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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 guide – Essais de froid et de chaleur sèche

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FOREWORD

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

This second edition cancels and replaces the first edition, published in 1974, and constitutes a technical revision.

The main changes with regard to the previous edition are as follows:

– removal of guidance regarding thermal characteristics of chamber walls;
– revision of sections that address environmental chambers that do not use movement of air for temperature control.

The text of this standard is based on the following documents:

FDIS	Report on voting
104/555/FDIS	104/558/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication 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- withdrawn,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

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.

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

3 Terms and definitions

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

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

3.2
non heat-dissipating specimen
specimen that does not produce heat to a level that can affect the air temperature surrounding the specimen or those specimens located nearby

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

4 Selection of test procedures

4.1 General background

4.1.1 General

Specimen performance may be influenced or limited by the temperatures in which the specimen is operated. The level of influence may 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 and/or dry heat tests are performed.

4.1.2 Ambient temperature

The maximum and minimum values of the ambient temperature where the specimen will be subjected to should be known. Preferred values for testing purposes are provided in IEC 60068-2-1 and/or IEC 60068-2-2.

Difficulties can arise due to the fact that heat transfer causes temperature variations in the area surrounding the specimen. Consequently, the affect from the transfer of heat to the ambient temperature of the surrounding atmosphere should be considered. Air flow 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 may be necessary to measure the temperature of the specimen under test at different locations, both internally and externally.

4.1.4 Specimens without heat dissipation

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 Specimens with heat dissipation

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/or 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 has not, however, been found necessary to differentiate between testing of single specimens and multiple specimens when the cold test is being performed.

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 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 Figures 1 and 2.

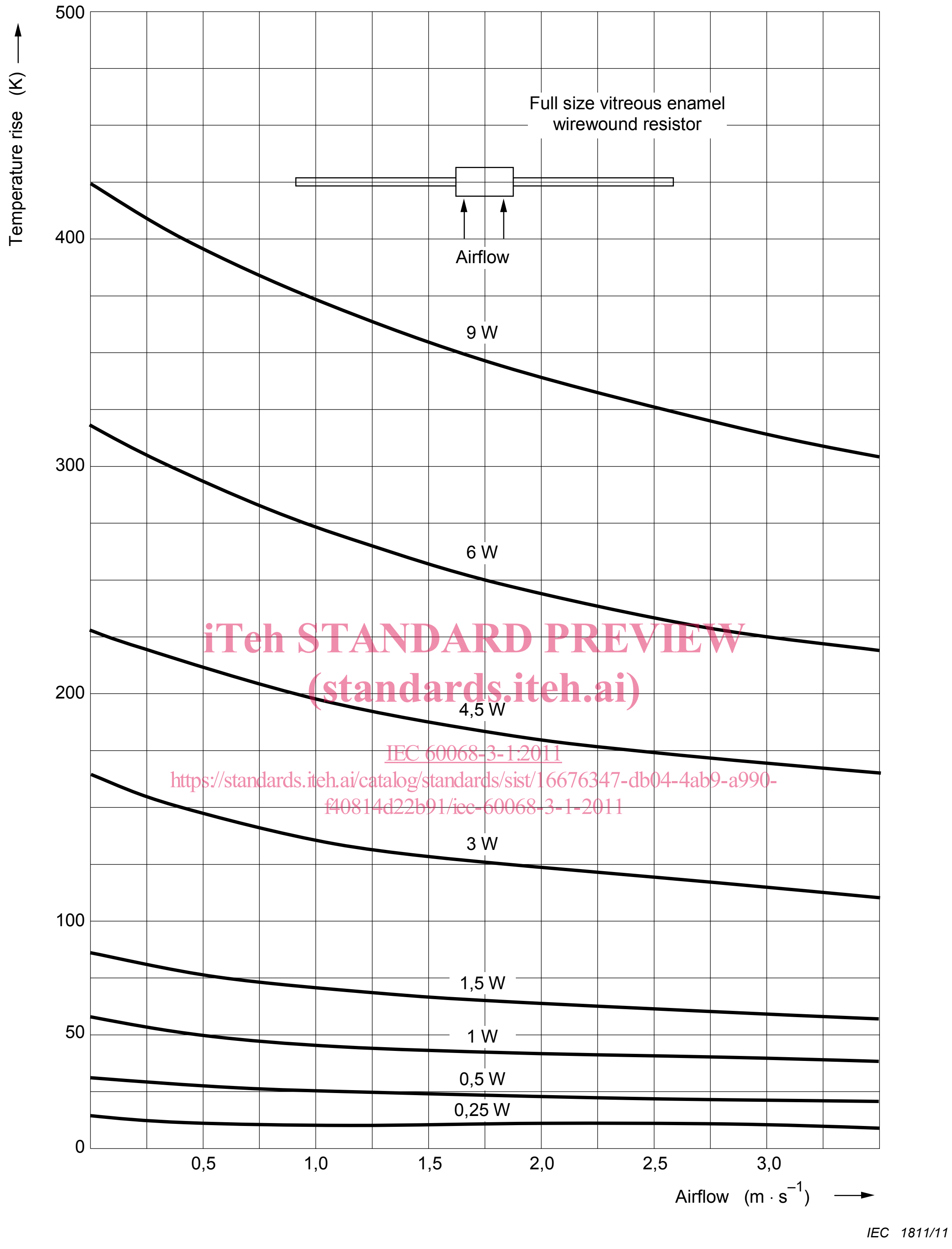

Figure 1 – Experimental data on the effect of airflow on surface temperature of a wire-wound resistor – Radial airflow

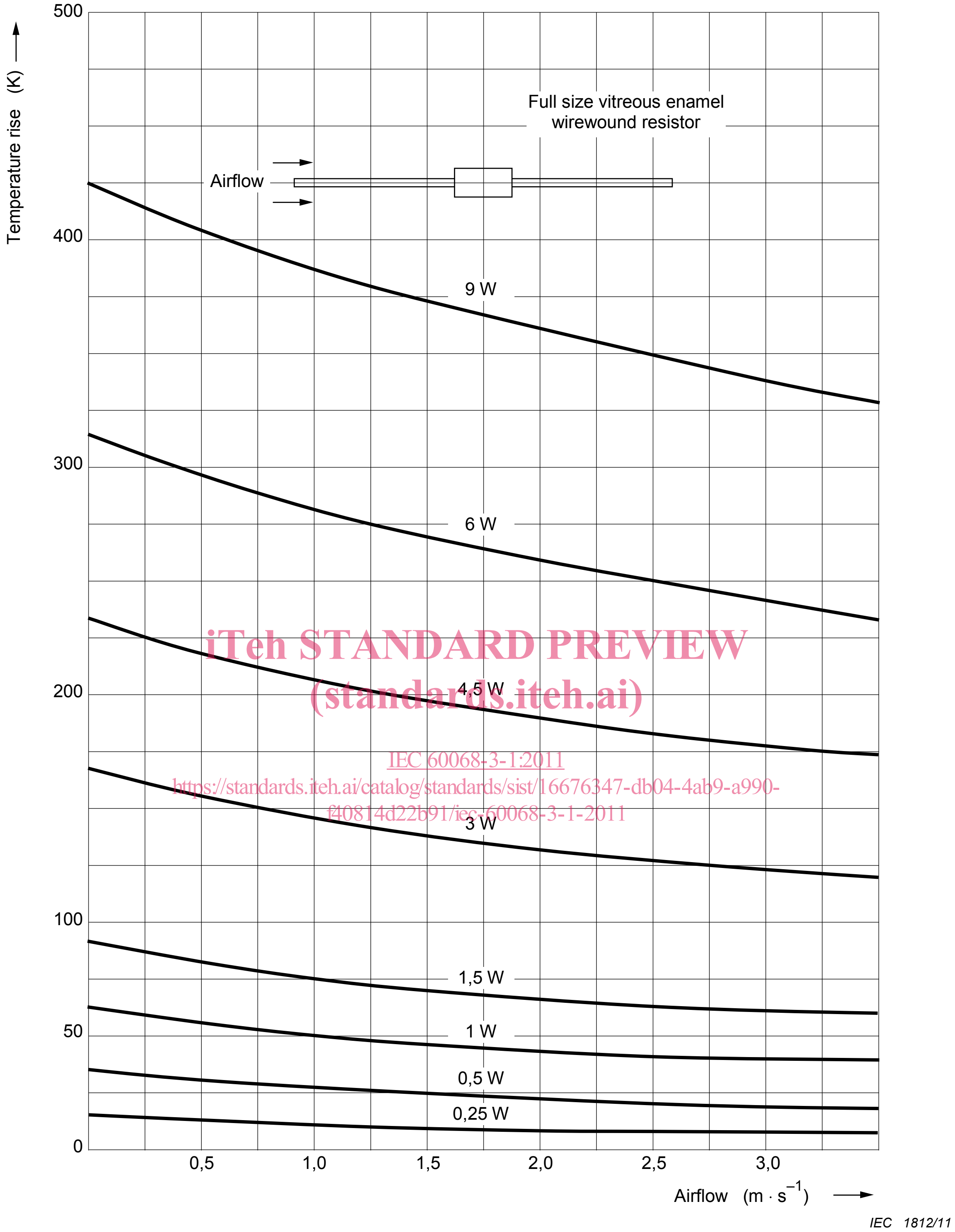

Figure 2 – Experimental data on the effect of airflow on surface temperature of a wire-wound resistor – Axial airflow

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.

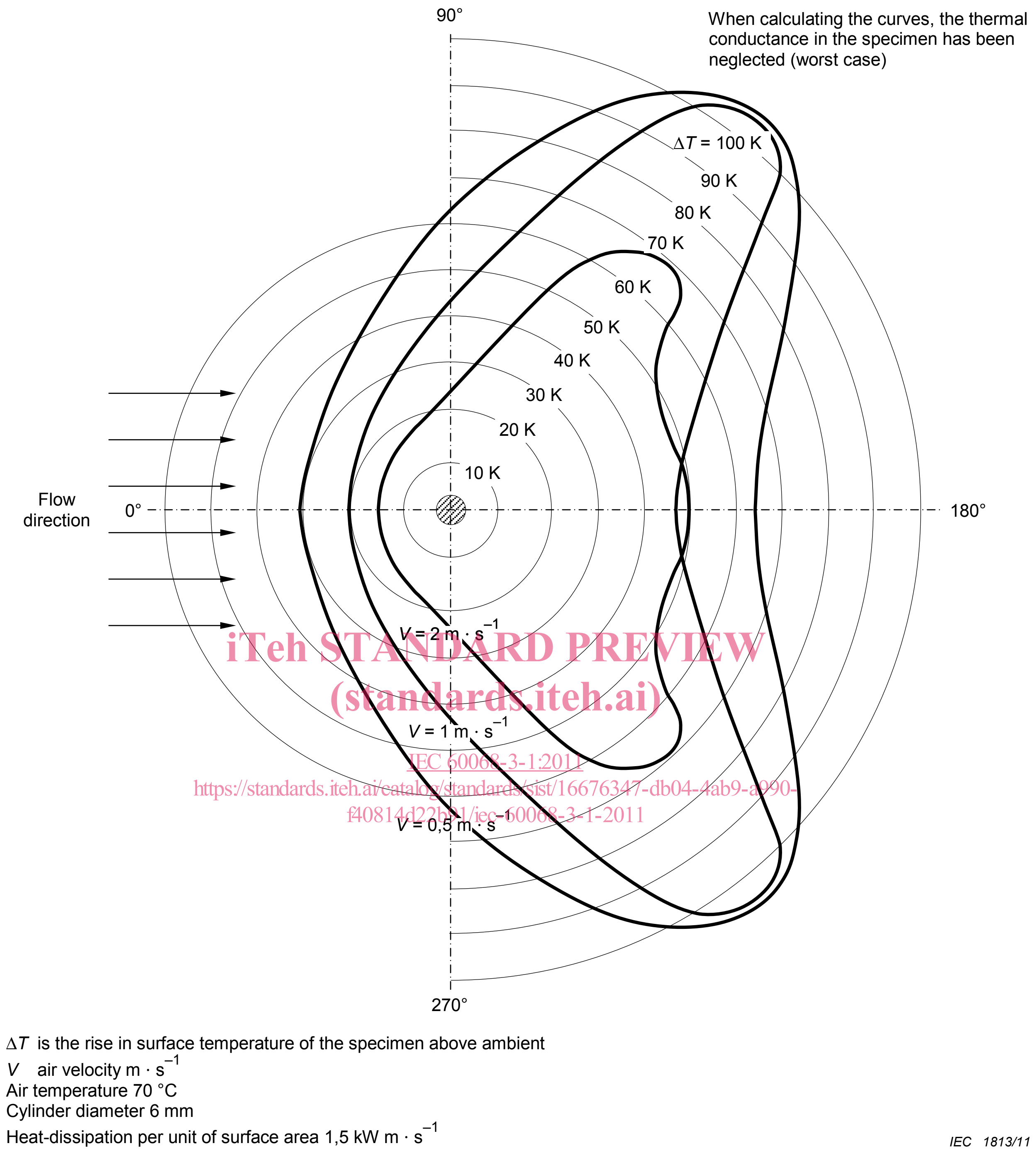

Figure 3 – Temperature distribution on a cylinder with homogeneous heat generation in airflow of velocities 0,5, 1 and 2 m·s^{-1}

Therefore, when testing heat-dissipating specimens, the effects of air flow 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.

4.2.2 Radiation

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

4.2.3 Thermal conduction

Heat transfer by thermal conduction depends on the thermal characteristics of mounting and other connections. These should be known in advance of the test.

Many heat-dissipating specimens are intended to be mounted on heat sinks or other well-conducting elements, with the result that a certain amount of heat is effectively transferred through thermal conduction.

The relevant specification shall define the thermal characteristics of the mounting and these characteristics should be reproduced when the test is made.

If a specimen can be mounted in more than one manner with different values of thermal conduction, the mounting device with the lowest thermal conductivity for dry heat tests on a specimen with heat dissipation and the mounting device with the highest thermal conductivity for all the other tests (dry heat tests on specimens without heat dissipation, cold tests on specimens with or without heat dissipation) should be used.

4.2.4 Forced air circulation

To verify that the temperature at representative points on the surface of the test specimen are not unduly influenced by the air velocity used in the chamber, measurements should be made with the specimen inside the chamber, with the chamber operating at standard atmospheric conditions for measurement and tests (see IEC 60068-1). If the surface temperature at any point of the test specimen is not reduced by more than 5 K by the influence of the air circulation used in the chamber, the cooling effect of the forced air circulation may be ignored.

Where the reduction of surface temperature exceeds 5 K, the temperatures from a representative number of points on the surface of the test specimen should be measured in order to give a basis for calculation of the surface temperatures at the specified test conditions. These measurements should be carried out under those load conditions which are specified for the test temperature by the relevant specification.

For small temperature differences (<5 K) between the ambient temperature and surface temperature of the specimen, the surface temperature can be assumed to be the same when tested at different ambient temperatures.

The choice of representative points to be checked should be based on a detailed knowledge of the test specimen (thermal distribution, thermally critical points, etc.). A single chamber characterization may cover the chamber performance for a long series of the same type of tests with similar specimens, whereas in other cases a characterization may need to be made prior to each test for different types of specimens.

4.3 Test chambers

4.3.1 General

Even in very large chambers, the air circulation and temperature distribution around the test specimen will not be identical with actual free air conditions. It is not practical for testing purposes to try to reproduce free air conditions, but it is possible to simulate the effects of these conditions. Nevertheless, it is established by experimental results and test experience that a reasonably large chamber with low air flow through the work space will affect the temperature of the test specimen in approximately the same way as would free air conditions.

Table 1 shows the parameters of a test chamber that should be considered when testing heat-dissipating specimen.