INTERNATIONAL STANDARD

ISO 15831

First edition
2004-02-01

Clothing — Physiological effects — Measurement of thermal insulation by means of a thermal manikin

Vêtements — Effets physiologiques — Mesurage de l'isolation thermique à l'aide d'un mannequin thermique

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47c3-8b7c-6f21f6dc341e/iso-15831-2004

Reference number
ISO 15831:2004(E)

© ISO 2004

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47c3-8b7c-6f21f6dc341e/iso-15831-2004

© ISO 2004

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

 © ISO 2004 – All rights reserved

Contents

Page

Foreword ... iv

1 Scope ... 1

2 Terms and definitions ... 1

3 Symbols and units ... 2

4 Principle ... 2

5 Apparatus ... 3
5.1 Manikin ... 3
5.2 Controlled climatic chamber ... 4

6 Selection and preparation of test garments ... 5

7 Test procedure ... 5

8 Recalibration of the manikin system ... 6

9 Calculation of test results ... 6
9.1 General ... 6
9.2 Serial model — Surface area weighted thermal insulation ... 6
9.3 Parallel model — Surface area averaged thermal insulation ... 6

10 Precision of results ... 7

11 Test report ... 7

Annex A (informative) Calculation of test results ... 8

Bibliography ... 11

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47e3-8b7e-6f21f6dc341e/iso-15831-2004

© ISO 2004 – All rights reserved

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 15831 was prepared by Technical Committee ISO/TC 38, *Textiles*.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47c3-8b7c-6f21f6dc341e/iso-15831-2004

© ISO 2004 – All rights reserved

Clothing — Physiological effects — Measurement of thermal insulation by means of a thermal manikin

1 Scope

This International Standard describes the requirements of the thermal manikin and the test procedure used to measure the thermal insulation of a clothing ensemble, as it becomes effective for the wearer in practical use in a relatively calm environment, with the wearer either standing or moving.

NOTE This thermal insulation, among other parameters, can be used to determine the physiological effect of clothing on the wearer in specific climate/activity scenarios.

2 Terms and definitions

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

iTeh STANDARD PREVIEW
(standards.iteh.ai)

2.1
clothing ensemble
group of garments worn together on the body at the same time

ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47c3-8b7c-6f21f6dc341e/iso-15831-2004

2.2
thermal insulation of clothing
temperature difference between the wearer's skin surface and ambient atmosphere divided by the resulting dry heat flow per unit area in the direction of the temperature gradient where the dry heat flow consists of conductive, convective and radiant components

NOTE Depending on the end use of the clothing, different thermal insulation values can apply.

2.2.1
total thermal insulation of clothing
I_t
total thermal insulation from skin to ambient atmosphere, including clothing and boundary air layer, under defined conditions measured with a stationary manikin

2.2.2
resultant total thermal insulation of clothing
I_{tr}
total thermal insulation from skin to ambient atmosphere, including clothing and boundary air layer, under defined conditions measured with a manikin moving its legs and arms

© ISO 2004 – All rights reserved

3 Symbols and units

a_i	surface area of the body segment i of the manikin	m^2
A	total body surface area of the manikin	m^2
f_i	fraction of the total manikin surface area represented by the surface area of segment i	
H_c	total heating power supplied to the manikin	W
H_{ci}	heating power supplied to the body segment i of the manikin	W
I_t	total thermal insulation of the clothing ensemble with the manikin stationary	$\frac{m^2K}{W}$
I_{tr}	resultant total thermal insulation of the clothing ensemble with the manikin moving	$\frac{m^2K}{W}$
RH	relative humidity of the air within the climatic chamber	%
T_a	air temperature within the climatic chamber	°C
T_s	mean skin surface temperature of the manikin	°C
T_{si}	skin surface temperature of the body segment i of the manikin	°C
v_a	air speed in the climatic chamber	m/s

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47c3-8b7c-6f21f6dc341e/iso-15831-2004

4 Principle

The components of the clothing ensemble to be tested are placed on the manikin in the same arrangement as in practical use.

The manikin, in the shape and size of an adult human body and, for the measurement of I_{tr}, with movable legs and arms, is internally heated to a constant skin surface temperature, uniform over its body. The manikin is placed in a climatic chamber where defined air temperature and air speed can be set, and air humidity controlled.

There will be a dry heat flow from the manikin's skin surface area through the clothing into the ambient air, which is measured after steady-state conditions have been reached. From this heat flow, related to the nude manikin's body surface area, the clothing ensemble's thermal insulation can be calculated, considering the temperature difference between the manikin's skin surface and the ambient air.

The measurement is performed with the manikin stationary and/or moving its legs and arms, with a defined number of movements per minute and a defined stride length.

The insulation values obtained include the thermal insulation provided by the clothing and the adhering air layer around the body. They apply only to the particular clothing ensemble, as tested, and to the specific conditions of the test, particularly with respect to the air movement around the manikin.

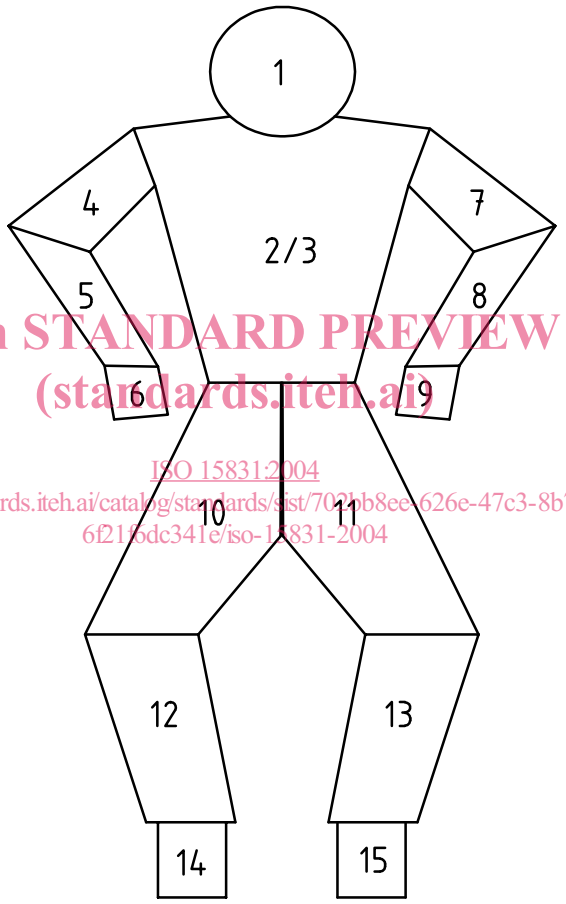
© ISO 2004 – All rights reserved

5 Apparatus

5.1 Manikin

5.1.1 Size and shape

The manikin, made from metal or plastic, shall be constructed to simulate the body of an adult human, i.e. it shall consist of an anatomically formed head, chest, abdomen, back, buttocks, arms, hands (preferably with fingers extended to allow gloves to be worn), legs and feet. The manikin shall consist of at least 15 body segments, each independently controlled with regard to surface temperature and monitored for heat flow. These 15 body segments shall be arranged as shown in Figure 1. If the manikin consists of more than 20 body segments, in the evaluation of the measured data, adjacent segments shall be combined using Equation (3), in order to approximate the segment arrangement shown in Figure 1.



iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47c3-8b7c-6f216dc341e/iso-15831-2004

Figure 1 — Schematic arrangement of the manikin's body segments

The body height of the manikin shall be (1,70 ± 0,15) m, with a body surface area of (1,7 ± 0,3) m^2.

The manikin's body proportions should correspond to those required for standard sizes of garments, because deviations in fit will affect the results.

For the measurement of I_t the manikin's arms and legs shall be movable, with joints at the shoulder, hip and knee. For the measurement of the clothing ensemble's resultant total thermal insulation, I_{tr}, the manikin, mechanically driven, shall perform (45 ± 2) double steps per min, and (45 ± 2) double arm movements per min cross walking. The stride length, measured from toe to toe, shall be (63 ± 10) cm, and the length of the arm movements, measured between the wrists at the base of the thumbs, (53 ± 10) cm.

© ISO 2004 – All rights reserved

5.1.2 Surface temperature

The manikin shall be constructed so as to maintain the same average constant temperature of (34,0 ± 0,2) °C measured at all segment surfaces of its nude body.

The surface temperatures of the manikin shall be measured by at least one appropriate temperature sensor (e.g. thermocouples, thermistors, resistance temperature devices) per body segment. The sensors shall not protrude more than 0,5 mm from the manikin's surface and shall be well bonded, both mechanically and thermally, to the manikin's surface. Lead wires shall be bonded to the surface, or preferably pass through the interior of the manikin.

When calculating the mean skin surface temperature of the manikin's body, each sensor temperature shall be area-weighted, considering the portion of the body surface area covered by the sensor.

5.1.3 Heating equipment and power measurement

Each body segment of the manikin shall be equipped with an independently controlled heating system, whose capacity is sufficiently high to guarantee a constant surface temperature of (34,0 ± 0,2) °C in the nude manikin at each body segment.

The dry heat flow from the manikin's body through the clothing can be determined by measuring the heating power necessary to maintain a constant surface temperature, supplied to each of the manikin's body segments during the test period.

The power measuring equipment shall be capable of giving an accurate average over the test period. Its accuracy shall be within ± 2 % of the value for the average power supplied to each body segment of the manikin during the test period.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

5.2 Controlled climatic chamber

ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47c3-8b7c-6f21f6dc341e/iso-15831-2004

5.2.1 General

The manikin shall be placed in a controlled climatic chamber, at least 2 m × 2 m × 2 m (length × width × height). The air flow in the chamber may be horizontal or vertical.

In the chamber, spatial variations within 0,5 m of the manikin's surface shall not exceed the following:

a) air temperature ± 1,0 °C;

b) relative humidity ± 10 %;

c) air speed ± 50 % of the mean value;

d) temperature of the walls, floor and ceiling shall not differ more than 1 K from the mean air temperature.

In the chamber, temporal variations during the test period shall not exceed the following:

e) air temperature ± 0,5 °C;

f) relative humidity ± 10 %;

g) air speed ± 20 % of the mean value for data averaged over 3 min.

5.2.2 Air temperature sensor(s)

To monitor the air temperature in the chamber during the test, a single sensor with an overall accuracy of ± 0,15 °C and a time constant not exceeding 1 min may be used. However, multiple sensors are preferable.

© ISO 2004 – All rights reserved

The temperature sensor(s) shall be placed at a distance of (0,5 ± 0,1) m from the manikin. If a single sensor is used, it shall be at least 1,0 m above the floor of the chamber. If multiple sensors are used, they shall be spaced at equal height intervals, and their readings averaged.

5.2.3 Relative humidity sensor

Any humidity sensing device with an accuracy of at least ± 5 % relative humidity and a repeatability of ± 3 % is acceptable. Only one location in the chamber needs to be monitored during the test to ensure that the temporal uniformity requirements mentioned in 5.2.1 are met.

5.2.4 Air speed sensor

For measuring the air speed in the climatic chamber an omni-directional anemometer with ± 0,05 m/s accuracy shall be used. Measurements shall be averaged for at least 3 min at locations spaced at equal height intervals (0,5 ± 0,1) m in front of the manikin. If it is demonstrated that the air speed does not vary temporally by more than ± 0,1 m/s, then it is not necessary to monitor air speed during a test.

6 Selection and preparation of test garments

It is desirable to independently test three different specimens of the clothing ensemble. However, if only one specimen is available, it shall be removed and put back on the manikin between each single measurement.

The garments tested shall be an appropriate fit to the manikin.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Garments should not normally be laundered or dry cleaned prior to testing, because different procedures may affect the results. However, if garments are cleaned the cleaning shall be in accordance with the care label, and the specific care procedures applied shall be stated in the test report.

ISO 15831:2004
https://standards.iteh.ai/catalog/standards/sist/702bb8ee-626e-47c3-8876-6f2116de341e/iso-15831-2004

Prior to testing, the garments shall be conditioned either at (20 ± 5) °C and (50 ± 20) % RH or at the test climate set in the climatic chamber for at least 12 h.

7 Test procedure

The manikin is dressed with the clothing ensemble to be tested, with each garment arranged on the appropriate part of its body as in practical use.

For the measurement of the total thermal insulation, I_t, the manikin is kept stationary, standing with its legs straight, and the arms hanging straight at its sides.

For the measurement of the resultant total thermal insulation, I_{tr}, the legs and arms of the manikin are mechanically moved, with the frequency and stride length specified in 5.1.1.

The skin surface temperature, T_{si}, at each of the manikin's body segments, is set and, during the test period, maintained at (34 ± 0,2) °C.

The air temperature in the climatic chamber, T_a, is set to at least 12 K below the manikin's mean skin temperature, T_s, and/or to a value ensuring a minimum heat flux of 20 W/m^2 at each segment of the manikin.

The relative humidity in the climatic chamber is set between 30 % and 70 %, preferably 50 %.

The air speed v_a in the climatic chamber is set to (0,4 ± 0,1) m/s.

After starting the test, allow the system to reach steady-state conditions, i.e., the skin surface temperatures, T_{si}, of the manikin's body segments and the power input to the segments during a time period of 10 min remain constant within ± 0,2 °C and ± 2 %, respectively.

© ISO 2004 – All rights reserved