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Respiratory protective devices — Human factors —

Part 3: Physiological responses and limitations of oxygen and limitations of carbon dioxide in the breathing environment

Appareils de protection respiratoire — Facteurs humains —

Partie 3: Réponses physiologiques et limitations en oxygène et en gaz carbonique dans l'environnement respiratoire



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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 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;
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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order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn.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again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.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 16976-3 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 15, *Respiratory protective devices*.

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

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Introduction

Due to the nature of their occupations, millions of workers worldwide are required to wear respiratory protective devices (RPD). RPD vary considerably, from filtering devices, supplied breathable gas devices, and underwater breathing apparatus (UBA), to escape respirators used in emergency situations (self-contained self-rescuer or SCSR). Many of these devices protect against airborne contaminants without supplying air or other breathing gas mixtures to the user. Therefore, the user might be protected from particulates or other airborne toxins but still be exposed to an ambient gas mixture that differs significantly from that which is normally found at sea level. RPD that supply breathing air to the user, such as an SCBA or UBA, can malfunction or not adequately remove carbon dioxide from the breathing space, thus exposing the user to an altered breathing gas environment. In special cases, RPD intentionally expose the wearer to breathing gas mixtures that significantly differ from the normal atmospheric gas mixture of approximately 79 % nitrogen and 21 % oxygen with additional trace gases. These special circumstances occur in aviation, commercial and military diving, and in clinical settings.

Breathing gas mixtures that differ from normal atmospheric can have significant effects on most physiological systems. Many of the physiological responses to exposure to high or low levels of either oxygen or carbon dioxide can have a profound effect on the ability to work safely, to escape from a dangerous situation, and to make clear judgements about the environmental dangers. In addition, alteration of the breathing gas environment can, if severe enough, be dangerous or even fatal. Therefore, monitoring and controlling the breathing gas, and limiting user exposure to variations in the concentration or partial pressure of oxygen and carbon dioxide, is crucial to the safety and health of the worker.

This Technical Specification discusses the gas composition of the Earth's atmosphere; the basic physiology of metabolism as the origin of carbon dioxide in the body, respiratory physiology and the transport of oxygen to the cells and tissues of the body; and the subsequent transport of carbon dioxide from the tissues to the lungs for removal from the body. Following the basic physiology of respiration, this Technical Specification addresses the physiological responses to altered breathing environments (hyperoxia, hypoxia) and to the effects of excess carbon dioxide in the blood (hypercarbia). Examples are given from the relevant biomedical literature.

Finally, it deals with the impact of altered partial pressures/concentrations of oxygen and carbon dioxide on respirator use. The content of this Technical Specification is intended to serve as the basis for advancing research and development of RPD with the aim of minimizing the changes in the breathing environment, thus minimizing the physiological impact of RPD use on the wearer. If this can be accomplished, the health and safety of all workers required by their occupation to wear RPD will be enhanced.