Statistical formulas
Control charts for Attributes

Statistical calculations

Average p = $\quad \bar{p} = \dfrac{\sum p_i}{n}$

Capability Cp = $\quad C_p = \dfrac{USL - LSL}{6\sigma}$

Average np = $\quad \overline{np} = \dfrac{\sum np_i}{n}$

Average c = $\quad \bar{c} = \dfrac{\sum c_i}{n}$

Average u = $\quad \bar{u} = \dfrac{\sum u_i}{n}$

$\sum p_i = p_1 + p_2 + p_3 \ldots\ldots + p_n$
$\sum np_i = np_1 + np_2 + np_3 \ldots\ldots + np_n$
$\sum c_i = c_1 + c_2 + c_3 \ldots\ldots + c_n$
$\sum u_i = u_1 + u_2 + u_3 \ldots\ldots + u_n$

USL = Upper specification limit
LSL = Lower specification limit

Control limits

p - Chart

$$UCL_p = \bar{p} + 3\sqrt{\dfrac{\bar{p}(1-\bar{p})}{n}}$$

$$LCL_p = \bar{p} - 3\sqrt{\dfrac{\bar{p}(1-\bar{p})}{n}}$$

$UCL_p =$ Upper control limit p
$LCL_p =$ Lower control limit p

np - Chart

$$UCL_{np} = \overline{np} + 3\sqrt{\overline{np}(1 - \overline{np}/n)}$$

$$LCL_{np} = \overline{np} - 3\sqrt{\overline{np}(1 - \overline{np}/n)}$$

$UCL_{np} =$ Upper control limit np
$LCL_{np} =$ Lower control limit np

c - Chart

$$UCL_c = \bar{c} + 3\sqrt{\bar{c}}$$

$$LCL_c = \bar{c} - 3\sqrt{\bar{c}}$$

$UCL_c =$ Upper control limit c
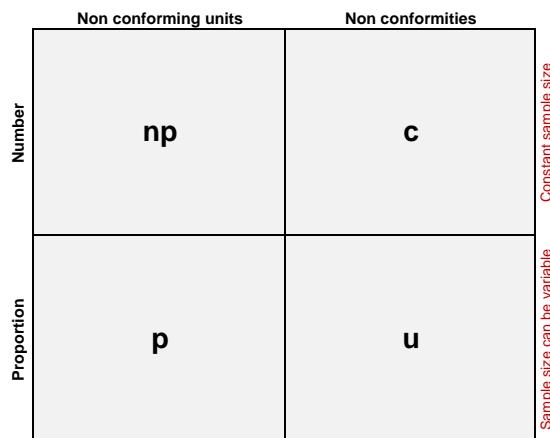$LCL_c =$ Lower control limit c

u - Chart

$$UCL_u = \bar{u} + 3\sqrt{\dfrac{\bar{u}}{n}}$$

$$LCL_u = \bar{u} - 3\sqrt{\dfrac{\bar{u}}{n}}$$

$UCL_u =$ Upper control limit u
$LCL_u =$ Lower control limit u

Guide for selection of Charts

	Non conforming units	Non conformities	
Number	np	c	Constant sample size
Proportion	p	u	Sample size can be variable

Quality Systems

Statistical alarms

► **One single point above the Upper control limit**
► **One single point above the Lower control limit**
► **8 consecutive points above the central line**
► **8 consecutive points below the central line**
Western Electric rules