PROCESS CAPABILITY FOR UNILATERAL TOLERANCES INCLUDING TRUE POSITION

Tools & Tips Webinar sponsored by the AESQ Process Control Methods SMIG

8th February 2023

CAPABILITY FOR UNILATERAL

Agenda – 60 minutes

Overview – P. Teti

Who is the PCM Subject Matter Interest Group – P. Teti

Why this webinar? Where can we find help?

PCM Community of Practice – Linked In

Process Capability – A. Stout

Non-normal – A. Stout

Capability for Unilateral Tolerances – A. Stout

Capability for True Position – A. Stout

Q&A – PCM SMIG Team

Summary and Close – P. Teti

Andrew Stout
MBB, +
Pratt & Whitney Canada

Pete Teti
Fellow, Quality Engineering
Pratt and Whitney

WEBINAR OVERVIEW

We are **recording** today's webinar and will distribute the video link following the close of the webinar. It will also be posted on the AESQ website for free viewing.

We will take **questions** during today's webinar using the **Chat** feature.

Please remain on Mute during the presentation to prevent background noise. We will also be muting all lines at the start of the session.

CAPABILITY FOR UNILATERAL

Why this webinar?

Communicate how to conduct a robust Process Capability study that meets RM13006 guidelines

Show how to use statistical tools in conducting and analyzing a Process Capability Analysis

Promote the available free documents and tools that can be used by any AESQ supplier

Answer questions suppliers may have about process capability methods

PROCESS CONTROL METHODS PER RM13006
Purpose of this reference manual

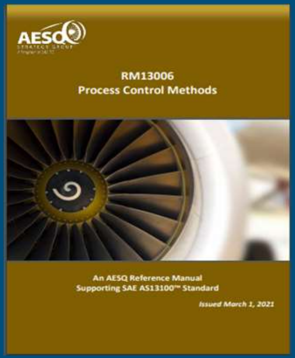
RM13006 provides the user with an array of practical approaches to process control used to ensure consistent product quality.

The purpose of this reference manual is to raise the overall capability of the aerospace engine supply chain, standardize the process control requirements across AESQ suppliers, and build on the requirements for PFMEA and Control Plans (ref. RM13004).

RM13006 supports AS9145 - Requirements for Advanced Product Quality Planning and Production Part Approval Process, and AS9103 - Variation Management of Key Characteristics, supported by detailed guidance and case studies.

This reference manual was developed by a dedicated team from AESQ member companies with expert knowledge and experience in the areas of process control, process improvement, quality systems, and supplier engagement.


AEROSPACE STANDARD
AS13100™
RATIONALE
FOREWORD



PROCESS CONTROL METHODS SUPPORT

What is the Process Control Methods SMIG Group?

- The purpose of the PCM Subject Matter Interest Group is to promote the effective deployment of the process control methods across the AESQ Supply Chain.
- The Group is made up of Subject Matter Experts from the AESQ Member Companies.
- The Group is accountable for the AS13100 related Requirements and associated Reference Manual content, ensuring that it is up to date and reflects current knowledge and best practice.
- It shall promote the effective deployment of the Reference Manual using Communities of Practice (CoP). The CoP is open to any subject matter expert or individual experienced or trained in process control from the aero engine community.
- Activities may include webinars, best practice sharing, development of shared training materials, conferences and published papers.

NO.	WEBINAR TOPICS	TARGET DATE/TIME
1	Process Control Methods - What is RM13006? Interaction with other AESQ Reference Manuals	12/6/2022 (11 AM US Eastern)
2	What makes a good Process Capability Study?	1/26/2023 (11 AM U.S. Eastern)
3	Process Capability for Unilateral Tolerances	2/8/2023 (11 AM U.S. Eastern)
4	The use of non-statistically based process control methods	3/8/2023 (11 AM U.S. Eastern)
5	The Power of Precontrol	4/11/2023 (11 AM U.S. Eastern)
6	The One-Hour Process Control Assessment	5/16/2023 (11 AM U.S. Eastern)
7	Why is statistical control a prerequisite for process capability?	Target 2nd Qtr (June)
8	Dealing with Non-Normal Data	Target 3rd Qtr. (September)
9	Conducting capability studies for one-sided geometric tolerances	Target 4th Qtr. (October)

https://aesq.sae-itc.com/interest-groups

SUBJECT MATTER INTEREST GROUPS

Who is the Process Control Methods SMIG Team?

Pete Teti
PWA
(Leader)

Andrew
Stout
PWC
(Co-Lead)

Nicklas
Gödebu
GKN

Paul Gorg
PCC

Rudi
Braunrieder
MTU

Karen
Scavotto
PWA

Steve
Hampton
PCC

Douglas
Dush
Honeywell

Grant
Braun
PCC

Geoffrey
Carpentier
Safran

Marnie
Ham
GE

Shailesh
Shinde
RR

Ricardo
Banuelas
RR

Curators for RM13006

Experts to answer process control related questions

Provider of process control related guidance

PROCESS CONTROL METHODS CoP

Where to get help

AESQ Supplementary Materials webpage for a copy of RM13000 and supporting templates

https://aesq.sae-itc.com/supplemental-material

Subject Matter Interest Group – meets monthly – supports continuous improvement of RM13006 and supporting templates & tools

AESQ Process Control Methods Community of Practice (CoP) on Linked-In

Current membership is 200 – let's get some more!!

https://www.linkedin.com/groups/12647920/

PROCESS CAPABILITY IN RM13006

SECTIONS INVOLVING PROCESS CAPABILITIES IN RM13006

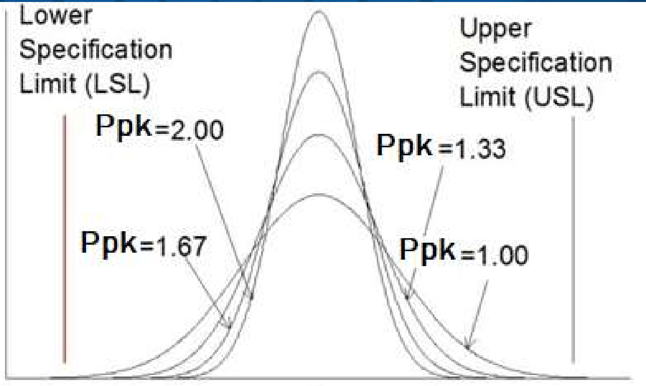
- 2.1.1 IMPORTANCE OF PRODUCT CAPABILITY
- 3.3 CHOICE OF CAPABILITY METRIC
- 5.3 PROCESS CAPABILITY FOR PROCESSES WITH INTENTIONAL SHIFTS
- → 6.0 **PROCESS CAPABILITY INDICES**
  - 6.1 FUNDAMENTALS OF VARIABLE DATA
  - 6.2 PROCESS STABILITY IN PRACTICE
  - 6.3 PROCESS CAPABILITY FOR ATTRIBUTE DATA
- → **7.0 GUIDANCE FOR NON-NORMAL DATA**
  - **7.2 CAPABILITY ANALYSIS FOR NON-NORMAL DATA**
- 9.1.2 PROCES CAPABILITY FOR MULTIPLE IDENTICAL FEATURES
- 11 DATA ANALYSIS ENABLERS
- 13 STATISTICAL FORMULAE FOR PROCESS CAPABILITY

+ New material for future update

THE IMPORTANCE OF PROCESS CAPABILITY

Why does Process Capability matter?

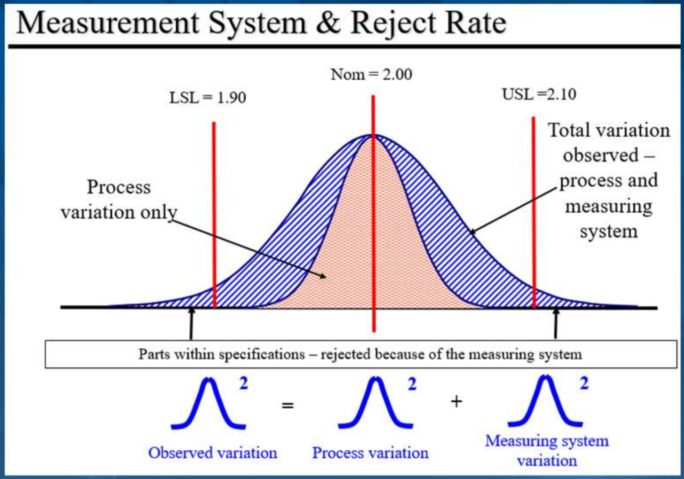
- It gives a voice to your process from the viewpoint of the customer
- It gives you a number to evaluate your process
- It lets you know your potential (compare Ppk to Cpk to Cp)
- It lets you know where to spend your resources and be proactive

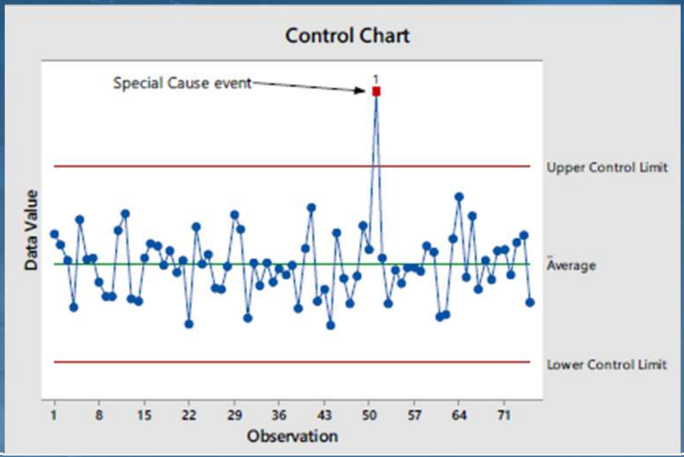


KEY PRINCIPLES OF PROCESS CAPABILITY

Before looking at capability

- Can you trust your measurements? (MSA)
- Can you can trust your data? (visualize)
- Do you have enough data to capture full process variation?

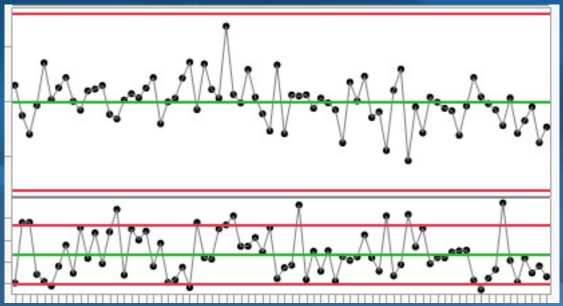




KEY PRINCIPLES OF PROCESS CAPABILITY

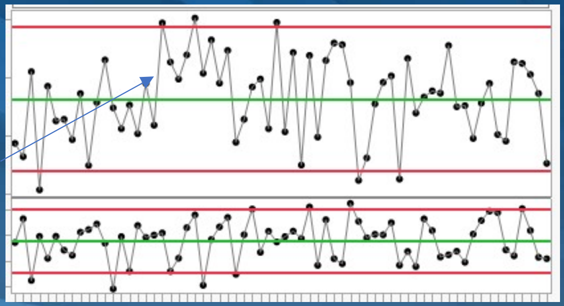
- Is the data in time order?
- Is the process in statistical control?

I-MR



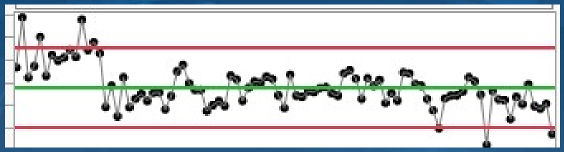
Looks good

I-MR



May be a trend at the start.
Investigate prior to starting capability analysis.

X Bar

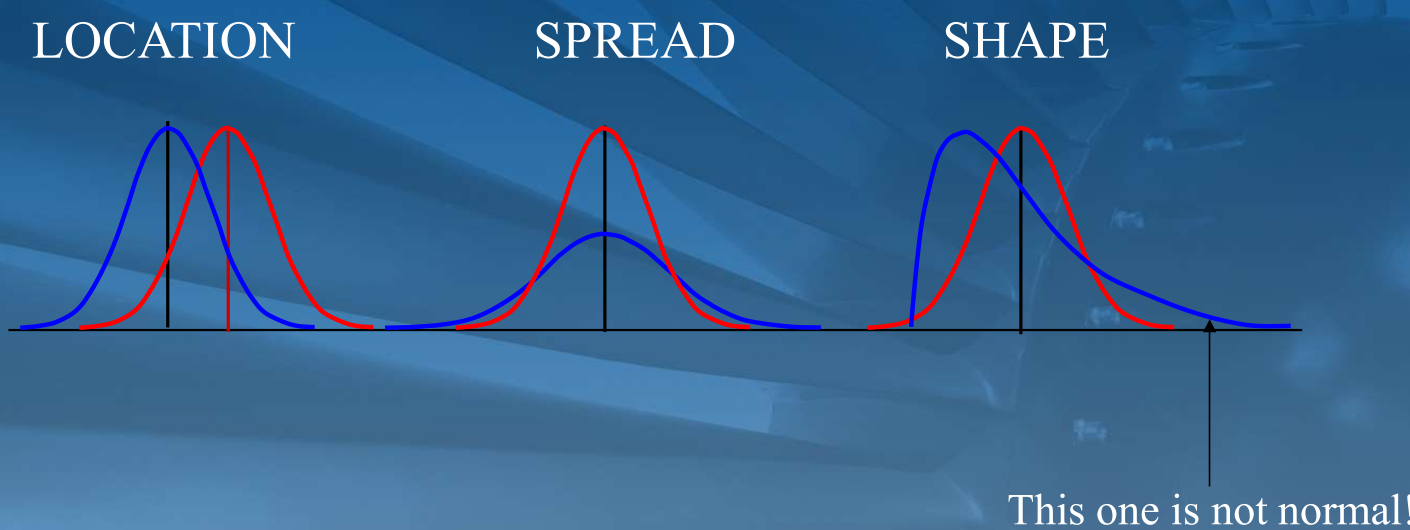


Red alert! Need to investigate shift before doing a capability analysis.

To get an estimate of capability it may be acceptable to allow up to 2 “out of control” points, per 25.
Every effort should be made to identify the root cause and correct it.
The real world is not so pretty.

KEY PRINCIPLES OF PROCESS CAPABILITY

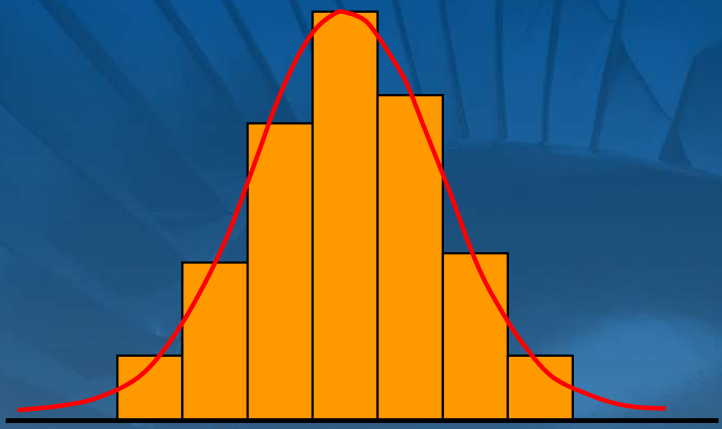
Distributions can differ in:



KEY PRINCIPLES OF PROCESS CAPABILITY

Normal Distribution

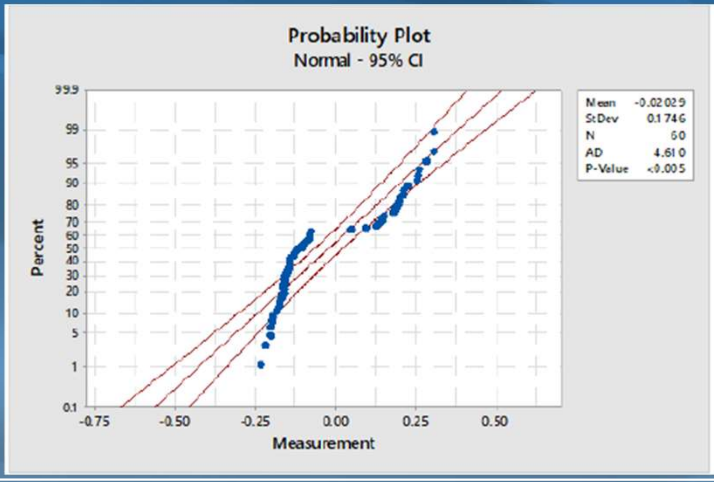
- The shape of a histogram can provide important information about the presence of assignable causes and variation
- The Normal distribution (bell-curve) frequently occurs when the process is subjected only to random variation (common causes)

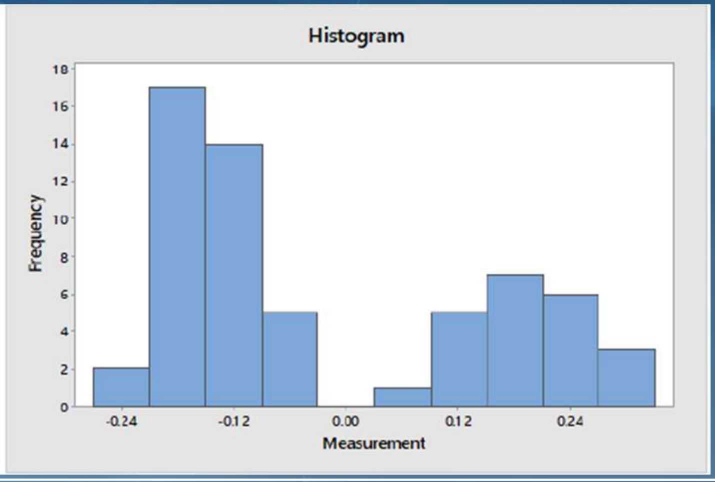


KEY PRINCIPLES OF PROCESS CAPABILITY

Bimodal Distribution

- The histogram exhibits two "humps" (NOT a normal distribution)
- Normal probability plot shows a poor fit to the confidence interval

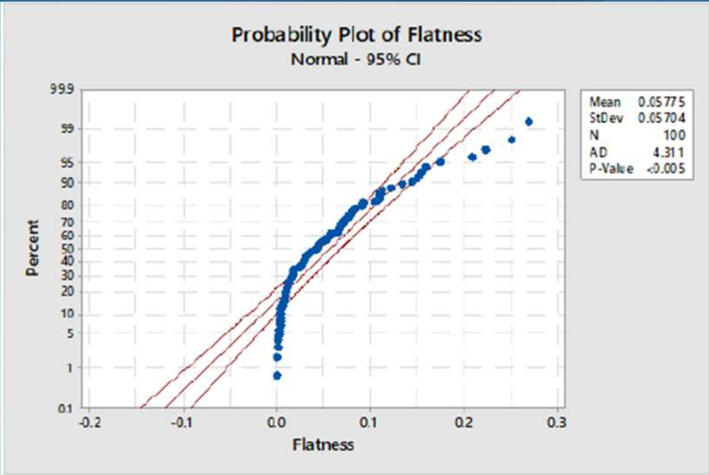


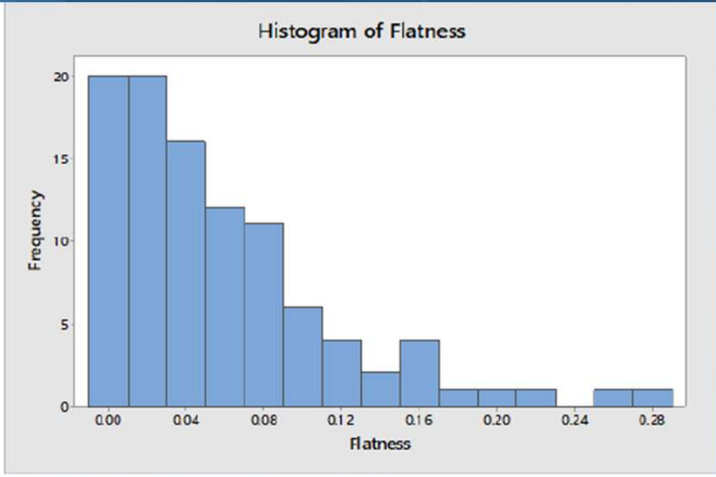


KEY PRINCIPLES OF PROCESS CAPABILITY

Skewed Distribution

- Not symmetrical, NOT a normal distribution
- One tail is longer than the other
- Skewing is said to be in the direction of the longer tail
- Could be due to unilateral tolerance





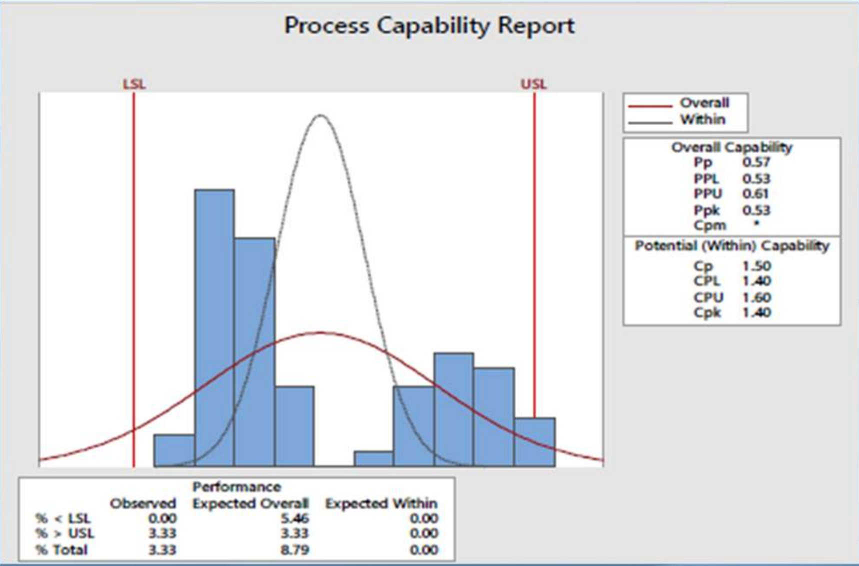
KEY PRINCIPLES OF PROCESS CAPABILITY

Truncated Distributions

- A distribution in which one or both tails are missing (NOT a normal distribution)
- The histogram either begins or ends abruptly

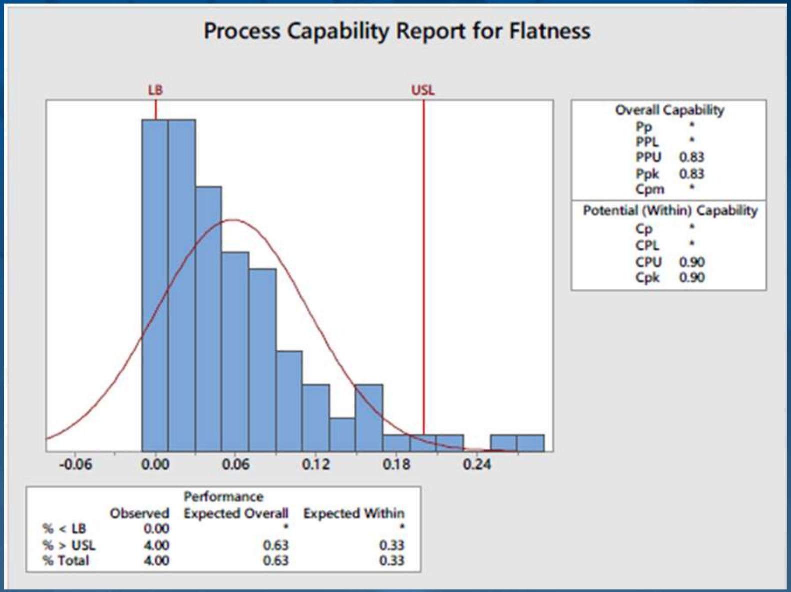
GUIDANCE FOR NON-NORMAL DATA

- Distribution fit
  - Using Normal for Non-Normal data will provide incorrect and misleading capability values



Cpk = 1.4
Really good?

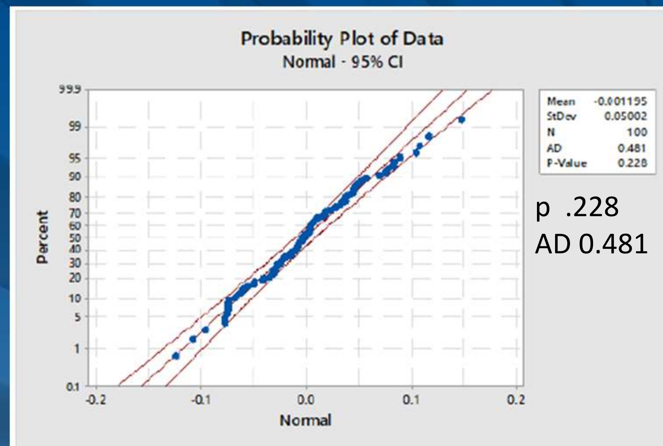
Ppk = 0.53
Is that right?

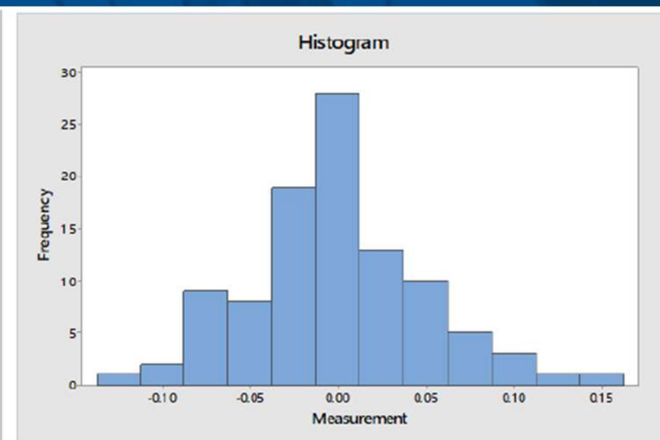


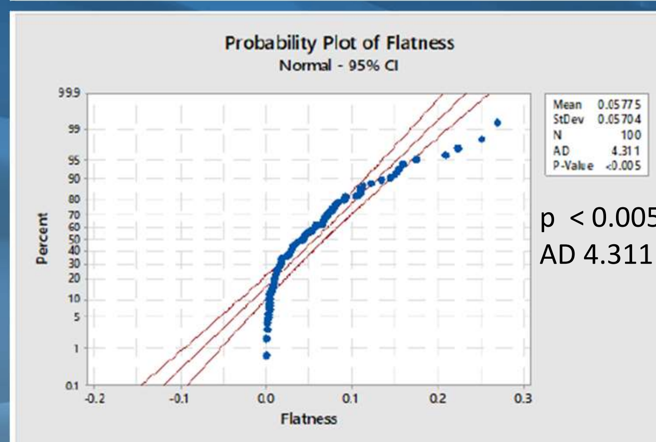
Cpk = 0.9, Ppk = .83
Is that correct?

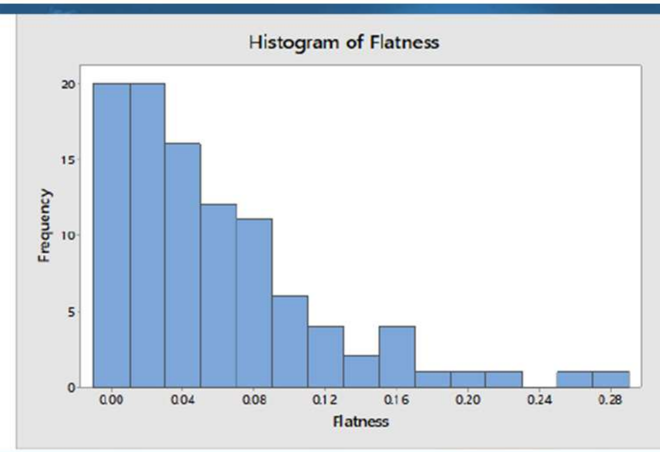
GUIDANCE FOR NON-NORMAL DATA

- Assessing Normality
  - A large amount of data can make goodness of fit too sensitive
  - Visually review of histogram
  - Probability plot shows a good fit, especially in area of risk (near spec limit)
  - p-value > 0.05 for Normal
  - Anderson Darling Number (AD or A** or A square) preferably < 0.75
  - Or other statistic (RJ, K-S, S-W, AIC,…)







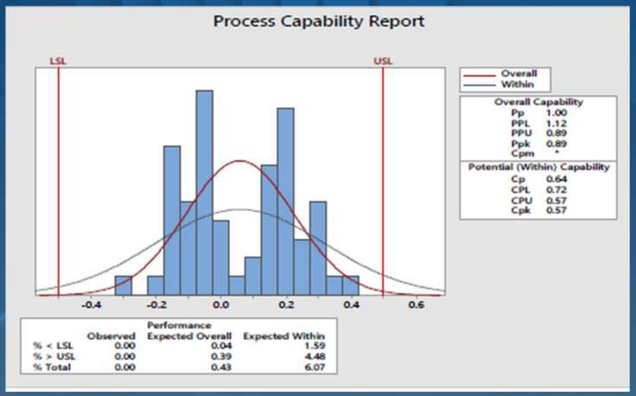


GUIDANCE FOR NON-NORMAL DATA

RM13006 Section 7 – Guidance for Non-Normal Data

Causes of Non-Normal include

- Natural skew due to a boundary condition
- Data from two or more components of variation (e.g., true position of a hole from x and y coordinates)
- A cyclic process behaviour
- A process with a natural tendency to drift
- Selective or biased measurements
- Process instability - lack of control
- Lack of resolution in measurement systems or rounding
- Reworking non-conformances prior to measurement
- Human factors (e.g., stopping at a maximum limit when machining down to a size)
- Two distributions being present within the data (i.e., bi-modal).



GUIDANCE FOR NON-NORMAL DATA

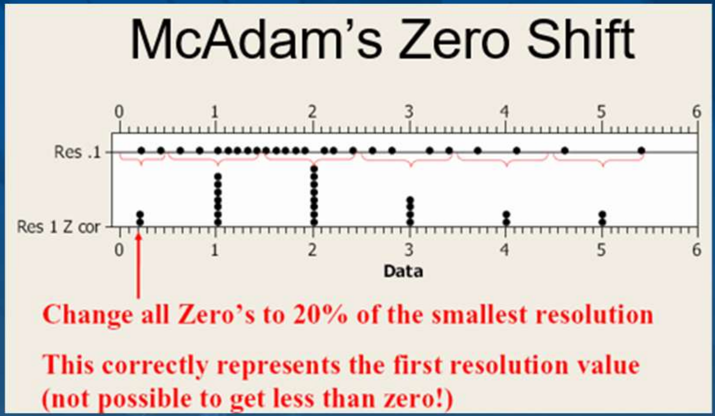
Actions

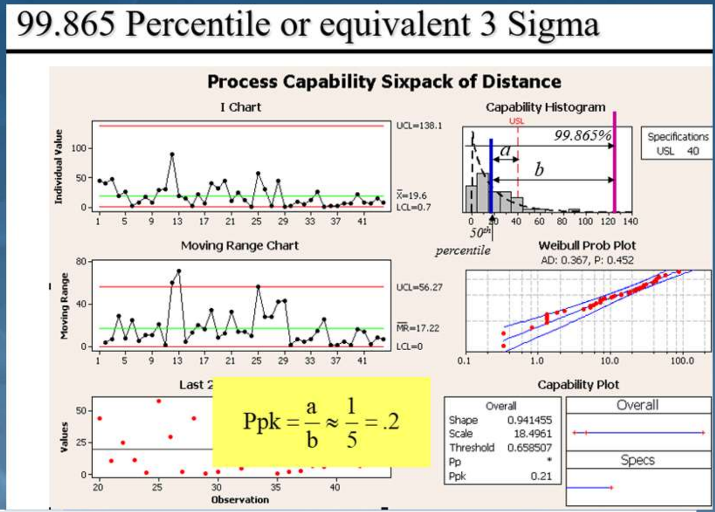
- **Check your process**
- **Check your data (at least 30)**
- **Find a non-normal distribution with better fit**
  - Weibull is often used
    - Zero values will need McAdam shift (see RM13006 section 7.2.2)
- **Capability**
    - Z-score method that uses proportions
    - ISO method uses 0.135 or 99.865 percentiles
    - Special cases
- **Last resort: Transform with Box Cox or Johnson**

For more

- See RM13006 section 7
- Attend our Webinar #8 - Dealing with Non-Normal Data

Note: Standard Deviation (SD or σ) is not applicable for non-normal distributions.



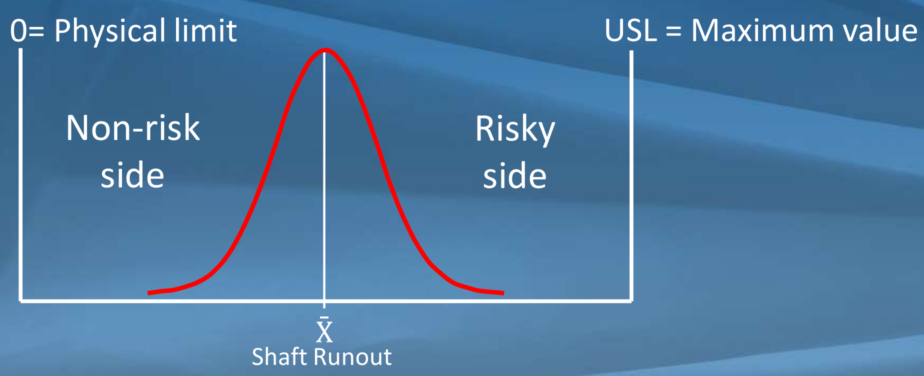


ONE SIDED TOLERANCES

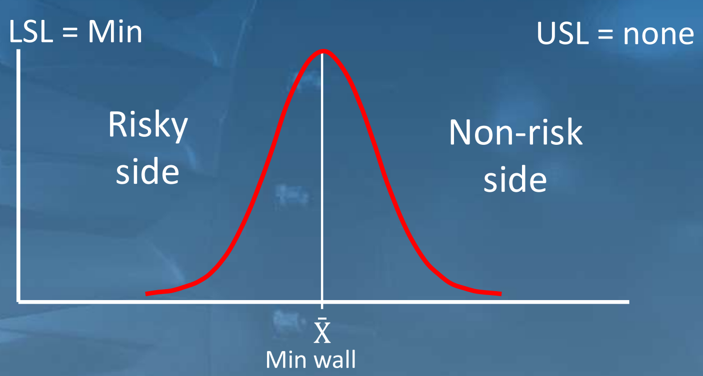
RM13006 Section 6. Process Capability Indices

"NOTE: It will <u>not be possible to calculate Cp or Pp</u> indices for processes with unilateral (single sided) tolerances as the <u>tolerance width cannot be defined</u>. However, Cpk and Ppk can be calculated from the Cpl/Ppl or Cpu/Ppu (whichever can be calculated)."

Case 1



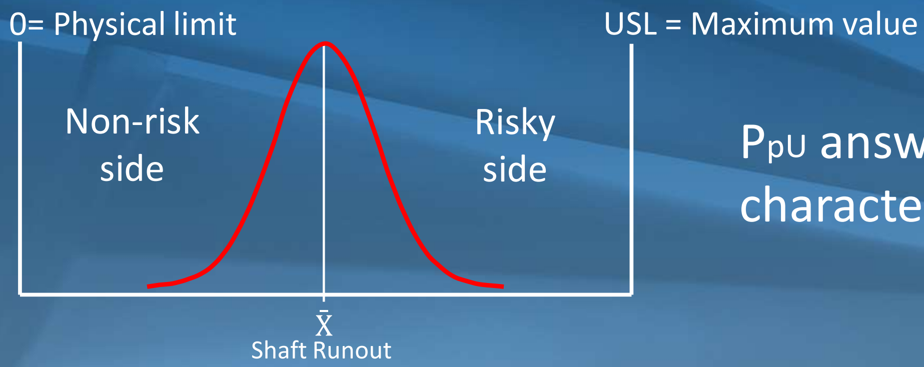
Case 2



ONE SIDED TOLERANCES

Unilateral – Case 1: A natural or physical limit on lower side

- Don't analyze as 2 sided
- Example: Shaft runout would have a maximum spec, not to be exceeded.
  But runout cannot be less than zero
- When calculating capability leave LSL blank or identify it as a boundary



P_{pU} answers: Is the process likely to yield products with characteristics beyond the maximum allowable?

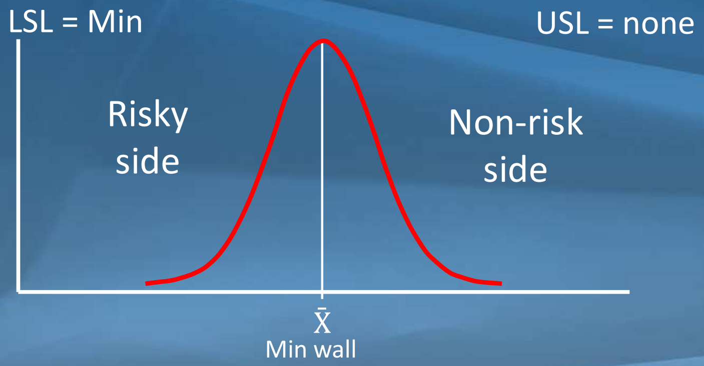
$$P_{pU} = \frac{USL - \bar{X}}{3\hat{\sigma}_{n-1}}$$

$$Ppk = P_{pU}$$

ONE SIDED TOLERANCES

Unilateral – Case 2: Lower spec only

Examples
- Min wall
- MTBF
- MTTF
- Horsepower



P_{pL} answers: Is the process likely to yield products with characteristics below the minimum allowable?

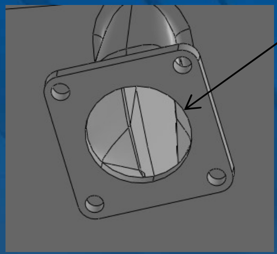
$$P_{pL} = \frac{\bar{X} - LSL}{3\hat{\sigma}_{n-1}}$$

$$Ppk = P_{pL}$$

MAXIMUM MATERIAL CONDITION

(M) MMC - Maximum Material Condition

- Condition where the most material exists
- Greatest mass on feature
- Min ID
- Max OD
- If (M) on drawing, as the feature deviates from its Maximum Material Condition, that amount may be added to the positional tolerance



Ø2.00 +/-.040
⌖ |Ø.060(M)|A|B

Dimensions in inches

Min ID is the MMC condition
2.000 - .040 = 1.960”

If Actual ID is 2.010”
MMC Bonus = 2.010 – 1.960 = .050” dia
Or .025” radial

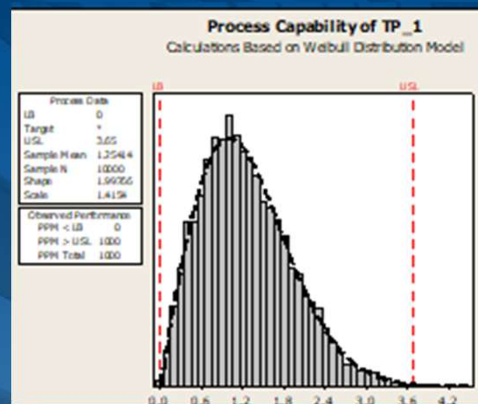
TP tolerance with bonus = .060 + .050 = .110” Dia
or .055” radial

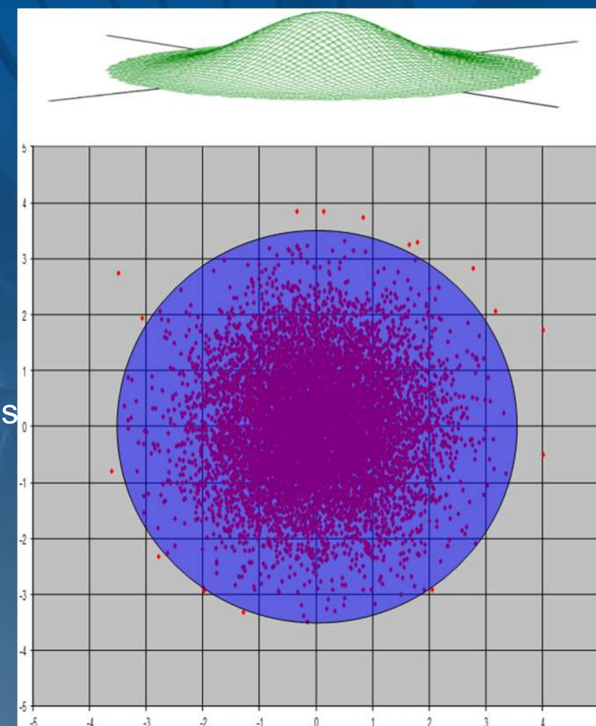
TRUE POSITION CAPABILITY

Special Case

How to analyse?

- TP Rad
- Adjusted TP
- Residual Tolerance
- Percent of Tolerance
- Effective Size to Virtual
- Area Method





TRUE POSITION CAPABILITY

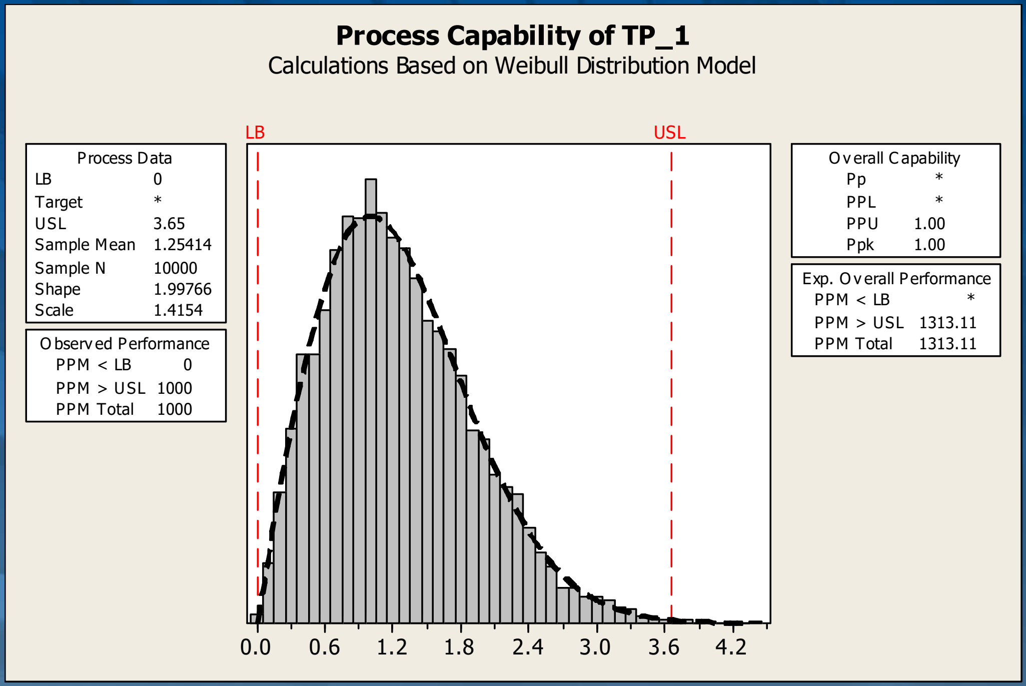
TP Rad

Using conventional radius/diameter analysis method

Good Weibull fit only occurs **only** when X & Y are on target.

Both X and Y axis are usually Normally distributed.

TP Rad is Non-Normally Distributed



$$\text{TP Rad} = \sqrt{x^2 + y^2}$$

TP Dia = 2 * TP Rad

TRUE POSITION CAPABILITY

Using TP Rad method

Capability Case 1 = Capability Case 2

Not good as variability is different

TRUE POSITION AREA METHOD

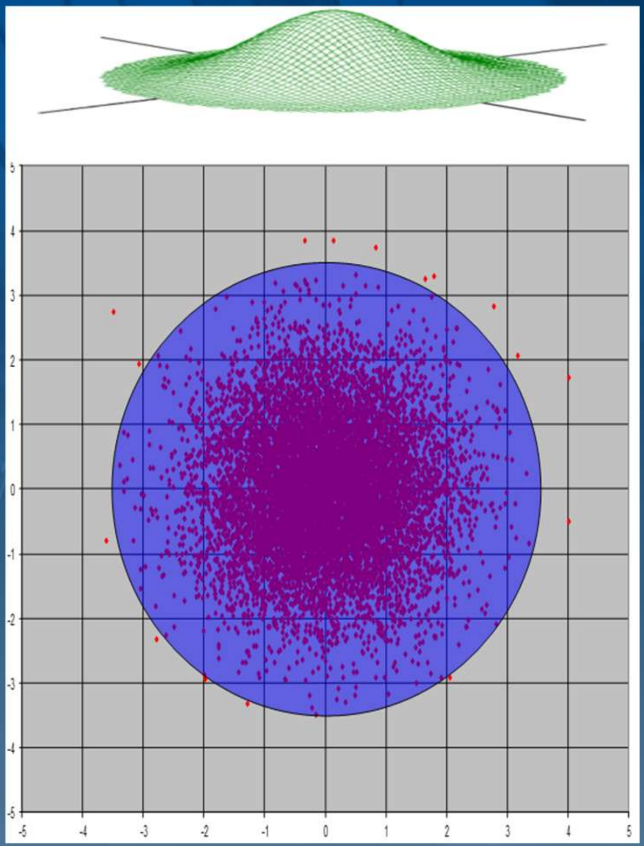
Not the only way, but a new way to start to understand.

Discussion, development and incorporation into RM13006 is pending.

Advantages of Area Method

- Good way to visualize and represent the true situation.

- "Most methods combine the individual variable bonus tolerance with the individual position deviation and then compare the resulting surrogate variable to a constant limit…found to be untrustworthy" isixsigma.com
- "…the natural variability must also be expressed in terms of a circular region." infinityqs.com



Y Axis

X Axis

TRUE POSITION AREA METHOD

$$Process\ Performance$$

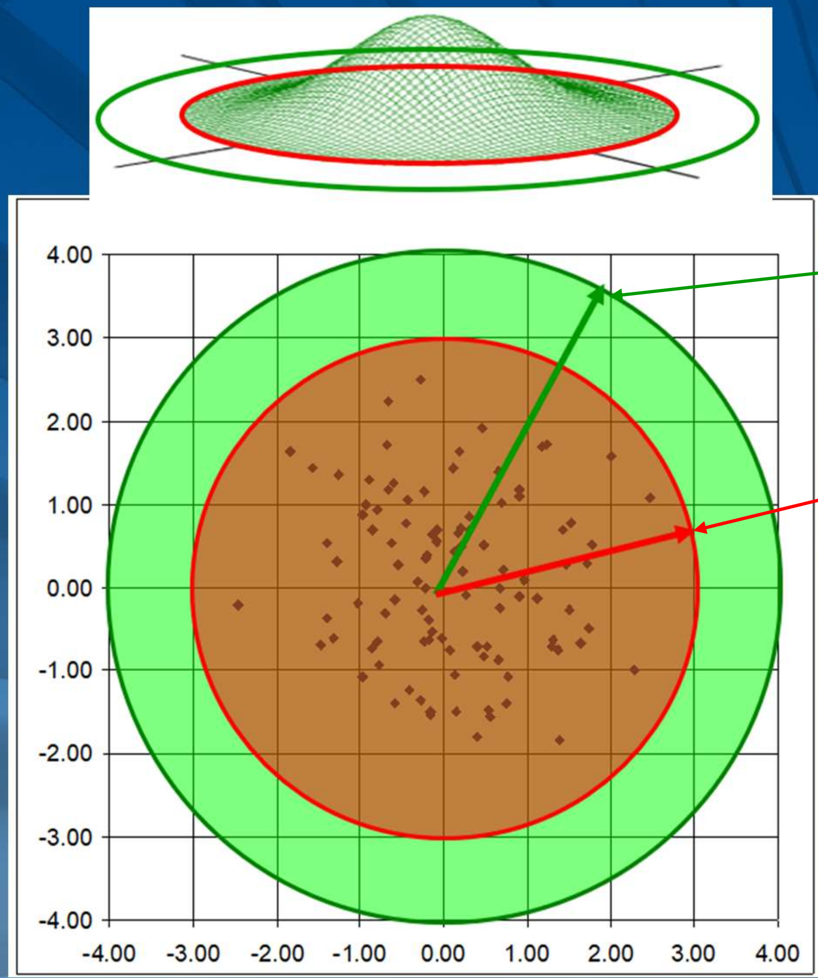
$$P_p = \frac{Tolerance}{Process\ spread} = \frac{green\ circle}{red\ circle}$$

$$Area = \pi r^2$$

$$AreaP_p = \frac{\pi R^2}{\pi r^2}$$

$$AreaPp = \frac{R^2}{(3s_{\max(x,y)})^2}$$

Y Axis



X Axis

R = Radial Tolerance

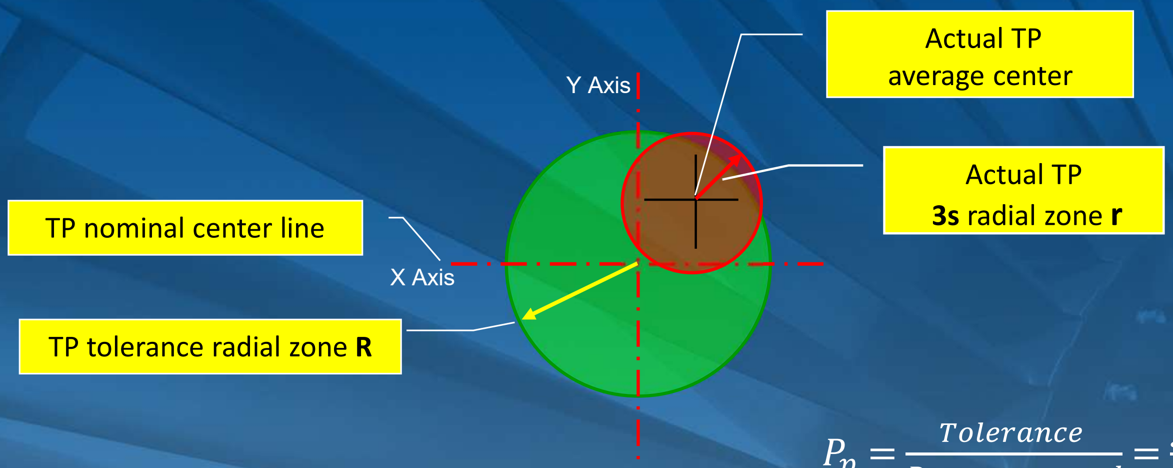
r = Process Radius ($3s_{max(x,y)}$)

To be conservative the larger variability is used, either x or y.

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

Used with Pp and Ppk

TRUE POSITION AREA METHOD



$$P_p = \frac{Tolerance}{Process\ spread} = \frac{green\ circle}{red\ circle}$$

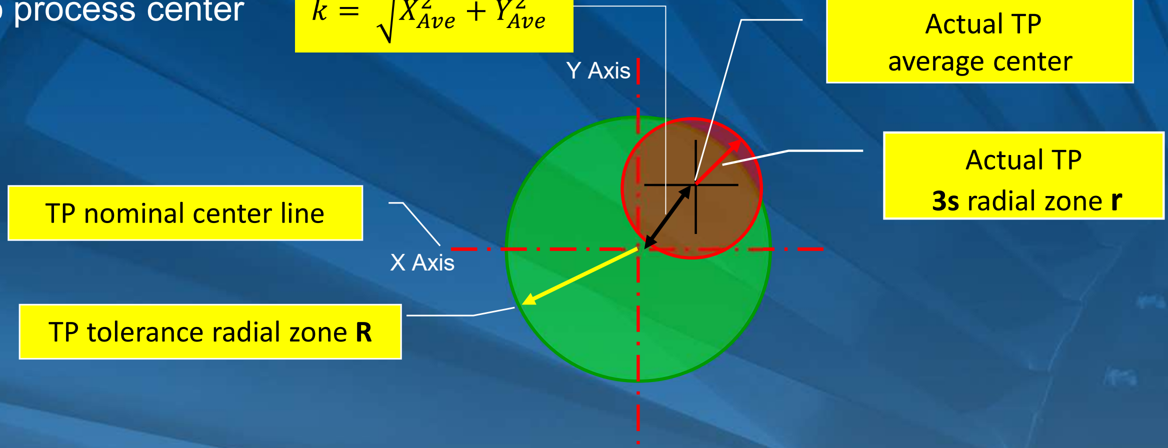
$$Area = \pi r^2$$

$$AreaP_p = \frac{\pi R^2}{\pi r^2} \qquad AreaPp = \frac{R^2}{(3s_{\max(x,y)})^2}$$

TRUE POSITION AREA METHOD

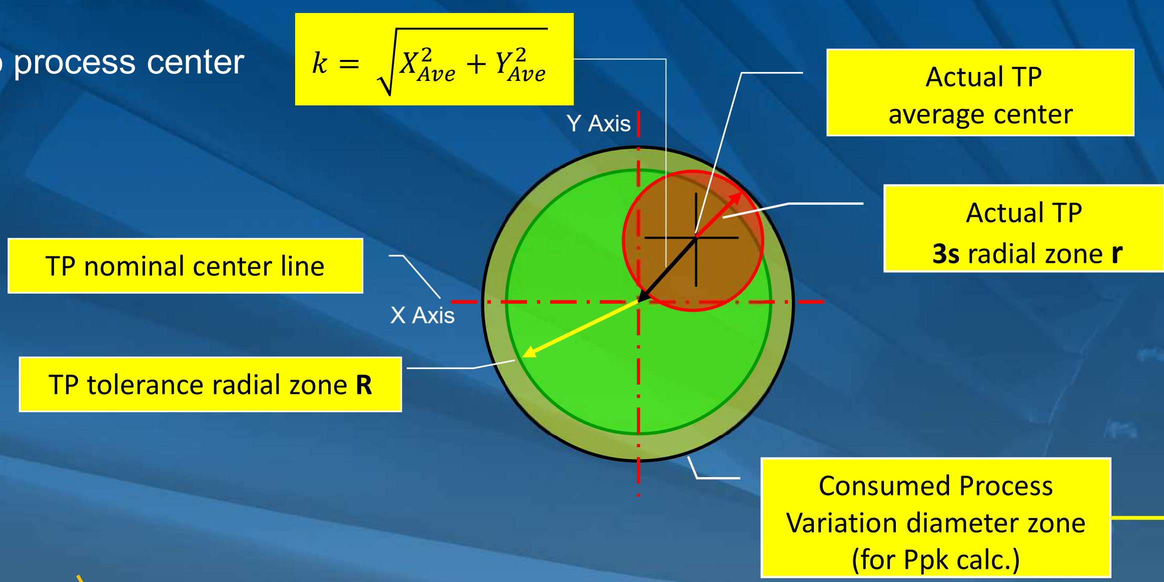
k = radius to process center

$$k = \sqrt{X_{Ave}^2 + Y_{Ave}^2}$$



TRUE POSITION AREA METHOD

k = radius to process center



$$AreaPpk = \frac{R^2}{(k+r)^2}$$

$$Ppk = \min(P_{pu}, \cancel{P_{pl}})$$

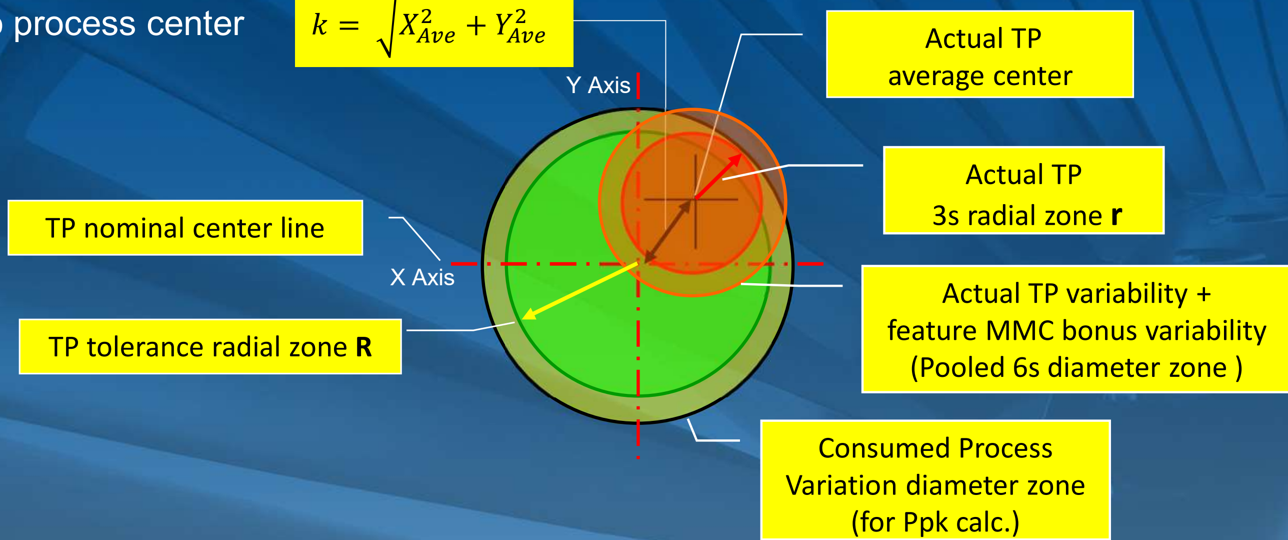
$$P_{pu} = \frac{USL - \bar{X}}{3s}$$

$$AreaPpk = \frac{R^2}{\left(\sqrt{X_{Ave}^2 + Y_{Ave}^2} + 3s_{\max(x,y)}\right)^2}$$

TRUE POSITION AREA METHOD

k = radius to process center

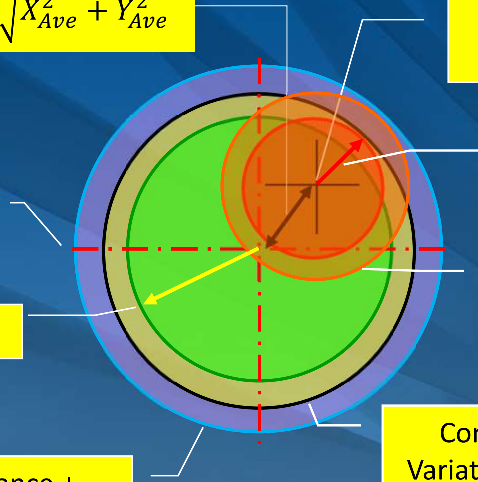
$$k = \sqrt{X_{Ave}^2 + Y_{Ave}^2}$$



TRUE POSITION AREA METHOD

k = radius to process center

$$k = \sqrt{X_{Ave}^2 + Y_{Ave}^2}$$



$$AreaPpk = \frac{R^2}{(k+r)^2}$$

Convert Bonus to radial

$$AreaPp_{Bonus} = \frac{(R + 0.5 * Bonus_{Ave})^2}{(3\sqrt{s_{\max(x,y)}^2 + s_{Bonus}^2})^2}$$

$$AreaPpk_{Bonus} = \frac{(R + 0.5 * Bonus_{Ave})^2}{(\sqrt{X_{Ave}^2 + Y_{Ave}^2} + 3\sqrt{s_{\max(x,y)}^2 + s_{Bonus}^2})^2}$$

TRUE POSITION AREA METHOD

Area Pp without MMC Bonus

$$AreaPp = \frac{R^2}{(3s_{\max(x,y)})^2}$$

Area Ppk without MMC bonus

$$AreaPpk = \frac{R^2}{(\sqrt{X_{Ave}^2 + Y_{Ave}^2} + 3s_{\max(x,y)})^2}$$

Area Pp with MMC Bonus

$$AreaPp_{Bonus} = \frac{(R + 0.5 * Bonus_{Ave})^2}{(3\sqrt{s_{\max(x,y)}^2 + s_{Bonus}^2})^2}$$

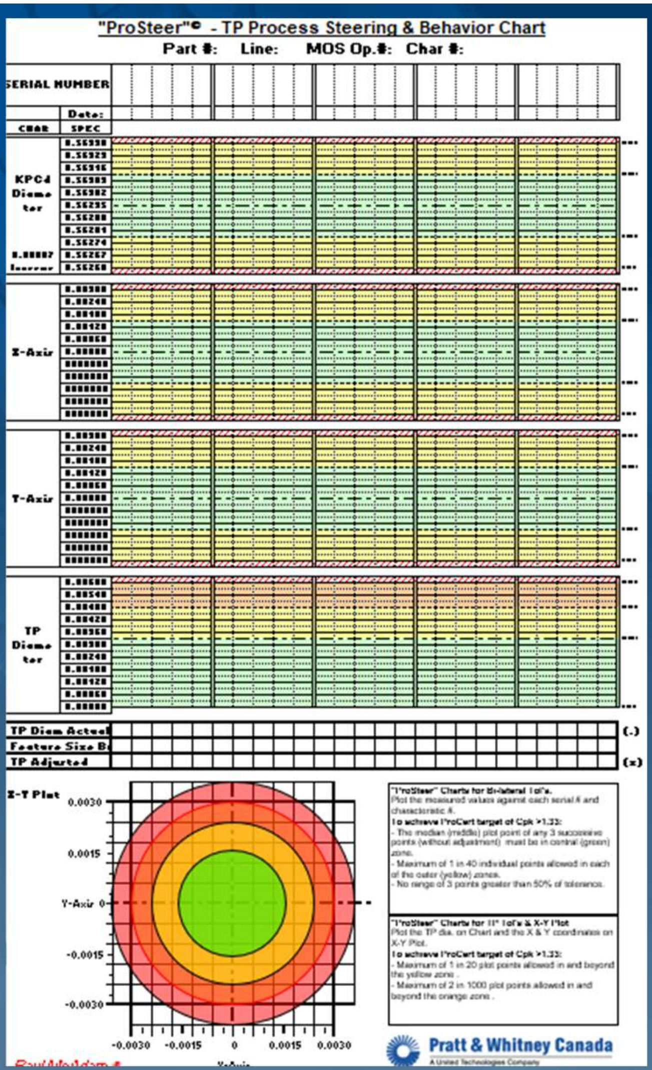
Area Ppk with MMC Bonus

$$AreaPpk_{Bonus} = \frac{(R + 0.5 * Bonus_{Ave})^2}{(\sqrt{X_{Ave}^2 + Y_{Ave}^2} + 3\sqrt{s_{\max(x,y)}^2 + s_{Bonus}^2})^2}$$

TRUE POSITION AREA METHOD

PreControl type chart to monitor

1. Diameter
2. X-axis
3. Y-axis
4. TP Dia
5. X-Y Plot



TRUE POSITION AREA METHOD

Example without Bonus

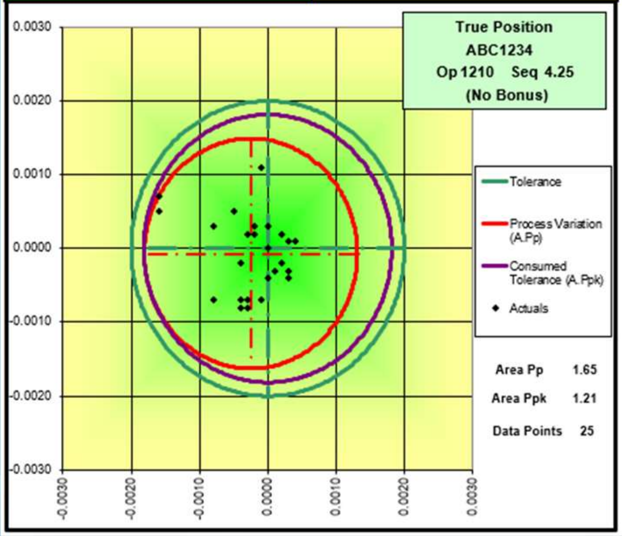
Capability Analysis- True Position (No Bonus)

Feature Information

CMM Type:	LK	Characteristic Ty	True Position
CMM S/N:	7462-02	TP Tolerance Dia	0.0040
Part Number:	ABC1234	MMC for FOS:	
Operation:	1210	Date:	1-Dec-2005
Sequence:	4.25	Data Points:	25
Notes:	Data from batch 43 and 44		

Calculations	X Value	Y Value	Resultant	Diameter
Mean	-0.000248	-0.000068	0.000634	0.266296
Std. Deviation(s)	0.000520	0.000513	0.000428	0.000114
Max $s_{(x,y)}$	Engr Tol Radius (TR)	Radius to Process Center (k)	3s Process (Pr)	Consumed Tol. Radius (Pr+k)
0.000520	0.0020	0.000257	0.001559	0.001816

Area Pp	Area Ppk
1.65	1.21



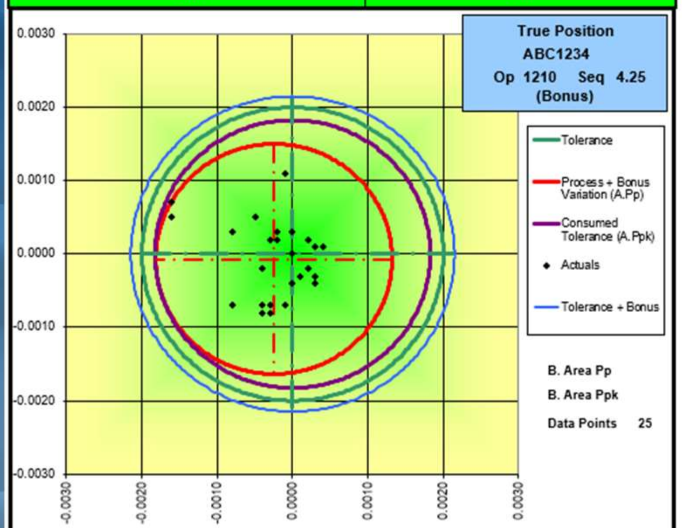
Data

S/N	Diameter	X Value	Y Value	Resultant
SN2000	0.26610	0.00000	0.00030	0.00030
SN2001	0.26620	-0.00040	-0.00020	0.00045
SN2002	0.26620	-0.00030	0.00020	0.00036
SN2003	0.26650	0.00020	-0.00020	0.00028
SN2004	0.26620	-0.00050	0.00050	0.00071
SN2005	0.26620	0.00020	0.00020	0.00028
SN2006	0.26620	-0.00080	0.00030	0.00085
SN2007	0.26630	0.00030	-0.00030	0.00042
SN2008	0.26630	-0.00010	-0.00070	0.00071
SN2009	0.26640	0.00000	-0.00040	0.00040
SN2010	0.26640	0.00030	-0.00040	0.00050
SN2011	0.26620	-0.00160	0.00050	0.00168
SN2012	0.26630	-0.00030	-0.00070	0.00076
SN2013	0.26650	-0.00020	0.00020	0.00028
SN2014	0.26650	0.00040	0.00010	0.00041
SN2015	0.26610	-0.00040	-0.00080	0.00089
SN2016	0.26640	-0.00080	-0.00070	0.00106
SN2017	0.26620	-0.00030	-0.00080	0.00085
SN2018	0.26640	-0.00040	-0.00070	0.00081
SN2019	0.26630	-0.00020	0.00030	0.00036
SN2020	0.26630	-0.00160	0.00070	0.00175
SN2021	0.26630	-0.00010	0.00110	0.00110
SN2022	0.26630	0.00000	0.00000	0.00000
SN2023	0.26630	0.00010	-0.00030	0.00032
SN2024	0.26630	0.00030	0.00010	0.00032

TRUE POSITION AREA METHOD

Example with Bonus

Capability Analysis- True Position (Bonus/No Bonus)				
Feature Information				
CMM Type:	LK	Characteristic Ty	True Position	
CMM S/N:	7462-02	TP Tolerance Dia	0.0040	
Part Number:	ABC1234	MMC for FOS:	0.2660	
Operation:	1210	Date:	1-Dec-2005	
Sequence:	4.25	Data Points:	25	
Notes:	Data from batch 43 and 44			
Calculations	X Value	Y Value	Resultant	Bonus (*0.5)
Mean	-0.000248	-0.000068	0.000634	0.000148
Std. Deviation (s)	0.000520	0.000513	0.000428	0.000057
Max $s_{(x,y)}$	Engr Tol Radius + Ave. (*0.5)Bonus (TB+BB)	Radius to Process Center (k)	3s Pooled Process & Bonus Var	Consumed Tol. Radius (PBr+k)
0.000520	0.002148	0.000257	0.001568	0.001826
Area Pp - Bonus		Area Ppk - Bonus		
1.88		1.38		



Data					
S/N	Diameter	X Value	Y Value	Resultant	Bonus (radial)
SN3000	0.26610	0.00000	0.00030	0.00030	0.00005
SN3001	0.26620	-0.00040	-0.00020	0.00045	0.00010
SN3002	0.26620	-0.00030	0.00020	0.00036	0.00010
SN3003	0.26650	0.00020	-0.00020	0.00028	0.00025
SN3004	0.26620	-0.00050	0.00050	0.00071	0.00010
SN3005	0.26620	0.00020	0.00020	0.00028	0.00010
SN3006	0.26620	-0.00080	0.00030	0.00085	0.00010
SN3007	0.26630	0.00030	-0.00030	0.00042	0.00015
SN3008	0.26630	-0.00010	-0.00070	0.00071	0.00015
SN3009	0.26640	0.00000	-0.00040	0.00040	0.00020
SN3010	0.26640	0.00030	-0.00040	0.00050	0.00020
SN3011	0.26620	-0.00160	0.00050	0.00168	0.00010
SN3012	0.26630	-0.00030	-0.00070	0.00076	0.00015
SN3013	0.26650	-0.00020	0.00020	0.00028	0.00025
SN3014	0.26650	0.00040	0.00010	0.00041	0.00025
SN3015	0.26610	-0.00040	-0.00080	0.00089	0.00005
SN3016	0.26640	-0.00080	-0.00070	0.00106	0.00020
SN3017	0.26620	-0.00030	-0.00080	0.00085	0.00010
SN3018	0.26640	-0.00040	-0.00070	0.00081	0.00020
SN3019	0.26630	-0.00020	0.00030	0.00036	0.00015
SN3020	0.26630	-0.00160	0.00070	0.00175	0.00015
SN3021	0.26630	-0.00010	0.00110	0.00110	0.00015
SN3022	0.26630	0.00000	0.00000	0.00000	0.00015
SN3023	0.26630	0.00010	-0.00030	0.00032	0.00015
SN3024	0.26630	0.00030	0.00010	0.00032	0.00015

Special recognition goes to Paul McAdam, retired P&WC Quality Fellow, who did most of the development of these methods.

SUMMARY

Have quality data you can trust (MSA)

Have enough data to capture full process variability

Make sure your process is stable (Control Charts)

Choose the correct distribution

Choose the appropriate capability Indices to evaluate your process (Ppk preferred, Area Method for TP)

Track and improve!

FUTURE WEBINARS

From the Process Control Methods SMIG Group

Look for these future topics in the "Upcoming Events" page on the AESQ website:

https://aesq.sae-itc.com/interest-groups

NO.	WEBINAR TOPICS	TARGET DATE/TIME	WEBINAR LEAD	SUPPORTING SUB-TEAM	BRIEF DESCRIPTION
1	**Process Control Methods - What is RM13006? Interaction with other AESQ Reference Manuals**	12/6/2022 (11 AM US Eastern)	Pete Teti	Nicklas Godebu/Marnie Ham	Overview of RM13006 and how it interacts with other AS13100 reference manuals.
2	**What makes a good Process Capability Study?**	1/26/2023 (11 AM U.S. Eastern)	Steve Hampton	Marnie Ham/Karen Scavotto	Cpk values are only as good as what goes into the data used to calculate Cpk, such as the adequacy of the measurement system and achieving statistical control.
3	**Process Capability for Unilateral Tolerances including True Position**	2/8/2023 (11 AM U.S. Eastern)	Andrew Stout	Grant Braun Karen Scavotto Shailesh Shinde	How do we handle process capability for one-sided or unlateral tolerances including true position where Maximum Material Condition modifiers may play a role.
4	**The use of non-statistically based process control methods**	3/8/2023 (11 AM U.S. Eastern)	Paul Gorg	Pete Teti/Earl Capozzi/Rudi Braunieder/Nicklas Godebu	Process controls need not only be statistically based. Here we explore non-statistical methods such as error-proofing devices, the PreControl method, and the use of run charts with non statistical limts.
5	**The Power of Precontrol**	4/11/2023 (11 AM U.S. Eastern)	Andrew Stout	Steve Hampton/Geoffrey Carpentier	PreControl is a powerpul non-statistical tool that is easy to get up and running with that can be used to qualify the set-up of a lot as well as a control for the production run.
6	**The One-Hour Process Control Assessment**	5/16/2023 (11 AM U.S. Eastern)	Pete Teti	Geoffrey Carpentier	If you were visiting a supplier and only had time to carve out one hour for a process control assessment, what questions would you ask and where whom would you ask those questions to?
7	**Why is statistical control a prerequisite for process capability?**	Target 2nd Qtr (June)	Marnie Ham	Andrew Stout/Geoffrey Carpentier/Douglas Dush	Process Capability indexes without the use of SPC Control Charts are invalid. Control Charts are the method to monitor and control a process and are a key prerequisite prior to calculating Cp & Cpk.
8	**Dealing with Non-Normal Data**	Target 3rd Qtr. (September)	Karen Scavotto	Marnie Ham/Shailesh Shinde/Andrew Stout	What happens when the data coming from a process is non-normal? What can be done to accurately assess process capability? We will show you!
9	**Conducting capability studies for one-sided geometric tolerances**	Target 4th Qtr. (October)	Karen Scavotto	Marnie Ham/Shailesh Shinde/Andrew Stout	Aerospace component manufacturers the world over deal with geometric/one-sided features such as runout, flatness, etc. What rules have to change when assessing process capability?

Q & A SESSION

USE THE "CHAT" FUNCTION TO ASK A QUESTION…

SUMMARY

All resources will be available on the AESQ website within a few days.

An email will be sent to all registrants with a link.

THANK YOU FOR PARTICIPATING