भारतीय मानक

Indian Standard

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औद्योगिक उत्पादों और डिजाइनों के मानवशास्त्रीय पहलुओं के परीक्षण के लिए परीक्षण व्यक्तियों के चयन और उपयोग के सिद्धांत

(पहला पुनरीक्षण)

Principles for Selecting and Using Test Persons for Testing Anthropometric Aspects of Industrial Products and Designs

(First Revision)

ICS 13.110

भारतीय मानक ब्यूरो
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NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical to ISO 15537 : 2022 ‘Principles for selecting and using test persons for testing anthropometric aspects of industrial products and designs’ issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on recommendation of the Ergonomics Sectional Committee and approval of the Production and General Engineering Division Council.

An investigation into how far ergonomic requirements are taken into consideration with regard to industrial products and designs is often performed using test equipment that permits only one or a few parameters (for example, body height) to be registered. With regard to the concurrent multifunctional testing and/or determination of product characteristics for which no technical testing procedures have been established, one or more people are often designated as test persons and are observed and/or questioned during or after product testing.

The reliability of any findings established in this way is very much dependent on the extent to which the test persons represent the intended user group in different aspects. How well a product or design is adjusted to the anthropometrics of the intended user population is dealt with in this document.

According to IS 16572/ISO 14738, workstations at machinery have to be designed with proper regard to the body dimensions of the intended user population. One means to verify that a product or a design fulfils this requirement is to set up a panel of test persons and let them test the product in different ways.

This standard was first published in 2004 based on ISO 15537 : 2004. This revision has been undertaken to align it with the latest version of ISO 15537.

The major changes have been incorporated in this revision are as follows:

a) The context has been broadened to include testing by computer-aided design (CAD); and

b) European values in tables have been replaced by global values.

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are however not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’; and

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed orcalculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'.

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Introduction

An investigation into how far ergonomic requirements are taken into consideration with regard to industrial products and designs is often performed using test equipment that permits only one or a few parameters (e.g. body height) to be registered. With regard to the concurrent multifunctional testing and/or determination of product characteristics for which no technical testing procedures have been established, one or more people are often designated as test persons and are observed and/or questioned during or after product testing.

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According to ISO 14738, workstations at machinery has to be designed with proper regard to the body dimensions of the intended user population. One means to verify that a product or a design fulfils this requirement is to set up a panel of test persons and let them test the product in different ways.

An example of the use of this document is given in Annex A.

Indian Standard

PRINCIPLES FOR SELECTING AND USING TEST PERSONS FOR TESTING ANTHROPOMETRIC ASPECTS OF INDUSTRIAL PRODUCTS AND DESIGNS

1 Scope

This document establishes methods for determining the composition of groups of persons whose anthropometric characteristics are to be representative of the intended user population of any specific object under test.

This document is applicable to the testing of anthropometric aspects of industrial products and designs having direct contact with the human body or dependent on human body measurements, such as machinery, work equipment, personal protective equipment (PPE), consumer goods, working spaces, architectural details or transportation equipment.

This document is also applicable to the testing of such safety aspects of products that are dependent on human body measurements. It does not deal with other aspects of the task or other requirements, such as perception of information (except geometrical arrangement of the viewing targets) and the use of controls (except their geometrical placement).

Although this document deals with selecting test persons from an anthropometric perspective, similar general principles can be applied for other test variables, e.g. biomechanical aspects.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
critical dimension
dimension estimated to cause a major limitation for the usage from an anthropometrical point of view, for the whole body or body parts, depending on the function of the product in question

Note 1 to entry: Critical dimension is related to reach, clearance, posture, contact pressure, vision or other factors which may result in difficulties of use, discomfort or health risks.

Note 2 to entry: A product to be tested can have more than one critical dimension, for example a combination of a reach dimension and a clearance dimension.

EXAMPLE The critical dimension for an access opening can be the width, or a combination of two dimensions, for example the width and the opening height.

3.2
critical anthropometric measurement
anthropometric measurement which is most affected by the critical dimensions of the product

Note 1 to entry: For instance, the critical anthropometric measurement for a person entering an opening for whole body access is the one with the greatest constraint (e.g. the body height and/or the body width, depending on the form of the access opening).

3.3
worst-case combination of critical dimensions and anthropometric measurements
combination of critical dimensions of the product, additional equipment and the critical anthropometric measurement imposing the biggest restriction on a person who is able to use the product or design as intended

3.4
slim body type
person for whom at least two width measurements (preferably shoulder width and hip breadth) and two depth measurements (preferably chest depth and abdominal depth) are smaller than the figure representing the 25th percentile or, where this figure is not available, the average value of the 5th and the 50th (mean) percentile for the population in question

3.5
corpulent body type
person for whom at least two breadth measurements (preferably shoulder breadth and hip breadth) and two depth measurements (preferably chest depth and abdominal depth) are bigger than the figure representing the 75th percentile or, where this figure is not available, the average value of the 50th percentile (mean) and the 95th percentile for the population in question

3.6
medium body type
person who is neither a slim body type nor a corpulent body type

4 Types of tests

4.1 General

Testing may be done with living humans or with virtual humans, sometimes known as computer manikins. Current design processes often involve computer-aided design (CAD) systems, where it is possible to insert virtual humans into the CAD design process. See ISO 15536-1 and ISO 15536-2 for information on computer manikins. The tests described in this subclause can be done with living humans in a physical mock-up or with virtual humans in a CAD environment. If virtual humans are used, users are cautioned to assess the validity of the models before assuming accurate test results.

Test participants – virtual or human – are specified by anthropometry. The simplest designs require anthropometric information on only a few dimensions. In such cases, defining test participants using population percentiles may be appropriate. For more complex designs, using percentiles on many dimensions can give a false sense of accommodation, because persons who are accommodated by one or two dimensions might not be accommodated by the next three dimensions, while persons accommodated by the third and fourth dimensions might not be accommodated on the first one or two. The reason for this is that many design-critical dimensions are often not well correlated with each other. For these more complex design problems, a good solution is a multivariate anthropometric approach. Unfortunately, multivariate solutions generally require access to raw anthropometric data, which are often proprietary or otherwise not publicly available.

Depending on the accuracy of the test results required and the availability of test persons or manikins, either a screening or a detailed test can be performed. In addition to critical dimensions of the product, at least the following shall be taken into account as selection criteria:

— the geographic or ethnic origin of the user population (global, regional or a specific population);

— the age of the user population (all or specific age groups);

— the sex of the user population (both or specific);

— occupation (if relevant).

4.2 Screening test

The screening test is not as complete or accurate as a detailed test and is used in the preliminary assessment of the usability of products and designs for a specified intended user population. Instead, screening tests can be used to quickly assess whether a general design concept is feasible. Screening tests may consist of looking up anthropometric percentiles in a table and comparing them to key dimensions of a prospective design.

Screening tests are never sufficient for complete assessment of safety aspects.

4.3 Detailed test

The detailed test takes into account all dimensions of a product or design (e.g. by using a mock-up, prototype or other physical model), in relation to anthropometric dimensions. The selection of anthropometric measurements and percentiles depends on the features of the product or design under test. The duration of a detailed test shall be long enough to give a good representation of the intended use of the product, including foreseeable non-regular or emergency use and maintenance.

5 Test with test persons or manikins

5.1 General requirements and recommendations

Test persons or manikins shall be selected to represent the anthropometric measurements of the relevant percentile of the intended user population.

The test shall be reproducible, as far as possible.

Refer to ISO 14738, ISO 15534-1, ISO 15534-2 and ISO 15534-3 for guidance on determining anthropometric dimensions for workstations and opening for access into machinery.

5.2 Procedure for testing

When developing test procedures:

— identify the intended user population (see 4.1);

— identify critical tasks that the user will perform in or with the product design, and the type of clothing and equipment used during these tasks;

— identify task factors such as reach, vision, clearance, posture, contact pressure or other factors which may result in difficulties of use, discomfort or health risks;

— identify posture or postural limits of the tasks to be performed;

— identify task constraints (e.g. restraints, concurrent tasks);

— identify the critical dimensions of the product under test;

— define worst-case combinations of critical dimensions and anthropometric measurements (e.g. short arms and large torso depth), including critical measurements with additional equipment;

— define safety margins, absolute (figures) or relative (percentile) to be added to the dimensions;

— select test persons according to 5.3 or 5.4, respectively;

— run the test(s), taking the following into account:

  — the measuring of critical dimensions and corresponding anthropometric measurements of the test persons;

  — registration of the test persons' subjective opinions during and/or after using the product;

  — observation of the test persons' behaviour and ability to perform the task when using the product as intended;

— document the test procedure and the test results (see 5.7).

Any individual test should cover at least one whole utilization cycle for each element of the object under test (e.g. adjustment gear, displays, controls, visibility). Any deviation from this recommendation shall be documented. The reliability of some tests can be improved by repeating them at least three times. Requirements for specific tests can be found in some product standards.

5.3 Selection of test persons within the intended user population for screening test

For each critical dimension, select at least three persons, representing the part of the user population anticipated to be limiting in this aspect. That is, if a clearance-dimension is to be tested, the persons should as far as possible represent the 95th percentile for that dimension. If a reach-dimension is to be tested, the persons should as far as possible represent the 5th percentile forward arm reach. The same test person can be used for testing more than one critical dimension. Table 1 shows 5th percentile female and 95th percentile male values for a selection of global human body measurements. ISO 7250-3 has a more complete listing of dimensions and additional percentiles. For some dimensions, the female P95 is larger than the male P95. In these cases, the female value should be used.

5.4 Selection of test persons within the intended user population for detailed test

The following shall be taken into account:

— For each critical dimension, select at least seven persons representing the part of the user population anticipated to be limiting in this aspect. That is, if a clearance dimension is to be tested, the persons should, as far as possible, represent the 95th percentile for that dimension. If a reach dimension is to be tested, the persons should, as far as possible, represent the 5th percentile.

— If the 95th and/or the 5th percentile for the critical dimensions are not known in the intended user population, then at least seven test persons representing the limiting (95th or 5th) percentile of stature shall be used. Of these seven test persons, slim, medium and corpulent body types should be included in those representing P5 and P95 of stature. It is also recommended that at least one person representing the 95th or the 5th percentile of the breadth or depth measurement be included in the test group. A test person can be used for testing more than one critical dimension.

— In a more complicated test situation, for example, where both clearance dimensions and reach dimensions are of concern, the sample of test persons should be specifically determined for its purpose.

— It is recommended that the 1st and the 99th percentiles are used instead of the 5th and the 95th percentiles, wherever possible. These values can be found in ISO 7250-3.

For safety considerations (e.g. for testing the access openings or safety distances), at least one person representing the 1st or the 99th percentile of the relevant body measurement shall be employed in the test.

Table 1 — Global human body measurements

Human body measurement[a]	Value mm		Reference from ISO 7250-3
	Female P5	Male P95	
Stature (body height)	1 467	1 969	4.1.2
Hip breath, standing	290	387[a]	4.1.12
Sitting height (erect)	735	1 012	4.2.1
Eye height, sitting	633	892	4.2.2
Shoulder (biacrominal) breadth	292	456	4.2.8
Shoulder (bideltoid) breadth	362	550	4.2.9
Hip breadth, sitting	310	438[b]	4.2.11
Lower leg length (popliteal height)	333	538	4.2.12
Knee height	418	617	4.2.14
Hand length	159	221	4.3.1
Hand breadth at metacarpals	66	110	4.3.3
Foot length	210	296	4.3.7
Head length	160	213	4.3.9
Head breadth	134	173	4.3.10
Head circumference	515	610	4.3.12
Elbow-grip length	268	428	4.4.3
Buttock-knee length	495	703	4.4.7

[a] Female value is larger; use female P95 of 423.

[b] Female value is larger; use female P95 of 501.

NOTE For children and the elderly, separate data sets are sometimes needed.

5.5 Experienced or inexperienced persons

In many situations, it is appropriate that persons with different familiarity with the product in question are engaged for the test, as long as they belong to the intended user population. When analysing the test data, a distinction should be made between experienced and inexperienced (naive) test persons concerning the use of the product or the design under test. In some cases, it may be useful to have an even finer differentiation concerning familiarity with the test situation.

5.6 Criteria for acceptance of a product with regard to anthropometric aspects

General criteria for acceptance are specified in certain standards (e.g. ISO 14738 and EN 614-1). The set of acceptance criteria for a given product is dependent on the product or design. For some products, acceptance criteria are formulated in specific product standards. For other products, or when specific user groups are intended, the designers may have to formulate their own acceptance criteria based on applicable anthropometric information.

For safety aspects, negative results concerning one single item shall lead to redesign.

NOTE Additional allowances for safety might be needed to provide protection for the whole population.

5.7 Documentation of the test procedure and the results

Identification of the product or design tested, the intended user population, specified critical dimensions and critical anthropometric measurements, test procedures, acceptance criteria and test results shall be documented.

Annex A
(informative)

Example of a test procedure for testing of anthropometric aspects of an elevator

A.1 General

A 10-person elevator which is planned for public use in a big five-floor department store in Europe needs to be tested. Two parking levels are situated on top of the store (6th and 7th floors).

The test in this example case relates to comfort, selective aspects of ergonomic-anthropometric relevance, as well as aspects of entry and exit. This annex does not address safety issues of elevators. For this purpose, ISO 4190-2, ISO 8100-30, EN 81-1, EN 81-2 and EN 81-3 should be consulted. This test also does not address issues associated with wheeled mobility devices.

A.2 Test procedure

Step 1: Determine the critical dimensions of the products to be tested and the critical anthropometric measurements of the users (see Table A.1, step 1).

Step 2: Determine the worst case (see Table A.1, step 2).

Step 3: Determination of different types of test.

For checking rough anthropometric data (e.g. for 10 persons), a screening test as well as a computer application can be used. As time aspects (duration of transport in the worst case: from the basement to the 7th floor with a stop at every floor level) will influence the acceptance of space inside an elevator, a detailed test with persons should be preferred.

Step 4: Selecting of test persons.

As the elevator is for use in a European department store, European anthropometric data will normally be sufficient.

The test persons should be experienced in using an elevator.

The test persons can be formed into three groups (see Table A.1, step 4):

— Group 1 (worst case): Ten persons representing the 95th percentile (corpulent), for testing the door width and the space inside the elevator. Probably the seven test persons needed for the press-button size test (big hands or index fingers) can be included in this group.

— Group 2: Seven children (aged 12 years) representing the 5th percentile, for testing the highest push button.

— Group 3 (realistic): Mixed adult group representing the 95th (three persons), the 50th (four persons) and the 5th (three persons) percentiles (including one person with a pram), instead of group 1.

Step 5: Procedures

Comfort in an elevator is a function of time and space. The detailed test should include the three test groups standing in the elevator, with the door closed for the worst-case duration (the time it takes to go from the 7th floor to the ground floor, with stops). If more than two of the 10 test persons experience discomfort, then changes to the interior elevator dimensions should be considered.

NOTE Some countries have national safety regulations that specify a fixed relationship between interior elevator space and a number of "standard persons". In such cases, comfort in the worst case, as defined in this example, can only be achieved by lowering the capacity limit of the elevator (number of persons) or by designing the cabin for more "standard persons".

A.3 Test results

Some test results can also be achieved by CAD, concerning the door height, the width and the space inside the elevator. Particularly when the time aspects are anticipated to influence the result, these CAD tests are not sufficient. A test procedure, including subjective and/or video-taped analysis, will give better results, even if it is performed as a screening test according to this document. A detailed test (A.2) will give the most valid results.

Table A.1 — Testing procedure of anthropometric aspects of an elevator design[a]

Step 1			Step 2	Step 3	Step 4	
Critical dimensions			Worst case	Type of test	Selecting test persons	Forming test groups
Product dimensions	Human body measurements	Allowances				
Door height	Body height, P95	Hat plus shoe allowance	One tall person, P95 with hat and high-heeled shoes	Screening test	Three persons (P95)	Group 1
Door width for two persons passing through simultaneously	Forearm–forearm breadth, P95	Allowance for a bag or a basket	Two corpulent persons (forearm–forearm breadth, P95) with two bags or baskets for each person	Screening test or detailed test	Forming of one subgroup (screening test) or four subgroups of two corpulent P95 persons each (detailed test), European population	
Space inside, for example 10 persons standing	Forearm–forearm breadth, P95; body depth P95	Allowance for a bag, basket or rucksack	Ten corpulent persons with one rucksack and two bags or baskets each	Screening test or detailed test	One group of 10 corpulent P95 persons, European population (detailed test)	
					One mixed group of 3 × P95, 4 × P50 and 3 × P5 persons (one corpulent and one slim person in each subgroup), European population (both sexes) or global population (screening test)	Group 3
Push button size and distance between buttons	Index finger breadth (at tip) P95	Allowance for gloves	Use of gloves	Screening test, detailed test	Three persons (screening test) or seven persons with big hands, P95 (detailed test), European population	Group 1
Height of highest push button above floor	Reach height, children, P5 (age 12 years)	—	One child without accompanying adults [age 12 years (P1)]	Screening test, detailed test	Three small children (screening test) or seven small children (age 12 years), P5 (detailed test), European population, specific age group	Group 2

Key

P5 5th percentile

P50 50th percentile

P95 95th percentile

[a] For safety aspects, see ISO 4190-2, ISO 8100-30, EN 81-1, EN 81-2 and EN 81-3.

Bibliography

[1] ISO 4190-2, *Lift (US: Elevator) installation — Part 2: Class IV lifts*

[2] ISO 7250-1, *Basic human body measurements for technological design — Part 1: Body measurement definitions and landmarks*

[3] ISO 7250-3, *Basic human body measurements for technological design — Part 3: Worldwide and regional design ranges for use in product standards*

[4] ISO 8100-30, *Lifts for the transport of persons and goods — Part 30: Class I, II, III and VI lifts installation*

[5] ISO 14738, *Safety of machinery — Anthropometric requirements for the design of workstations at machinery*

[6] ISO 15534-1, *Ergonomic design for the safety of machinery — Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery*

[7] ISO 15534-2, *Ergonomic design for the safety of machinery — Part 2: Principles for determining the dimensions required for access openings*

[8] ISO 15534-3, *Ergonomic design for the safety of machinery — Part 3: Anthropometric data*

[9] ISO 15536-1, *Ergonomics — Computer manikins and body templates — Part 1: General requirements*

[10] ISO 15536-2, *Ergonomics — Computer manikins and body templates — Part 2: Verification of functions and validation of dimensions for computer manikin systems*

[11] EN 81-1, *Safety rules for the construction and installation of lifts — Part 1: Electric lifts*

[12] EN 81-2, *Safety rules for the construction and installation of lifts — Part 2: Hydraulic lifts*

[13] EN 81-3, *Safety rules for the construction and installation of lifts — Part 3: Electric and hydraulic service lifts*

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

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