

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Classification of environmental conditions –  
Part 2-2: Environmental conditions appearing in nature – Precipitation and wind**

**Classification des conditions d'environnement –  
Partie 2-2: Conditions d'environnement présentes dans la nature – Précipitations  
et vent**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2024 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

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

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://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](http://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 It also gives information on projects, replaced and withdrawn publications.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](http://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](http://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](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Discover our powerful search engine and read freely all the publications provided, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 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](http://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](http://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](http://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](mailto:sales@iec.ch).

#### IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



**Classification of environmental conditions –  
Part 2-2: Environmental conditions appearing in nature – Precipitation and wind**

**Classification des conditions d'environnement –  
Partie 2-2: Conditions d'environnement présentes dans la nature –  
Précipitations et vent**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 19.040

ISBN 978-2-8322-9873-2

**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

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references .....	8
3 Terms and definitions .....	8
4 Rain .....	8
4.1 General.....	8
4.2 Global distribution of rainfall .....	9
4.3 Characteristics of rain .....	11
4.3.1 Formation .....	11
4.3.2 Types of rain .....	11
4.3.3 Distribution of raindrop sizes .....	12
4.3.4 Terminal velocity .....	12
4.4 Rates of rainfall .....	13
4.4.1 Instantaneous rates and clock-hour totals.....	13
4.4.2 Frequency of instantaneous rates .....	14
4.5 Heavy rates of rainfall .....	15
4.5.1 Thunderstorm rain .....	15
4.5.2 Prolonged heavy rain.....	15
4.5.3 Worldwide extremes .....	15
4.6 Spatial variations of rainfall rate.....	16
4.6.1 General .....	16
4.6.2 Rainfall rates below 2 mm/h.....	17
4.6.3 Rainfall rates between 2 mm/h and 10 mm/h .....	17
4.6.4 Rainfall rates between 10 mm/h and 25 mm/h.....	17
4.6.5 Rainfall rates exceeding 25 mm/h.....	18
4.7 Rainfall probabilities along a line .....	18
5 Snow .....	19
5.1 General.....	19
5.2 Global distribution of the incidence of snowy weather .....	19
5.3 Global distribution of the incidence and depth of lying snow.....	22
5.4 Mass, size and fall-speed of snow.....	22
6 Hail.....	26
6.1 General.....	26
6.2 Global distribution of hailstones .....	26
6.3 Seasonal variations in global distribution .....	27
6.3.1 Diurnal variation.....	28
6.3.2 Size of hail.....	28
6.4 Terminal velocity.....	30
6.5 Duration and diameter of hail cell.....	31
7 Ice.....	32
7.1 General.....	32
7.2 Hoar frost.....	32
7.3 Rime ice (including in-cloud icing and freezing fog).....	32
7.4 Glazed frost (including freezing rain and freezing drizzle) .....	33
7.5 Wet snow accretion.....	34

7.6	Water content of fog and cloud at temperatures below 0 °C .....	34
7.7	Altitude variations .....	35
8	Wind .....	35
8.1	General .....	35
8.2	Mean wind speed .....	36
8.2.1	General .....	36
8.2.2	Variation of mean wind speed with height .....	37
8.2.3	Frequency of winds .....	39
8.3	Gustiness .....	46
8.3.1	General .....	46
8.3.2	Gust factor .....	46
8.3.3	Gust ratios .....	46
8.3.4	Variation of gust speed with height .....	47
8.4	Effects of topography .....	48
8.5	Wind types and extreme winds .....	48
8.6	Effects of wind .....	50
8.7	Wind in conjunction with other damaging agents .....	52
	Bibliography .....	53
	Figure 1 – Average annual rainfall (AAR) for global land areas, based on 1961 to 1990 data [1] .....	9
	Figure 2 – Estimated conversion factor for converting to hours at instantaneous rate [1] .....	14
	Figure 3 – Average decay of correlation with distance, of 1 min rainfall rate and total storm rainfall rate [1] .....	17
	Figure 4 – Estimated percentage of days on which an amount of snow equivalent to at least 1 mm of rainfall falls in northern and southern hemispheres [1] .....	21
	Figure 5 – Satellite derived average rainfall equivalent of lying snow and ice [1] .....	25
	Figure 6 – Estimated average annual number of days per year with hail of diameter $\geq 15$ mm [1] .....	27
	Figure 7 – Estimated average seasonal number of days per year with hail of diameter $\geq 15$ mm, based on post-processed global model data (oceans excluded) [1] .....	29
	Figure 8 – Relationship between diameter and terminal velocity of spherical hailstones [1] .....	31
	Figure 9 – Air temperature and wind speed criteria for the formation of different types of ice [1] [15] .....	33
	Figure 10 – Power spectrum of wind speed fluctuations [1] .....	36
	Figure 11 – Annual mean 10 m wind speed (m/s) for global land areas, averaged over the period 1961 to 1990 [1] .....	38
	Figure 12 – Measurement stations with station numbers .....	40
	Figure 13 – Vortex formation produced when wind strikes the corner of a structure .....	51
	Figure 14 – Contours of pressure coefficients produced by vortices .....	51
	Table 1 – Estimated number of raindrops per cubic metre for various rates of rainfall [1] .....	12
	Table 2 – Terminal velocity of raindrops in still air [1] .....	13
	Table 3 – Duration in the average year of instantaneous point rainfall equalling or exceeding specified rates [1] .....	14
	Table 4 – Predicted worldwide extremes of rainfall [1] .....	15

Table 5 – Observed world maximum rates of rainfall [1] ..... 16

Table 6 – Estimated duration (h) in the average year when stated distances along given tracks simultaneously have rainfall at or exceeding specific rates [1] ..... 18

Table 7 – Snow crystals: relation between mass (mg) and diameter (mm) of the sphere which just contains the crystal [1] ..... 23

Table 8 – Values of  $\alpha$  and  $\beta$  for different crystal types [11] ..... 24

Table 9 – Number of hailstones per cubic metre (at about 4 000 m) for specified maximum hailstone size and specific ranges of stone size [1] ..... 30

Table 10 – Meteorological parameters controlling atmospheric ice accretion [15] ..... 33

Table 11 – Details of stations, their location, elevation, observation rate and total number of observations [19] ..... 41

Table 12 – Percentile mean wind speed and percentage frequencies of measured wind speeds for each station [19] [20] [21] ..... 43

Table 13 – Terrain type and gust factor [1] ..... 46

Table 14 – Ratio of the probable maximum gust speed, averaged over time, to the mean hourly wind speed for level sites in open country [1] ..... 47

Table 15 – Suggested ratios for estimating maximum gust speed over short periods from a known mean hourly wind speed ..... 47

Table 16 – Factors for calculating maximum mean wind speed for various intervals using the mean speed measured over the hour [1] ..... 47

Table 17 – Spatial and temporal scales of meteorological wind systems plus characteristic wind speed ranges ..... 49

currently in preview, click buy full vers.

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –****Part 2-2: Environmental conditions appearing in nature –  
Precipitation and wind**

## 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. For 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 Publications”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may 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 far 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60721-2-2 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 2012. This edition constitutes a technical revision.

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

- a) the layout of the information provided has been re-organized;
- b) the information provided has been extensively enhanced and revised;
- c) new information on wind severities has been included.

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

Draft	Report on voting
104/1066/FDIS	104/1074/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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

A list of all parts in the IEC 60721 series, published under the general title *Classification of environmental conditions*, 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](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

**IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

## INTRODUCTION

This part of IEC 60721 presents fundamental properties, quantities for characterization, and a classification of environmental conditions dependent on precipitation and wind relevant to electrotechnical products. The information presented is intended to be used as background material when selecting appropriate severities of parameters related to precipitation and wind for product applications.

Precipitation encompasses all forms of hydrometeors, both liquid and solid, which are free in the atmosphere, and which reach the Earth's surface. At altitudes below the freezing level, precipitation can occur as liquid or solid particles but above this level snow or hail will predominate. For this document, the different forms of hydrometeors are addressed separately and under the more commonly referred to meteorological conditions of rain, snow and hail. Also encompassed are icing conditions but only that occurring at ground level.

This document additionally and separately addresses wind.

The majority of the information presented in this document has been assembled by the UK Met Office from published sources as well as historical and forecasting weather records. The information has been assembled and maintained for the UK Ministry of Defence for equipment design and testing purposes [1]<sup>1</sup>. The historical meteorological data employed for this work meets World Meteorological Organization criteria for validity. However, such data are only available from a limited number of worldwide locations (typically a few hundred). Forecasting weather records, which were extensively utilized for this work, are available from a significant number of locations (typically tens of thousands) but are not necessarily verified. Whenever the latter information has been used, an appropriate strategy was adopted to remove spurious data.

---

<sup>1</sup> Numbers in square brackets refer to the Bibliography.

## CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

### Part 2-2: Environmental conditions appearing in nature – Precipitation and wind

#### 1 Scope

This part of IEC 60721 presents fundamental properties, quantities for characterization and a classification of environmental conditions dependent on precipitation and wind relevant to electrotechnical products.

The information presented within this document is intended to be used as background material when selecting appropriate severities of parameters related to precipitation and wind for product applications.

For the purpose of this document, precipitation is considered to encompass all forms of hydrometeors, both liquid and solid, which are free in the atmosphere and which reach the Earth's surface. The different forms of hydrometeors are addressed separately and under the more commonly referred to meteorological conditions of rain, snow and hail. Whilst icing conditions are additionally considered, only that occurring at ground level, is addressed.

This document separately addresses the climatic conditions of wind and provides methodologies and quantitative information to enable wind severities and frequencies to be estimated worldwide.

#### 2 Normative references

There are no normative references in this document.

#### 3 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:

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

#### 4 Rain

##### 4.1 General

Rain is the primary focus of Clause 4 as it is the dominant meteorological condition associated with the wetting of electrotechnical products.