PD ISO/TS 16976-1:2015

BSI Standards Publication

Respiratory protective devices — Human factors

Part 1: Metabolic rates and respiratory flow rates

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National foreword

This Published Document is the UK implementation of ISO/TS 16976-1:2015. It supersedes DD ISO/TS 16976-1:2007 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PH/4, Respiratory protection.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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TECHNICAL SPECIFICATION

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Respiratory protective devices — Human factors —

Part 1: Metabolic rates and respiratory flow rates

Appareils de protection respiratoire — Facteurs humains —
Partie 1: Régimes métaboliques et régimes des débits respiratoires

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 15, *Respiratory protective devices*.

This second edition cancels and replaces the first edition (ISO/TS 16976-1:2007), of which it constitutes a major revision with the following technical change:

— 7.3 has been added.

ISO/TS 16976 consists of the following parts, under the general title *Respiratory protective devices — Human factors*:

— *Part 1: Metabolic rates and respiratory flow rates* [Technical Specification]

— *Part 2: Anthropometrics* [Technical Specification]

— *Part 3: Physiological responses and limitations of oxygen and limitations of carbon dioxide in the breathing environment* [Technical Specification]

— *Part 4: Work of breathing and breathing resistance: Physiologically based limits* [Technical Specification]

— *Part 5: Thermal effects* [Technical Specification]

— *Part 6: Psycho-physiological effects* [Technical Specification]

— *Part 7: Hearing and speech* [Technical Specification]

— *Part 8: Ergonomic factors* [Technical Specification]

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Introduction

For an appropriate design, selection, and use of respiratory protective devices, it is important to consider the basic physiological demands of the user. The type and intensity of work affect the metabolic rate (energy expenditure) of the wearer. The weight and weight distribution of the device on the human body also may influence metabolic rate. Metabolic rate is directly correlated with oxygen consumption, which determines the respiratory demands and flow rates. The work of breathing is influenced by the air flow resistances of the device and the lung airways. The work (or energy cost) of a breath is related to the pressure gradient created by the breathing muscles and the volume that is moved in and out of the lung during the breath. Anthropometric and biomechanical data are required for the appropriate design of various components of a respiratory protective device, as well as for the design of relevant test methods.

This part of ISO/TS 16976 is the first part of a series of documents providing basic physiological and anthropometric data on humans. It contains information about metabolic rates and respiratory flow rates for various types of physical activity.

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Respiratory protective devices — Human factors —

Part 1: Metabolic rates and respiratory flow rates

1 Scope

This part of ISO/TS 16976 provides information on factors related to human anthropometry, physiology, ergonomics, and performance for the preparation of standards for performance requirements, testing, and use of respiratory protective devices. This part of ISO/TS 16976 contains information related to respiratory and metabolic responses to rest and work at various intensities. Information is provided for the following:

— metabolic rates associated with various intensities of work;

— oxygen consumption as a function of metabolic rate and minute ventilation for persons representing three body sizes;

— peak inspiratory flow rates during conditions of speech and no speech for persons representing three body sizes as a function of metabolic rates.

The information contained within this part of ISO/TS 16976 represents data for healthy adult men and women of approximately 30 years of age, but is applicable for the age range of the general population.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8996:2004, *Ergonomics of the thermal environment — Determination of metabolic rate*

3 Terms and definitions

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

3.1
aerobic energy production
biochemical process in the human cells that delivers energy by combustion of fat, carbohydrates and, to a lesser extent, protein in the presence of oxygen, with water and carbon dioxide as end products

3.2
anaerobic energy production
biochemical process in the human cells that delivers energy by combustion of carbohydrates without oxygen, with lactic acid as the end product

3.3
ambient temperature pressure saturated
ATPS
standard condition for the expression of ventilation parameters related to expired air

Note 1 to entry: Actual ambient temperature and atmospheric pressure; saturated water vapour pressure.

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3.4
ambient temperature pressure humidity
ATPH
standard condition for the expression of ventilation parameters related to inspired air

Note 1 to entry: Actual ambient temperature, atmospheric pressure and water vapour pressure.

3.5
breath cycle
respiratory period comprising an inhalation and an exhalation phase

3.6
body temperature pressure saturated
BTPS
standard condition for the expression of ventilation parameters

Note 1 to entry: Body temperature (37 °C), atmospheric pressure 101,3 kPa (760 mmHg), and water vapour pressure (6,27 kPa) in saturated air.

3.7
peak inspiratory flow rate
highest instantaneous flow rate during the inhalation phase of a breath cycle

Note 1 to entry: It is expressed in l/s BTPS.

Note 2 to entry: L/s is the preferred unit as the flow takes place during only a short fraction of the breath cycle.

3.8
minute ventilation
V_E
total volume of air inspired (or expired) in the lungs during 1 min

Note 1 to entry: It is expressed in l/s BTPS.

3.9
oxygen consumption
V_{O2}
amount of oxygen consumed by the human tissues for aerobic energy production

Note 1 to entry: It is expressed in l/min STPD.

3.10
physical work capacity
ability of a person to engage in muscular work

3.11
standard temperature pressure dry
STPD
standard conditions for expression of oxygen consumption

Note 1 to entry: Standard temperature (0 °C) and pressure (101,3 kPa, 760 mmHg), dry air (0 % relative humidity).

4 Activity and metabolic rate

Users of respiratory protective devices (RPD) perform physical work at various intensities. Physical work, in particular when associated with large muscle groups as is the case with firefighting, requires high levels of metabolic energy production (metabolic rate). The energy is produced in human cells by aerobic or anaerobic processes.

Aerobic energy production is by far the most common form of energy yield for all types of human cells. It is also the normal form of energy production for the muscles. Depending on physical fitness and other

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