



SLOVENSKI STANDARD
oSIST prEN IEC 60721-2-2:2024
01-februar-2024

Klasifikacija okoljskih pogojev - 2-2. del: Okoljski pogoji v naravi - Padavine in veter

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

Klassifizierung von Umgebungsbedingungen - Teil 2-2: Natürliche Umgebungsbedingungen - Niederschlag und Wind

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

Ta slovenski standard je istoveten z: prEN IEC 60721-2-2:2023

[oSIST prEN IEC 60721-2-2:2024](http://standards.international/catalog/standards/sist/42667613-3387-4833-8eac-69a676332716/osist-pr-en-iec-60721-2-2-2024)

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ICS:

19.040	Preskušanje v zvezi z okoljem	Environmental testing
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oSIST prEN IEC 60721-2-2:2024 **en**



104/1026/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC 60721-2-2 ED3

DATE OF CIRCULATION:

2023-11-17

CLOSING DATE FOR VOTING:

2024-02-09

SUPERSEDES DOCUMENTS:

104/975/CD, 104/994A/CC

IEC TC 104 : ENVIRONMENTAL CONDITIONS, CLASSIFICATION AND METHODS OF TEST	
SECRETARIAT: Sweden	SECRETARY: Mr Henrik Lagerström
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
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TITLE:

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

PROPOSED STABILITY DATE: 2028

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CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

119

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

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FOREWORD

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International Standard IEC 60721-2-2 has been prepared by IEC technical committee 104: Environmental conditions, classification, and methods of test.

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This third edition cancels and replaces the second edition, published in 1997, and constitutes a technical revision.

157

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

158

a) The layout of the information provided has been re-organised.

159

b) The information provided has been extensively enhanced and revised.

160

c) New information on wind severities has been included.

161

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

FDIS	Report on voting
xxx	xxx

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163

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

- 164 This document has been drafted in accordance with the ISO/IEC Directives, Part 2.
- 165 A list of all parts in the IEC 60721 series, published under the general title *Classification of*
166 *environmental conditions*, can be found on the IEC website.
- 167 The committee has decided that the contents of this document will remain unchanged until the stability
168 date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific
169 document. At this date, the document will be
- 170 reconfirmed,
171 withdrawn,
172 replaced by a revised edition, or
173 amended.

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INTRODUCTION

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

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

186 This document additionally and separately addresses wind.

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188 CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

189 Part 2-2: Environmental conditions appearing in nature – 190 Precipitation and wind

191 1 Scope

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

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

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

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

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

211 2 Normative references

212 There are no normative references in this document.

213 3 Terms and definitions

214 No terms and definitions are listed in this document.

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

- 216 • IEC Electropedia: available at <http://www.electropedia.org/>
- 217 • ISO Online browsing platform: available at <http://www.iso.org/obp>

218 4 Rain

219 4.1 General

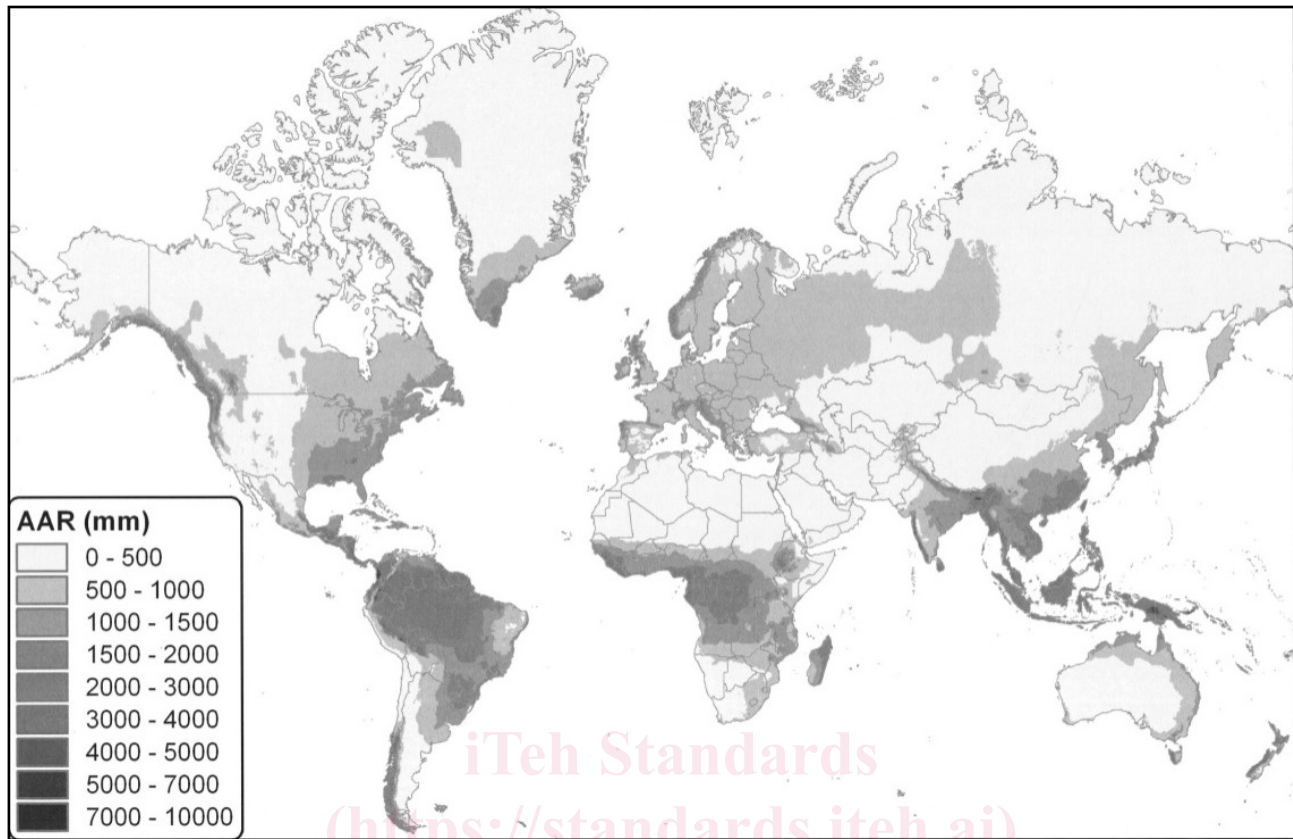
220 Rain is the primary focus of this clause as it the dominant meteorological condition associated with the wetting
221 of electrotechnical products.

222 4.2 Global Distribution of Rainfall

223 Compared with meteorological air temperature which, at any particular time is often substantially the same
224 (± 5 °C) over relatively large regions, rainfall is a much more spatially variable climatic condition. In particular,
225 the precipitation intensity that constitutes a near extreme value is peculiar to the highly localised area. Even a
226 relatively short distance away, the intensity may differ by a factor of two or more. Thus, it is impracticable to
227 relate precipitation intensity to specific geographical areas of the world, as is the case with temperature.

228 Precipitation intensity is defined as the rate at which precipitation falls. Although values of precipitation intensity
229 may be considered as instantaneous rates, in practice they are averages taken over periods of one minute or
230 longer. When using any rainfall data, it should be remembered that as the pattern of rainfall is infinitely variable
231 both in time and space, only general information can be given by means of maps or diagrams.

232 For most places, readily available rainfall data are limited to observations of the rainfall catch made once daily.
 233 Where precipitation is of snow, the observations record the rainfall equivalent of that snow. The daily
 234 observations may be summarised to provide average monthly, seasonal or annual amounts. Figure 1
 235 represents such a summary for annual amounts, based on observations from 27075 locations worldwide over
 236 the period 1961 to 1990.



237

238 NOTE At higher latitudes, an increasing proportion of this "rainfall" will fall as snow.

239 **Figure 1 -- Average Annual Rainfall (AAR) for global land areas, based on 1961 to 1990 data [1]**

240 The fundamental requirements for precipitation to fall in significant amounts are high atmospheric moisture
 241 content and a mechanism for the uplift of air. Ascending air cools by expansion due to the decreasing
 242 atmospheric pressure with height. Given that the lower the temperature the less moisture the air can retain in
 243 vapour state, then if cooling and moisture content are sufficient, precipitation is the result. As a generalisation,
 244 the wetter land regions of the world belong to one of the following three broad geographical categories:

- 245 a. Along the equator $\pm 15^\circ$ of latitude e.g., Indonesia, equatorial Africa, and the Amazon rain forest. The
 246 high rainfall of these regions is primarily due to convection, triggered by solar heating and accentuated
 247 by the convergence of the northern hemisphere tropic's north-easterly winds and the southern
 248 hemisphere tropic's south-easterly winds along the 'inter-tropical convergence zone'. Here, copious
 249 moisture is provided by either rain forest or warm, tropical ocean.
- 250 b. The western side of continents in mid latitudes e.g., UK, Western Europe, the north-western coastal
 251 fringe of North America and the south-western coastal fringe of South America (southern Chile). At
 252 these latitudes, winds blow predominantly from the west and therefore reach the western side of
 253 continents having picked up moisture over a long ocean track. The lifting mechanisms are varied and
 254 include convection and orographic uplift, but the dominant lifting mechanism is cyclonic/frontal uplift in
 255 weather disturbances that develop on, and move eastwards along, the boundary between polar and
 256 tropical air masses. In North and South America, the inland penetration of high rainfall is severely
 257 limited by the high, north-south aligned mountain chains of the American Cordillera. By contrast, the
 258 western fringe of Europe has no north-south aligned barrier of such proportion, so that moderate
 259 rainfall is able to penetrate well inland across the European plain. Iceland, the Falkland Islands,
 260 Tasmania, and the exposed west of South Island New Zealand also belong to this regime.
- 261 c. Extending polewards from the equatorial regions along the eastern seaboard of continents e.g.,
 262 Eastern Asia from India to Kamchatka, North America from the Gulf of Mexico to Quebec (including
 263 the southern extremity of Greenland), South America from southern Brazil to north-eastern Argentina,

264 the east of South Africa and the eastern fringe of Australia. The reasons for high rainfall in these areas
 265 are complex but include the predominantly easterly moist onshore winds of tropical latitudes and, at
 266 sub-tropical latitudes, the drawing of moist summer monsoon winds of tropical ocean origin inland
 267 towards a heat-generated continental low-pressure area, as in the Indian and south-east Asian
 268 summer monsoons. Further poleward, at mid latitudes, the prevailing wind is from the west, blowing
 269 offshore; however, the eastern seaboard of both North America and Asia are favoured regions for the
 270 development of precipitation-bearing cyclonic weather systems which then move north-eastwards
 271 close to the mid-latitude coastline.

272 The important influence of topography on rainfall is demonstrated by the heavier rainfall in mountainous
 273 regions, particularly where a mountain range runs parallel to the coast and intercepts moisture laden winds as
 274 they blow onshore. Mountains also usually reduce rainfall downwind – the ‘rain-shadow’ effect.

275 Many of the great deserts of the world lie within or close to latitudes 20 degrees to 30 degrees of latitude,
 276 where relatively high atmospheric pressure dominates. e.g., the Sahara Desert and Saudi Arabia, the deserts
 277 of California and Arizona, the Atacama Desert in Chile, the Namibian, and Kalahari Deserts of southern Africa
 278 and much of interior and western Australia. The dryness of some deserts is accentuated by the rain-shadow
 279 effect of adjacent mountain barriers (e.g., the inland deserts of California and Arizona). An additional factor in
 280 some coastal deserts is a cold ocean current offshore that suppresses convection e.g., the narrow Atacama
 281 Desert of Chile is trapped between high mountains to the east and a cool ocean current offshore.

282 In Asia the circum-global belt of high pressure at sub-tropical latitudes is displaced by the Asian monsoon,
 283 which blows outwards from intense high pressure over Siberia in winter and blows into low pressure over
 284 southern interior Asia in summer. This effectively transfers the latitudinal desert belt by ~15 degrees of latitude
 285 poleward to lie north and inland of the areas reached by the Indo-Asian monsoon e.g., the Gobi Desert of
 286 Mongolia and China.

287 Precipitation in polar regions is generally not particularly high on account of the reduced amount of water
 288 vapour in the air at low temperatures.

289 4.3 Characteristics of rain

290 4.3.1 Formation

291 Clouds are formed when air is cooled below its dewpoint, usually as a result of lifting and consequent
 292 expansion. At first the cloud droplets grow by the condensation of water on to them, but it can be shown that
 293 this process alone cannot produce drops of the size found in rain. Two mechanisms are thought to be important
 294 in the formation of raindrops.

295 Firstly, droplets which are slightly larger than the average will fall, relative to the air, and towards neighbouring
 296 smaller droplets, and so may collide and coalesce with some of them to become larger still. This process may
 297 continue until a droplet eventually falls out of the base of the cloud. This mechanism is confined mainly, but
 298 not exclusively, to the tropics, where clouds can remain devoid of solid precipitation throughout their depth.
 299 Theoretical studies have shown that a significant amount of rain can be produced in this way, provided the
 300 cloud is several kilometres deep.

301 Secondly, when a cloud top becomes appreciably colder than 0 °C, it contains a mixture of ice crystals and
 302 supercooled water drops. At first the crystals grow by direct sublimation of water vapour on to them, but as
 303 they become larger, they may collide with the supercooled droplets and other ice crystals to form snowflakes,
 304 and when these snowflakes have fallen below the level at which the temperature is 0 °C they will melt to form
 305 raindrops. This is the dominant mechanism in middle and high latitudes, but it also occurs within the tropics
 306 and applies to clouds with a top colder than about -10 °C. In convective (cumuliform) cloud, graupel or small
 307 hail, rather than snowflakes, may be produced.

308 4.3.2 Types of rain

309 Rainfall is often classified according to the process causing the uplift of air initiating the rain formation; there
 310 are three main types of rain which are not mutually exclusive, and these are known as orographic, cyclonic,
 311 and convective.

312 Orographic rain is caused by one, or sometimes both, of two primary mechanisms. The most commonly known
 313 mechanism is the forced ascent of a moist airstream over the physical barrier of the high ground. The
 314 ascending airstream cools by expansion, often to the temperature at which saturation occurs, above which
 315 altitude cloud forms. This may result in drizzle or rain over the high ground when there is none on the adjacent
 316 low ground, but more often it enhances cyclonic cloud and rain that are also affecting adjacent low ground.
 317 This enhancement is often due primarily to raindrops scavenging additional water as they fall through the