SLOVENSKI STANDARD
oSIST prEN ISO 7726:2023

01-julij-2023

Nadomešča:
SIST EN ISO 7726:2002

Ergonomija toplotnega okolja - Instrumenti za merjenje in spremljanje fizikalnih veličin (ISO/DIS 7726:2023)

Ergonomics of the thermal environment - Instruments for measuring and monitoring physical quantities (ISO/DIS 7726:2023)

Ergonomie der thermischen Umgebung - Instrumente zur Messung physikalischer Größen (ISO/DIS 7726:2023)

Ergonomie des ambiances thermiques - Appareils de mesure des grandeurs physiques (ISO/DIS 7726:2023)

Ta slovenski standard je istoveten z: **prEN ISO 7726**

ICS:

13.180	Ergonomija	Ergonomics
17.020	Meroslovje in merjenje na splošno	Metrology and measurement in general

oSIST prEN ISO 7726:2023 **en,fr,de**

DRAFT INTERNATIONAL STANDARD
ISO/DIS 7726

ISO/TC **159**/SC **5** Secretariat: **BSI**

Voting begins on: **2023-05-25** Voting terminates on: **2023-08-17**

Ergonomics of the thermal environment — Instruments for measuring and monitoring physical quantities

ICS: 13.180

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

Reference number
ISO/DIS 7726:2023(E)

Contents

Page

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. www.iso.org/directives

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 XXX.

Introduction

This document is one of a series of International Standards intended for use in the study of thermal environments.

This series of International Standards deals in particular with

— the finalization of definitions for the terms to be used in the methods of measurement, testing or interpre-tation, taking into account standards already in existence or in the process of being drafted;

— the laying down of specifications relating to the methods for measuring the physical quantities which char-acterize thermal environments;

— the selection of one or more methods for interpreting the parameters;

— the specification of recommended values or limits of exposure for the thermal environments coming within the comfort range and for extreme environments (both hot and cold);

— the specification of methods for measuring the efficiency of devices or processes for personal or collective protection from heat or cold.

Any measuring instrument which achieves the accuracy indicated in this International Standard, or even bet-ter improves on, may be used.

The description or listing of certain instruments in the annexes can only signify that they are "recommended", since characteristics of these instruments may vary according to the measuring principle, their construction and the way in which they are used. It is up to users to compare the quality of the instruments available on the market at any given moment and to check that they conform to the specifications contained in this Inter-national Standard.

Ergonomics of the thermal environment — Instruments for measuring and monitoring physical quantities

1 Scope

This International Standard specifies the minimum characteristics of instruments for measuring physical quantities characterizing an environment as well as the methods for measuring the physical quantities of this environment.

Its aim is simply to standardize the process of recording information leading to the determination of values of physical quantities. Other International Standards give details of the methods making use of the information obtained in accordance with this standard.

This International Standard is used as a reference when establishing

a) specifications for manufacturers and users of instruments for measuring the physical quantities of the environment;

b) a written contract between two parties for the measurement of these quantities.

It applies to the influence of hot, moderate, comfortable or cold environments on people. This Standard is applied in the cases in which comfort or human strain are the main concern and may be supersedes by other Standards.

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.

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the

possibility of applying the most recent edition of the standard indicated below. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 7243, *Ergonomics of the thermal environment — Assessment of heat stress using the WBGT (wet bulb globe temperature) index*

ISO 7730, *Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria*

ISO 7933, *Ergonomics of the thermal environment – Analytical determination and interpretation of heat stress using calculation of the predicted heat strain*

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

ISO 9920, *Ergonomics of the thermal environment — Estimation of thermal insulation and water vapour resistance of a clothing ensemble*

ISO 11079, *Ergonomics of the thermal environment — Determination and interpretation of cold stress when using required clothing insulation (IREQ) and local cooling effects*

ISO 13731, *Ergonomics of the thermal environment — Vocabulary and symbols*

ISO 14505-2, *Ergonomics of the thermal environment - Evaluation of thermal environment*

in vehicles. Part 2: Determination of Equivalent Temperature.

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

ISO 15743, *Ergonomics of the thermal environment — Cold workplaces — Risk assessment and management*

3 Terms and definitions

3.1 Symbols and abbreviation

For the purposes of this Standard the definitions given in ISO 13731 and the following apply.

Cres	respiratory convective heat flow, [W·m-2]
E	evaporative heat flow at the skin surface, [W·m-2]
Eres	respiratory evaporative heat flow, [W·m-2]
Icl,st	static clothing thermal insulation, [W·m-2·K]
K	conductive heat flow, [W·m-2]
M	metabolic rate, [W·m-2]
p	atmospheric pressure, [Pa]
pa	water vapour partial pressure at air temperature, [Pa]
R	radiative heat flow, [W·m-2]
C	convective heat flow, [W·m-2]-2
Re,cl	static clothing water vapour resistance, [m2·kPa·W-1]
RH	relative humidity, [%]
S	body heat storage rate, [W·m-2]
ta	air temperature, [°C] or [K]
td	dew-point temperature, [°C] or [K]
tg	globe temperature or black globe temperature or temperature of the sensor placed inside the globe, [°C] or [K]
tnw	natural wet bulb temperature, [°C] or [K]
to	operative temperature, [°C] or [K]
tpr	plane radiant temperature, [°C] or [K]
tr	mean radiant temperature, [°C] or [K]
ts	surface temperature, [°C] or [K]
tw	wet bulb temperature, [°C] or [K]

va air velocity, [m·s-1]

W effective mechanical power, [W·m-2]

wa humidity ratio, [g·kg-1]

4 General

4.1 Specifications and methods

The specifications and methods contained in this International Standard have been divided into two classes according to the extent of the thermal annoyance to be assessed. The type C specifications and methods re-late to measurements carried out in moderate environments. The type S specifications and methods relate to measurements carried out in severe environments.

The specifications and methods described for each of these classes have been determined bearing in mind the practical possibilities of in situ measurements and monitoring and the performances of measuring instruments available at present.

Instructions for monitoring (how, where, when) and for post processing recorded data are provided.

4.2 The heat exchanges between human body system and its environment

The energy balance equation on the human body is:

$$S = (M-W) \pm R \pm C \pm E \pm Eres \pm Cres \pm K \quad (1)$$

where

S body heat storage rate

M metabolic rate

W effective mechanical power

R radiative heat flow

C convective heat flow

E evaporative heat flow at the skin

Eres respiratory evaporative heat flow

Cres respiratory convective heat flow

K conductive heat flow

Where the sign ± indicates the direction of heat flow between the human body and its surroundings.

Each term in equation (1) requires the knowledge of some physical quantities. In tables 1 these quantities and their connections with energy balance on a human body are shown.

In general, the quantities affecting the energy balance on a system can be divided into two categories, basic and derived, depending to the possibility to measure them directly or indirectly.

Table 1 — Main independent quantities involved in the analysis of the thermal balance on human body and analysed in this Standard. Heat conduction is not considered because its limited influence on the total balance.

Elements in thermal balance	t_a Air temperature	t_r Mean radiant temperature	t_s Surface temperature	v_a Air velocity	p_a Partial vapour pressure
Heat transfer by radiation, R		X	X		
Heat transfer by convection, C[1)]	X			X	
Heat exchanges through evaporation: — **evaporation from the skin, E** — **evaporation by respiration, E_{res}**				X	X
Convection by respiration, C_{res}	X				
Heat transfer by conduction			**X**		

1) **Heat transfer by convection is also affected by body movements. The resultant air velocity at skin level is usually defined relative air velocity (v_{ar}).**

5 The physical quantities characterizing heat exchanges between a system and its environment

5.1 The basic physical quantities

The basic physical quantities are the quantities directly measurable.

These quantities are as follows:

- air temperature;
- radiation;
- plane radiant temperature;
- dew point temperature;
- relative humidity;
- air velocity;
- surface temperature;
- globe temperature;
- wet bulb temperature;
- natural wet bulb temperature.

5.1.1 Air temperature

It is the temperature of the air around the human body. It is measured by a temperature sensor shielded against radiation (see Annex A).

5.1.2 Radiation directional

It is the energy exchanged by radiation from system and its environment. It can be measured by a radiometer (see Annex C).

5.1.3 Plane radiant temperature

It is the uniform temperature of an enclosure where the irradiance on one side of a small plane element is the same as in the non-uniform actual environment. It can be measured from radiation with a radiometer or calculated from the surface temperatures of the environment and the shape factors between the surfaces and the plane element (see Annex C).

5.1.4 Dew point temperature

The dew-point temperature is defined as the temperature at which the partial vapor pressure of water in moist air would be sufficient to saturate the air. In other words, the partial vapor pressure at the given temperature is equal to the partial saturation vapor pressure at the dew-point temperature (see Annex D).

5.1.5 Relative humidity

The relative humidity is the actual vapour pressure divided by vapour pressure at saturation at the same temperature (see Annex D).

5.1.6 Surface temperature

It is the temperature of a given surface. This is used to evaluate the radiant heat exchange between the hu-man body by means of the mean radiant and/or the plane radiant temperature. It is also used to evaluate the effect of direct contact between the body and a given surface (see Annex F).

5.1.7 Air velocity

It is a quantity defined by its magnitude and direction. The quantity to be considered in the case of thermal environments is the magnitude of the velocity vector of the flow at the measuring point considered (see Annex E).

5.1.8 Globe temperature

is the temperature measured from a black-globe thermometer consisting of a black globe in the centre of which is placed a temperature sensor such as a thermocouple or a resistance probe (see Annex B).

5.1.9 Wet bulb temperature

The wet-bulb temperature is the reading registered by a temperature sensor, shielded against radiation, placed in a moist gas stream and covered with a wetted cloth or wick. This temperature is lower than that of the gas stream itself and is the dynamic equilibrium value attained when the convective heat transfer to the sensor effectively equals the evaporative heat load associated with the moisture loss from the wetted sur-face. If small corrections are applied to a wet bulb thermometer (e.g. a gas stream velocity greater than 3 m·s-1), it returns with a good approximation the thermodynamic wet-bulb temperature. This is the limiting temperature reached as a gas cools on adiabatic saturation and is more properly termed the adiabatic-saturation temperature to avoid confusion (see Annex D).

5.1.10 Natural wet bulb temperature

The natural wet bulb temperature is the temperature value read by a sensor covered with a wetted wick that is ventilated naturally (i.e. placed in the environment under consideration without additional forced ventilation). Since the sensor is unshielded, this quantity is affected also by radiation and cannot be confused with the psychrometric wet bulb temperature (see Annex H).

5.2 Derived physical quantities

The derived physical quantities are calculated from basic ones or represent or characterize a group of factors of the environment, weighted according to the characteristics of the sensors used. The second ones are often used to define an empirical index of comfort or thermal stress without having recourse to a rational method based on estimates of the various forms of heat exchanges between the human body and the thermal environments, and of the resulting thermal balance and physiological strain. Some derived quantities are de-scribed in the specific standards as they apply and where measuring requirements are included.

— mean radiant temperature;

— radiant temperature asymmetry;;

— operative temperature;

— partial vapour pressure;

— humidity ratio.

5.2.1 Mean radiant temperature

It is the uniform temperature of an imaginary enclosure in which radiant heat transfer from the human body is equal to the radiant heat transfer in the actual non-uniform enclosure.

The mean radiant temperature can be calculated from quantities measured by instruments which allow the generally heterogeneous radiation from the walls of an actual enclosure to be "integrated" into a mean value (see annex B).

The mean radiant temperature can also be calculated from measured values of the temperature of the sur-rounding walls and the size of these walls and their position in relation to a person. (See annex B.)

The mean radiant temperature may also be calculated from the plane radiant temperature in six opposite directions weighted according to the projected area factors for a person. Similarly, it can be estimated from the measurement of the radiant flux from different directions. (See annex B).

NOTE The concept of mean radiant temperature allows the study of radiative exchanges between man and his environment. It presupposes that the effects on man of the actual environment which is generally heterogeneous and the virtual environment which is defined as homogeneous are identical. When this hypothesis is not valid, in particular in the case of asymmetric radiation, the radiation exchanges arising from thermally different regions and the extent of their effect on man should also be assessed using the concept of plane radiant temperature.

5.2.2 Radiant temperature asymmetry

The radiant temperature asymmetry is the difference between the plane radiant temperature of the two oppo-site sides of a small plane element (see 5.1.3).

The concept of radiant temperature asymmetry is used when the mean radiant temperature does not completely describe the radiative environment, for instance when the radiation is coming from opposite parts of the space with appreciable thermal heterogeneities (see Annex B).

The asymmetric radiant field is defined in relation to the position of the plane element used as a reference. It is, however, necessary to specify exactly the position of the latter by means of the direction of the normal to this element.

The radiant temperature asymmetry is measured or calculated from the measured value of the plane radiant

temperature in the two opposing directions (see Annex C).

5.2.3 Operative temperature

The operative temperature is the uniform temperature of an imaginary black enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the actual non-uniform environment (see Annex G).

5.2.4 Partial vapour pressure

The partial vapour pressure of a sample of moist air is the pressure which the water vapour would exert if it alone occupied the whole volume occupied by the mixture at the same temperature. It is proportional to the absolute humidity, which represents to the actual amount of water vapour contained in the air as opposed to quantities such as the relative humidity or the saturation level.

The partial vapour pressure can be determined directly or indirectly by the measurement of several quantities simultaneously (see Annex D).

5.2.5 Humidity ratio

The humidity ratio of a given moist air sample is defined as the ratio of the mass of water vapor to the mass of dry air in the sample (see Annex D).

5.2.6 Turbulence intensity

Turbulence Intensity is a scale characterizing turbulence expressed as a percent.

6 The characteristics of physical quantities measuring instruments

The characteristics depend on the class (C and S).

6.1 Characteristics of instruments for measuring the basic quantities

When a measurement is carried out, it is necessary to make difference between the accuracy of the physical quantity that is affected by the variables involved in the measuring operations (e.g. the position of the sensors) and the accuracy of the sensor. To obtain reliable results the former is the most important.

The measuring ranges, the measuring accuracy of the sensors for measuring the basic quantities are summarized in table 3. These characteristics shall be considered to be minimum requirements for each class (C and S). That means that according to needs and technical manufacturing possibilities, it is always possible to specify more exact characteristics or more prescriptive values. For certain quantities, very precise thermal stress measurements may require the use of appliances with measuring ranges in class S and accuracy of class C.

		Class C (comfort)			Class S (stress)			Comments
Quantity	**Symbol**	**Measuring range**	**Accuracy**	**Response time**	**Measuring range**	**Accuracy**	**Response time**	
Air temperature	t_a	10 °C ÷ 35 °C	Required: ±(0,3 °C + 0,005·|t_a|°C) Desiderable: ±(0,1 °C + 0,001 7·|t_a|°C)	≤1 min	-60 °C ÷ 150 °C	Required: ±(0,6 °C + 0,01·|t_a|°C) Desiderable: ±(0,15 °C + 0,002·|t_a|°C)	≤1 min	Response time takes into account that the measurement is carried out in air.

