
THE

SURYA PRAKASH

Speaker

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- **Working with ITC PSPD- Unit Bhadrachalam. (Production and process/ product development)**
- **M.Tech. in Pulp and Paper technology from IPT Saharanpur.**

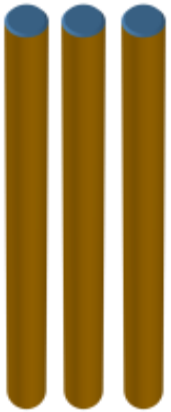
  Certified professional in "Six Sigma Green Belt & Black Belt " & in "Statistical Quality Control methodology" by Indian Statistical Institute (ISI) - Hyderabad.

Passionate in improving efficiency with an inclination towards training & sharing of knowledge among the team members.

- **Quality (NCP Reduction by 8%) and productivity (by 18%) improvement in Absorbent Kraft Paper by identifying the controlling factors for castor oil absorbency.**
- **Improved the board surface for better printing by optimizing the steam and condensate system for improving adhesion at MG.**

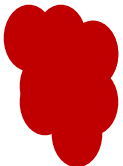
  (The above 2 case studies were presented at Chemical Department , IIT Roorkee)
- **Productivity enhancement in MG Tx (Cup Stock) by 12% .**

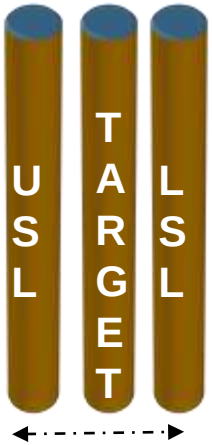
  This case study was presented in CII South India .



Poor control on bowling

Not capable

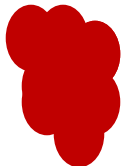


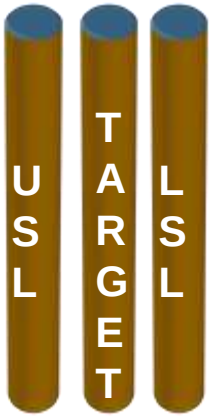


Range where the bowling is Required

Capability : how many balls are on wickets?

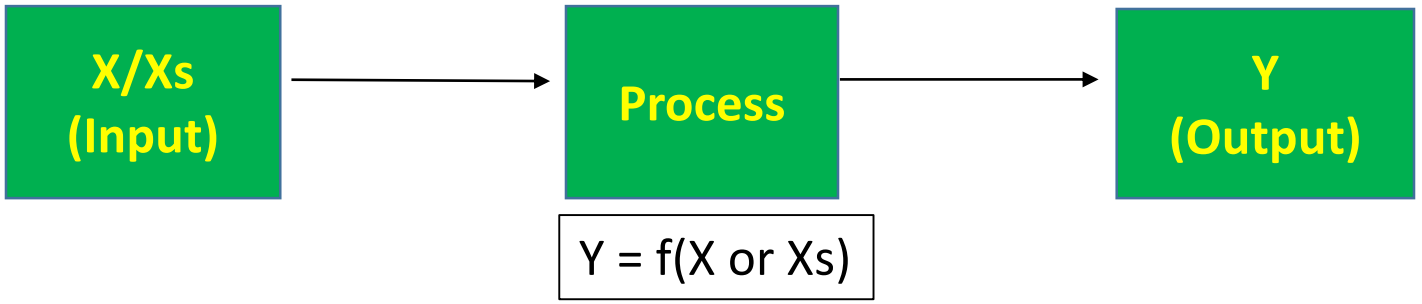
Range where the bowling is Actual happening





Better than before & this time it is capable also.

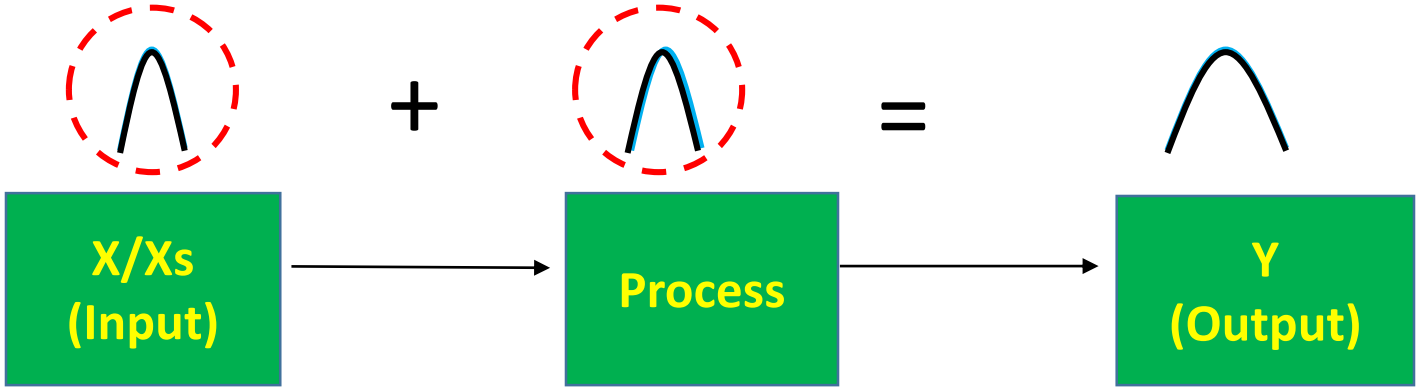
Statistical Model of any process- IPO



Say for example,

1. The formation index is a function of Head Box % Cy.
2. Plybond is a function of refining & moisture of the layers being merged.
3. Burst factor is a function of SR, starch level, starch cooking conditions etc.
4. Steam economy at the evaporators is a strong function of % solid of and temp of weak black liquor.
5. Productivity is a function of gsm..maximum at anchored gsm

How variability in output comes ?



1. Chip thickness in pulping.
2. Blending of raw material
3. Properties of raw material
4. Change in Chemical

1. Temp variation
2. Vac level variation
3. Flow rate variation
4. %Cy variation
5. SR Variation

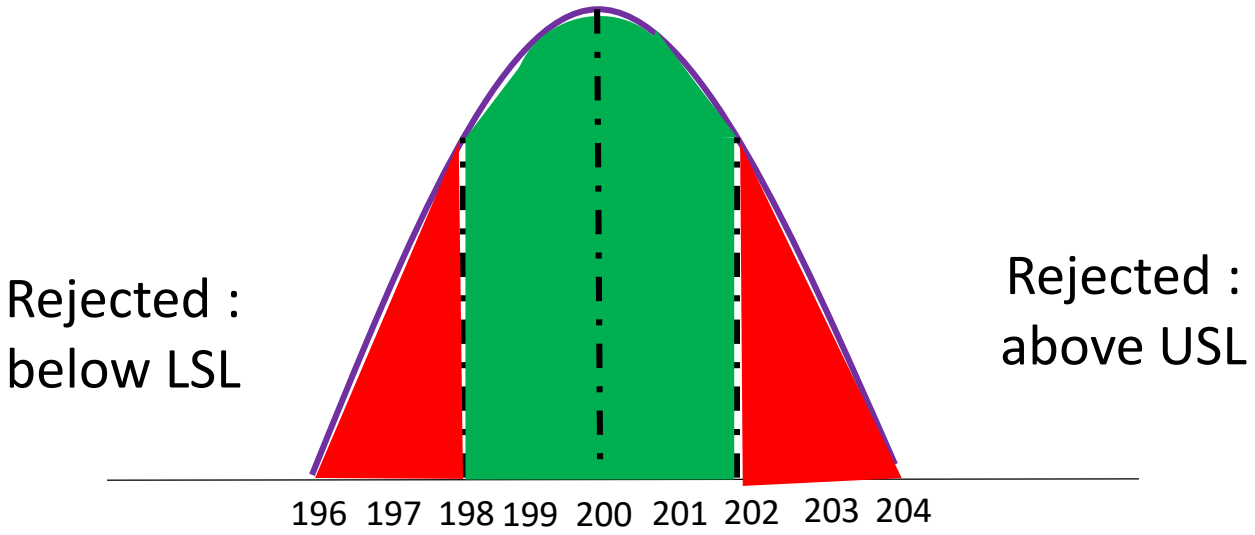
Variability in Y/Output is a summation of variability in inputs and process

So the variations in the inputs & process are to be controlled to Minimize the variability in the Output

Variation- Partially accepted / Partially rejected

The boundaries which bound the acceptable region are called as Lower specification limits LSL & upper specification limit USL.

The difference USL- LSL is called accepted range or **Tolerance.**



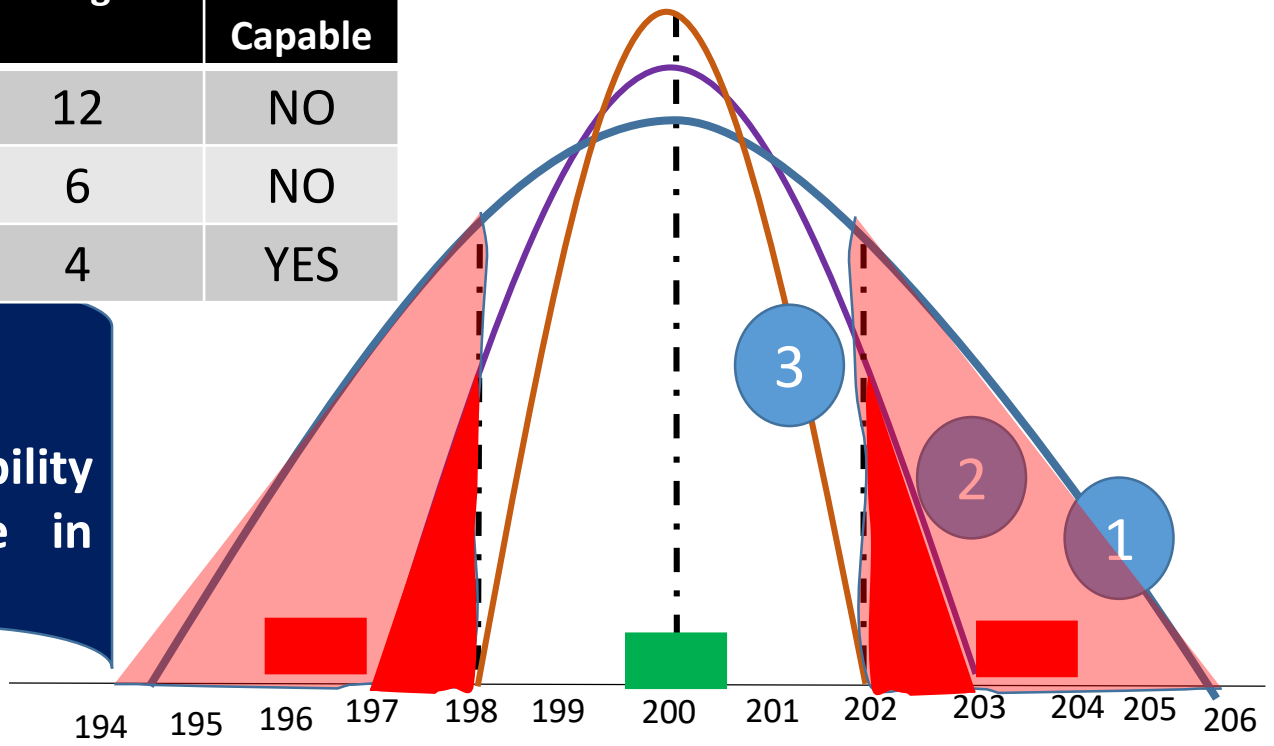
The variation must be within **TOLERANCE.**

It is a measure of **Process Capability.**

This is the minimum condition of a **Capable Processes.**

Process	Min	Max	Produced Range	Is Process Capable
1	194	206	12	NO
2	197	203	6	NO
3	198	202	4	YES

Inference:-
The Process Capability Increases with decrease in range being produced.



We can not control until we measure

So ,let us measure the capability of a process

Calculation of Process Capability (Cp)

$$Cp = \frac{\text{Required Range / Tolerance (USL-LSL) (customer specification)}}{6^* \boldsymbol{\sigma} \textbf{ (sigma/Standard deviation SD)}}$$

Fixed : defined by the customer

6* **σ > Tolerance , Cp < 1 Process is not capable ,**

6* **σ = Tolerance , Cp = 1 Process is just capable,**

6* **σ < Tolerance , Cp > 1 Process is in better control and can take care of small deviation too.**

It shows that higher the value of Cp, higher is the capability of the process.

But the important question is how to increase Cp?

The only option left over is " Reduce Variation" i.e. "Reduce SD…

Why improving Cp is required ?

- Improving /Controlling Cp improves the quality of the output.
- Quality/ Service becomes more consistent.
- It can be used value adding parameter to enhance the brand value.
- It helps in reducing cost of poor quality. (Rework / inspection)
- Apart of reducing cost, it improves morale of the team.
- And the above all the quality becomes **Predictable.**

Methodology to implement Cp

Three step method :

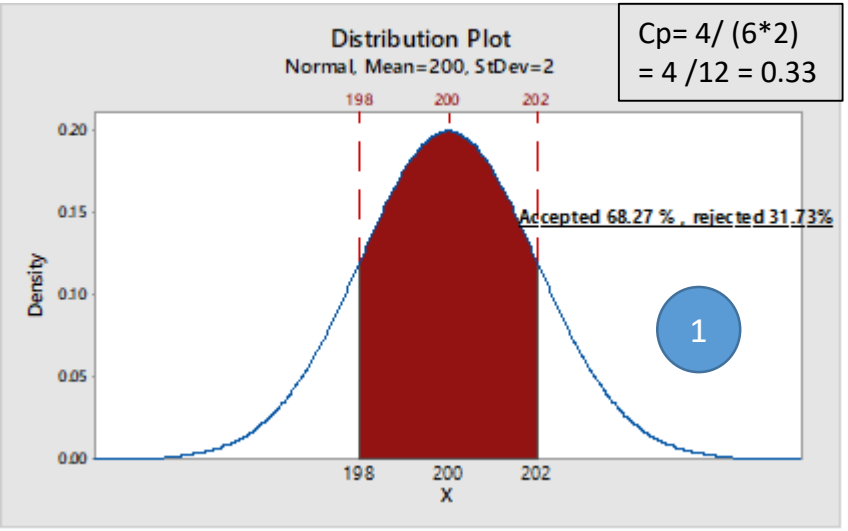
1. Find the tolerance, i.e USL-LSL
2. Find the maximum allowable SD by equation

$$6^* \sigma_{(max)} = \textbf{Tolerance}$$

$$\sigma_{(max)} = \textbf{Tolerance}/\ 6$$

3. This is Max allowable value of SD. It makes the process just capable. Any reduction in SD from this value adds on the capability of the process. Try to reduce the SD on regular basis.

Let us recall the 3 processes and check their capabilities



Cp= 4/ (6*2)
= 4 /12 = 0.33

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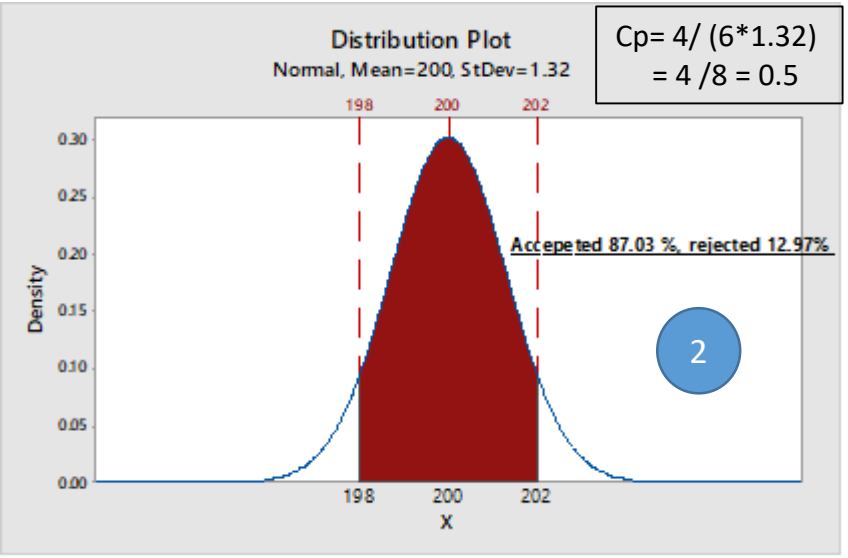
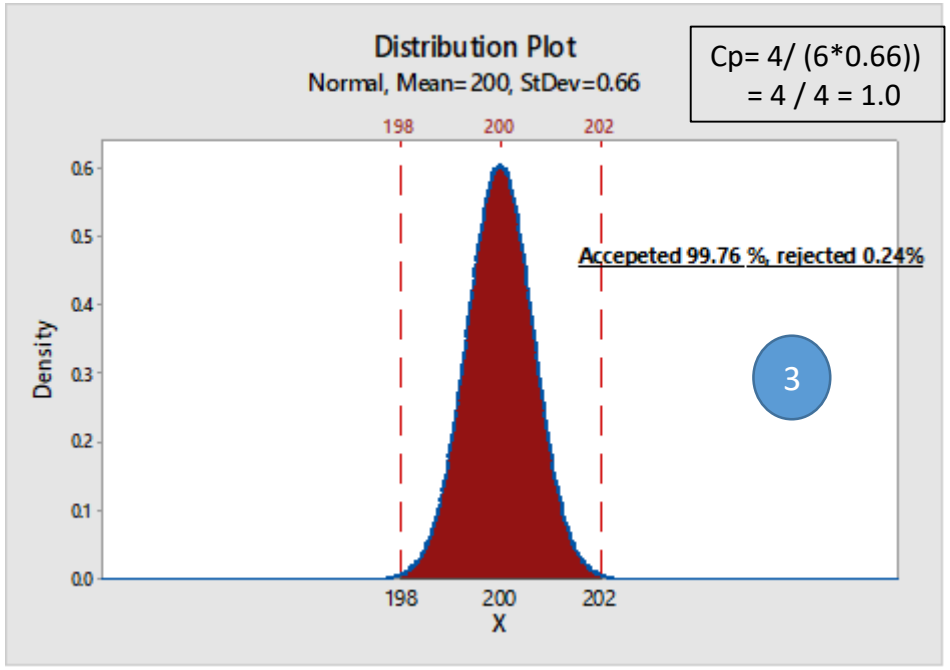


Cp= 4/ (6*1.32)
= 4 /8 = 0.5



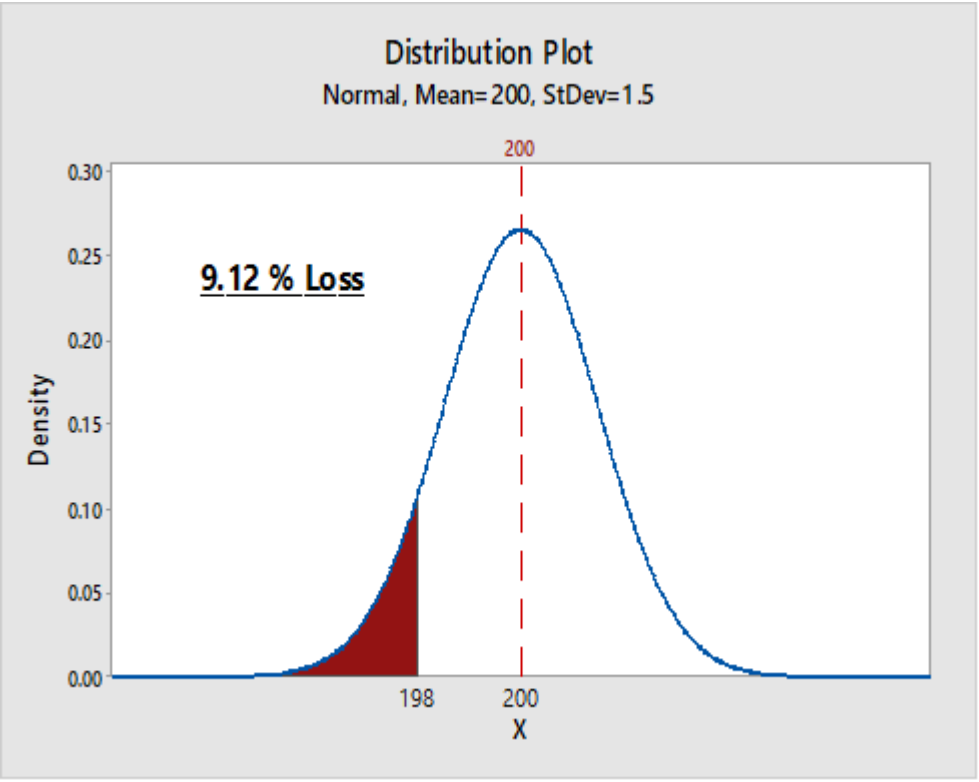
Cp= 4/ (6*0.66))
= 4 / 4 = 1.0

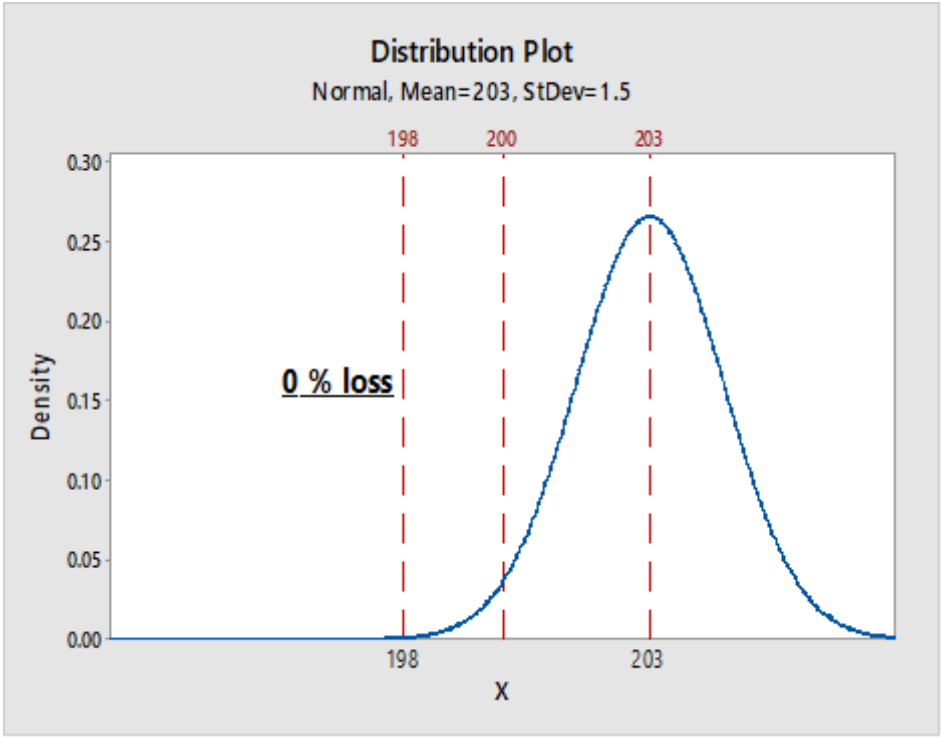
Real time scenario: Where Cp provides an optimal solution with reduction in cost & reduces not value additive activities

Customer is asking for 200 gsm with +/- 2 gsm and the raising voice of the customer was that sometimes he gets below LSL i.e below 198.

What shall be our target ? 199…200… 201…. ??

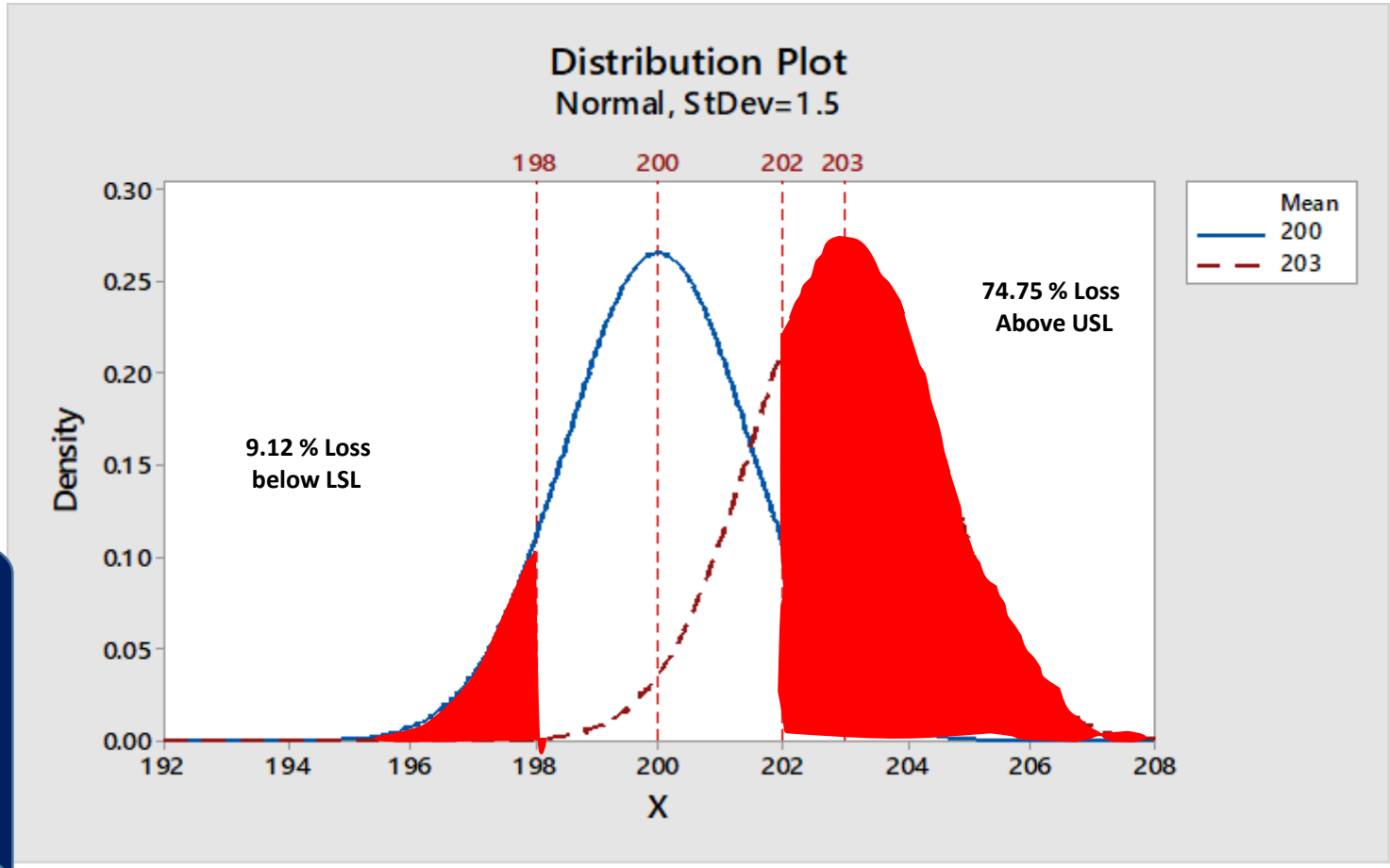
Constraint : Voice of the complaining customer..
Minimum gsm 198.
Process Sd (initially) = 1.5 , Cp = (4/6*1.5) =0.44
As Cp < 1 : Process is not capable enough





But Is it real a saving ??

Let us review the gain or loss



Was it right decision to increase gsm in this case ?

Not advisable for a longer time and on continuous basis for future.
The right way is to reduce Standard deviation.
And to improve Process Capability

Let us check the capability of the process as such

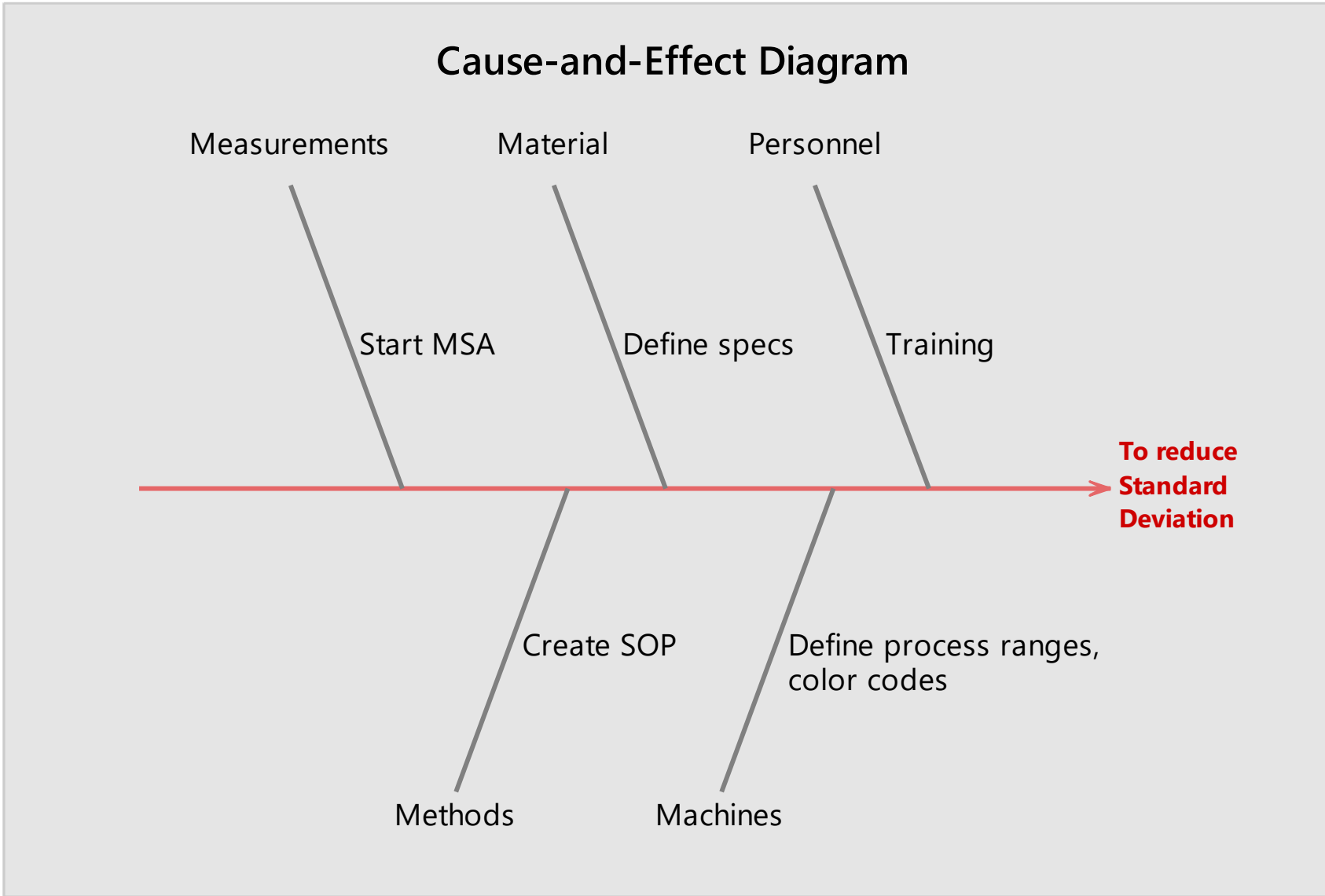
Tolerance = 202-198 = 4 , $\sigma_{(max)}$ = Tolerance/ 6 , $\sigma_{(max)}$ = 4/6 =0.66

But as such $\sigma_{(Process)}$ = 1.5

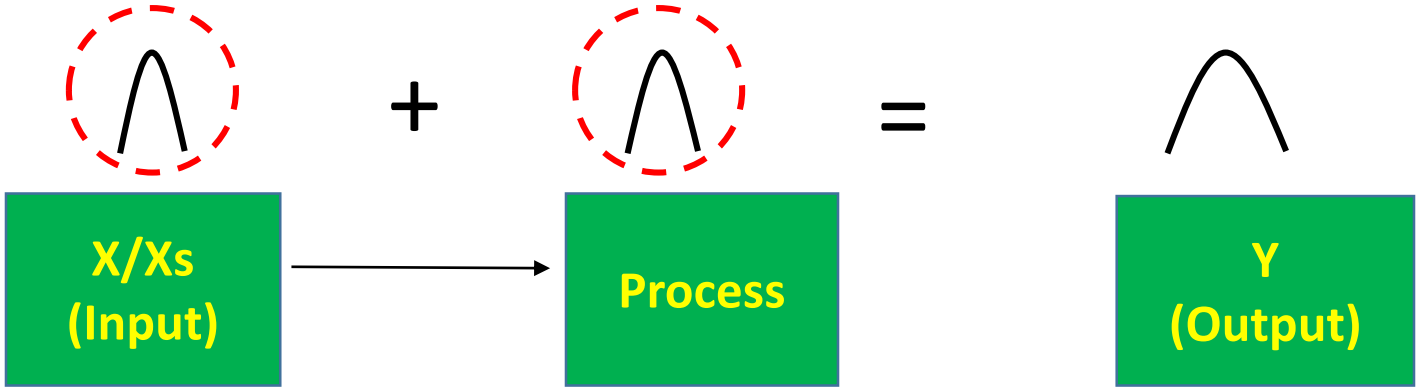
Existing Cp= 4/6(1.5) = 4/9 =0.44 – Process is not capable

Inference : the SD has to be controlled at priority as max allowable SD is 0.66 only and we are at 1.5 SD.

Steps to reduce SD



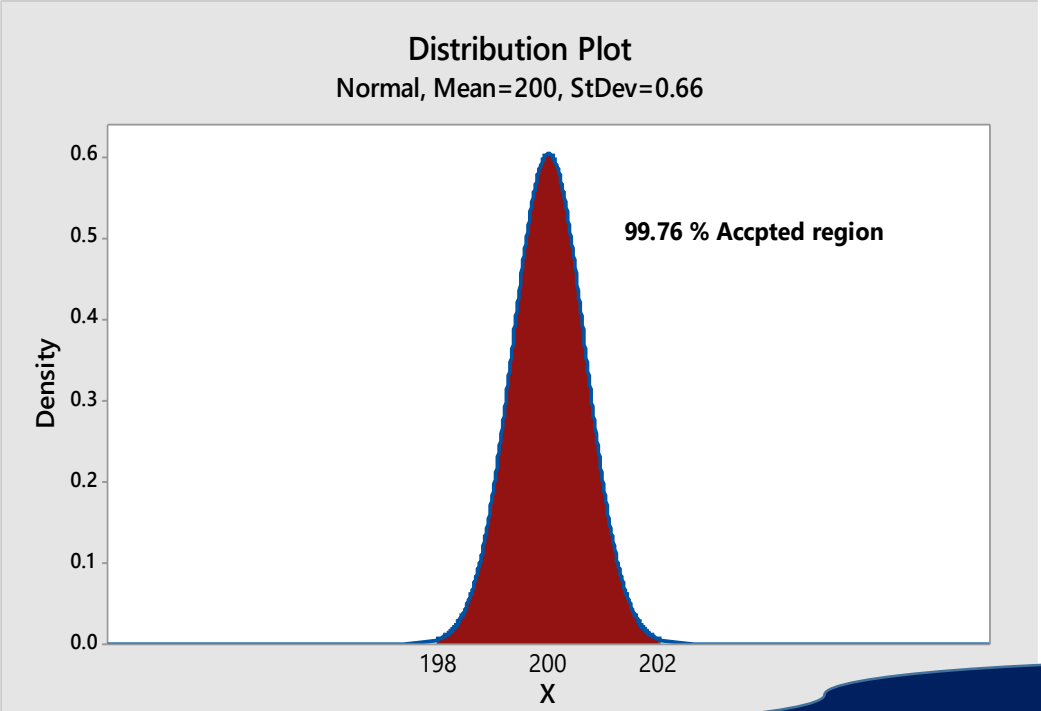
Steps to reduce SD



1. Identify the inputs which are highly correlated with Output. **Cutoff may be at coefficient of correlation at 0.6**
2. Define these as **Key Process Input variables** and fix their ranges .
3. Control Charts can be initiate for controlling the input variable in defined range.
4. Color codes can be given for a better visual and control for these KPIVs.
5. Operating procedure to be standardized
6. Training of Members. Convert why why into Know why.. (Approach and attitude **`To Cure `** will start converting towards **`To Prevent`**

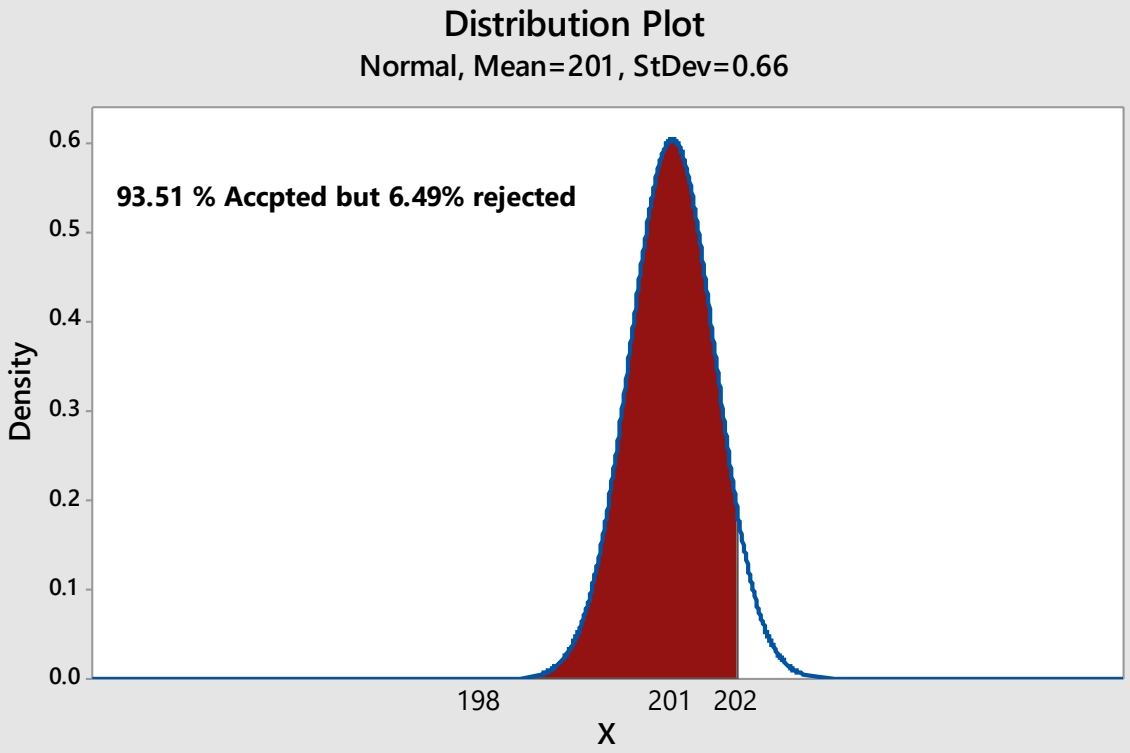
Let us start
journey Step 1 – process is at highest value of SD which is calculated as $\sigma_{(max)}$ = Tolerance/ 6

Tolerance = 202-198 =4 , **$\sigma_{(max)}$ = Tolerance/ 6** = 4/6 =0.66 So , **Cp = 1**



Inference :
This system is Just capable , Until unless target and average are same it is ok.
But risk is that any time it can go out of specifications.

If Process average shifts from Target a little in just capable process having Cp =1

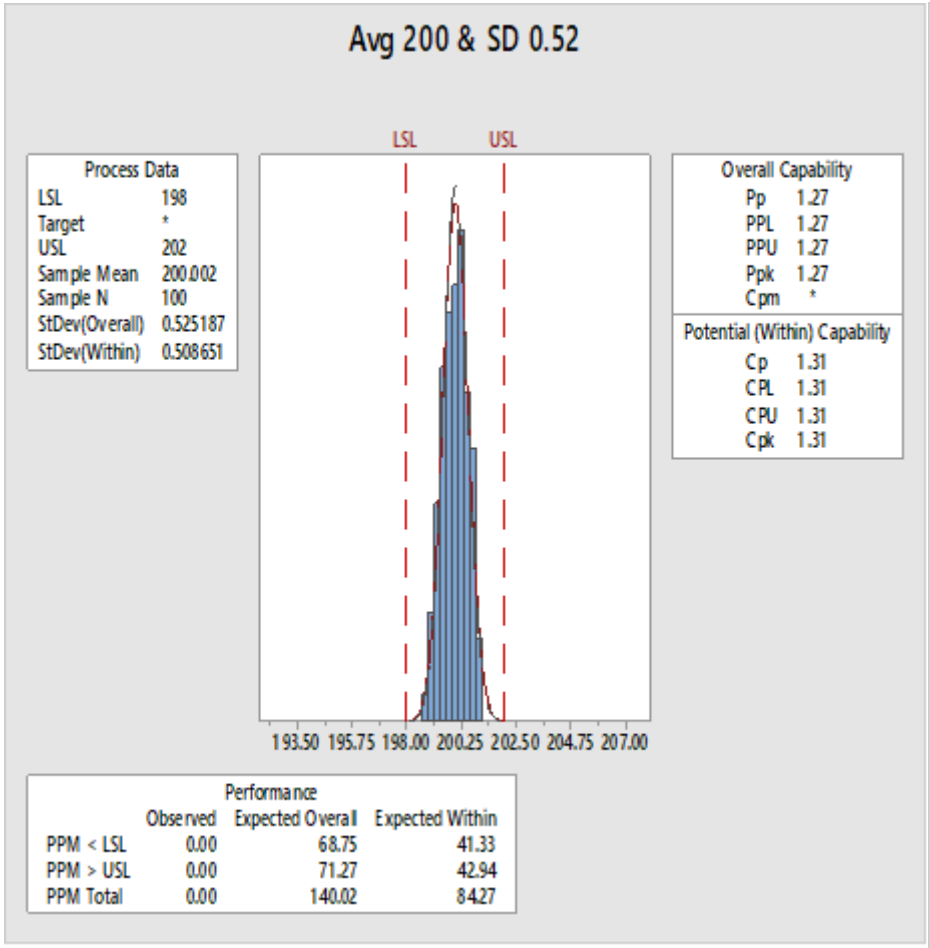


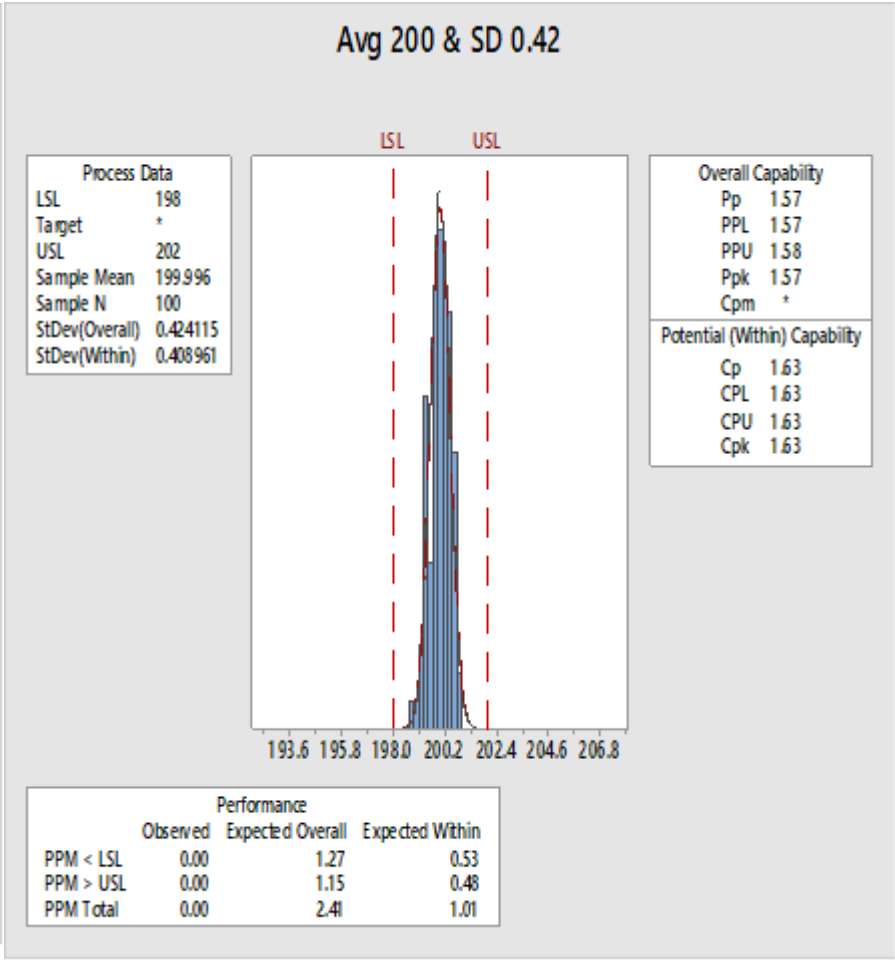
Inference : A just capable process is always at a risk due to any slight variation. Therefore Cp value should be higher than 1 to absorb the slight variation in running process.

Standard Values of Cp

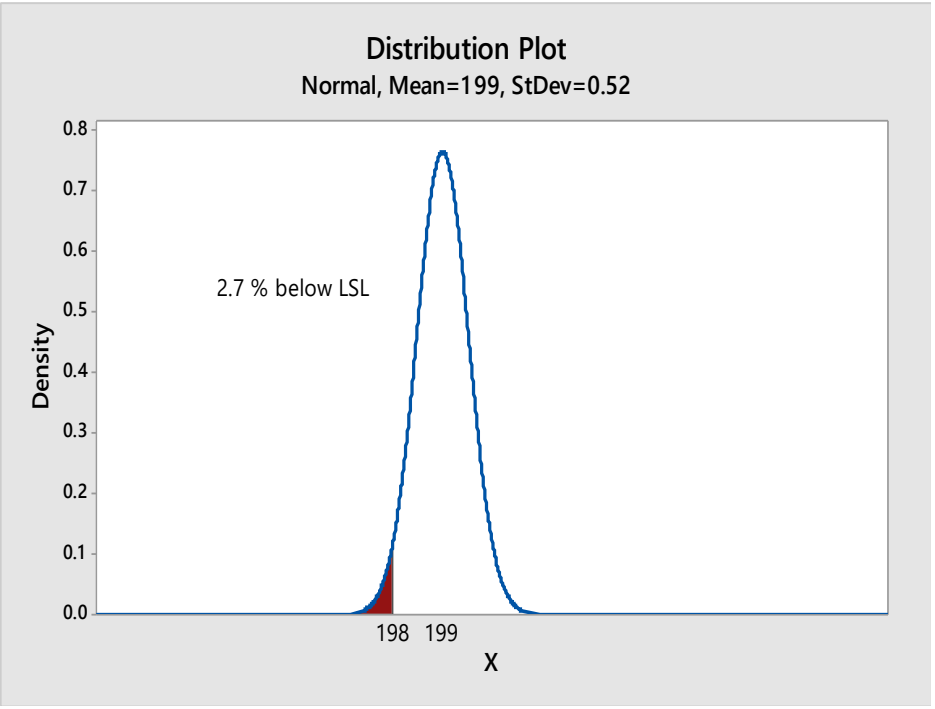
Cp	Process	Actions to be taken
Cp <1	Not capable	Loss is high. COPQ is more. Reduce SD.
Cp = 1	Capable and able to handle if process mean is at target	Maintaining Target is must. Always at Risk.
1.33 > Cp >1	Capable and able to handle slight variation.	Positive Phase of the process starts. Losses start reducing.
1.67 > Cp > 1.33	Very good control and can absorb the variation of +/- 1 sigma	Economical benefits starts and system will absorb slight variation.
>1.67	Very good control and can absorb the large variations too.	Excellent Control on the process, some cost cutting steps can be taken.

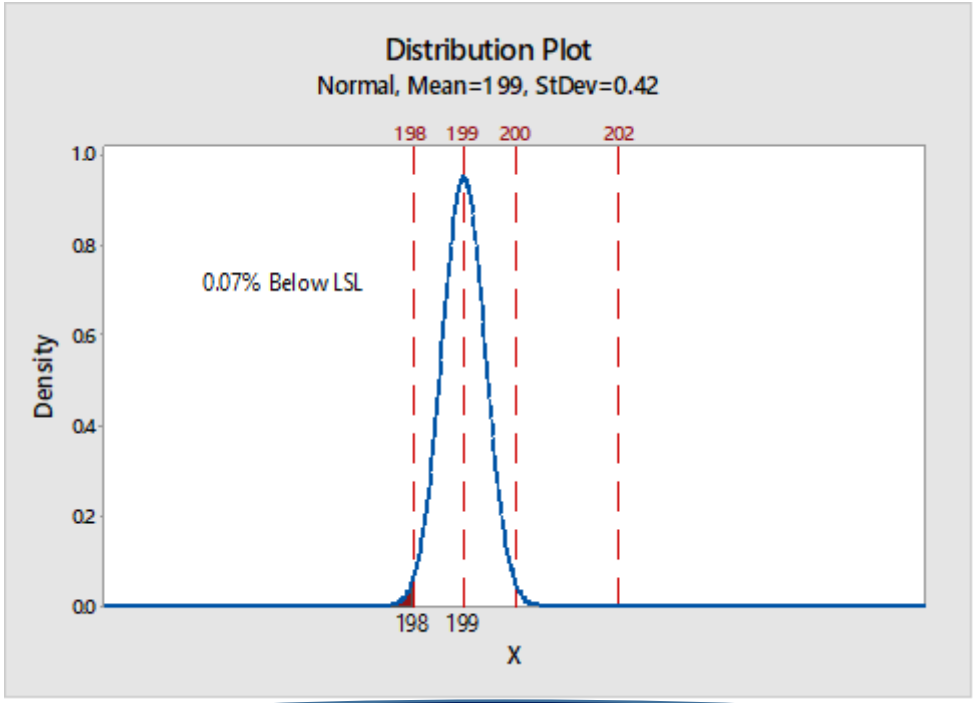
Cp = 1.33 and 1.63





Behavior at Cp = 1.33 and 1.63





Inference : Higher the Cp, tighter is the control. The variation remains much within the tolerance. As during run, average is bound to shift from defined target therefore this process will take care of such variation too.

THANK YOU