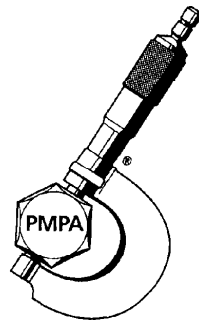


QUALITY

Statistical Process Control

Glossary



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P R E F A C E

The purpose of this manual is to provide Association members with a basic guide to SPC terminology that is clear, concise, and reasonably complete. The Committee would appreciate your thoughts regarding additions or corrections. Please let us hear from you.

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STATISTICAL PROCESS CONTROL GLOSSARY

ACCEPTABLE QUALITY LEVEL (AQL)

The maximum percentage or proportion of defective units in a lot or batch that, for the purposes of acceptance sampling, can be considered satisfactory as a process average.

ACCEPTANCE SAMPLING

Evaluating a sample to determine whether a lot is of acceptable quality. For incoming or outgoing product inspection.

ACCURACY

The closeness of agreement between an observed and an accepted reference value.

ASSIGNABLE CAUSE

A non-random source of variation indicating an unstable, unpredictable process evidenced by a point beyond the control limits of a chart, or a shift, trend or cycle, the source of which can be determined and perhaps eliminated.

ATTRIBUTE DATE

Qualitative data that typically shows only the number of articles conforming and the number of articles failing to conform to a specified criteria. Examples include characteristics such as the presence of a required label, installation of all required fasteners, acceptability of a specification when measured on a go/no-go gage. Results are recorded in a simple yes/no fashion. Charts used for attribute data include: p, np, c and u charts.

ATTRIBUTES

Characteristics that are evaluated on the basis of qualitative data, such as conforming or non-conforming, pass or fail, go or no-go, present or absent.

AVERAGE or ARITHMETIC MEAN

The sum of the numerical values divided by the number of values. Represented by putting a bar over the symbol being averaged (\bar{X} , \bar{R} , \bar{p} , \bar{c})

AVERAGE OUTGOING QUALITY (AOQ)

The AOQ is the average quality of outgoing product including all accepted lots or batches, plus all rejected lots or batches after the rejected lots or batches have been effectively 100 percent inspected and all defectives replaced by nondefectives.

AVERAGE OUTGOING QUALITY
QUALITY LIMIT (AOQL)

The AOQL is the maximum of the AOQ's for all possible incoming qualities for a given acceptance sampling plan.

BELL-SHAPED CURVE

See NORMAL DISTRIBUTION

BIAS

A systematic error which contributes to the difference between a population mean of measurements or test results and an accepted reference value.

BIOMODAL DISTRIBUTION

A frequency distribution has two peaks.

BINOMIAL DISTRIBUTION

A probability distribution that applies when random samples are identified in terms of two classifications, such as 'accept' and 'reject,' forming the basis of p and np charts.

c CHART

See CONTROL CHART

CALIBRATION (of
instrument)

Adjusting an instrument to reduce the difference between the average reading of the instrument and the "true" values of some standard being measured, i.e. to reduce measurement bias.

CAPABILITY

See PROCESS CAPABILITY

CAUSE-EFFECT DIAGRAM

A tool for problem solving that uses a graphical description of the various process elements to analyze potential sources of process variation. Also known as a fishbone (after its appearance) or an Ishikawa diagram.

CELL

The interval of values chosen to represent the frequency distribution of measured values; the width of each bar in a histogram.

CENTRAL LINE

The line on a control chart that represents the average or median value.

CENTRAL LIMITS THEOREM

If samples of a population with size n are drawn, and the values of \bar{X} are calculated, and the distribution of \bar{X} is found, the distribution's shape is found to approach a normal distribution for sufficiently large n . This theorem allows one to use the assumption of a normal distribution when dealing with \bar{X} . "Sufficiently large" depends on the population's distribution and on what range of \bar{X} is being considered; for practical purposes, the easiest approach may be to take a number of samples of a desired size and see if their means are normally distributed; if not, the sample size should be increased.

CENTRAL TENDENCY

A measure of the point about which a group of values is clustered; some measures of central tendency are mean, mode, and median.

COMMON CAUSE

Those sources of variability in a process which are truly random, i.e., inherent in the process itself.

CONFIDENCE INTERVAL

The "confidence interval" is a range of values which includes (with a preassigned probability called "confidence level") the true value of a population parameter.

CONFIDENCE LEVEL

Confidence level is the probability that an assertion about the value of a population parameter is correct.

CONFIDENCE LIMITS

"Confidence limits" are the upper and lower boundaries of the confidence interval.

CONFORMANCE (of
product)

Compliance with specifications.

CONFORMANCE LEVEL

The proportion of a product that meets specifications.

CONSUMER'S RISK

For acceptance sampling: The probability that a bad lot will be accepted by a given sampling plan.

CONTROL CHART

A graphical method for evaluating whether a process is or is not in a state of statistical control (stable). The decisions are made through a comparison of the values of some statistical measure calculated from the data with control limits. The prime use of the control chart is to detect assignable causes of variations in the process.

\bar{X} Chart:	A control chart where the average of the subgroup is the statistical measure that is being calculated and plotted.
R Chart:	A control chart of the range of variation amongst the individual elements of a sample -- i.e., the difference between the largest and smallest elements -- as a function of time, or lot number, or similar chronological variable.
Sigma Chart:	For variable data: Control charts for the standard deviation (sigma) of subgroups of data.
Median Chart:	For variable data: A control chart of the median of subgroups.
p Chart:	Used for data that consist of the ratio of the number of occurrences of an event to the total number of occurrences. Commonly used to report the percent nonconforming.
np Chart:	For attribute data: A control chart of the number of defective units in a subgroup.
c Chart:	For attribute data: A control chart of the number of defects found in a subgroup of fixed size. The c-Chart is used where each unit typically has a number of defects.
u Chart	For attribute data: A control chart of the percentage of defects in one subgroup to total defects for an inspection.

CONTINUOUS DISTRIBUTION (For 'variables' data)

A probability distribution in which the characteristics being measured can take on any value within the range and sensitivity of the measurements.

CONTROL LIMITS

The limits within which the product of a process is expected (or required) to remain. Note: Control limits are not the same as tolerance limits.

COVARIANCE

A measure of whether two variables are related (correlated).

CP

CP is a capability index for process capability studies. CP may range in value from 0 to infinity, with a larger value indicating a more capable process. A value near 1.33 is normally considered acceptable.

CPK

An index combining CP and K to indicate whether the process will produce units within the tolerance limits. CPK has a value equal to CP if the process is centered on the mean specification; if CPK is negative, the process mean is outside the specification limits; if CPK is between 0 and 1 then some of the 6 sigma spread falls outside the tolerance limits. If CPK is larger than 1, the 6 sigma spread is completely within the tolerance limits.

CR

Capability ratio, CR, is the inverse of CP. CR can range from 0 to infinity in value, with a smaller value indicating a more capable process.

CYCLE

A recurring pattern.

DATA

Measurements gathered concerning a process. Data may be either attribute or variable.

DEFECT

A single instance of non-conformance to specification.

DESIGN OF EXPERIMENTS

A plan to conduct tests where questions that need to be answered are thought out in advance, data collection sheets are made out in advance, analysis of data is laid out in advance and limitations of the tests are known in advance. It involves all of the prework that needs to be done before any tests are conducted.

DETECTION

Inspection of parts for quality.

DISTRIBUTION

A way of describing the output of a common-cause system of variation in which the behavior of individual values is not predictable but the outcome as a group form a pattern that can be described in terms of location, spread, and shape.

DISPERSION

The tendency of the values of the elements in a sample to differ from each other. Dispersion is commonly expressed in terms of the range of the sample, the difference between the lowest and highest values, or by the standard deviation.

EVOLUTIONARY OPERATIONS
(EVOP)

A procedure to optimize the performance of a process by making small, known variations in the parameters entering the process and observing the effects of the variation on the product.

F DISTRIBUTION

The distribution of F, the ratios of variances for pairs of samples taken from the same population. Used to determine whether or not the populations from which two samples were taken have the same standard deviation. The F distribution is usually expressed as a table of the upper limit below which F can be expected to lie with some confidence level, for samples of a specified number of degrees of freedom.

F TEST

Test of whether two samples are drawn from populations with same standard deviation, with some specified confidence level. The test is performed by determining whether F, as defined above, falls below the upper limit given by the F distribution table.

FAILURE RATE

The average number of failures per unit time. Used for assessing reliability of a product in service.

FAILURE VARIABLE
TESTING

Testing items until they fail and then analyzing the data (typically by Weibull Analysis) to calculate conformance level.

FLOW CHART (for
programs, decision
making, process
development)

A pictorial representation of a process indicating the main steps, branches, and eventual outcomes of the process.

FREQUENCY DISTRIBUTION

A graphical representation which indicates how often each measured value occurs in a given set of observations.

GAGE SYSTEM ERROR

The combination of gage accuracy, repeatability, reproducibility, stability and linearity.

GOODNESS OF FIT

Any measure of how well a set of data matches a proposed form. Chi-Square is the most common measure for frequency distributions. Simple visual inspection of a histogram is a less quantitative, but equally valid, way to determine goodness-of-fit.

HISTOGRAM

A pictorial way to display data in frequency form. This provides a visual way to evaluate the form of the data.

INHERENT CAUSES

See COMMON CAUSE

INSPECTION ACCURACY

The percentage of defective units which are correctly identified by an inspector. The percentage is determined by having a second inspector review both the accepted and rejected units.

ISHIKAWA DIAGRAM

See CAUSE-EFFECT DIAGRAM

K

A measure of difference between the process mean and the specification mean for process capability studies.

KURTOSIS

A measure of how well a distribution is fit by a normal curve: If the distribution has larger tails than a normal distribution of the same standard deviation, it is said to have positive kurtosis; if it has smaller tails, then it has negative kurtosis.

LOWER CONTROL LIMIT
(LCL)

For control charts: The limit above which the process remains when it is in control.

<u>LIFE TESTING</u>	Testing used to determine the life characteristics of a particular item.
<u>LINEARITY - GAGE</u>	The difference in the accuracy values through the expected operating range of the gage.
<u>LOGICAL PROBLEM SOLVING</u>	The process of moving from symptoms to causes to action in order to improve performance.
<u>LOWER SPECIFICATION LIMIT (LSL)</u>	The lowest value of a product dimension or measurement which meets requirements.
<u>MATRIX</u>	An array of data arranged in rows and columns.
<u>MEAN</u>	See <u>AVERAGE</u>
<u>MEASUREMENT ACCURACY</u>	The extent to which the average result of a repeated measurement tends toward the true value of the measured quantity. The difference between the true value and the average measured value is called the instrument bias, and may be due to such things as improper zero adjustment, nonlinear instrument response, or even improper use of the instrument.
<u>MEASUREMENT ERROR</u>	The difference between the actual and measured value of a measured quantity.
<u>MEDIAN</u>	The middle value in a group of measurements when arranged from lowest to highest.
<u>MEDIAN CHART</u>	See <u>CONTROL CHART</u>
<u>METROLOGY</u>	The science of measurement.
<u>MODE</u>	The value which occurs most frequently in a given set of observations.
<u>NOMINAL DIMENSION</u>	The desired value for the particular dimension.
<u>NON-CONFORMING PART</u>	An item that contains one or more defects.

NORMAL DISTRIBUTION

A symmetrical bell-shaped frequency distribution for variables; commonly used to establish control-chart limits. When measurements have a normal distribution, about 68.26% lie within ± 2 standard-deviation units from the mean, and about 99.73% lie within ± 3 standard deviation units from the mean.

np CHART

See CONTROL CHART

OPERATING CHARACTER-
ISTICS CURVE

For acceptance sampling: A curve showing the percent defective in a lot vs. the probability that the lot will be rejected, for a specified lot size and sampling plan.

OUT OF CONTROL

The condition describing a process from which all assignable causes of variation have not been eliminated. This condition is evident on a control chart by the presence of points beyond the control limit or by non-random patterns within the control limits.

p CHART

See CONTROL CHART

PARETO ANALYSIS

An analysis of the frequency of occurrence of various possible concerns. This is a useful way to decide quality control priorities when more than one concern is present. The underlying "Pareto Principle" states that a very small number of concerns is usually responsible for most quality problems.

PARETO DIAGRAM

A simple tool for problem prioritization that involves ranking all potential problem areas or sources of variation according to their contribution to cost or to total variation. Typically, a few problems contribute to most of the cost so that the Pareto Chart can help to focus on the "vital few" rather than the "trivial many."

PERCENTAGE DEFECTIVE

The percentage of units in a lot which are non-conforming.

POISSON DISTRIBUTION

A probability distribution for attribute data that applies to nonconformities per unit and underlies the c and u charts.

<u>POPULATION</u>	The totality of items or units of material under consideration.
<u>PRECISION</u>	See REPEATABILITY
<u>PRE-CONTROL</u>	This semi-graphical method is a sequenced acceptance sampling scheme for the continuous monitoring of a process. With this method, the process performance levels are divided into acceptable, caution, and unacceptable zones. They minimally do not require computations or plotting, making it easier to implement; however, this means that trend and performance information are not readily available.
<u>PREVENTION</u>	A process control strategy that improves quality by directing analysis and action towards process management, consistent with the philosophy of continuous quality improvement.
<u>PRIMARY REFERENCE STANDARD</u>	For measurements: A standard maintained by the National Bureau of Standards for a particular measuring unit. The primary reference standard duplicates as nearly as possible the international standard and is used to calibrate other (transfer) standards, which in turn are used to calibrate measuring instruments for industrial use.
<u>PROBABILITY</u> <u>(Mathematical)</u>	<p>A number expressing the likelihood of occurrence of a specific event.</p> <p>That area of mathematics that studies the expected occurrence of an event given a certain, specific set of conditions. i.e., the chance of something happening or not happening.</p>
<u>PROBABILITY DISTRIBUTION</u>	A relation giving the probability of observing each possible outcome of a random event. The relation may be given by a mathematical expression, or it may be given by drawing a frequency distribution for a large enough sample.
<u>PROCESS</u>	The combinations of people, equipment, materials, methods and environment that produce output.

<u>PROCESS CAPABILITY</u>	Process Capability is the measured inherent reproducibility of the product turned out by a process.
<u>PROCESS CONTROL</u>	Maintaining the performance of a process at its capability level. Process control involves a range of activities such as sampling the process product, charting its performance, determining causes of any problems, and taking corrective actions.
<u>PROCESS CONTROL PLAN</u>	A written document to describe the statistical methods used to regulate the process.
<u>PRODUCER'S RISK</u>	For acceptance sampling: The probability that a good lot of product will be rejected by a particular sampling plan.
<u>QUALITY ASSURANCE</u>	All those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given needs.
<u>QUALITY CHARACTERISTIC</u>	A particular aspect of a product which relates to its ability to perform its intended function.
<u>QUALITY CONTROL</u>	The operational techniques and the activities which sustain a quality of product or service that will satisfy given needs; also the use of such techniques and activities.
<u>R CHART</u>	See <u>CONTROL CHART</u>
<u>RANDOM</u>	Varying with no discernable pattern.
<u>RANDOM SAMPLES</u>	Samples chosen in such a way that any member of the process output is equally likely to be selected, without regard for any ordering property, such as sequence of production, that might be present.
<u>RANGE</u>	The difference between the smallest and the largest elements in a set of observations.
<u>RATIONAL SUBGROUPING</u>	Designing the sampling size, frequency, etc., in a logical manner consistent with the statistical model and assumptions being used and with the purpose of the sampling.

REGRESSION ANALYSIS

A calculation to define the mathematical relationship between two or more variables.

REJECTABLE QUALITY
LEVEL (RQL)

The minimum quality level at which a lot will be accepted. The term is usually used in lot inspection by sampling.

RELIABILITY

The probability that a product will function properly for some specified period of time, under specified conditions.

REPEATABILITY - GAGE

The variation in measurements obtained with one gage when used several times by one operator while measuring the identical characteristic on the same parts.

REPRODUCIBILITY - GAGE

The variation in the average of the measurements made by different operators using the same gage while measuring the identical characteristic on the same parts.

RESPONSE SURFACE
METHODOLOGY (RSM)

A method of determining the optimum operating conditions and parameters of a process, by varying the process parameters and observing the results on the product. This is the same methodology used in Evolutionary Operations (EVOP), but is used in process development rather than actual production.

SAMPLE

A subgroup of objects drawn from some population with the intent of drawing inference from that population.

SAMPLE SIZE

The number of elements, or units, in a sample.

SAMPLING

The process of selecting a sample of a population and determining the properties of the sample. The sample is chosen in such a way that its properties are representative of the population.

SAMPLING VARIATION

The variation of a sample's properties from the properties of the population from which it was drawn.

SCATTER DIAGRAM

A plot of two variables, one against the other to display trends.

<u>UPPER CONTROL LIMIT (UCL)</u>	For control charts, the upper limit below which a process remains if it is in control.
<u>UNIVERSE</u>	The totality of individual units under consideration.
<u>UPPER SPECIFICATION LIMIT (USL)</u>	The highest value of a product dimension or measurement which meets requirements.
<u>VARIABLE DATA</u>	Measurements taken on a continuous scale. Examples might be the diameter of a piston or the gap between a hood and fender.
<u>VARIABILITY</u>	The property of exhibiting variation, i.e., changes or differences, in particular in the product of a process.
<u>VARIABLES</u>	Characteristics evaluated on the basis of actual measured values, such as dimensions.
<u>VARIANCE</u>	The square of the standard deviation.
<u>VARIATION</u>	A change in the value of a measured characteristic.
\bar{X} and R CHART	See <u>CONTROL CHART</u>

Credit is given to the following reference texts used in preparing this glossary:

DataMyte Handbook, DataMyte Corporation, 1984.

General Motors Statistical Process Control Manual.

Statistical Process Control, Gilbert/Commonwealth.

Statistical Quality Control, American Machinist, January, 1984.

<u>STATISTICAL CONTROL</u>	The condition describing a process from which all assignable causes of variation have been eliminated and only common causes remain; evidenced on a control chart by the absence of points beyond the control limits and by the absence of nonrandom patterns or trends within the control limits.
<u>STATISTICAL PROCESS CONTROL</u>	A systematic method for improving the quality and productivity of processes by analyzing, quantifying and classifying the variation of the processes with the goal of controlling and reducing the variation.
<u>STATISTICAL QUALITY CONTROL</u>	The process of maintaining product quality by means of statistical methods.
<u>STRATIFIED SAMPLING</u>	The process of selecting units deliberately from various locations within a lot or batch or from various phases or periods of a process to obtain a sample.
<u>SUBGROUP</u>	A group of consecutively produced units from a process.
<u>SYSTEMATIC VARIATION (of a process)</u>	Variations which exhibit a predictable pattern. The pattern may be cyclic (i.e., a recurring pattern) or may progress linearly (trend).
<u>TOLERANCE</u>	The permitted range of variation about the nominal.
<u>TREND</u>	A gradual, systematic change with time or other variable.
<u>TYPE I ERROR</u>	In control chart analysis: Concluding that a process is unstable when in fact it is stable.
<u>TYPE II ERROR</u>	In control chart analysis: Concluding that a process is stable when in fact it is unstable.
<u>u CHART</u>	See <u>CONTROL CHART</u>

<u>SENSITIVITY (of a measuring instrument)</u>	The smallest change in the measured quantity which the instrument is capable of detecting.
<u>SIGMA</u>	As a lower-case Greek letter, used to designate a standard deviation. As a capital Greek letter, it designates summation.
<u>SIGMA CHART</u>	See <u>CONTROL CHART</u>
<u>SKEW</u>	A nonsymmetric distribution is said to be skewed.
<u>SPECIFICATION</u>	<p>The engineering requirement for judging acceptability of a particular characteristic.</p> <p>(Of a product) - A listing of the required properties of a product. These specifications may include the desired mean and/or tolerances, for certain dimensions or other measurements; the color or texture of surface finish; or any other properties which define the product.</p>
<u>STABILITY</u>	The absence of assignable cause of variation; the property of being in statistical control.
<u>STABILITY - GAGE</u>	The difference in the average of at least two sets of measurements obtained with a gage on the same parts as a result of time.
<u>STANDARD DEVIATION</u>	A measure of the spread of the process output denoted by the Greek letter sigma.
<u>STATISTIC</u>	A calculated value that describes some characteristic (i.e., average, standard deviation) of a sample and which can be used to estimate the corresponding characteristic for a population.
<u>STATISTICS</u>	A mathematical method to systematically collect, analyze, interpret and present masses of numerical facts.