
**Ergonomics — Computer manikins and
body templates —**

Part 2:

**Verification of functions and validation of
dimensions for computer manikin
systems**

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Ergonomie — Mannequins informatisés et gabarits humains —

*Partie 2: Vérification des fonctions et validation des dimensions pour les
systèmes de mannequins informatisés*

ISO 15536-2:2007

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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 15536-2 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 3, *Anthropometry and biomechanics*.

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ISO 15536 consists of the following parts, under the general title *Ergonomics — Computer manikins and body templates*:

- *Part 1: General requirements*
- *Part 2: Verification of functions and validation of dimensions for computer manikin systems*

Introduction

In order to apply computer manikins with confidence and trust to equipment design, designers need to know the accuracy and reliability of these tools. The needed accuracy depends on the purpose of their use. Some designers need high degrees of accuracy (e.g. quantitative clearance analyses), while others need less (e.g. training simulations). A method of checking the basic degree of accuracy is given in ISO 15536-1:2005. It is based on the comparison between anthropometric data used in creation of the manikin and the corresponding measurements taken from the manikin itself. These data and measurements apply to the standardized measurement postures only, i.e. standing and sitting (see ISO 7250:1996).

However, computer manikins are used to simulate a wider range of human postures and movements during equipment design than standardized postures, and it is essential that designers know the level of their anthropometric accuracy also in these conditions. Moreover, problems arise when trying to assess the accuracy and repeatability of computer manikins and their associated applications because of the many anthropometric and biomechanical parameters used in constructing them. Many specialized tests are required to accurately measure every possible size, shape and working posture that people can exhibit. This problem is further compounded when manikin data or algorithms are changed, requiring additional tests assessing their dimensional accuracy.

Because it is not economically feasible for one organization to test every manikin parameter under every possible test condition, developers and users need to share the responsibility for assessing computer manikin accuracy. Developers may test manikin system accuracy for the most common situations, but it is essential that the users be provided with the means to test the accuracy and repeatability of manikin systems for their specific applications, too. Therefore, users need to measure manikin accuracy for their specific applications and developers need to provide computer manikins and simple processes for measuring and assessing manikin accuracy.

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Ergonomics — Computer manikins and body templates —

Part 2:

Verification of functions and validation of dimensions for computer manikin systems

1 Scope

This part of ISO 15536 establishes the requirements for the verification of the functions and validation of dimensions of computer manikins. These requirements concern the documentation of the data employed to construct computer manikins and the methods employed to verify and validate their functions with regards to their dimensional accuracy.

This part of ISO 15536 extends to anthropometric and biomechanical data and to software functions as they are applied to create computer manikins. Although this document primarily refers to anthropometric data and methods, some biomechanical parameters are required to build and apply computer manikins and are therefore included.

This part of ISO 15536 provides a framework for reporting computer manikin accuracy and human-source data. The standard is intended to enable even non-specialist users of the manikin systems to independently perform measurements of each function under field testing conditions using automated software tools provided by developers.

It is not intended to require developers to perform specific verification and validation of their manikin systems.

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).

ISO 7250:1996, *Basic human body measurements for technological design*

ISO 15535, *General requirements for establishing anthropometric databases*

ISO 15536-1:2005, *Ergonomics — Computer manikins and body templates — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15536-1 and the following apply.

3.1 manikin accuracy
manikin accuracy refers to the precision with which a computer manikin system reproduces the size, shape, posture, angles, movement paths and other geometric characteristics of the individual from whom the measurements were taken

3.2 developer
company, institution or individual who develops computer manikin systems

3.3 field-testing conditions
conditions in which the user of the manikin system normally works, typically consisting of a computer workstation in an office environment, and where highly specialized anthropometric and biomechanical laboratory tools and support personnel are assumed to be unavailable

3.4 manikin function
capability of the computer manikin software system to simulate some characteristic, activity or condition of the human body

3.5 measurement landmarks
points located and placed on the human body's surface or on a computer manikin, used for measurement of distance or displacement

3.6 repeatability
extent to which the values of a dimension measured more than once on the same subject are the same

NOTE A completely repeatable function would have a standard deviation of zero.

3.7 manikin verification
activity of confirming that computer manikin functions work as described

3.8 manikin validation
activity of measuring computer manikin accuracy

NOTE For the definition of manikin accuracy, see 3.1.

3.9 digital user documentation
electronic reference material included with the computer manikin system that can be accessed while using the software

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4 Requirements for computer manikin verification

4.1 General

The requirements specified in 4.2 to 4.5 are given to enable non-specialist users of a manikin system to independently measure the accuracy of manikin dimensions and to verify the manikin's functions under field-testing conditions using automated software tools provided by manikin system developers.

4.2 Listing of functions

Each computer manikin function identified as being provided by the developer (e.g. interference or reach analyses) shall be listed in a table labelled "List of functions". The list shall be accessible from the digital user documentation.

4.3 Description of functions

A description of each computer manikin function, listed in the "List of functions" table, shall be provided in the digital user documentation. The description shall include the function's intended purpose and boundary conditions of appropriate use.

4.4 Verification of functions — Examples supplied by developers

Each computer manikin function listed in the "List of functions" table shall be accompanied in the digital user documentation by at least one example illustrating and simulating its operation. The example shall permit users to input representative values and observe corresponding output performance.

4.5 Verification of functions — Enabling manikin system user to record/report performance

The user of the system shall be provided with a means to electronically record and report the performance of each function, as defined in 4.3, in a standard digital format suitable for output to standard printing devices. A means shall be provided for automatically generating a report each time a function is tested. The report shall include the values input by the user and the function's output performance.

5 Requirements for documenting source data

5.1 Listing of parameters

Each computer manikin function that employs measurements of human characteristics shall identify the parameter's name and units of measurement. Each parameter shall be listed by name in a table labelled "List of human data parameters" and be accessible from the digital user documentation.

5.2 Parameter description

Each data parameter listed in the "List of human data parameters" table shall be accompanied in the user documentation by a description of its statistical characteristics and method of measurement. The nomenclature, landmarks and measurement methods of ISO 7250 shall be employed, where appropriate.

The statistical description of each parameter in the human data set shall include its source, sample size, minimum and maximum values, mean, mode, standard deviation, and 1st, 5th, 50th, 95th, 99th percentile values; if information is not available, this shall be stated explicitly. If the data parameter is from a publicly available data set, the source publication shall be referenced.

5.3 Sampling method

Each data parameter listed in the “List of human data parameters” table shall describe the methods employed to sample (select) individuals from the subject population for measurement; if the information is not available, this shall be stated explicitly.

5.4 Sample demographics

Each data parameter listed in the “List of human data parameters” table shall identify the sex and age of the individuals measured in accordance with ISO 15535; if the information is not available, this shall be stated explicitly. If population segments, occupation, or other demographic variables are used to define model parameters, they shall also be listed.

6 Requirements for computer manikin validation

6.1 General requirements

Automated software tools shall be provided to support the measurement and reporting of manikin system accuracy and repeatability by users under field-testing conditions.

In order for a specific manikin function or characteristic to be in compliance with this part of ISO 15536, the developer shall have provided methods for manikin measurement and data documentation in accordance with its requirements. Compliance does not ensure the accuracy of any specific manikin, but only indicates that the user can test manikin accuracy.

This document takes no position on which measures or measurement conditions are preferred for validation, due to the extremely large number of manikins, sizes, shapes, postures and conditions that would need to be tested to satisfy all users and their diverse applications.

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6.1.1 Measurement landmarks

Landmarks and reference planes necessary in order to perform the human body measurements in accordance with ISO 7250:1996, Clause 4, shall be placed on each computer manikin or appropriate planar surfaces with provisions to toggle them on or off.

6.1.2 Adding new measurement landmarks

A means shall be provided to add new measurement landmarks to manikin structural elements for the purpose of making automated manikin measurements. Each user-created landmark shall have the same functional characteristics as the landmarks specified in 6.1.1.

6.1.3 Listing of landmarks

Each measurement landmark provided in or added to the manikin system shall be listed in a table labelled “List of measurement landmarks” and shall be accessible from the digital user documentation.

6.1.4 Measurement reporting

All computer manikin parameters listed in the “List of human data parameters” table shall be provided with a means for automatically measuring and reporting their accuracy. If a means for the automatic measurement of dimension values is not provided, this shall be stated explicitly.

6.1.5 Manikin accuracy

The user shall be provided with a means to calculate the accuracy of each parameter. The manikin accuracy is calculated as the difference between the input and output values for a particular manikin dimension in terms of difference and percent error (see ISO 15536-1:2005, 6.4). Input values are measured from landmarks placed on an actual person, while output values are measured from corresponding landmarks (see 6.1.1) on the manikin which were created to represent the person whose measurements were used as the input. Input values should be based on the average of at least three measurements.

Difference errors, e_{dif} , is expressed as the difference between the input and output values:

$$e_{\text{dif}} = V_{\text{out}} - V_{\text{in}}$$

where

V_{out} is the output value;

V_{in} is the input value.

The percentage error, e_{p} , is expressed as a percentage of the input value, in accordance with ISO 15536-1:2005, 6.4:

$$e_{\text{p}} = \frac{V_{\text{out}} - V_{\text{in}}}{V_{\text{in}}} \times 100$$

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6.1.6 Repeatability

The user shall be provided with a means to calculate the repeatability of each parameter.

A recommended metric of repeatability is the standard deviation of a function's output values when calculations are repeatedly performed with a small sample size such as 10. For example, the measurement of a parameter from a single individual would be input to a function ten times and the resulting output would be observed for variability.

6.1.7 Field-test condition measurement support

Annexes A and B are provided to help users make independent measurements of manikin accuracy and repeatability under field-testing conditions relevant to their specific equipment-design applications.

6.2 Static functions

A general approach, recommended for validation testing of dimensional and angle measurements for static functions, is provided in Annex B.

6.2.1 Static testing of manikin dimensions

The capabilities described in 6.2.1.1 to 6.2.1.4 shall be provided to support the user's need to validate application-specific manikin features in the field.

6.2.1.1 Linear measurements

A means shall be provided to make horizontal and vertical distance measurements and shortest-distance measurements between any of the landmarks specified in 6.1.1 and 6.1.2.