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Statistics — Vocabulary and symbols —

Part 2:
Applied statistics

[Revision of first edition (ISO 3534-2:1993)]

Statistique — Vocabulaire et symboles —

Partie 2: Statistique appliquée

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Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

Contents

Statistics – Vocabulary and symbols – Part 2: Applied statistics

1 Scope

ISO 3534–2 defines applied statistics terms, and expresses them in a conceptual framework in accordance with normative terminology practice.

Term entries are arranged thematically within a conceptual framework and an alphabetical index is provided. Standardized symbols and abbreviations are also defined.

ISO 3534-1 and ISO 3534 -2 are intended to be compatible. They share the common goal of restricting their respective mathematical levels to the minimum levels necessary to attain correct and concise definitions. Part 1 on terms used in probability and statistics is foundational so, by necessity, is presented at a relatively more sophisticated mathematical level. Recognizing that users of Part 2 on applied statistics may occasionally consult Part 1 for certain terms, notes following selected terms in Part 1 are provided in the form of verbal descriptions of a less technical nature. Although these informal descriptions, given in the notes, are not a substitute for formal definitions, the intent is to serve the needs of multiple users of these terminology standards.

2. Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. . For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3534-1 : 2000 : Statistics – Vocabulary and symbols: Part 1: Probability and general statistical terms

ISO 3534-3 : 1999 : Statistics – Vocabulary and symbols: Part 3: Design of experiments

ISO 9000: 2000 : Quality management systems – Fundamentals and vocabulary

ISO/IEC Guide 51 : Safety aspects – Guidelines for their inclusion in standards

ISO/IEC Guide 2 : General terms and their definitions concerning standardization and related activities

ISO 704 : Principles and methods of terminology

ISO 10241 : International terminology standards – Preparation and layout

VIM : International vocabulary of basic and general terms used in measurement

GUM: Guide to the expression of uncertainty in measurement

ISO 31-0 : Quantities and units – Part 0: General principles

ISO 31-11 : Quantities and units – Part 11: Mathematical signs and symbols for use in the physical sciences and technology

3 Vocabulary

A term in a definition or note which is defined elsewhere in this clause is indicated by boldface followed by its entry number in parenthesis. Such a boldface term may be replaced in the definition by its complete definition.
A concept limited to a special meaning in a particular context is indicated by designating the subject field in angle brackets < >, before the definition.

3.1 Data generation and collection

3.1.1 Systems of reference values for characteristics

3.1.1.1
characteristic

distinguishing feature

[ISO 9000]

NOTE 1 A characteristic can be inherent or assigned.

NOTE 2 A characteristic can be quantitative or qualitative.

NOTE 3 There are various classes of characteristic, such as the following :

- physical (e.g. mechanical, electrical, chemical, biological);
- sensory, (e.g. relating to smell, touch, taste, sight, hearing);
- behavioural, (e.g. courtesy, honesty, veracity);
- temporal, (e.g. punctuality, reliability, availability);
- ergonomic, (e.g. linguistic or physiological or related to human safety);
- functional, (e.g. range, speed, rate of climb of an aircraft).

3.1.1.2
quality characteristic

inherent **characteristic** (3.1.1.1) of a **product** (3.1.2.32), **process** (3.2.1.1) or system related to a requirement

[ISO 9000]

NOTE 1 Inherent means existing in something, especially as a permanent characteristic.

NOTE 2 A characteristic assigned to a product, process or system (e.g. the price of a product, the owner of a product) is not a quality characteristic of that product, process or system .

3.1.1.3

scale

system of reference values for a **characteristic** (3.1.1.1)

NOTE The term value is used in a broad sense to include qualitative information.

3.1.1.4
continuous scale

numerical **scale** (3.1.1.3) with a continuum of possible values

EXAMPLES **interval scale** (3.1.1.6) and **ratio scale** (3.1.1.7)

NOTE 1 A continuous scale may be transformed into ordinal, by grouping values. This inevitably leads to some loss of information.

NOTE 2 Scale resolution may be adversely affected by measurement system limitations.

3.1.1.5
discrete scale

scale (3.1.1.3) with only a set or sequence of distinct values

NOTE Discrete values are often integers.

3.1.1.6
interval scale

continuous scale (3.1.1.4) which has an arbitrary zero

EXAMPLE Temperature degrees Celsius and Fahrenheit and calendar time.

NOTE Differences between values are not affected by a change of zero for the scale.

3.1.1.7
ratio scale

continuous scale (3.1.1.4) which has an absolute or natural zero

EXAMPLES Mass, height and money value.

NOTE Ratios between values are not affected by a change of unit for the scale.

3.1.1.8
ordinal scale

scale (3.1.1.3) with ordered labelled categories

NOTE 1 There is sometimes a blurred borderline between ordinal and discrete scales. When subjective opinion ratings such as excellent, very good, neutral, poor and very poor are coded, say, 1 to 5, this has the apparent effect of converting from ordinal to discrete form. However, they should not be treated as ordinary numbers as the distance between 1 and 2 may not be the same as between 2 and 3, or 3 and 4, say. On the other hand some categories which are ordered objectively according to magnitude, such as the Richter scale which ranges from 0 to 8 according to the amount of energy release, could equally well be related to a discrete scale.

NOTE 2 Sometimes nominal scales are ordered by convention. An example is the blood group ABO, which are always stated in this order. The same is the case if different categories are denoted by single letters. They are then ordered, by convention, according to the alphabet.

3.1.1.9
nominal scale

scale (3.1.1.3) with unordered labelled categories

EXAMPLES Nationality, colour, model of car, breed of dog, type of fault.

NOTE It is possible to count by category but not order or measure.

3.1.2 Sources of data

3.1.2.1
population

<reference> totality of **objects** (3.1.2.11) under consideration

NOTE 1 A population may be real and finite or hypothetical and infinite.

NOTE 2 Extended sampling from a finite real population can give rise to the generation of actual .relative frequencies or frequency distributions. Alternatively, or arising from this, a theoretical model of the hypothetical population based on probability distributions may be derived. This enables predictions to be made.

NOTE 3 A population may also be the result of an ongoing process which may include future output.

3.1.2.2

population parameter

summary measure of the values of some **characteristic** (3.1.1.2) of a **population** (3.1.2.1)

NOTE Population parameters are usually symbolized by lower case Greek letters in italics

EXAMPLES Population mean = μ ; population standard deviation = σ .

3.1.2.3
sub-population

part of a **population** (3.1.2.1)

3.1.2.4
lot

definite part of a **population** (3.1.2.1) constituted under essentially the same conditions as the **population** (3.1.2.1) with respect to the sampling purpose

NOTE The sampling purpose may, for example, be to determine lot acceptability, or to estimate the mean value of a particular characteristic.

3.1.2.5

isolated lot

lot (3.1.2.4) separated from the sequence of lots in which it was formed and not forming part of a current sequence

3.1.2.6
isolated sequence of lots

group of lots in succession but not forming part of a large sequence or produced by a continuing process

3.1.2.7
unique lot

lot (3.1.2.4) formed under conditions peculiar to that lot and not part of a routine sequence

3.1.2.8
pilot lot

small **lot** (3.1.2.3) run prior to a routine sequence in order to gain information and experience

3.1.2.9
re-submitted lot

lot (3.1.2.4) which previously has been designated as not acceptable and which is submitted again for **inspection** (3.4.1.2) after having been further treated, tested, sorted, reprocessed, etc.

3.1.2.10
sub-lot
definite part of a **lot** (3.1.2.4)

3.1.2.11
item
object

entity

anything conceivable or perceivable

EXAMPLES A discrete physical item,: a defined amount of bulk material ; an activity, person, system or some combination thereof.

NOTE See also **sampling unit** (3.1.2.14)

3.1.2.12
nonconforming item

item (3.1.2.11) with one or more **nonconformities** (3..3.1.10)

3.1.2.13
defective item

item (3.1.2.11**)** with one or more **defects** (3.3.1.11)

3.1.2.14
sampling unit
unit

one of the individual parts into which a **population** (3.1.2.1) or **sampling frame** (3.1.2.27) is divided

NOTE 1 A sampling unit may contain one or more **item**s (3.1.2.11), for example, a box of matches, but one test result will be obtained for it.

NOTE 2 It may consist of discrete items or a defined amount of bulk material.

NOTE 3 For sampling unit <bulk material> see clause 3.5.1.4.

3.1.2.15
nonconforming unit

unit (3.1.2.14) with one or more **nonconformities** (3.3.1.10)

3.1.2.16
defective unit

unit (3.1.2.14) with one or more **defects** (3.3.1.11)

3.1.2.17
sample

subset of a specified **population** (3.1.2.1) or **sampling frame** (3.1.2.27) made up of one or more **sampling units**(3.1.2.14)

NOTE Many different ways, random and not random, in selecting a sample may be envisaged. A collection of data obtained by biased sampling , which is unavoidable in many areas, e.g. in human genetics of families detected through abnormal children, is also a sample. In survey sampling, sampling units are often selected with a probability proportional to size of a known variable, giving a biased sample.

3.1.2.18
sample statistic

summary measure of some **observed value** (3.3.2.8) of a **sample** (3.1.2.17)

NOTE Sample statistics (random variables) are symbolised by upper case Latin letters in italics (e.g. $\overline{X}$ and *S*) whereas the actual realization of sample statistics (observed values) are symbolised by lower case Latin letters in italics (e.g. $\overline{x}$ and s. This contrasts with population parameters which are symbolised by lower case Greek letters in italics (e.g. μ and σ)

3.1.2.19
sub-sample

selected part of a **sample** (3.1.2.17)

NOTE 1 It can be selected by the same method as was used in selecting the original sample, but need not be so.

3.1.2.20
duplicate sample

one of the two or more **samples** (3.1.2.17) or **sub-samples** (3.1.2.19) obtained separately at the same time by the same sampling procedure or sample division procedure

3.1.2.21
primary sample

sample (3.1.2.17) taken during the first stage of **multistage sampling** (3.1.3.10)

3.1.2.22
secondary sample

sample (3.1.2.17) taken from the **primary sample** (3.1.2.21) during the second stage of **multistage sampling** (3.1.3.10)

NOTE This may be extended to the *k*th stage for k>2.

3.1.2.23
final sample

sample (3.1.2.17) obtained at the final stage of **multistage sampling** (3.1.3.10)

3.1.2.24
simple random sample

sample (3.1.2.17) of *n* **sampling units** (3.1.2.14) selected from a **population** (3.1.2.1) in such a way that all possible combinations of *n* sampling units have the same probability of being taken

3.1.2.25
random sample

sample (3.1.2.17) of *n* sampling **units** (3.1.2.14) selected from a **population** (3.1.2.1) in such a way that each of the possible combinations of n **sampling units** (3.1.2.14) has a particular probability of being taken

NOTE This definition relates to a physical sample in contrast to the random sample defined in ISO 3534-1 which is a theoretical concept.

3.1.2.26
sample size

number of **sampling units** (3.1.2.14) in a **sample** (3.1.2.17)

NOTE In a multi-stage sample, the sample size is the total number of **sampling units** (3.1.2.14) at the conclusion of the final stage of sampling.

3.1.2.27
sampling frame

complete list of **sampling units** (3.1.2.14)

EXAMPLES An inventory of parts in a warehouse, a manifest of bales of wool on a ship, or a schedule of accounts payable.

NOTE The sampling frame, or 'sampled population' may differ from the 'target population'. For example an electoral register may be taken as a sampling frame to represent the adult population in a particular area. It is unlikely that it will be totally accurate.

3.1.2.28
cluster

part of a **population** (3.1.2.1) divided into mutually exclusive groups of **sampling units** (3.1.2.14) related in a certain manner

3.1.2.29
stratum

mutually exclusive and exhaustive sub-population considered to be more homogeneous with respect to the characteristics investigated than the total population

EXAMPLES In bulk sampling, strata, based on time, mass and space are typically production periods (e.g. 15 minutes): production masses (e.g. 100 tonnes): holds in vessels, wagons in a train and containers.

3.1.2.30
stratification
division of a **population** (3.1.2.1) into **strata** (3.1.2.29)

EXAMPLES Stratification of a cat or dog population into breeds, a human population into gender and social classes and a country divided into regions.

3.1.2.31
area of opportunity

unit (3.1.2.14) or portion of material, process, product or service in which designated event(s) can occur

3.1.2.32
product

result of a **process** (3.2.1.1)

[ISO 9000]

NOTE There are four generic product categories, as follows :

- services (e.g. transport);
- software (e.g. computer program);
- hardware (e.g. engine mechanical part);
- processed materials (e.g. lubricant).

Many products comprise elements belonging to different generic product categories. Whether the product is then called service, software, hardware or processed material depends on the dominant element.

3.1.2.33
service

product (3.1.2.32) that is the result of at least one activity performed at the interface between the supplier and the customer

NOTE Service may involve, for example, the following :

- an activity performed on a customer supplied tangible product (e.g automobile to be repaired);
- the delivery of a tangible product (e.g. in the transportation industry);
- the delivery of an intangible product (e.g. the delivery of information);
- the creation of ambience for the customer (e.g. in hotels and restaurants).

3.1.2.34

identical test/measurement item

sample (3.1.2.17) which is prepared and can be presumed to be identical for the purpose of a specific accuracy experiment

NOTE Practical requirements are given clearly in the protocol of the accuracy experiment.

3.1.3 Types of sampling

3.1.3.1.
sampling

act of drawing or constituting a **sample** (3.1.2.17)

3.1.3.2
bulk sampling

sampling (3.1.3.1) of **bulk material** (3.5.1.1)

EXAMPLE Sampling of a bulk of coal for ash content or of tobacco for moisture content.

3.1.3.3
discrete sampling

sampling (3.1.3.1) of discrete material

3.1.3.4
simple random sampling

sampling (3.1.3.1) where a **sample** (3.1.2.17) of *n* **sampling units** (3.1.2.14) is taken from a **population** (3.1.2.1) in such a way that all possible combinations of *n* sampling units have the same probability of being taken

NOTE In bulk sampling, if the sampling unit is an increment, the positioning, delimitation and extraction of increments is such that all sampling units have an equal probability of being selected.

3.1.3.5
random sampling

sampling (3.1.3.1) where a **sample** (3.1.2.17) of *n* **sampling units** (3.1.2.14) is taken from a **population** (3.1.2.1) in such a way that each of the possible combinations of n sampling units has a particular probability of being taken

3.1.3.6
stratified sampling

sampling (3.1.3.1) such that portions of the **sample** (3.1.2.17) are drawn from the different **strata** (3.1.2.29) and each stratum is sampled with at least one **sampling unit** (3.1.2.14)

NOTE In some cases the portions are specified proportions determined in advance. However in post stratified sampling the specified proportions would not be known in advance.

3.1.3.7
stratified simple random sampling

simple random sampling (3.1.3.4) from each **stratum** (3.1.2.29)

3.1.3.8
quota sampling

stratified sampling (3.1.3.6) where the **sample** (3.1.2.17) is selected in a non random manner

3.1.3.9
cluster sampling

sampling (3.1.3.1) in which a **random sample** (3.1.2.25) of **clusters** (3.1.2.28) is selected and all the **sampling units** (3.1.2.14) which constitute the clusters are included in the **sample** (3.1.2.17)

3.1.3.10
multi-stage sampling

sampling (3.1.3.1) in which the **sample** (3.1.2.17) is selected by stages, the **sampling units** (3.1.2.14) at each stage being sampled from the larger sampling units chosen at the previous stage

NOTE 1 Multi-stage sampling is different from multiple sampling. Multiple sampling is sampling by several criteria at the same time.

NOTE 2 The sampling method may be different for the various stages, such that the primary sample may be selected by e.g. simple random sampling , while the final sample is obtained through e.g. systematic sampling.

3.1.3.11

multi-stage cluster sampling

cluster sampling (3.1.3.9) with two or more stages, each **sampling** (3.1.3.1) being made on **clusters** (3.1.2.28), in which the clusters already obtained by the preceding **sample** (3.1.2.17) have been divided

3.1.3.12
systematic sampling

sampling (3.1.3.1) according to a methodical plan

NOTE 1 In bulk sampling , systematic sampling may be achieved by taking items at fixed distances or after time intervals of fixed length. Intervals may, for example, be on a mass or time basis.

In the case of a mass basis, sampling units or increments should be of equal mass.

With respect to a time basis, sampling units or increments are taken from a moving stream or conveyor, say, at uniform time intervals. In this case the mass of each sampling unit or increment should be proportional to the mass flow rate at the instant of taking the sampling unit or increment.

NOTE 2 If the lot is divided into strata, stratified systematic sampling can be carried out by taking increments at the same relative locations within each stratum.

3.1.3.13
periodic systematic sampling
systematic sampling (3.1.3.12) in which the **sampling units** (3.1.2.14) in a **population** (3.1.2.1) are arranged in order, and numbered from 1 to N within the sample, then constituted as the sampling units numbered $h, h + k, h + 2k, \ldots\ldots h + (n - 1)k,$

where, h and k are positive integers satisfying the relationships : $nk \leq N < n(k + 1)$ and $h \leq k,$

and, h is generally taken at random from the first k integers.

NOTE 1 A periodic systematic sample is usually used to obtain a sample which is random with respect to certain characteristics which are known to be independent of the systematic basis.

NOTE 2 One systematic basis could be order of production. However care needs to be taken. If one were to take every 6th, 12th or 18th item produced from a six headed machine it is highly unlikely that the sample would be representative of the output from the machine.

3.1.3.14
spot sampling
systematic sampling (3.1.3.12) in which a **sample** (3.1.2.17) of specified number or size is taken from a specified place in the medium or at a specified place and time in a stream and considered representative of its own local or immediate environment

3.1.3.15
sampling with replacement

sampling (3.1.3.1) in which each **sampling unit** (3.1.2.14) taken and observed is returned to the **population** (3.1.2.1) before the next sampling unit is taken

NOTE In this case the same sampling unit may appear more than once in the sample.

3.1.3.16
sampling without replacement

sampling (3.1.3.1) in which each **sampling unit** (3.1.2.14) is taken from the **population** (3.1.2.1) once only without being returned to the population

3.1.3.17
acceptance sampling

sampling (3.1.3.1) in which decisions are made to accept or not to accept a **lot** (3.1.2.4), or other grouping of product, material or service, based on sample results

3.1.3.18
survey sampling

sampling (3.1.3.1) used in enumerative or analytic studies to estimate the values of one or more **characteristics** (3.1.1.1) in a **population** (3.1.2.1) , or for estimating how those characteristics are distributed across the population

EXAMPLE The sampling of production to carry out a process capability analysis, and a system audit to assess the degree of system compliance against an international standard .

3.2 Statistical process management

3.2.1 General process related concepts

3.2.1.1
process

set of inter-related or interacting activities which transforms inputs into outputs

[ISO 9000]

NOTE 1 Inputs to a process are generally outputs from other processes.

NOTE 2 Processes in an organisation are generally planned and carried out under controlled conditions to add value.

3.2.1.2
process management

coordinated activities to direct and control an organization with regard to **processes** (3.2.1.1

3.2.1.3
statistical methods

collection of methods which makes it possible to reach reasonable, optimal decisions from data under uncertainty

NOTE 1 Data refer to numerical or non-numerical facts or information.

NOTE 2 Statistical methods comprise methods for data collection, data organization, data presentation, data analysis, data interpretation and decision making.

3.2.1.4
statistical process management

process management (3.2.1.2) related to the application of **statistical methods** (3.2.1.3) to **process planning** (3.2.1.5), **process control** (3.2.1.6) **and process improvement** (3.2.1.7)

3.2.1.5

process planning

process management (3.2.1.2) focused on establishing process objectives and requirements and specifying how these are to be achieved

3.2.1.6
process control

process management (3.2.1.2) focused on fulfilling process requirements

3.2.1.7
process improvement

process management (3.2.1.2) focused on reducing variation and improving process effectiveness and efficiency

NOTE 1 Effectiveness is the extent to which planned activities are realized and planned results are achieved [ISO 9000].

NOTE 2 Efficiency is the relationship between result achieved and resources used [ISO 9000].

3.2.1.8
statistical process control
SPC

activities focused on the use of statistical techniques to reduce **variation** (3.2.2.1) increase knowledge about the **process** (3.2.1.1) and steer the process in the desired way.

NOTE 1 SPC operates most efficiently by controlling variation of a process characteristic or an in-process product characteristic that is correlated with a final product characteristic; and/or by increasing the robustness of the process against this variation. A supplier's final product characteristic may be a process characteristic to the next downstream supplier's process.

NOTE 2 Although SPC originally was concerned primarily with manufactured goods, it is also equally applicable to processes producing services or transactions, for example, those involving data, software, communications and movement of material.

NOTE 3 SPC involves both process control and process improvement.

3.2.1.9
control plan

<process> document describing the system elements to be applied to control variation of **characteristics** (3.1.1.1) of processes, products and services, and to minimize deviation from their preferred values

NOTE A document is a medium containing information [ISO 9000]. It may be a combination of different types of media, for example, paper, magnetic, electronic or optical computer disc, photograph or master sample.

3.2.1.10
process analysis

study intended to give rise to action on a cause and effect system to control and/or improve a process, product or service

3.2.2 Variation related concepts

3.2.2.1
variation

differences between values of a **characteristic** (3.1.1.1)

3.2.2.2
inherent process variation

variation (3.2.2.1) present when a **process** (3.2.1.1) is operating in a **state of statistical control** (3.2.2.7)

NOTE 1 When it is expressed in terms of standard deviation, the subscript '*w*' is applied,(e.g. σ_w, S_w ,or s_w), indicating inherent. See also clause 3.2.6.1 Note 2.

NOTE 2 This variation is correspondent to 'within subgroup variation' when the variability control chart indicates a state of statistical control.

3.2.2.3
total process variation

variation (3.2.2.1) due to both **special causes** (3.2.2.4) and **common causes** (3.2.2.5)

NOTE 1 When it is expressed in terms of standard deviation, the subscript '*t*' is applied (e.g. σ_t, S_t or s_t), indicating total. See also clause 3.2.5.1 Note 3.

NOTE 2 This variation is correspondent to the sum of the 'within subgroup variation' and the 'between subgroup variation'.

3.2.2.4
special cause

source of variation over and above inherent **variation** (3.2.2.1) in a process

NOTE 1 Sometimes 'special cause' is taken to be synonymous with 'assignable' cause'. However a distinction is recognised. A special cause is assignable only when it is specifically identified.

NOTE 2 A special cause arises because of specific circumstances which are not always present. As such, in a process subject to special causes, the magnitude of the variation from time to time is unpredictable.

3.2.2.5
random cause
common cause

source of **variation** (3.2.2.1) which is inherent in a process over time

NOTE 1 In a **process** (3.2.1.1) subject only to random cause variation, the variation is predictable within statistically established limits.

NOTE 2 The reduction of these causes give rise to process improvement. However the extent of their identification, reduction and removal will be the subject of cost/benefit analysis in terms of technical tractability and economics.

3.2.2.6
rational subgroup

subgroup, within which **variation** (3.2.2.1) is due only to **random causes** (3.2.2.5), and between which variation is due to **special causes** (3.2.2.4), selected to enable the detection of any special causes of variation between subgroups

NOTE 1 A subgroup is a set of data taken from a process in such a way as to ensure the greatest similarity among the data in each subgroup and the greatest difference between the data in different subgroups. The larger the subgroup the more sensitive is the **control chart** (3.2.3.1) to shifts in process level. Ideally each measurement in a subgroup should be independent of one another.

NOTE 2 The most common method to obtain a rational subgroup is to form it at a point of time. Data from different time periods would then be in different subgroups. An example would be to take measurements on 5 consecutive parts from a particular machine every hour. The **sample statistics** (3.1.2.18) from the subgroups could then be plotted on a control chart in time order. This would facilitate the detection of time related variation .

3.2.2.7
stable process
process in a state of statistical control

process (3.2.1.1) subject only to **random causes** (3.2.2.4)

NOTE 1 A stable process will generally behave as though the results are simple random samples from the same **population** (3.1.2.1).

NOTE 2 This state does not imply that the random variation is large or small, within or outside of **specification** (3.3.1.1), but rather that the variation is predictable using statistical techniques.

NOTE 3 The **process capability** (3.2.6.1) of a stable process is usually improved by fundamental changes that reduce or remove some of the random causes present and/or adjusting the mean towards the preferred value.

3.2.2.8
out-of-control criteria

set of decision rules for identifying the presence of **special causes** (3.2.2.4)

NOTE Decision rules may include those relating to points outside of control limits, runs, trends, cycles, periodicity, unusual spread of points within control limits (dispersion large or small) and relationships among values within sub-groups.

3.2.2.9
average run length
ARL

<control chart> expected value of the number of samples plotted on a control chart up to and including the point that gives rise to a decision that a **special cause** (3.2.2.4) is present

NOTE 1 If no special cause is present the ideal value of the ARL is infinity, in which case the decision is, rightly, never taken. A practical objective is to make the ARL large when no special cause is present .

NOTE 2 Conversely, when a special cause is present, the ideal value of the ARL would be 1 in which case the decision is made when the next sample is taken.

NOTE 3 The choice of ARL is thus a compromise between these conflicting requirements.

NOTE 4 Taking action appropriate for a special cause when in fact the **process** (3.2.1.1) has not changed; gives rise to over-control.

NOTE 5 Not taking appropriate action when the process is affected by special cause ; gives rise to under-control.

3.2.3 Control related charts

3.2.3.1
control chart

chart on which some statistical measure of a series of samples is plotted in a particular order to steer the **process** (3.2.1.1) with respect to that measure and to control and reduce **variation** (3.2.2.1)

NOTE 1 The particular order is usually time or sample number order based.

NOTE 2 The control chart operates most effectively when the measure is a process variable which is correlated with an ultimate product or service characteristic.

3.2.3.2
Shewhart control chart

control chart (3.2.3.1) intended primarily to distinguish between **variation** (3.2.2.1)in the plotted measure due to **random causes** (3.2.2.5) and that due to **special causes** (3.2.2.4)

3.2.3.3
acceptance control chart

control chart (3.2.3.1) intended primarily to evaluate whether or not the plotted measure can be expected to satisfy specified tolerances

3.2.3.4
adaptive control chart

control chart (3.2.3.1) which uses a prediction model of the process to estimate the future course of the process if no change is made, and to quantify the change to be made to keep the process deviations within acceptable limits

3.2.3.5
cumulative sum chart
CUSUM chart

chart where the cumulative sum of deviations of successive sample values from a reference value is plotted to detect shifts in the level of the measure plotted

NOTE 1 The ordinate of each plotted point represents the algebraic sum of the previous ordinate and the most recent deviation from the reference, target or control value.

NOTE 2 The best discrimination of changes in level is achieved when the reference value is equal to the overall average value.

NOTE 3 The chart can be used in control, diagnostic or predictive mode.

NOTE 4 When used in control mode it can be interpreted graphically by a mask (e.g. V-mask) superimposed on the graph. A signal occurs if the path of the cusum intersects or touches the boundary of the mask.

3.2.3.6
variables control chart

control chart (3.2.3.1) in which the measure plotted represents data on a **continuous scale** (3.1.1.4)