

CETOL 60 **TM**

2011 U2U CONFERENCE

TEXAS MOTOR SPEEDWAY, OCT 25-26

Pattern of Features Used as a Datum

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Raytheon
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- Present a method for using a pattern of features as a datum using CETOL, Version 8.2
 - Simplified scenario created
 - Calculated results by hand
 - Analyzed scenario in CETOL
 - Validate methodology for pattern of features by comparing results of hand calculations and CETOL

Simplified Scenario

- Plate edge clearance to Base wall

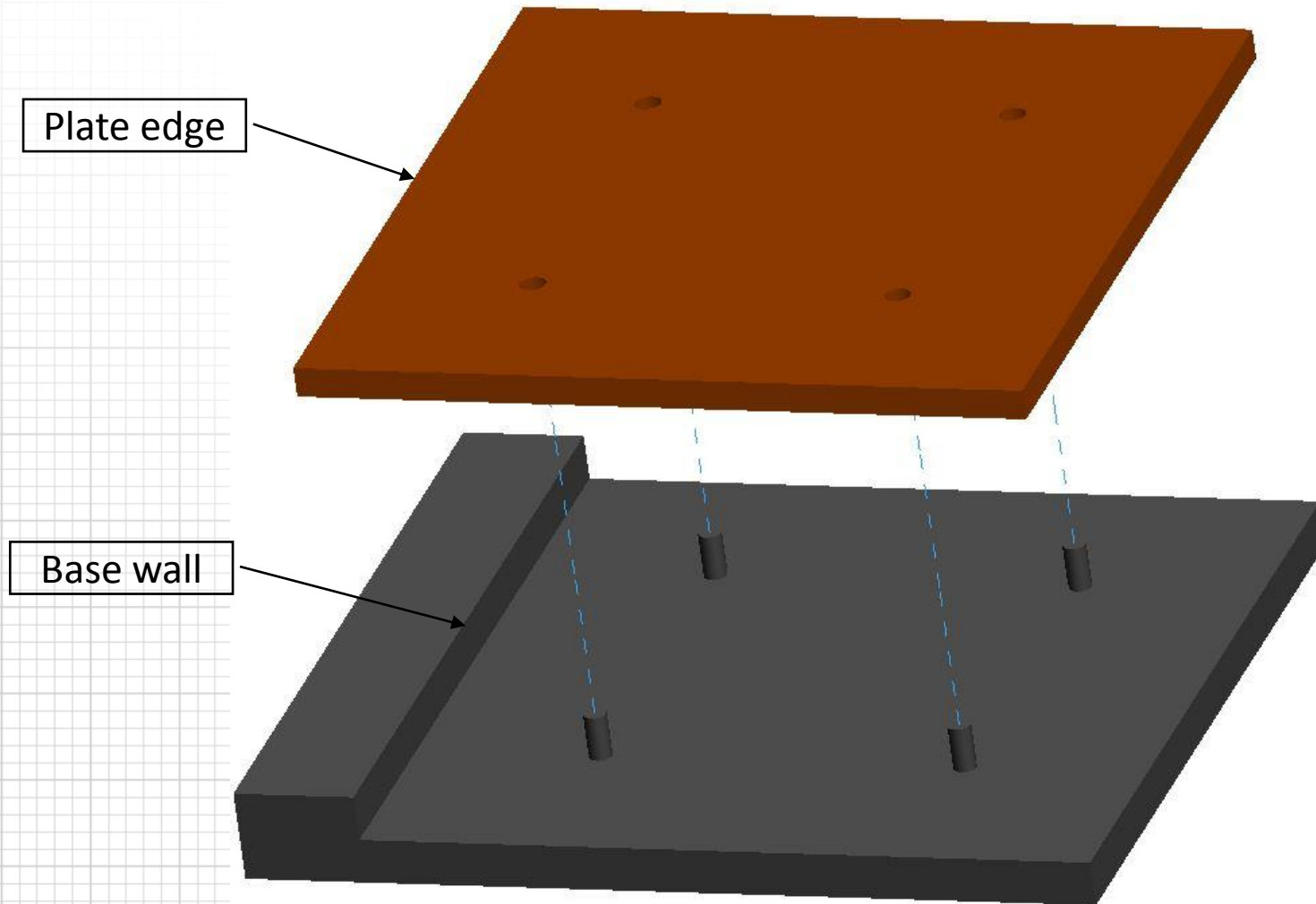
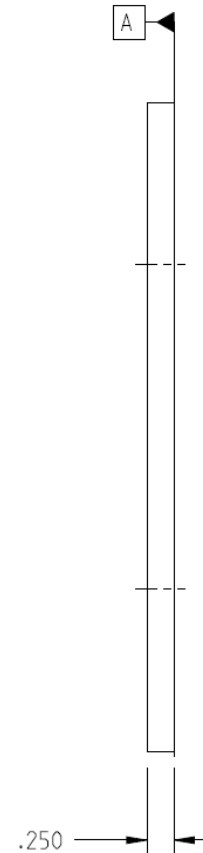
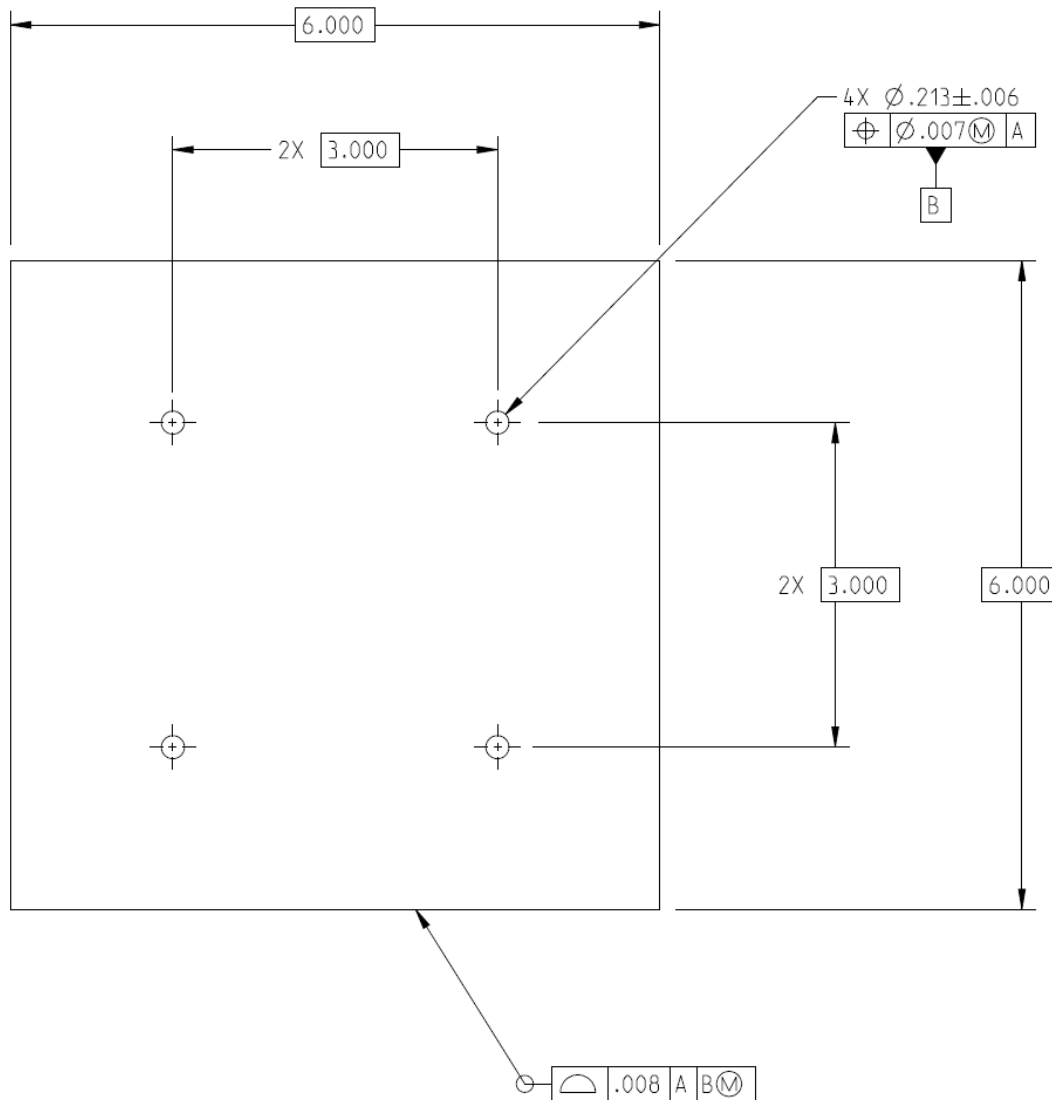
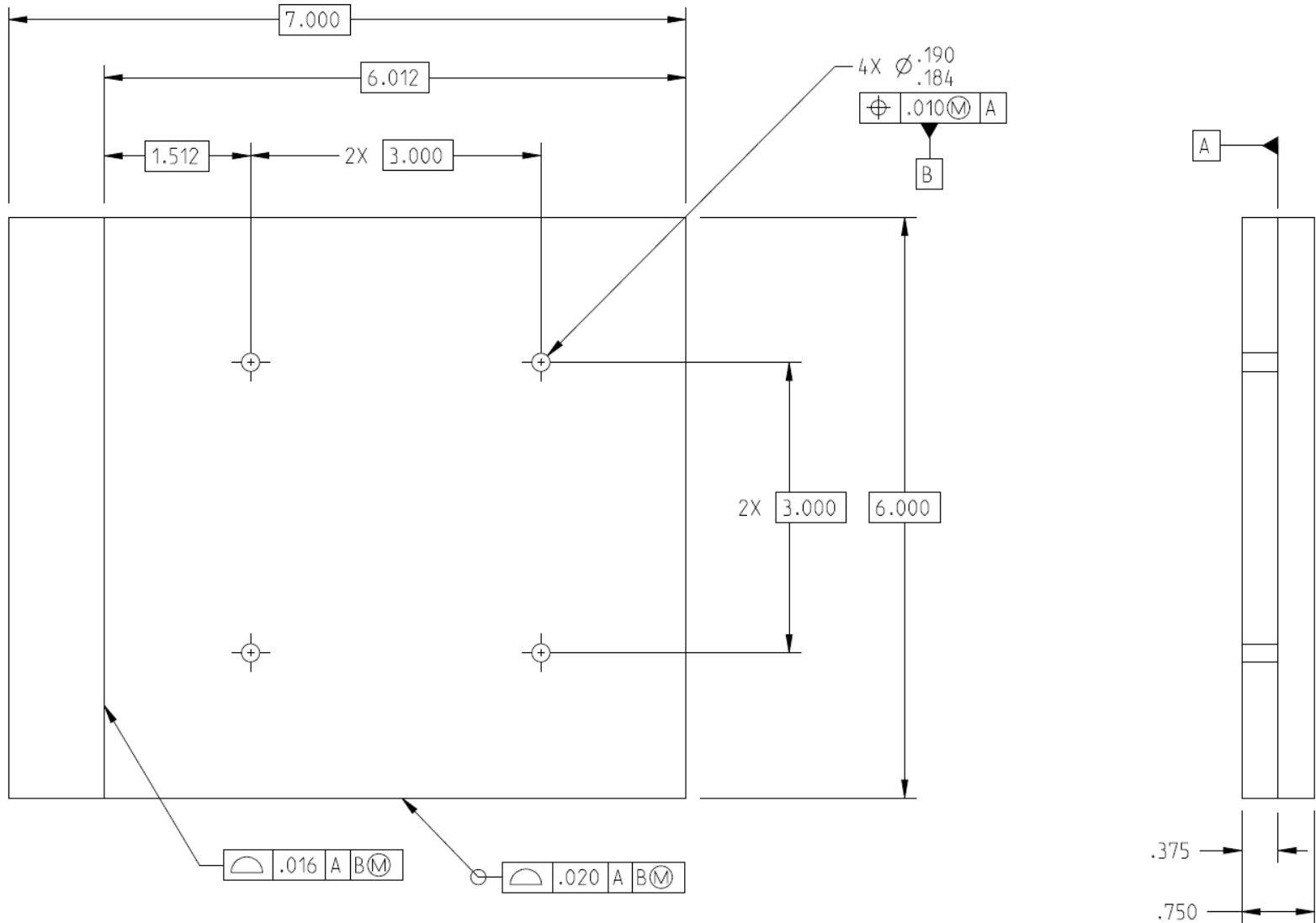


Plate Details

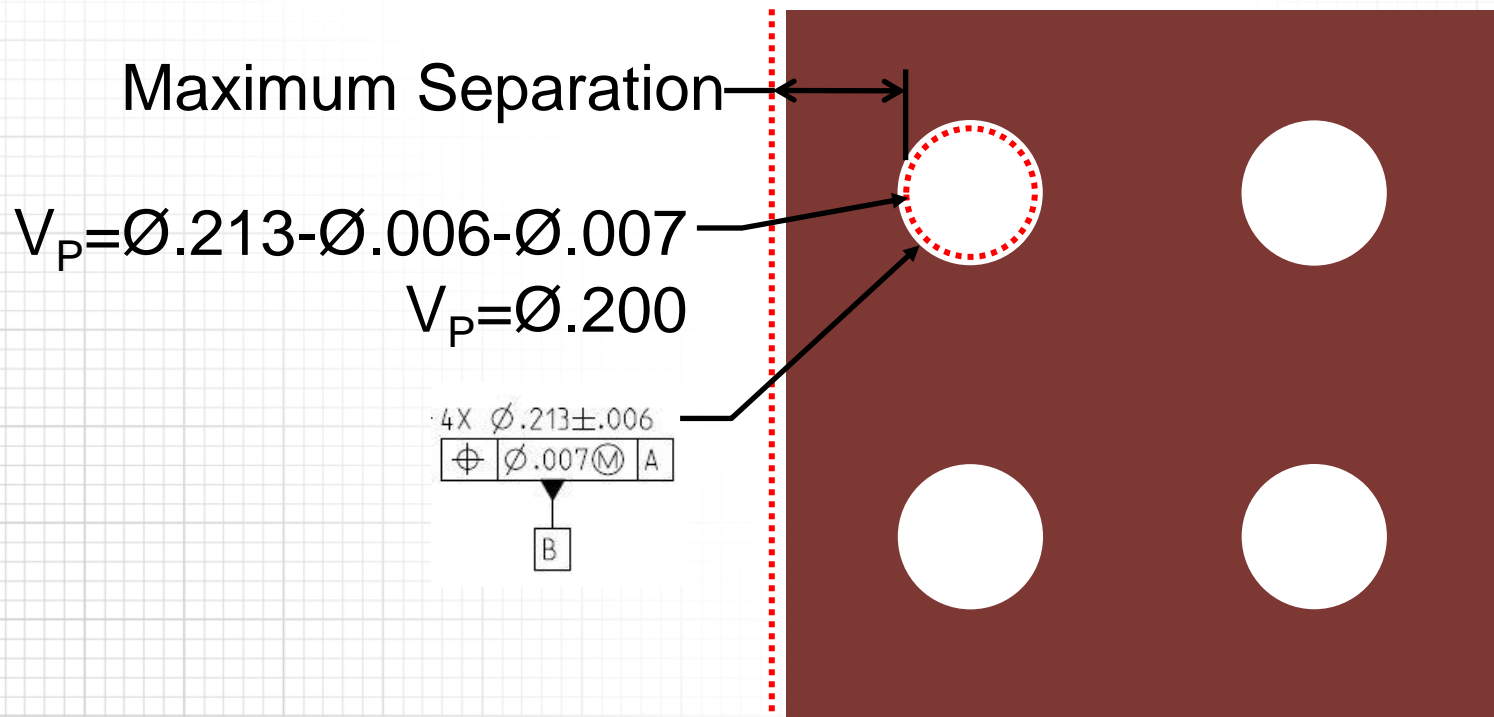


Base Details



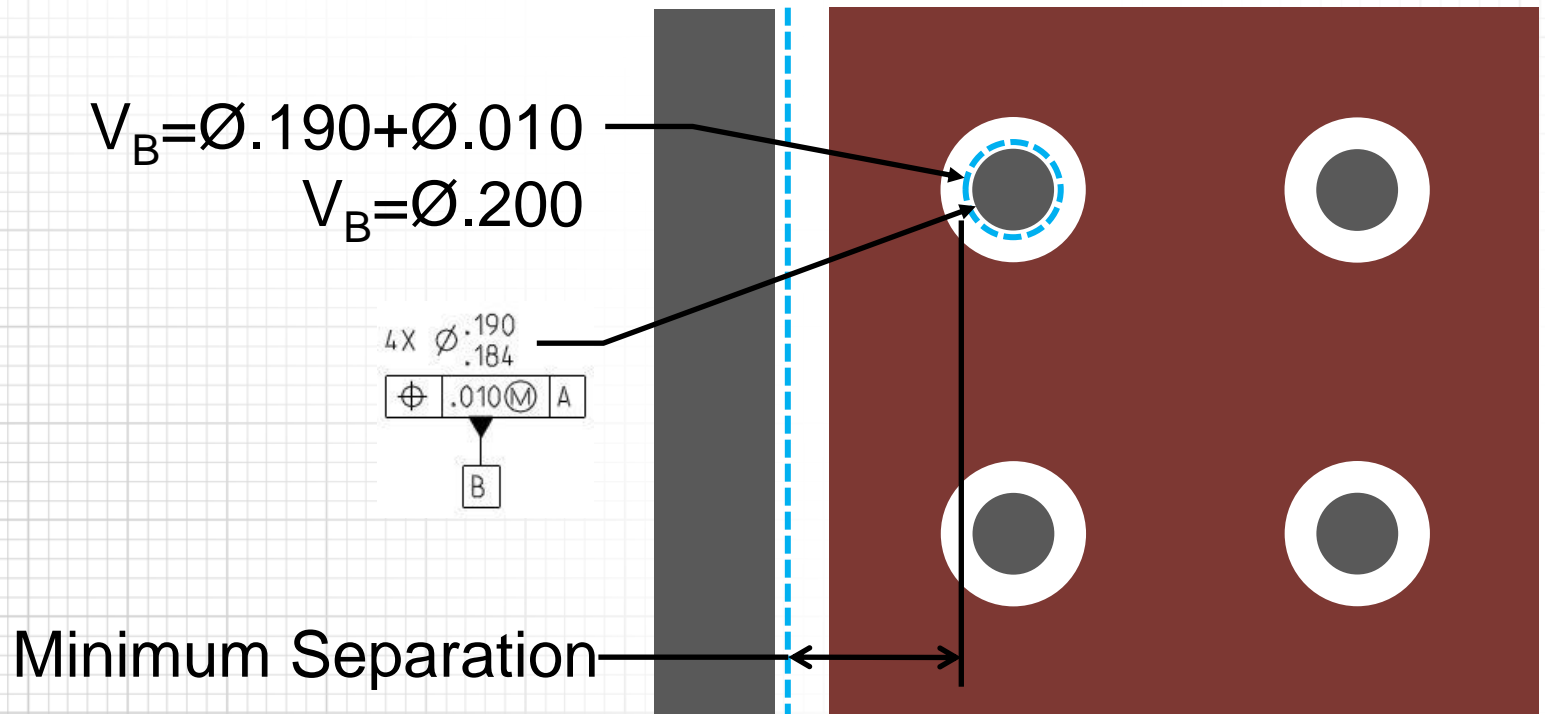
Hand Calculations of Gap

- Minimum Worst-Case Gap based on feature boundaries
- Calculate the maximum separation between plate features
- Use Virtual Condition of hole
- Use outer boundary of edge profile tolerance zone



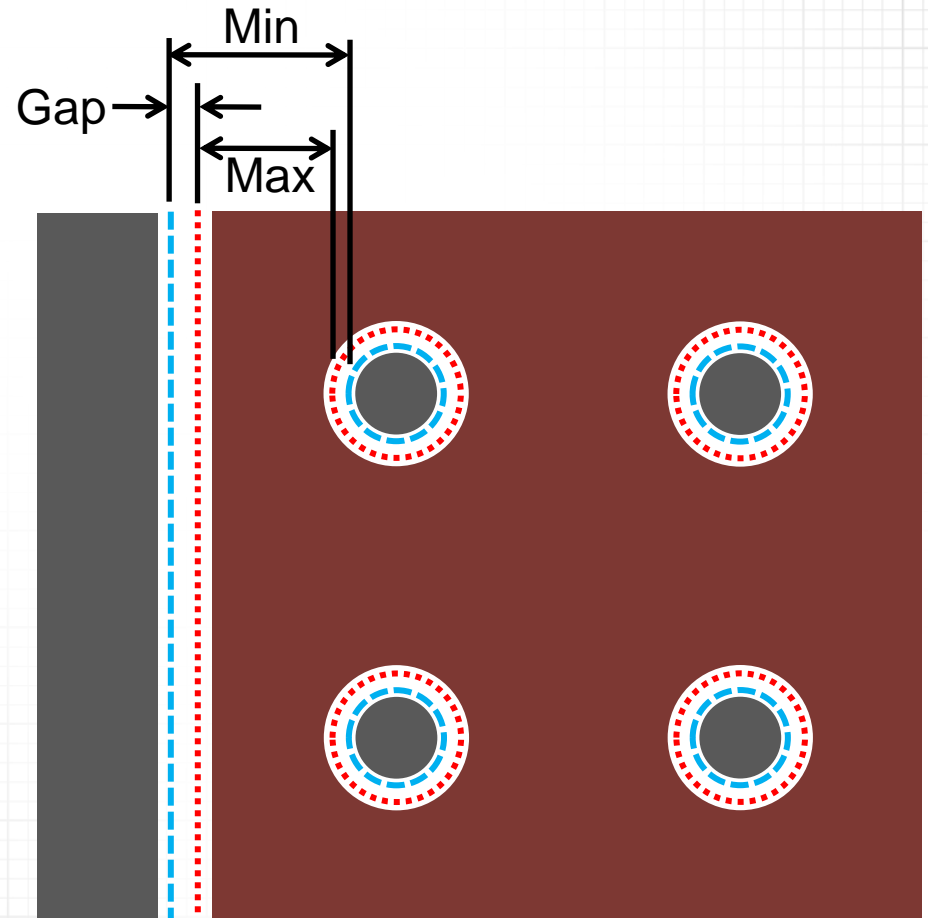
Hand Calculations of Gap

- Calculate the minimum separation between base features
- Use Virtual Condition of pin
- Use outer boundary of wall profile tolerance zone



Hand Calculations of Gap

- Minimum Worst-Case Gap based on feature boundaries



Hand Calculations of Gap

- Minimum Worst-Case Gap based on feature boundaries

$$L_P - T_P/2 - V_P/2 =$$

$$Gap_{MIN} + L_B + T_B/2 - V_B/2$$

$$1.512 - .016/2 - (.190 + .010 + 0)/2$$

$$= Gap_{MIN} + 1.500 + .008/2$$

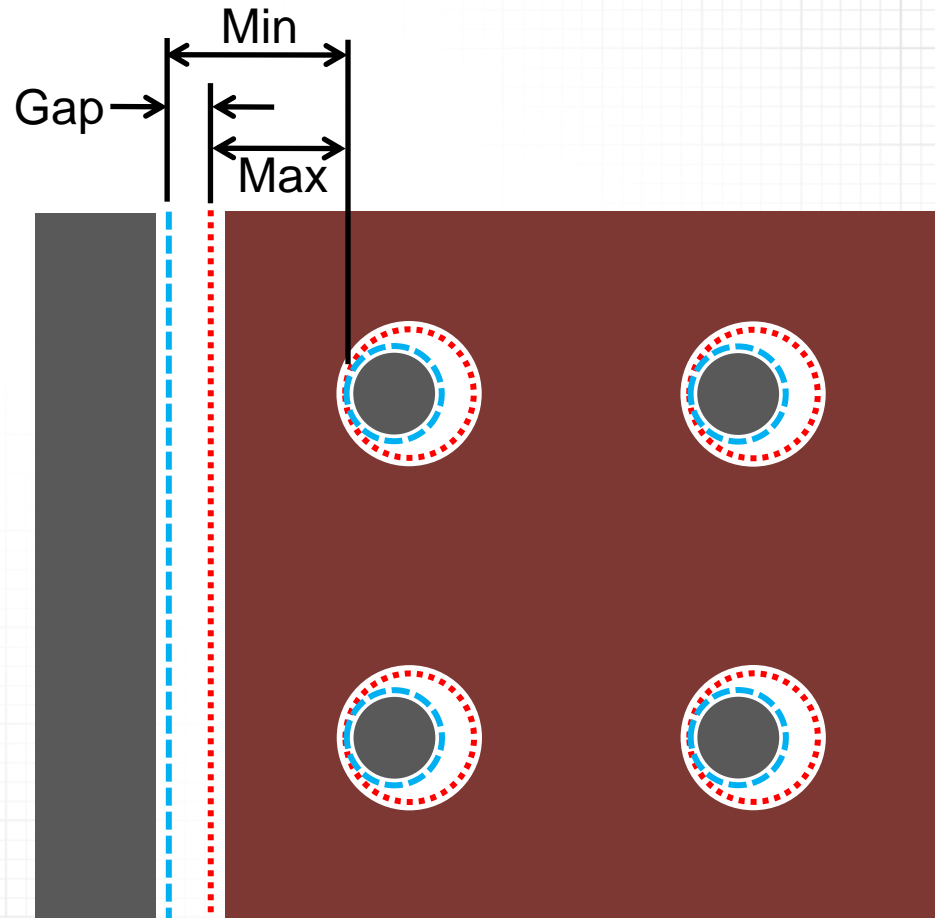
$$- (.207 - .007 - 0)/2$$

$$1.512 - .008 - .100 =$$

$$Gap_{MIN} + 1.500 + .004 - .100$$

$$1.404 = Gap_{MIN} + 1.404$$

$$Gap_{MIN} = 0.000$$



Hand Calculations of Gap

- Maximum Worst-Case Gap based on feature boundaries

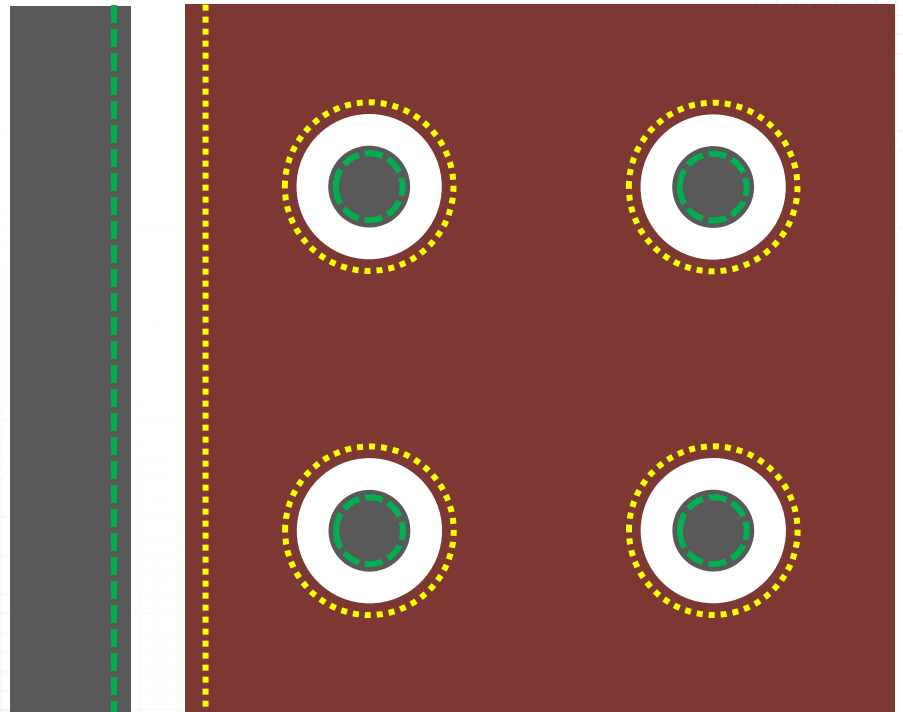
$$L_P + T_P/2 - R_P/2 = Gap_{MAX} + L_B - T_B/2 - R_B/2$$

$$1.512 + .016/2 - (.184 - .010 - .006)/2 = Gap_{MAX} + 1.500 + .008/2 - (.219 + .007 + .012)/2$$

$$1.512 + .008 - .084 = Gap_{MAX} + 1.500 - .004 - .119$$

$$1.436 = Gap_{MAX} + 1.377$$

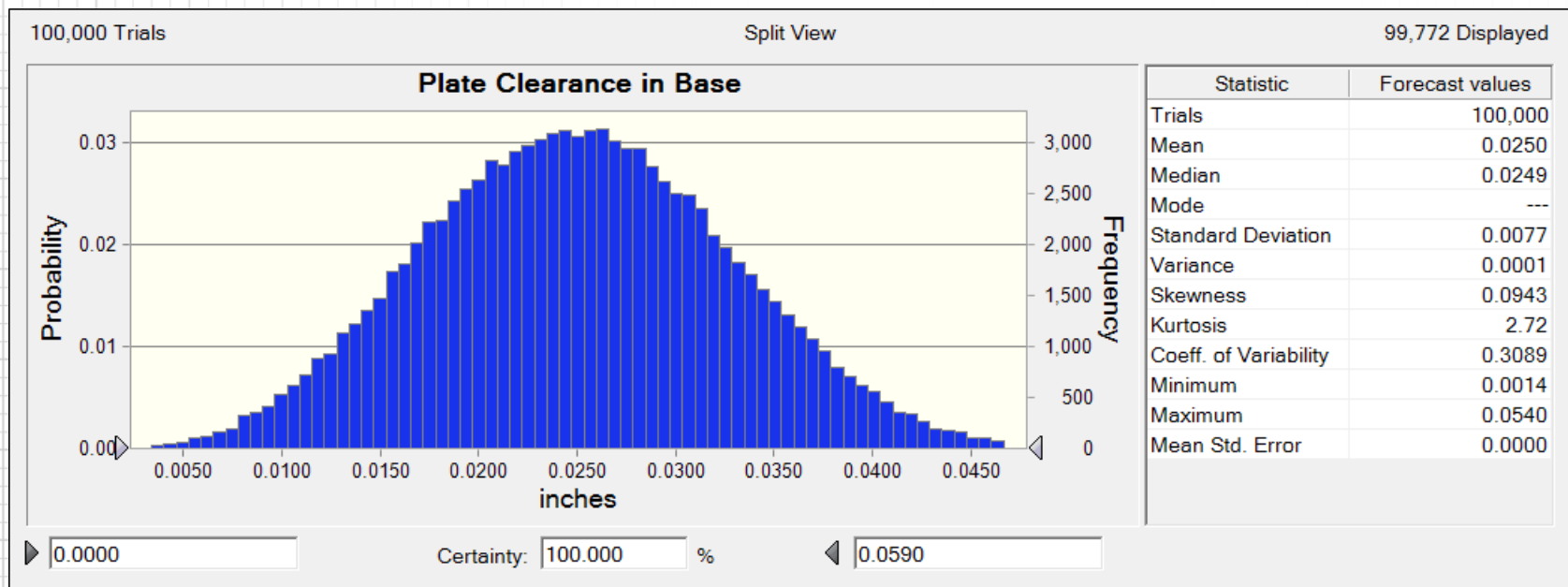
$$Gap_{MAX} = 0.059$$



Statistical Results of Hand Calculations



- Worst-Case Minimum Gap = .000
 - Worst-Case Maximum Gap = .059
 - Estimated Mean = .0250
 - Estimated Standard Deviation = .0077
 - Estimated Skewness = .0943
 - Estimated Kurtosis = 2.72
- Obtained from hand calculations
- Obtained from Monte Carlo simulation



Goal

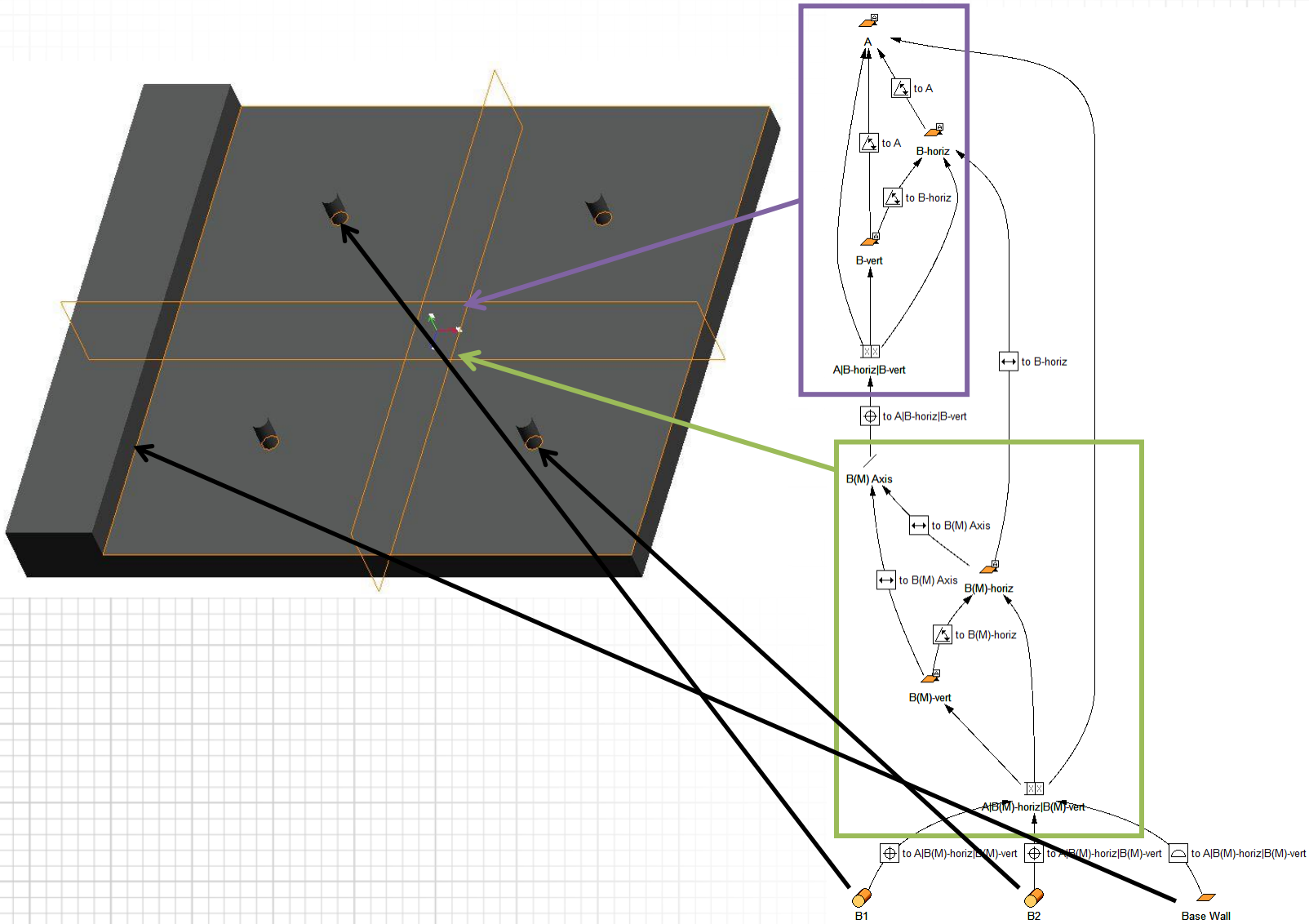


- Develop a method within CETOL that will achieve similar results
- Qualify that methodology
- Apply that methodology to similar situations

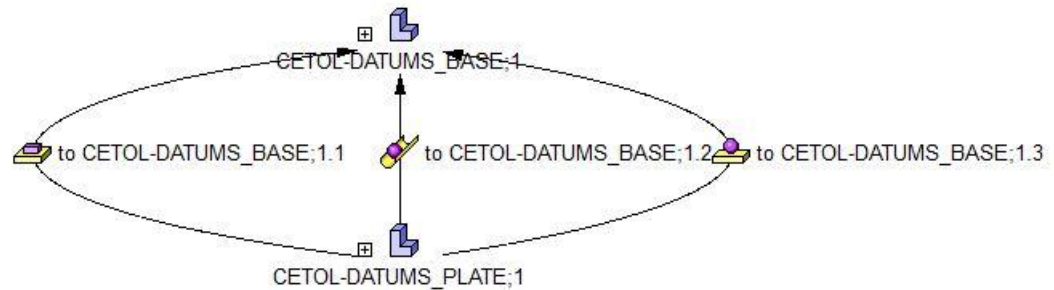
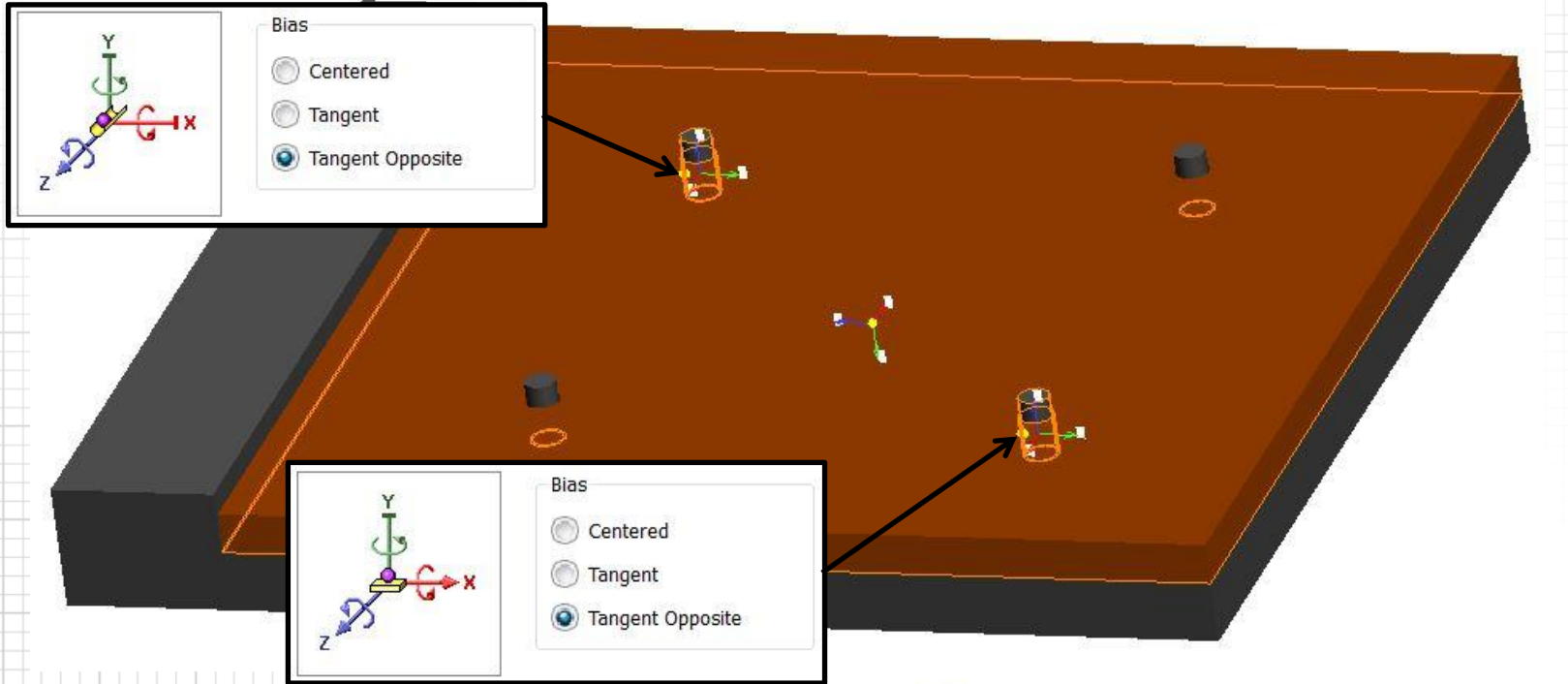
Methodology for Pattern of Features

- Step 1: create a fixed datum reference frame at the origin of the pattern (2 perpendicular planes)
- Step 2: create an axis at the fixed datum reference frame
- Step 3: apply a positional tolerance to the axis relative to the fixed datum reference frame. The value is the maximum bonus tolerance that could exist for each feature in the pattern
- Step 4: create a floating datum reference frame through the axis and oriented to the fixed datum reference frame (2 perpendicular planes)
- Step 5: use the floating datum reference frame to locate the features of the pattern relative to each other
- Step 6: use the floating datum reference frame to locate other features to the pattern

Features of Base

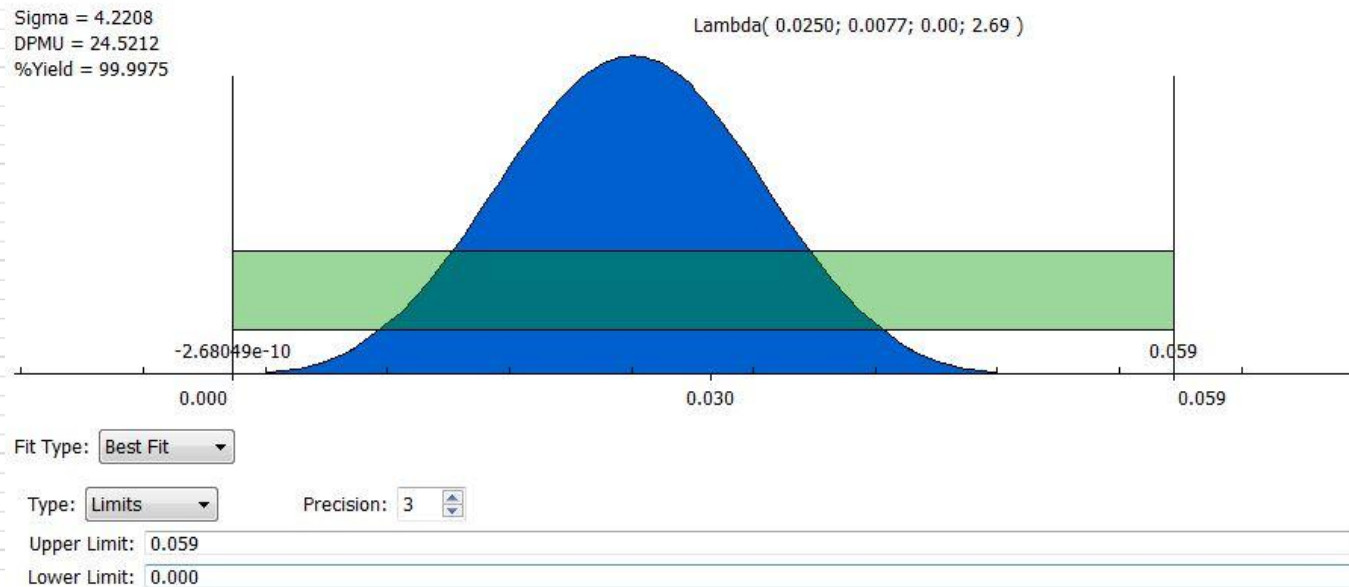


Assembly Constraints



Analysis Results

- Worst-Case Minimum = .000
- Worst-Case Maximum = .059
- Mean = 0.0250
- Standard Deviation = 0.0077
- Skewness = 0.00
- Kurtosis = 2.69



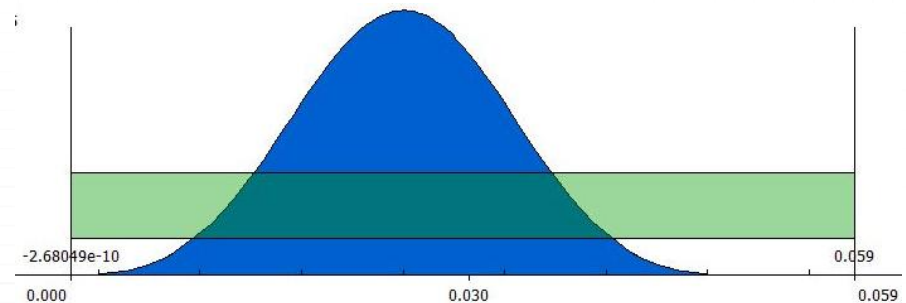
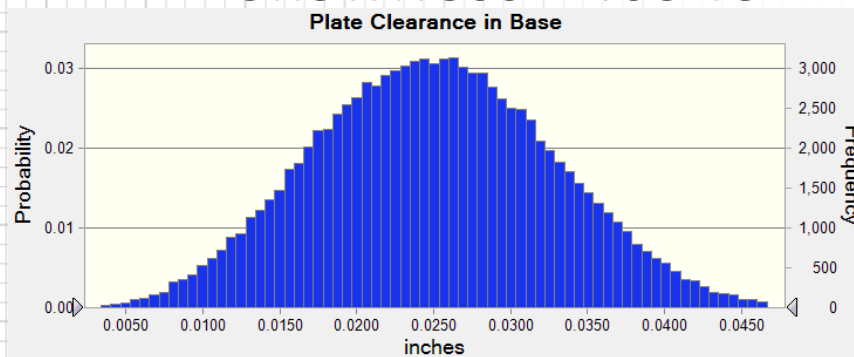
Comparison of Results

■ Hand Calculations:

- Minimum = .000
- Maximum = .059
- Mean = .0250
- St. Dev. = .0077
- Skewness = .0943

■ CETOL Analysis:

- Minimum = .000
- Maximum = .059
- Mean = .0250
- St. Dev. = .0077
- Skewness = .000



Conclusion



- Method developed accurately handles a pattern of features used as a datum
- Method can be applied to any flat pattern of features referenced as a datum

Questions?

