<u>Statistical Quality Control (SQC)</u>

Statistical Quality Control (SQC) is a statistical method for finding whether the variation in the quality of the product is due to random causes or assignable causes.

Process Control means control of the quality of the goods while they are in the process of production.

Control Chart is a graphical device mainly used for the study and control of the manufacturing process.

There are **two types** of control charts namely,

1. Control charts of variables (Mean and range charts).
2. Control charts of attributes (p-chart and c-chart).

Variables are the quality characteristics of a product that are measurable. E.g., diameter of a hole in bored drilling machine.

Attributes are the quality of the characteristics of a product that are not measurable. E.g., presence of defective items in a sample.

Control charts for Attributes

p-chart - proportion of defectives

np-chart - number of defects

c- chart - number of defects in a unit

Construction of $\bar{x}$-chart

The following values must be computed for drawing an $\bar{x}$ chart:

(i) The mean of each sample, i.e., $\overline{x_1}$, $\overline{x_2}$, $\overline{x_3}$, etc., are obtained using $\bar{x} = \frac{\sum x}{n}$ where n is the number of items in the sample (or sample size).

(ii) The mean of the sample means $\bar{\bar{x}}$ is obtained by $\bar{\bar{x}} = \frac{\sum \bar{x}}{number\ of\ samples}$

(iii) The control limits are set at UCL= $\bar{\bar{x}} + 3\frac{\sigma}{\sqrt{n}}$ (or) UCL $= \bar{\bar{x}} + A_2\bar{R}$ and LCL= $\bar{\bar{x}} - 3\frac{\sigma}{\sqrt{n}}$ or LCL= $\bar{\bar{x}} - A_2\bar{R}$ where σ is the standard deviation and $\bar{R}$ is a biased estimator of σ found by $\bar{R} = \frac{\sum R}{n}$ and R is the sample range. The value of A_2 can be obtained from the table in the appendix.

Construction of R-chart

The general procedure for constructing the R chart is similar to that of $\bar{x}$ chart. The steps are:

(i) The range of each sample, R is determined.
(ii) The mean of the sample ranger, $\bar{R}$ is calculated.
(iii) The total control limits are found as
UCL= $\bar{R} + 3\sigma_R$

and LCL= $\bar{R} - 3\sigma_R$

where σ_R is the standard error of the range. However, in practice, it is convenient to compute UCL and LCL by using the values of D_4 and D_3 provided as

UCL= $D_4\bar{R}$ and LCL= $D_3\bar{R}$.

Construction of p-chart

This chart gives best results when the sample size is large. The steps in constructing the chart are:

(i) The average fraction defective $\bar{p}$ is computed by dividing the number of defectives by the total number of units inspected.
(ii) The central line is drawn with value $\bar{p}$.
(iii) UCL and LCL are determined using
UCL= $\bar{p}$ +3$\sqrt{\frac{\bar{p}\,(1-\bar{p}\,)}{n}}$ and LCL= $\bar{p}$ $-$3$\sqrt{\frac{\bar{p}\,(1-\bar{p}\,)}{n}}$

It is to be noted that, if p is small, substitution in the formula for LCL might yield a negative number. When this occurs, it is customary to assume the LCL to be equal to zero.

Construction of np-chart

Instead of plotting the fraction defective in a sample of size n, the number of defectives can be plotted directly. Such a chart is called control chart for number of defectives or np chart. To obtain this chart, the central line as well as control limits of p chart are multiplied by n. Therefore, we get,

Central line= $n\bar{p}$

UCL= $n\bar{p} + 3\sqrt{n\bar{p}(1-\bar{p})}$ and LCL= $n\bar{p} - 3\sqrt{n\bar{p}(1-\bar{p})}$

Construction of c-chart

There are situations where it is necessary to control the number of defects in a unit of product, rather than the fraction defective or the number of defectives. For example, controlling the number of defects per hundred meters of cloth, number of air bubbles in a piece of glass, etc. Such situations are described by the Poisson distribution.

Let C represents the number of defects counted in one unit of cloth and $\bar{c}$ represent the mean of the defects counted in several such units of cloth.

Central line$= \bar{c}$, UCL$= \bar{c} + 3\sqrt{\bar{c}}$ and LCL$= \bar{c} - 3\sqrt{\bar{c}}$
