

## APPLICATIONS BULLETIN

# How do I Apply Statistics to Print Quality?

### Statistical Print Metrics

**Cp – Process Capability Index** – relates process variation to specification limits

**Cpk – Process Capability Index** - relates process variation to specification limits AND process centering between the limits

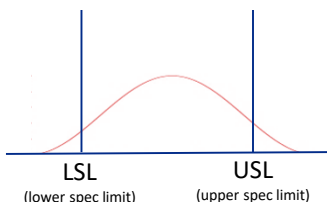
**CV – Coefficient of Variation** – relates variation to average and removes spec limits from the equation

Each metric uses  $\sigma$  (sigma), the standard deviation, to describe the spread of the data.

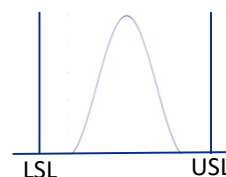
Each metric uses  $\sigma$  in different ways

$$Cp = \frac{USL - LSL}{6\sigma}$$

Compares standard deviation with specification range  
Higher is better. Goal is >2.0



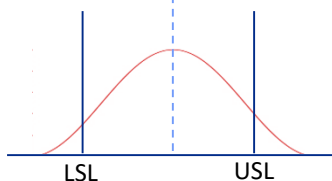
Low Cp



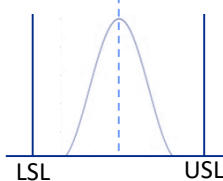
High Cp

$$Cpk = \min\left(\frac{USL - Avg}{3\sigma} \text{ or } \frac{Avg - LSL}{3\sigma}\right)$$

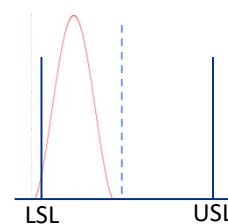
Breaks the spec range in half to determine how well the distribution is centered in the process window  
Higher is better. Goal is >2.0



Low Cpk



High Cpk



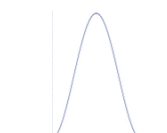
High Cp, Low Cpk

$$CV = \frac{\sigma}{Avg}$$

Compares standard deviation with average, %  
NO SPEC LIMITS  
Lower is better. Goal is <10%



High CV



Low CV

To begin controlling a print process:

First reduce variation (Cp, CV), then adjust the average (Cpk)