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Ergonomics of the thermal environment — Management of working conditions in hot environments

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Foreword

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This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 5, *Ergonomics of the physical environment*.

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Introduction

This document belongs to a group of thermal standards intended for use in the assessment and management of work in hot environments.

Several outdoor and indoor lines of industries, commerce and occupations involve substantial exposure, where individuals can be exposed to high temperatures, humidity and/or thermal radiation. Working in such hot environments can lead to several adverse effects on human performance and health, such as thermal discomfort, increased strain, decreased performance and heat-related disorders. Heat can also interfere with several other factors in the workplace, modifying or aggravating the risk of common hazards and increasing the risk of heat-associated disorders. In addition, skin contact with hot surfaces can lead to burns.

Due to the negative impact of heat on human health and performance, as well as on work productivity, quality and safety, it is necessary to consider a comprehensive strategy of risk assessment and management practices.

While other standards have described specific indices to be used to assess the hot work environment and the potential physiological consequences, this document describes the methods and practices for organizing the management of these work environments and the supervision of the exposed persons.

The choice of when to use the methods described in this document is at the discretion of the persons responsible for occupational safety and/or health.

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Ergonomics of the thermal environment — Management of working conditions in hot environments

1 Scope

This document adopts an approach where actions, particularly control measures and medical supervision, are specified as a function of the class of severity of the potential effects. It provides instructions for appropriate management practices for hot workplaces and describes:

— a procedure for managing work in hot environments;

— guidelines on how to apply the different International Standards in the field of thermal environments when assessing heat-related risks;

— guidelines to organize the medical supervision of the people working in hot environments;

— information for instructing the persons working in hot environments;

— an example of assessment of a hot working situation.

The procedure described in this document aims to anticipate the problems related to work in warm to hot environments by classifying the different work situations according to their potential health effects, informing the persons concerned (workers and management) of the seriousness of these effects, planning appropriate measures to be implemented to prevent these effects and providing medical surveillance of exposed persons.

This document supports good occupational safety and health practices and is applicable to both indoor and outdoor work situations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 15265:2004, *Ergonomics of the thermal environment — Risk assessment strategy for the prevention of stress or discomfort in thermal working conditions*

3 Terms, definitions and symbols

3.1 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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3.2 Symbols and abbreviated terms

Symbol or abbreviated term	Definition	Units
D_{lim}	duration limit of exposure	min
EC	exposure class of a work situation	
I_{cl}	static (or basic) clothing thermal insulation	clo
M	metabolic rate	W
p_a	partial water vapour pressure	kPa
PHS	predicted heat strain	
PMV	predicted mean vote	
PPD	predicted percentage of dissatisfied	%
RH	relative humidity	%
t_a	air temperature	°C
t_g	globe temperature	°C
TEF	thermal exposure form of a work situation	
v_a	air velocity	$m \cdot s^{-1}$
WBGT	wet bulb globe temperature	°C
WBGTlim	limit of the WBGT index as a function of metabolic rate	°C

4 Classification of the working situations in hot environments

4.1 General

The nature and the urgency of the control measures to improve and eliminate a working situation where a heat-related health problem could occur depend upon the severity of this problem. Table 1 defines the six ECs and the classification criteria, according to the PMV value and the D_{lim} of the thermal condition. As defined in ISO 7933, D_{lim} is the duration of exposure after which either the total sweating exceeds 3 % of the body weight of the average worker or the core temperature reaches 38 °C.

Table 1 — Definition of the six ECs for hot working situations

EC	Definition	Criteria
1	Thermal comfort as defined in ISO 7730[1)]	$-0{,}7 < PMV < 0{,}7$
2	Light thermal discomfort	$0{,}7 \leq PMV < 1{,}7$
3	Strong thermal discomfort	$1{,}7 \leq PMV$ and $D_{lim} \geq 480$ min
4	Thermal constraint in the long term	$120 < D_{lim} < 480$ min
5	Thermal constraint in the short term	$30 < D_{lim} \leq 120$ min
6	Immediate thermal constraint	$D_{lim} \leq 30$ min

This document describes the procedure to identify as soon as possible the EC of a given work environment, select accordingly the optimal control measures to eliminate or minimize the exposure, organize the working situation in consequence and protect adequately the exposed persons.

1) Under preparation. Stage at the time of publication: ISO/DIS 7730:2024.

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4.2 Risk management system

The heat risk management model shall be fully integrated into the occupational health and safety management system and practices of the organization, to ensure the implementation and continuance of the activities.

NOTE This kind of system can be established according to, for example, ISO 45001, which was prepared to be compatible with ISO 9001 for quality management systems and ISO 14001 for environmental management systems.

4.3 Exposure assessment and prevention procedure

4.3.1 General

The exposure assessment procedure follows the principles presented in ISO 15265, with the addition of an initial stage for the recognition of the situations where a heat-related health problem could occur. The procedure therefore includes four stages and is illustrated in Figure 1.

— Stage 1, screening: where the working situations that are causing or are likely to lead to heat stress exposures are identified and listed.

— Stage 2, observation: where the working situations identified in stage 1 are reviewed qualitatively to determine the simple and straightforward measures to be implemented to reduce the class of the working situation to EC 1, or at least EC 2.

  A decision is made to perform a further analysis if the problem is neither eliminated nor sufficiently reduced, or whenever it is uncertain whether the preventive actions will be or have been sufficient to guarantee the persons' health and safety.

— Stage 3, analysis: where quantitative evaluations are made of the parameters characterizing the working situations and the thermal indices defined in ISO 7730 (PMV and PPD), ISO 7243 (WBGT) and ISO 7933 (PHS) are computed. Additional control or organisational measures are determined and their effects to improve the working situations are evaluated.

  It is anticipated that most common problems of work in hot situations can be managed using the methods and procedures in stages 1 to 3. For unusual or peculiar work circumstances, a further expertise stage is conducted (stage 4).

— Stage 4, expertise: will usually deal with highly complex thermal working circumstances and require sophisticated or specific measurements. This stage is conducted by the same persons as stage 3, with the additional assistance of highly specialized experts. The approach and techniques that are required will vary according to the nature of the problem and are within the responsibility of the intervening experts. This stage will therefore not be further discussed in this document.

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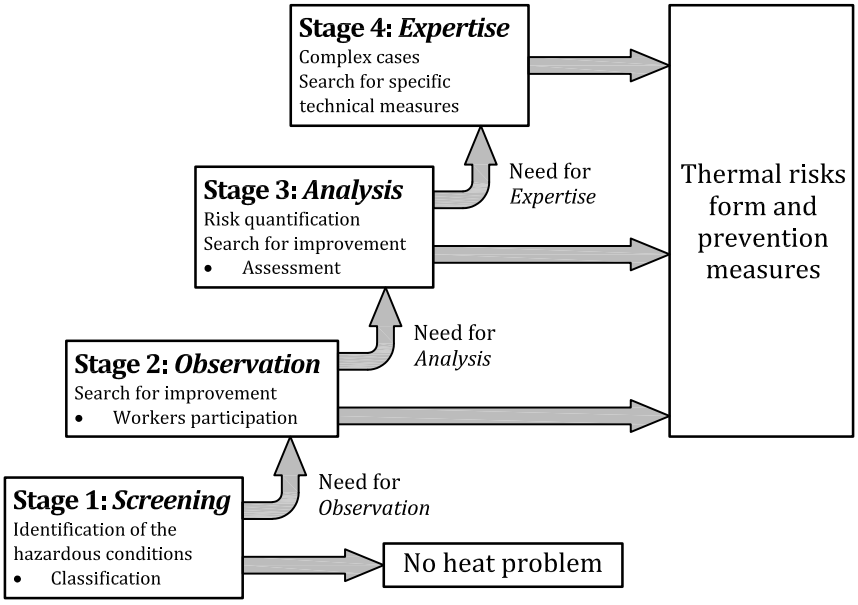

Figure 1 — Model for heat risk assessment in workplaces

4.3.2 Stage 1, screening

The screening datasheet presented in Annex A can be used to conduct this screening to identify the climatic working situations that need to be assessed, as these can lead to thermal problems for the persons exposed. This stage is performed in anticipation of the problems by a qualified health and safety professional.

The procedure is as follows:

a) Consider the work situation as a whole: before using the checklist, review the different exposure circumstances that can exist (e.g. day, night, season, production demands).

b) Categorize these work circumstances and choose to study the circumstance(s) that is (are) most thermally problematic.

c) Complete the data sheet for each selected work circumstance by checking separately each aspect listed and retaining the options that best match.

d) Collect the opinion of the workers involved in the activity.

e) Record any information related to each aspect.

At the end of this stage, it is decided:

— whether the working situation is definitely of EC 1 or 2, in which case the procedure comes to an end;

— whether additional information needs to be collected to reach a professional decision, in which case the procedure of evaluation proceeds to stage 2.

This screening data sheet shall be periodically reviewed in one of the following instances:

— at least once a year, preferably before the hot season in the case of seasonal variations;

— when the work activity has changed substantially;

— when the work environment has changed significantly.

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