

Activity 6.5 – Using the SPC Device

Purpose

In Lesson 6.4 we learned the basics of statistical process control. We will check the diameter and length of your test sample with a new instrument. This instrument takes the readings automatically and records them on a paper tape for us. It can even automatically produce a histogram.

Equipment

SPC device with digital caliper
Material Testing sample

Procedure

1. The following table contains the various statistical symbols and their meaning. Look through the table and research any item you are unfamiliar with.

Statistical Data – General Information:

USL/ LSL	Upper Statistical Limit/Lower Statistical Limit - “Specification” limits or desired limits set for the characteristic being measured
N	Sample size or number of observations or data points
MAX	Maximum value recorded or observed
MIN	Minimum value recorded or observed
R	Range of values
\bar{x}	Average or “mean” of all of the samples
σ_n	Standard deviation of an entire population of values
σ_{n-1} or s	Standard deviation of a sample of an entire population of values (usually used in process control settings)
P	Percentage of defective (out of specification) units
Cp	<p>Process capability that indicates the precision of a process (describes the spread of the distribution)</p> <p>If the spread is bigger than the allowable range of the specification, $C_p < 1$</p> <p>If the spread is smaller than the allowable range of the specification, $C_p > 1$</p> <p>Desired value: $C_p > 1$</p> <p>Limitation: this is an indicator of the precision of a process but not of the</p>

	accuracy of the process
Cpk	Process capability that indicates both the accuracy of the process, as well as the precision of the process (describes the spread and the location of the distribution) Desired value: Cpk > 1

2. The following are the statistical equations you will be using. If you are unsure of any of them you should research them before proceeding.

Equations to Solve for Statistical Quantities:

$$\bar{x} = \frac{\sum x}{N} \quad s = \sigma_{n-1} = \sqrt{\frac{\sum (x - \bar{x})^2}{N - 1}} \quad \sigma_n = \sqrt{\frac{\sum (x - \bar{x})^2}{N}}$$

$$C_P = \frac{USL - LSL}{6\sigma_{n-1}} \quad C_{pk} = \frac{USL - \bar{x}}{3\sigma_{n-1}} \quad \text{or} \quad C_{pk} = \frac{\bar{x} - LSL}{3\sigma_{n-1}}$$

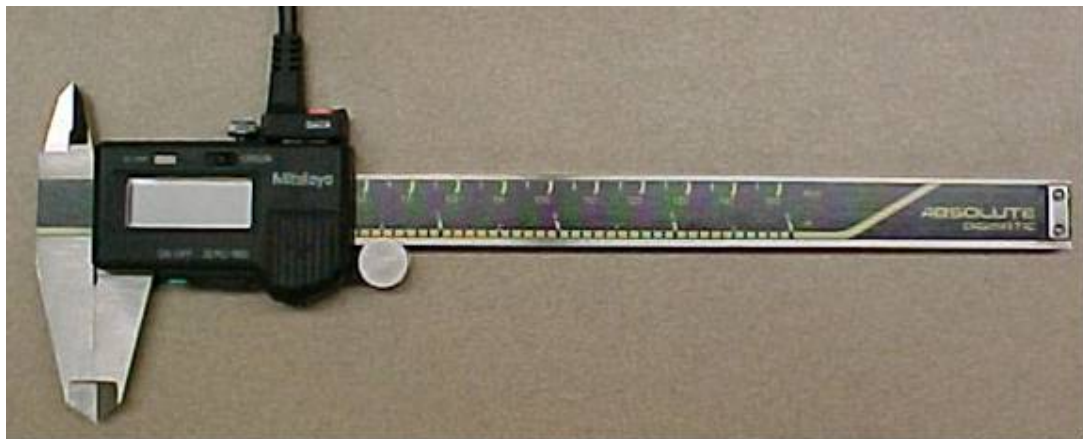
Using the SPC Device to Generate Statistical Data

An SPC device will be used to generate statistical data in the material testing unit. The primary components of this device include the Digimatic Mini-Processor and digital calipers with an SPC cable, shown below.

SPC Device and Key Pad:



Digital Calipers with SPC Cable



SPC Device – Full Analysis (with Tolerances)

Use the following steps to do a full analysis (with tolerances and a histogram) of a particular dimension. This is recommended for the diameter measurements of the gage length of the tensile specimen.

1. CL to clear
2. TOL LIM to begin the tolerance limit process
3. Zero the digital calipers
4. Set the digital calipers to the USL
5. Press DATA
6. This will appear on the tape as LMT
7. Set the digital calipers to the LSL
8. Press DATA
9. This will appear on the tape as LMT
10. Press TOL LIM again
11. New tolerance limits should appear on the tape as USL and LSL, respectively
12. Use the digital calipers to measure the dimension
13. Press the DATA button to enter measurement
14. Repeat last two steps for each piece of data entered (Recommendation: N=5 for diameter)
15. Press STAT button.
16. Press FEED after printing has stopped to advance paper.

SPC Device – Partial Analysis (without Tolerances)

Use the following steps to do a partial analysis (without tolerances and a histogram) of a particular dimension. This is recommended for the shoulder-to-shoulder distance, overall length, and necked-down diameter measurements the tensile specimen.

1. CL to clear
2. Press TOL LIMIT once – old limit data will be displayed
3. Press CL – *LIMIT CLEAR* should appear on your tape
4. Use the digital calipers to measure the dimension
5. Press the DATA button to enter measurement

6. Repeat last two steps for each piece of data entered (Recommendation: N=3 for shoulder-to-shoulder distance, overall length, and necked-down diameter measurements)
7. Press STAT button.
8. Press FEED after printing has stopped to advance paper.

Reading the SPC Tape

There are additional symbols and statistical information on the SPC tape. These are as follows:

- TOL – Overall tolerance between USL and LSL
- LMT – entered for upper tolerance limit or lower tolerance limit of dimension
- -NG (Full analysis only) – number of data points below the LSL
- +NG (Full analysis only) – number of data points above the USL
- Histogram information (Full analysis only) – the histogram places the data points on a graph that shows the LSL, USL, -NG, +NG, and a range scale (broken into divisions) between the LSL and USL. Small rectangles represent data.
 - DIV – number of divisions shown for the histogram
 - = # – the rectangle represents “#” data points (in our case, each rectangle represents one data point
 - A, B, C ... - these represent the numbers in the histogram between the LSL and USL