

This document is a preview generated by EVS

## **Ergonomics of the thermal environment - Determination of metabolic rate**

Ergonomics of the thermal environment -  
Determination of metabolic rate

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

<p>Käesolev Eesti standard EVS-EN ISO 8996:2004 sisaldab Euroopa standardi EN ISO 8996:2004 ingliskeelset teksti.</p> <p>Käesolev dokument on jõustatud 21.12.2004 ja selle kohta on avaldatud teade Eesti standardiorganisatsiooni ametlikus väljaandes.</p> <p>Standard on kättesaadav Eesti standardiorganisatsioonist.</p>	<p>This Estonian standard EVS-EN ISO 8996:2004 consists of the English text of the European standard EN ISO 8996:2004.</p> <p>This document is endorsed on 21.12.2004 with the notification being published in the official publication of the Estonian national standardisation organisation.</p> <p>The standard is available from Estonian standardisation organisation.</p>
--	---

<p><b>Käsitlusala:</b> The metabolic rate, as a conversion of chemical into mechanical and thermal energy, measures the energetic cost of muscular load and gives a numerical index of activity. Metabolic rate is an important determinant of the comfort or the strain resulting from exposure to a thermal environment. In particular, in hot climates, the high levels of metabolic heat production associated with muscular work aggravate heat stress, as large amounts of heat need to be dissipated, mostly by sweat evaporation.</p>	<p><b>Scope:</b> The metabolic rate, as a conversion of chemical into mechanical and thermal energy, measures the energetic cost of muscular load and gives a numerical index of activity. Metabolic rate is an important determinant of the comfort or the strain resulting from exposure to a thermal environment. In particular, in hot climates, the high levels of metabolic heat production associated with muscular work aggravate heat stress, as large amounts of heat need to be dissipated, mostly by sweat evaporation.</p>
---	---

ICS 13.180

Võtmesõnad:

**English version**

Ergonomics of the thermal environment  
**Determination of metabolic rate**  
(ISO 8996 : 2004)

Ergonomie de l'environnement thermique – Détermination du métabolisme énergétique (ISO 8996 : 2004)

Ergonomie der thermischen Umgebung – Bestimmung des körpereigenen Energieumsatzes (ISO 8996 : 2004)

This European Standard was approved by CEN on 2004-08-26.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

The European Standards exist in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

**CEN**

European Committee for Standardization  
Comité Européen de Normalisation  
Europäisches Komitee für Normung

**Management Centre: rue de Stassart 36, B-1050 Brussels**

## Foreword

International Standard

ISO 8996 : 2004 Ergonomics of the thermal environment – Determination of metabolic rate, which was prepared by ISO/TC 159 'Ergonomics' of the International Organization for Standardization, has been adopted by Technical Committee CEN/TC 122 'Ergonomics', the Secretariat of which is held by DIN, as a European Standard.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by April 2005 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard:

Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

## Endorsement notice

The text of the International Standard ISO 8996 : 2004 was approved by CEN as a European Standard without any modification.

## Contents

	Page
Foreword .....	2
1 Scope .....	3
2 Normative references .....	3
3 Principle and accuracy .....	3
4 Level 1, screening .....	5
4.1 Table for the estimation of metabolic rate by occupation .....	5
4.2 Classification of metabolic rate by categories .....	5
5 Level 2, observation .....	5
5.1 Estimation of metabolic rate by task requirements .....	5
5.2 Metabolic rate for typical activities .....	6
5.3 Metabolic rate for a work cycle .....	6
5.4 Influence of the length of rest periods and work periods .....	7
5.5 Obtaining values by interpolation .....	8
5.6 Requirements for the application of metabolic-rate tables .....	8
6 Level 3, analysis .....	8
6.1 Estimation of metabolic rate using heart rate .....	8
6.2 Relationship between heart rate and metabolic rate .....	9
7 Level 4, expertise .....	10
7.1 Determination of metabolic rate by measurement of oxygen consumption rate .....	10
7.2 The doubly labelled water method for long-term measurements .....	16
7.3 Direct calorimetry — Principle .....	16
Annex A (informative) Evaluation of the metabolic rate at level 1, screening .....	17
Annex B (informative) Evaluation of the metabolic rate at level 2, observation .....	19
Annex C (informative) Evaluation of the metabolic rate at level 3, analysis .....	22
Annex D (informative) Evaluation of the metabolic rate at level 4, expertise — Examples of the calculation of metabolic rate based on measured data .....	23

## 1 Scope

The metabolic rate, as a conversion of chemical into mechanical and thermal energy, measures the energetic cost of muscular load and gives a numerical index of activity. Metabolic rate is an important determinant of the comfort or the strain resulting from exposure to a thermal environment. In particular, in hot climates, the high levels of metabolic heat production associated with muscular work aggravate heat stress, as large amounts of heat need to be dissipated, mostly by sweat evaporation.

This International Standard specifies different methods for the determination of metabolic rate in the context of ergonomics of the climatic working environment. It can also be used for other applications — for example, the assessment of working practices, the energetic cost of specific jobs or sport activities, the total cost of an activity, etc.

The estimations, tables and other data included in this International Standard concern an “average” individual:

- a man 30 years old weighing 70 kg and 1,75 m tall (body surface area 1,8 m<sup>2</sup>);
- a woman 30 years old weighing 60 kg and 1,70 m tall (body surface area 1,6 m<sup>2</sup>).

Users should make appropriate corrections when they are dealing with special populations including children, aged persons, people with physical disabilities, etc.

## 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) applies.

ISO 9886, *Ergonomics — Evaluation of thermal strain by physiological measurements*

ISO 15265, *Ergonomics of the thermal environment — Risk assessment strategy for the prevention of stress or discomfort in thermal working conditions*

## 3 Principle and accuracy

The mechanical efficiency of muscular work — called the “useful work”,  $W$  — is low. In most types of industrial work, it is so small (a few percent) that it is assumed to be nil. This means that the total energy consumption while working is assumed equal to the heat production. For the purposes of this International Standard, the metabolic rate is assumed to be equal to the rate of heat production.

Table 1 lists the different approaches presented in this International Standard for determining the metabolic rate.

These approaches are structured following the philosophy exposed in ISO 15265 regarding the assessment of exposure. Four levels are considered here: