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**Ergonomic design for the safety of  
machinery —**

**Part 2:  
Principles for determining the dimensions  
required for access openings**

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*Conception ergonomique pour la sécurité des machines —*

*Partie 2: Principes de détermination des dimensions requises pour les  
orifices d'accès*

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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 3.

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 part of ISO 15534 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15534-2 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*.

ISO 15534 consists of the following parts, under the general title *Ergonomic design for the safety of machinery* :

- *Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery*
- *Part 2: Principles for determining the dimensions required for access openings*
- *Part 3: Anthropometric data*

Annex A forms a normative part of this part of ISO 15534. Annexes B and C are for information only.

## Introduction

This part of ISO 15534 is one of several ergonomics standards for the safety of machinery.

EN 614-1 ([2] in the Bibliography) describes the principles designers should adopt in order to take account of ergonomic factors. This part of ISO 15534 describes how these principles should be applied to the design of access openings.

This part of ISO 15534 is based on EN 547-2:1996 that was prepared as a harmonized standard conforming with the Machinery Directive and associated European Free Trade Association (EFTA) regulations.

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# Ergonomic design for the safety of machinery —

## Part 2: Principles for determining the dimensions required for access openings

### 1 Scope

This part of ISO 15534 specifies the dimensions of openings for access into machinery as defined in ISO/TR 12100-1. It provides the dimensions to which the values given in ISO 15534-3 are applicable. Values for additional space requirements are given in annex A. This part of ISO 15534 has been prepared primarily for non-mobile machinery; there may be additional specific requirements for mobile machinery.

Dimensions for access openings are based on the values for the 95th percentile, whereas reach distances are based on the values for the 5th percentile, in each case the least favourable body dimension of the expected user population being used as a basis. The same considerations apply to the location of access openings.

The anthropometric data given in ISO 15534-3 originate from static measurements of nude persons and do not take into account body movements, clothing, equipment, machinery-operating conditions or environmental conditions.

This part of ISO 15534 shows how to combine the anthropometric data with suitable allowances to take these factors into account.

Situations where people are to be prevented from reaching a hazard are dealt with in ISO 13852.

### 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15534. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15534 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/TR 12100-1:1992, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*. (EN 292-1:1991)

ISO 13852:1996, *Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs*. (EN 294:1992)

ISO 15534-3:2000, *Ergonomic design for the safety of machinery — Part 3: Anthropometric data*.

### 3 General requirements

Operations requiring reach through minimum-access openings are likely to be less efficient, less safe and less healthy than working with unrestricted access. Therefore, before installing access openings other options should be considered, e.g. possibility to open machinery, withdrawal of parts for repair. This is particularly important where the task demands frequent access.

When access openings cannot be avoided, the following criteria are of particular significance:

- a) ease of access is influenced by
  - the demands of the task, e.g. posture, nature and speed of movement, lines of sight, application of force,
  - the location of the access opening relative to the position of the person, e.g. convenient height above floor, within easy reach, sufficient space outside to allow adoption of a comfortable posture, sufficient space inside to allow performance of the task,
  - frequency and duration of task,
  - whether tools are being carried, e.g. for maintenance or repair purposes,
  - length of access openings, e.g. through a relatively thin wall (wall of a vessel) or through a channel-type opening,
  - whether additional equipment, such as personal protective equipment (including protective clothing), or portable lighting, is being carried or worn,
  - the type of clothing, e.g. light or heavy clothing, bare hands or thick gloves, bare headed or wearing a helmet;
- b) environmental conditions (e.g. darkness, heat, noise, moisture);
- c) level of risk during the task.

Therefore, in addition to the anthropometric data in each case, allowances shall be provided for the respective opening dimensions and reach distances, taking into account the above criteria.

The applications on how to apply this part of ISO 15534 in practice are contained in annex A, concerning allowances, and in annex B, concerning the position of access openings.

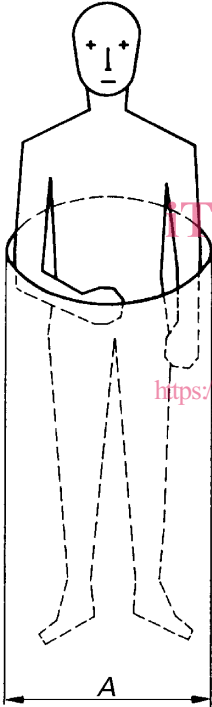
Annex C gives information on the use of symbols for dimensions and anthropometric measurements.



## 4 Access openings

An access opening is an opening through which a person can lean forward, reach forward, or extend the upper body, (head, arm, hand, a finger or several fingers), leg or foot, to be able to carry out measures during work procedures, such as operating of control actuators, repair duties or monitoring of processes or displays. See Figures 1 to 12.

This part of ISO 15534 does not specify optimum dimensions, but minimum dimensions for the size of the opening and maximum dimensions for reach. Wherever possible, the basic dimensions for the openings should be increased, and the maximum dimensions for reach should be decreased.

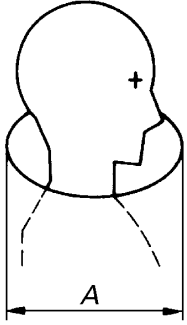
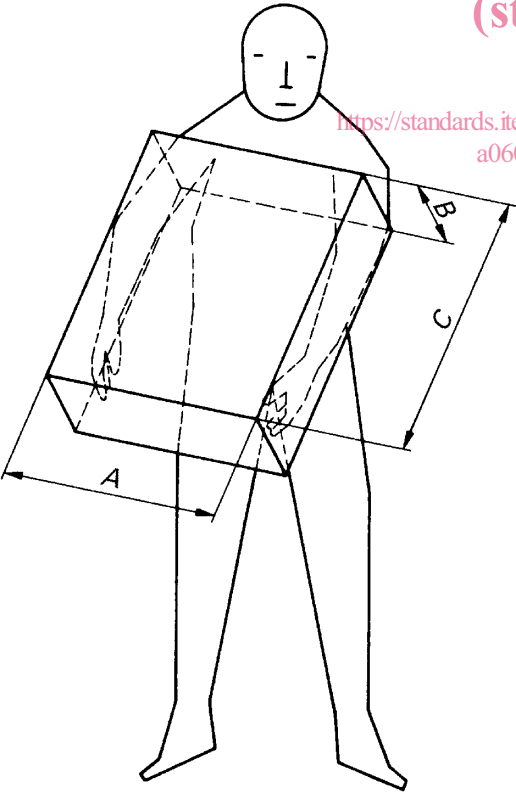
	Symbol	Explanation of measurement
<p><b>4.1 Access opening for the upper body and arms</b></p>  <p><b>Figure 1</b></p>	<p><math>A</math></p> <p><math>a_1</math></p> <p><math>x</math></p>	<p><math>A = a_1 (P95^{1}) + x</math></p> <p>Opening diameter</p> <p>Elbow-to-elbow breadth</p> <p>Allowance</p>

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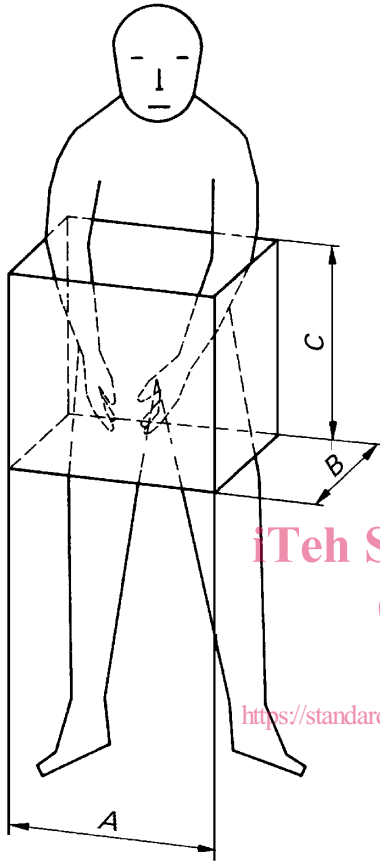
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1) P95: 95th percentile of the expected user population.

	Symbol	Explanation of measurement
<p><b>4.2 Access opening for the head as far as the shoulders for inspection tasks</b></p>  <p>Figure 2</p>	<p><math>A</math></p> <p><math>c_3</math></p> <p><math>x</math></p>	<p>This type of access should be avoided wherever possible</p> <p><math>A = c_3 (P95) + x</math></p> <p>Opening diameter</p> <p>Head length from tip of nose</p> <p>Allowance</p>
<p><b>4.3 Access opening for both arms (either forward or downward)</b></p>  <p>Figure 3</p>	<p><math>A</math></p> <p><math>B</math></p> <p><math>C</math></p> <p><math>a_1</math></p> <p><math>d_1</math></p> <p><math>t_1</math></p> <p><math>x</math></p> <p><math>y</math></p>	<p><math>A = a_1 (P95) + x</math></p> <p><math>B = d_1 (P95) + y</math></p> <p><math>C = t_1 (P5)</math></p> <p>Opening breadth</p> <p>Opening width</p> <p>Opening depth</p> <p>Elbow-to-elbow breadth</p> <p>Upper-arm diameter</p> <p>Operating-arm length</p> <p>Breadth allowance</p> <p>Width allowance</p>

**4.4 Access opening for both lower arms up to the elbow (either forward or downward)**



**Figure 4**

**Symbol**

**Explanation of measurement**

$$A = 2d_2 (P95) + x$$

$$B = d_2 (P95) + y$$

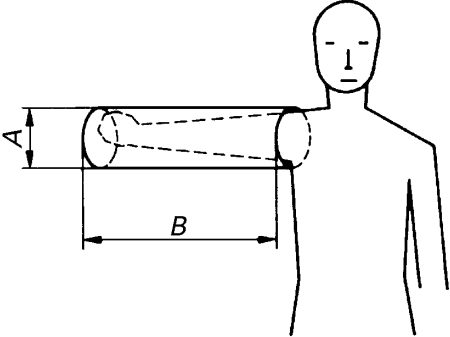
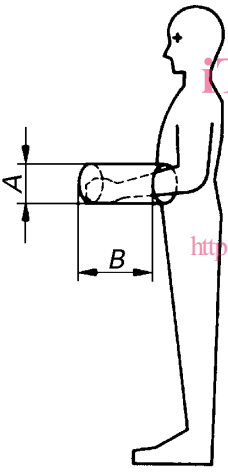
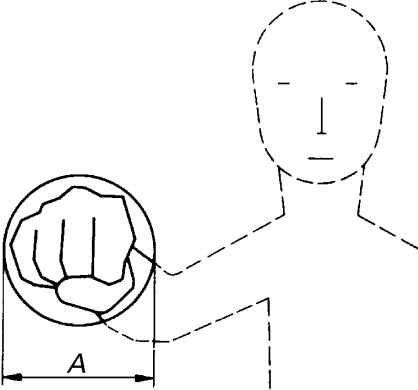
$$C = t_2 (P5)$$

- A* Opening breadth
- B* Opening width
- C* Opening depth
- d*<sub>2</sub> Lower-arm diameter
- t*<sub>2</sub> Forearm reach
- x* Breadth allowance
- y* Width allowance

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	Symbol	Explanation of measurement
<p><b>4.5 Opening for access to the side for one arm up to shoulder joint</b></p>  <p>Figure 5</p>	<p><math>A</math></p> <p><math>B</math></p> <p><math>d_1</math></p> <p><math>t_3</math></p> <p><math>x</math></p>	<p><math>A = d_1 (P95) + x</math></p> <p><math>B = t_3 (P5)</math></p> <p>Opening diameter</p> <p>Opening depth</p> <p>Upper-arm diameter</p> <p>Arm reach to the side</p> <p>Allowance</p>
<p><b>4.6 Access opening for one lower arm up to the elbow</b></p>  <p>Figure 6</p>	<p><math>A</math></p> <p><math>B</math></p> <p><math>a_3</math></p> <p><math>t_2</math></p> <p><math>x</math></p>	<p><math>A = a_3 (P95) + x</math></p> <p><math>B = t_2 (P5)</math></p> <p>Opening diameter</p> <p>Opening depth</p> <p>Hand breadth at thumb</p> <p>Forearm reach</p> <p>Allowance</p>
<p><b>4.7 Access opening for fist</b></p>  <p>Figure 7</p>	<p><math>A</math></p> <p><math>d_3</math></p> <p><math>x</math></p>	<p><math>A = d_3 (P95) + x</math></p> <p>Opening diameter</p> <p>Fist diameter</p> <p>Allowance</p>