
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.

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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

- an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;
- an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 16976-1 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 15, *Respiratory protective devices*.

ISO 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]

The following parts are under preparation:

- *Part 2: Anthropometrics*
- *Part 3: Physiological responses and limitations of oxygen and limitations of carbon dioxide in the breathing environment*

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 Technical Specification 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 Technical Specification is part of a series that 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 Technical Specification contains information related to respiratory and metabolic responses to rest and work at various intensities. Information is provided for:

- 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 Technical Specification 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 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 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 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 human cells that delivers energy by combustion of carbohydrates without oxygen, with lactic acid as the end product