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Ergonomic design for the safety of machinery —

Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery

Conception ergonomique pour la sécurité des machines —

Partie 1: Principes de détermination des dimensions requises pour les ouvertures destinées au passage de l'ensemble du corps dans les machines

Reference number
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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 15534-1 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. Annex B is 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 openings which will allow whole-body access.

This part of ISO 15534 is based on EN 547-1:1996 that was prepared as a harmonized standard conforming with the Machinery Directive and associated European Free Trade Association (EFTA) regulations.

Ergonomic design for the safety of machinery —

Part 1:
Principles for determining the dimensions required for openings for whole-body access into machinery

1 Scope

This part of ISO 15534 specifies the dimensions of openings for whole-body 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 passages are based on the values for either the 95th or the 99th percentiles of the expected user population. Values for the 99th percentile apply to emergency egress routes.

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

This part of ISO 15534 specifies the relevant dimensions of openings with respect to different body positions.

In arriving at values for these dimensions, in addition to the basic anthropometirc data, it is necessary to add allowances to permit unhindered and safe entry and working, taking into account aspects specific to the operator and to the operating conditions.

In this respect the following criteria are of particular significance:

a) ease of passage of a person is influenced by

- the type of clothing, e.g. light or heavy clothing,
- whether tools are being carried, e.g. for maintenance or repair purposes,
- whether additional equipment, such as personal protective equipment (including protective clothing), or portable lighting, is being carried or worn,
- the demands of the task, e.g. posture, nature and speed of movement, lines of sight, application of force,
- frequency and duration of task,
- length of passage, e.g. through a relatively thin wall (wall of a vessel) where there is space for movement at the exit or through a channel-type passage,
- amount of space available to allow for the dynamic nature of movement to escape from danger,
- the position and size of supports for the body, e.g. foot support, hand holds;

b) environmental conditions (e.g. darkness, heat, noise, moisture),

c) level of risk during the task.

The allowances to be made for these items will depend on the particular machinery concerned and its application.

Annex A provides the application on how to apply this part of ISO 15534 in practice.

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

4 Passage openings

A passage opening is an opening which allows the movement or the entry of a person's entire body, to enable the person to carry out measures such as operating of control actuators, monitoring of work processes and inspection of work results. See Figures 1 to 6.

This part of ISO 15534 specifies minimum, not optimum, dimensions for openings.

SAFETY PRECAUTIONS — Wherever possible, from the safety point of view, the dimensions should be increased. Furthermore, passage openings should be sufficiently large to allow rapid egress in the event of danger.

The allowances x and y in 4.1 to 4.5 are given in annex A. The values for a_1, h_1, etc. are given in ISO 15534-3.

	Symbol	Explanation of measurement
4.1 Opening for horizontal forward movement in upright posture		$A = h_1$ (P95[1)] or P99[2)]) + x
		$B = a_1$ (P95 or P99) + y
	A	Opening height
	B	Opening width
	h_1	Body height
	a_1	Elbow-to-elbow breadth
	x	Height allowance
	y	Width allowance

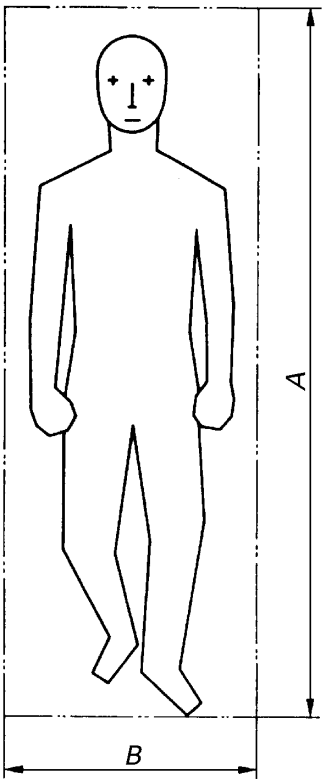


Figure 1

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

2) P99: 99th percentile of the expected user population.

	Symbol	Explanation of measurement
4.2 Opening for horizontal sideways movement over short distances in upright posture		Not applicable for emergency egress routes
		$A = h_1$ (P95) + x
		$B = b_1$ (P95) + y
	A	Opening height
	B	Opening width
	h_1	Body height
	b_1	Body depth
	x	Height allowance
	y	Width allowance

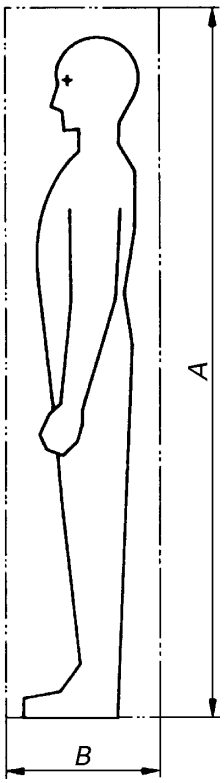
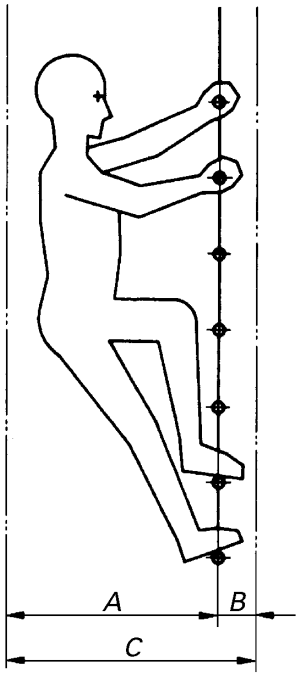
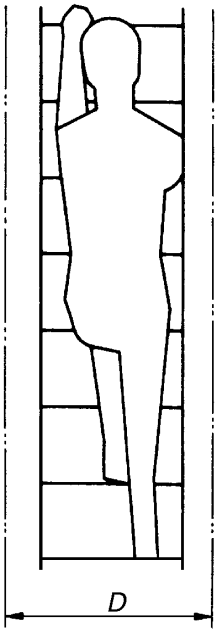
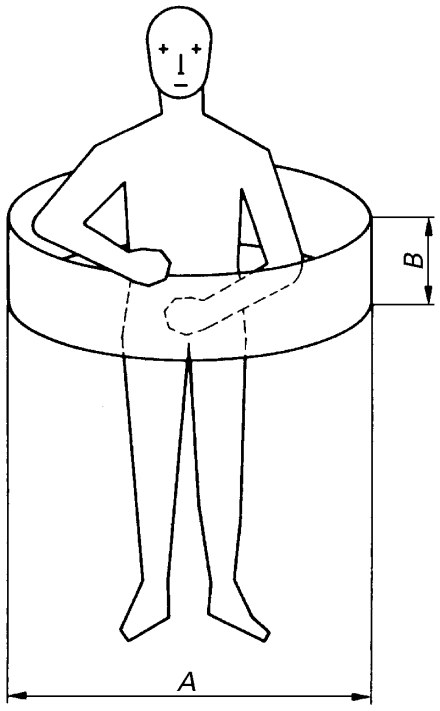
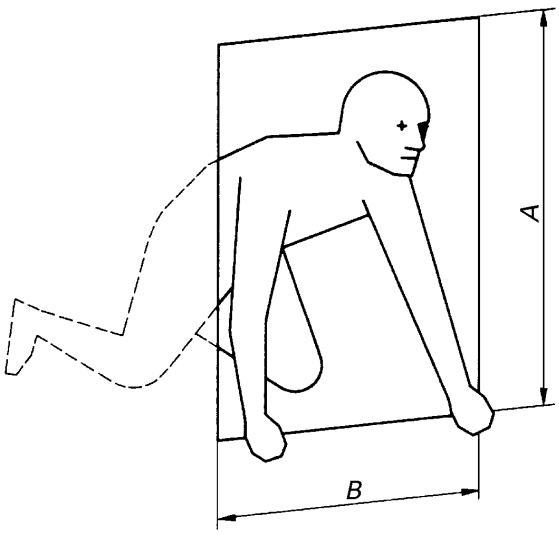


Figure 2

	Symbol	Explanation of measurement
4.3 Vertical movement through a duct, using a ladder		$A = c_1$ (P95 or P99) + x
		$B = 0{,}74 \times c_2$ (P95)
		$C = A + B$
	A	Opening width[3)]
	B	Clearance for foot
	C	Duct width
	c_1	Thigh length
	c_2	Foot length
	x	Width allowance
Figure 3		
		$D = a_1$ (P95 or P99) + y
	D	Opening breadth
	a_1	Elbow-to-elbow breadth
	y	Breadth allowance
Figure 4		

3) Opening width A does not take account of the need for protection from falling.

	Symbol	Explanation of measurement
4.4 Manhole through which rapid active movement needs to be possible  **Figure 5**		$A = a_1$ (P95 or P99) + x A Opening diameter B Length of the passage should be less than 500 mm a_1 Elbow-to-elbow breadth x Allowance
4.5 Opening for entry in kneeling posture  **Figure 6**		$A = b_2$ (P95 or P99) + x $B = a_1$ (P95 or P99) + y A Opening height B Opening width b_2 Forward reach (grip reach) a_1 Elbow-to-elbow breadth x Height allowance y Width allowance

Annex A
(normative)

Application of the measurements in practice

A.1 Introduction

The purpose of this annex is to explain how to apply the anthropometric measurements given in this part of ISO 15534 according to ergonomic and safety and health principles.

This part of ISO 15534 describes minimum dimensions for openings based on anthropometric measurements, i.e. static measurements of nude persons.

The opening dimensions, including allowances, in this part of ISO 15534 do not always take into consideration, for example:

— aspects of health and safety arising from contact with the passage opening itself;

— whether the body positions and movements that must be used in the passage mean any risk to the user's safety and health, e.g. in relation to how often or how long the person has to use the passage;

— whether the person has to adopt a certain body position in order to meet the force demands of the task without becoming overloaded;

— the space required for transportation of equipment, tools and injured or unconscious persons through the passage;

— the space required for using equipment and tools in the passage in a proper ergonomic way, e.g. cleaning, repair and maintenance work;

— personal protective equipment the user might wear when passing through the passage;

— the space requirements for entrance to and exit from the passage.

The design of a passage that takes ergonomic principles into proper consideration usually leads to more efficient work, which is also of economic benefit. For example, in most cases the operation time increases as the size of the opening decreases.

A.2 Principles for determining additional space

For each of the openings in this part of ISO 15534, a number of allowances are described in clause A.3 for conditions that need to be taken into consideration when determining the practical size of a specific passage. Where they are applicable, these conditions determine allowances which shall be added to the anthropometric measurements in order to ensure safety and health while using the passage. These allowances are not simply additive; some of the conditions overlap. When designing a specific passage, consideration shall be given to each condition given in clause A.3. A decision has to be made as to which ones are applicable and which ones are the most critical and then an integration of the factors shall be made by an expert, ending with a definite figure on the total allowance required in each direction.

A.3 Additional space requirements for openings

A.3.1 Opening for horizontal forward movement in upright posture (see 4.1)

The following allowances shall be added, where appropriate, to the anthropometric measurements given in ISO 15534-3.

Height allowance x for

— basic allowance for body movement ..... 50 mm

— fast walking or running or frequent or long-duration use ..... 100 mm

— shoes or heavy footwear ..... 40 mm

— personal protective equipment which add height to the person, e.g. helmets ..... 60 mm

Width allowance y for

— basic allowance for body movement ..... 50 mm

— fast walking or running or frequent or long-duration use ..... 100 mm

— working clothes ..... 20 mm

— clothes that will be damaged by contact with the passage walls ..... 100 mm

— heavy winter clothing or personal protective clothing ..... 100 mm

— transportation of injured person ..... 200 mm

A.3.2 Opening for horizontal sideways movement over short distances in upright posture (see 4.2)

The following allowances shall be added, where appropriate, to the anthropometric measurements given in ISO 15534-3.

Height allowance x and width allowance y:

If any of the conditions mentioned in A.3.1 for allowances x and y are present, the corresponding allowances from A.3.1 shall be used.

A.3.3 Vertical movement through a duct, using a ladder (see 4.3)

The following allowances shall be added, where appropriate, to the anthropometric measurements given in ISO 15534-3.

Width allowance x and breadth allowance y for

— basic allowance for body movement ..... 100 mm

— working clothes ..... 20 mm

— heavy winter clothing or personal protective clothing ..... 100 mm

— personal protective equipment (excluding breathing apparatus) ..... 100 mm

A.3.4 Manhole through which rapid active movement needs to be possible (see 4.4)

The following allowances shall be added, where appropriate, to the anthropometric measurements given in ISO 15534-3:

Allowance x:

If any of the conditions mentioned in A.3.3 are present, the corresponding allowances from A.3.3 shall be used.

A.3.5 Opening for entry in kneeling posture (see 4.5)

A height allowance x shall be added, where appropriate, to the anthropometric measurements given in ISO 15534-3 for looking forward during movement ..... 100 mm

Height allowance x and allowance y:

If any of the conditions mentioned in A.3.3 for allowances x and y are present, the corresponding allowances from A.3.3 shall be used.

Annex B
(informative)

Symbols for dimensions and anthropometric body measurements

The purpose of this annex is to explain the use of symbols for dimensions and anthropometric body measurements in this part of ISO 15534.

The size of passages, access openings and other physical dimensions is calculated by a formula determined for each dimension considering the relevant anthropometric measurement and one or more allowances.

The physical dimensions are shown in Figures 1 to 6 and are denoted by the capital letters A, B, C and D. The letters are used in order in each figure. The meaning need not be the same from figure to figure. Indices (subscripts) are used when needed.

Allowances and body measurements are not indicated in Figures 1 to 6.

Anthropometric measurements are denoted by lower-case letters with indices. For allowances, the lower-case letters x and y are used.

The letters denoting the anthropometric body measurements have the following general meaning:

- h height of whole body or part of body
- a breadth of trunk including arms and shoulders, etc., breadth of body part
- b depth of body or body part; in one case used for forward reach
- c length of body part or segment.

The indices (subscripts) are used in order with no particular meaning attached, with the following exception. When a measurement is taken in both the standing and sitting posture, the index for the measurement in the standing posture is a one-digit number, the index for the corresponding measurement in the sitting posture is 10 higher.

When a specific percentile of the body measurement is referred to, this is denoted by the actual percent figure preceeded by the letter “P” within brackets after the index.

The anthropometric measurements are defined in the ISO 7250:1996. The corresponding European Standard is EN ISO 7250:1997. Values for the measurements are given in ISO 15534-3.

The symbols for the anthropometric measurements used in this part of ISO 15534 are listed in Table B.1. The index numbers are not consecutive since not all the defined anthropometric measurements are used in this part of ISO 15534.

Table B.1 — Symbols and definitions of anthropometric measurements in this part of ISO 15534

Symbol	Explanation	Definition See ISO 7250:1996 [a], subclause	Use See this part of ISO 15534, subclause
h_1	Stature (body height)	4.1.2	4.1, 4.2
a_1	Elbow-to-elbow breadth	4.2.10	4.1, 4.3, 4.4, 4.5
b_1	Body depth, standing	4.1.10	4.2
b_2	Grip reach; forward reach	4.4.2	4.5
c_1	Buttock-knee length (thigh length)	4.4.7	4.3
c_2	Foot length	4.3.7	4.3

[a] The number in EN ISO 7250 is the same.

Bibliography

[1] ISO 7250:1996, *Basic human body measurements for technological design*. (EN ISO 7250:1997)

[2] EN 614-1:1995, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*.

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