
**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*

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Foreword

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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.

2.1

clothing ensemble

group of garments worn together on the body at the same time

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

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	$\frac{\text{m}^2\text{K}}{\text{W}}$
I_{tr}	resultant total thermal insulation of the clothing ensemble with the manikin moving	$\frac{\text{m}^2\text{K}}{\text{W}}$
RH	relative humidity of the air within the climatic chamber	%
T_a	air temperature within the climatic chamber	$^{\circ}\text{C}$
T_s	mean skin surface temperature of the manikin	$^{\circ}\text{C}$
T_{si}	skin surface temperature of the body segment i of the manikin	$^{\circ}\text{C}$
v_a	air speed in the climatic chamber	m/s

4 Principle

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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.