



# SLOVENSKI STANDARD

## SIST ISO 22514-1:2010

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**Statistične metode za obvladovanje procesov - Sposobnost in delovanje - 1. del:  
Splošna načela in pojmi**

Statistical methods in process management - Capability and performance - Part 1:  
General principles and concepts

### iTeh STANDARD PREVIEW

Méthodes statistiques dans la gestion de processus - Aptitude et performance - Partie 1:  
Principes et concepts généraux

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**ICS:**

03.120.30	Uporaba statističnih metod	Application of statistical methods
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# INTERNATIONAL STANDARD

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## Statistical methods in process management — Capability and performance —

### Part 1: General principles and concepts

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*Méthodes statistiques dans la gestion de processus — Aptitude et  
performance —  
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Partie 1: Principes et concepts généraux*

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Case postale 56 • CH-1211 Geneva 20  
Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
Web [www.iso.org](http://www.iso.org)

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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 22514-1 was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 4, *Applications of statistical methods in process management*.

ISO 22514 consists of the following parts, under the general title *Statistical methods in process management — Capability and performance*:

- *Part 1: General principles and concepts*
- *Part 3: Machine performance studies for measured data on discrete parts*
- *Part 4: Process capability estimates and performance measures* [Technical Report]

The following parts are planned:

- *Part 5: Process capability statistics for attribute characteristics*
- *Part 6: Process capability statistics for characteristics following a multivariate normal distribution*
- *Part 7: Capability of measurement processes*

It is planned to reissue ISO 21747, *Statistical methods — Process performance and capability statistics for measured quality characteristics*, as part 2 of ISO 22514 in the future.

## Introduction

**0.1** This introduction to capability treats the subjects “capability” and “performance” in a general way. To fully understand the concepts, it would be helpful to consult ISO 22514-3, ISO/TR 22514-4 and ISO 21747. These documents extend this introductory explanation to more specific uses of the procedures.

A process can either be a discrete process or a continuous process. A discrete process generates a sequence of distinguishable items and a continuous process generates a continuous product (e.g. a lane of paper).

The purpose of a process is to manufacture a product or perform a service which satisfies a set of preset specifications. The specifications for a process under investigation are defined for one or more characteristics of the product or service. However, in process performance or capability, only one characteristic is considered at a time. The characteristic can be measurable, countable or a property. The process thus generates either a discrete or a continuous stochastic process.

- The discrete process can be
  - a process of real numbers,
  - a process of natural numbers, or
  - a process telling which event from a set of events has occurred for the individual items.

As an example, the set of events for the individual items could be {colour acceptable; colour not acceptable}.

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In general, the notation for a discrete stochastic process is  $\{X_i\}$ , where  $X_i$  is the outcome of element  $i$  in the process. In the case where the characteristic is a property  $X_i$ , it is a value given to each of the events in the set of events used for characterizing the process. For a discrete process, the index  $i$  is normally the number of the item in the generated sequence of items. However, sometimes it may be more convenient to use the time from a fixed point as the index.

- When the process is continuous, a number of possibilities exist for the index, depending on the nature of the product. When the product is e.g. a lane of paper, the index could be the length from a starting point or it could be the time from a fixed point.

It should be noted that normally a serial correlation exists in a stochastic process.

A stochastic process is either stationary or non-stationary. The stringent definition of a stationary stochastic process will not be given here. However, for a stationary process, a distribution exists for  $X_i$  which is independent of  $i$ .

To obtain a process which satisfies the specifications, the stochastic process should be a stationary process or a well-defined non-stationary process (e.g. a periodic process).

To evaluate a process, a performance study is performed. A performance study should, in fact, start as a theoretical study of all the elements in the process before the process is physically implemented. When the parameters of the various stages in the process have been analysed and redefined, the process is implemented (this may be only as a test process).

Based on sampling from the implemented process, the numerical part of the performance study of the process is started. A number of questions concerning the process must, beyond any reasonable doubt, be answered correctly. The most important question to be answered is whether the process is a stationary process which is

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stable or predictable for a reasonable period. For the process, it is then important to identify the probability distribution of the process and to obtain estimates of the distribution parameters within a reasonable small variance. Based on this information, the next stage in the performance study is to map the properties of the characteristics under investigation and decide whether they are acceptable. If the properties cannot be accepted, the parameters of the process itself must be changed in order to obtain a process with acceptable properties.

Consider a well-defined and implemented process that has been accepted using a performance study. The next stage for the process would then be to ensure that the parameters of the process and, thus, of the stochastic process do not change, or change in a predicted way. This is performed by defining a suitable capability study.

Studies of performance and capability indices are used more and more to assess production equipment, a process, or even measurement equipment relative to specification criteria. Different types of studies are used depending on the circumstances.

**0.2** The concepts of performance and capability have been subject to large shifts of opinion. The most fundamental shift has been to philosophically separate what is called “capability conditions” in this part of ISO 22514-1 from “performance conditions”, the primary difference being whether statistical stability has been obtained (capability) or not (performance). This naturally leads to the two sets of indices that are to be found in 2.2 and 2.3. It has become necessary to draw a firm distinction between these sets, since it has been observed in industry that companies have been misled about their true capability position due to inappropriate indices being calculated and published.

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# Statistical methods in process management — Capability and performance —

## Part 1: General principles and concepts

### 1 Scope

This part of ISO 22514 describes the fundamental principles of capability and performance of manufacturing processes. It has been prepared to provide guidance about circumstances where a capability study is requested or is necessary to determine if the output from a manufacturing process or the production equipment (a production machine) is acceptable according to appropriate criteria. Such circumstances are common in quality control when the purpose for the study is part of some kind of production acceptance. These studies may also be used when diagnosis is required concerning a production output or as part of a problem solving effort. The methods are very versatile and have been applied for many situations.

This part of ISO 22514 is applicable to the following:

- organizations seeking confidence that their product characteristics requirements are fulfilled;
- organizations seeking confidence from their suppliers that their product specifications are and will be satisfied;
- those internal or external to the organization who audit it for conformity with the product requirements;
- those internal to the organization who deal with analysing and evaluating the existing production situation to identify areas for process improvement.

### 2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

#### 2.1 Basic terms

##### 2.1.1

##### **requirement**

need or expectation that is stated, generally implied or obligatory

[ISO 9000:2005, definition 3.1.2]

**ISO 22514-1:2009(E)****2.1.2****process**

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

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

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

NOTE 3 Adapted from ISO 3534-2:2006, definition 2.1.1.

**2.1.3****system**

set of interrelated or interacting elements

[ISO 9000:2005, definition 3.1.3]

**2.1.4****product**

result of a process

NOTE 1 Four generic product categories are:

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

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Many products comprise elements belonging to different generic product categories. What the product is then called depends on the dominant element.

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NOTE 2 In mathematics, the concept of product is limited to the result of multiplication.

[ISO 3534-2:2006, definition 1.2.32]

**2.1.5****characteristic**

distinguishing feature (of an item)

NOTE 1 Adapted from ISO 9000:2005, definition 3.5.1

NOTE 2 Item is defined in ISO 3534-2:2006, definition 1.2.11.

**2.1.6****quality**

degree to which a set of inherent **characteristics** (2.1.5) of a **product** (2.1.4) fulfils **requirements** (2.1.1) of customers and other interested parties

NOTE In ISO 9000:2005 (3.1.1), quality is defined without specification of who defines the requirements.

**2.1.7****product characteristic**

inherent **characteristic** (2.1.5) of a **product** (2.1.4)

NOTE 1 Product characteristics can be either quantitative or qualitative.

NOTE 2 The product characteristic may be multidimensional.

**2.1.8****process characteristic**

inherent **characteristic** (2.1.5) of a **process** (2.1.2)

NOTE 1 Process characteristics can be either quantitative or qualitative.

NOTE 2 The process characteristic may be multidimensional.

**2.1.9****quality characteristic**

inherent **characteristic** (2.1.5) of a **product** (2.1.4), **process** (2.1.2) or **system** (2.1.3) related to a **requirement** (2.1.1)

NOTE 1 Quality characteristics can be either quantitative or qualitative.

NOTE 2 The quality characteristic may be multidimensional.

NOTE 3 Often, there is a strong correlation between a process characteristic and a product characteristic realized by a process. However, the individual requirements differ. For a process characteristic, the individual requirement is part of the quality requirement for the process; for a product characteristic realized by the process, the individual requirement is part of the quality requirement for a product.

**2.1.10****specification**

document stating **requirements** (2.1.1)

NOTE A specification can be related to activities (e.g. procedure document, process specification and test specification), or products (e.g. product specification, performance specification and drawing).

[ISO 9000:2005, definition 3.7.3]

**2.1.11****specification limit**

limiting value stated for a **characteristic** (2.1.5)

[ISO 3534-2:2006, definition 3.1.3]

NOTE Sometimes specification limits are called "tolerance limits".

**2.1.12****upper specification limit**

*U*

**specification limit** (2.1.11) that defines the highest value a quality characteristic may have and still be considered conforming

NOTE 1 The preferred symbol for upper specification limit is *U*.

NOTE 2 Adapted from ISO 3534-2:2006, definition 3.1.4.

**2.1.13****lower specification limit**

*L*

**specification limit** (2.1.11) that defines the lowest value a quality characteristic may have and still be considered conforming

NOTE 1 The preferred symbol for lower specification limit is *L*.

NOTE 2 Adapted from ISO 3534-2:2006, definition 3.1.5.

**ISO 22514-1:2009(E)****2.1.14****specification interval****tolerance interval**

interval between upper and lower **specification limits** (2.1.11)

NOTE This term is completely different from a statistical tolerance interval, which is an interval with stochastic borders.

**2.1.15****tolerance zone**

space limited by one or several geometrically perfect lines or surfaces, and characterized by a linear dimension, called a tolerance

[ISO 1101:2004, definition 3.1]

**2.1.16****target value**

*T*

preferred or reference value of a **characteristic** (2.1.5) stated in a **specification** (2.1.10)

[ISO 3534-2:2006, definition 3.1.2]

**2.1.17****nominal value**

reference value of a **characteristic** (2.1.5) stated in a specification

NOTE In ISO 3534-2:2006, nominal value and target value are synonyms, with target value as the preferred term. There is a need to distinguish the reference value in a specification and the preferred value used in production.

**2.1.18****actual value**

value of a quantity in a **characteristic** (2.1.5)

**2.1.19****variation**

difference between values of a **characteristic** (2.1.5)

NOTE Variation is often expressed as a variance or standard deviation.

[ISO 3534-2:2006, definition 2.2.1]

**2.1.20****random cause****common cause****chance cause**

(process variation) source of process **variation** (2.1.19) that is inherent in a **process** (2.1.2) over time

NOTE In a process subject only to random cause variation, the variation is predictable within statistically established limits.

**2.1.21****product characteristic in control**

**product characteristic** (2.1.7) parameter of the distribution of the characteristic values, which practically do not change or do change only in a known manner or within known limits