IEC®

IEC 60068-3-1

Edition 3.0 2023-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 3-1: Supporting documentation and guidance – Cold and dry heat tests

Essais d'environnement –
Partie 3-1: Documentation d'accompagnement et recommandations – Essais de froid et de chaleur sèche

IEC 60068-3-1:2023-06(en-fr)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

IEC 60068-3-1

Edition 3.0 2023-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 3-1: Supporting documentation and guidance – Cold and dry heat tests

Essais d'environnement –
Partie 3-1: Documentation d'accompagnement et recommandations – Essais de froid et de chaleur sèche

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 19.040

ISBN 978-2-8322-7134-6

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

Part 3-1: Supporting documentation and guidance – Cold and dry heat tests

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with can participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication can be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60068-3-1 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test. It is an International Standard.

This third edition cancels and replaces the second edition published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) information relating to specimen temperatures has been revised;
b) information relating to tests of multiple specimens has been revised;
c) the effect of air density has been added;
d) a recommendation for corrective actions regarding IR radiation has been added;
e) the requirements for the mounting and supports of the specimen have been revised.

The text of this International Standard is based on the following documents:

Draft	Report on voting
104/986/FDIS	104/1002/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60068 series, published under the general title *Environmental testing*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

ENVIRONMENTAL TESTING –

Part 3-1: Supporting documentation and guidance – Cold and dry heat tests

1 Scope

This part of IEC 60068 provides guidance regarding the performance of cold and dry heat tests.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
heat-dissipating specimen
specimen on which the hottest point on its surface, measured in free-air conditions and under the air pressure as specified in IEC 60068-1, is more than 5 K above the ambient temperature of the surrounding atmosphere after thermal stability has been reached

[SOURCE: IEC 60068-1:2013, 3.6, modified – The definition has been slightly adapted and Note 1 to entry has been deleted.]

3.2
non heat-dissipating specimen
specimen on which the hottest point on its surface, measured in free-air conditions and under the air pressure as specified in IEC 60068-1, is equal or less than 5 K above the ambient temperature of the surrounding atmosphere after thermal stability has been reached

3.3
free-air conditions
conditions within an infinite space where the movement of the air is affected only by the heat-dissipating specimen

Note 1 to entry: Free-air conditions can apply to the laboratory environment. The conditions during the measurement should be stated in the test report (if not specified otherwise).

[SOURCE: IEC 60068-1:2013, 3.7, modified – In the preferred term "free" has been added, in the definition "itself" has been deleted and the Note 1 to entry has been added.]

4 Selection of test procedures

4.1 General background

4.1.1 General

Specimen performance can be influenced or limited by the temperatures in which the specimen is operated. The level of influence can be affected by test gradients that exist within the test system (climatic or environmental chamber) and internal temperatures within the specimen itself. In order to determine the level of influence that exists and to ensure that the specimen is designed appropriately, cold or dry heat tests or both are performed.

4.1.2 Ambient temperature

The maximum and minimum ambient temperature values, in which the specimen is intended to operate, should be known. Preferred values for testing purposes are provided in IEC 60068-2-1 or IEC 60068-2-2 or both.

Difficulties can arise due to the fact that heat transfer causes temperature variations in the area surrounding the specimen. Consequently, the effect from the transfer of heat to the ambient temperature of the surrounding atmosphere should be considered. Airflow related to spacing between specimens should also be considered when performing a test.

4.1.3 Specimen temperatures

The performance of the specimen can be affected by its own temperature in the case of heat-dissipating specimens. Because of this, when controlling the test environment, it can be necessary to measure the temperature of the specimen under test at different locations, both internally and externally.

The change of temperature at a point on the surface of a specimen follows approximately an exponential law. Inside large specimens, temperature equalization can be reached with significant delay.

In case of doubt, how the temperature change is reflected by the specimen, the monitoring of the temperature of the specimens at a representative point (or points) is recommended.

NOTE For further information on the influence of test temperatures on specimens, IEC 60068-2-14 or IEC 60068-3-11 can be helpful.

4.1.4 Non heat-dissipating specimens

If the ambient temperature is uniform and constant and there is no generation of heat within the specimen, heat will flow from the ambient atmosphere into the specimen if the ambient atmosphere is at a higher temperature. Conversely, heat will flow from the specimen into the ambient atmosphere if the specimen is at a higher temperature. This heat transfer will continue until the specimen has completely reached thermal equilibrium with the surrounding atmosphere. From that moment on, the heat transfer ceases and will not start again unless the ambient temperature changes.

4.1.5 Heat-dissipating specimens

If heat is generated within the specimen, the temperature of the specimen will rise to a stabilization point above the ambient temperature. It follows that if a steady temperature is reached, heat will flow continuously from the specimen by convection, radiation, and conduction into the atmosphere whereby the specimen is cooled.

If more than one specimen is subjected to a dry heat test in the same chamber, it is necessary to ensure that all specimens are in the same ambient temperature and have identical mounting conditions. It can become necessary to differentiate between testing of single specimens and multiple specimens when the cold test is being performed.

NOTE If more than one specimen is tested in the same test chamber, a uniform incoming airflow can be disturbed.

4.2 Mechanisms of heat transfer

4.2.1 Convection

Heat transfer through convection is an important factor when testing heat-dissipating specimens. The coefficient of heat transfer from the surface of the test specimen to the ambient air is affected by the velocity and density of the surrounding air. The greater the air velocity, the more efficient the heat transfer is. Therefore, the higher the air velocity, the lower the surface temperature of the test specimen will be with the same temperature of the ambient air. This effect is illustrated in Figure 1 and Figure 2.

Air density also has a significant influence on heat transfer. Cold air is denser than warm air. Therefore, hot air causes a lower heat transfer than cold air.

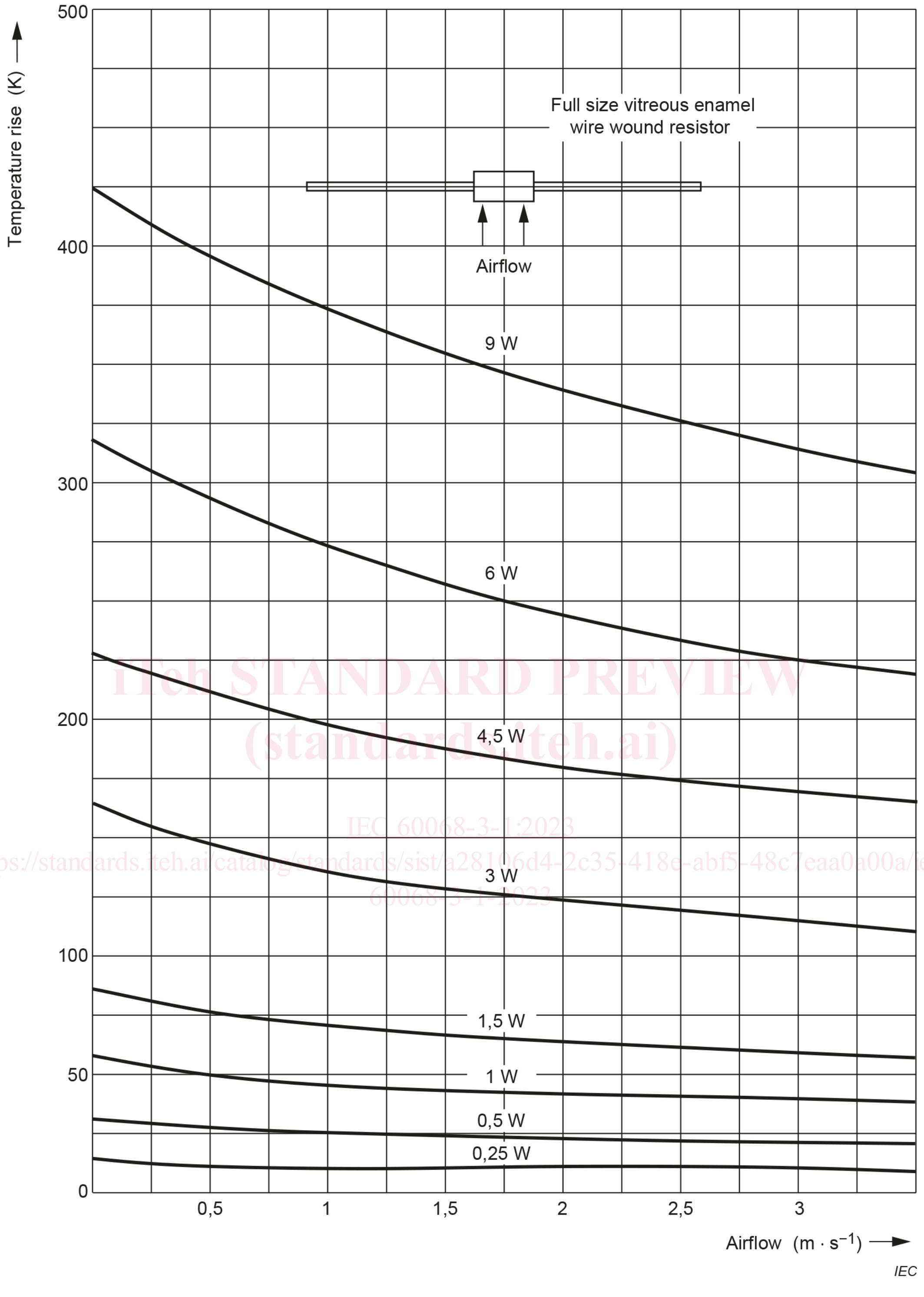

Figure 1 – Experimental data on the effect of airflow on the surface temperature of a wire-wound resistor – Radial airflow

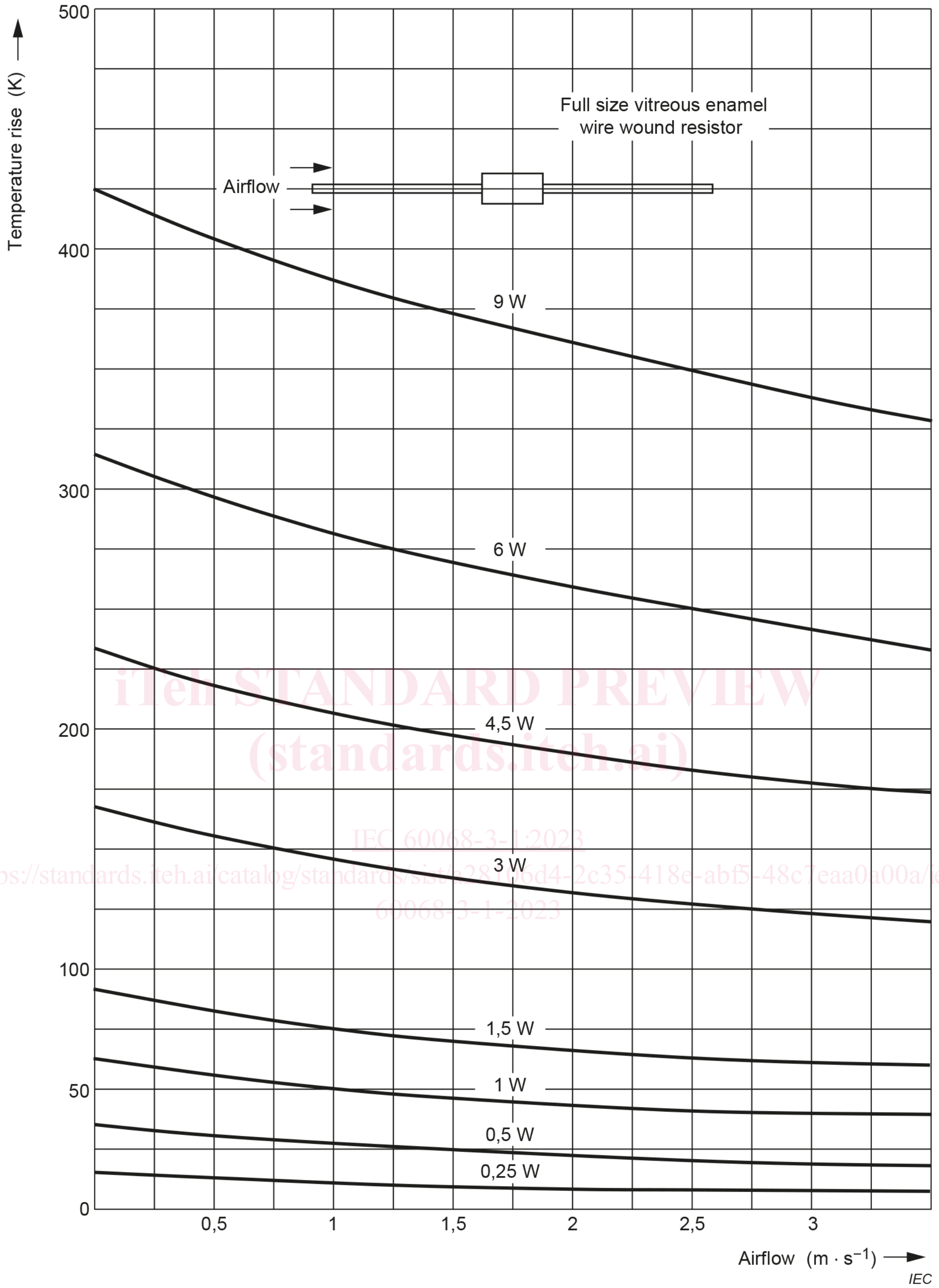

Figure 2 – Experimental data on the effect of airflow on the surface temperature of a wire-wound resistor – Axial airflow

In addition to the influence on the surface temperature of the test specimen, the airflow within the chamber will also affect the temperature distribution over the surface of the specimen under test. This effect is illustrated in Figure 3.

Therefore, when testing heat-dissipating specimens, the effects of airflow around or over the specimen should be known to ensure that the conditions approximate as close as possible typical free-air conditions or those conditions expected when the specimen is in use.

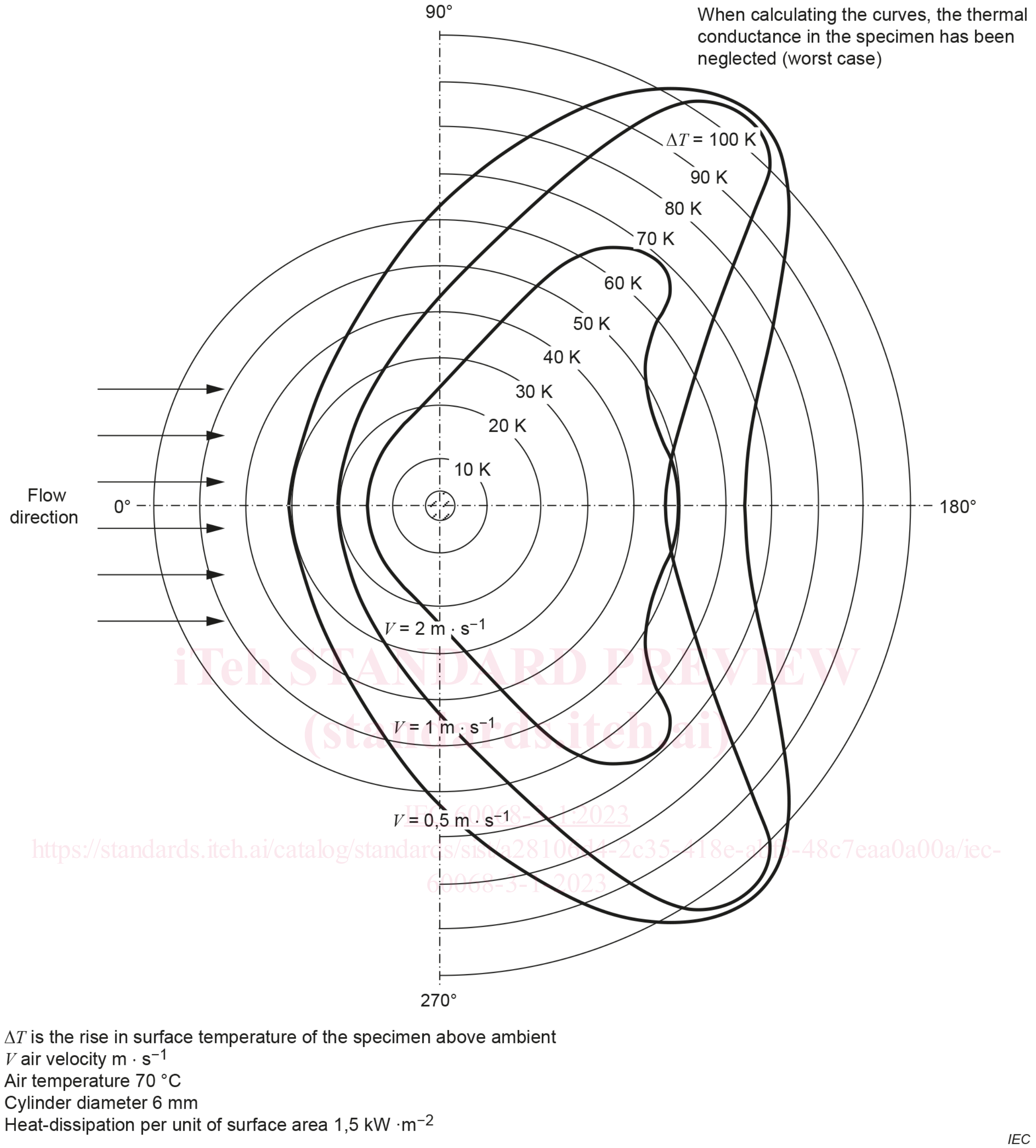

Figure 3 – Temperature distribution on a cylinder with homogeneous heat generation in airflow of velocities (0,5, 1 and 2) m · s^{-1}

4.2.2 Radiation

Heat transfer by thermal radiation cannot be neglected when test chamber conditions for testing of heat-dissipating specimens are considered. In a "free air" condition, the heat transferred from the test specimen is absorbed by its surroundings.

Corrective actions should be considered to minimize the effect of IR radiation.

NOTE IR radiation through the chamber window (observing window) can impact the specimen’s temperature. This effect can be increased by radiation heating systems in the laboratory or windows in the laboratory allowing IR radiation of the sun to enter the test space.