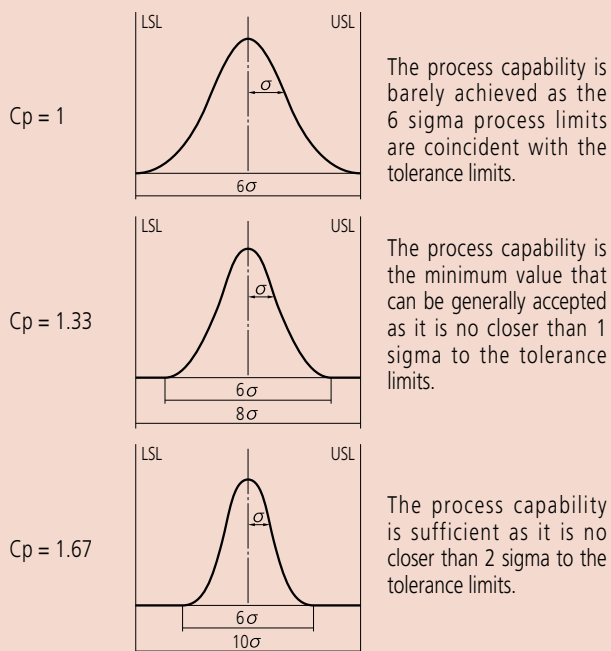**Specific examples of a process capability index (Cp) (bilateral tolerance)**

Cp = 1

The process capability is barely achieved as the 6 sigma process limits are coincident with the tolerance limits.

Cp = 1.33

The process capability is the minimum value that can be generally accepted as it is no closer than 1 sigma to the tolerance limits.

Cp = 1.67

The process capability is sufficient as it is no closer than 2 sigma to the tolerance limits.

Note that Cp only represents the relationship between the tolerance limits and the process dispersion and does not consider the position of the process mean.

Notes: A process capability index that takes the difference between the process mean from the target process mean into consideration is generally called Cpk, which is the upper tolerance (USL minus the mean) divided by 3σ (half of process capability) or the lower tolerance (the mean value minus LSL) divided by 3σ, whichever is smaller.

■ Control Chart

Used to control the process by separating the process variation into that due to chance causes and that due to a malfunction. The control chart consists of one centreline (CL) and the control limit lines rationally determined above and below it (UCL and LCL). It can be said that the process is in a state of statistical control if all points are within the upper and lower control limit lines without notable trends when the characteristic values that represent the process output are plotted. The control chart is a useful tool for controlling process output, and therefore quality.
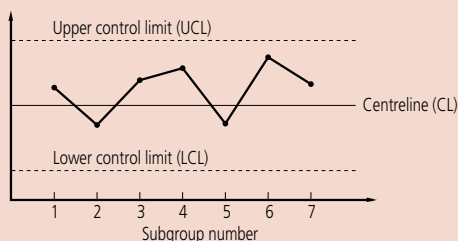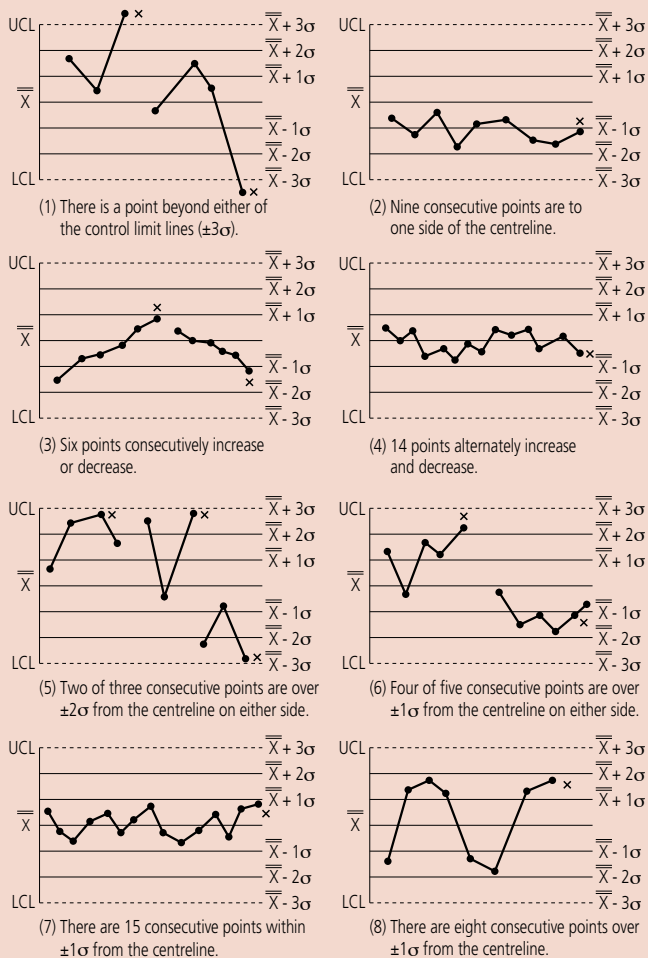
■ Chance Causes

These causes of variation are of relatively low importance. Chance causes are technologically or economically impossible to eliminate even if they can be identified.

■ X̄-R Control Chart

A control chart used for process control that provides the most information on the process. The X̄-R control chart consists of the X̄ control chart that uses the mean of each subgroup for control to monitor abnormal bias of the process mean and the R control chart that uses the range for control to monitor abnormal variation. Usually, both charts are used together.

■ How to Read the Control Chart

Typical trends of successive point position in the control chart that are considered undesirable are shown below. These trends are taken to mean that a 'special cause' is affecting the process output and that action from the process operator is required to remedy the situation. These determination rules only provide a guideline. Take the process-specific variation into consideration when actually making determination rules. Assuming that the upper and the lower control limits are 3σ away from the centreline, divide the control chart into six regions at intervals of 1σ to apply the following rules. These rules are applicable to the X control chart and the X̄ control chart. Note that these 'trend rules for action' were formulated assuming a normal distribution. Rules can be formulated to suit any other distribution.

(1) There is a point beyond either of the control limit lines (±3σ).

(2) Nine consecutive points are to one side of the centreline.

(3) Six points consecutively increase or decrease.

(4) 14 points alternately increase and decrease.

(5) Two of three consecutive points are over ±2σ from the centreline on either side.

(6) Four of five consecutive points are over ±1σ from the centreline on either side.

(7) There are 15 consecutive points within ±1σ from the centreline.

(8) There are eight consecutive points over ±1σ from the centreline.

Note: This part of 'Quick Guide to Quality Control' (A-21 to A-22) has been written by Mitutoyo based on its own interpretation of the JIS Quality Control Handbook published by the Japanese Standards Association.

References
- JIS Quality Control Handbook (Japanese Standards Association)

Z 8101:   1981
Z 8101-1: 1999
Z 8101-2: 1999
Z 9020:   1999
Z 9021:   1998

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