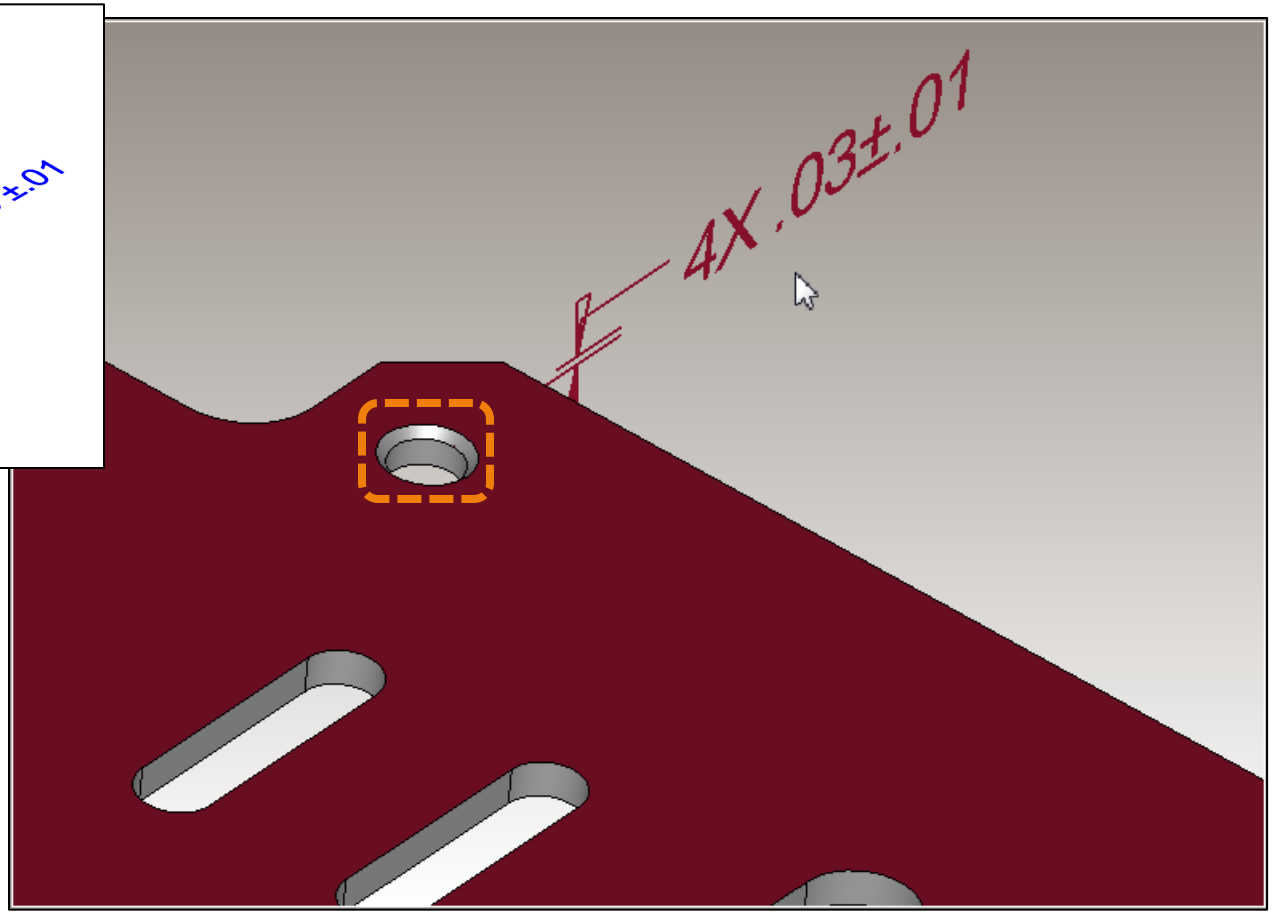
Return to Index

# Annotation Parameters: Chamfer DIM width not defined



## Test Case



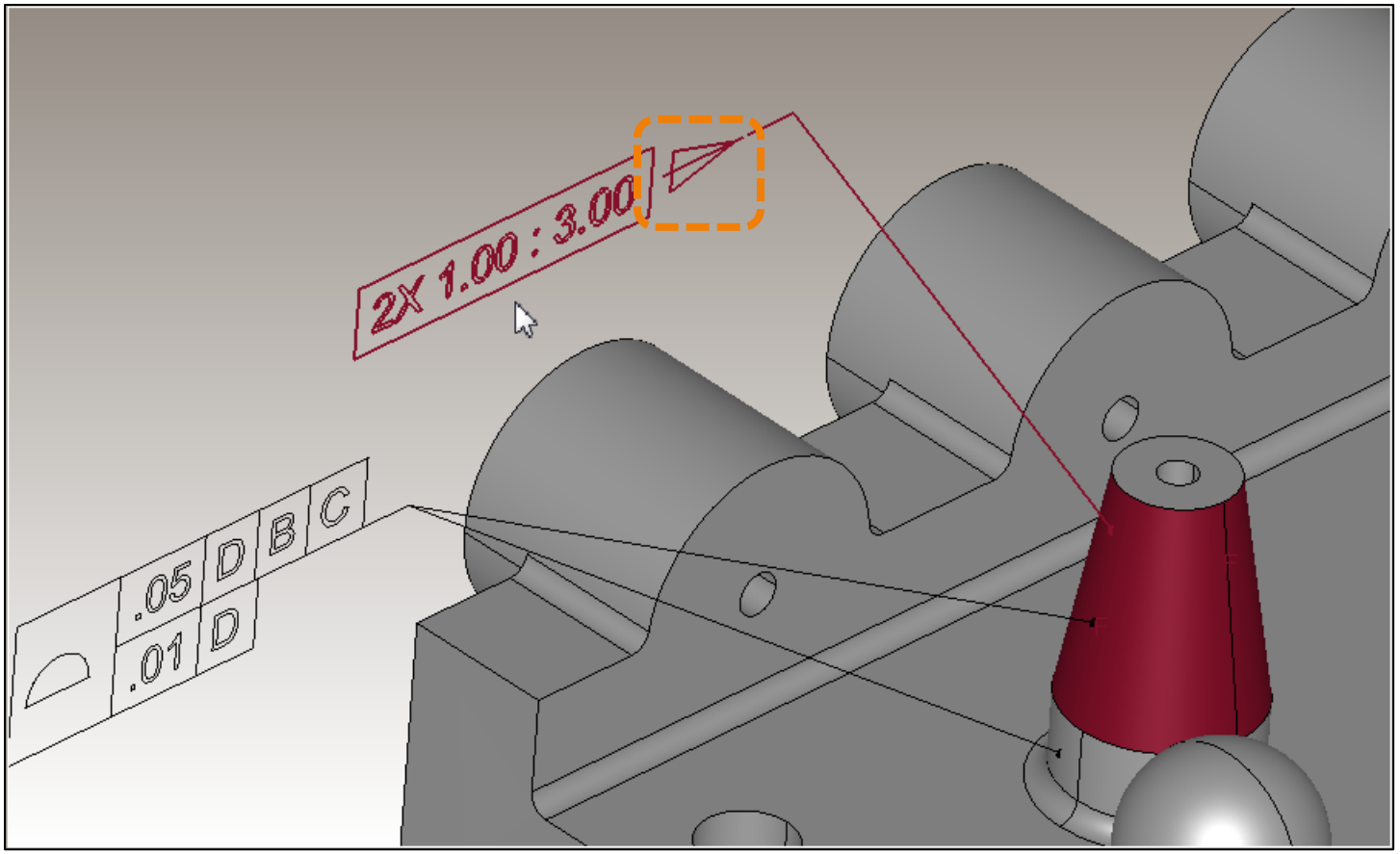




This chamfer is missing the dimension that defines its width.

Return to Index

# Annotation Parameters: DIM conic surfaces defined with encoded text

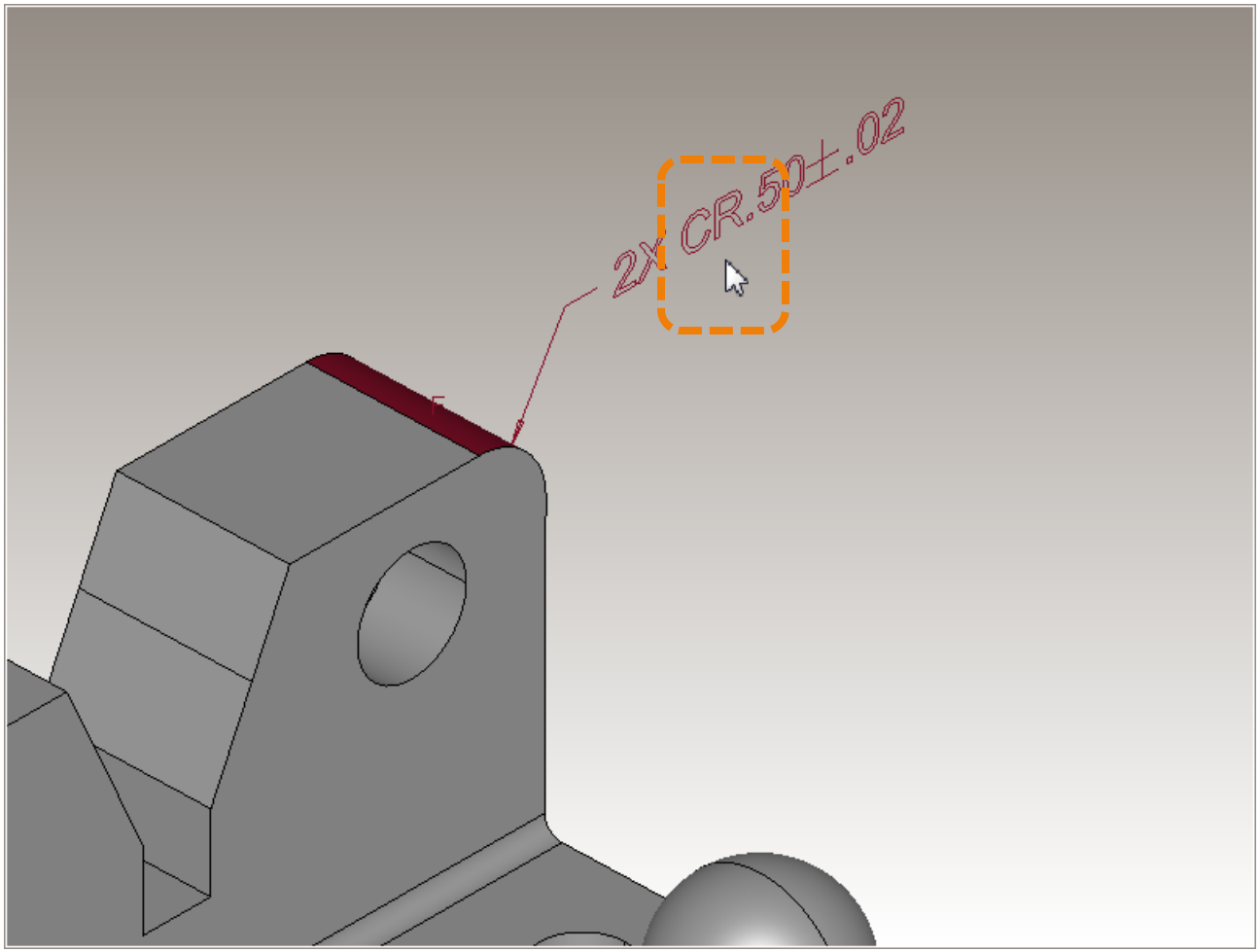





The conic surfaces portion of this dimension is defined using encoded text.

Return to Index

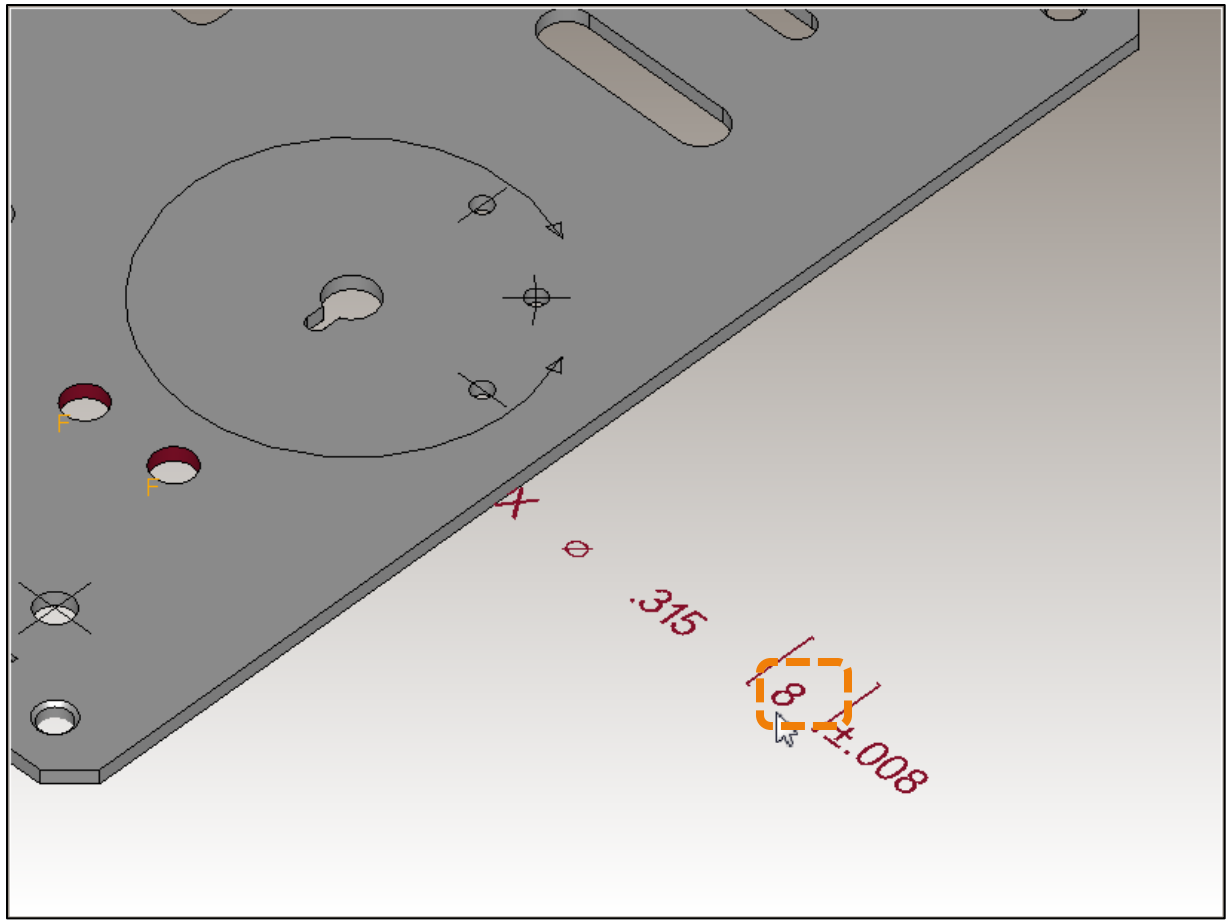
# Annotation Parameters: DIM controlled radius defined with encoded text




The controlled radius parameter of this dimension is defined using encoded text.

Return to Index

# Annotation Parameters: DIM missing dual dimension tolerance

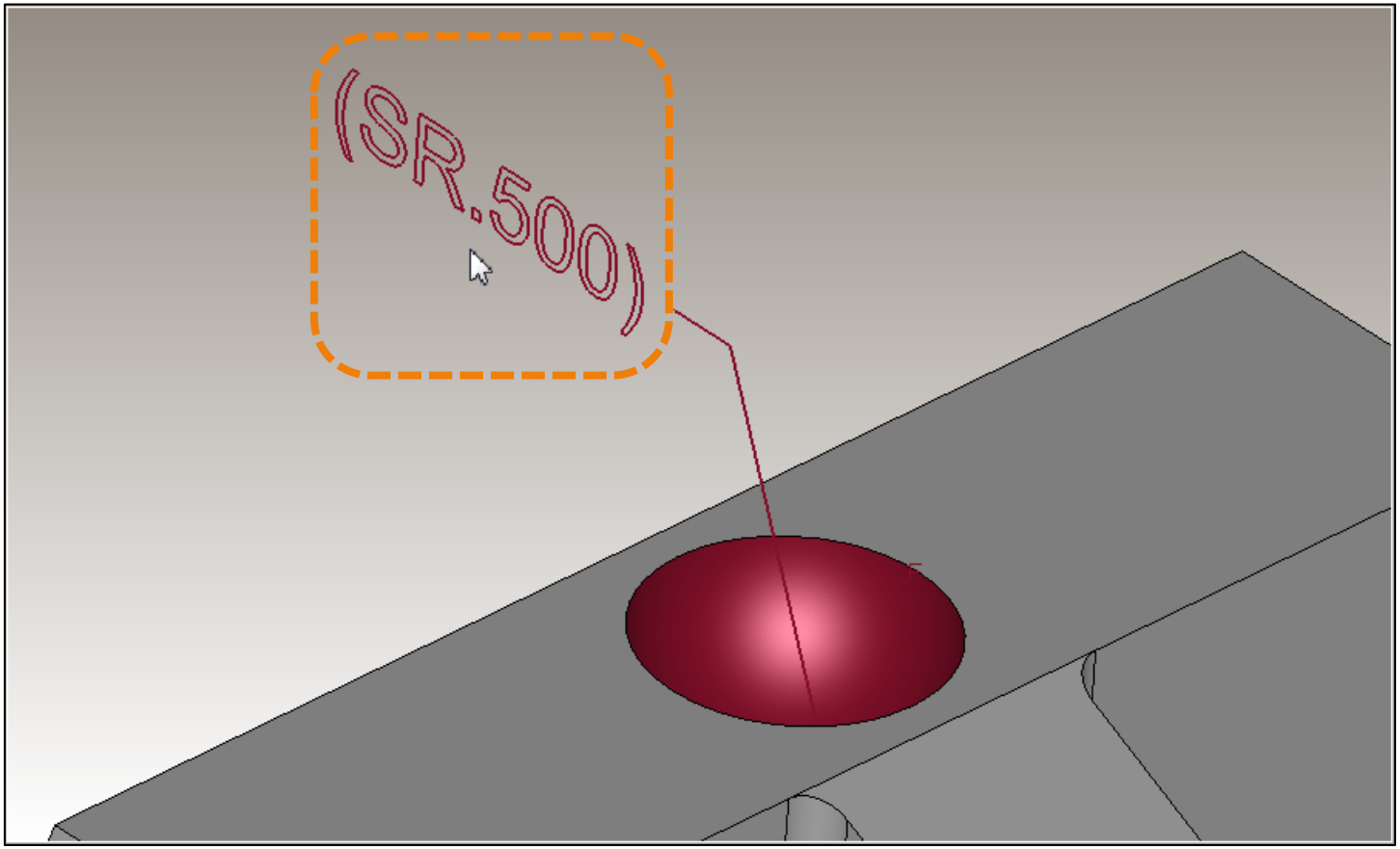



This dual dimension is missing a tolerance value.

Return to Index

# Annotation Parameters: DIM not defined as reference DIM






This dimension has parentheses, as specified, but is not defined as a reference dimension.

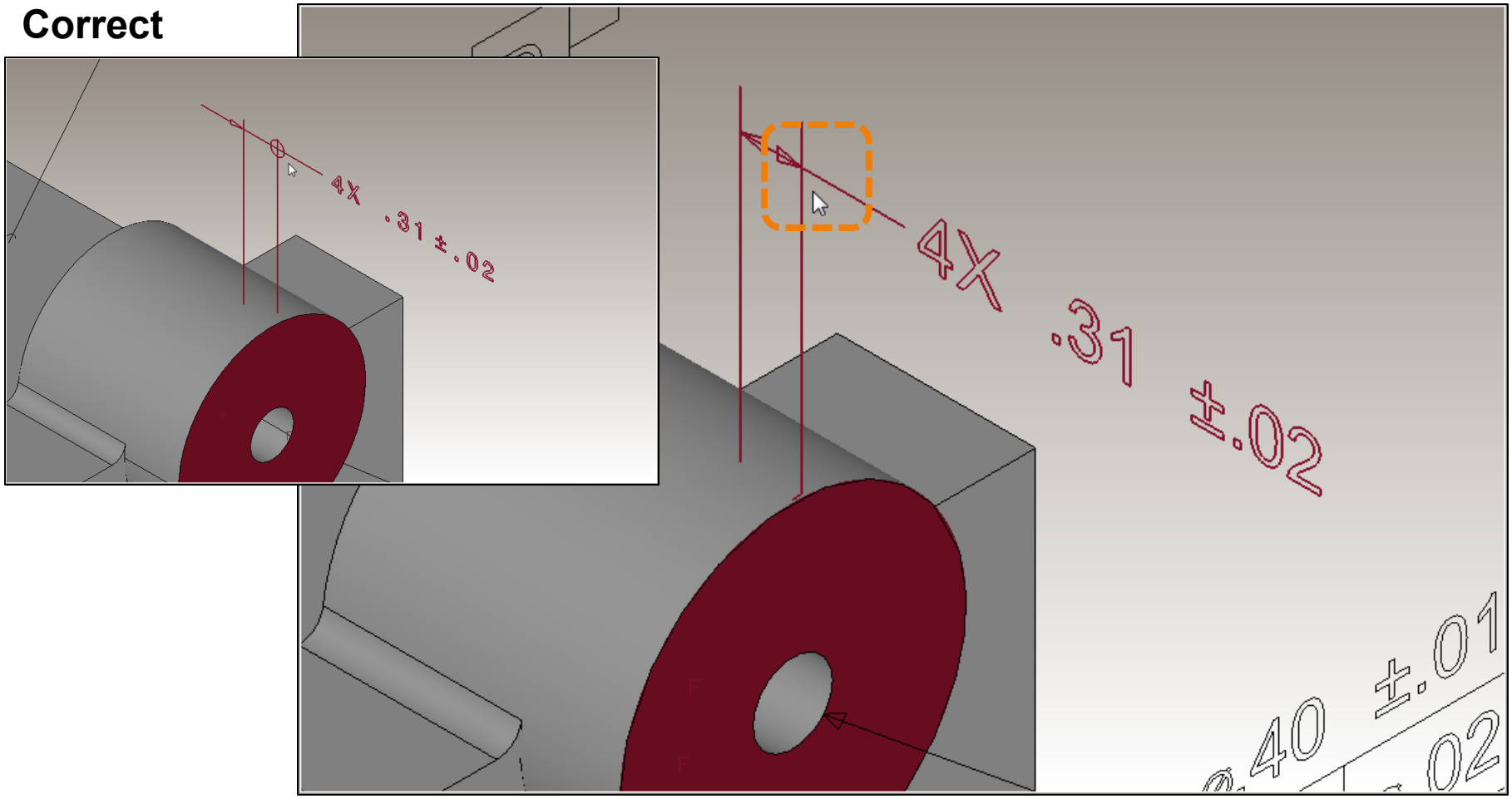
Return to Index

# Annotation Parameters: DIM origin not defined



Incorrect

Correct

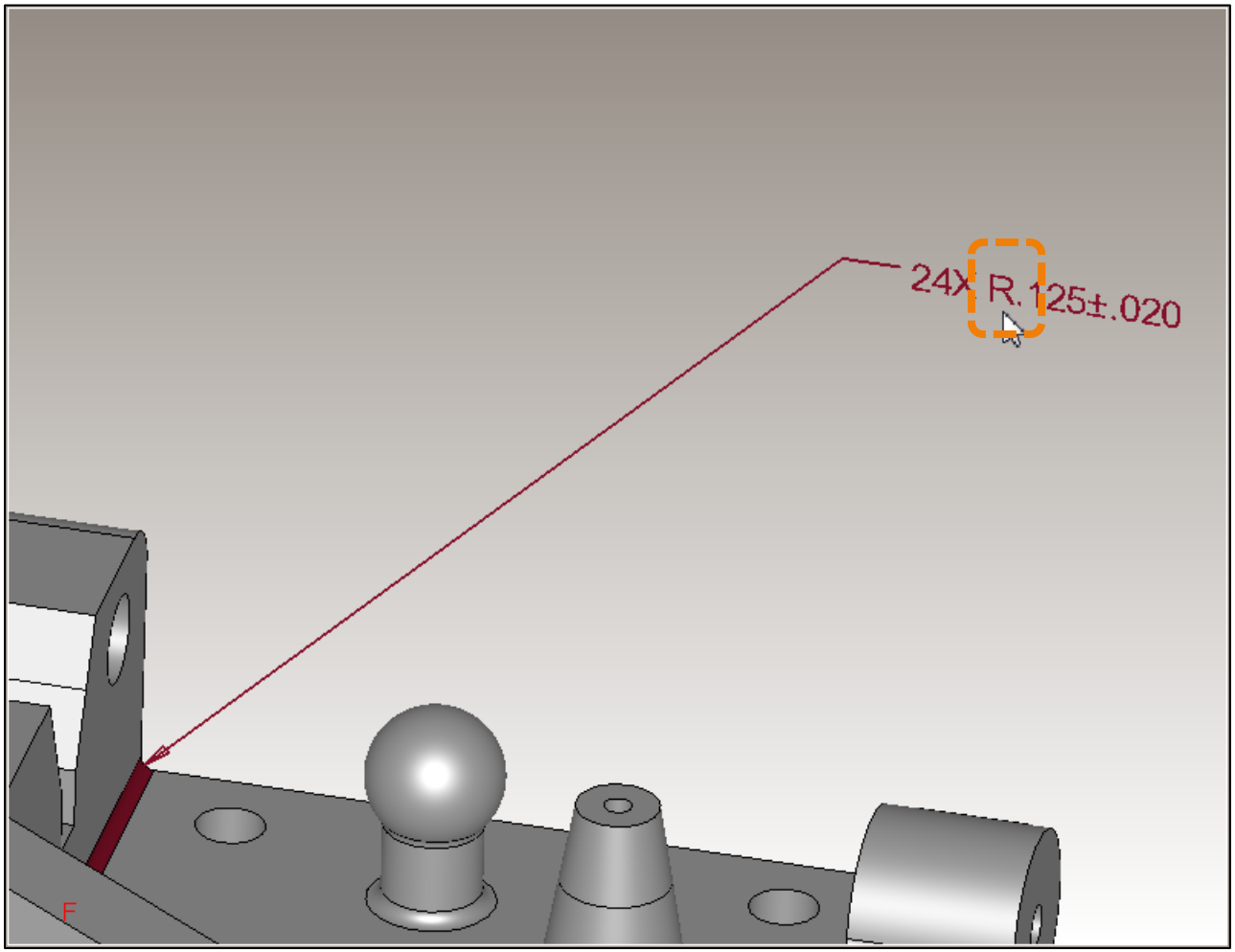



The origin for this oriented dimension is not defined.

Return to Index

# Annotation Parameters: DIM radius defined with encoded text



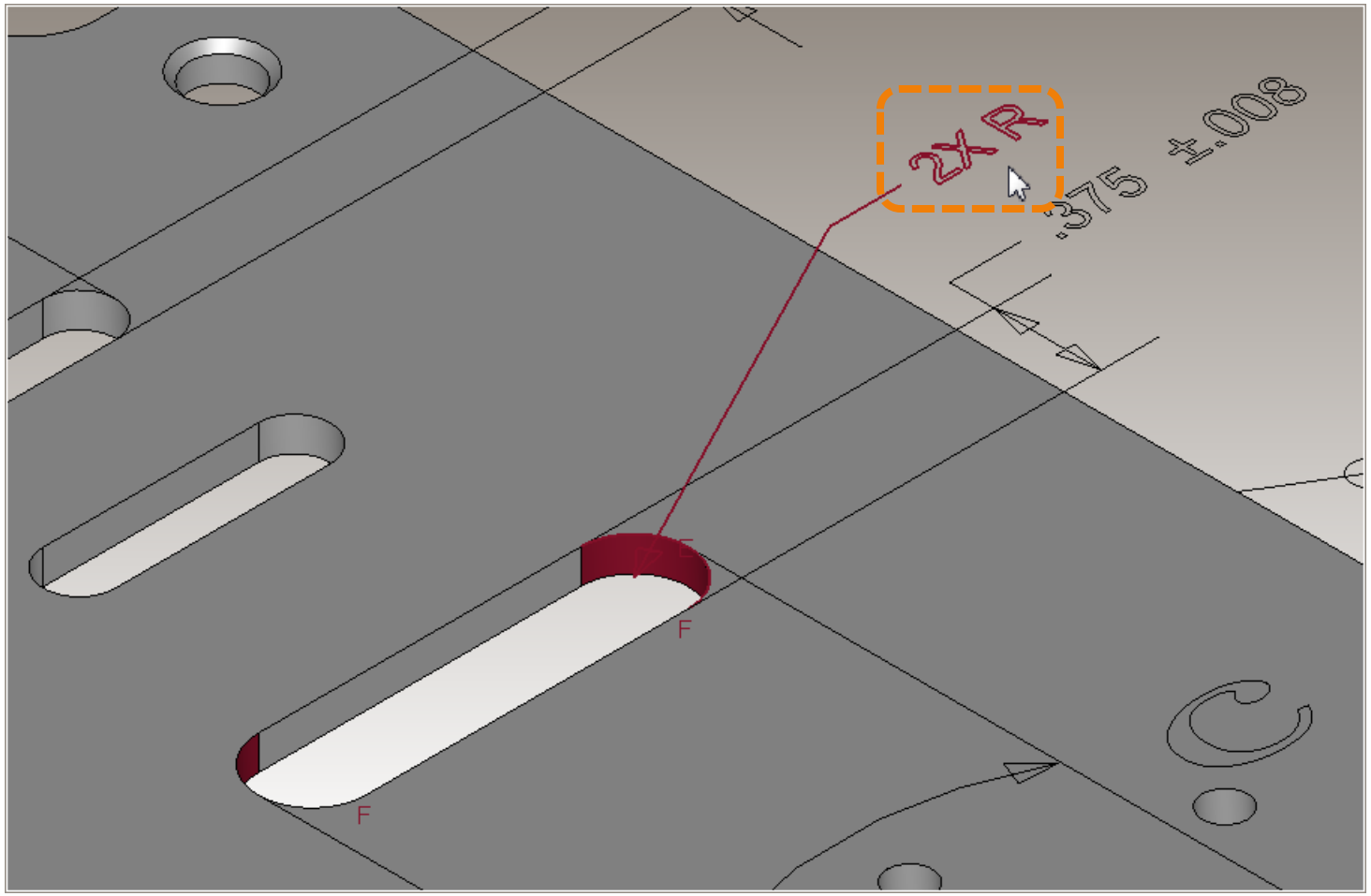



The radius parameter of this dimension is defined using encoded text.

Return to Index

# Annotation Parameters: DIM slot radius defined with encoded text

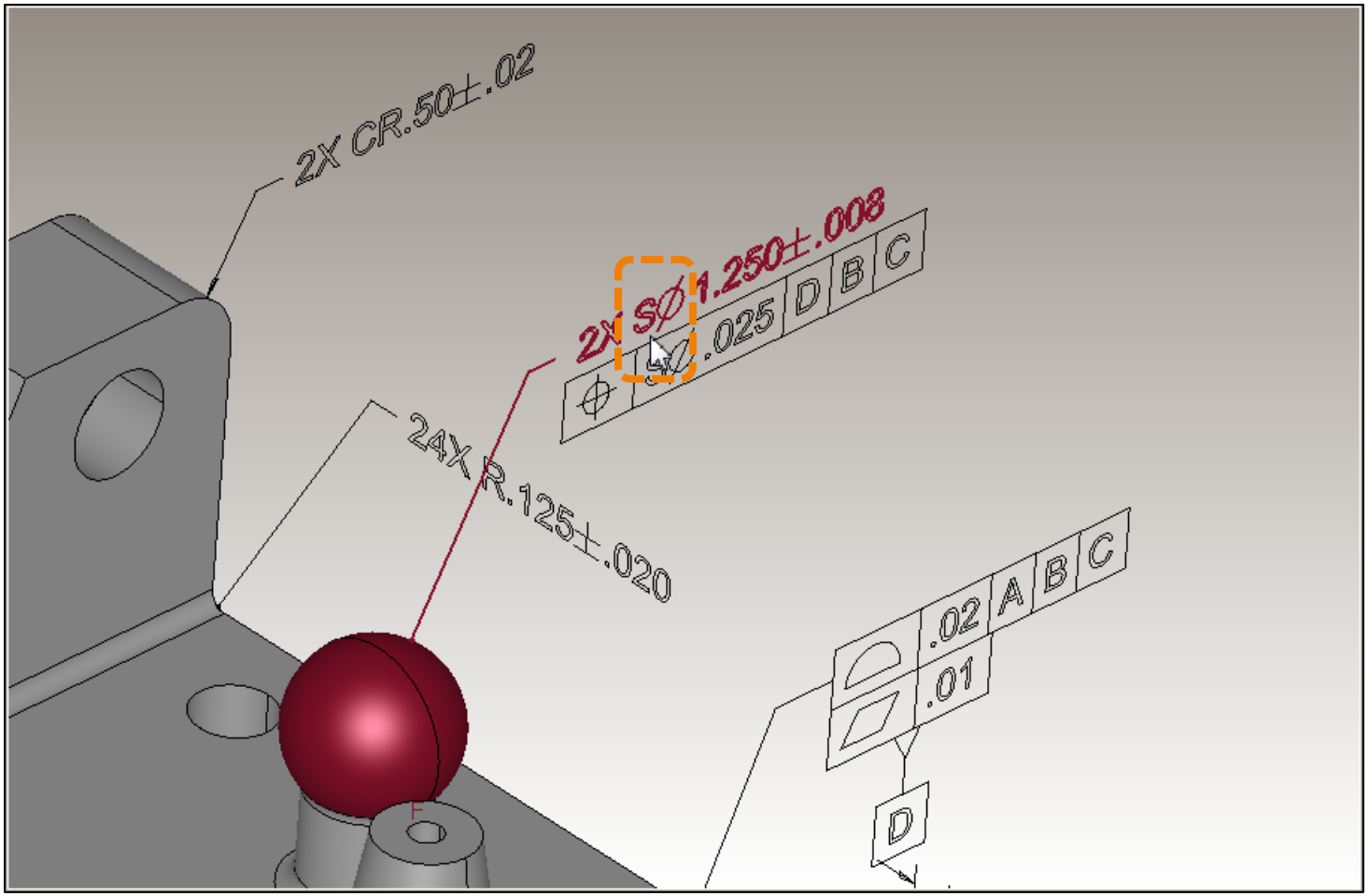





The radius parameter of this dimension is defined using encoded text.

Return to Index

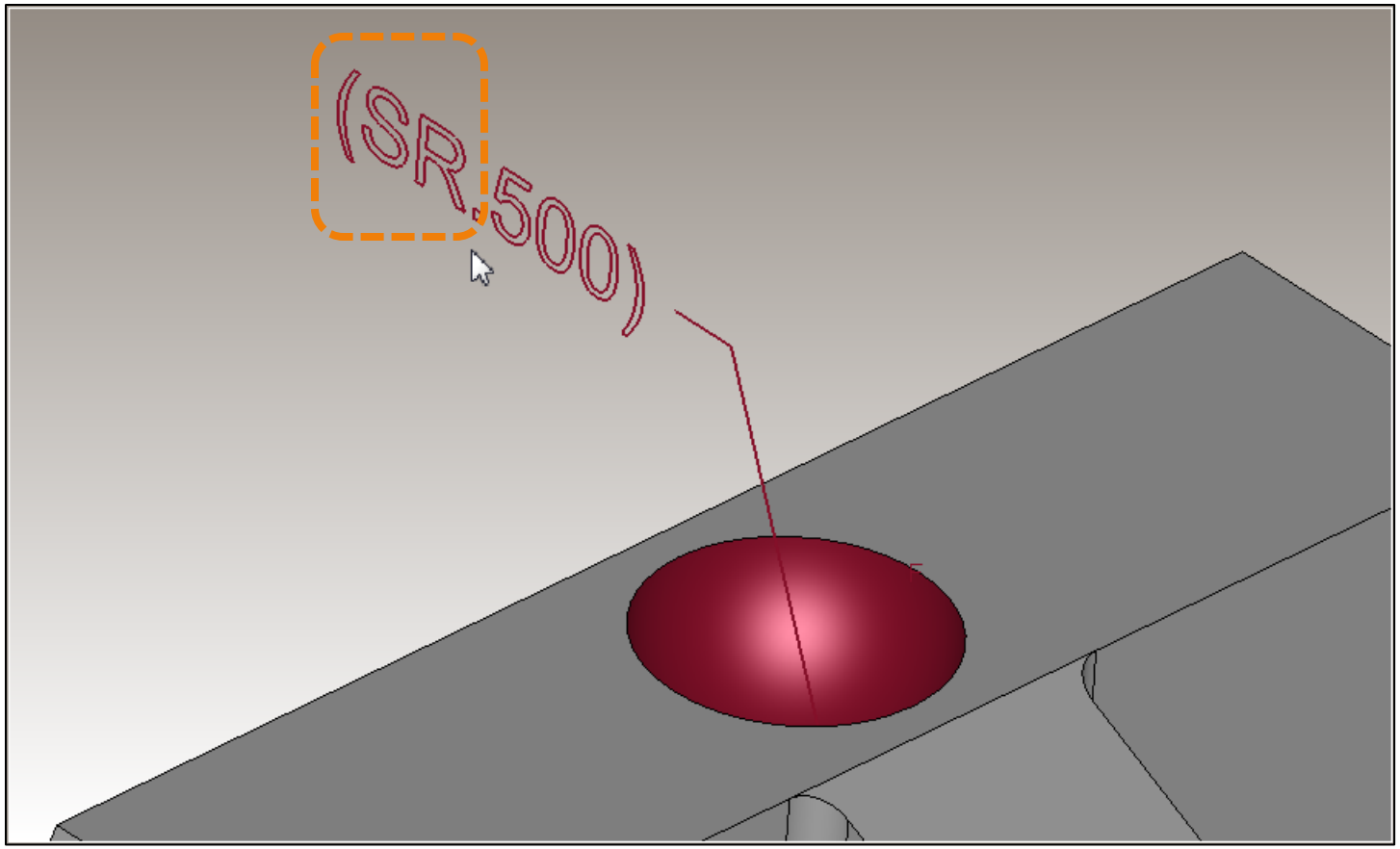
# Annotation Parameters: DIM spherical diameter defined with encoded text




The spherical diameter parameter of this dimension is defined using encoded text.

Return to Index

# Annotation Parameters: DIM spherical radius defined with encoded text

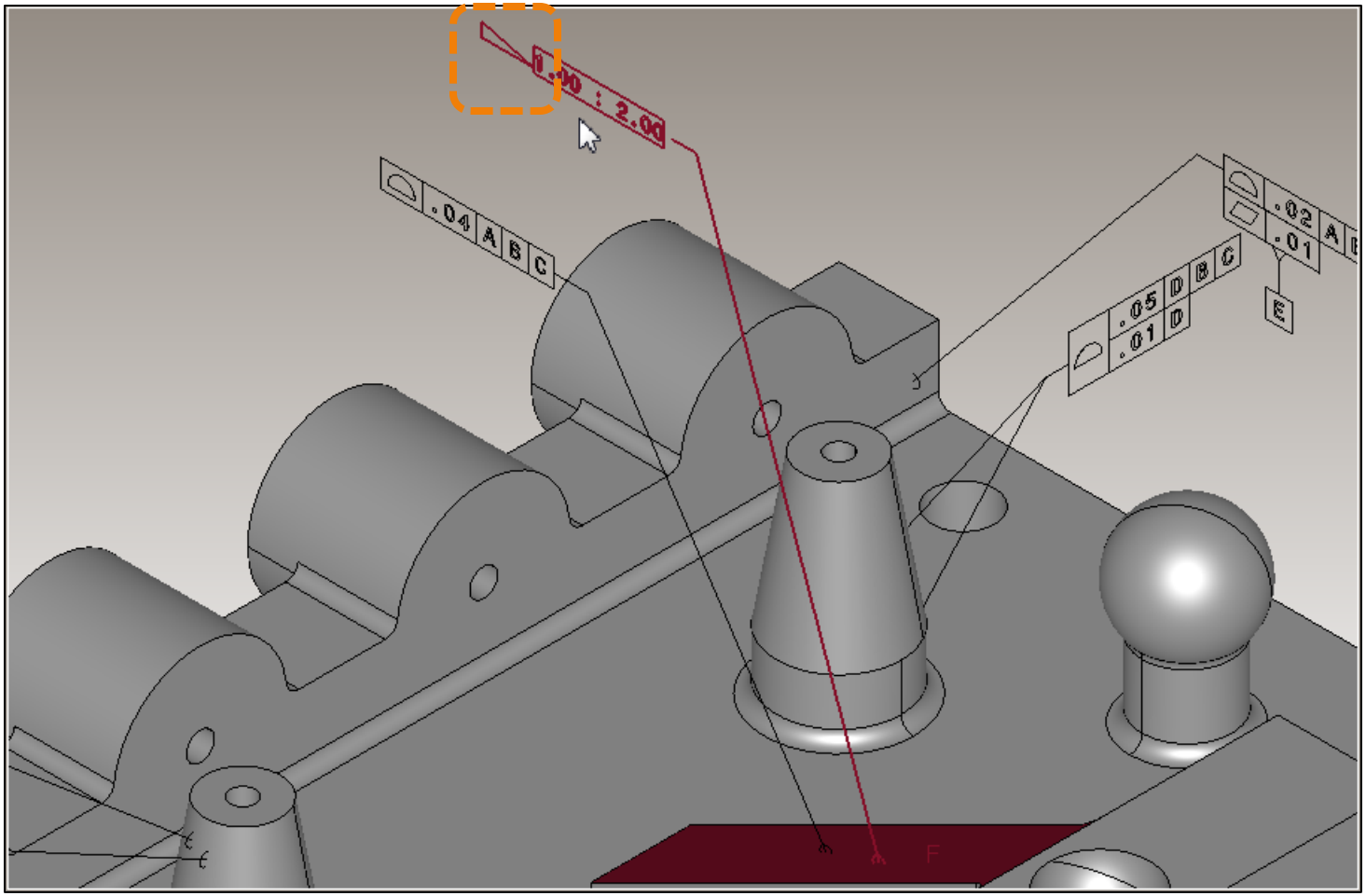



This spherical radius parameter of this dimension is defined using encoded text.

Return to Index

# Annotation Parameters: DIM tapered center defined with encoded text



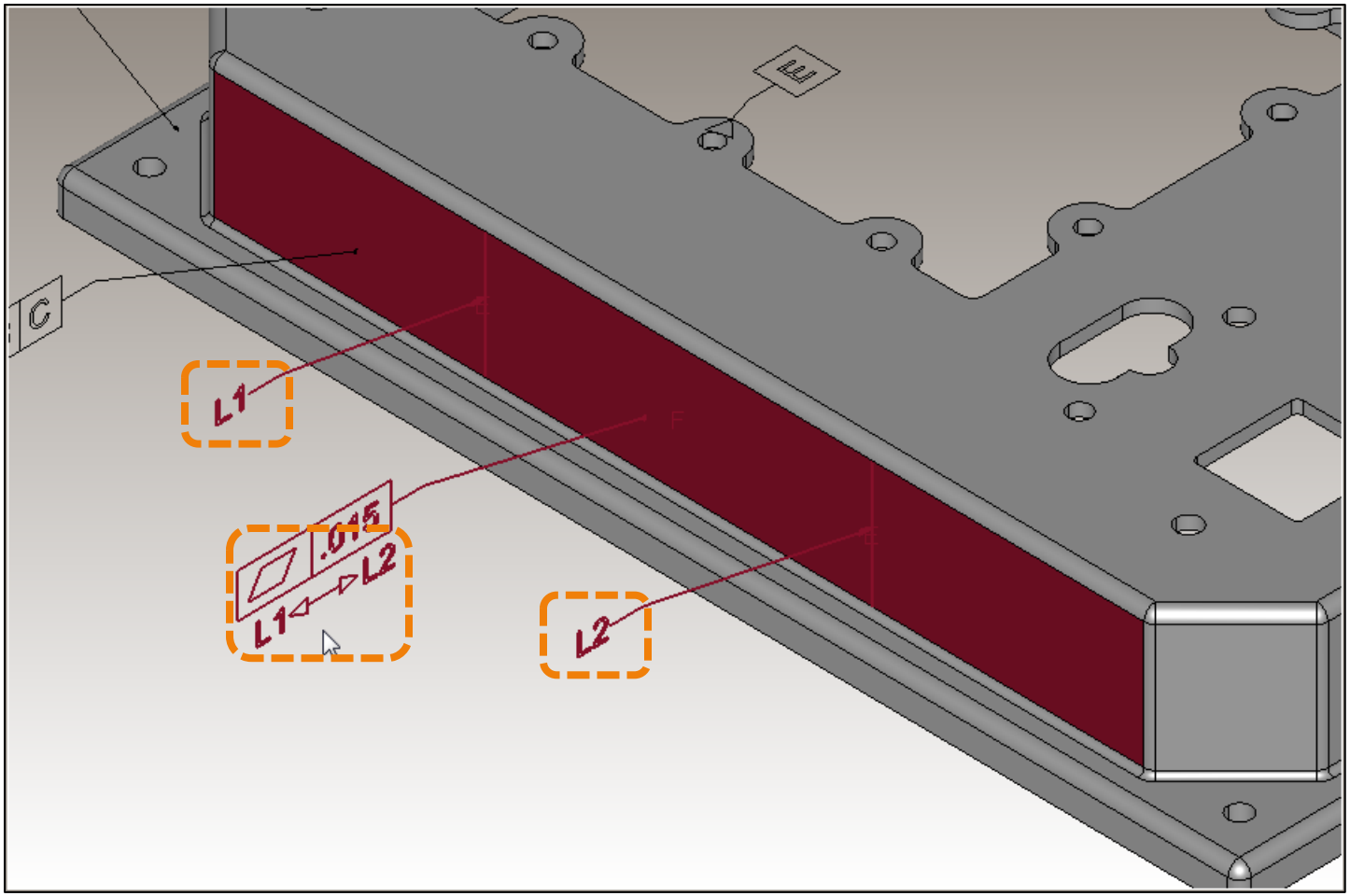



The tapered center parameter of this dimension is defined using encoded text.

Return to Index

# Annotation Parameters: FCF between-basis defined with encoded text





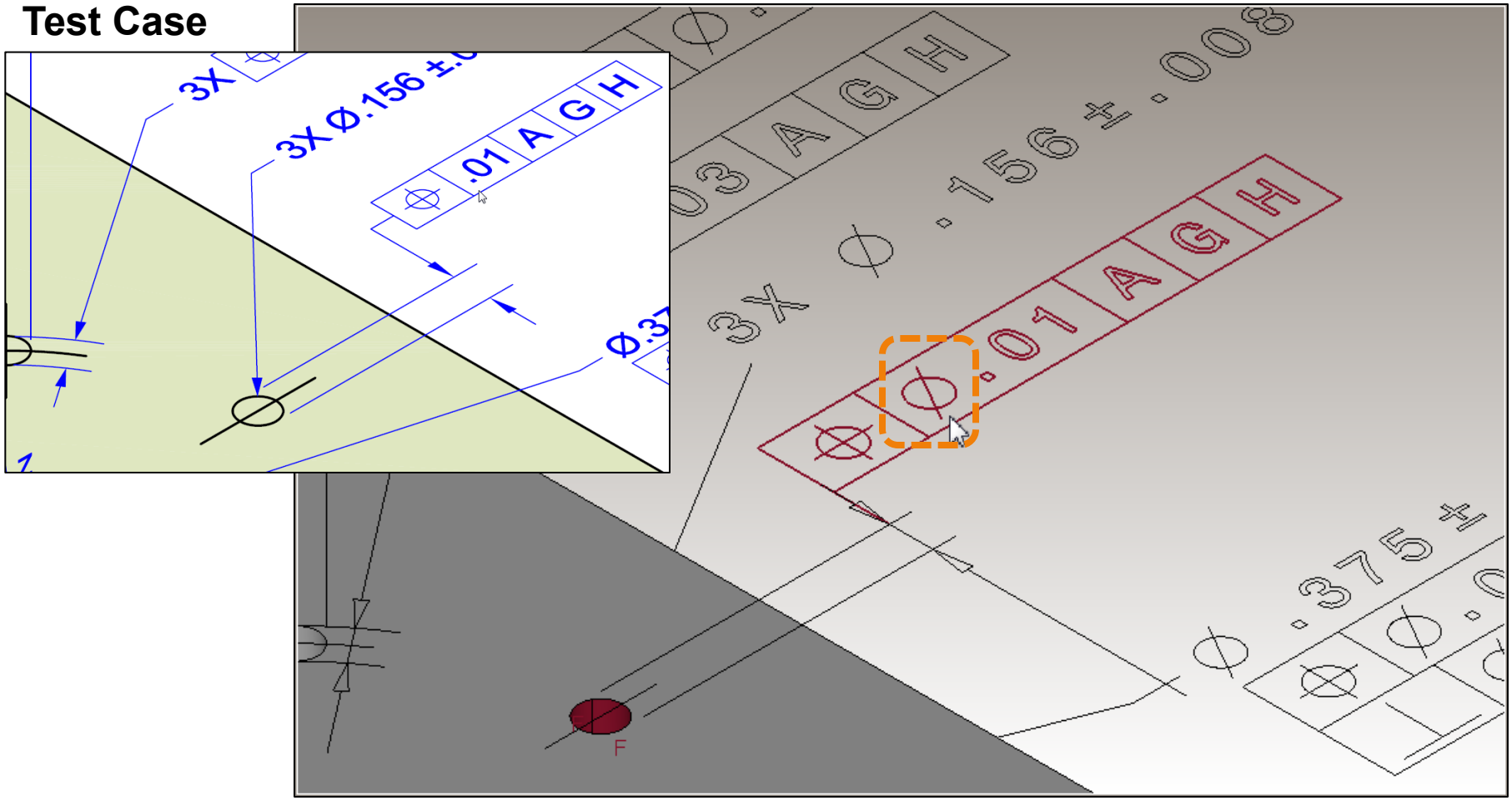

The between-basis for this feature control frame is defined as encoded text and not with named parameters.

Return to Index

# Annotation Parameters: FCF diameter symbol not specified



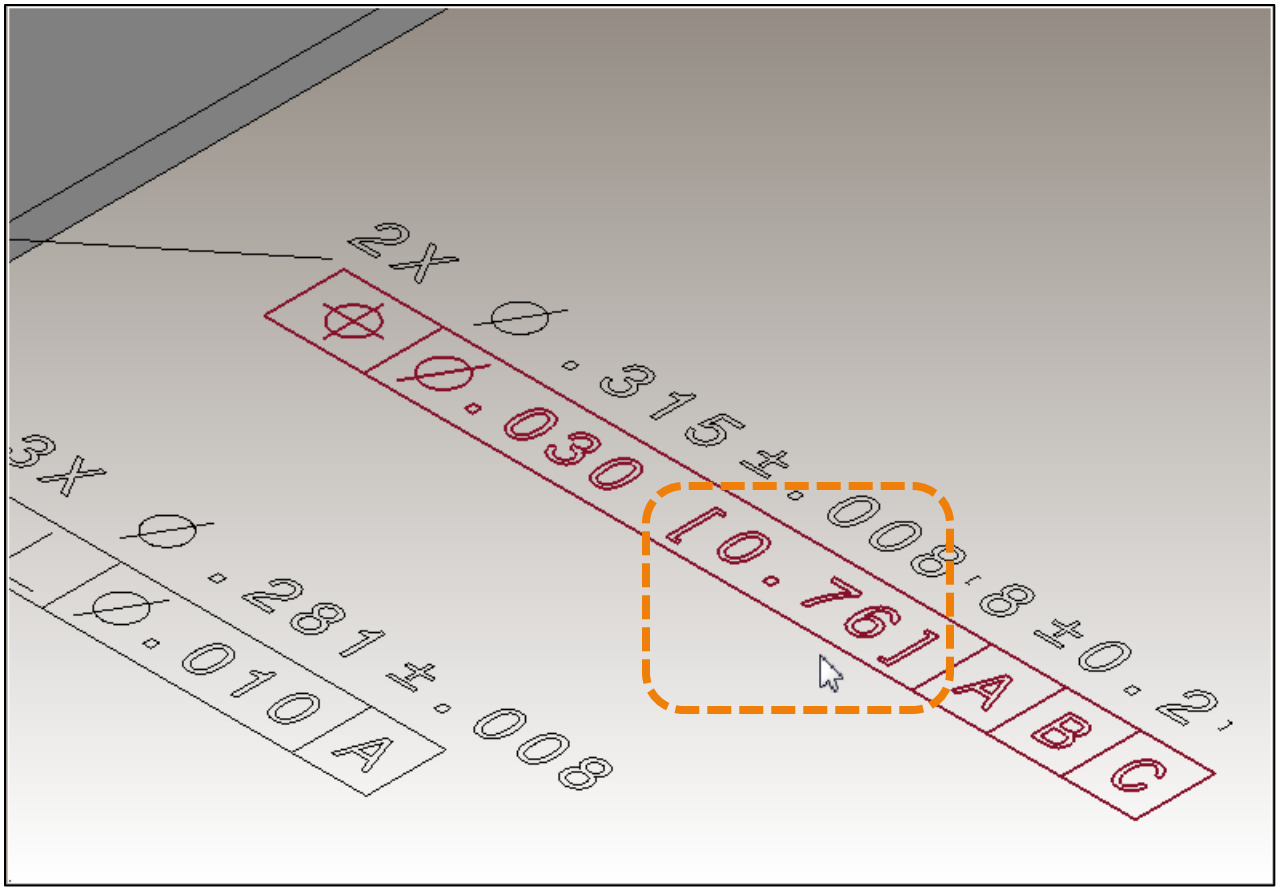
Test Case




This geometric tolerance has an incorrect diameter symbol.

Return to Index

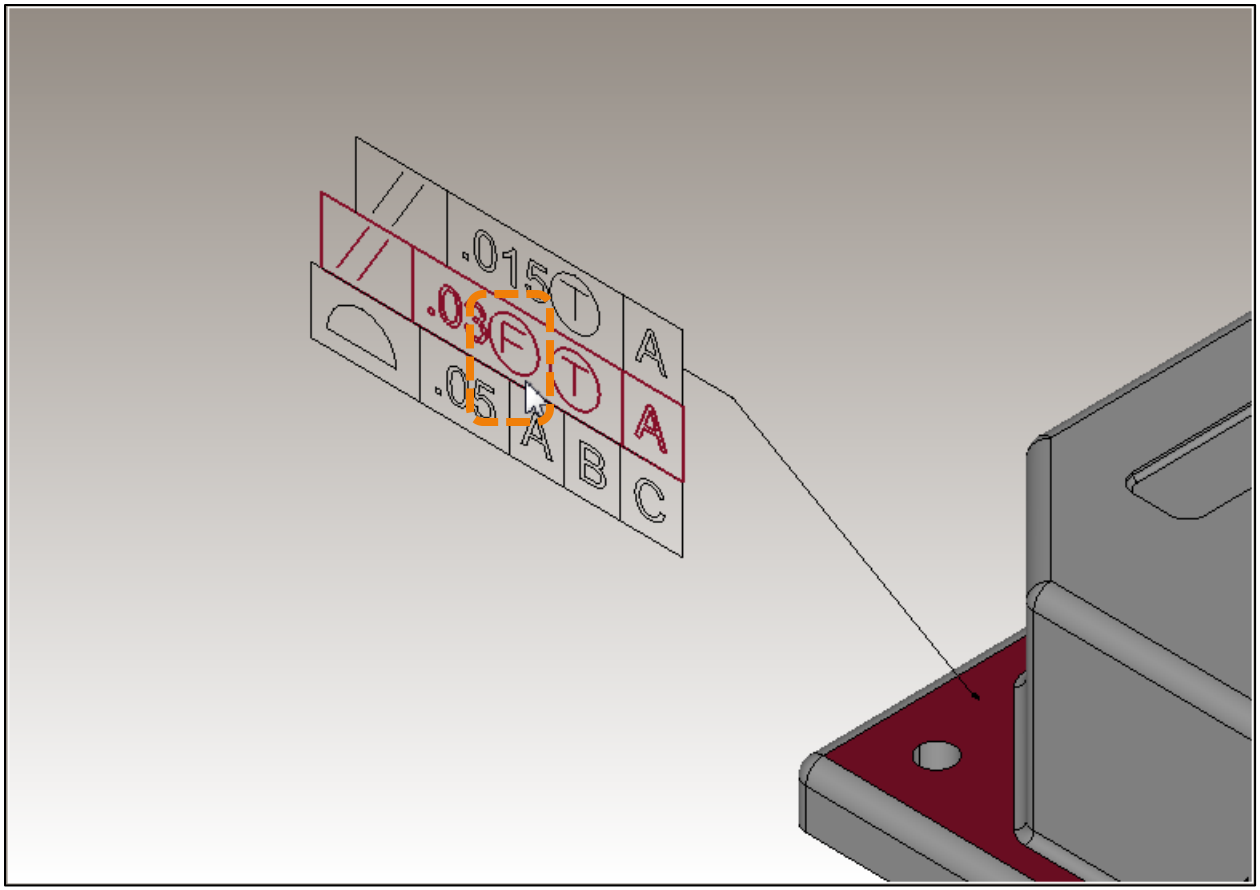
# Annotation Parameters: FCF dual dimension defined with encoded text




This dual dimension is defined using encoded text.

Return to Index

# Annotation Parameters: FCF free state defined with encoded text



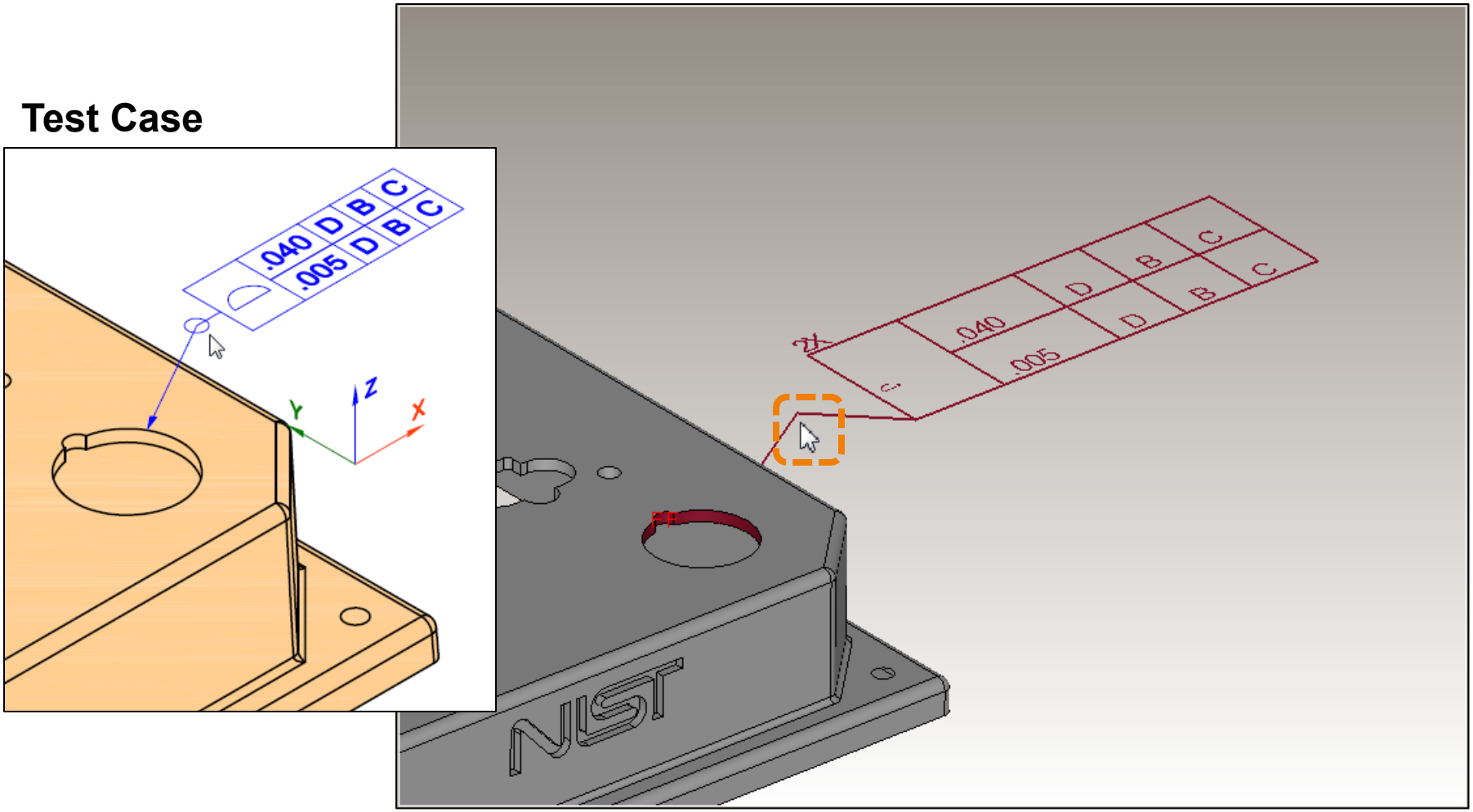

This free state tolerance modifier is defined using encoded text.

Return to Index

# Annotation Parameters: FCF missing all-around designation



Test Case



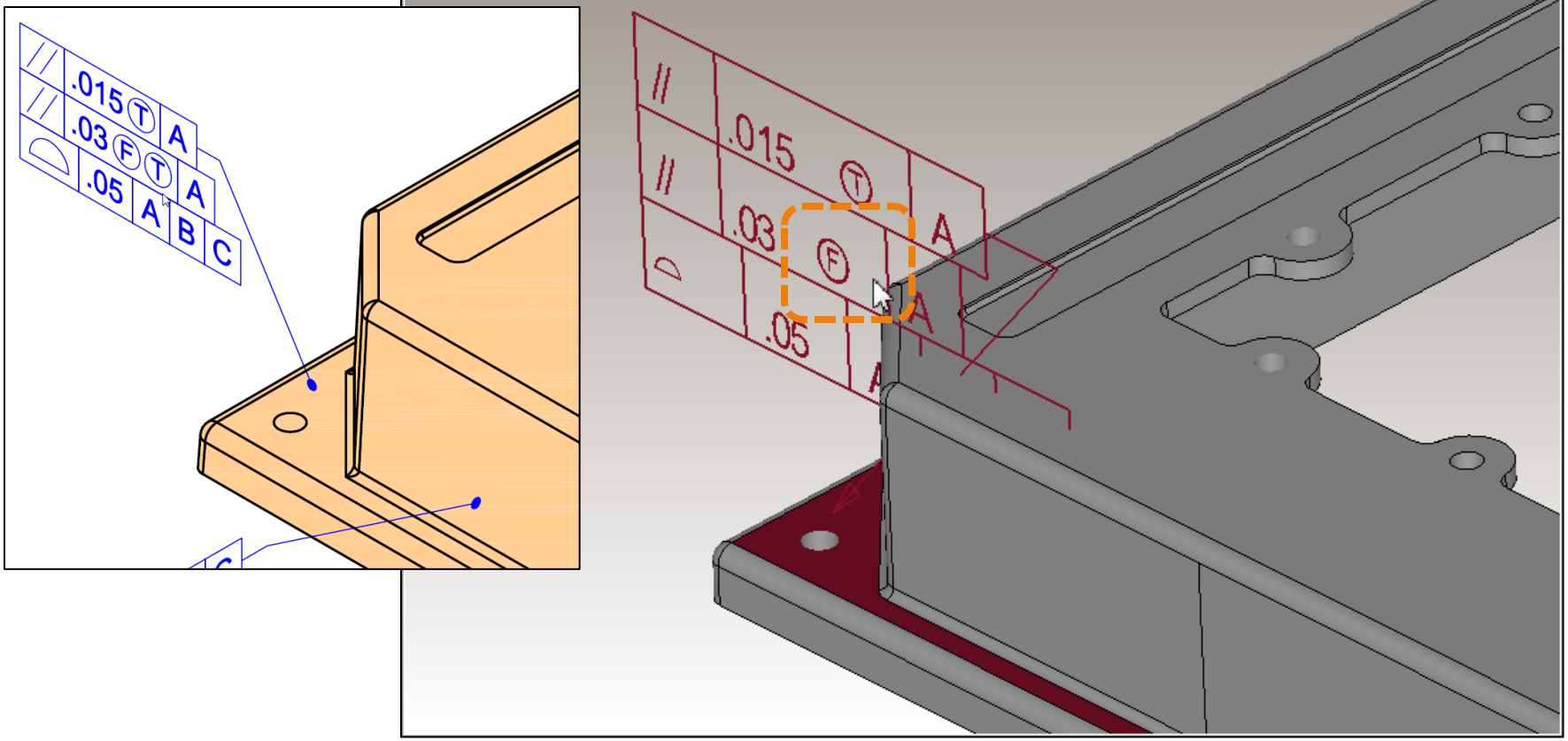

This feature control frame is missing an all-around symbol.

Return to Index

# Annotation Parameters: FCF missing tangent plane modifier



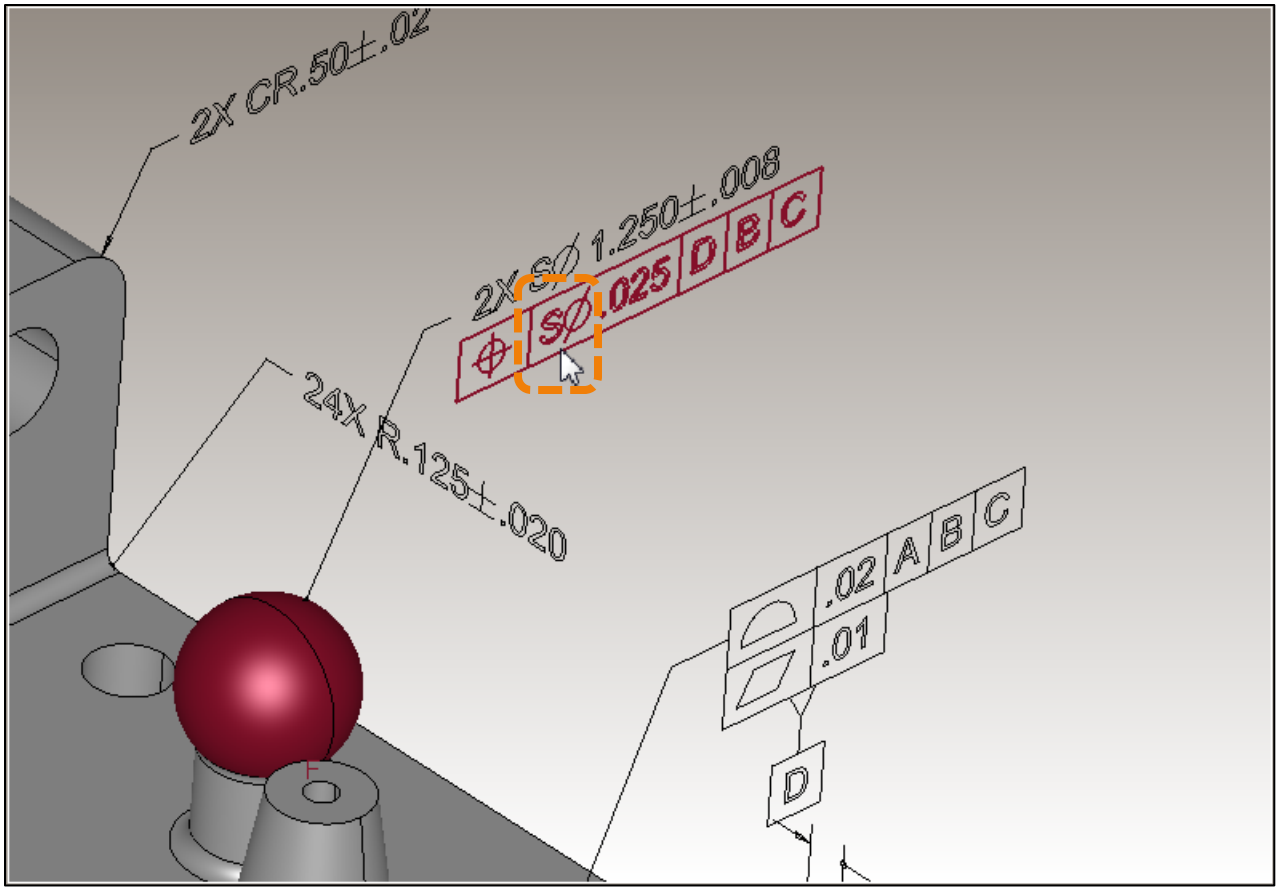
Test Case




This feature control frame is missing the specified tangent plane modifier.

Return to Index

# Annotation Parameters: FCF spherical diameter defined with encoded text




This spherical diameter tolerance zone symbol is defined using encoded text.

Return to Index

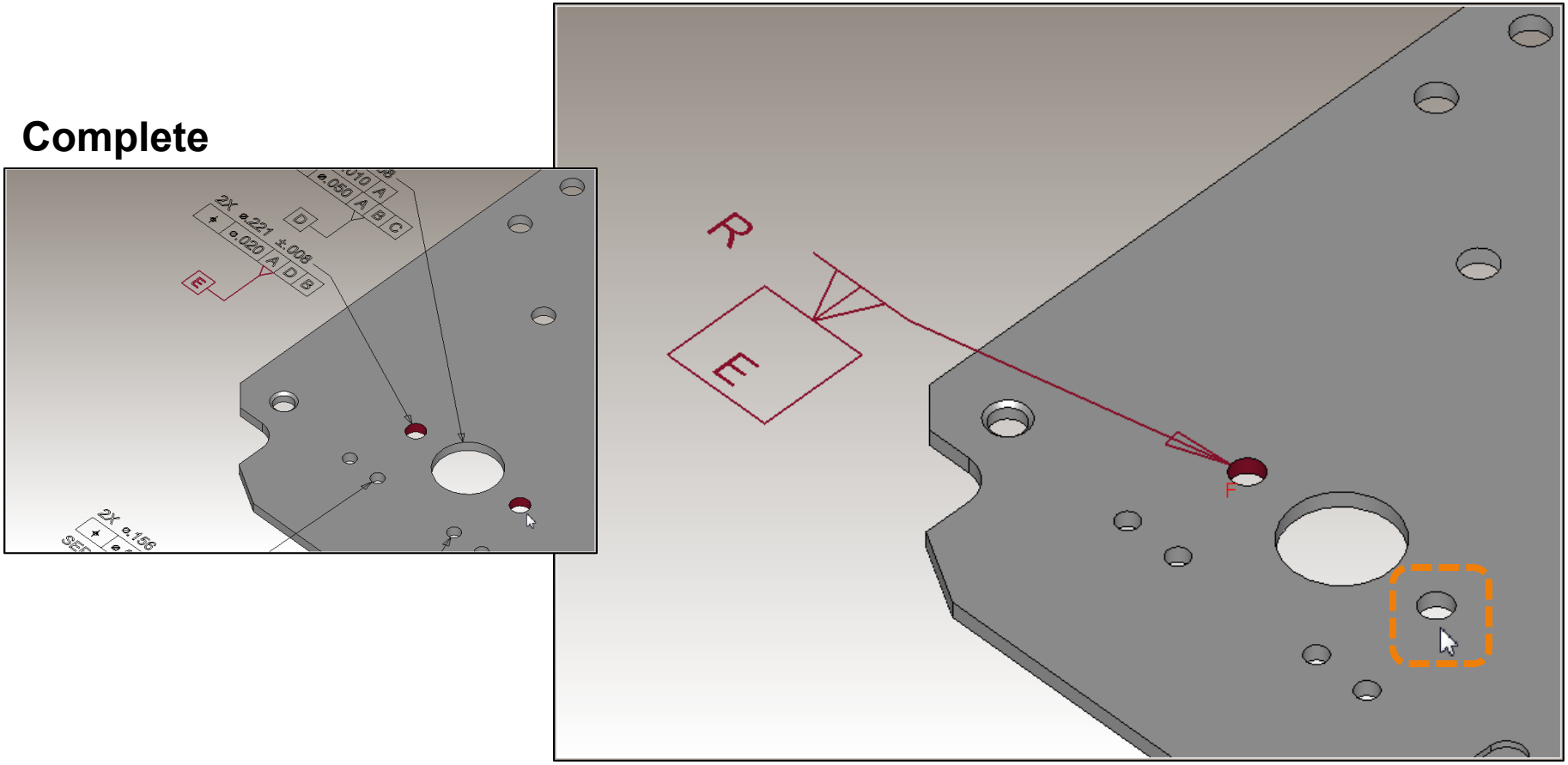
# CAD System Representation Limitations for Annotation Geometry

Return to Index

# Annotation Geometry: DFS not associated with complete set of faces

**Incomplete**

**Complete**




This datum feature symbol is not associated with all of the specified faces.

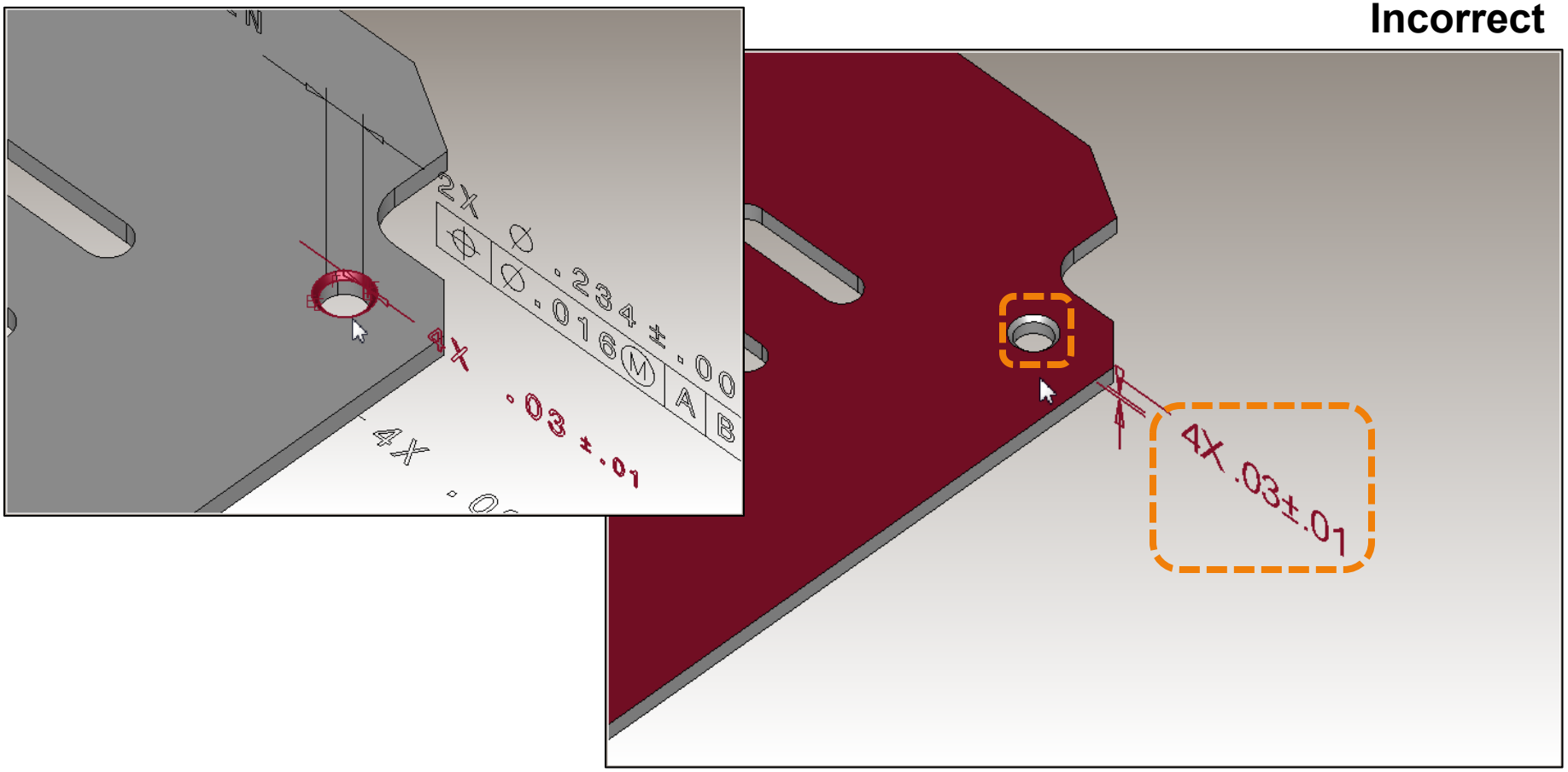
Return to Index

# Annotation Geometry: DIM associated with incorrect face



Correct

Incorrect

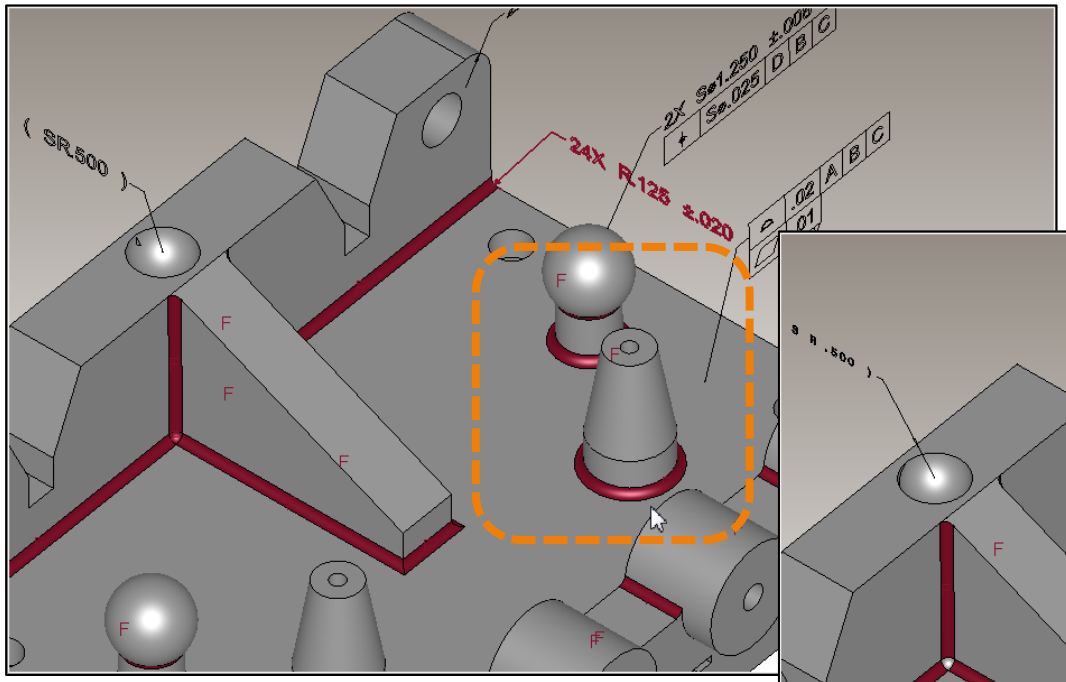



This dimension is not associated with the correct specified face.

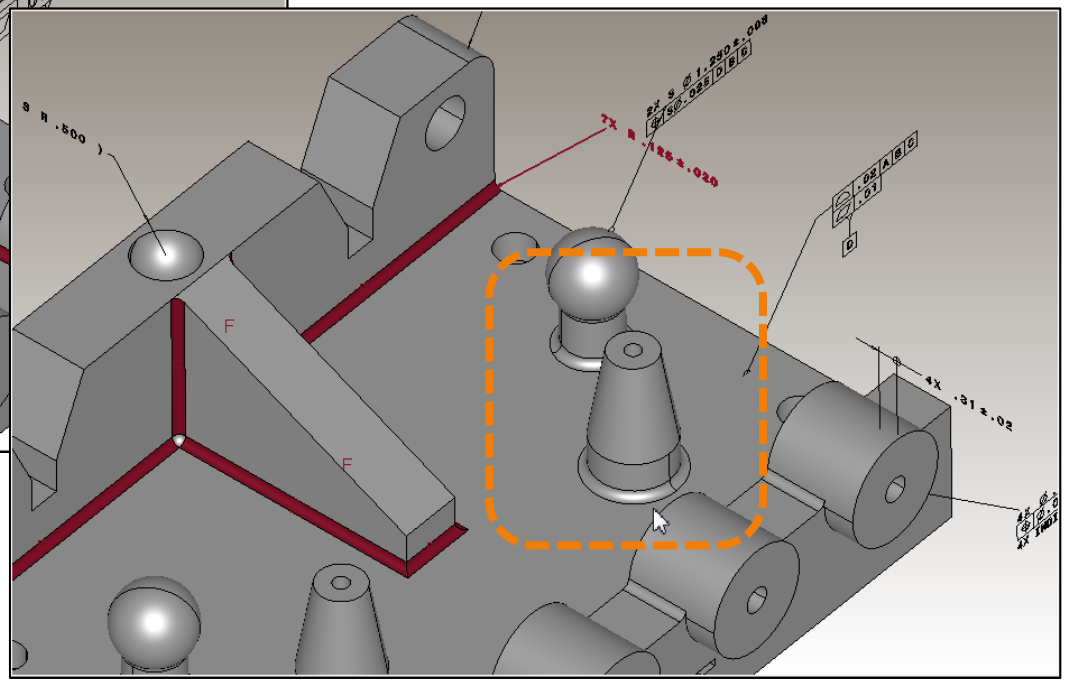
Return to Index

# Annotation Geometry: DIM not associated with complete set of faces

**Complete**




**Incomplete**



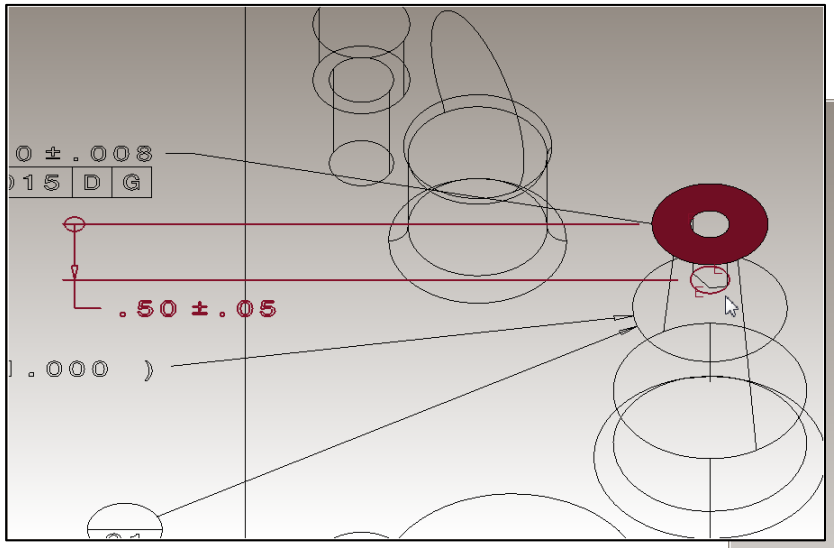

This dimension is only associated with some of the specified faces.

Return to Index

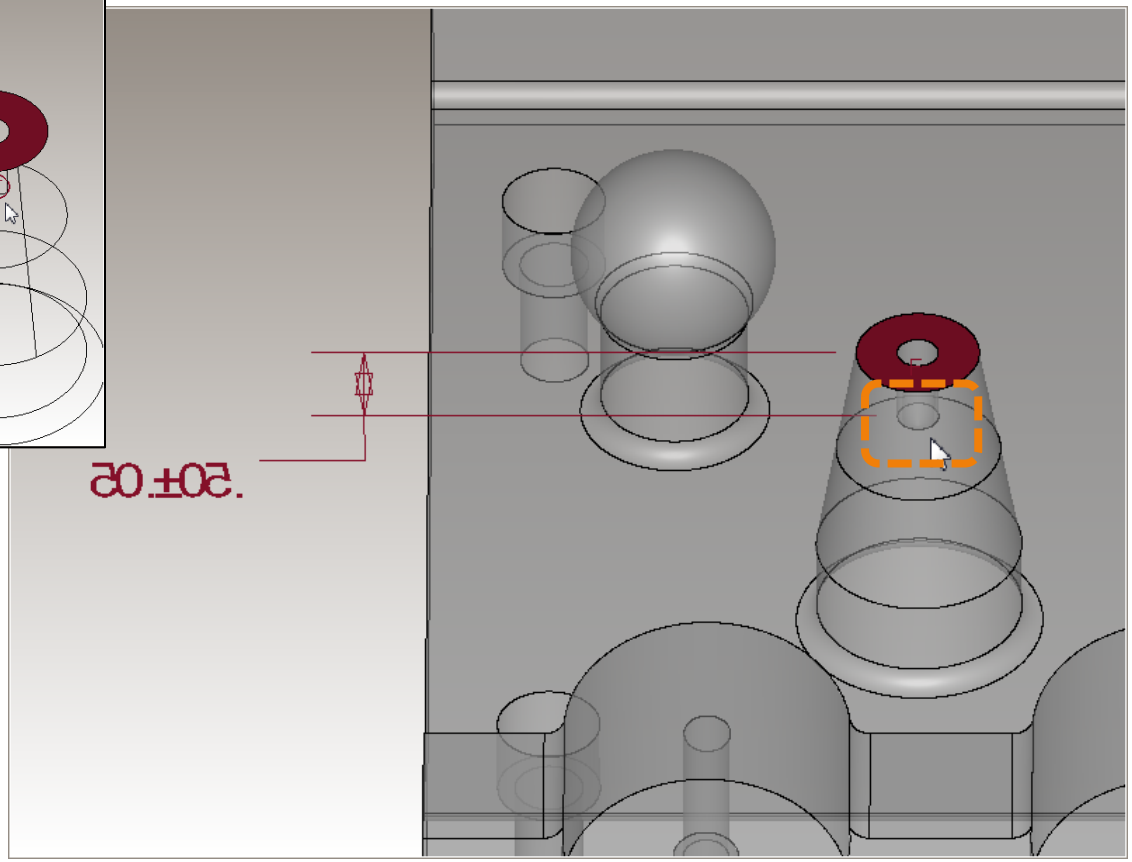
# Annotation Geometry: DIM not associated with edge



**Correct**




**Incorrect**



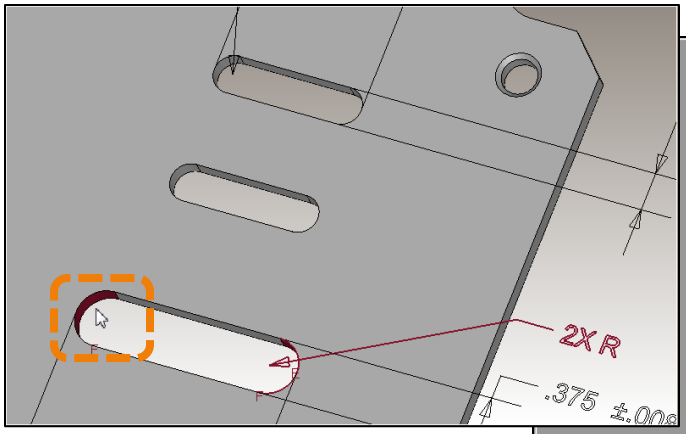

This dimension is not associated with the specified edge.

Return to Index

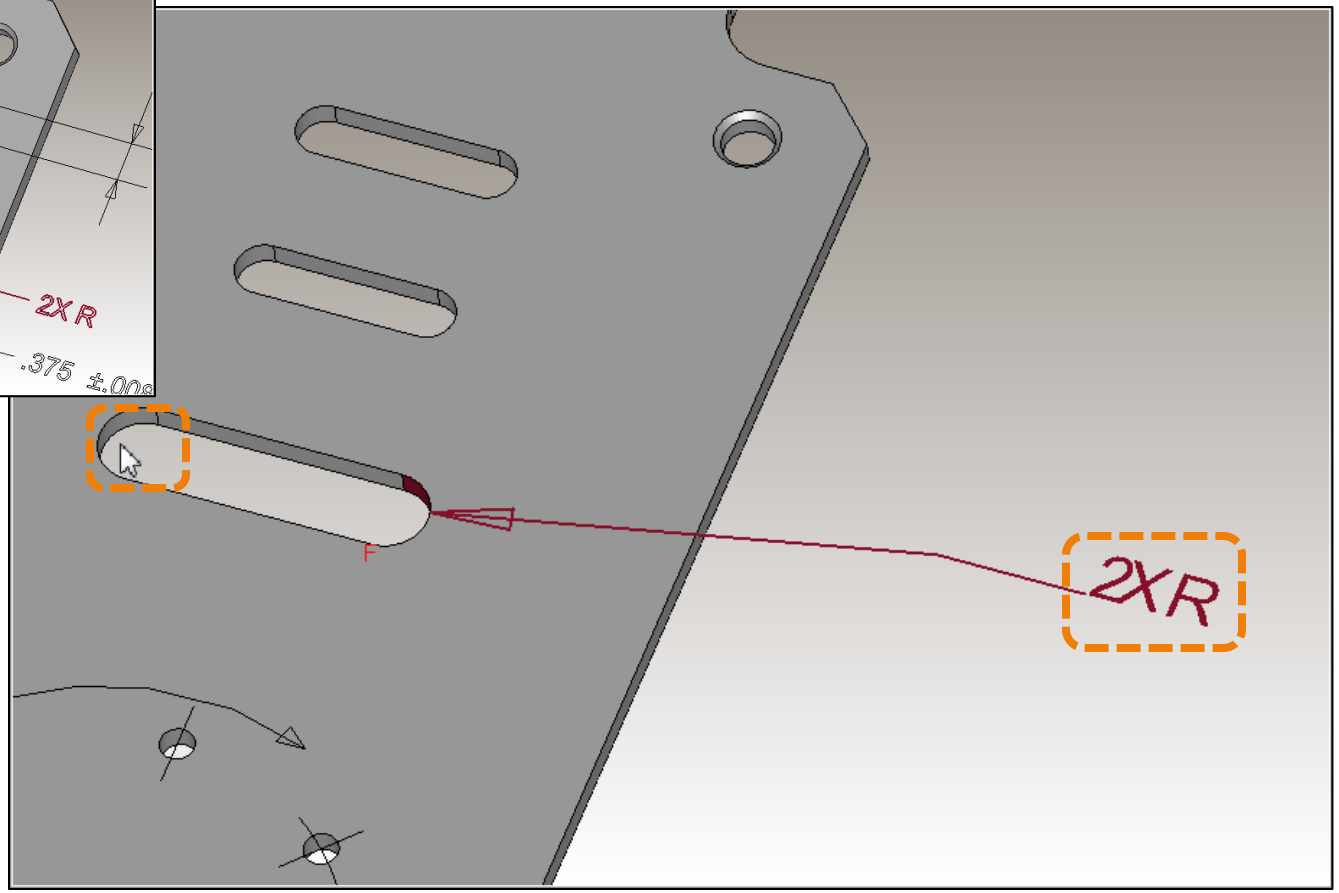
# Annotation Geometry: DIM not associated with face



**Correct**




**Incorrect**




This dimension is not associated with both specified faces.

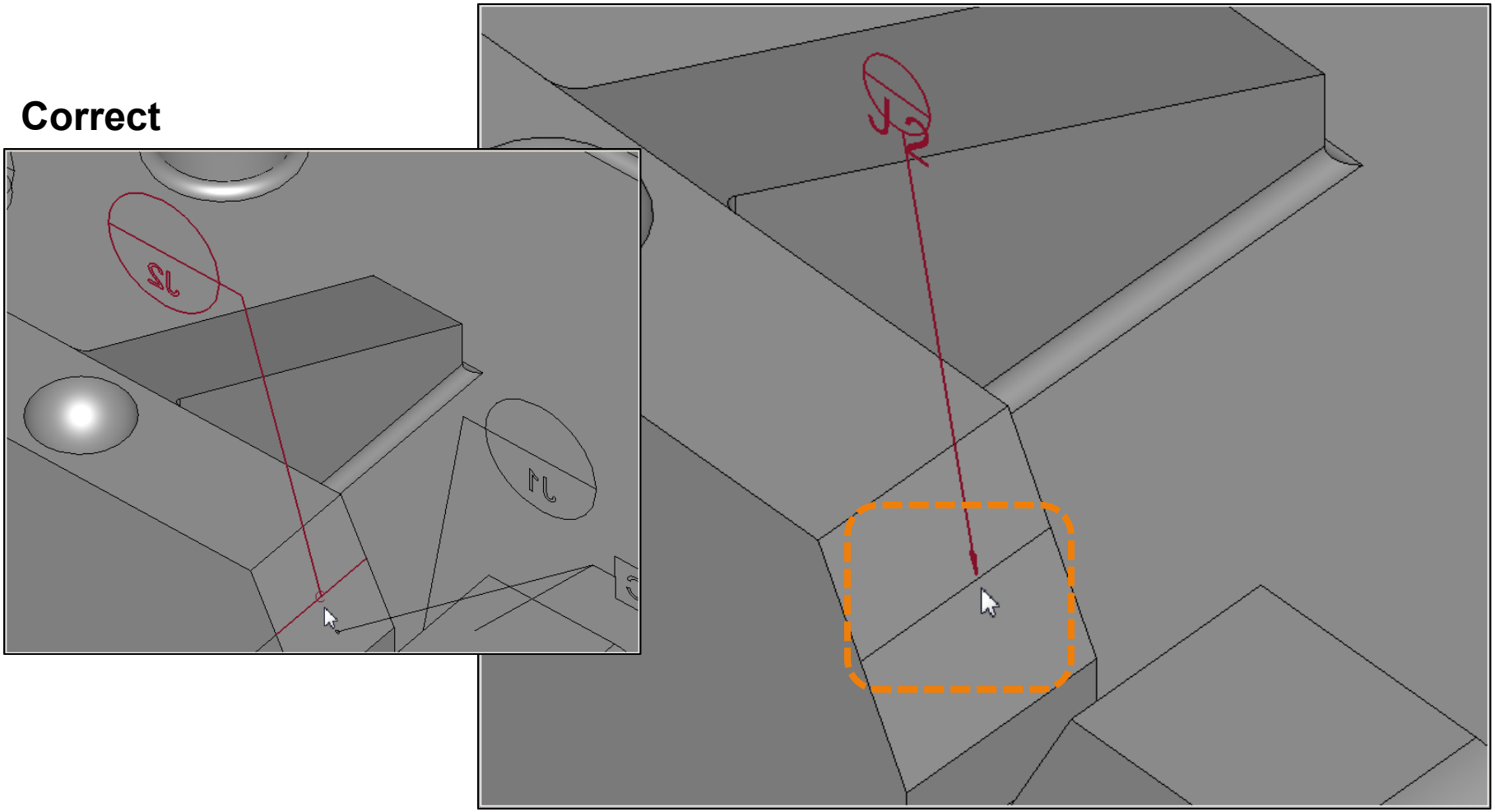
Return to Index

# Annotation Geometry: DTS not associated with SG curve



Incorrect

Correct

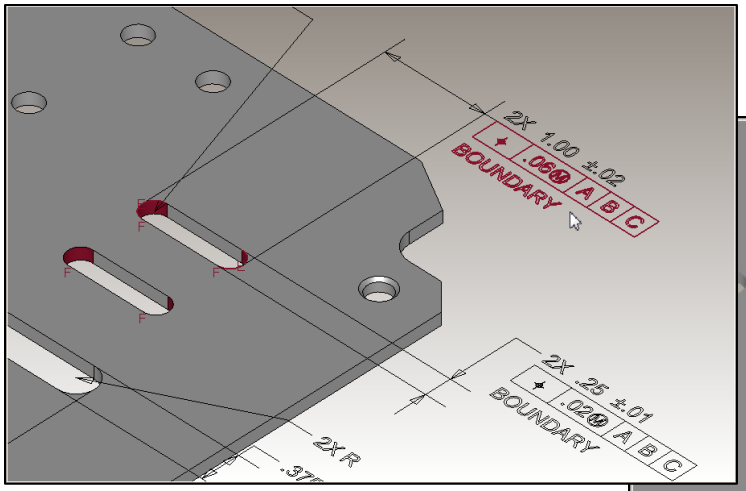


This datum target symbol is not associated with the specified curve.

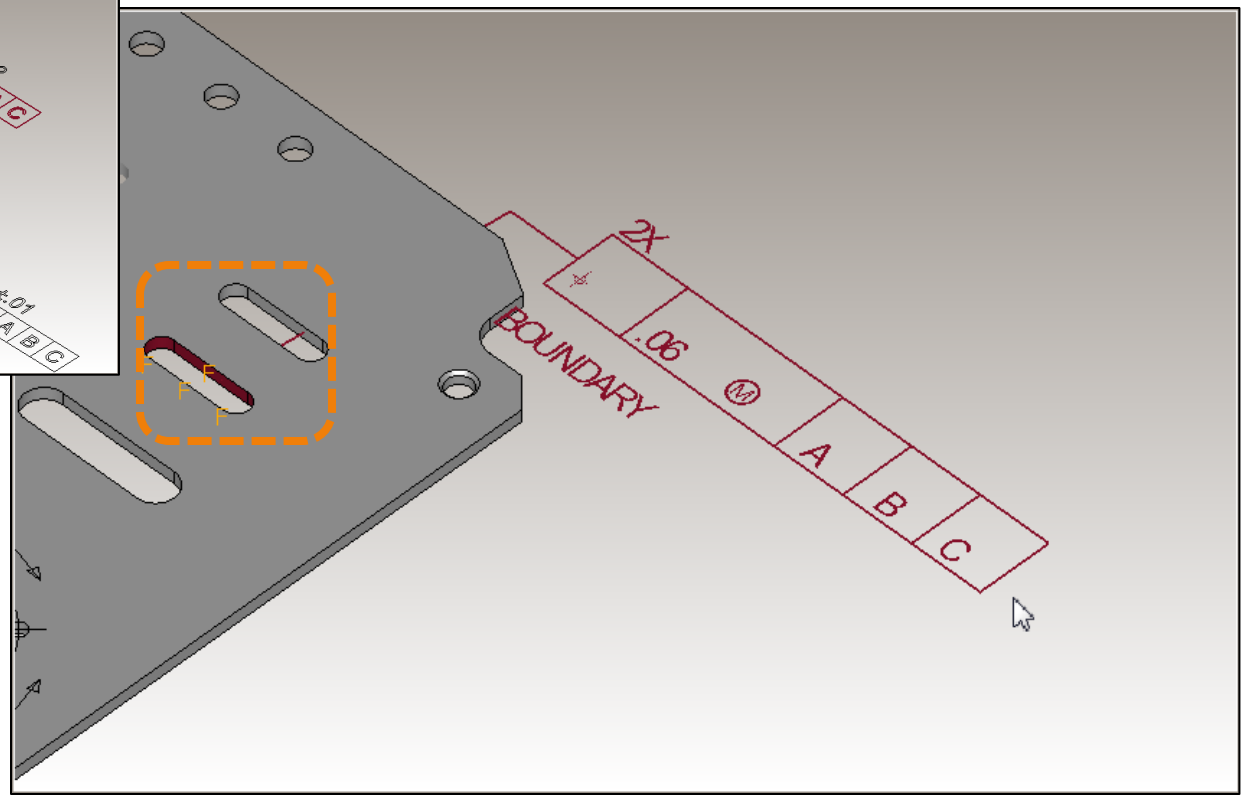
Return to Index

# Annotation Geometry: FCF associated with incorrect face

**Correct**




**Incorrect**



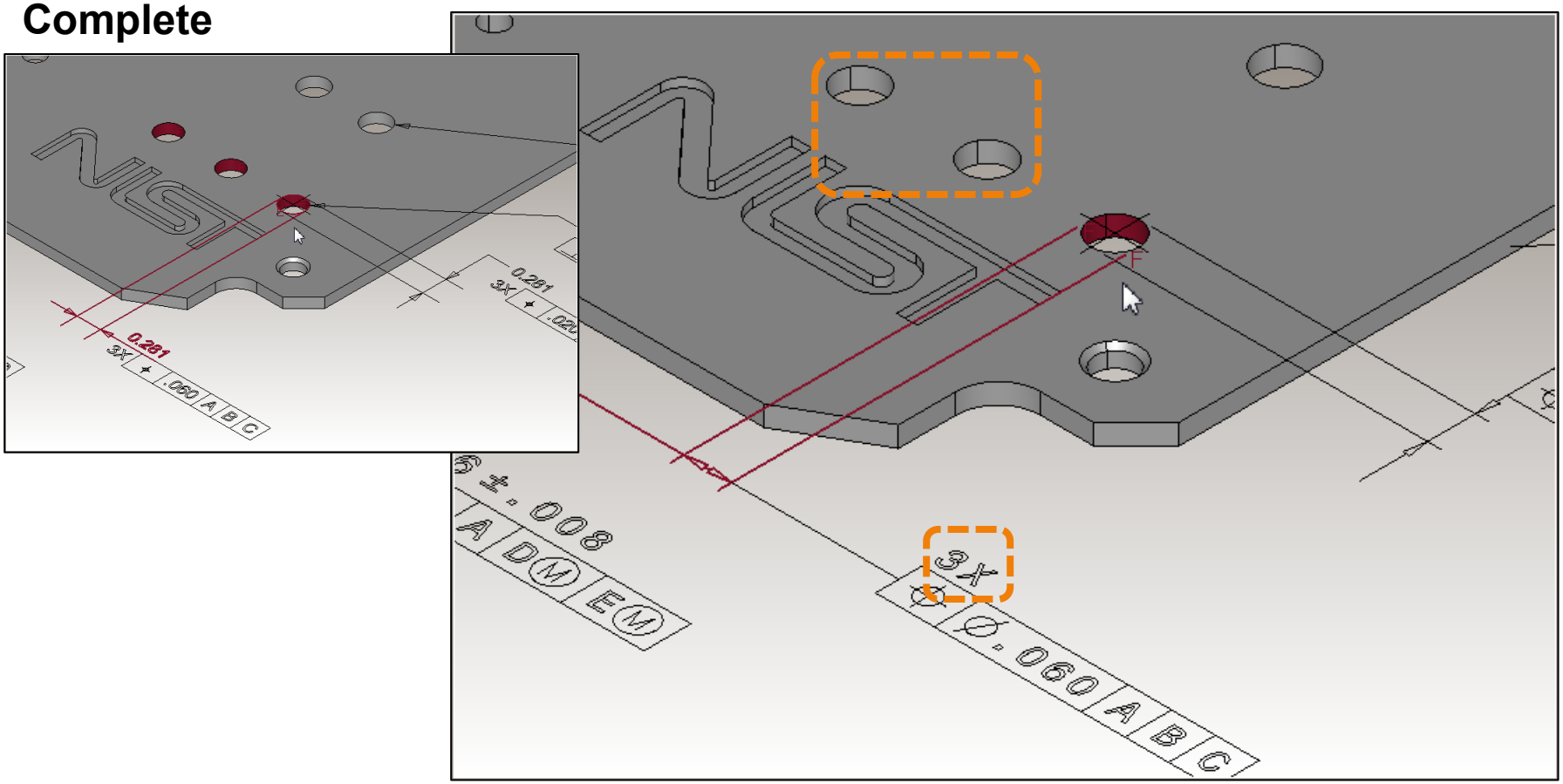

This feature control frame is not associated with the correct faces.

Return to Index

# Annotation Geometry: FCF extension line DIM not associated with correct face

**Complete**

**Incomplete**



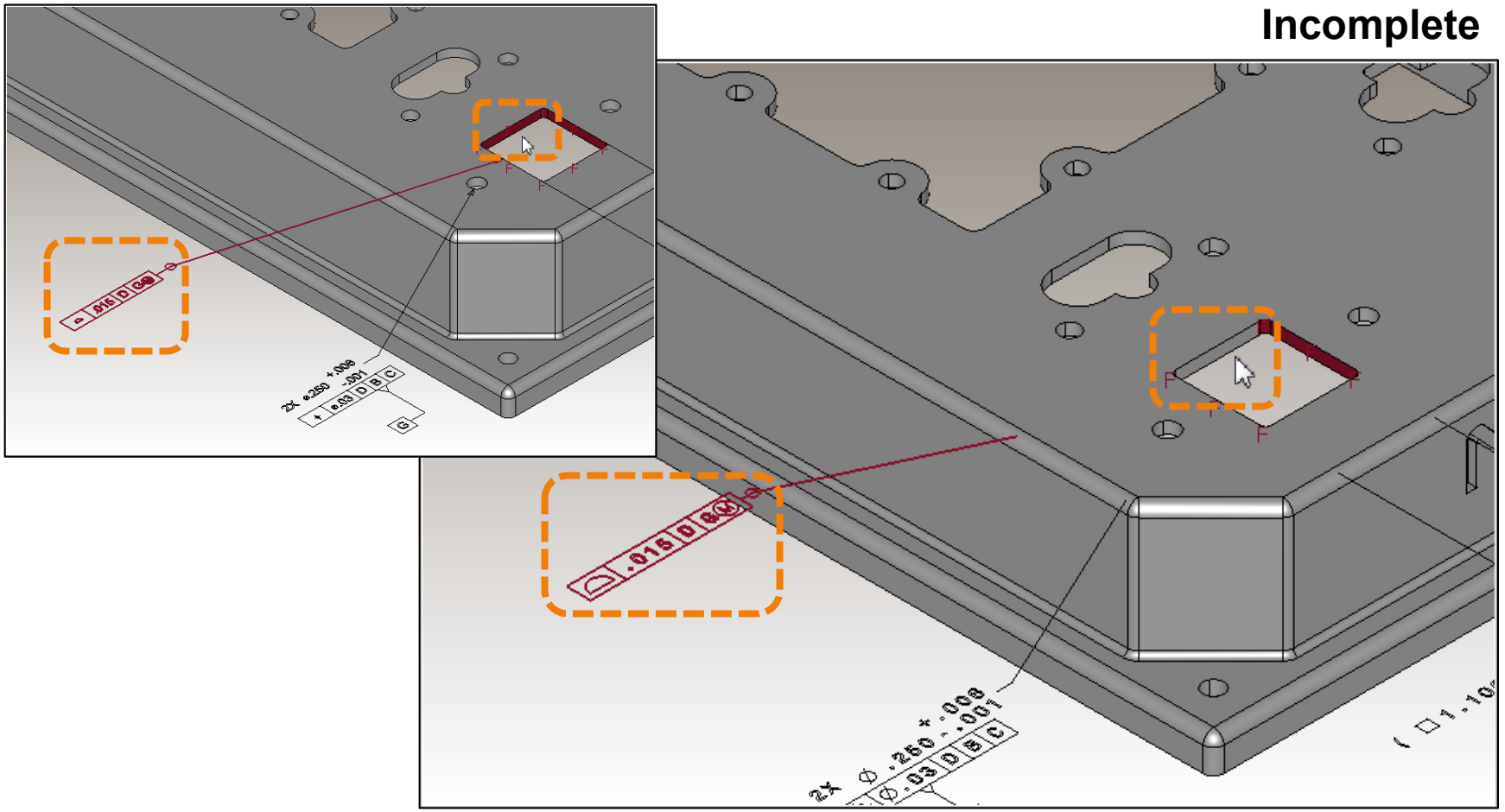

The extension lines for this dimension are not associated with all of the specified faces.

Return to Index

# Annotation Geometry: FCF not associated with complete set of faces

**Complete**

**Incomplete**

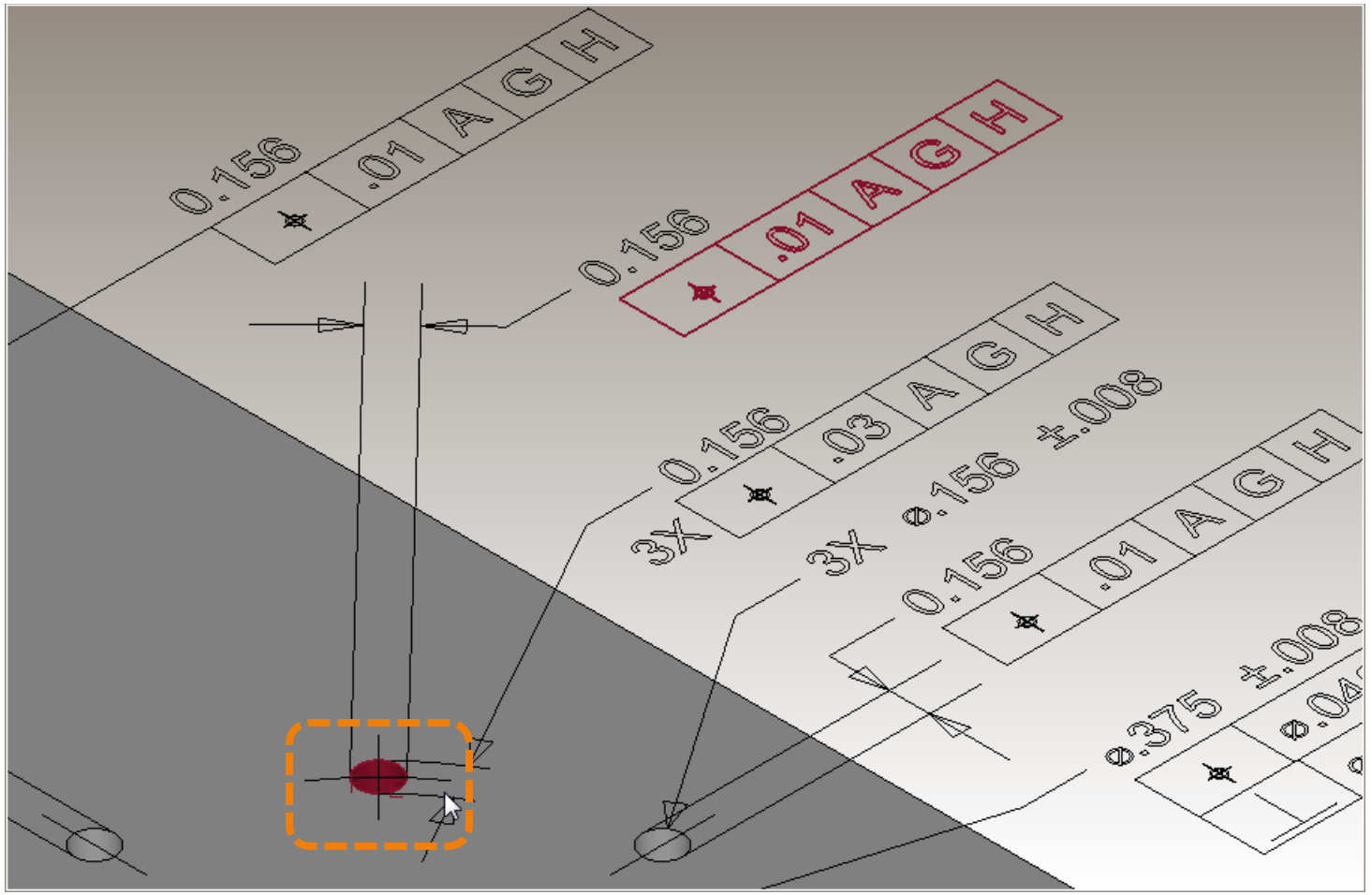



This feature control frame is not associated with all of the specified faces.

Return to Index

# Annotation Geometry: FCF not associated with SG curve






This feature control frame is not associated with the supplemental geometry curve that defines its tolerance direction on this face.

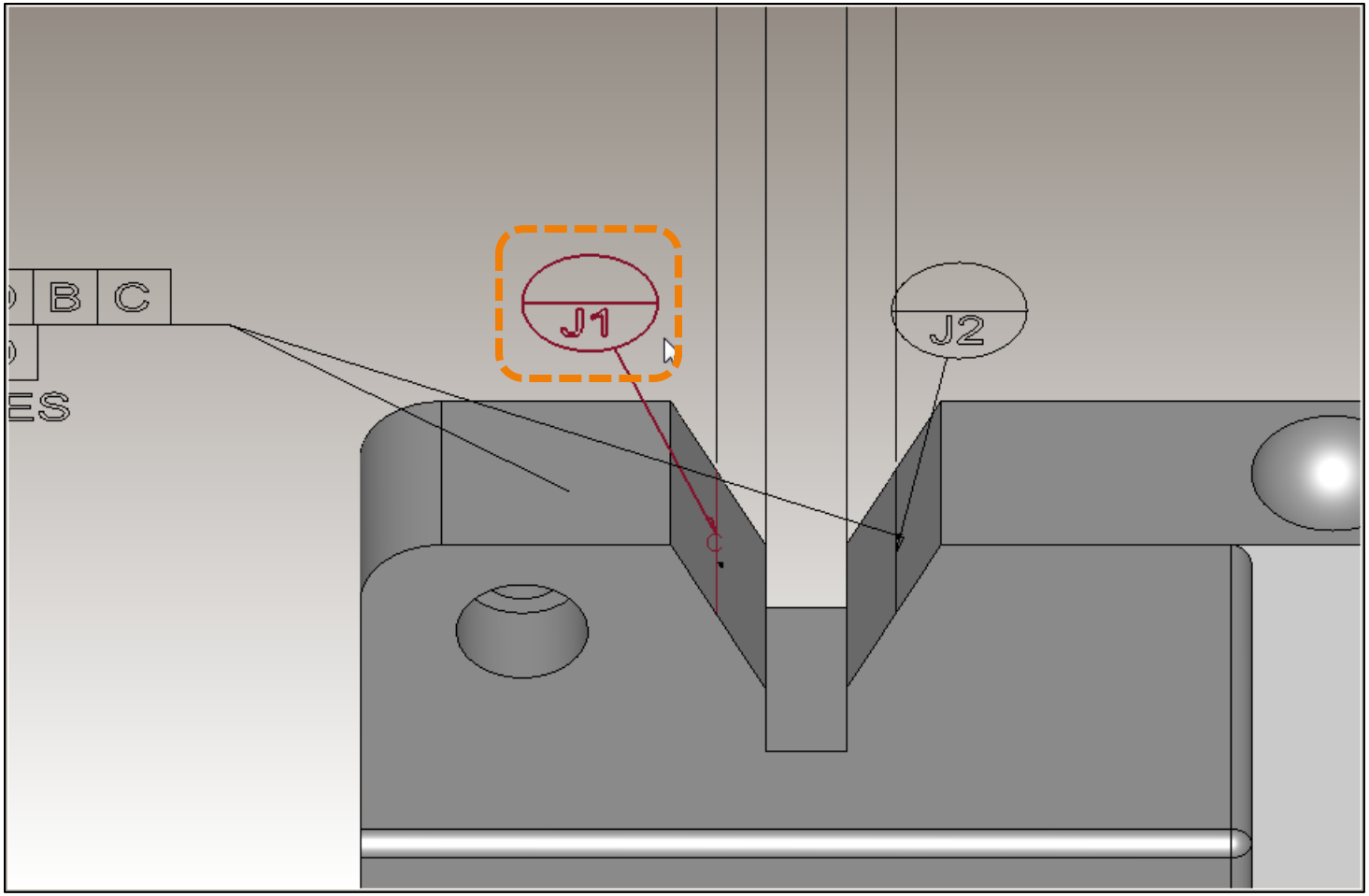
Return to Index

# CAD System Style Differences for Annotation Structure

Return to Index

# Annotation Structure: DTS requires DFS to be defined

Style Difference




The system requires a datum feature symbol to be defined when a datum target symbol is defined. It allows the datum feature symbol to be hidden so the view appears as specified in the test case.

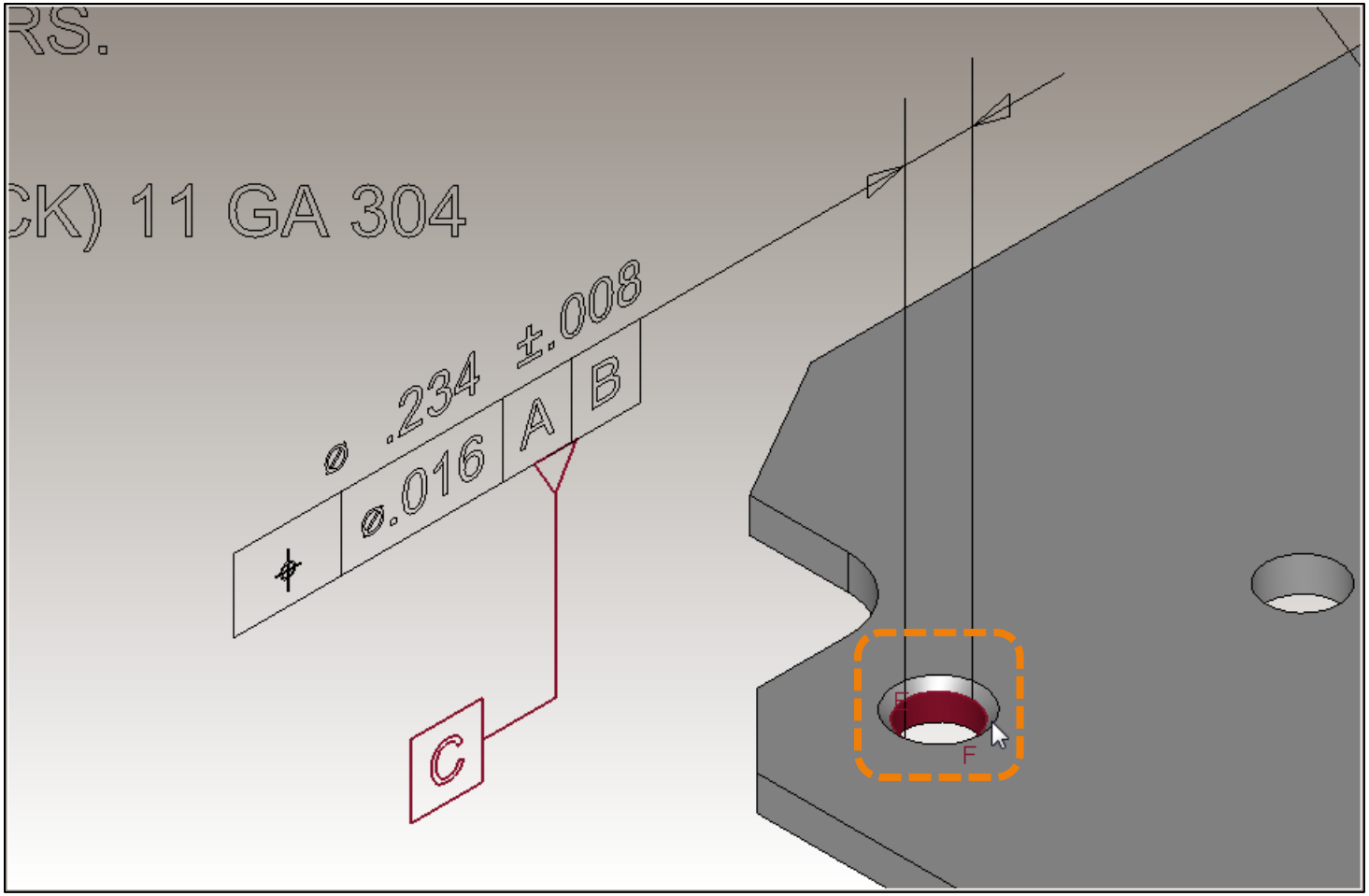
Return to Index

# CAD System Style Differences for Annotation Geometry

Return to Index

# Annotation Geometry: DFS edge association is extraneous

Style Difference



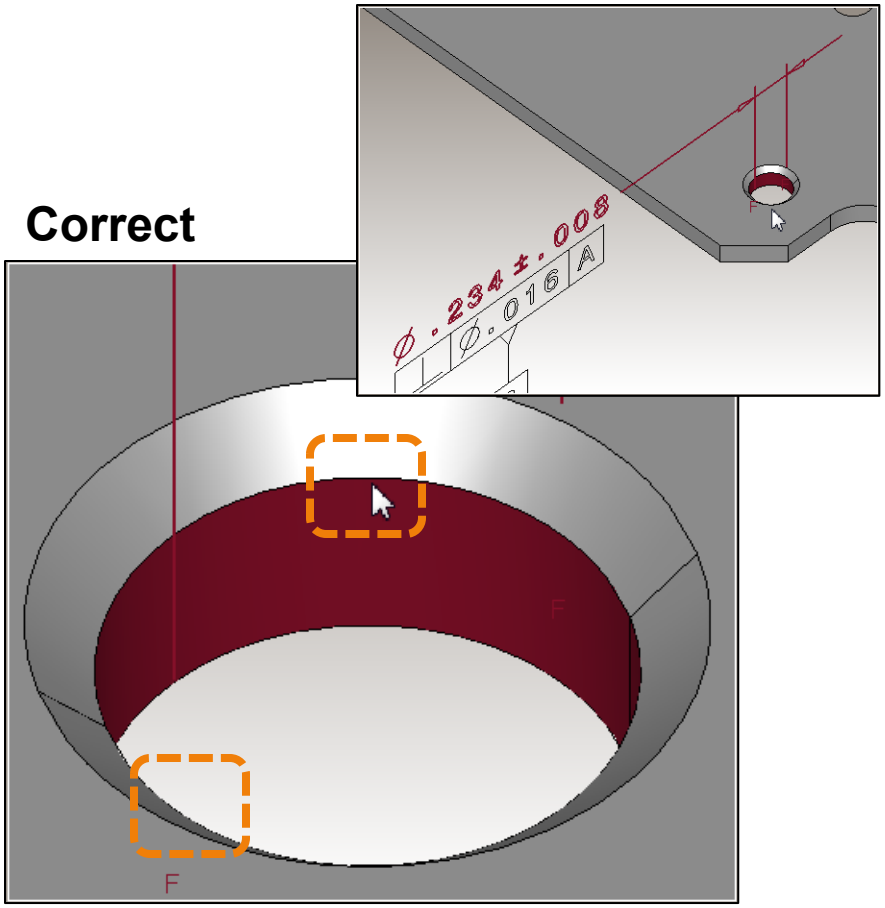

The association of this datum feature symbol with the edge of the hole is used to indicate graphical placement. It is not specified in the test case.

Return to Index

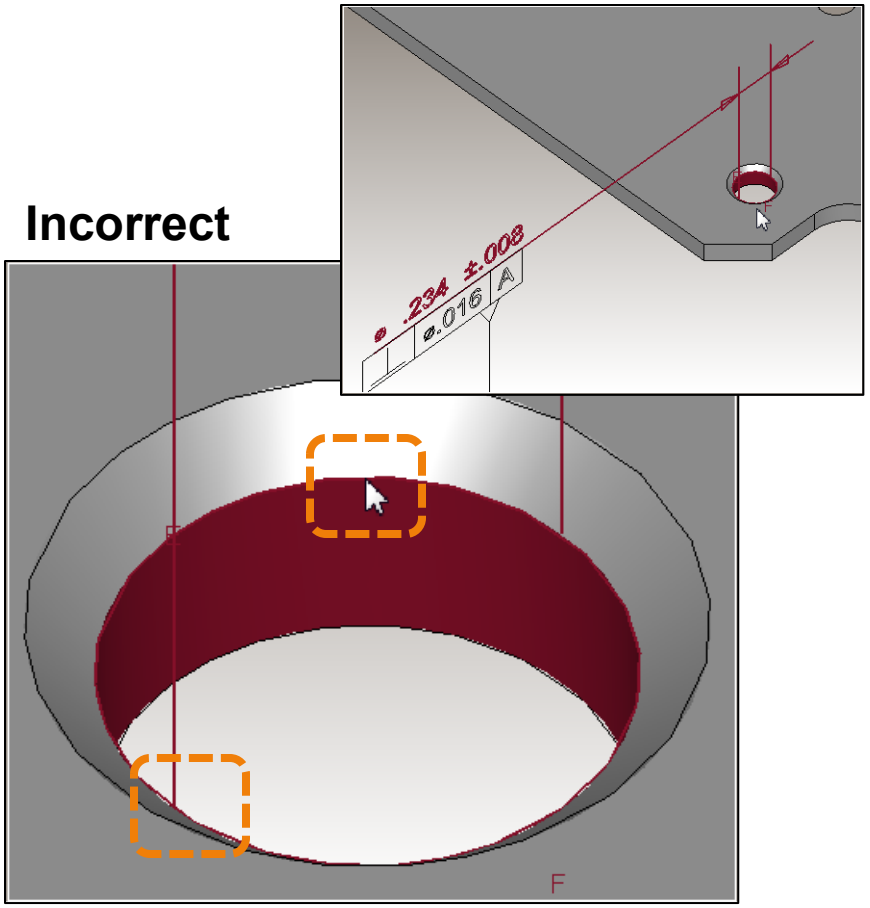
# Annotation Geometry: DIM edge association is extraneous

Style Difference

Correct




Incorrect



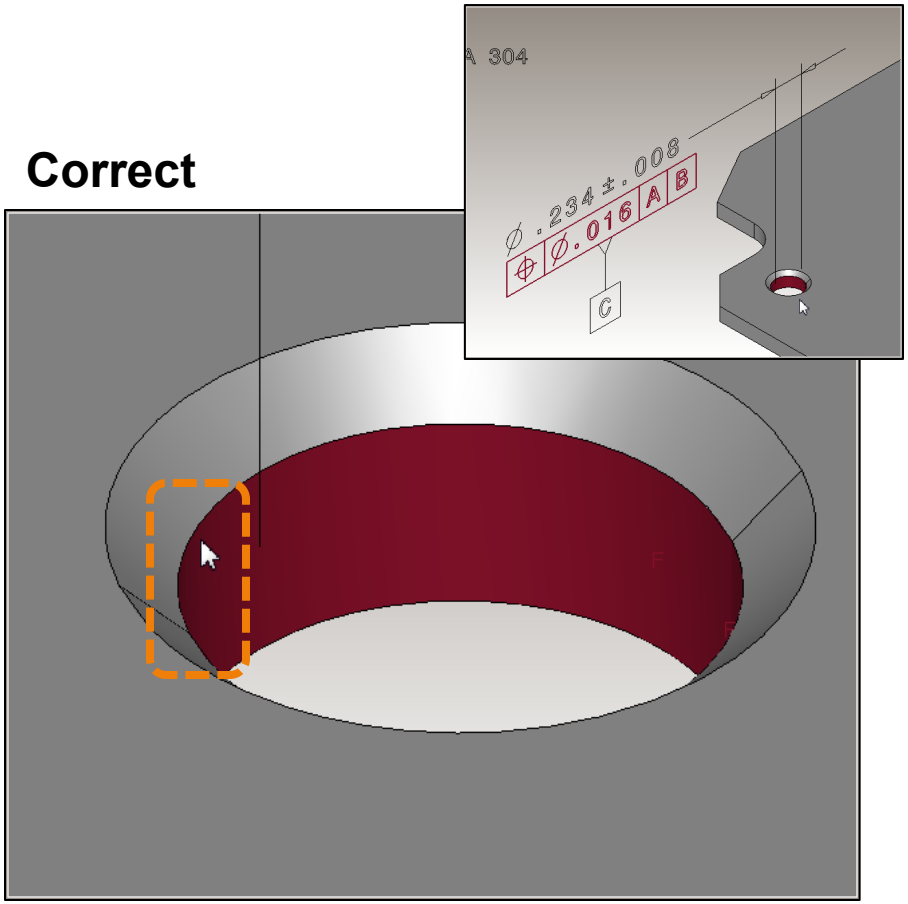

This dimension is unnecessarily associated with the edges of this hole.

Return to Index

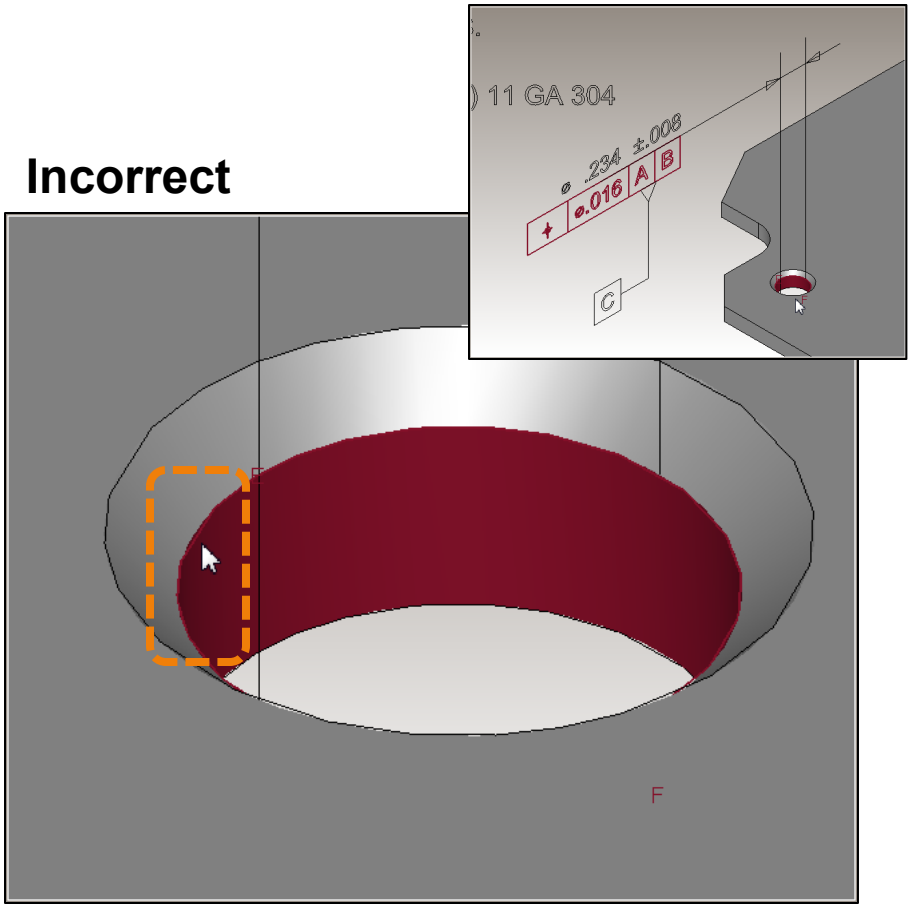
# Annotation Geometry: FCF edge association is extraneous

Style Difference

Correct




Incorrect




This geometric tolerance is unnecessarily associated with the edges of this hole.

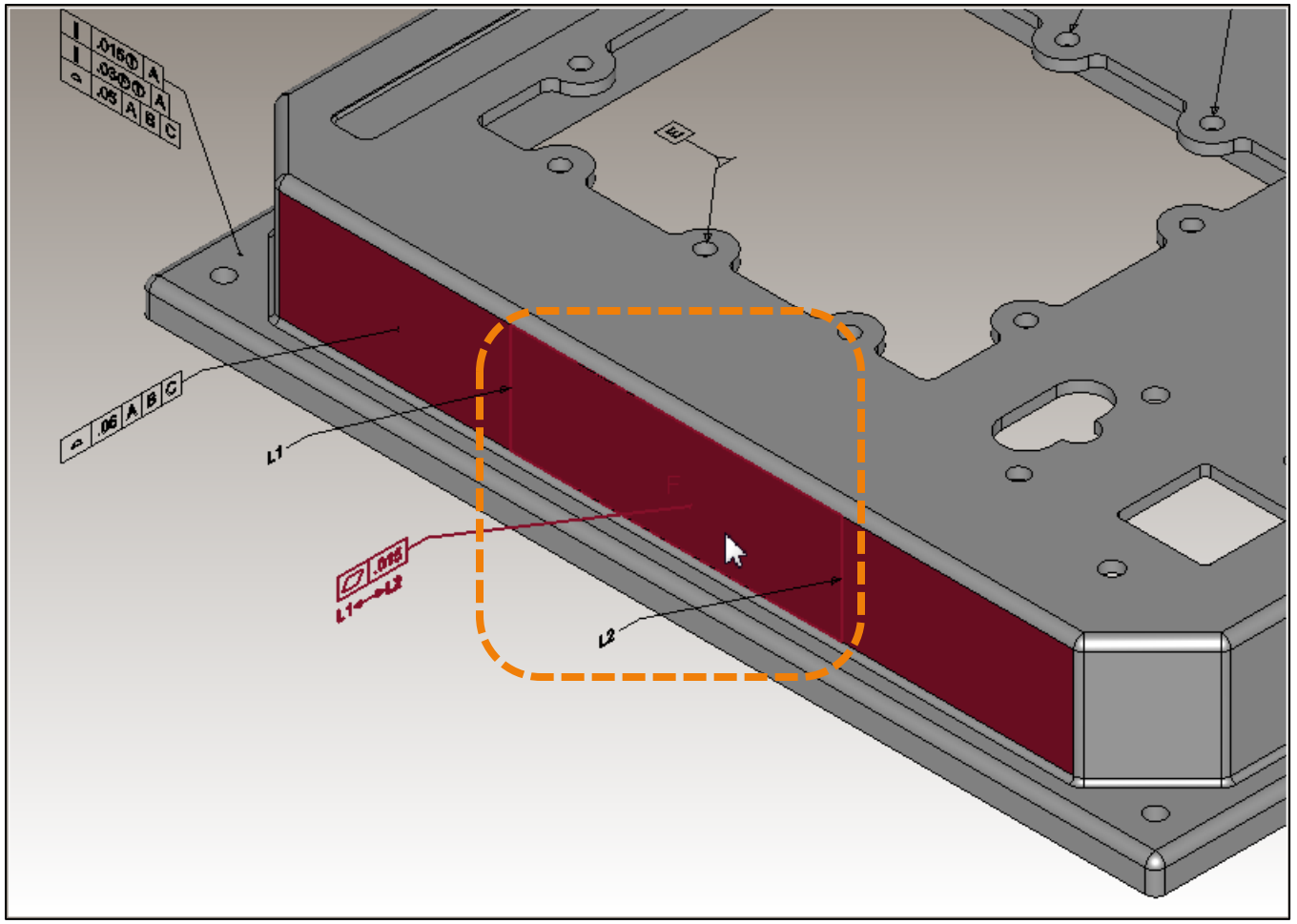
Return to Index

# CAD System Style Differences for Supplemental Geometry Structure

Return to Index

# Supplemental Geometry Structure: FCF limited area is non-solid surface on solid face

Style Difference

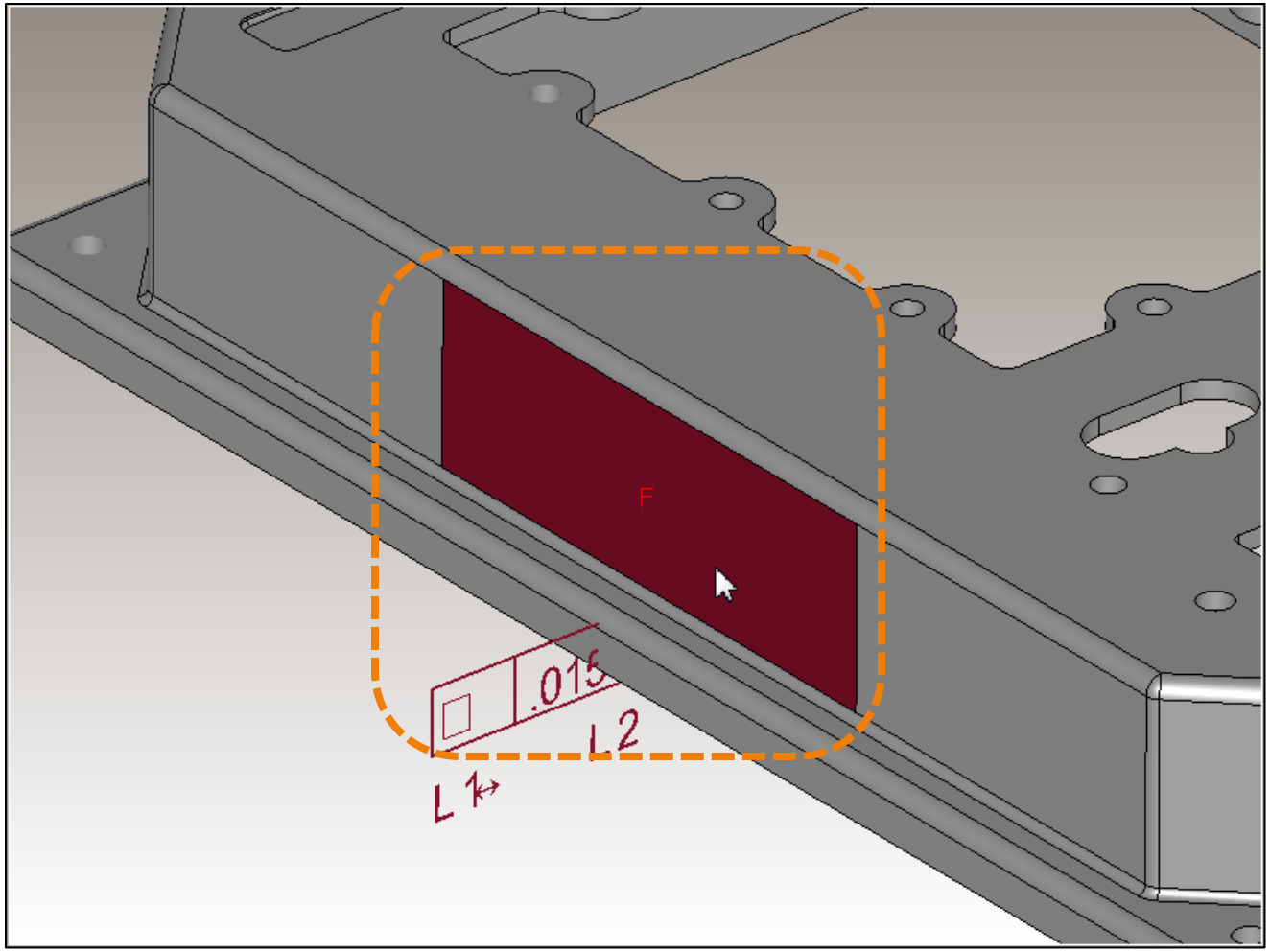



The limited area for this feature control frame is defined as a non-solid surface placed on the solid face.

Return to Index

# Supplemental Geometry Structure: FCF limited area is subdivided solid face

Style Difference




The limited area for this feature control frame is defined as a solid face that has been separated from the adjacent faces in this solid.

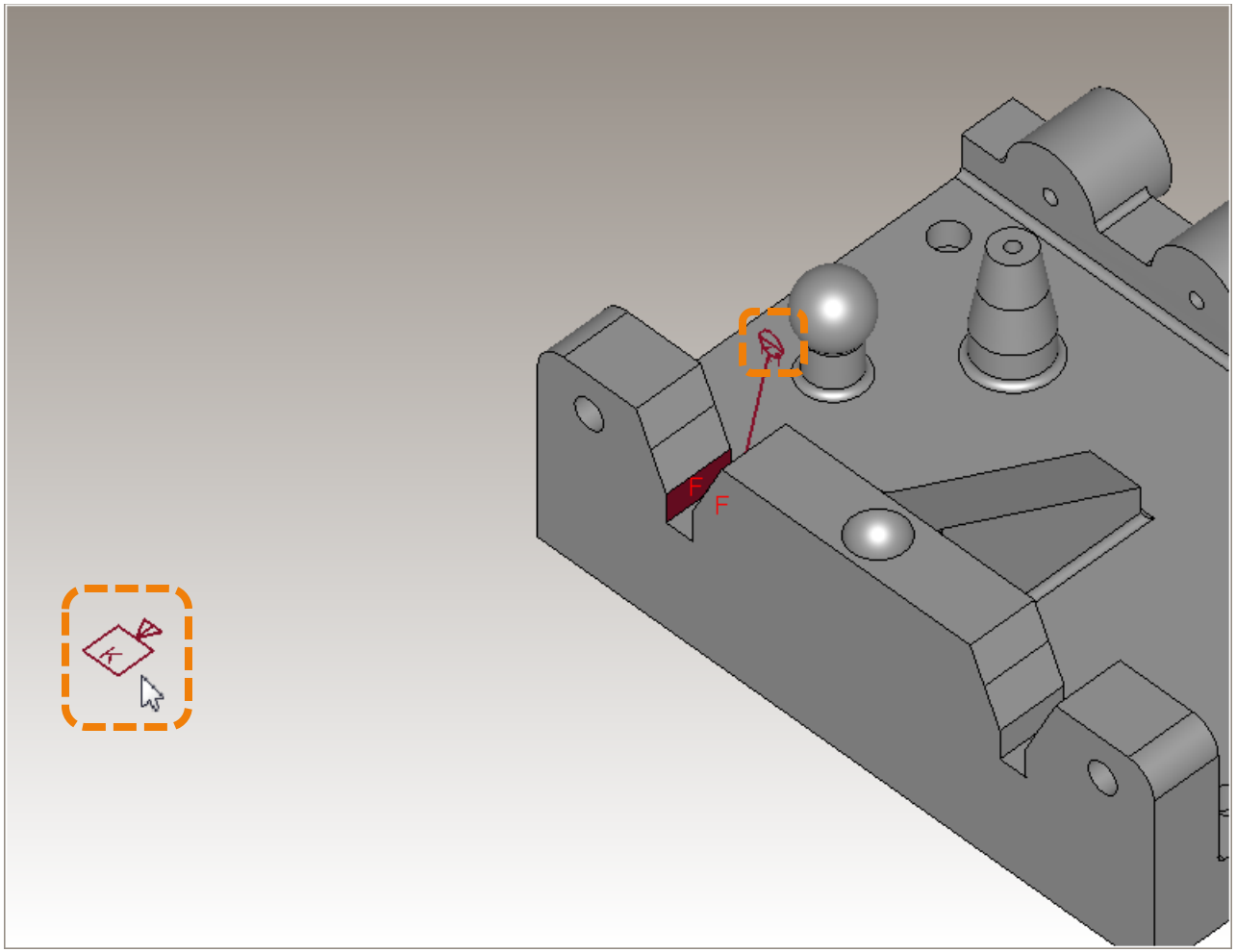
Return to Index

# CAD System Presentation Limitations for Annotation Visibility

Return to Index

# Annotation Visibility: DFS is extraneous when DTS is defined

Presentation Limitation




This datum feature symbol is unnecessary when a datum target symbol is defined.

Return to Index

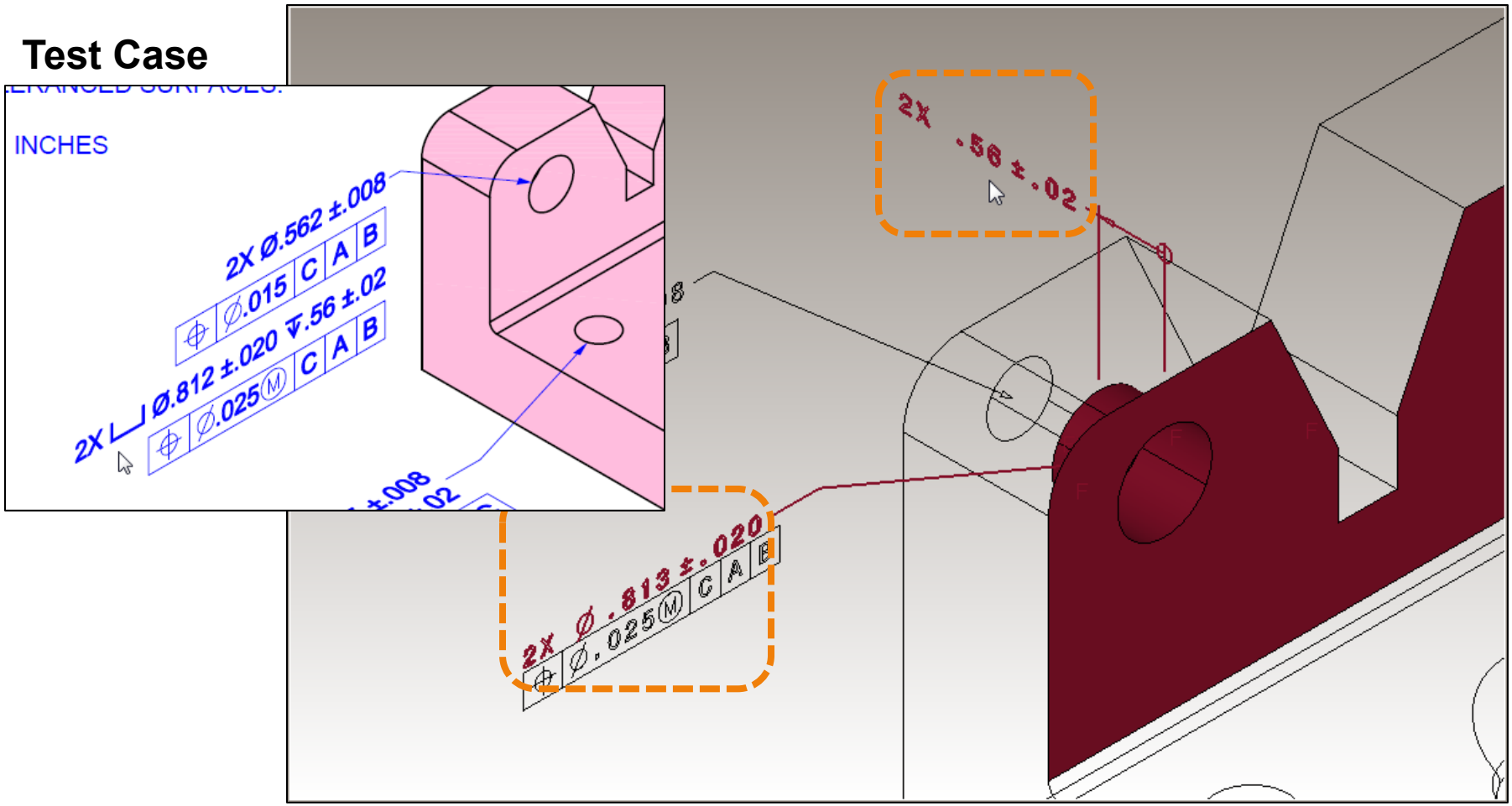
# CAD System Presentation Limitations for Annotation Layout

Return to Index

# Annotation Layout: Counterbore DIM defined as two separate DIM's

Presentation Limitation

**Test Case**



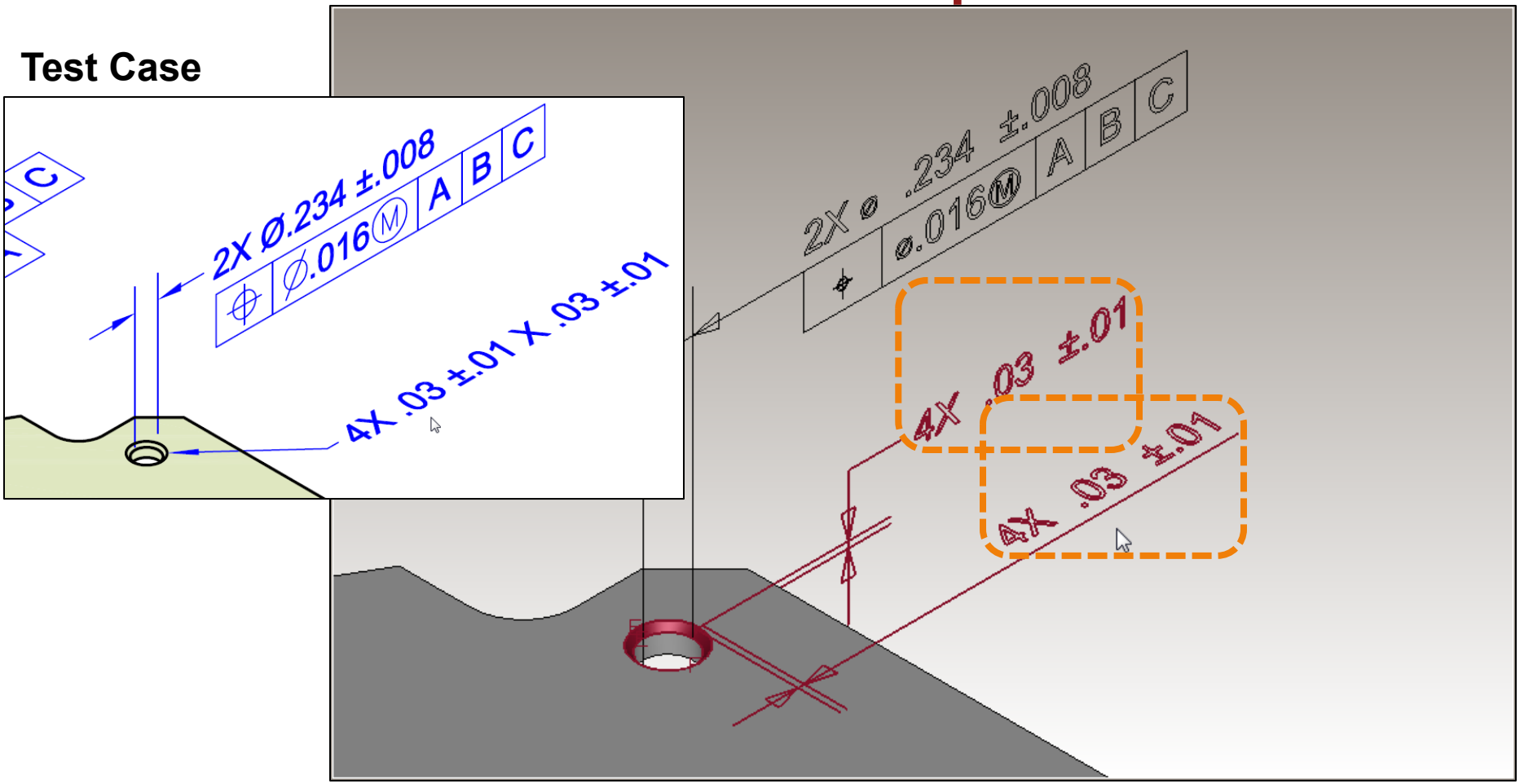

This counterbore dimension cannot be defined as a single annotation with named parameters that each have correct face associations. It must be defined as two separate dimensions.

Return to Index

# Annotation Layout: Countersink DIM defined as two separate DIM's

Presentation Limitation

**Test Case**




This countersink dimension cannot be defined as a single annotation with named parameters that each have correct face associations. It must be defined as two separate dimensions.

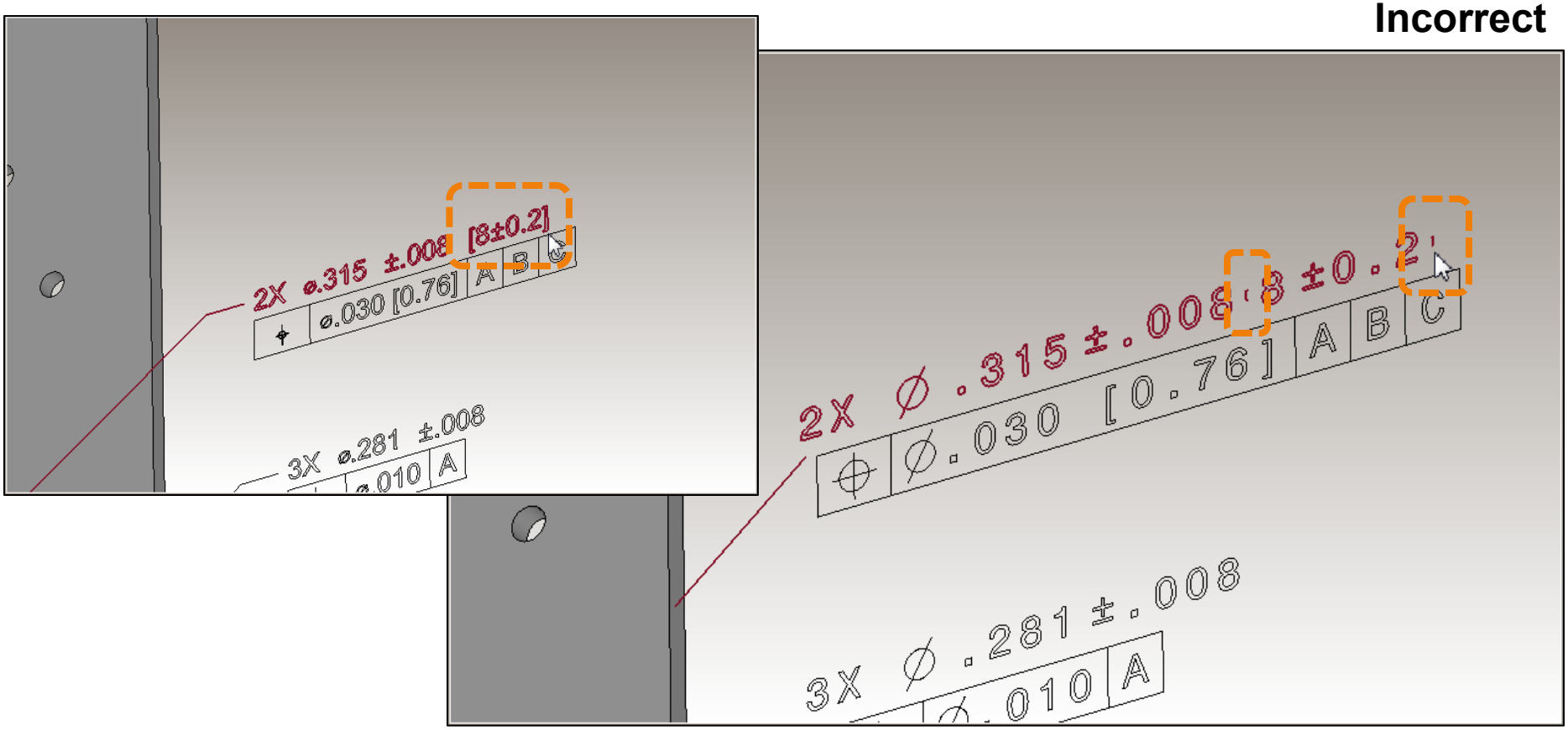
Return to Index

# Annotation Layout:
# DIM dual dimension bracket size very small

Presentation Limitation

**Correct**

**Incorrect**




The brackets on this dimension are very small relative to the text height.

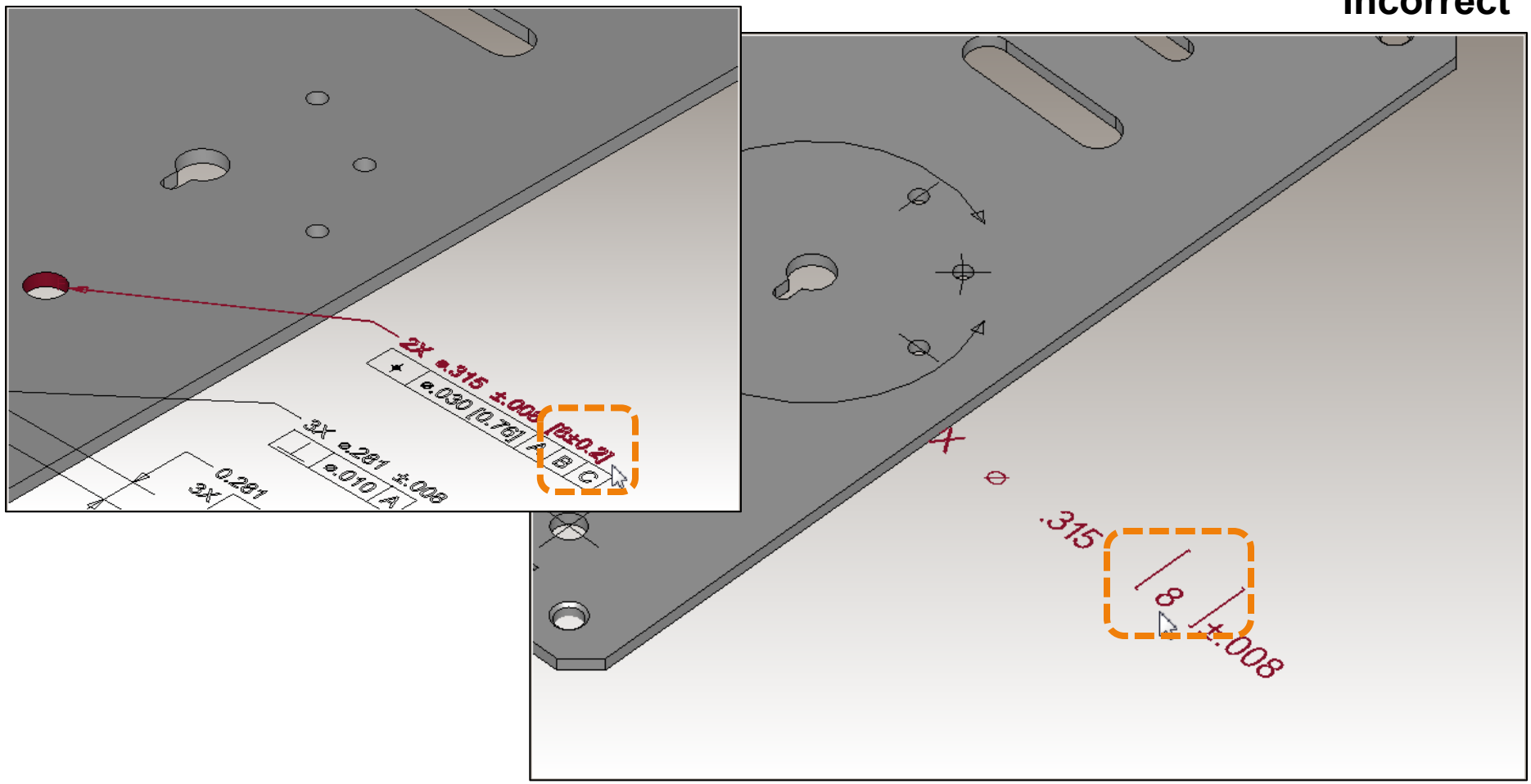
Return to Index

# Annotation Layout:
# DIM dual dimension position is incorrect

Presentation Limitation

**Correct**

**Incorrect**



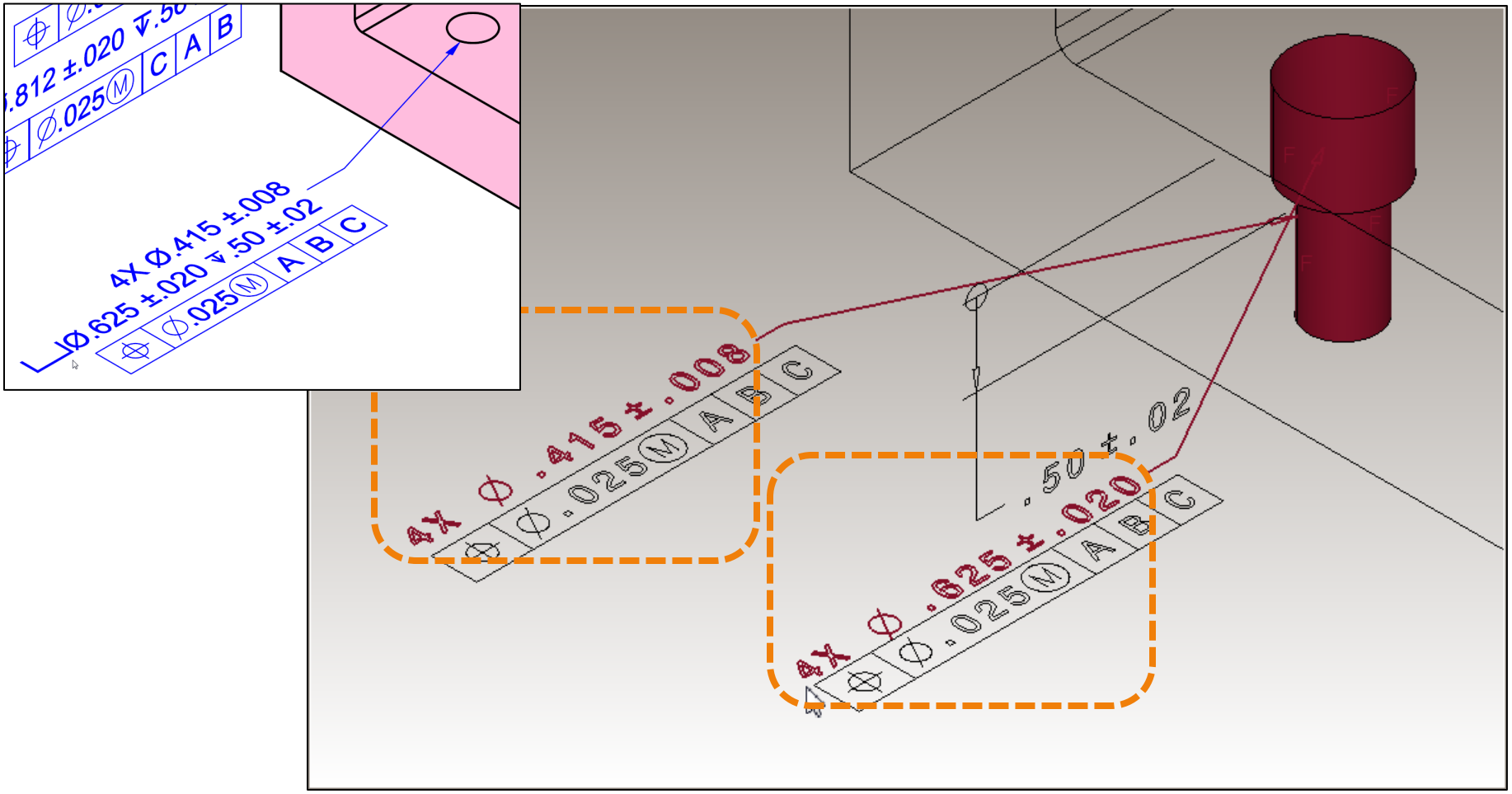

This dual dimension is inserted between the primary nominal dimension and its tolerance.

Return to Index

# Annotation Layout: DIM not stacked correctly

Presentation Limitation

## Test Case



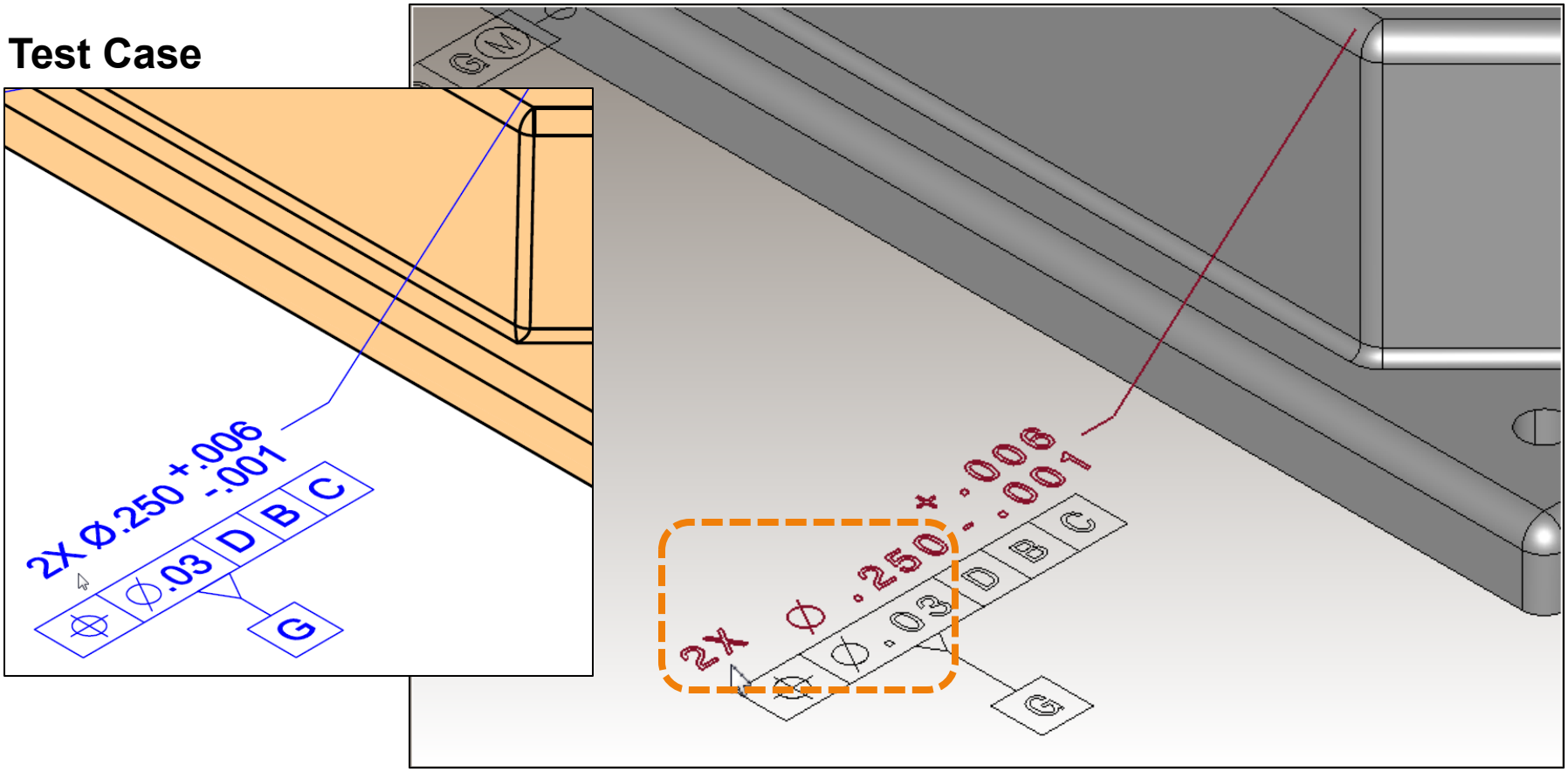

These hole and counterbore dimensions are not combined as specified.

Return to Index

# Annotation Layout: DIM text misaligned

Presentation Limitation

**Test Case**

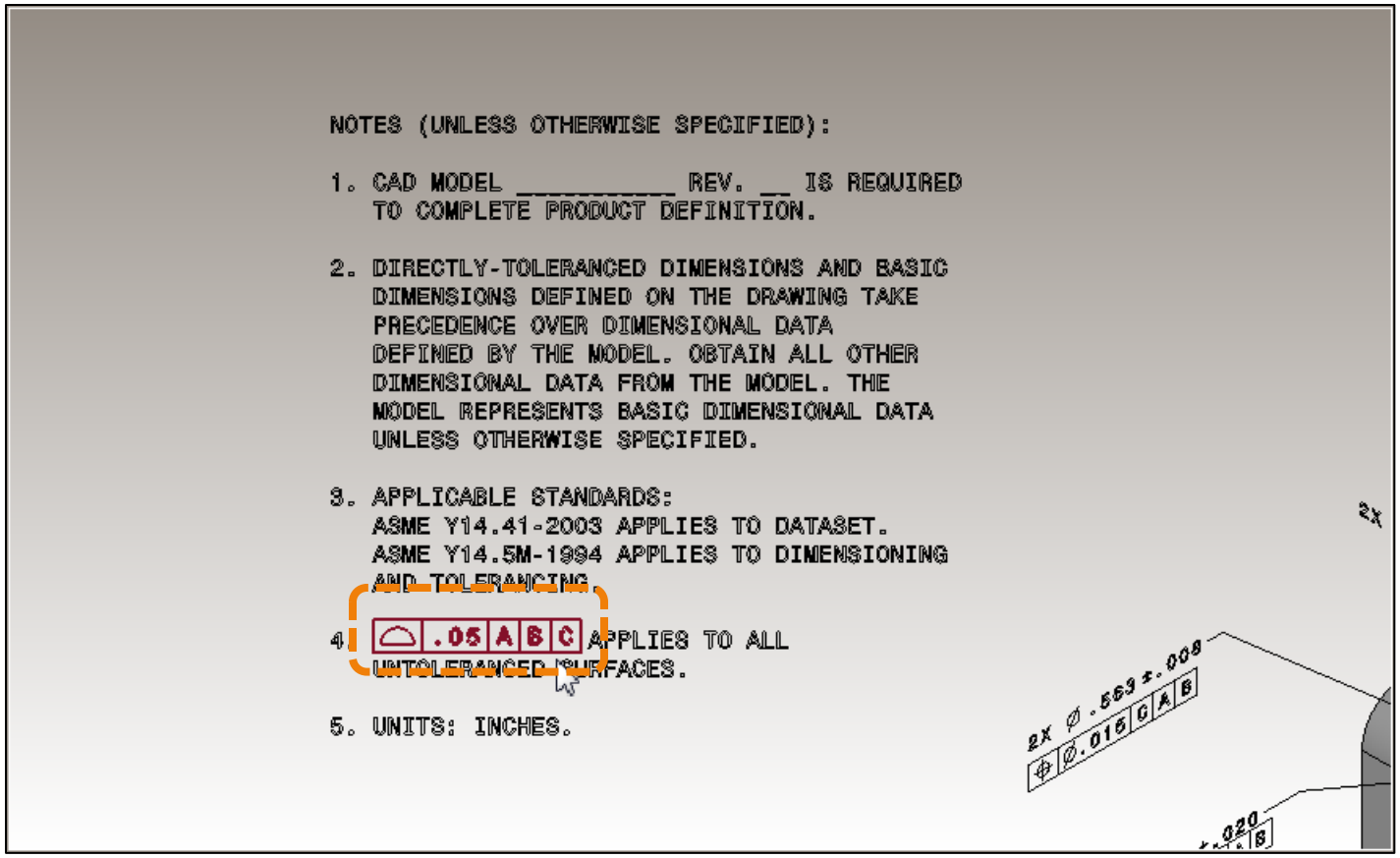



The text for the nominal value of this dimension is not aligned as specified.

Return to Index

# Annotation Layout:
# FCF defined separate from general note text

Presentation Limitation



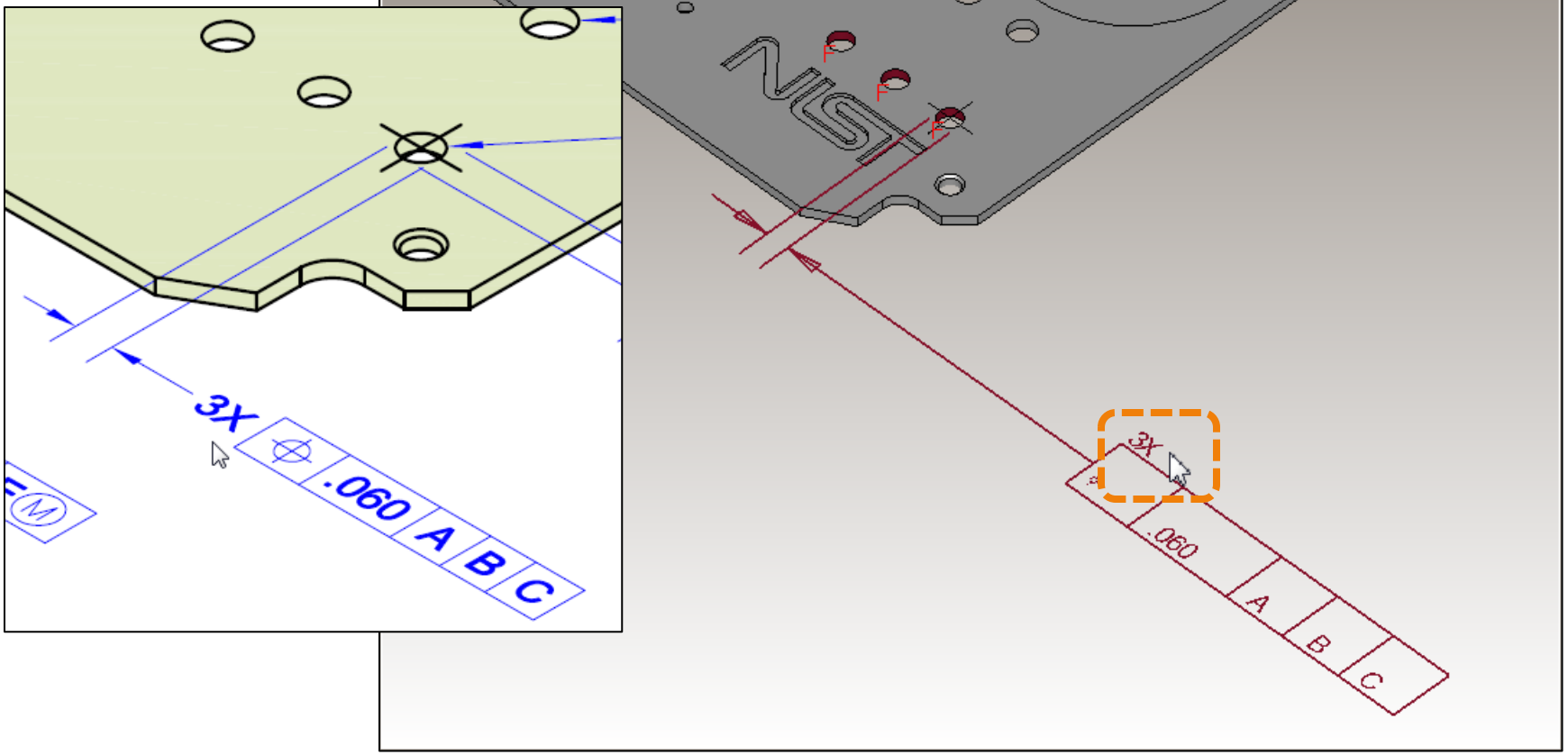

This geometric tolerance is defined as a separate entity from the general notes.

Return to Index

# Annotation Layout: FCF instance count not in front

Presentation Limitation

Test Case



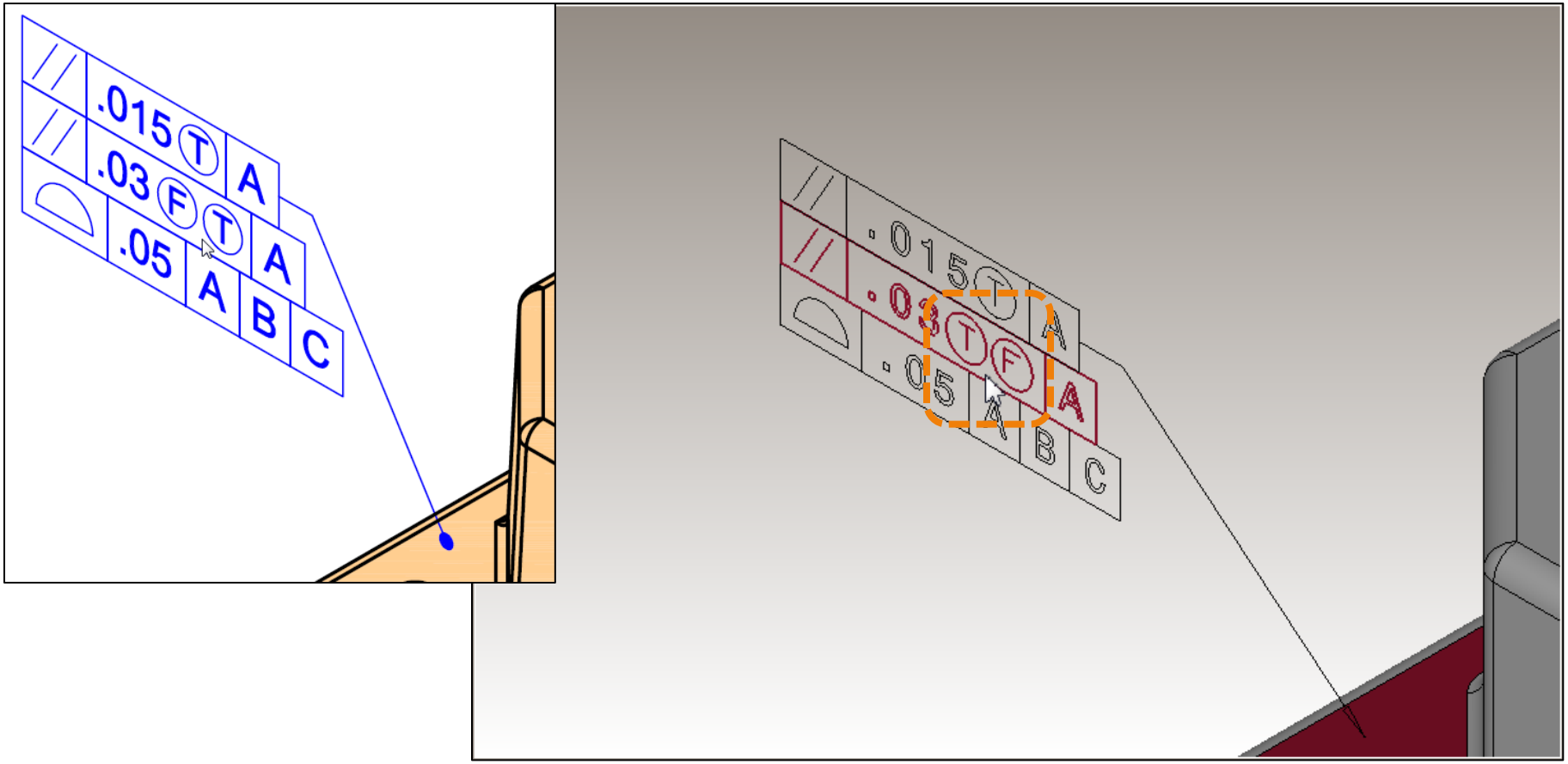

This instance count is not in the specified location.

Return to Index

# Annotation Layout: FCF modifiers reversed

Presentation Limitation

## Test Case



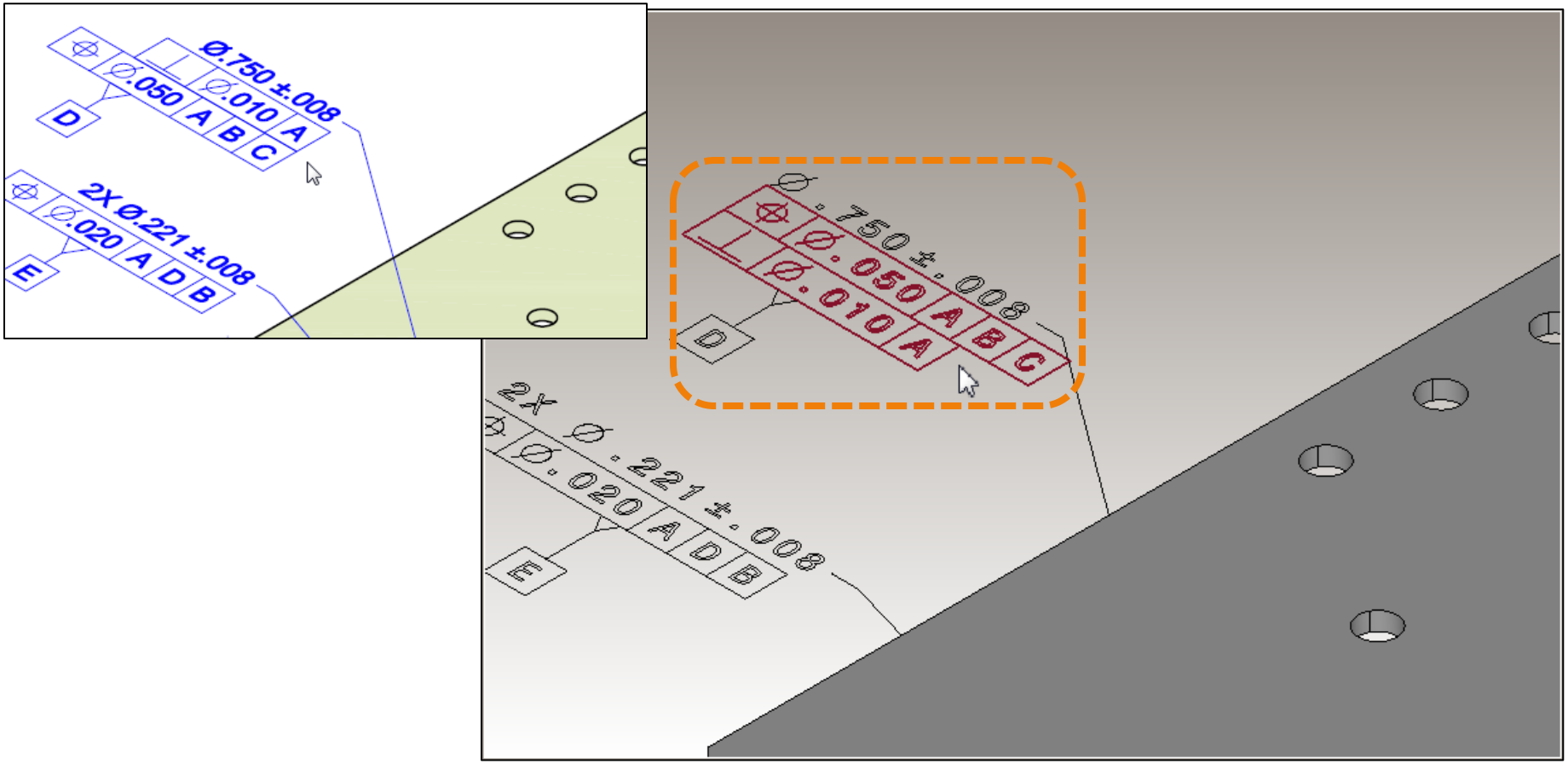

The order of these feature control frame modifiers is reversed from the specification.

Return to Index

# Annotation Layout: FCF stack order reversed

Presentation Limitation

## Test Case



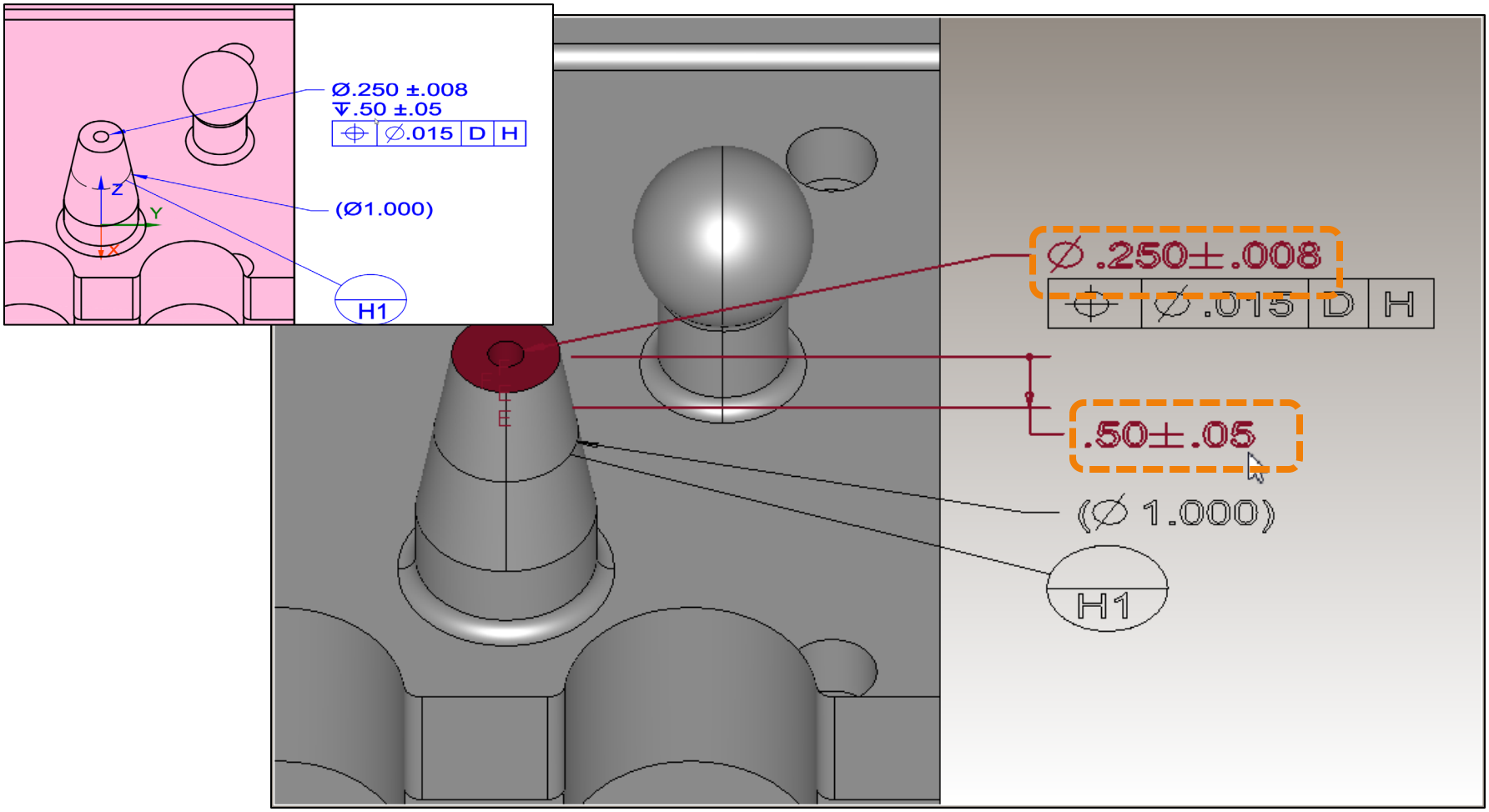

These feature control frames are not stacked as specified.

Return to Index

# Annotation Layout:
# Hole DIM defined as two separate DIM's

Presentation Limitation

## Test Case



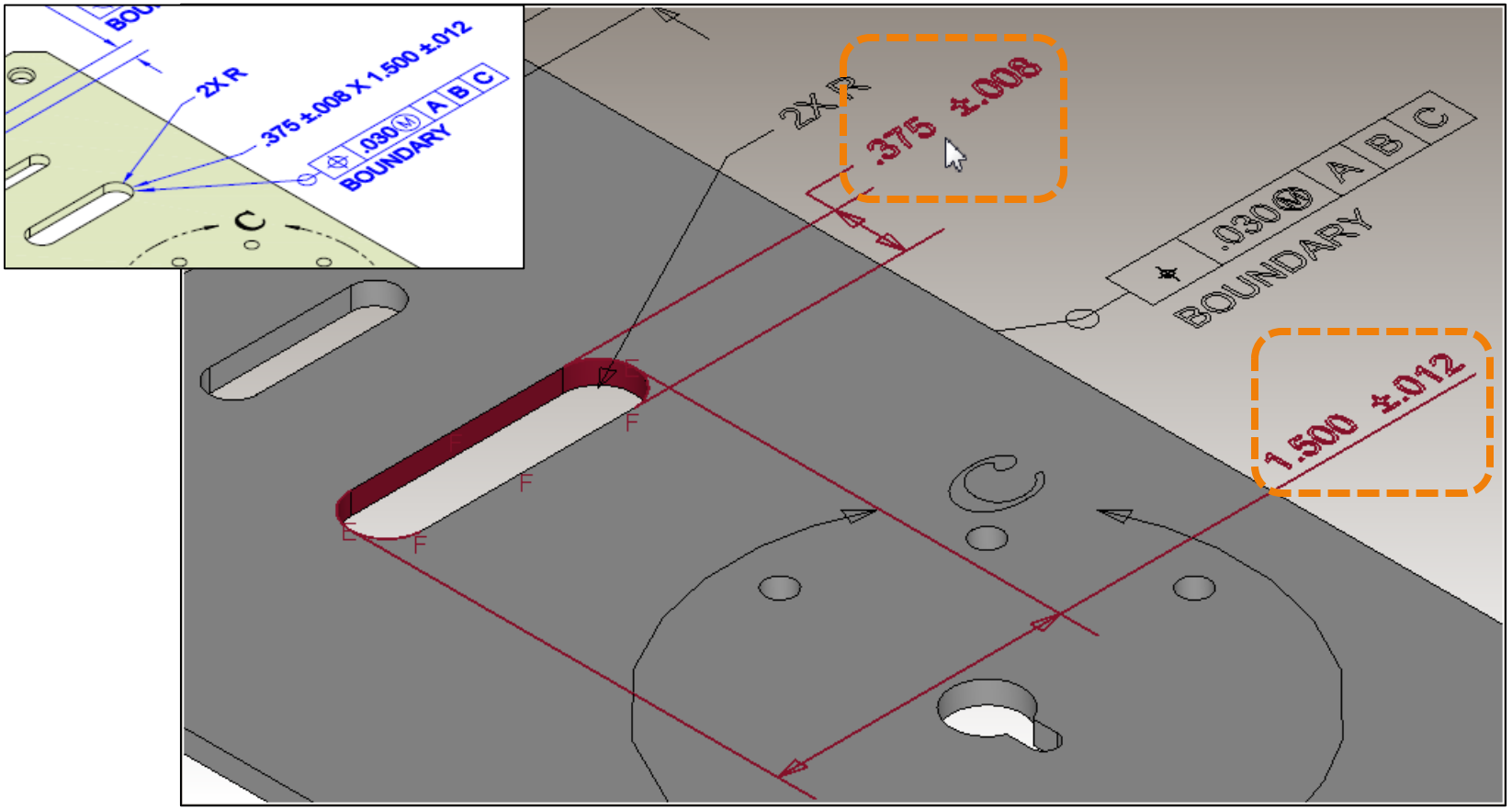

This hole dimension is defined using two separate dimensions.

Return to Index

# Annotation Layout:
# Slot DIM defined as two separate DIMS

Presentation Limitation

## Test Case




This slot dimension is defined using two separate dimensions.

Return to Index

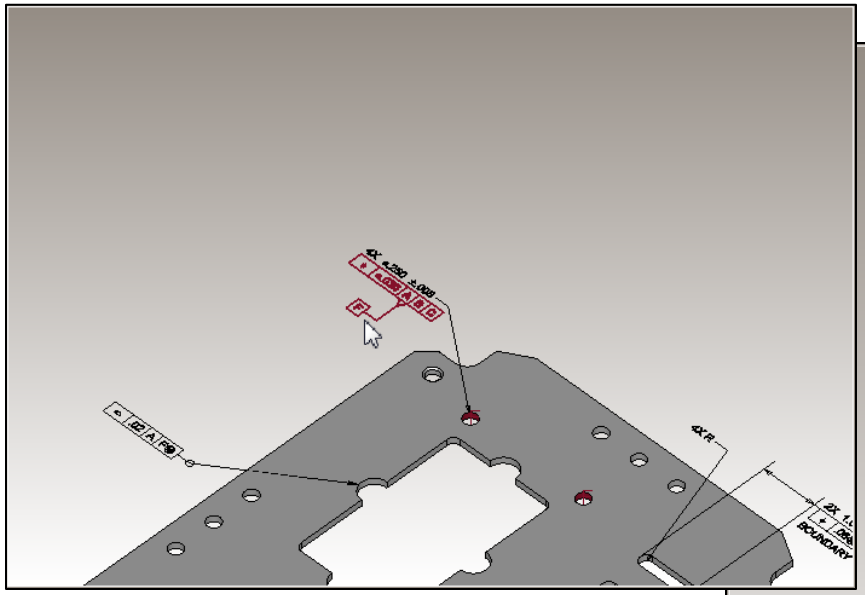
# CAD System Presentation Limitations for Annotation Location

Return to Index

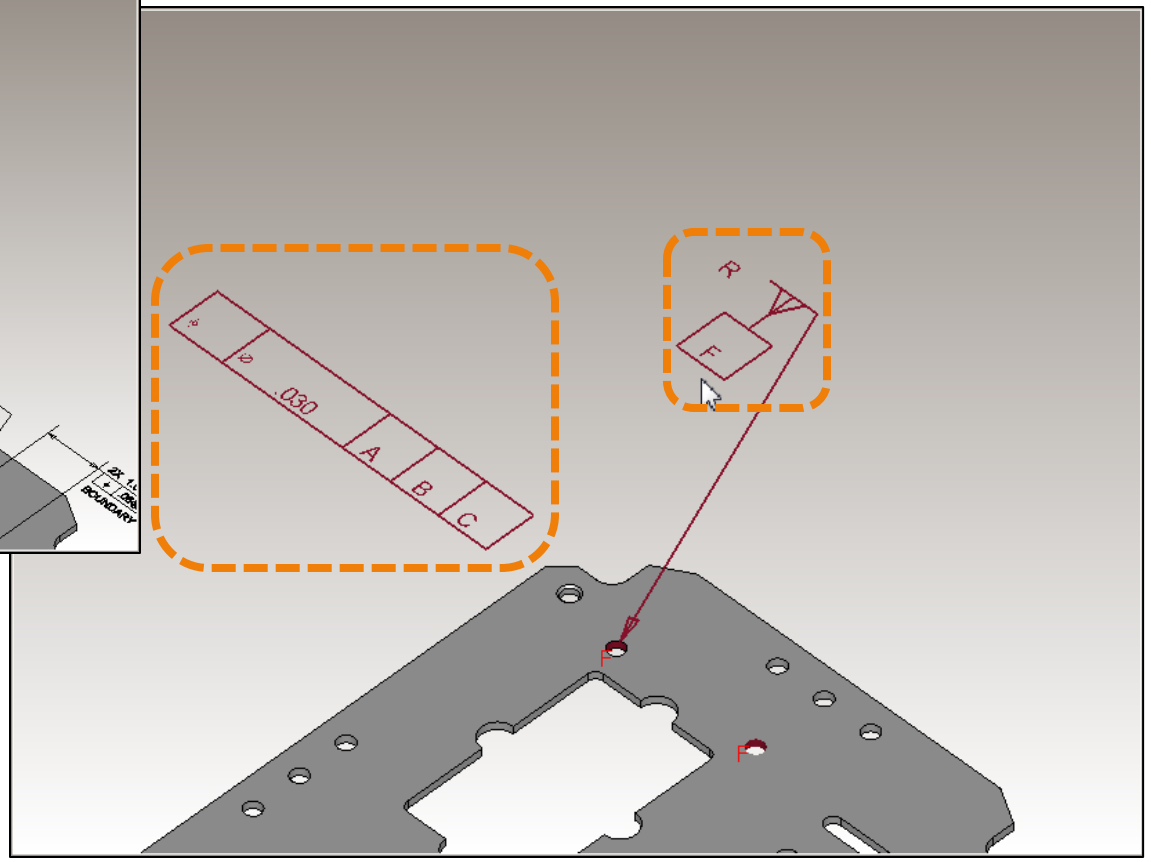
# Annotation Location: DFS not attached to FCF

Presentation Limitation

**Attached**



**Not Attached**



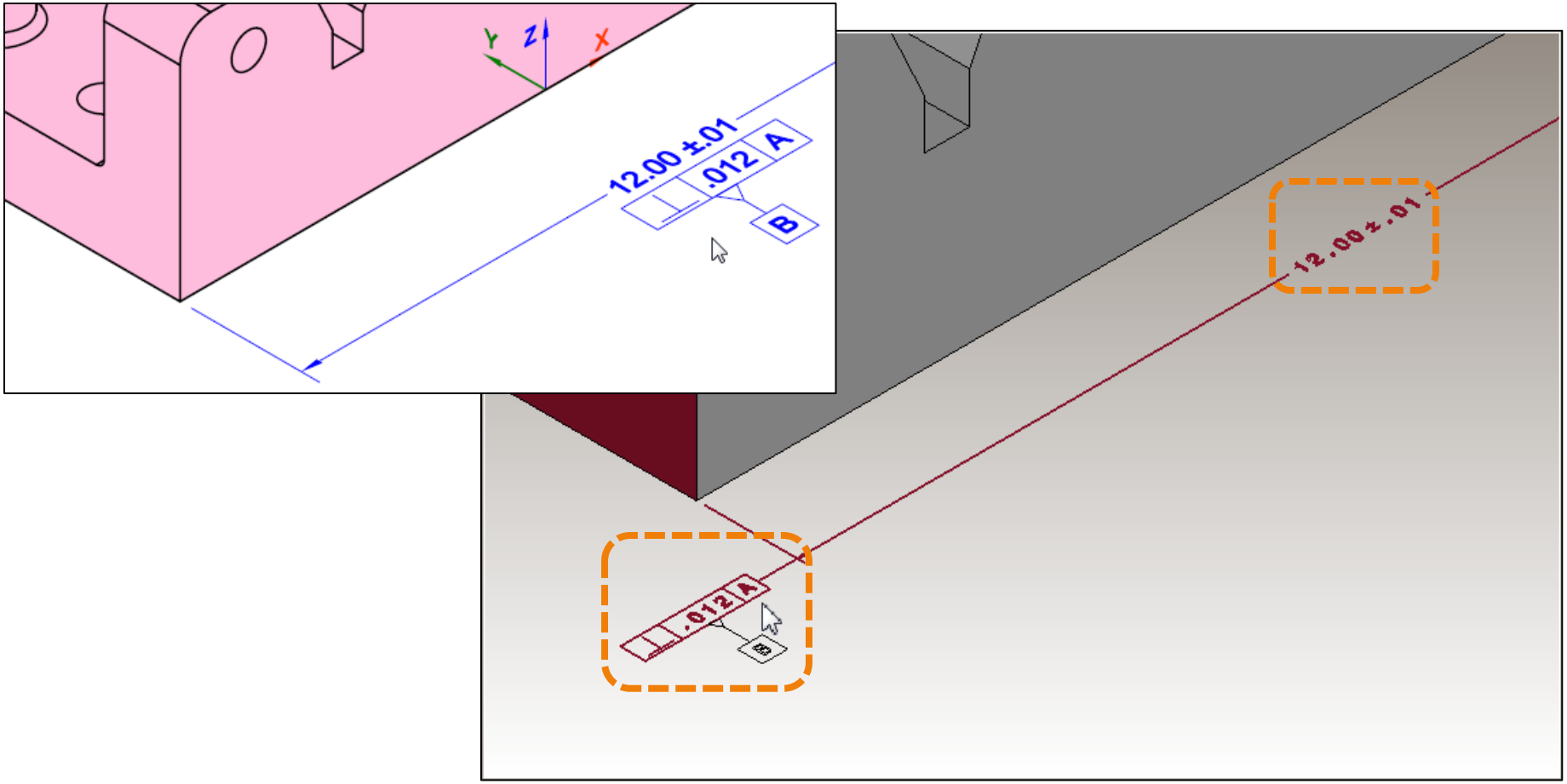

This datum feature symbol is not attached to the associated feature control frame for this hole pattern.

Return to Index

# Annotation Location: FCF not attached to DIM

Presentation Limitation

## Test Case




This feature control frame is not attached to it's associated dimension.

Return to Index

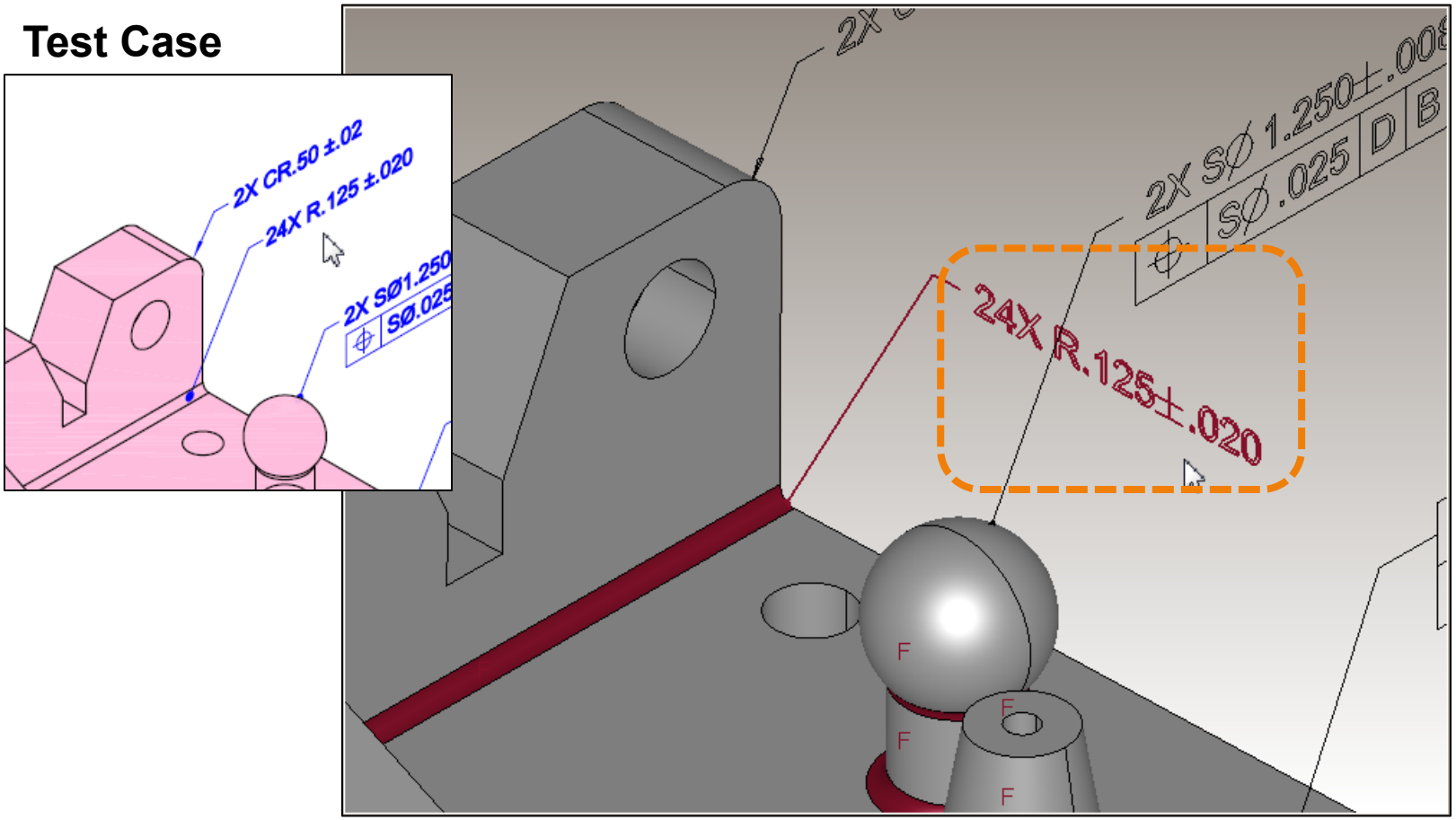
# CAD System Presentation Limitations for Annotation Orientation

Return to Index

# Annotation Orientation: DIM view plane rotated

Presentation Limitation

**Test Case**



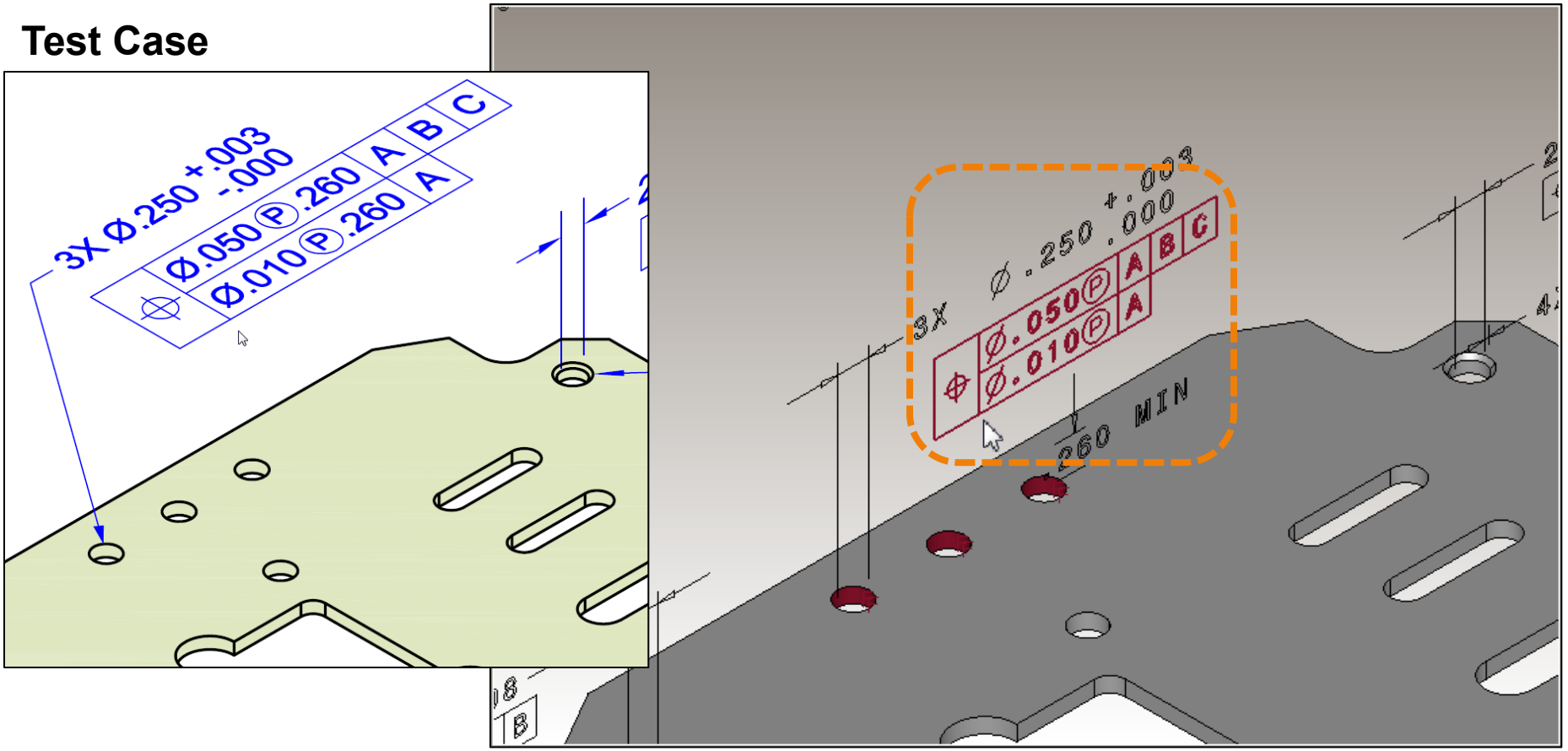

This dimension is not oriented as specified.

Return to Index

# Annotation Orientation: FCF view plane rotated

Presentation Limitation

Test Case




This feature control frame is not oriented as specified.

Return to Index

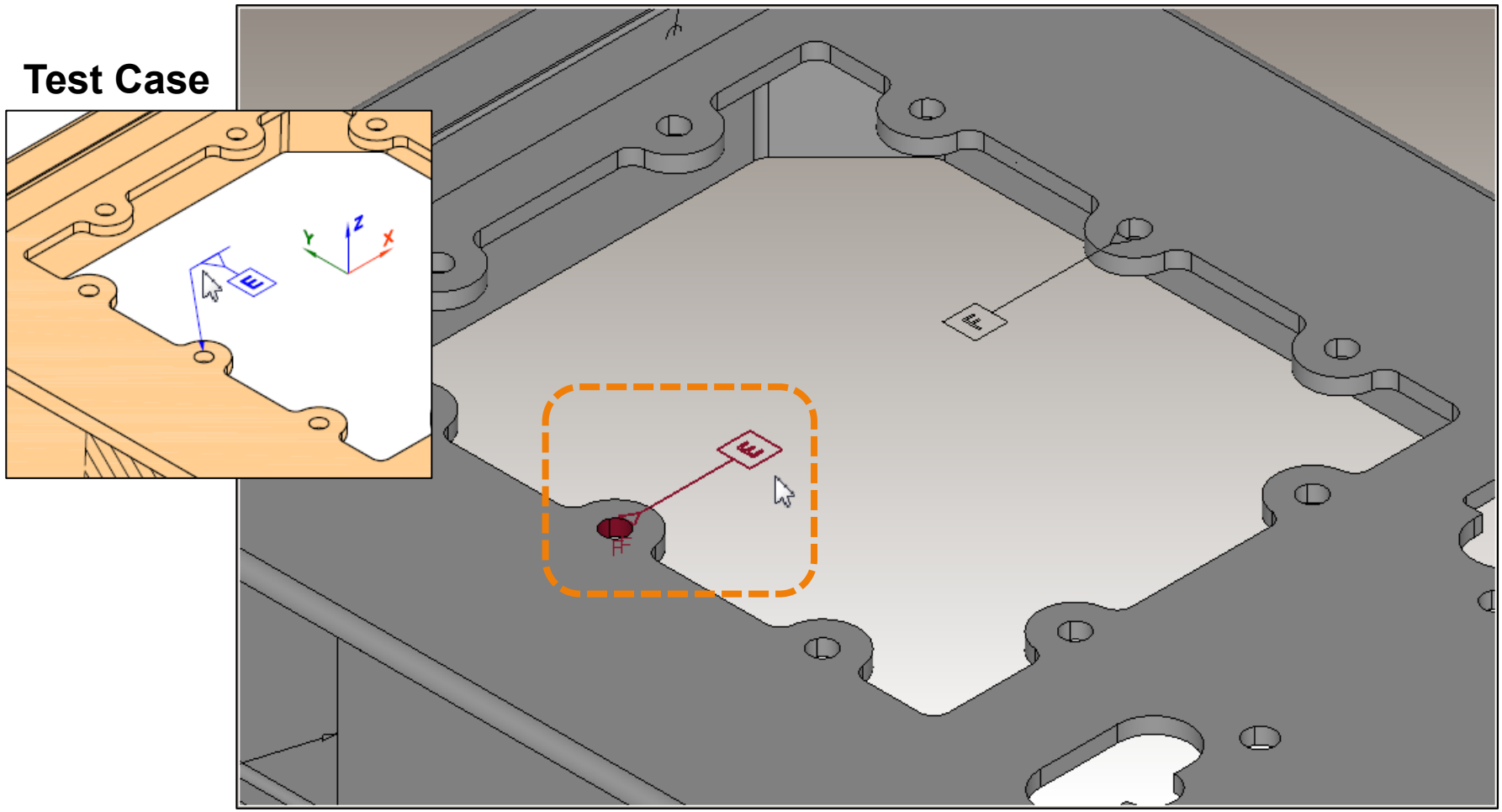
# CAD System Presentation Limitations for Annotation Lines

Return to Index

# Annotation Lines: DFS missing extension line

Presentation Limitation

Test Case



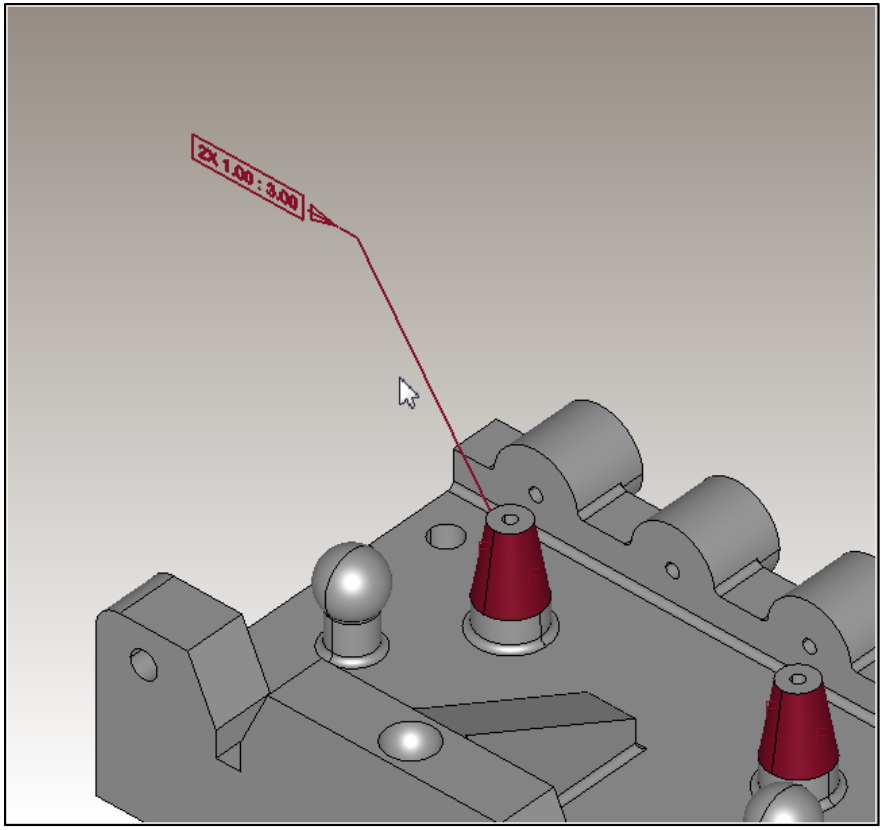
This datum feature symbol does not have the specified extension line.

Return to Index

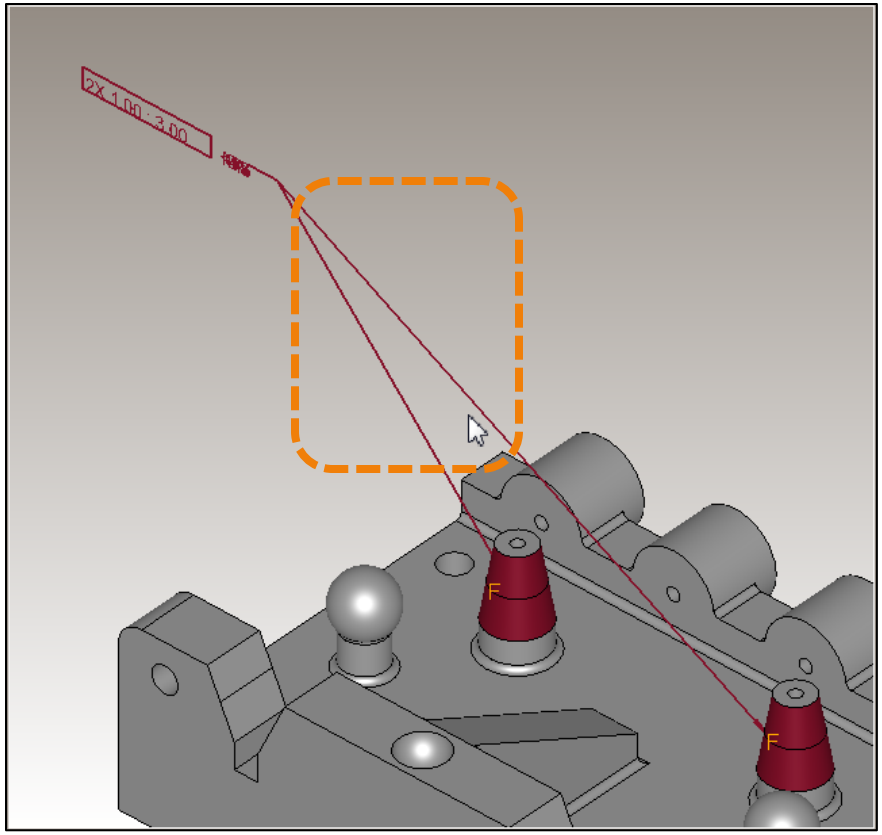
# Annotation Lines: DIM leader line is extraneous

Presentation Limitation

**Correct**




**Incorrect**



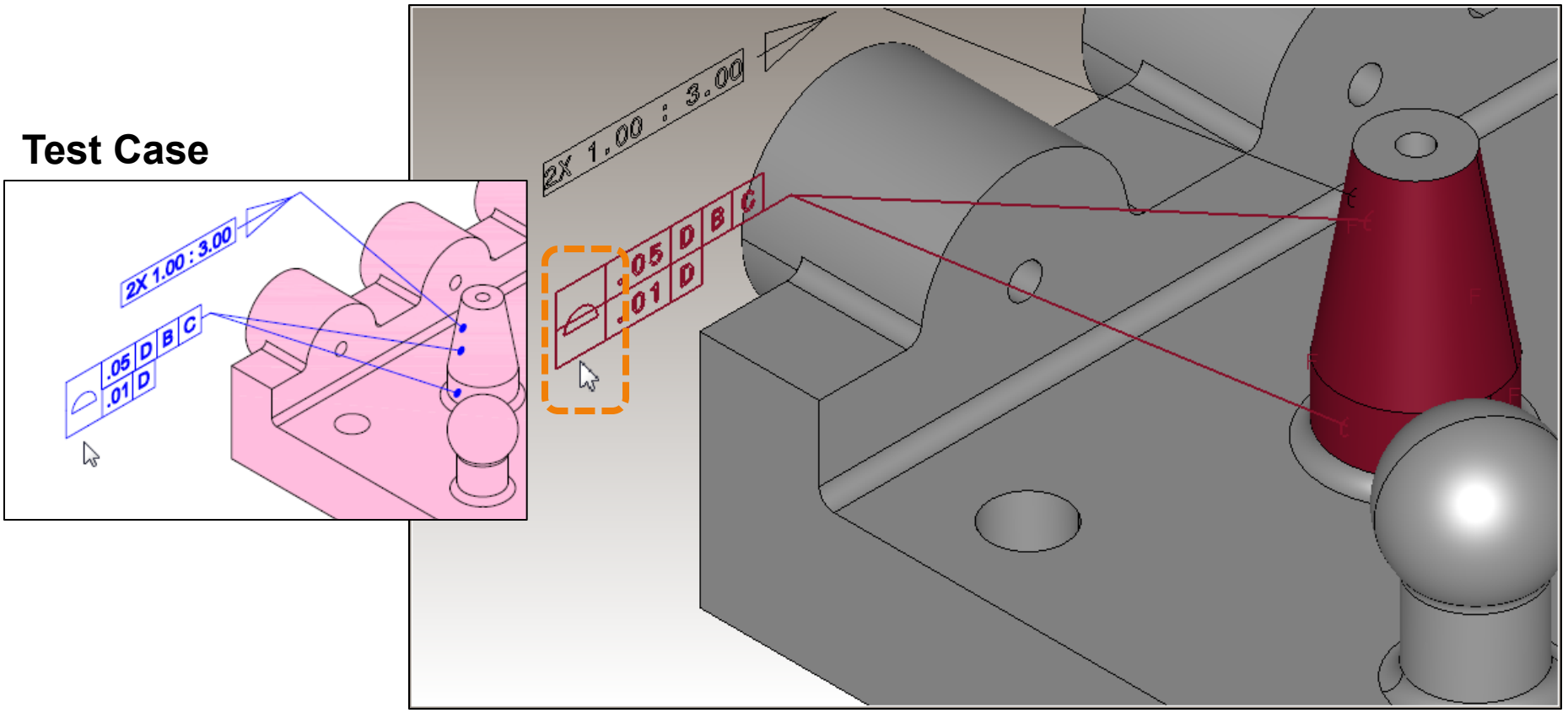

This dimension has an extra leader line that is not specified.

Return to Index

# Annotation Lines:
# FCF divider line cuts through symbol

Presentation Limitation

**Test Case**



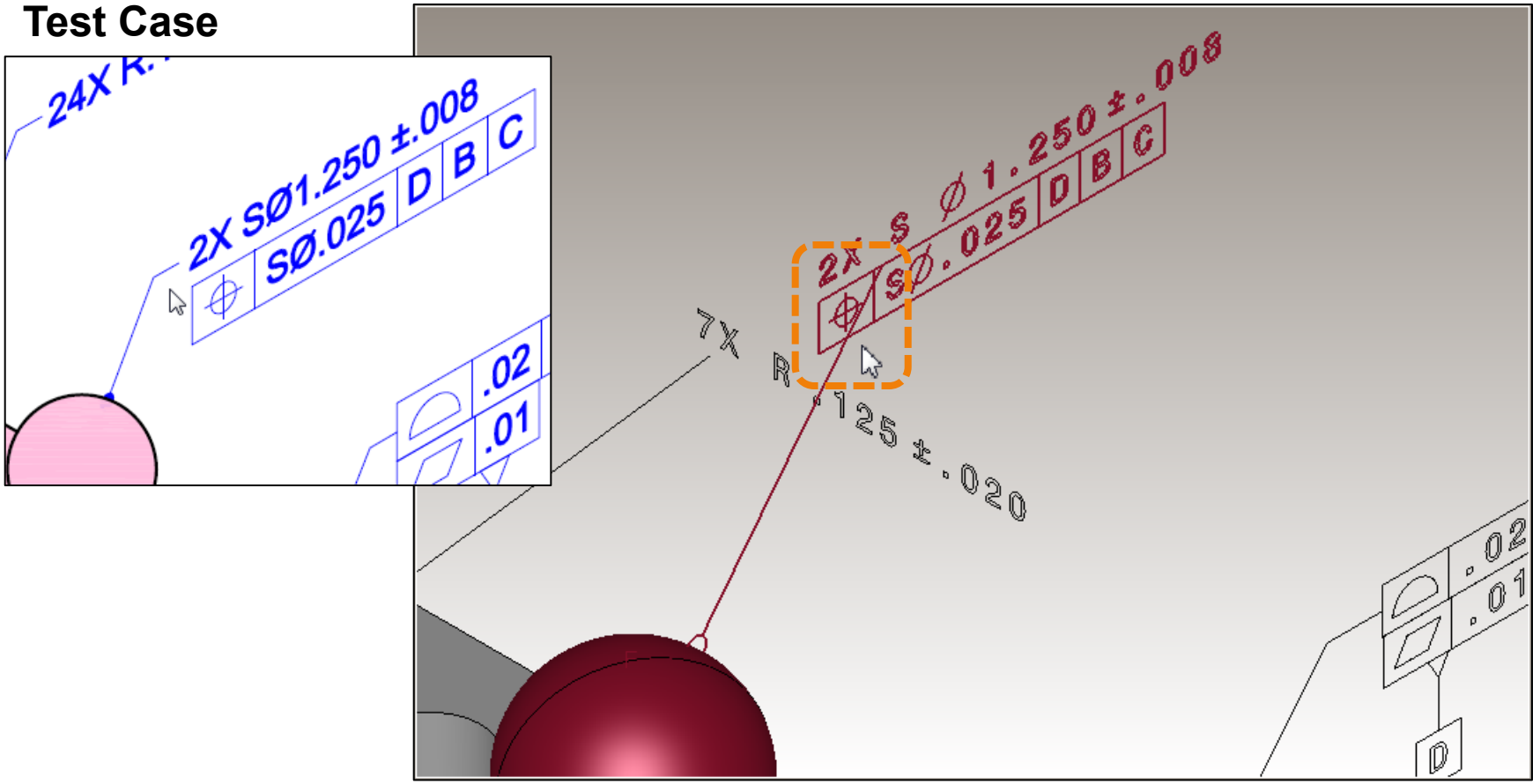

The divider line of this feature control frame runs through the tolerance symbol.

Return to Index

# Annotation Lines:
# FCF leader line passes through FCF

Presentation Limitation

**Test Case**



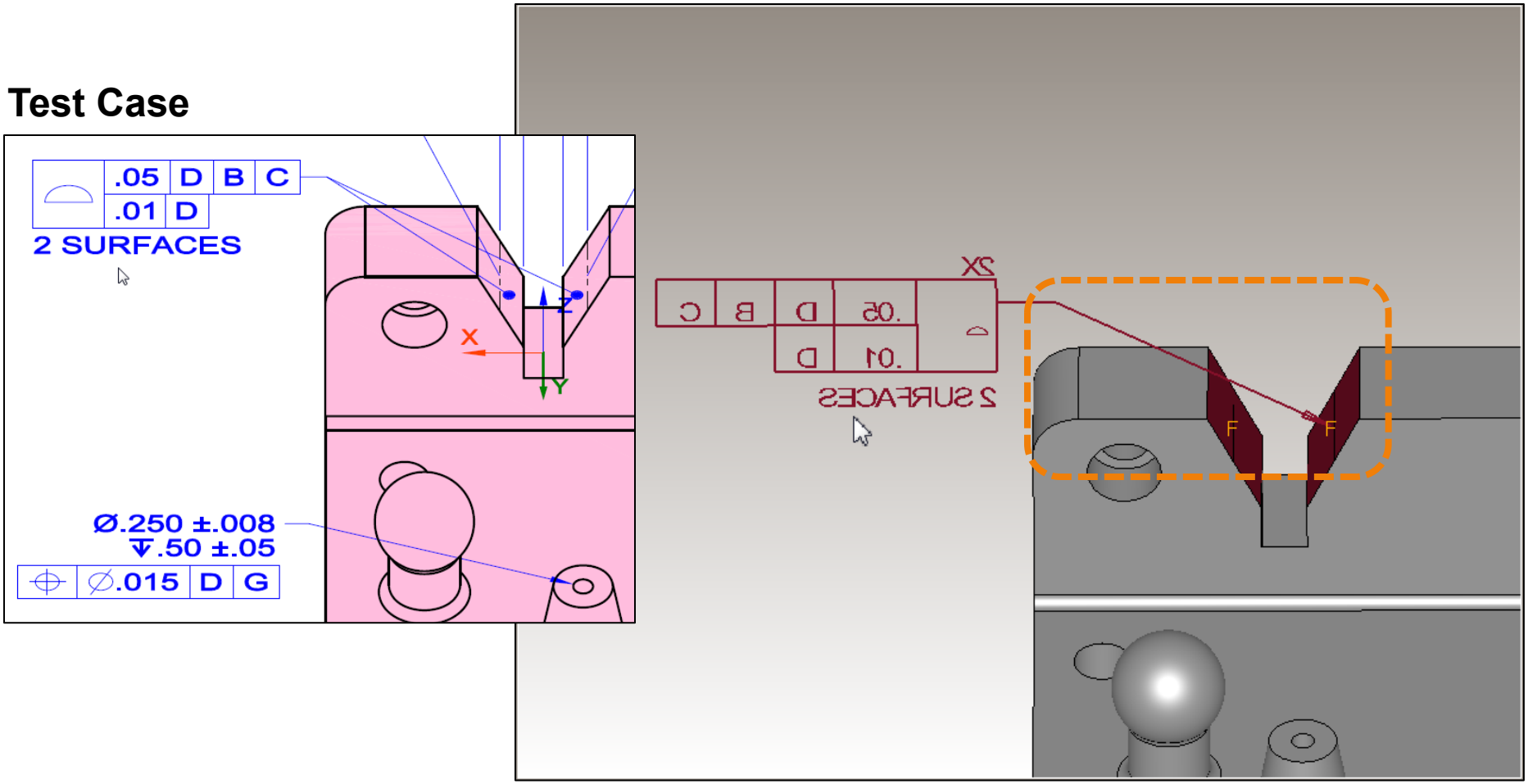

The leader line for this annotation stack passes through the feature control frame.

Return to Index

# Annotation Lines:
# FCF missing dual leader lines

Presentation Limitation

## Test Case

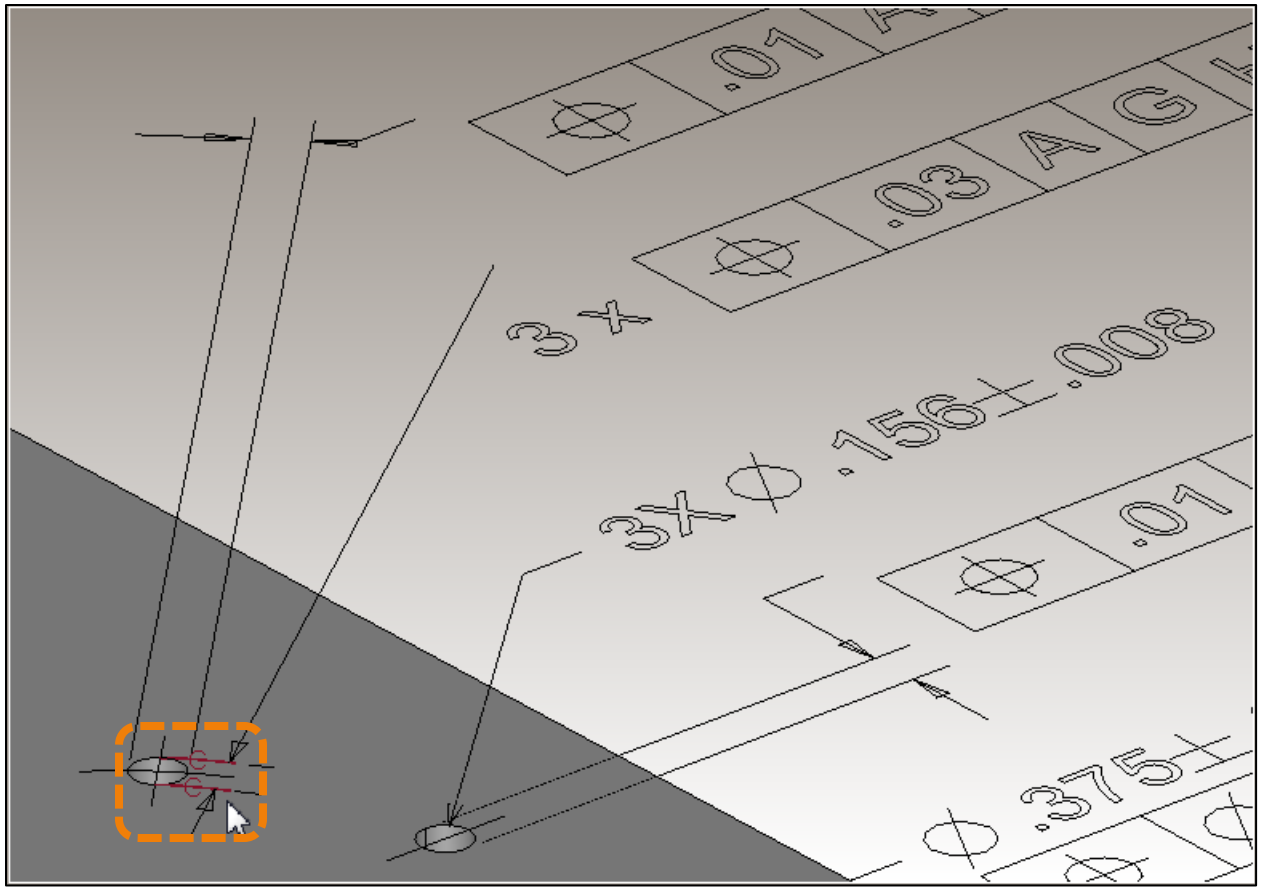



This feature control frame is missing a second leader line.

Return to Index

# Annotation Lines:
# FCF radial extension lines defined as SG curves

Presentation Limitation




These extension lines have been created as non-solid curves in the model.

Return to Index

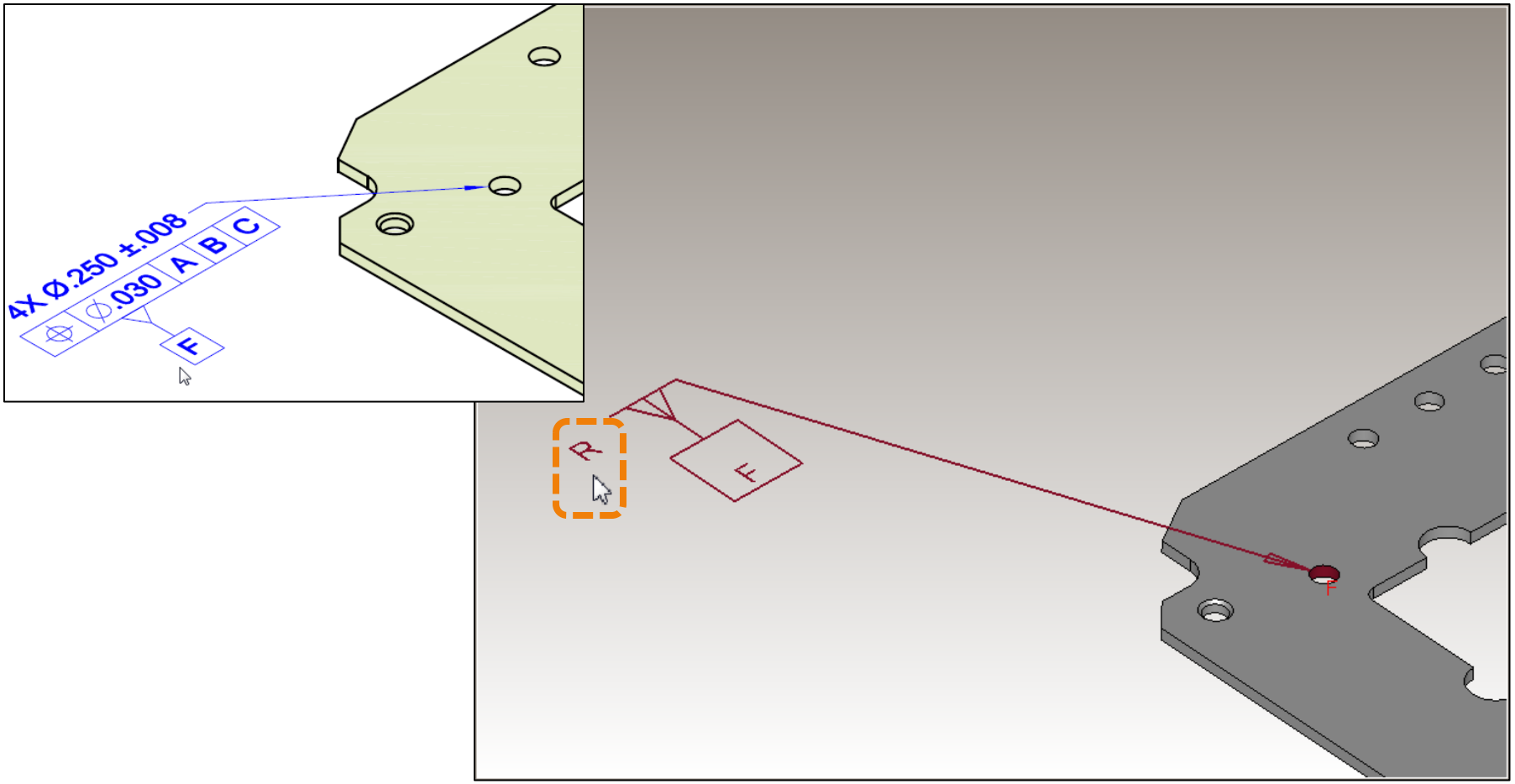
# CAD System Presentation Limitations for Annotation Text

Return to Index

# Annotation Text: DFS text is extraneous

Presentation Limitation

## Test Case



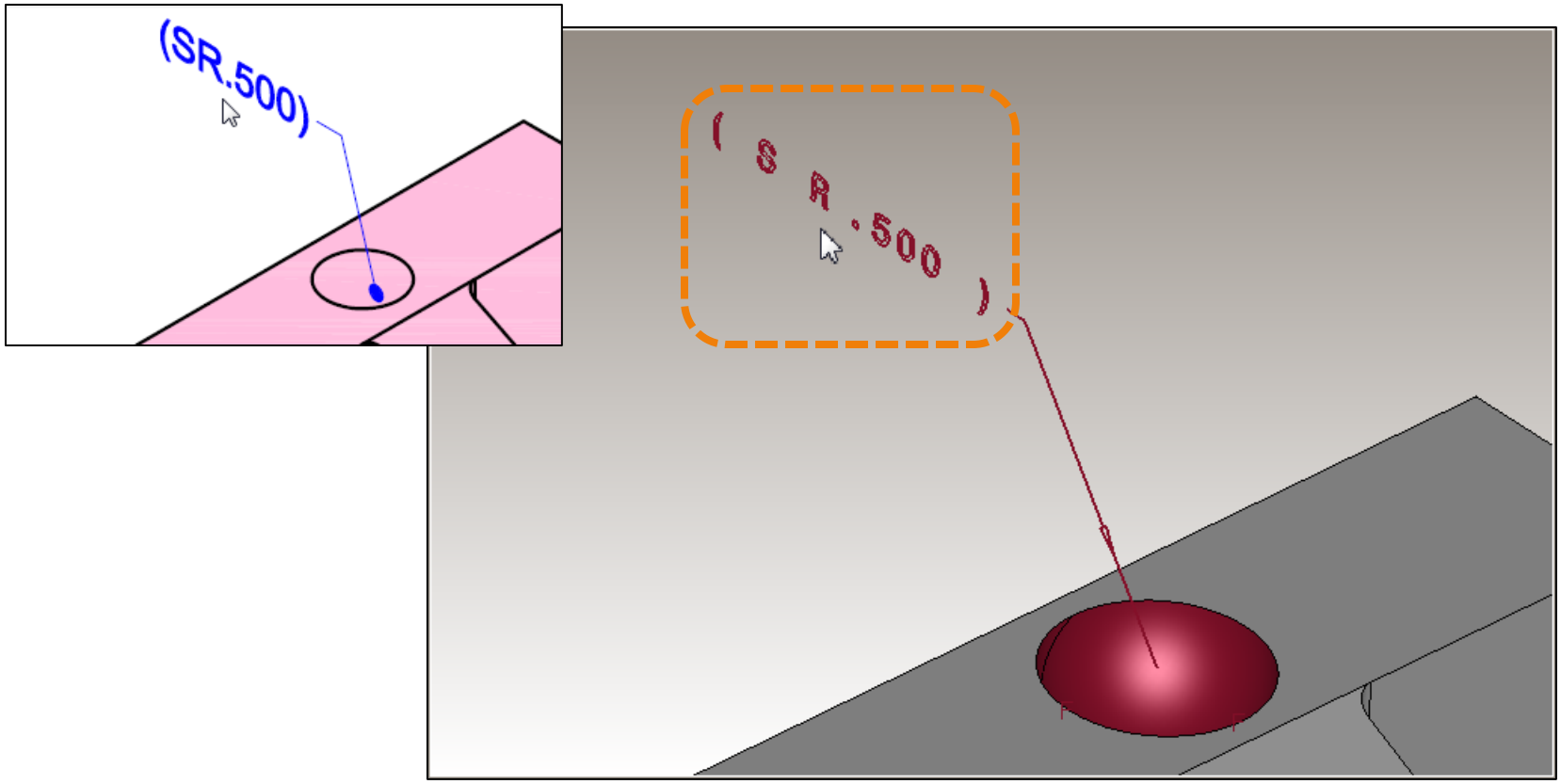

This datum feature symbol has an unspecified “R” symbol.

Return to Index

# Annotation Text: DIM has extraneous space

Presentation Limitation

**Test Case**



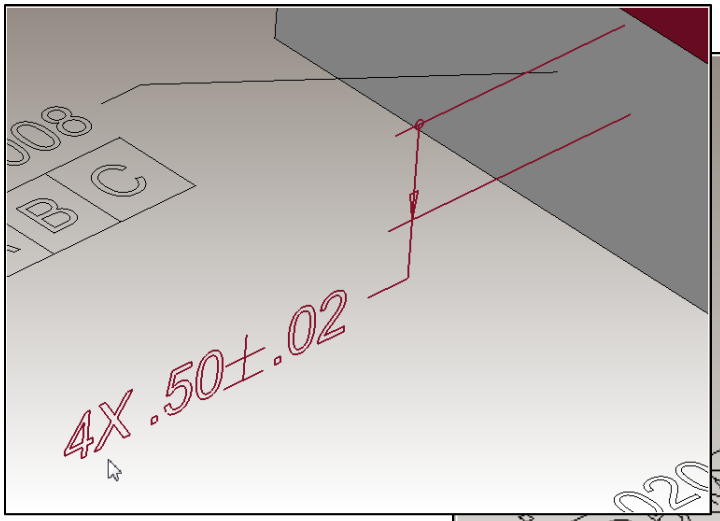

This dimension has extra spaces around the parentheses.

Return to Index

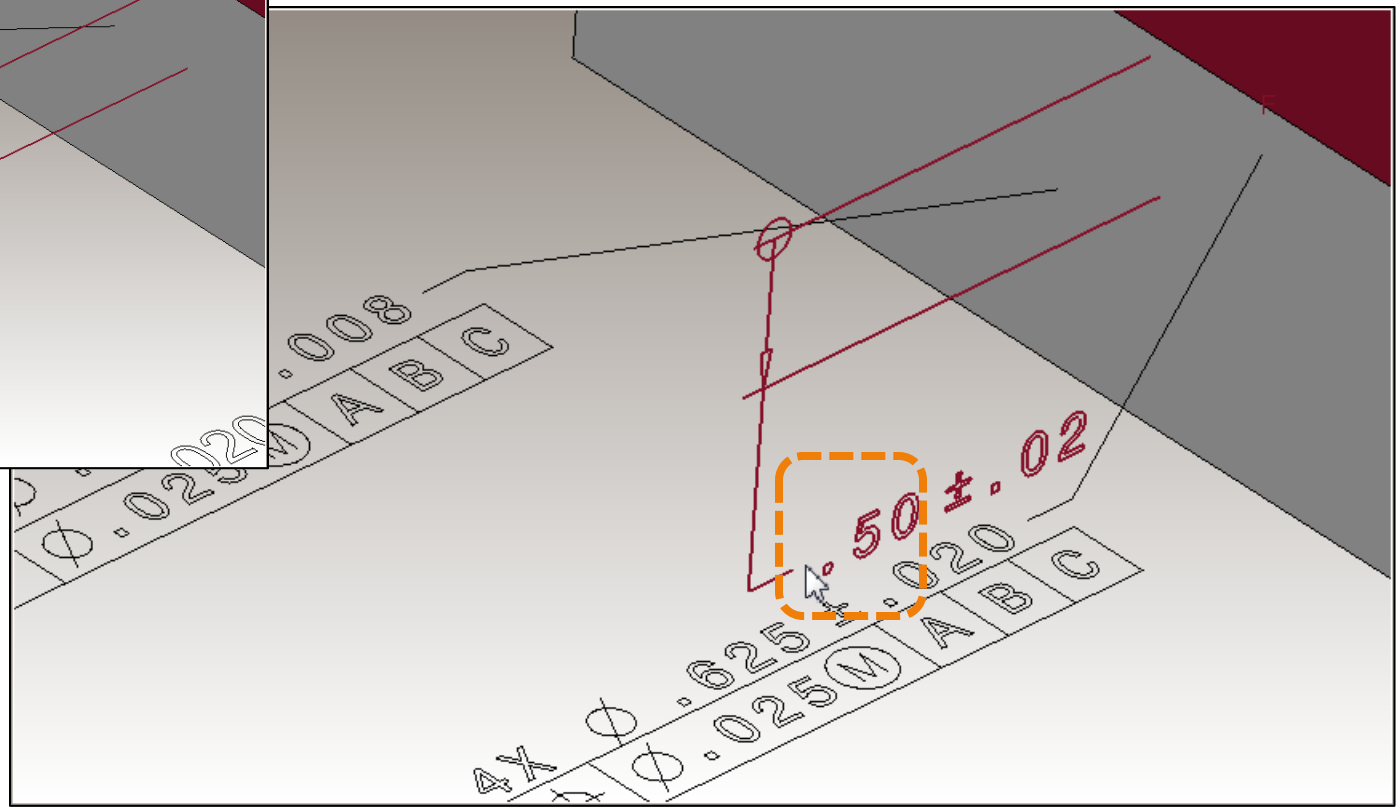
# Annotation Text: DIM missing pattern text

Presentation Limitation

**Complete**




**Incomplete**



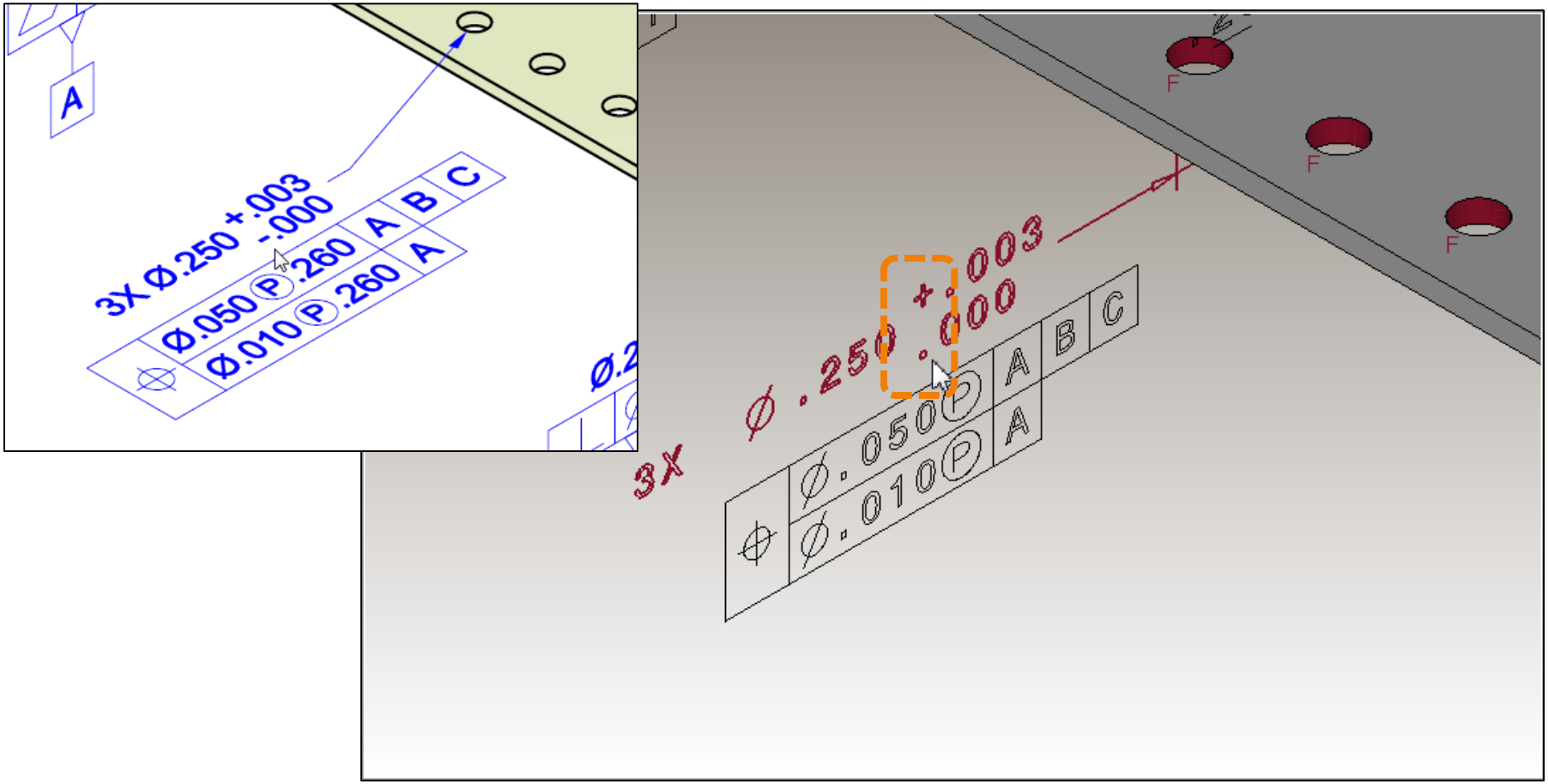

This annotation is missing the pattern instance count.

Return to Index

# Annotation Text:
# DIM missing zero tolerance limit negative sign

Presentation Limitation

## Test Case



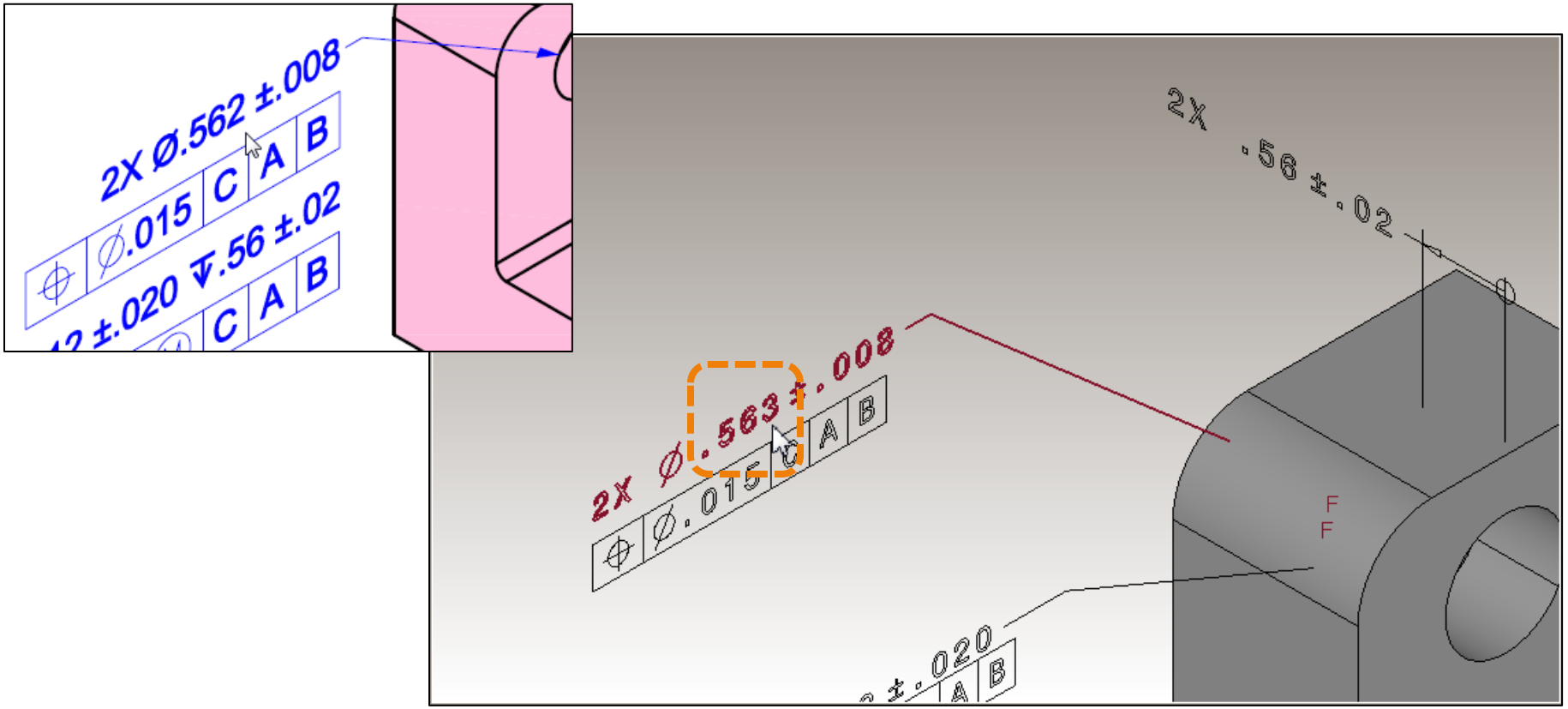

This tolerance is missing the specified negative sign.

Return to Index

# Annotation Text: DIM nominal value rounded incorrectly

Presentation Limitation

## Test Case



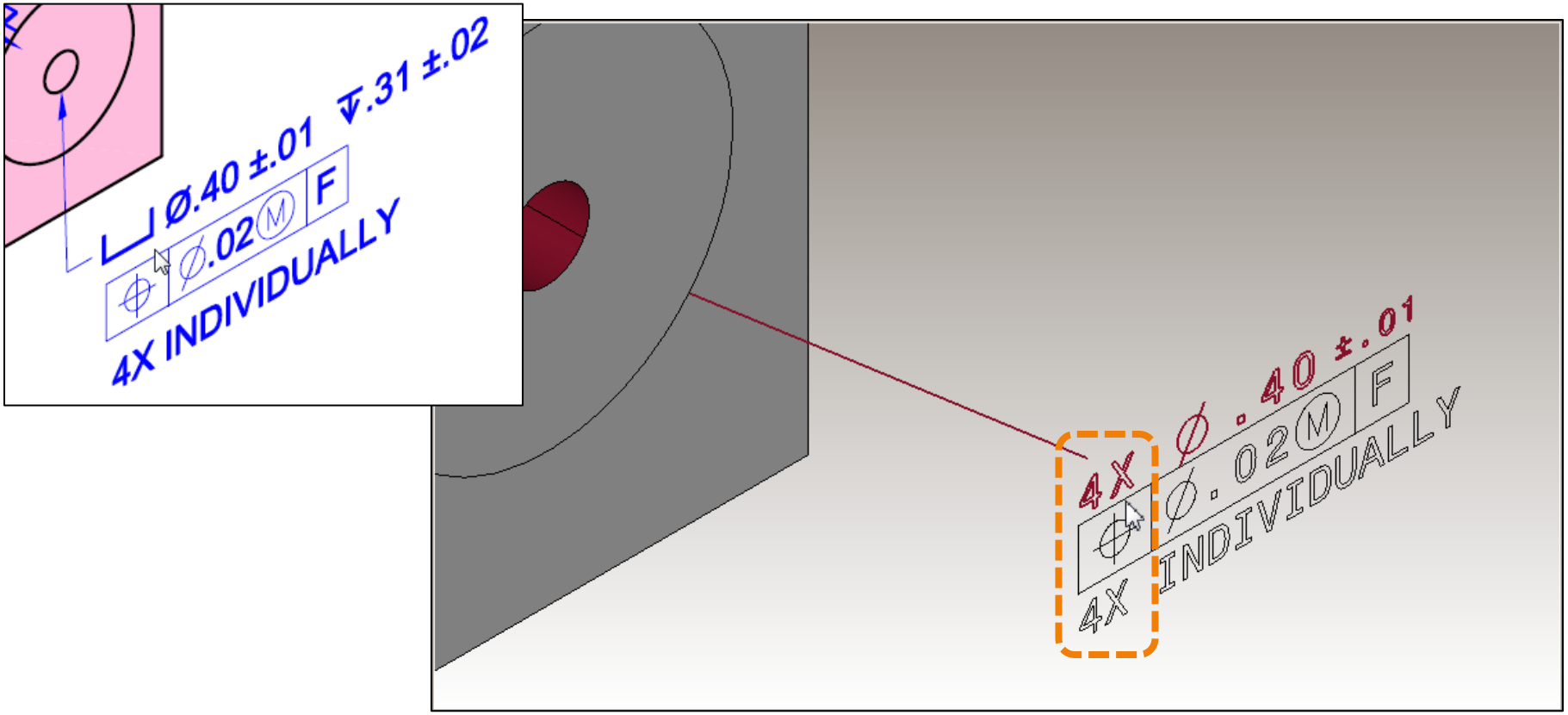

The nominal value of this dimension is rounded incorrectly.

Return to Index

# Annotation Text:
# DIM pattern text is extraneous

Presentation Limitation

## Test Case



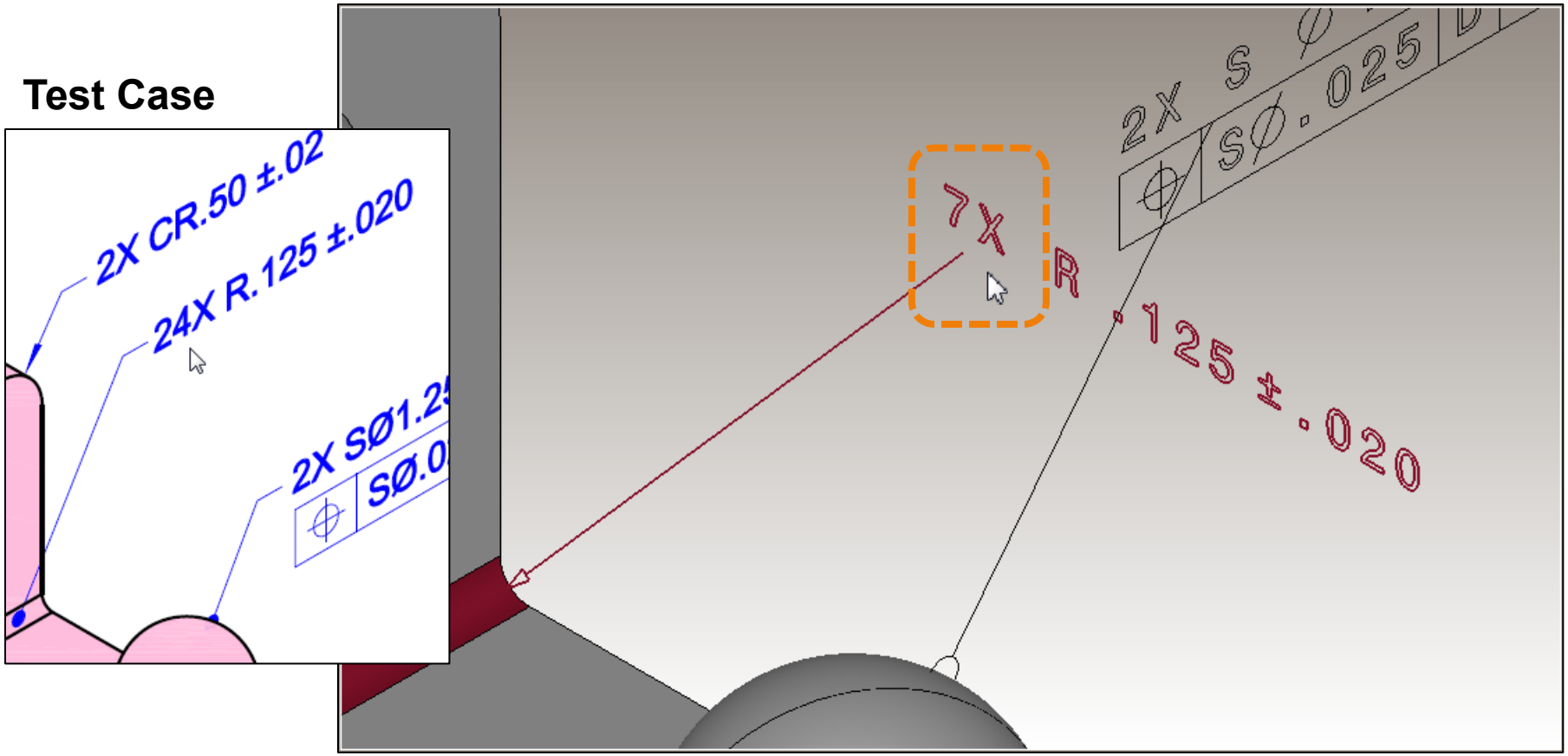

This dimension has extra pattern text.

Return to Index

# Annotation Text: DIM pattern text is incorrect

Presentation Limitation

**Test Case**



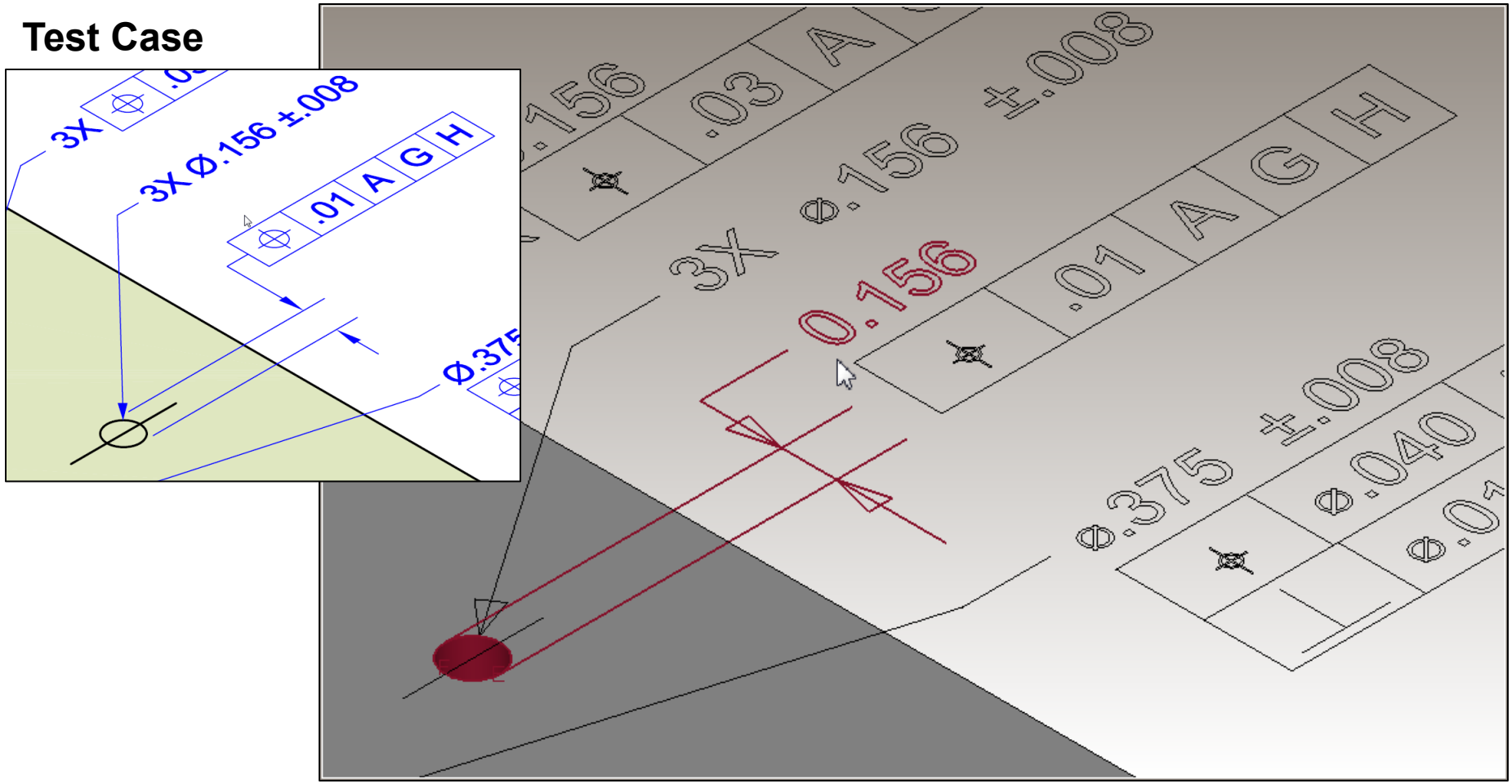

This dimension does not show the specified instance count.

Return to Index

# Annotation Text:
# FCF extension line DIM text is extraneous

Presentation Limitation

**Test Case**



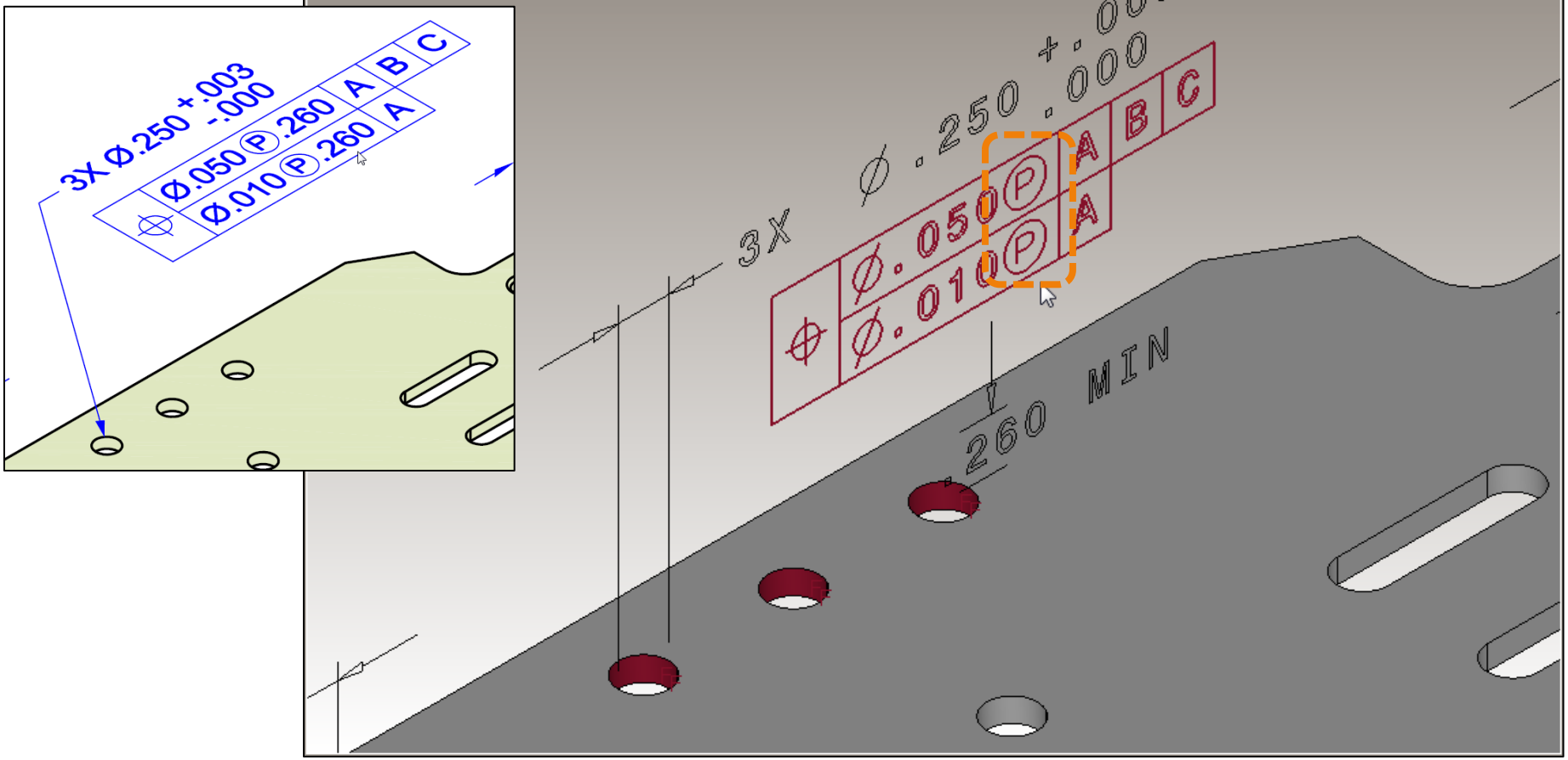

The extension lines for this feature control frame include an unspecified dimension.

Return to Index

# Annotation Text:
# FCF missing projected tolerance zone length

Presentation Limitation

**Test Case**



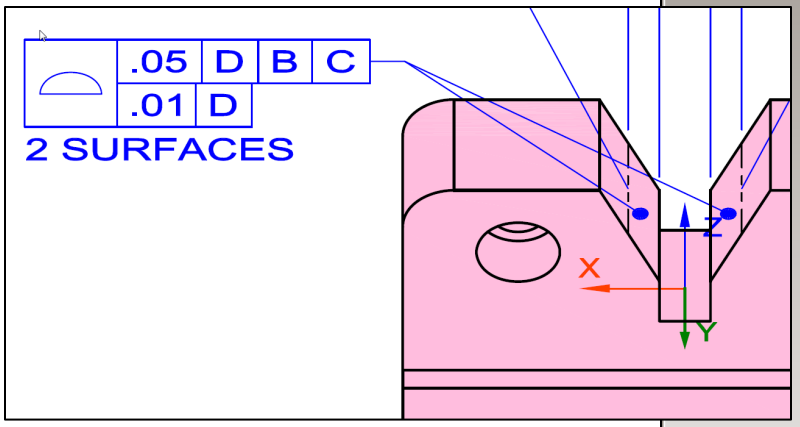

The length of the projected tolerance zone for this feature control frame is not displayed as specified.

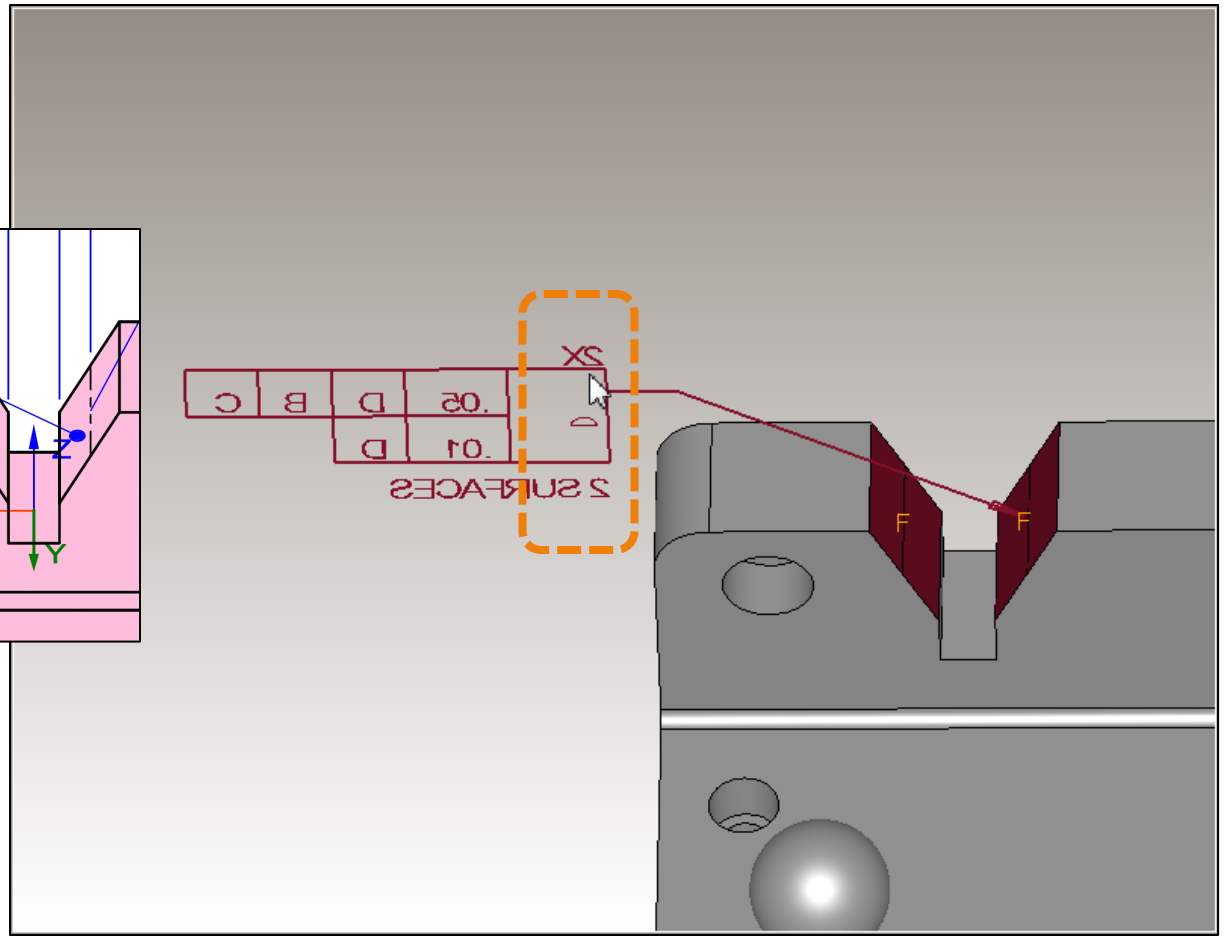
Return to Index

# Annotation Text:
# FCF pattern text is extraneous

Presentation Limitation

**Test Case**



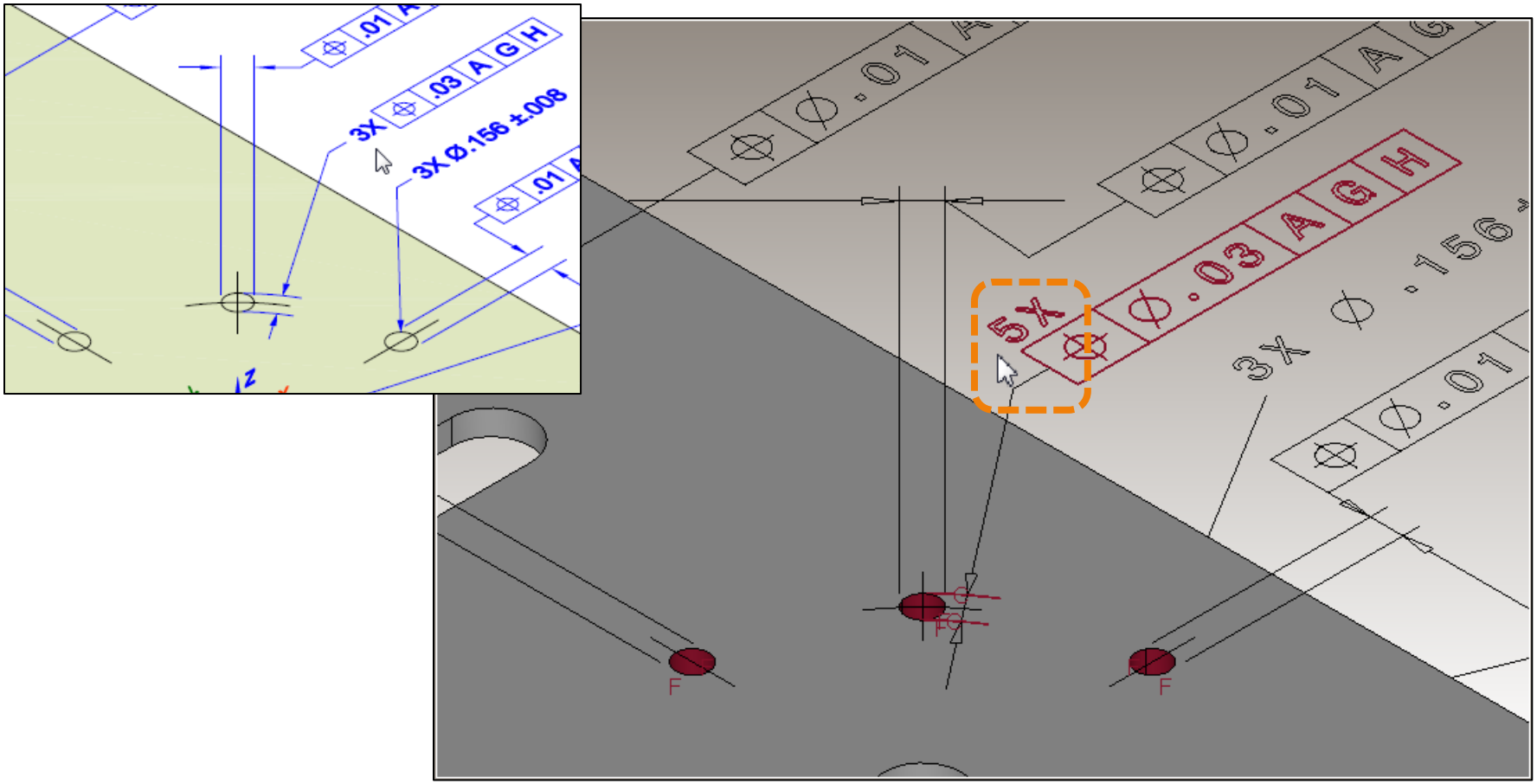

This feature control frame has extra pattern text.

Return to Index

# Annotation Text: FCF pattern text is incorrect

Presentation Limitation

## Test Case




This feature control frame does not show the specified instance count.

Return to Index

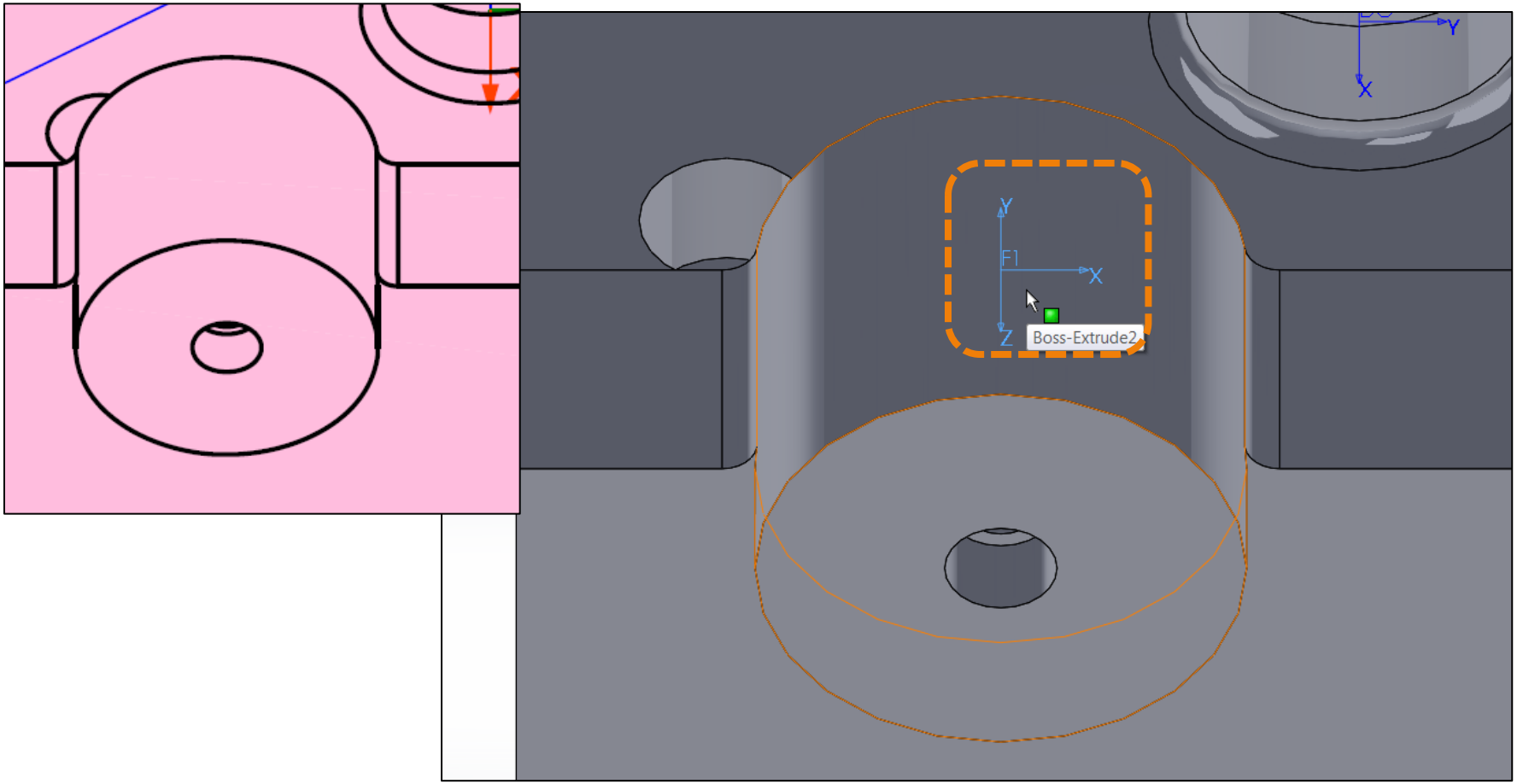
# CAD System Presentation Limitations for Coordinate System Visibility

Return to Index

# Coordinate System Visibility: CS visible in wrong view

Presentation Limitation

## Test Case




This coordinate system is shown in a view for which it is not specified.

Return to Index

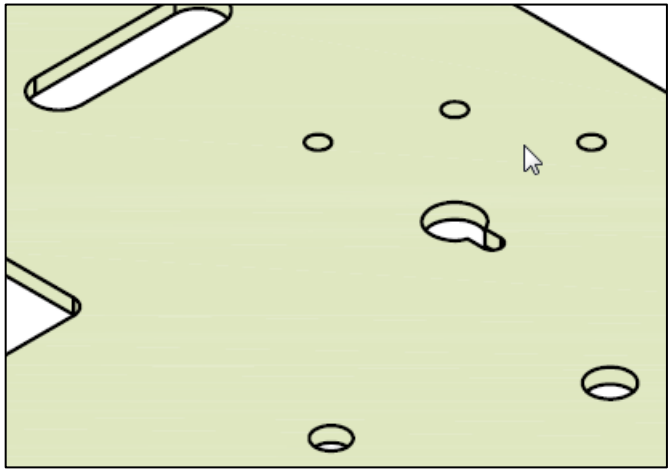
# CAD System Presentation Limitations for Supplemental Geometry Visibility

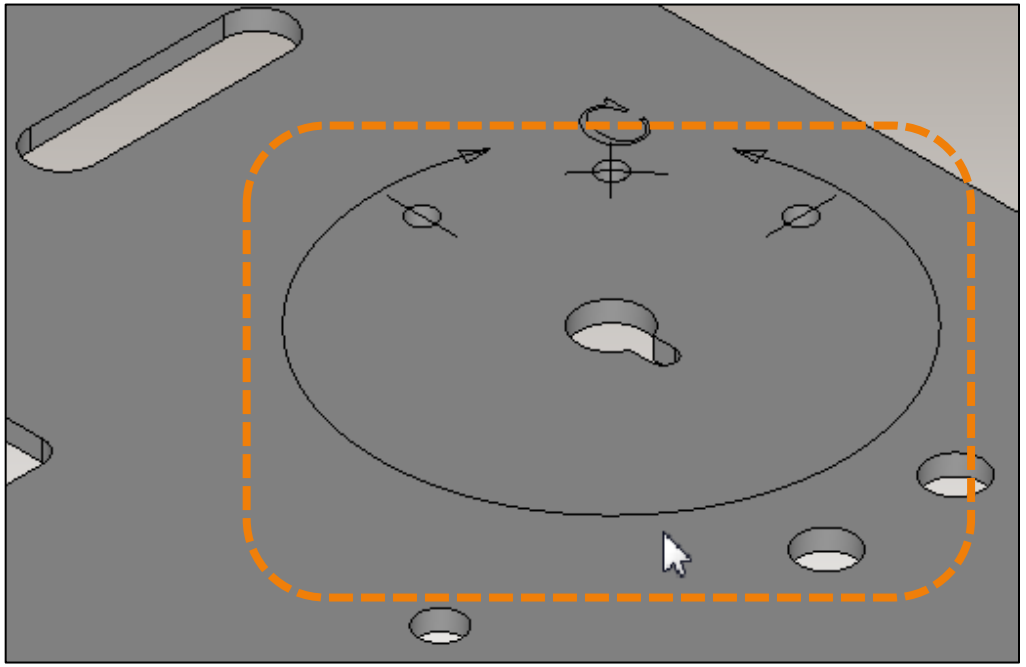
Return to Index

# Supplemental Geometry Visibility: SG curve visible in wrong view

Presentation Limitation

**Test Case**





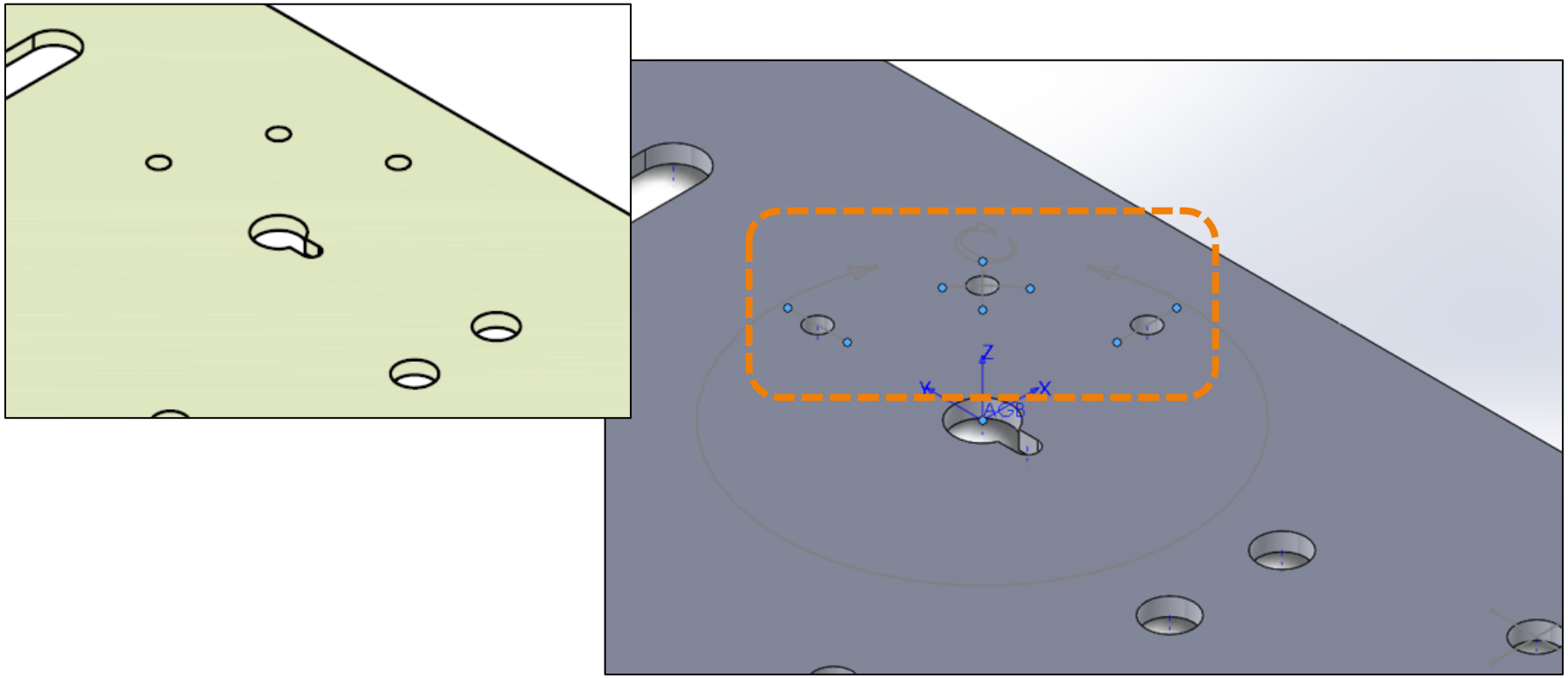
These supplemental curves are visible in a view for which they are not specified.

Return to Index

# Supplemental Geometry Visibility: SG point visible in wrong view

Presentation Limitation

**Test Case**




These supplemental points are visible in a view for which they are not specified.

Return to Index

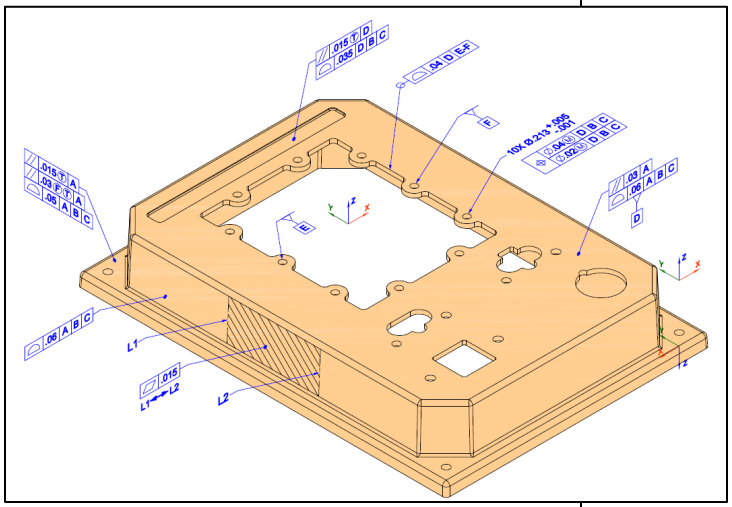
# CAD System Presentation Limitations for Saved View Structure

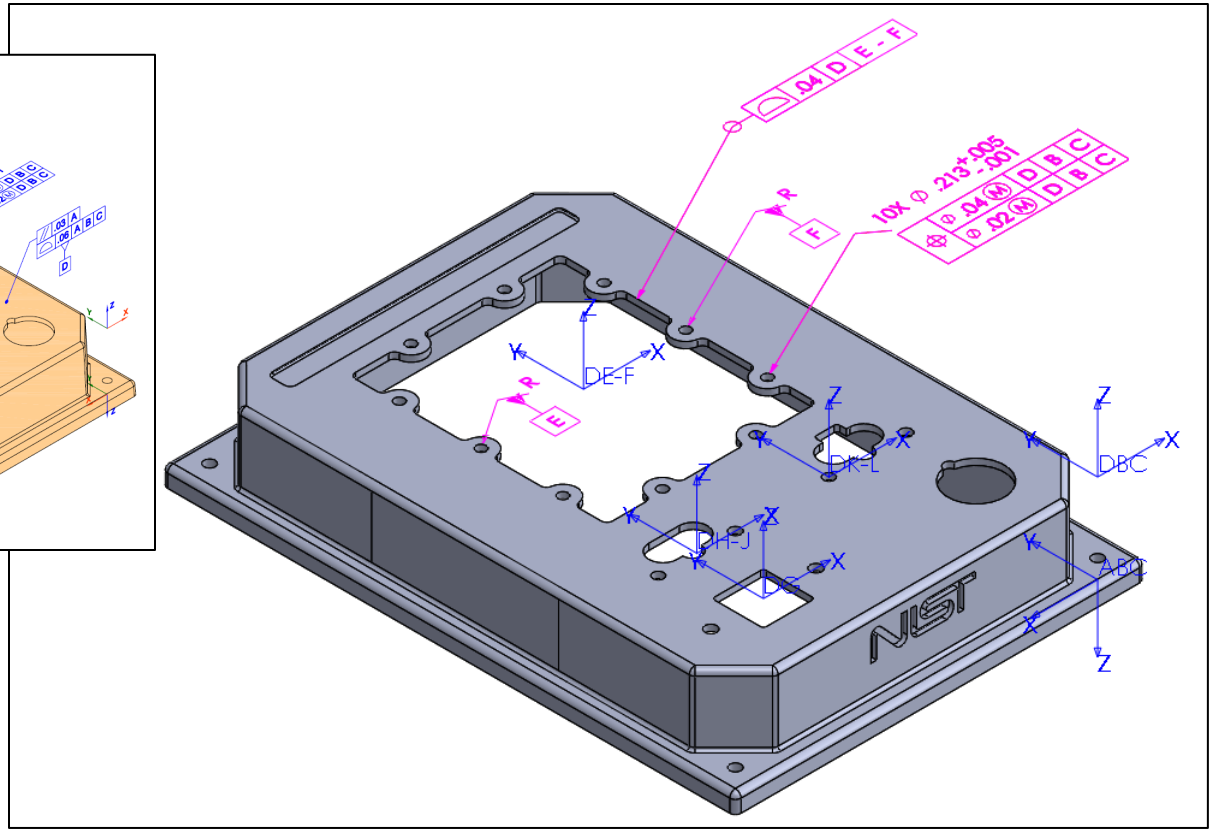
Return to Index

# Saved View Structure:
# View cannot contain annotations on different planes

Presentation Limitation

## Test Case






The PMI views in this system are limited to annotations with the same view and reading directions. The specified saved view has annotations with multiple view and reading directions.

Return to Index

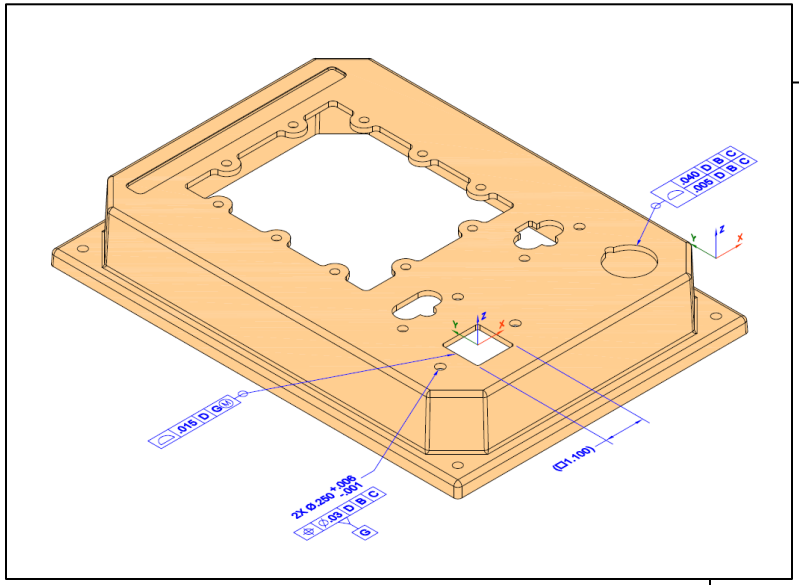
# CAD System Presentation Limitations for Saved View Frustum

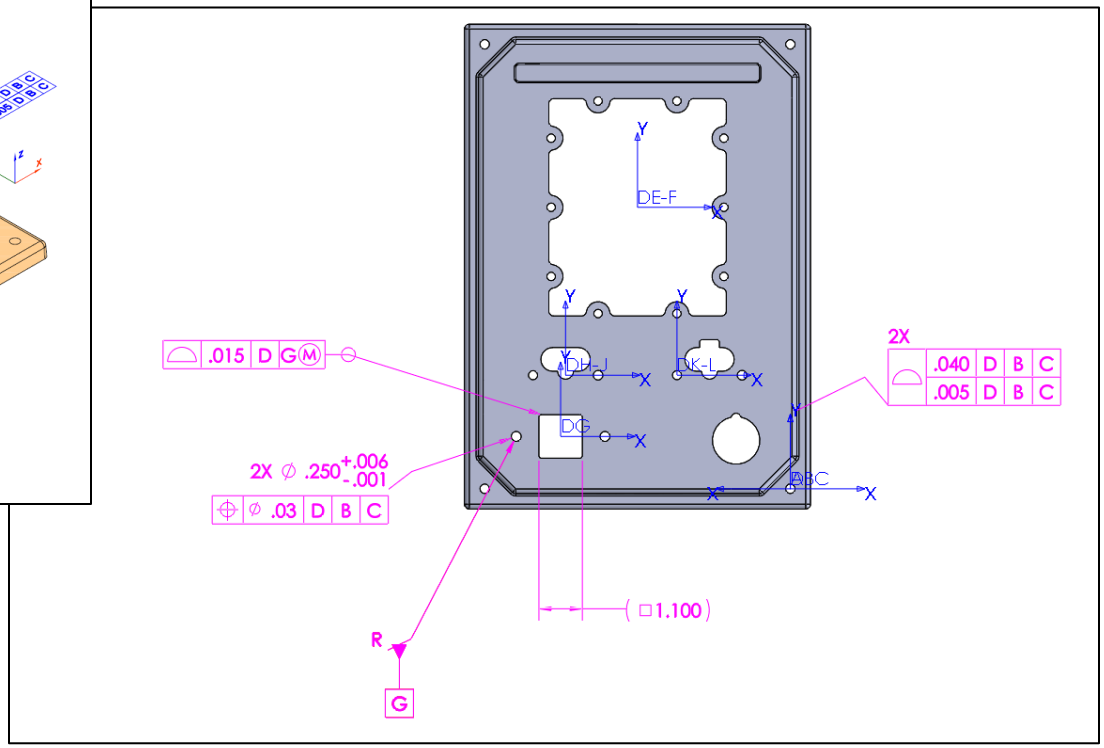
Return to Index

# Saved View Frustum: View camera position not defined

Presentation Limitation

## Test Case






Each saved view in the test case has a specified camera position (view direction and zoom level). This system is unable to store a camera position in its PMI view definition.

Return to Index

# PMI Constructs

Return to Index

# PMI Constructs in FTC 6

| Feature Description | Specification | Ano ID | Comments |
|---|---|---|---|
| Datum Feature A | Flatness .01 | T1 | |
| | Datum Feature Symbol A | DF1 | |
| Datum Feature B | 12.00 ±.01 | D1 | |
| | Perpendicularity .012 \| A | T2 | |
| | Datum Feature Symbol B | DF2 | |
| Datum Feature C | Perpendicularity .012 \| A \| B | T3 | |
| | Datum Feature Symbol C | DF3 | |
| Datum Feature D | Profile Surface .02 \| A \| B \| C | T4 | |
| | Flatness .01 | T5 | |
| | Datum Feature Symbol D | DF4 | |
| Datum Feature E | Profile Surface .02 \| A \| B \| C | T6 | |
| | Flatness .01 | T7 | |
| | Datum Feature Symbol E | DF5 | |
| Datum Feature F | 4X Ø.281 ±.008 | D2 | |
| | Position Ø.015 \| E \| A \| B | T8 | |
| | Datum Feature Symbol F | DF6 | |
| | 4X INDIVIDUALLY | STR1 | |
| Datum Target G1 | Datum Target Symbol G1 | DT1 | |
| | Represented line element | RLE1 | Circular line element for datum target G1 and controlled element |
| | (Ø1.000) | D3 | Defines RLE1 |
| Datum Target H1 | Datum Target Symbol H1 | DT2 | |
| | Represented line element | RLE2 | Circular line element for datum target H1 and controlled element |
| | (Ø1.000) | D4 | Defines RLE2 |
| Datum Target J1, J2 | Datum Target Symbols J1-J2 | DT3, DT4 | |
| | Profile Surface .05 \| D \| B \| C<br>Profile Surface .01 \| D | T9 | Surfaces are grouped |
| | 2 SURFACES | STR2 | Groups surfaces for T9 |
| | Represented line element | RLE3 | |
| | Represented line element | RLE4 | |
| | (1.106) | D5 | Applies to datum target lines |
| Datum Target K1, K2 | Datum Target Symbols K1-K2 | DT5, DT6 | |
| | Profile Surface .05 \| D \| B \| C<br>Profile Surface .01 \| D | T10 | Surfaces are grouped |
| | 2 SURFACES | STR3 | Groups surfaces for T10 |
| | Represented line element | RLE5 | |
| | Represented line element | RLE6 | |
| | (1.106) | D6 | Applies to datum target lines |
| Spherical Diameter Surfaces | 2X SØ 1.250 ±.008 | D7 | |
| | Position SØ.025 \| D \| B \| C | T11 | |
| Counterbored Holes - Set 1 | 4X Ø.415 ±.008 | D8 | |
| | ⌴Ø.625 ±.020 | D9-1 | |
| | Position Ø.025Ⓜ \| A \| B \| C | T12 | Applies to F18-F28 |
| | ↧.50 ±.02 | D9-2 | |
| Counterbored Holes - Set 2 | 2X Ø.562 ±.008 | D10 | |
| | Position Ø.015 \| C \| A \| B | T13 | |
| | 2X ⌴ Ø.812 ±.020 | D11-1 | |
| | Position Ø.025Ⓜ \| C \| A \| B | T14 | |
| | ↧.56 ±.02 | D11-2 | |
| Counterbored Holes - Set 3 | ⌴Ø.40 ±.01 | D12-1 | |
| | Position Ø.02Ⓜ \| F | T15 | Applies individually to 4 holes |
| | ↧.31 ±.02 | D12-2 | |
| | 4X INDIVIDUALLY | STR4 | |
| Fillets | 24X R.125 ±.020 | D13 | |

| Feature Description | Specification | Ano ID | Comments |
|---|---|---|---|
| Spherical Cutout | (SR.500) | D14 | Reference Dimension |
| Large External Rounds | 2X CR.50 ±.02 | D15 | |
| Tapered Center Rib Surface | 1.00 : 2.00 | D16 | Basic Dimension |
| | Profile Surface .04 \| A \| B \| C | T16 | |
| Conic Surfaces | 2X 1.00 : 3.00 | D17 | Basic Dimension |
| Cone w/ G1 | Profile Surface .05 \| D \| B \| C<br>Profile Surface .01 \| D | T17 | Applies to cone and cylinder |
| Cylindrical Cone Support | Profile Surface .05 \| D \| B \| C<br>Profile Surface .01 \| D | T17 | Applies to cone and cylinder |
| Cone w/ H1 | Profile Surface .05 \| D \| B \| C<br>Profile Surface .01 \| D | T18 | Applies to cone and cylinder |
| Cylindrical Cone Support | Profile Surface .05 \| D \| B \| C<br>Profile Surface .01 \| D | T18 | Applies to cone and cylinder |
| Cylindrical hole in cone w/ G1 | Ø.250 ±.008 | D18 | |
| | Position Ø.015 \| D \| G | T19 | |
| Bottom of Hole | ↧.50 ±.05 | D19 | |
| Cylindrical hole in cone w/ H1 | Ø.250 ±.008 | D20 | |
| | Position Ø.015 \| D \| H | T20 | |
| Bottom of Hole | ↧.50 ±.05 | D21 | |
| Width feature of size @ J1-J2 | .500 ±.008 | D22 | |
| | Position .025 \| D \| C \| J | T21 | |
| Width feature of size @ K1-K2 | .500 ±.008 | D23 | |
| | Position .025 \| D \| C \| K | T22 | |
| General Profile Tolerance 1 | Profile Surface .05 \| A \| B \| C | T23 | |
| MCS for Views 1, 2, 3 | | CS1-1 | Main MCS for model |
| MCS for DRF A | | CS1-2 | " " " " |
| MCS for DRF A \| B | | CS1-3 | " " " " |
| MCS for DRF A \| B \| C | | CS1-4 | " " " " |
| MCS for DRF C \| A \| B | | CS1-5 | " " " " |
| MCS for DRF D \| B \| C | | CS2 | |
| MCS for DRF E \| A \| B | | CS3 | |
| MCS for DRF F1 | | CS4 | First of 4 individual datum reference frames for F |
| MCS for DRF F2 | | CS5 | Second of 4 individual datum reference frames for F |
| MCS for DRF F3 | | CS6 | Third of 4 individual datum reference frames for F |
| MCS for DRF F4 | | CS7 | Fourth of 4 individual datum reference frames for F |
| MCS for DRF D \| G | | CS8 | |
| MCS for DRF D \| H | | CS9 | |
| MCS for DRF D \| C \| J | | CS10 | |
| MCS for DRF D \| C \| K | | CS11 | |
| General Notes | NOTES... | STR5 | Flat to screen |

Return to Index

# PMI Constructs in FTC 8

| Feature Description | Specification | Ano ID | Comments |
|---|---|---|---|
| Datum Feature A | Flatness .03Ⓕ | T1 | Applies in free state |
| | Flatness .015 | T2 | |
| | Datum Feature Symbol A | DF1 | |
| Datum Feature B | Ø.238 +.005/-.001 | D1 | |
| | Perpendicularity Ø.015Ⓜ\|Ⓕ\|A | T3 | Applies in free state |
| | Datum Feature Symbol B | DF2 | |
| Datum Feature C | Ø.238 +.005/-.001 | D2 | |
| | Position Ø.020Ⓜ\|Ⓕ\|A\|B | T4 | Applies in free state |
| | Datum Feature Symbol C | DF3 | |
| Datum Feature D | Parallelism .03\|A | T5 | |
| | Profile .06\|A\|B\|C | T6 | |
| | Datum Feature Symbol D | DF4 | |
| Datum Feature E | Datum Feature Symbol E | DF5 | Controlled by D3 and T7 |
| Datum Feature F | Datum Feature Symbol F | DF6 | Controlled by D3 and T7 |
| Pattern of PCB Mtg Holes | 10X Ø.213 +.005/-.001 | D3 | Controls DF E and DF F |
| | Position Ø.04Ⓜ\|D\|B\|C<br>Position Ø.02Ⓜ\|D\|B\|C | T7 | Controls DF E and DF F |
| Datum Feature G | 2X Ø.250 +.006/-.001 | D4 | |
| | Position Ø.03\|D\|B\|C | T8 | |
| | Datum Feature Symbol G | DF7 | |
| Datum Feature H | Ø.228 +.005/-.001 | D5 | |
| | Position Ø.050Ⓜ\|D\|B\|C<br>Position Ø.020Ⓜ\|D\|B\|C<br>SIM REQT 1 | T9 | |
| | Datum Feature Symbol H | DF8 | |
| Datum Feature J | Ø.242 +.005/-.001 | D6 | |
| | Position Ø.050Ⓜ\|D\|B\|C<br>Position Ø.020Ⓜ\|D\|B\|C<br>SIM REQT 1 | T10 | |
| | Datum Feature Symbol J | DF9 | |
| Datum Feature K | Ø.228 +.005/-.001 | D7 | |
| | Position Ø.050Ⓜ\|D\|B\|C<br>Position Ø.020Ⓜ\|D\|B\|C<br>SIM REQT 2 | T11 | |
| | Datum Feature Symbol K | DF10 | |
| Datum Feature L | Ø.242 +.005/-.001 | D8 | |
| | Position Ø.050Ⓜ\|D\|B\|C<br>Position Ø.020Ⓜ\|D\|B\|C<br>SIM REQT 2 | T12 | |
| | Datum Feature Symbol L | DF11 | |
| Pattern of 2 Other Main Mtg Holes | 2X Ø.238 +.005/-.001 | D9 | |
| | Position Ø.023Ⓜ\|Ⓕ\|A\|B\|C | T13 | Applies in free state |
| Bottom Inside Surface | Parallelism .02\|D | T14 | |
| | Profile .06\|A\|B\|C | T15 | |
| Surface Opposite Datum Feature A | Parallelism .015Ⓣ\|A | T16 | |
| | Parallelism .03Ⓕ\|Ⓣ\|A | T17 | Applies in free state |
| | Profile .05\|A\|B\|C | T18 | |
| External Sidewall in -X Direction | Profile .06\|A\|B\|C | T19 | |
| Limited Area on External Sidewall in -X Direction | Flatness .015<br>L1◄►L2 | T20 | Tolerance applies between line elements L1 and L2 |
| | Represented line element | RLE1 | L1 |
| | Represented line element | RLE2 | L2 |

| Feature Description | Specification | Ano ID | Comments |
|---|---|---|---|
| | Leader-Directed Note L1 | LDN1 | Labels RLE 1 that bounds limited area |
| | Leader-Directed Note L2 | LDN2 | Labels RLE 2 that bounds limited area |
| Recess for Placard | Parallelism .015Ⓣ\|D | T21 | |
| | Profile .035\|D\|B\|C | T22 | |
| Cutout for PCB Mtg | Profile .04\|D\|E-F<br>All Around | T23 | |
| Square hole cutout | (□1.100) | D10 | |
| | Profile .015\|D\|GⓂ<br>All Around | T24 | |
| Cutout for E Stop | Profile .040\|D\|B\|C<br>Profile .005\|D\|B\|C<br>All Around | T25 | |
| Cutout for Middle Switch on -X Side | Profile .015\|D\|HⓂ-JⓂ<br>All Around | T26 | |
| Cutout for Middle Switch on +X Side | Profile .015\|D\|KⓂ\|LⓂ<br>All Around | T27 | |
| General Profile Tolerance | Profile Surface .06\|A\|B\|C | T28 | |
| MCS for Views A, B | | CS1-1 | Main MCS for model |
| MCS for DRF A | | CS1-2 | Same location as MCS1 |
| MCS for DRF A\|B | | CS1-3 | Same location as MCS1 |
| MCS for DRF A\|B\|C - Free State | | CS1-4 | Same location as MCS1 |
| MCS for DRF A\|B\|C - Restrained | | CS1-5 | Same location as MCS1 |
| MCS for Views C, D | | CS2-1 | |
| MCS for DRF D | | CS2-2 | Same location as MCS2 |
| MCS for DRF D\|B\|C | | CS2-3 | Same location as MCS2 |
| MCS for DRF D\|E-F | | CS3 | |
| MCS for DRF D\|GⓂ | | CS4 | |
| MCS for DRF D\|HⓂ-JⓂ | | CS5 | |
| MCS for DRF D\|KⓂ\|LⓂ | | CS6 | |
| General Notes | NOTES... | STR1 | Flat to screen |

Return to Index

# PMI Constructs in FTC 9

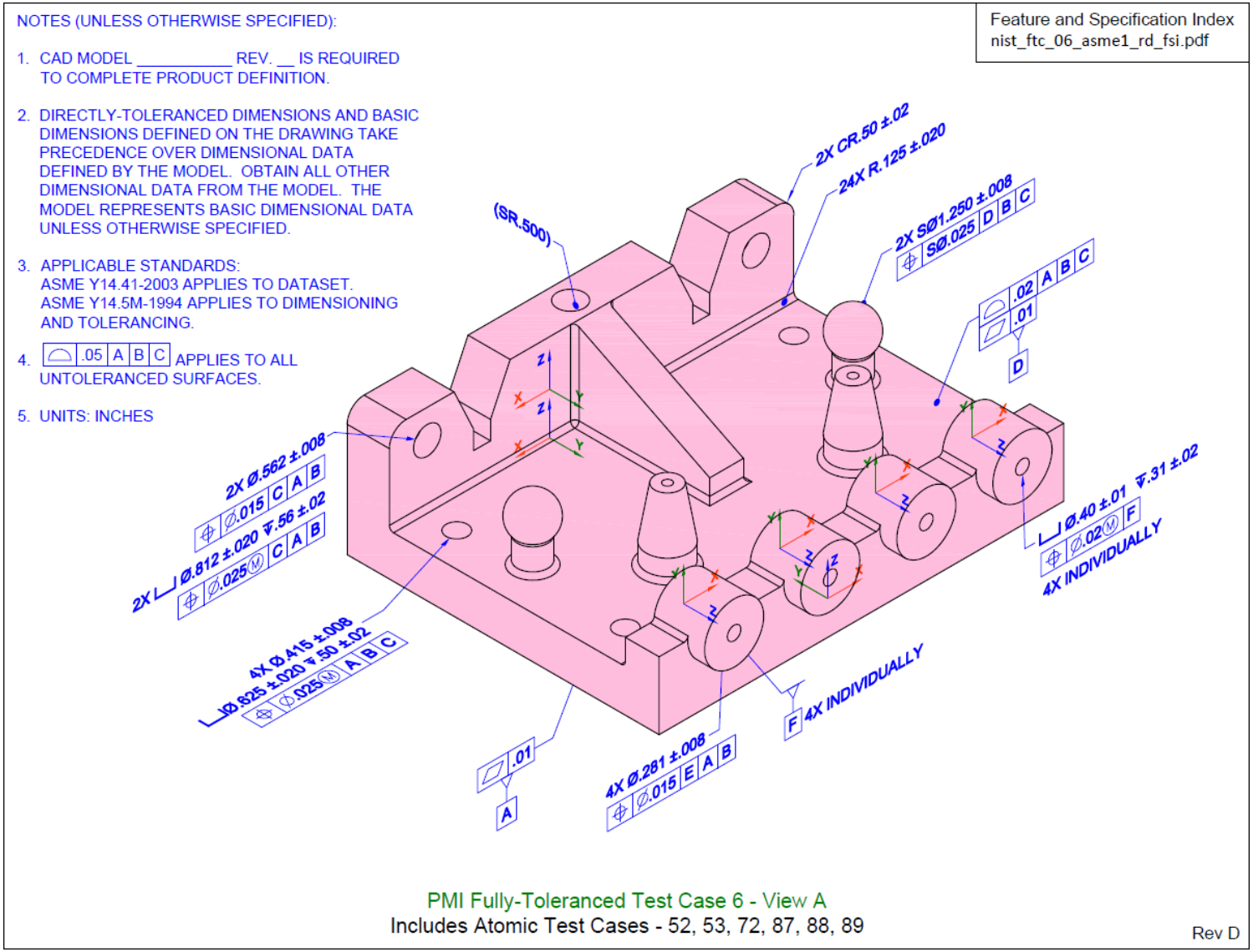
| Feature Description | Specification | Ano ID | Comments |
|---|---|---|---|
| Datum Feature A | Flatness .01 | T1 | |
| | Datum Feature Symbol A | DF1 | |
| Datum Feature B | Ø.234 ±.008 | D1 | |
| | Perpendicularity Ø.016 \| A | T2 | |
| | Datum Feature Symbol B | DF2 | |
| Datum Feature C | Ø.234 ±.008 | D2 | |
| | Position Ø.016 \| A \| B | T3 | |
| | Datum Feature Symbol C | DF3 | |
| Datum Feature D | Ø.750 ±.008 | D3 | |
| | Perpendicularity Ø.010 \| A | T4 | |
| | Position Ø.050 \| A \| B \| C | T5 | |
| | Datum Feature Symbol D | DF4 | |
| Datum Feature E | 2X Ø.221 ±.008 | D4 | |
| | Position Ø.020 \| A \| D \| B | T6 | |
| | Datum Feature Symbol E | DF5 | |
| Datum Feature F | 4X Ø.250 ±.008 | D5 | |
| | Position Ø.030 \| A \| B \| C | T7 | |
| | Datum Feature Symbol F | DF6 | |
| Datum Feature G | Ø.375 ±.008 | D6 | |
| | Position Ø.040 \| A \| B \| C | T8 | |
| | Perpendicularity Ø.010 \| A | T9 | |
| | Datum Feature Symbol G | DF7 | |
| Datum Feature H | .140 ± .008 | D7 | SIELD |
| | Position Ø.010 \| A \| G \| B | T10 | SIELD |
| | Datum Feature Symbol H | DF8 | |
| Radial End - Datum Feature H | Profile .008 \| A \| G \| H | T11 | |
| Chamfers (cones) | 4X .03 ±.01 X .03 ±.01 | D8 | 2 dims and tols in one spec |
| Hole Pattern 1 - Panel Mounting | 2XØ.234 ±.008 | D9 | Other 2 panel mounting holes |
| | Position Ø.016Ⓜ \| A \| B \| C | T12 | |
| Hole Pattern 2 - Horizontal | 3X Ø.250 +.003/-.000 | D10 | Holes sized for PEM CLSS-032-3 self-clinching nuts |
| | Position Ø.050 Ⓟ.260 \| A \| B \| C<br>Position Ø.010 Ⓟ.260 \| A | T13 | Composite Position 2 Segments with Projected tolerance zone |
| Hole Pattern 3 - Vertical | 3X Ø.250 +.003/-.000 | D11 | Holes sized for PEM CLSS-032-3 self-clinching nuts |
| | Position Ø.050 Ⓟ.260 \| A \| B \| C<br>Position Ø.010 Ⓟ.260 \| A | T14 | Composite Position 2 Segments with Projected tolerance zone |
| Cutout - for FTC10 Insert | Profile .02 \| A \| FⓂ<br>All Around | T15 | Cutout for insert into FTC10 |
| Small Slots | 2X .25 ±.01 | D12 | Width |
| | Position .02Ⓜ \| A \| B \| C | T16 | |
| | BOUNDARY | STR1 | |
| | 2X 1.00 ±.02 | D13 | Length - SIELD |
| | Position .06Ⓜ \| A \| B \| C | T17 | SIELD |
| | BOUNDARY | STR2 | SIELD |
| | 4X R | D14 | Ends |
| Large Slot | .375 ±.008 X 1.500 ±.012 | D15 | 2 dims and tols in one spec |
| | Position .030Ⓜ \| A \| B \| C<br>All-Around | T18 | |
| | BOUNDARY | STR3 | |
| | 2X R | D16 | Ends |
| Hole Pattern 4 - Polar | 3X Ø.156 ±.008 | D17 | |
| | 3X Position .03 \| A \| G \| H | T19 | Radial Direction - SIELD |
| | Represented line element | RLE1 | Curve represents radial path |
| Polar Hole 1 - Horizontal | Position .01 \| A \| G \| H | T20 | Applies in X direction - SIELD |
| | Represented line element | RLE2 | Line represents X direction |
| Polar Hole 2 - Diagonal | Position .01 \| A \| G \| H | T21 | Applies 45° to X direction - SIELD |
| | Represented line element | RLE3 | Line represents 45° to X direction |
| Polar Hole 3 - Vertical | Position .01 \| A \| G \| H | T22 | Applies in Y direction - SIELD |
| | Represented line element | RLE4 | Line represents Y direction |
| Dual Unit Holes | 2X Ø.315 ±.008 [8 ±0.2] | D18 | Inch and [mm] per DRM 11th ed. |
| | Position Ø.030 [0.76] \| A \| B \| C | T23 | Inch and [mm] per DRM 11th ed. |
| Hole Pattern 5 - Bidirectional Tols | 3X Ø.281 ±.008 | D19 | |
| | Perpendicularity Ø.010 \| A | T24 | |
| | 3X Position .060 \| A \| B \| C | T25 | Applies in X direction - SIELD |
| | Represented line element | RLE5 | Line represents X direction |
| | 3X Position .020 \| A \| B \| C | T26 | Applies in Y direction - SIELD |
| | Represented line element | RLE6 | Line represents Y direction |
| Hole Pattern 6 - SIM REQT LH | 2X Ø.156 ±.008 | D20 | |
| | Position Ø.025Ⓜ \| A \| DⓂ \| EⓂ | T27 | |
| | SEP REQT | STR4 | |
| Hole Pattern 7 - SIM REQT RH | 2X Ø.156 ±.008 | D21 | |
| | Position Ø.025Ⓜ \| A \| DⓂ \| EⓂ | T28 | |
| | SEP REQT | STR5 | |
| Profile Tolerance 1 | Profile Surface .05 \| A \| B \| C<br>All Around | T29 | Peripheral (sheared) surfaces |
| MCS for Views A, B, C, D | | CS1-1 | Main MCS for model |
| MCS for DRF A | | CS1-2 | Same location as MCS1 |
| MCS for DRF A \| B | | CS1-3 | Same location as MCS1 |
| MCS for DRF A \| B \| C | | CS1-4 | Same location as MCS1 |
| MCS for DRF A \| D \| B | | CS2 | |
| MCS for DRF A \| DⓂ \| EⓂ | | CS3 | Same location as DRF A \| D \| B |
| MCS for DRF A \| FⓂ | | CS4 | |
| MCS for DRF A \| G \| B | | CS5 | |
| MCS for DRF A \| G \| H | | CS6 | Same location as DRF A \| G \| B |
| General Notes | NOTES... | STR6 | Flat to screen |
| Identifier for Detail View C | | VSI1 | |

Return to Index

# Test Case Drawings and Models

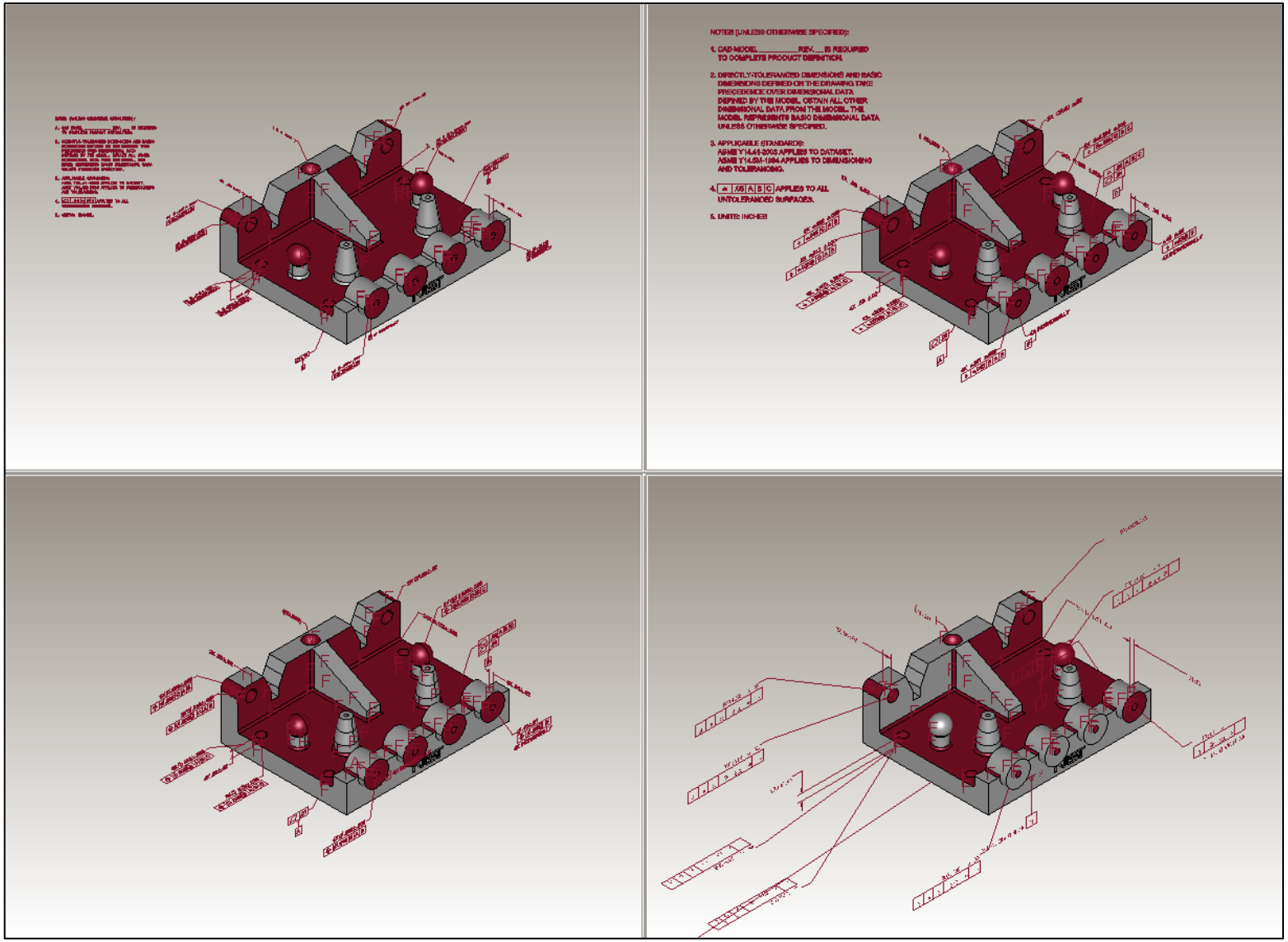
Return to Index

# Fully-toleranced Test Case 6
# Saved View MBD_A Drawing



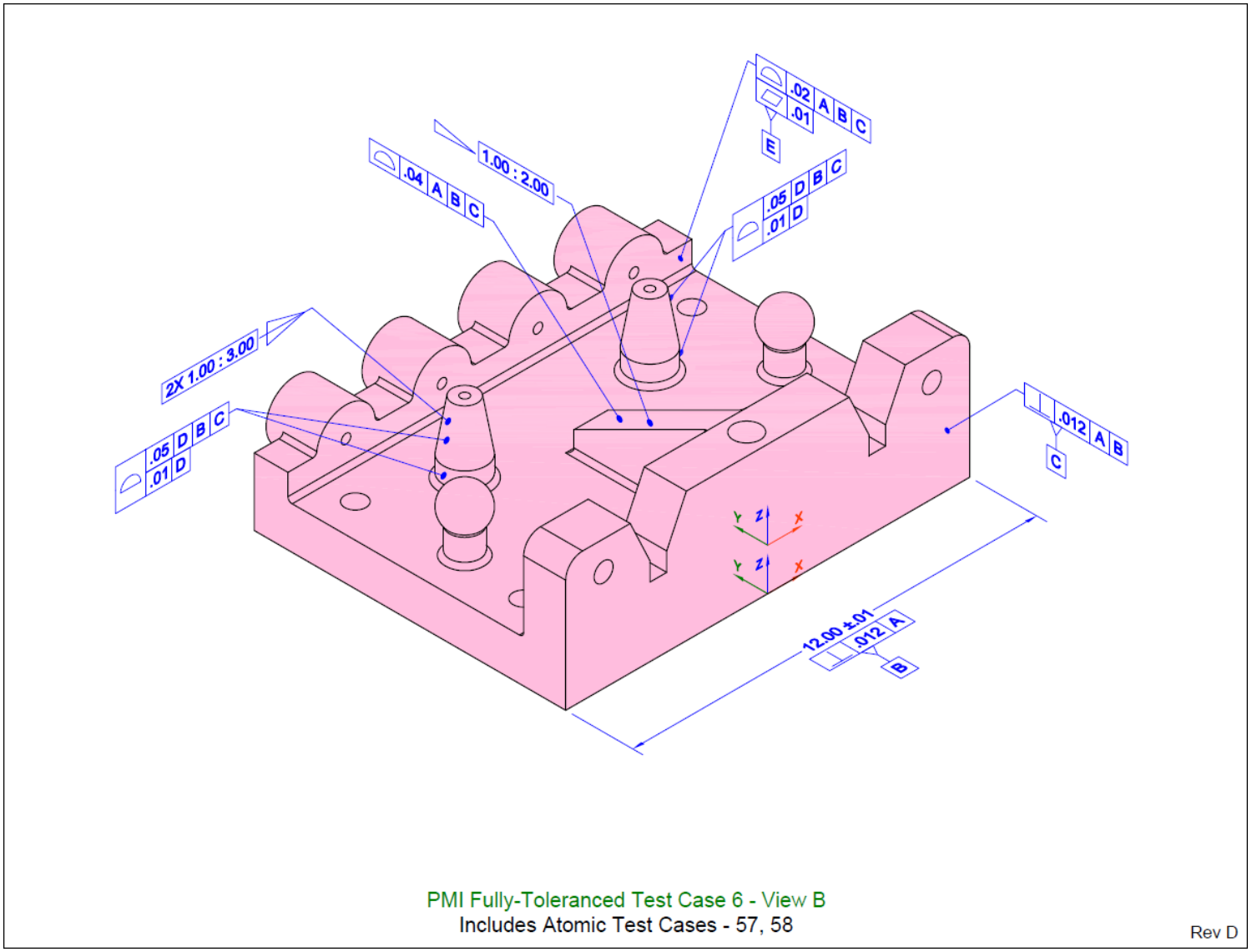

Return to Index

# Fully-toleranced Test Case 6
# Saved View MBD_A Models



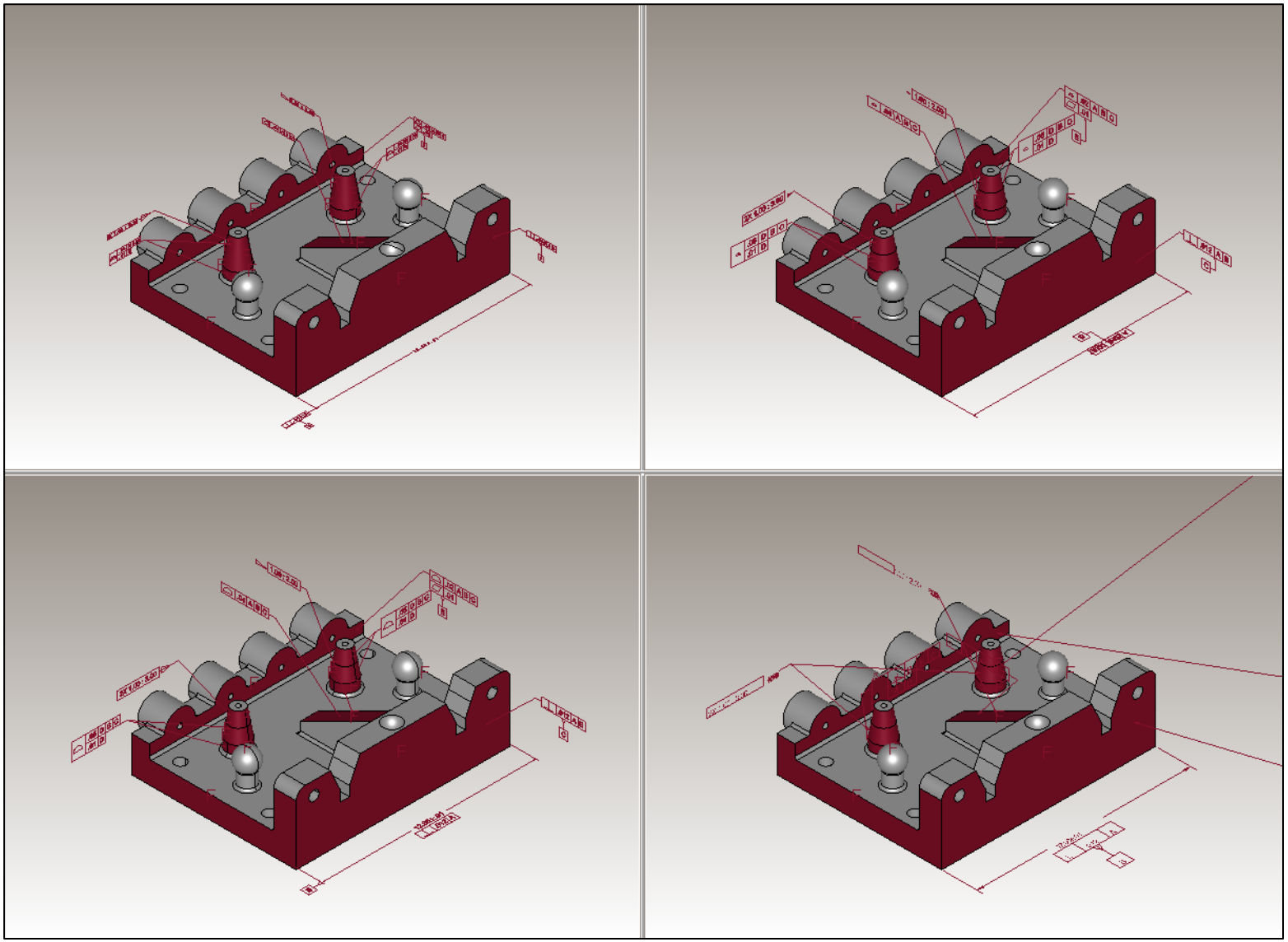
Return to Index

# Fully-toleranced Test Case 6
# Saved View MBD_B Drawing



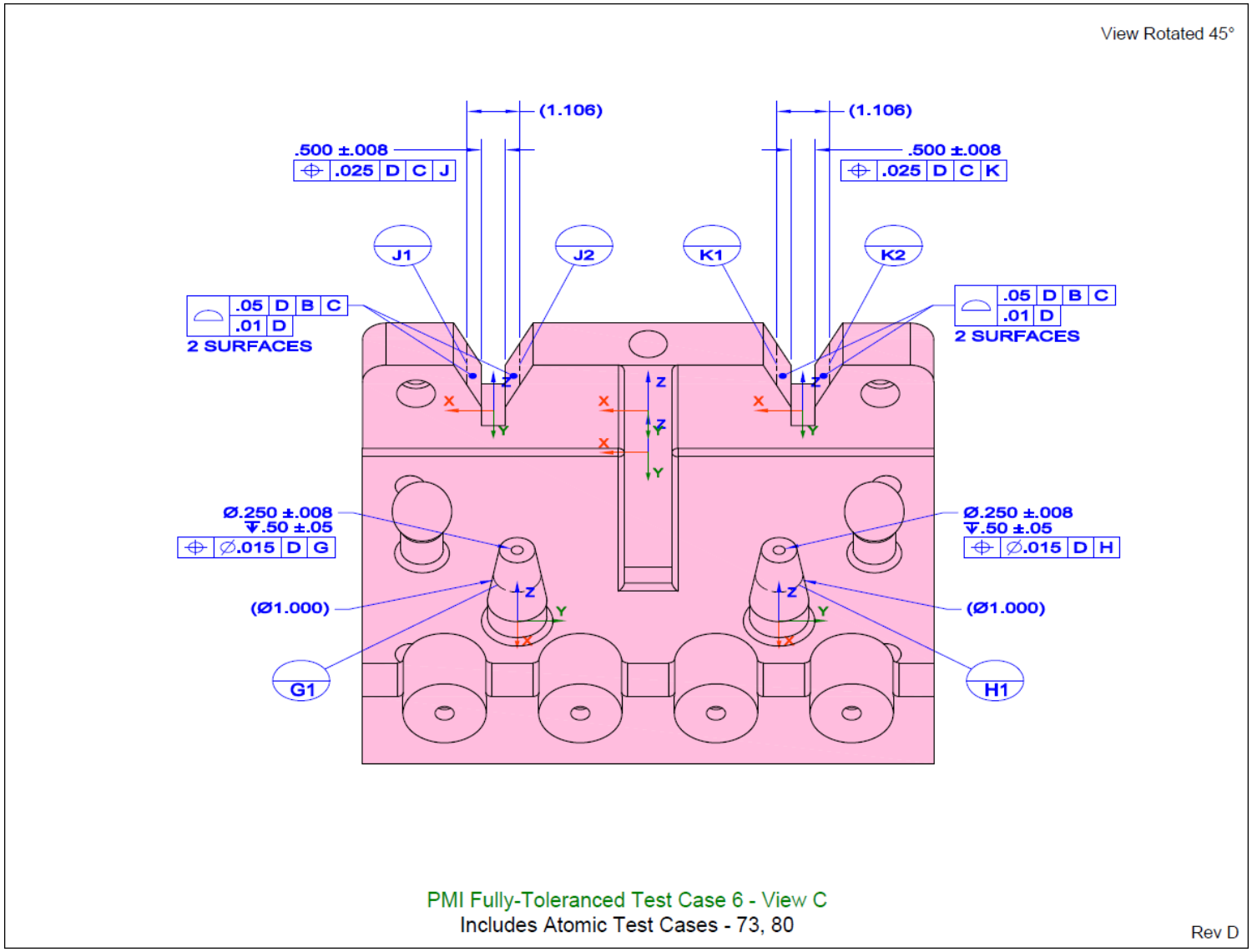

Return to Index

# Fully-toleranced Test Case 6
# Saved View MBD_B Models



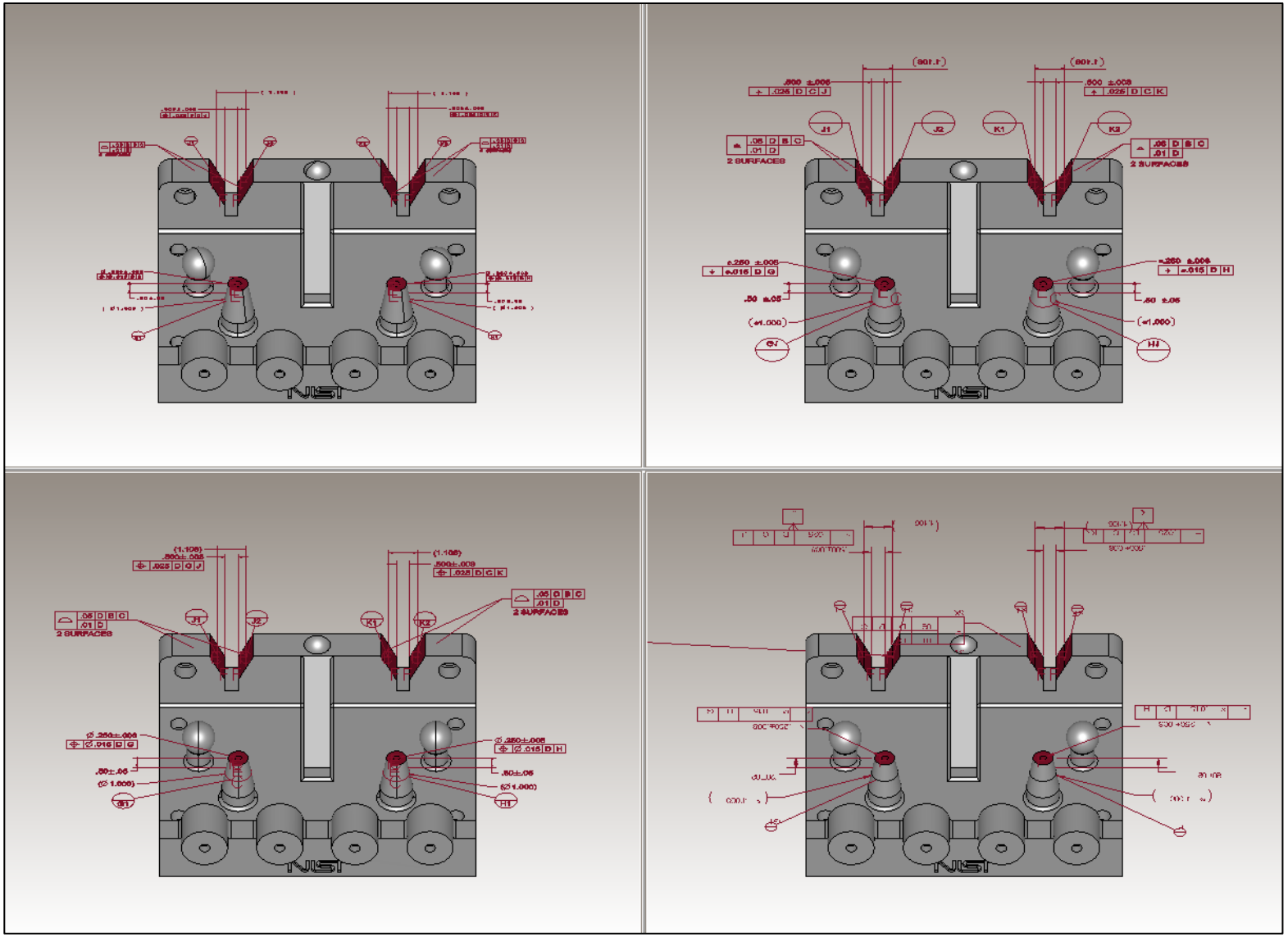
Return to Index

# Fully-toleranced Test Case 6
# Saved View MBD_C Drawing




Return to Index

# Fully-toleranced Test Case 6
# Saved View MBD_C Models



Return to Index

# Fully-toleranced Test Case 8
# Saved View MBD_A Drawing

Feature and Specification Index
nist_ftc_08_asme1_rc_fsi.pdf

NOTES (UNLESS OTHERWISE SPECIFIED):

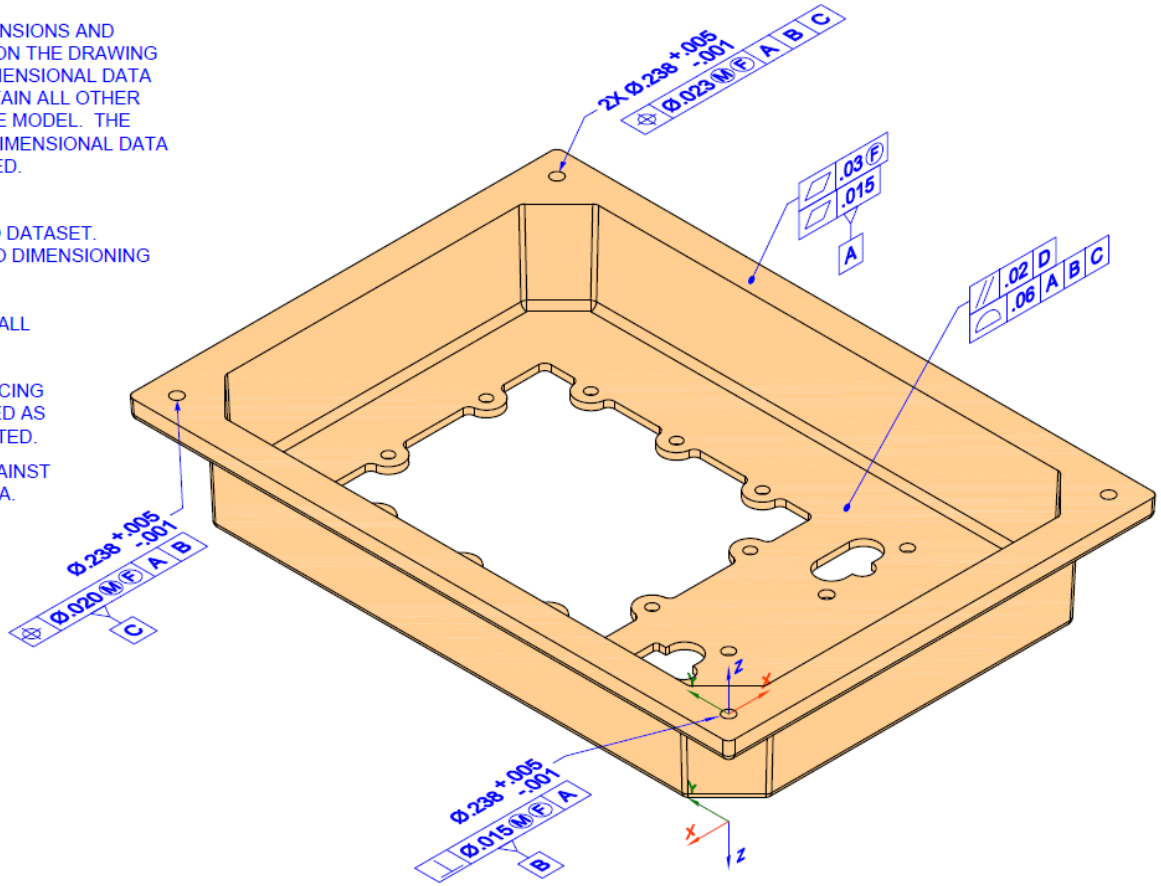
1. CAD MODEL _____ REV. __ IS REQUIRED TO COMPLETE PRODUCT DEFINITION.
2. DIRECTLY-TOLERANCED DIMENSIONS AND BASIC DIMENSIONS DEFINED ON THE DRAWING TAKE PRECEDENCE OVER DIMENSIONAL DATA DEFINED BY THE MODEL. OBTAIN ALL OTHER DIMENSIONAL DATA FROM THE MODEL. THE MODEL REPRESENTS BASIC DIMENSIONAL DATA UNLESS OTHERWISE SPECIFIED.
3. APPLICABLE STANDARDS:
   ASME Y14.41-2003 APPLIES TO DATASET.
   ASME Y14.5M-1994 APPLIES TO DIMENSIONING AND TOLERANCING.
4. ⌓ .06 A B C APPLIES TO ALL UNTOLERANCED SURFACES.
5. DIMENSIONING AND TOLERANCING APPLY WITH PART RESTRAINED AS FOLLOWS, EXCEPT AS INDICATED.

   PLACE DATUM FEATURE A AGAINST DATUM FEATURE SIMULATOR A.

   ENGAGE DATUM FEATURES B AND C WITH DATUM FEATURE SIMULATORS B AND C RESPECTIVELY.

   APPLY LOAD TO PART TO RESTRAIN DATUM FEATURE A AGAINST ITS SIMULATOR.

   DETAILED INSPECTION PLAN NEEDED TO COMPLETELY DEFINE RESTRAINT.
6. UNITS: INCHES

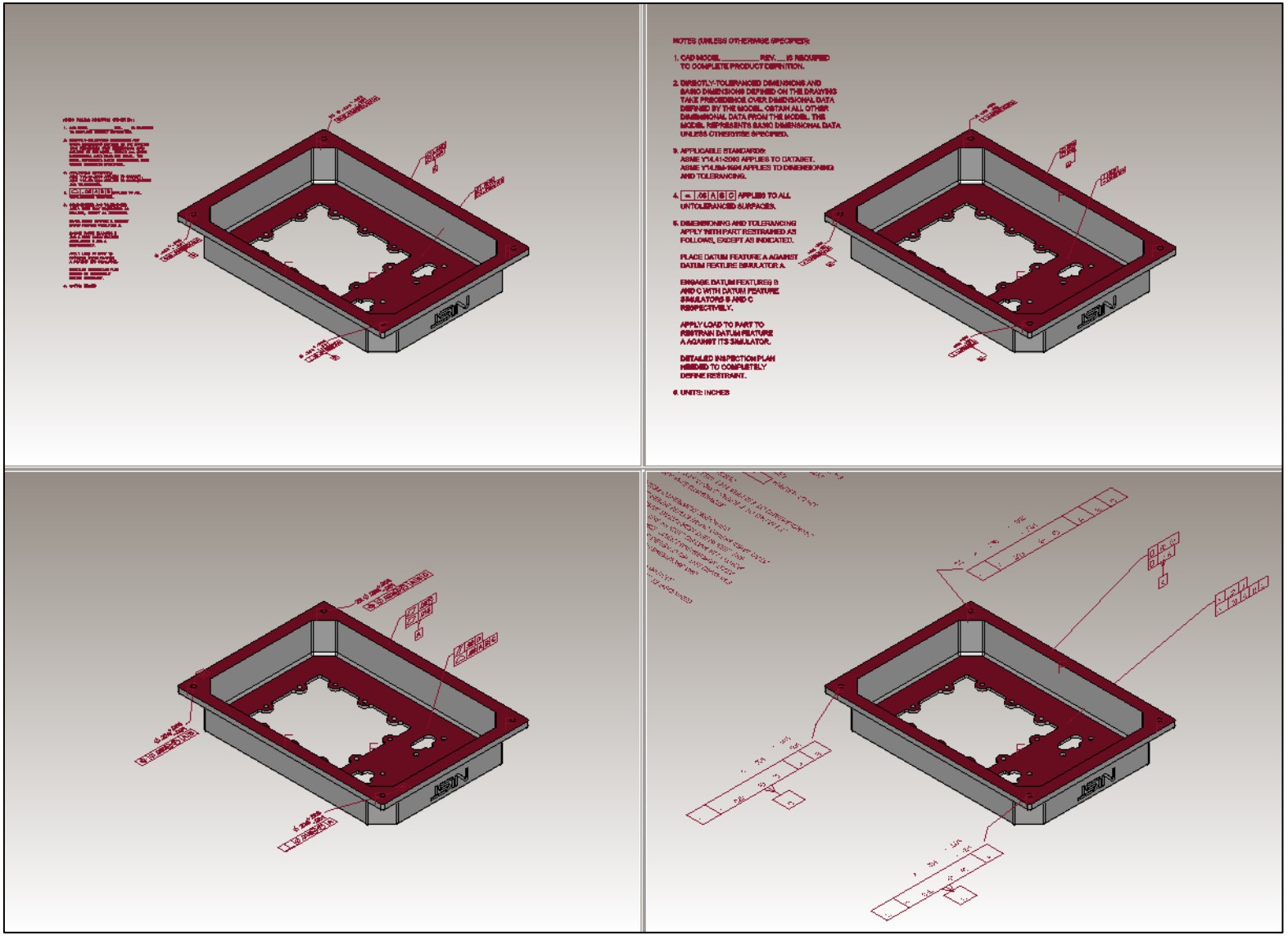



PMI Fully-Toleranced Test Case 8 - View A
Includes Atomic Test Cases - 66, 90

Rev C

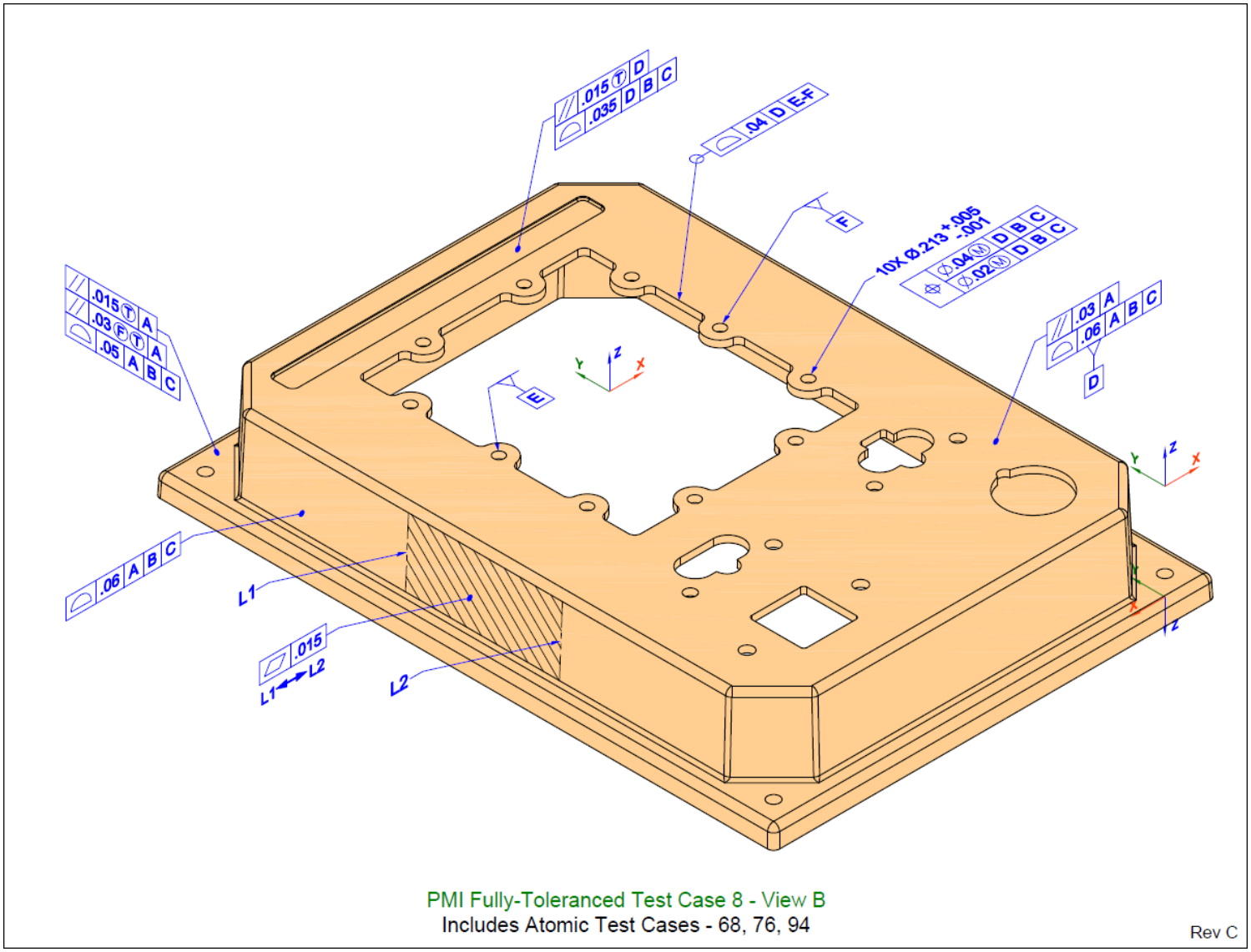
Return to Index

# Fully-toleranced Test Case 8
# Saved View MBD_A Models



Return to Index

# Fully-toleranced Test Case 8
# Saved View MBD_B Drawing

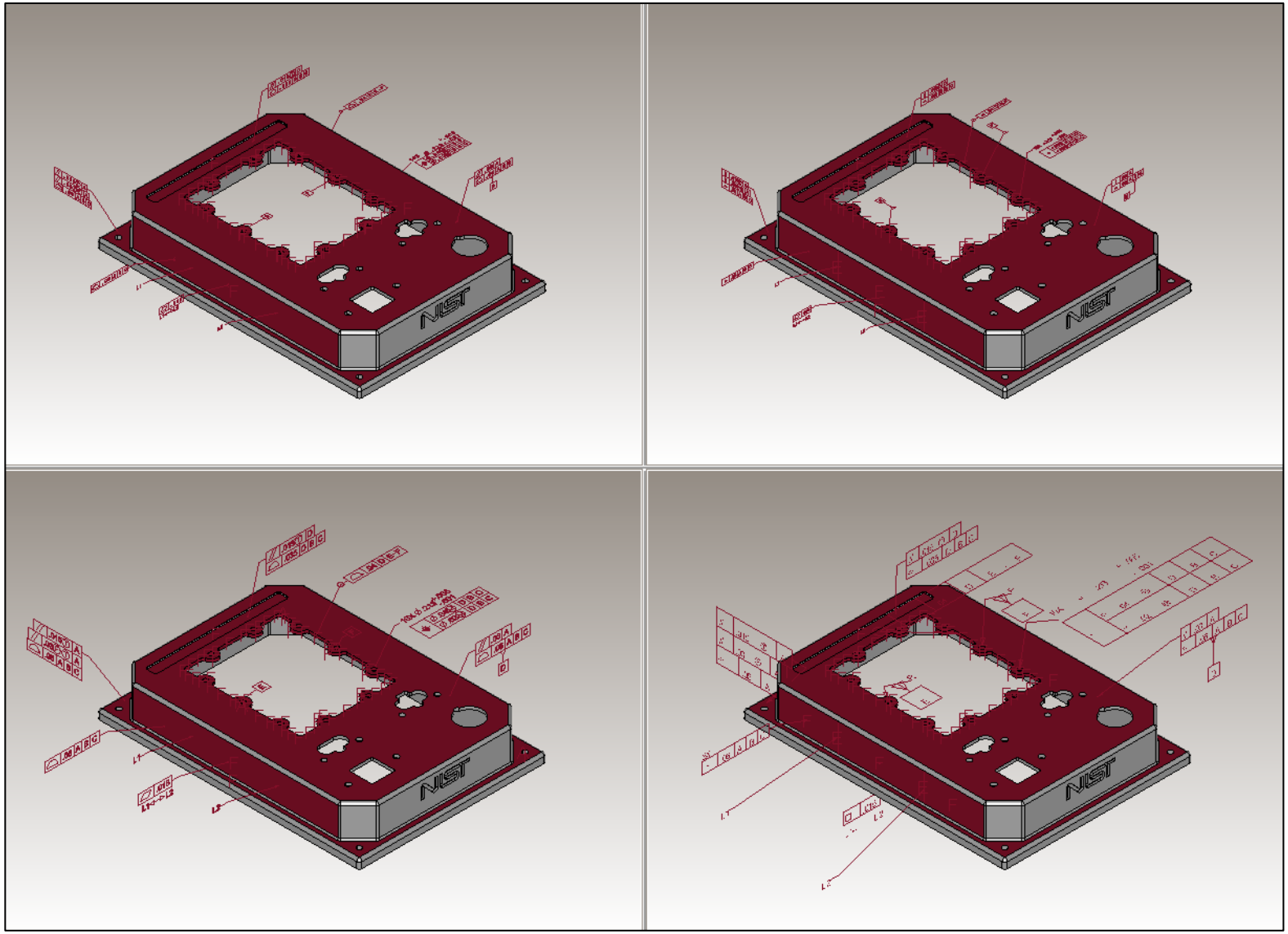



PMI Fully-Toleranced Test Case 8 - View B
Includes Atomic Test Cases - 68, 76, 94

Rev C

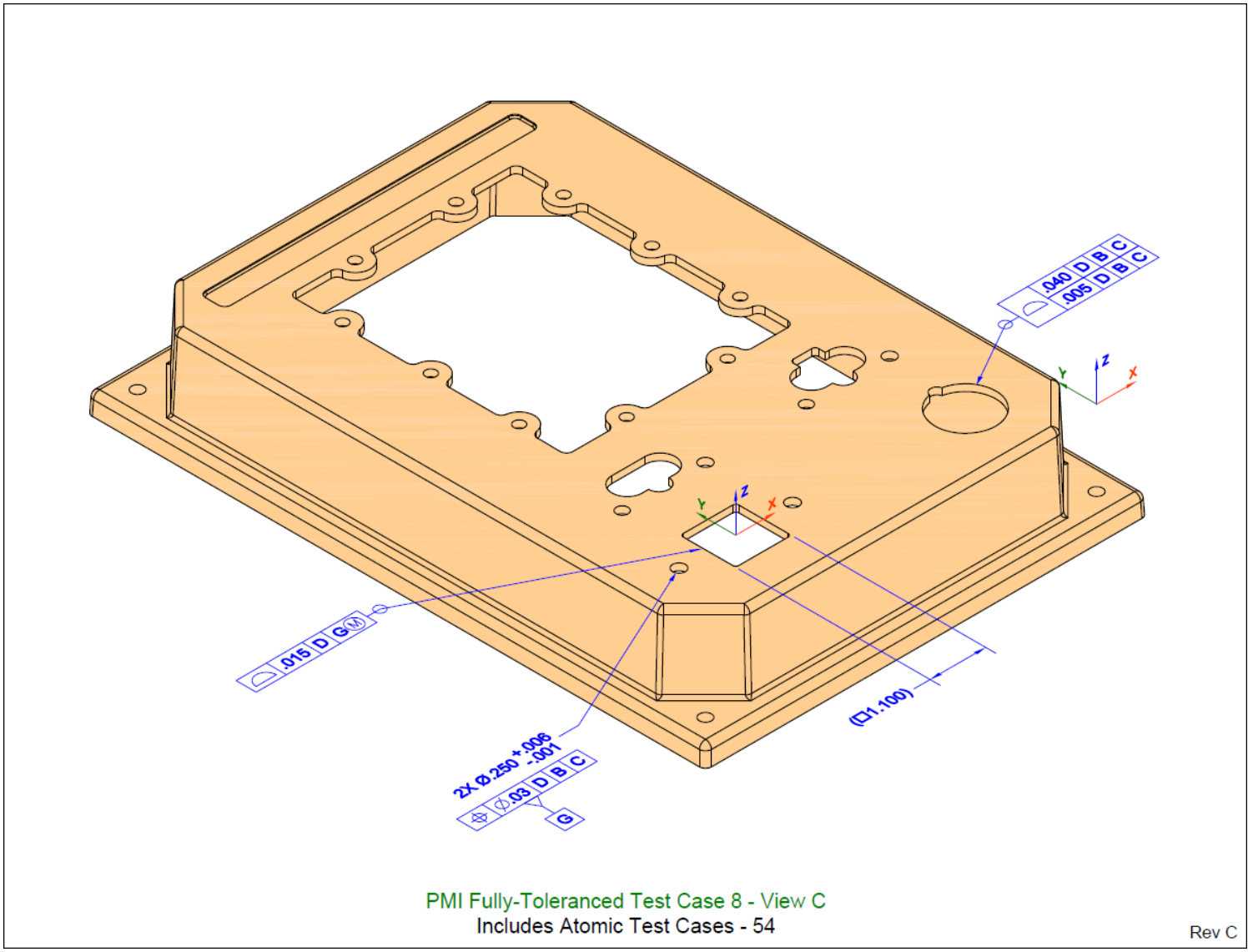
Return to Index

# Fully-toleranced Test Case 8
# Saved View MBD_B Models




Return to Index

# Fully-toleranced Test Case 8
# Saved View MBD_C Drawing

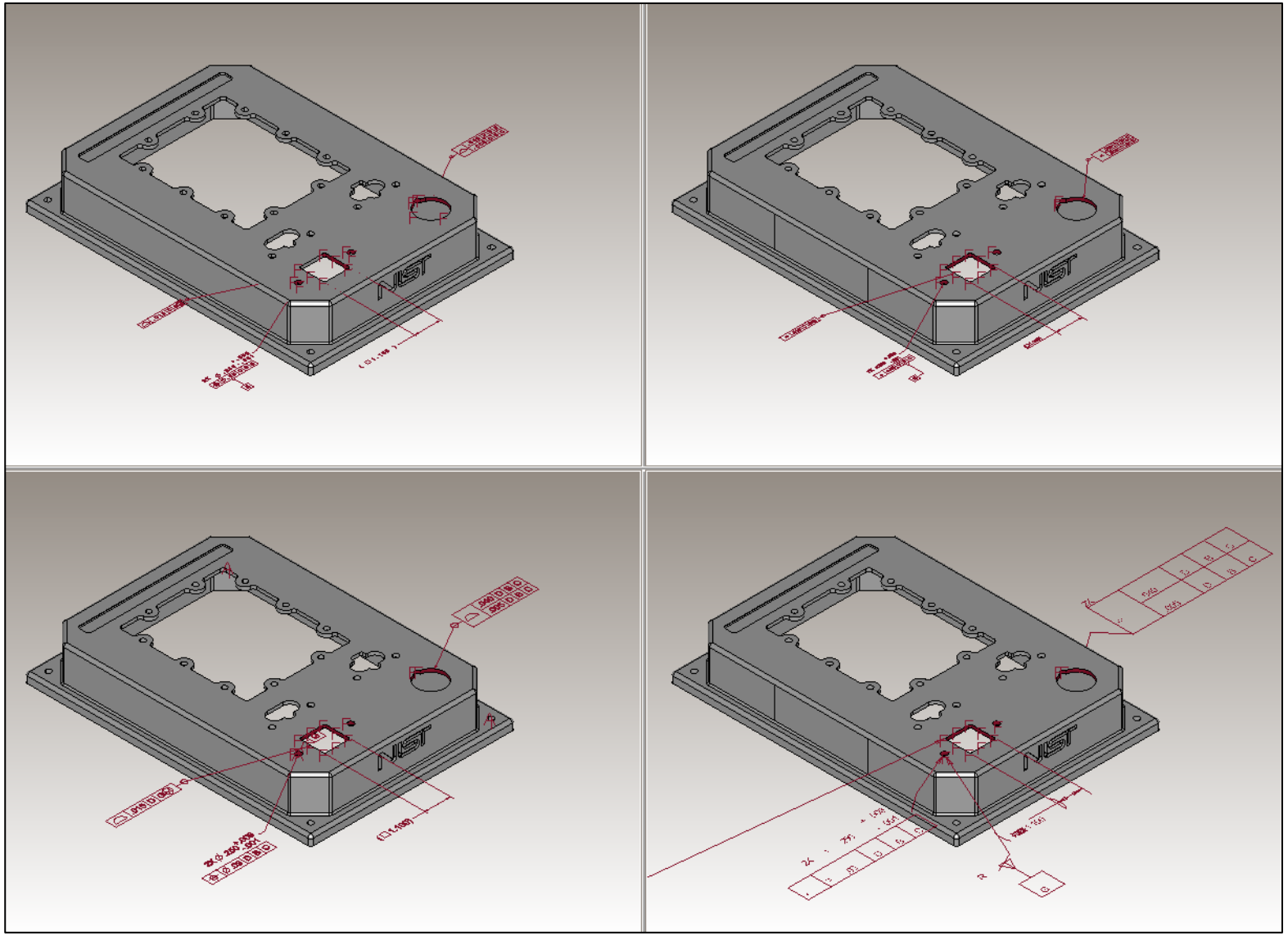



PMI Fully-Toleranced Test Case 8 - View C
Includes Atomic Test Cases - 54

Rev C

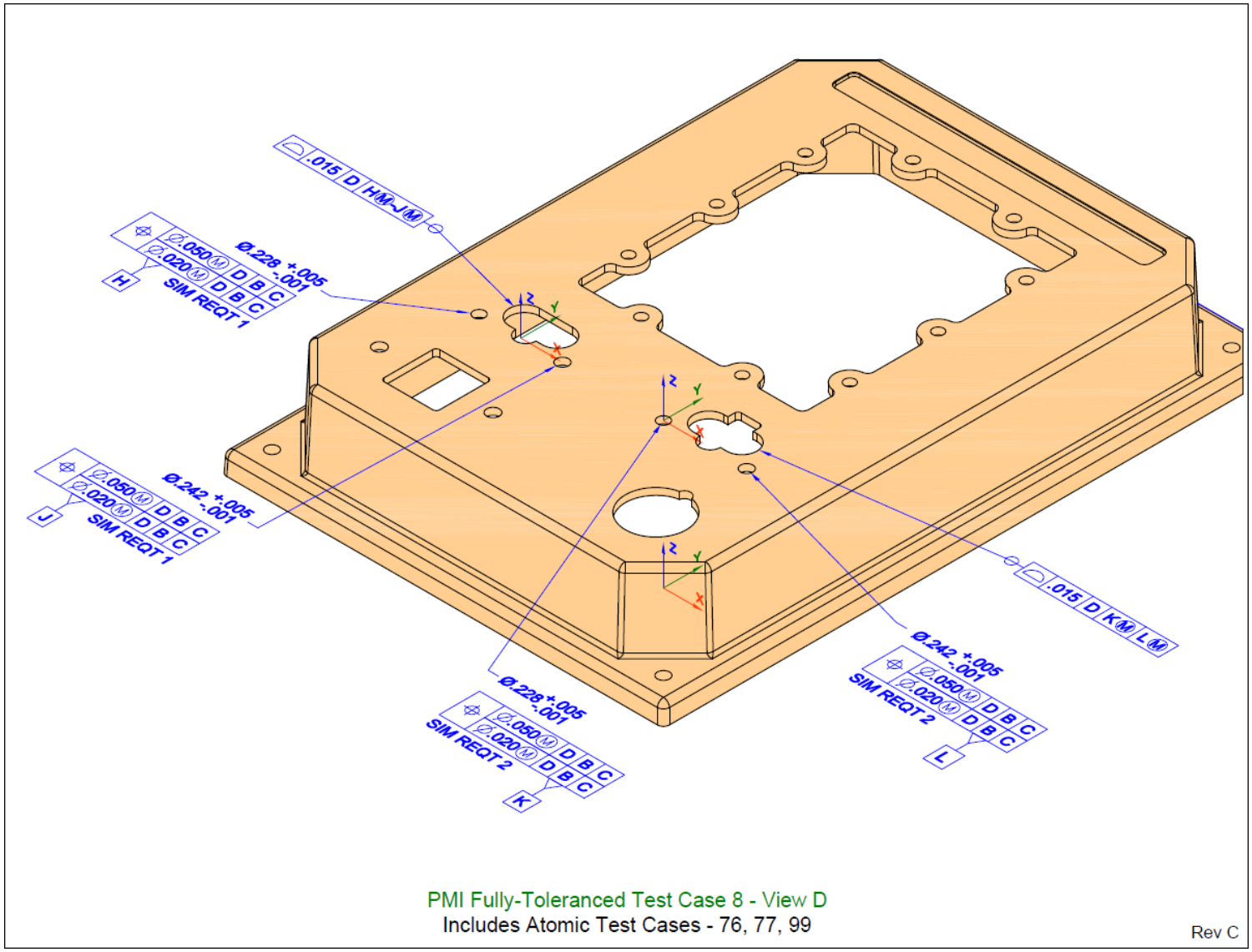
Return to Index

# Fully-toleranced Test Case 8
# Saved View MBD_C Models



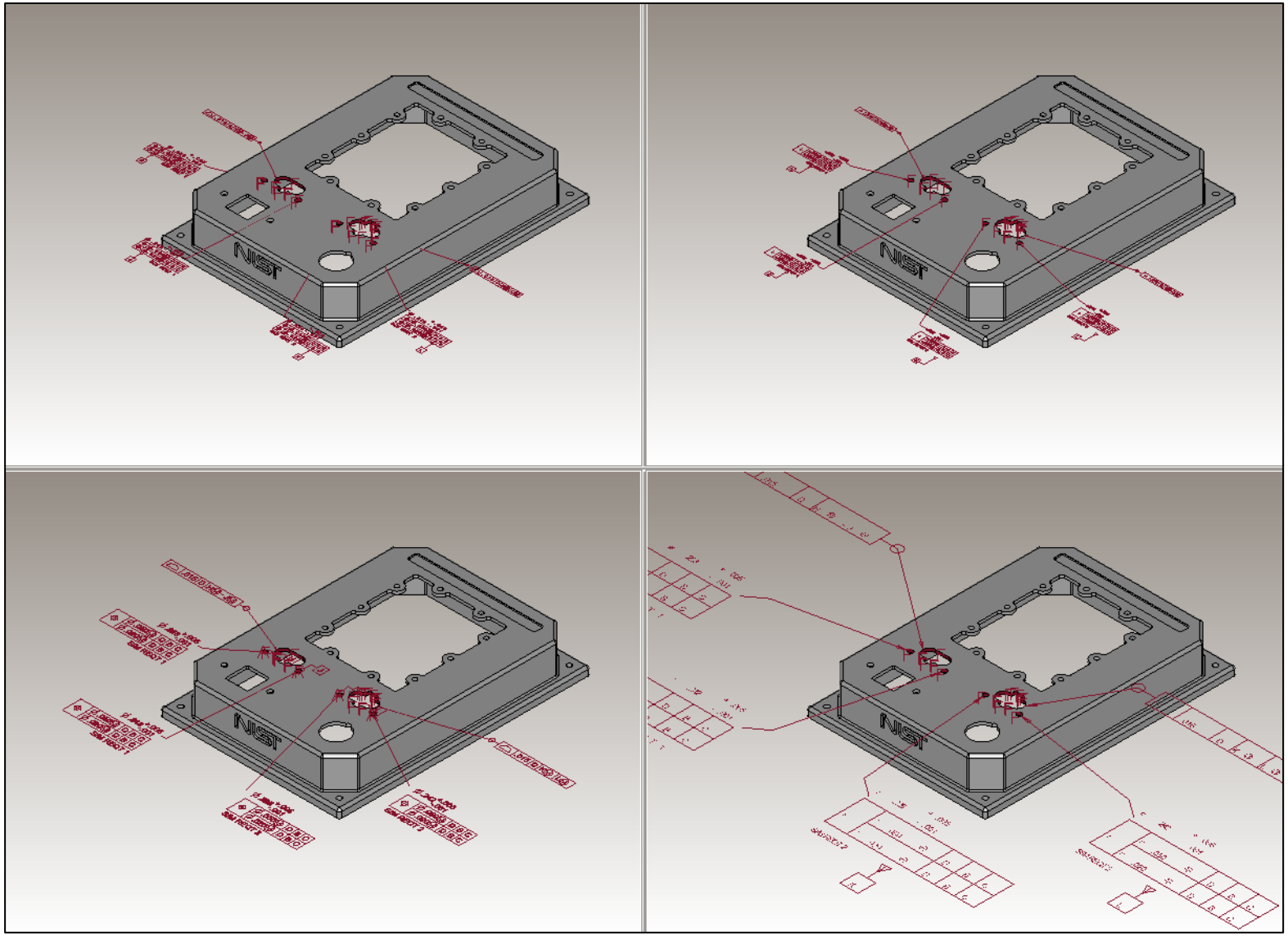
Return to Index

# Fully-toleranced Test Case 8
# Saved View MBD_D Drawing




Return to Index

# Fully-toleranced Test Case 8
# Saved View MBD_D Models



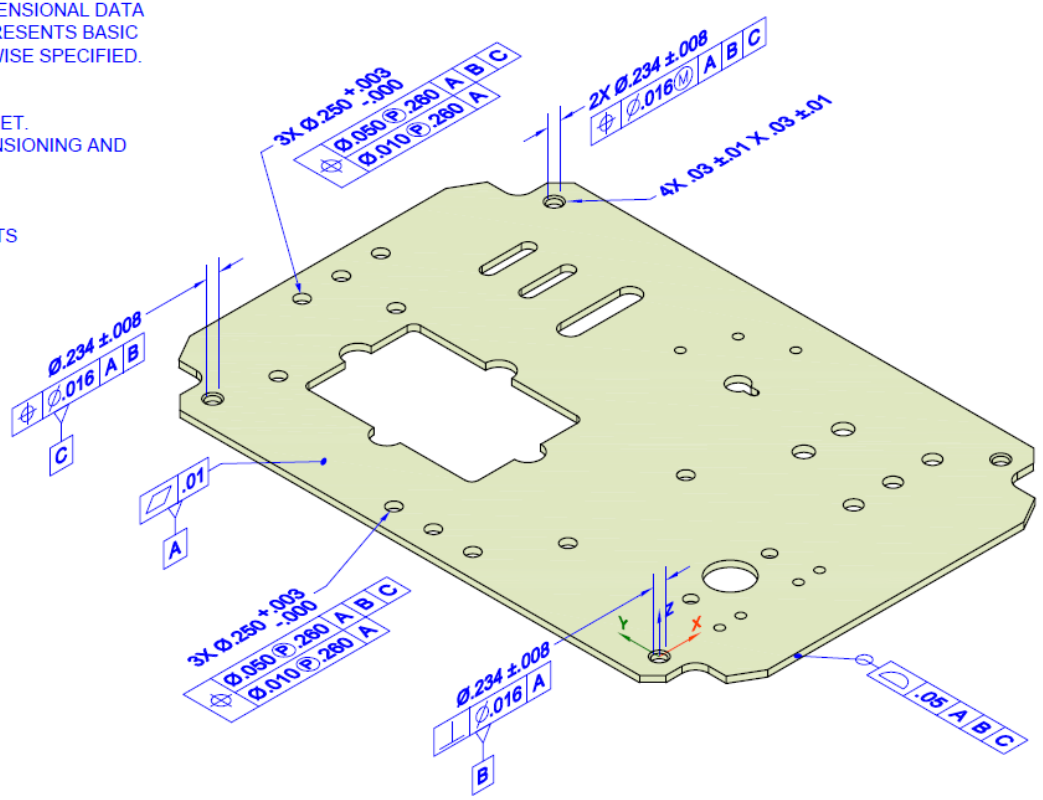

Return to Index

# Fully-toleranced Test Case 9
# Saved View MBD_A Drawing

Feature and Specification Index
nist_ftc_09_asme1_rd_fsi.pdf

NOTES (UNLESS OTHERWISE SPECIFIED):

1. CAD MODEL _____ REV. __ IS REQUIRED TO COMPLETE PRODUCT DEFINITION.
2. DIRECTLY-TOLERANCED DIMENSIONS AND BASIC DIMENSIONS DEFINED ON THE DRAWING TAKE PRECEDENCE OVER DIMENSIONAL DATA DEFINED BY THE MODEL. OBTAIN ALL OTHER DIMENSIONAL DATA FROM THE MODEL. THE MODEL REPRESENTS BASIC DIMENSIONAL DATA UNLESS OTHERWISE SPECIFIED.
3. APPLICABLE STANDARDS:
   ASME Y14.41-2003 APPLIES TO DATASET.
   ASME Y14.5M-1994 APPLIES TO DIMENSIONING AND TOLERANCING.
4. DIMENSION AND TOLERANCE VALUES SHOWN IN SQUARE BRACKETS [XXX] ARE MILLIMETERS.
5. MATERIAL: (.1195 THICK) 11 GA 304 SST SHT, ASTM A240.
6. UNITS: INCHES

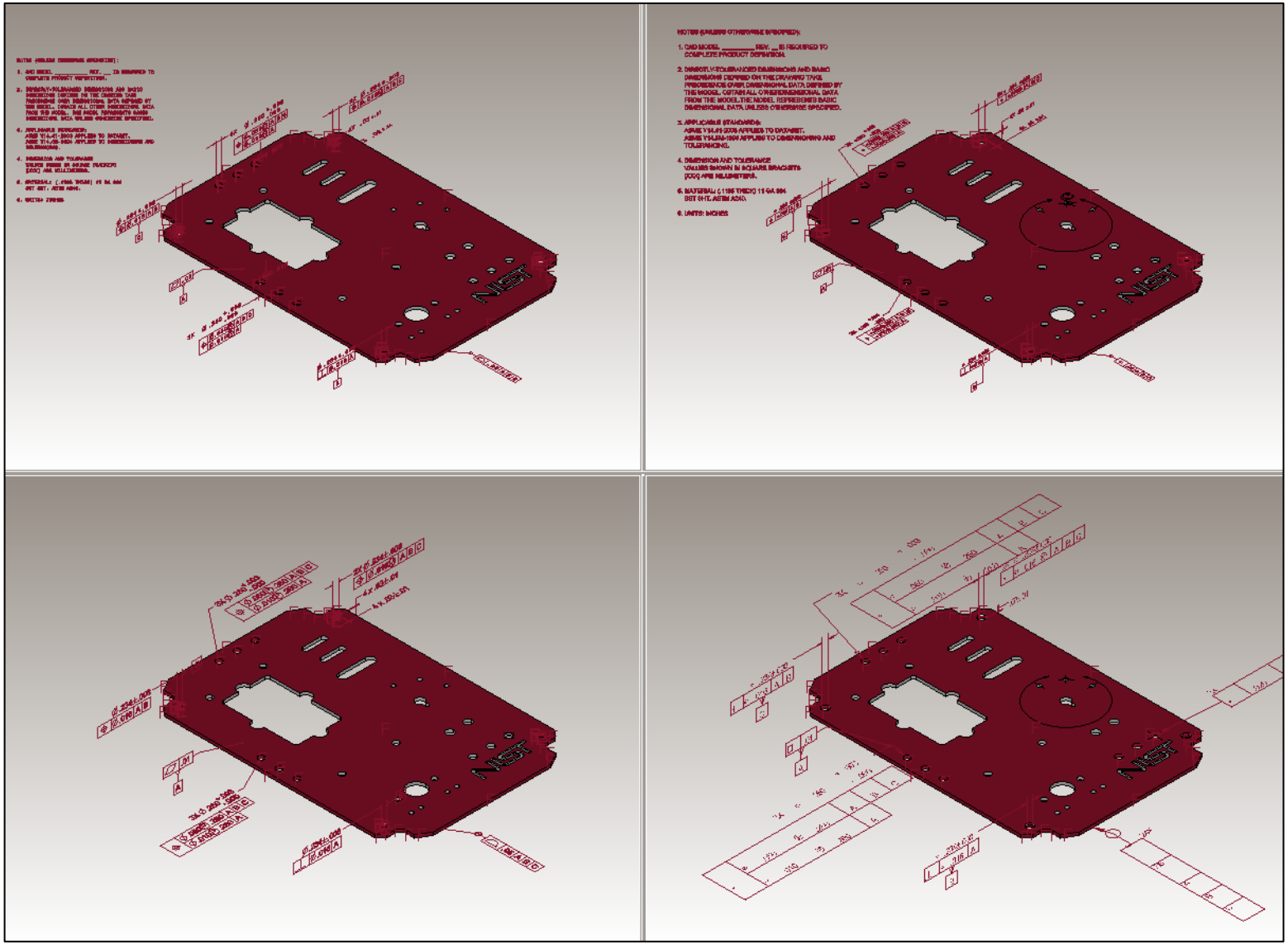



PMI Fully-Toleranced Test Case 9 - View A
Includes Atomic Test Cases - 59, 61

Rev D

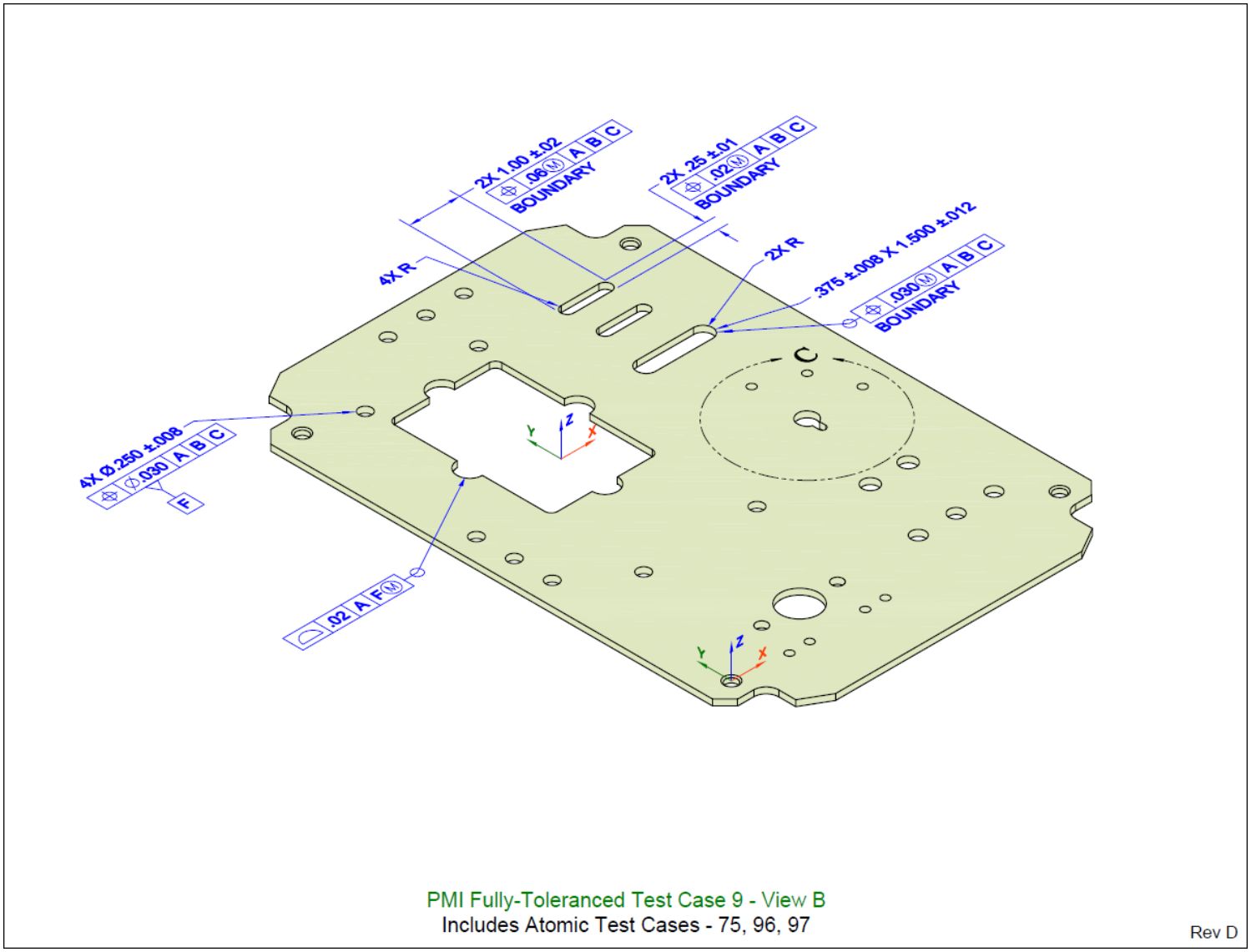
Return to Index

# Fully-toleranced Test Case 9
# Saved View MBD_A Models



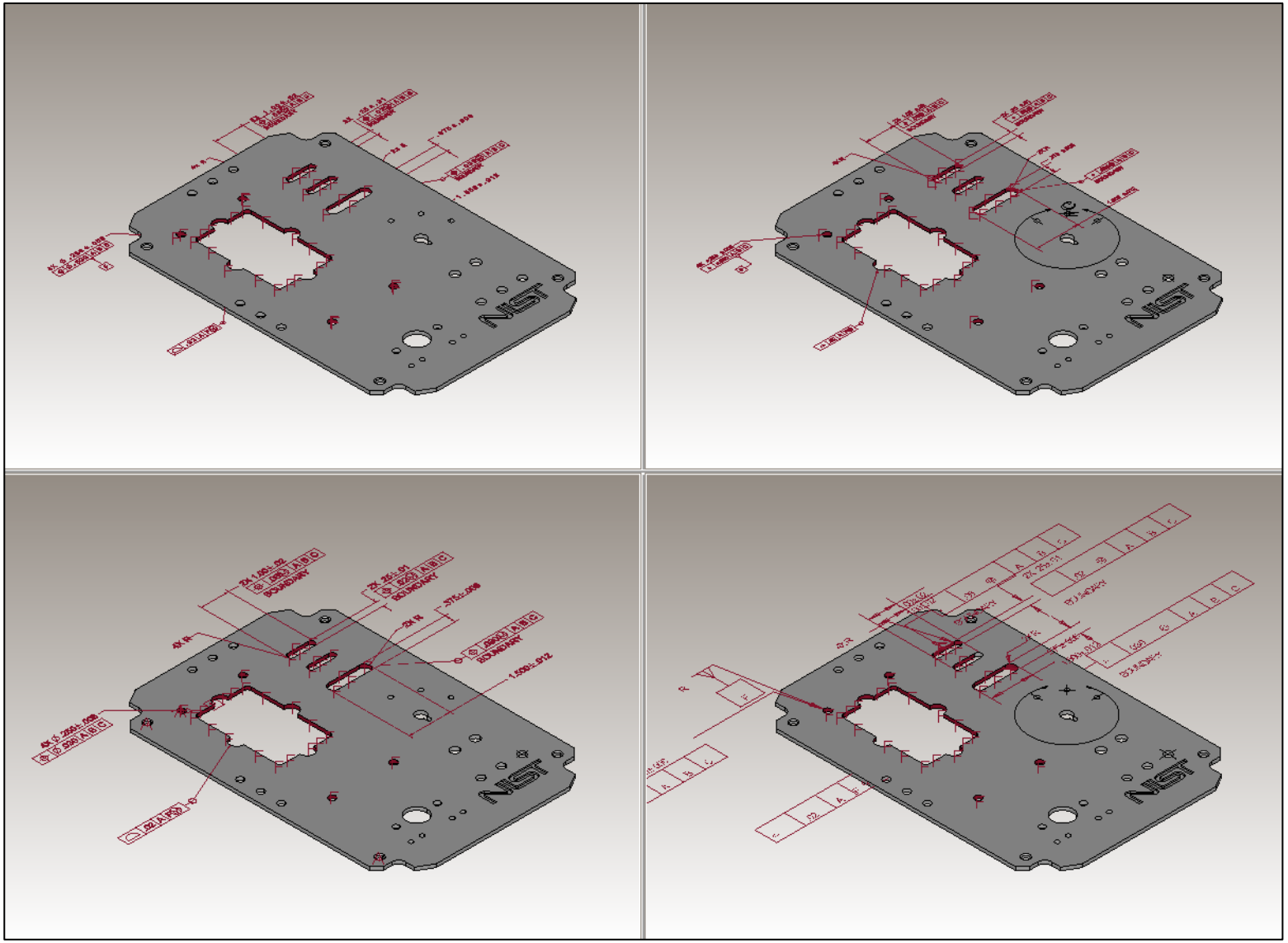
Return to Index

# Fully-toleranced Test Case 9
# Saved View MBD_B Drawing



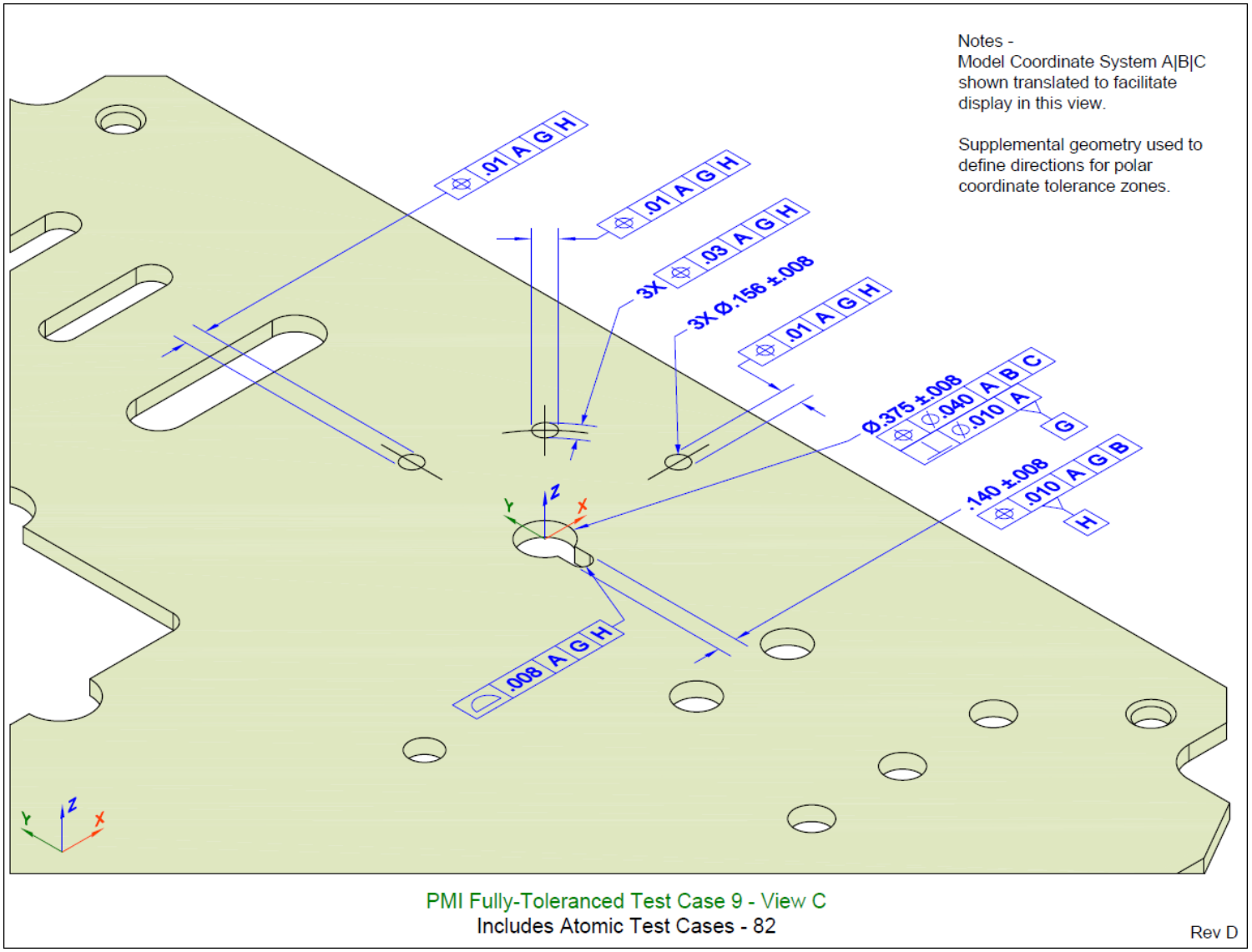

Return to Index

# Fully-toleranced Test Case 9
# Saved View MBD_B Models



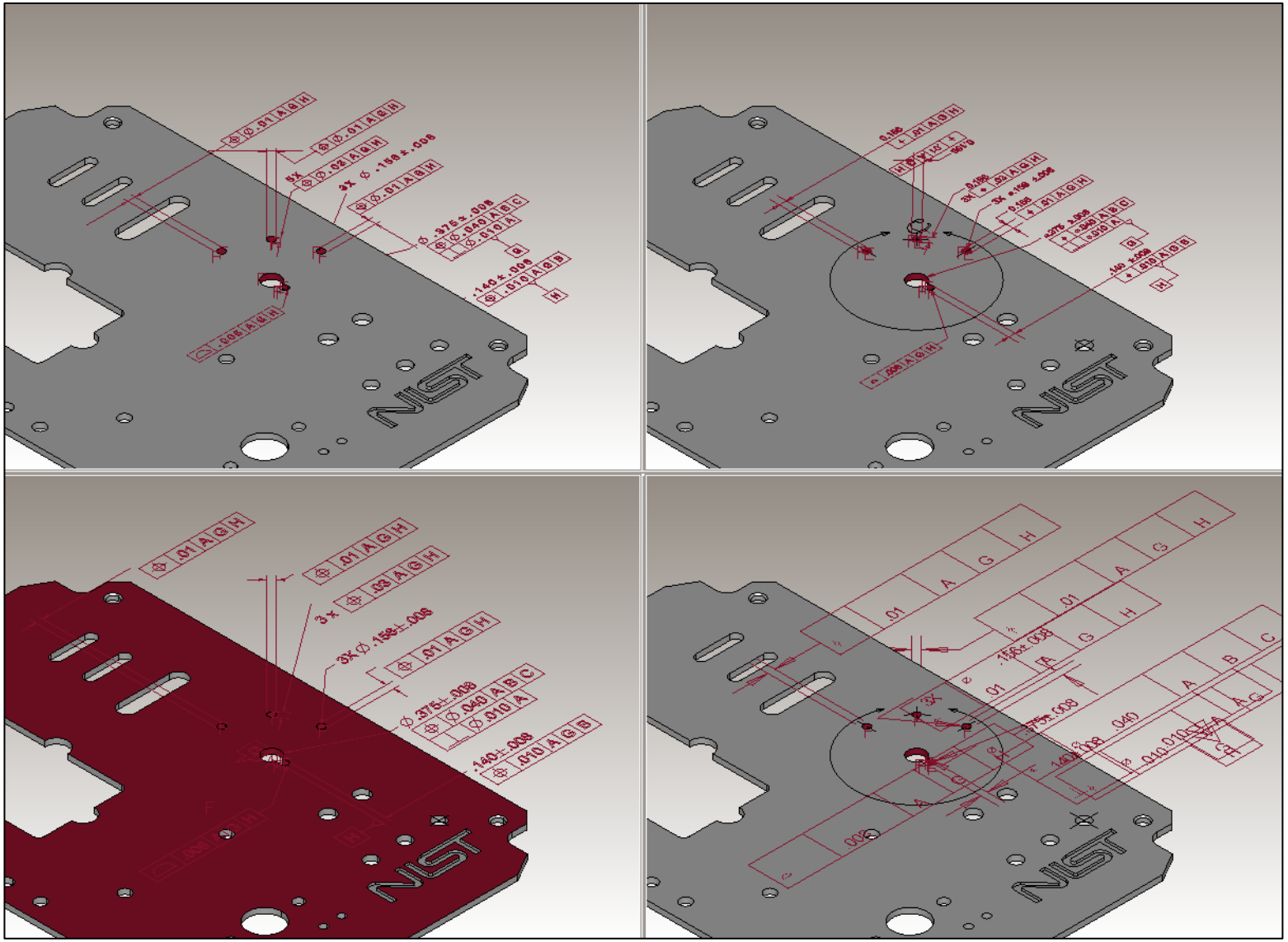
Return to Index

# Fully-toleranced Test Case 9
# Saved View MBD_C Drawing



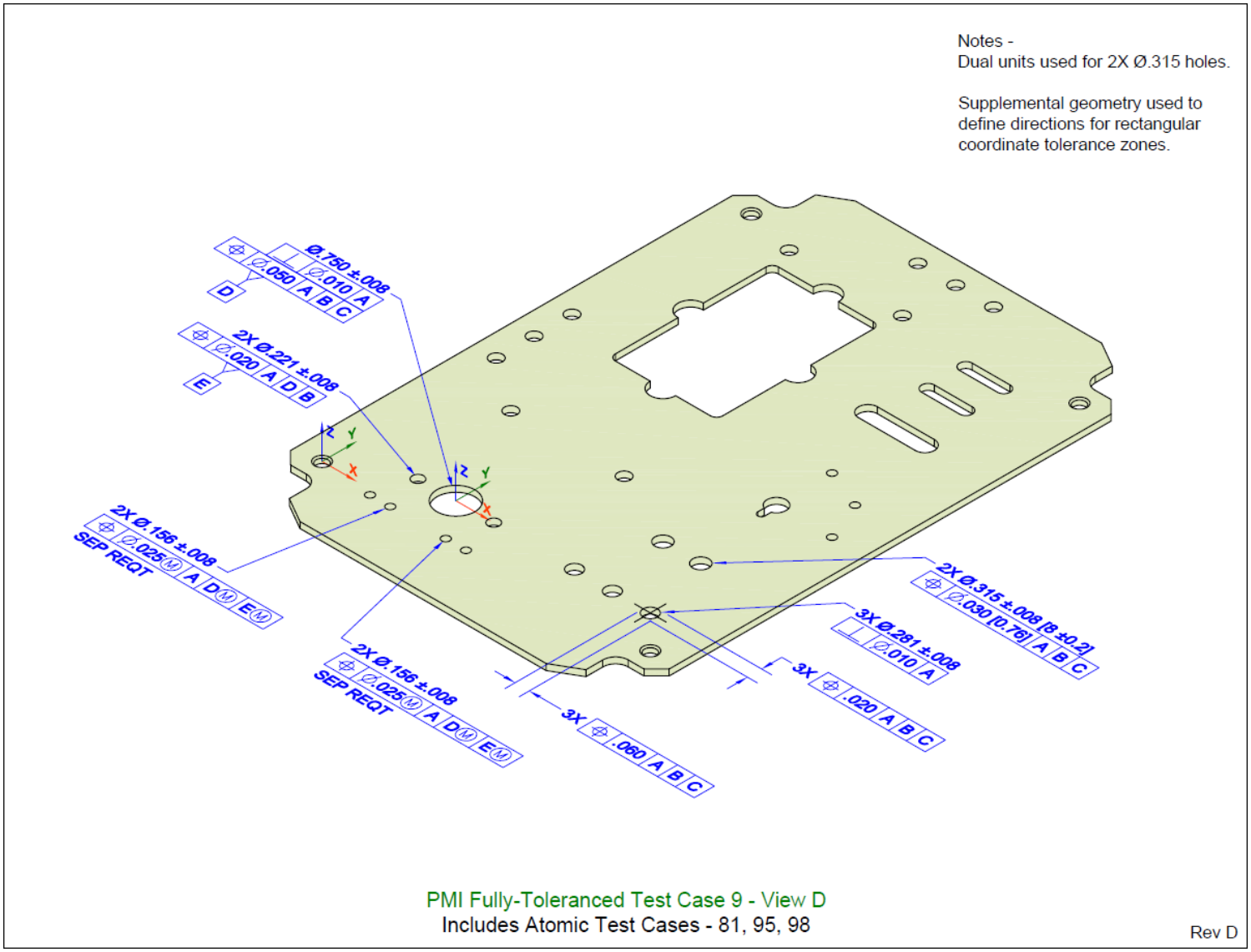

Return to Index

# Fully-toleranced Test Case 9
# Saved View MBD_C Models



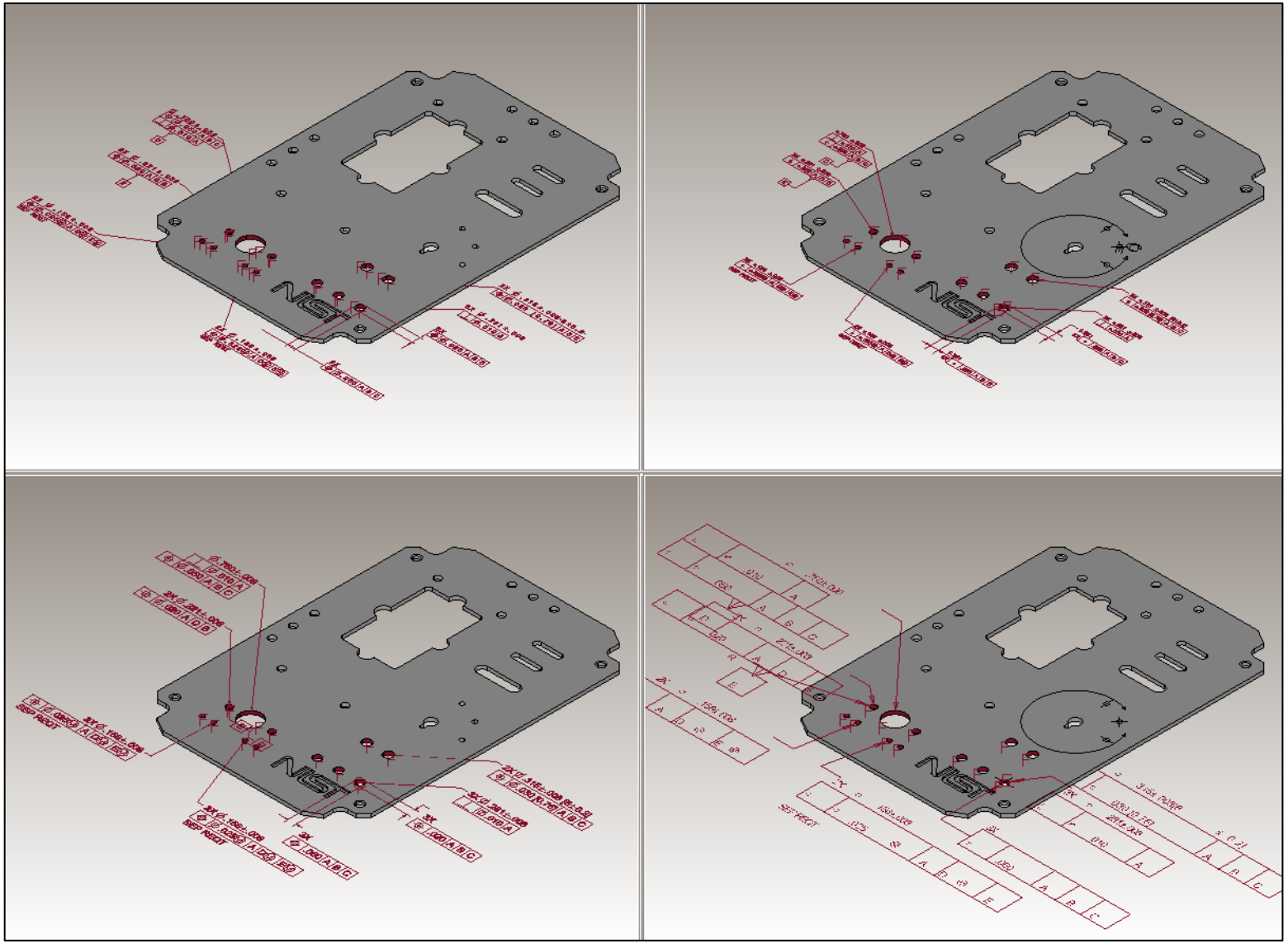

Return to Index

# Fully-toleranced Test Case 9
# Saved View MBD_D Drawing




Return to Index

# Fully-toleranced Test Case 9
# Saved View MBD_D Models



Return to Index