INTERNATIONAL STANDARD

ISO 7870-1

First edition
2007-10-01

Control charts —

Part 1: General guidelines

Cartes de contrôle —

Partie 1: Lignes directrices générales

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ISO 7870-1:2007
https://standards.iteh.ai/catalog/standards/sist/2e6d52aa-82dc-48a7-9d22-c92e1dd235ca/iso-7870-1-2007

Reference number
ISO 7870-1:2007(E)

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Contents

Page

iTeh STANDARD PREVIEW
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ISO 7870-1:2007
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7870-1 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 4, *Applications of statistical methods in process management*.

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This first edition of ISO 7870-1 cancels and replaces ISO 7870:1993.

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ISO 7870 consists of the following parts, under the general title *Control charts*:

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— *Part 1: General guidelines*

The following parts are planned:

— *Part 2: Shewhart control charts*

— *Part 3: Process acceptance control charts*

— *Part 4: Process adjustment control charts*

— *Part 5: Specialized control charts*

— *Part 6: Guide to the application of statistical control charts*

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Introduction

Every production, service, or administrative process contains a certain amount of variability due to the presence of a large number of causes. The observed results from a process are, as a result, not constant. Studying this variability to gain an understanding of its characteristics provides a basis for taking action on a process.

Control charts are a fundamental tool of statistical process control (SPC). They provide a simple graphical method that can be used to:

a) indicate if the process is, or is not, stable, i.e. operating within a stable system of random causes, also known as inherent variability and referred to as being in a “state of statistical control”;

b) estimate the magnitude of the inherent variability of the process;

c) compare information from samples representing the current state of a process against limits reflecting this variability, with the objective of determining whether the process has remained stable or not and variability has been reduced or not;

d) identify, investigate and possibly reduce/eliminate the effect of special causes of variability, which may drive the process to an unacceptable level of performance;

e) aid in the regulation of a process through the identification of patterns of variability such as trends, runs, cycles and the like;

f) determine if the process is behaving in a predictable and stable manner so that it will be possible to assess if the process is able to meet specifications;

g) determine whether or not the process can be expected to satisfy product or service requirements and process capability for the characteristic(s) being measured;

h) provide a basis for process adjustment through prediction using statistical models;

i) assist in the assessment of the performance of a measurement system.

A major virtue of the control chart is its ease of construction and use. It provides the production or service operator, engineer, administrator and manager with an on-line indicator about the behaviour of the process. However, in order for the control chart to be a reliable and efficient indicator of the state of the process, careful attention must be paid at the planning stage to such matters as selecting the appropriate type of chart for the process under study and determining a proper sampling scheme.

General concepts useful to a successful design of a control chart are presented in this part of ISO 7870.

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Control charts —

Part 1: General guidelines

1 Scope

This part of ISO 7870 presents key elements and philosophy of the control chart approach, and identifies a wide variety of control charts (including those related to the Shewhart control chart and those stressing process acceptance or on-line process adjustment).

It presents an overview of the basic principles and concepts and illustrates the relationship among various control chart approaches to aid in the selection of the most appropriate standard for given circumstances. It does not specify statistical control methods using control charts. These methods will be specified in future parts of ISO 7870.

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2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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ISO 3534-2:2006, *Statistics — Vocabulary and symbols — Part 2: Applied statistics*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3534-2 and the following apply. In some cases, additional clarification on terms from ISO 3534-2 is provided.

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 with respect to that measure and to control and reduce variation

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

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.

[ISO 3534-2:2006, 2.3.1]

3.2
Shewhart control chart
control chart with Shewhart control limits intended primarily to distinguish between the variation in the plotted measure due to random causes and that due to special causes

[ISO 3534-2:2006, 2.3.2]

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3.3
acceptance control chart
control chart intended primarily to evaluate whether or not the plotted measure can be expected to satisfy specified tolerances

[ISO 3534-2:2006, 2.3.3]

3.4
process adjustment control chart
control chart which uses a prediction model of the process to estimate and plot 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

[ISO 3534-2:2006, 2.3.3]

3.5
cumulative sum control chart
CUSUM chart
control 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 reference value is equal to the overall average value.

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

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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.

ISO 7870-1:2007
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[ISO 3534-2:2006, 2.3.5]

3.6
variables control chart
Shewhart control chart in which the measure plotted represents data on a continuous scale

[ISO 3534-2:2006, 2.3.6]

3.7
attribute control chart
Shewhart control chart in which the measure plotted represents countable or categorized data

[ISO 3534-2:2006, 2.3.7]

3.8
c chart
count control chart
attribute control chart for the number of incidences where the opportunity for occurrence is fixed

NOTE Incidences of a particular type, for example, number of absentees, number of sales leads, form the count. In the quality field, incidences are often expressed as nonconformities and the fixed opportunity relates to samples of constant size or fixed amount of material. Examples are “flaws in each 100 square metres of fabric” and “errors in each 100 invoices”.

[ISO 3534-2:2006, 2.3.8]

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3.9
u chart
count per unit control chart
attribute control chart for the number of incidences per unit where the opportunity is variable

NOTE Incidences of a particular type, for example, number of absentees and number of sales leads, form the count. In the quality field, incidences are often expressed as nonconformities and the variable opportunity relates to subgroups of variable size or variable amounts of material.

[ISO 3534-2:2006, 2.3.9]

3.10
np chart
number of categorized units control chart
attribute control chart for number of units of a given classification where the sample size is constant

NOTE In the quality field, the classification usually takes the form of "nonconforming units".

[ISO 3534-2:2006, 2.3.10]

3.11
p chart
proportion or percent categorized units control chart
attribute control chart for number of units of a given classification per total number of units in the sample expressed either as a proportion or percent

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NOTE 1 In the quality field, the classification usually takes the form of "nonconforming unit".

NOTE 2 The "p" chart is applied particularly when the sample size is variable.

NOTE 3 The plotted measure can be expressed as a proportion or as a percentage.

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[ISO 3534-2:2006, 2.3.11]

3.12
Xbar control chart
average control chart
variables control chart for evaluating the process level in terms of subgroup averages

[ISO 3534-2:2006, 2.3.12]

3.13
median control chart
variables control chart for evaluating the process level in terms of subgroup medians

[ISO 3534-2:2006, 2.3.13]

3.14
moving average control chart
control chart for evaluating the process level in terms of the arithmetic average of each successive n observations

NOTE 1 This chart is particularly useful when only one observation per subgroup is available. Examples are process characteristics such as temperature, pressure and time.

NOTE 2 The current observation replaces the oldest of the latest n + 1 observations.

NOTE 3 It has the disadvantage of an unweighted carry-over effect lasting n points.

[ISO 3534-2:2006, 2.3.14]

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3.15
individuals control chart
X control chart
variables control chart for evaluating the process level in terms of the individual observations in the sample

NOTE 1 This chart is usually accompanied by a moving range chart, frequently, with n = 2.

NOTE 2 It sacrifices the advantages of averaging in terms of minimizing random variation and the normal distribution central limit theorem assumptions.

NOTE 3 Individual values are expressed by the symbols x_1, x_2, x_3,... Sometimes, the symbol y is used instead of x.

NOTE 4 In the case of charts for individuals, the symbol R represents the value of the moving range, which is the absolute value of the difference between two successive values, thus:

$|x_1 - x_2|$, $|x_2 - x_3|$, etc.

NOTE Adapted from ISO 3534-2:2006, 2.3.15.

3.16
EWMA control chart
exponentially weighted moving average control chart
control chart for evaluating the process level in terms of an exponentially smoothed moving average

[ISO 3534-2:2006, 2.3.16]

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3.17
trend control chart
control chart for evaluating the process level with respect to the deviation of the subgroup averages from an expected change in the process level

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NOTE 1 The trend may be determined empirically or by regression techniques.

NOTE 2 A trend is an upward or downward tendency, after exclusion of the random variation and cyclical effects, when observed values are plotted in the time order of the observations.

[ISO 3534-2:2006, 2.3.17]

3.18
R chart
range control chart
variables control chart for evaluating variation in terms of subgroup ranges

NOTE 1 The value of the subgroup range, is given by the symbol R, the difference between the largest and smallest observations of a subgroup.

NOTE 2 The average of the range values for all subgroups is denoted by the symbol $\bar{R}$.

NOTE 3 Adapted from ISO 3534-2:2006, 2.3.18.

3.19
s chart
standard deviation control chart
variables control chart for evaluating variation in terms of subgroup standard deviations

[ISO 3534-2:2006, 2.3.19]

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3.20
moving range control chart
variables control chart for evaluating variation in terms of the range of each successive n observations

NOTE The current observation replaces the oldest of the latest $n + 1$ observations.

[ISO 3534-2:2006, 2.3.20]

3.21
multivariate control chart
control chart in terms of the responses of two or more mutually correlated variates combined as a single sample statistic for each subgroup

[ISO 3534-2:2006, 2.3.21]

3.22
multiple characteristic control chart
attribute control chart for evaluating the process level based on more than one characteristic

[ISO 3534-2:2006, 2.3.22]

3.23
demerit control chart
quality score chart
multiple characteristic control chart for evaluating the process level where different weights are apportioned to events depending on their perceived significance

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[ISO 3534-2:2006, 2.3.23]

3.24
process adjustment
action to reduce the deviation from the target in the output characteristic by feed-forward control and/or feedback control

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NOTE Ongoing monitoring determines whether the process and the system of process adjustment itself are, or are not, in a state of statistical control.

[ISO 3534-2:2006, 2.3.24]

3.25
feed-forward control
making appropriate compensatory changes in some other control variable by measurement of fluctuations in an input variable

[ISO 3534-2:2006, 2.3.25]

3.26
feedback control
making appropriate compensatory changes in the control variable by using the deviation from target or error signal of the output characteristic itself

[ISO 3534-2:2006, 2.3.26]

3.27
control variable
variable in the process that is varied as a function of the actuating signal so as to change the value of the process output

NOTE 1 Actuating signal may be triggered by measurable changes in process.

NOTE 2 Adapted from ISO 3534-2:2006, 2.3.27.

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