IEC 60721-2-7

Edition 2.0 2018-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Classification of environmental conditions –
Part 2-7: Environmental conditions appearing in nature – Fauna and flora

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Classification des conditions d'environnement –
Partie 2-7: Conditions d'environnement présentes dans la nature –Faune et flore

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CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

Part 2-7: Environmental conditions appearing in nature – Fauna and flora

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International Standard IEC 60721-2-7 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This bilingual version (2018-11) corresponds to the monolingual English version, published in 2018-03.

This second edition cancels and replaces the first edition published in 1987. This edition constitutes a technical revision.

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

a) This edition has been entirely rewritten.

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

CDV	Report on voting
104/741/CDV	104/792/RVC

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.

The French version of this standard has not been voted upon.

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

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 "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,
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CLASSIFICATION OF ENVIRONMENTAL CONDITIONS –

Part 2-7: Environmental conditions appearing in nature – Fauna and flora

1 Scope

This document addresses the occurrence of fauna and flora, including its main effects on electrotechnical products. Exposure and damage from the effects of fauna and flora can occur at almost any time in a product's life cycle. Moreover, there are many agents of attack with various actions.

This document addresses the occurrence and damage arising from fauna and flora in all locations a product can be stored, transported or used. Generally, fauna can be present and cause damage to products in both the natural environments experienced in open-air locations as well as in artificially created environments, such as in a warehouse or building. However, flora will predominantly be present and cause damage to products only in open-air locations. Fungus and bacteria can be present in both open-air locations as well as in warehouses or buildings.

2 Normative references

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There are no normative references in this document.

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3 Terms and definitions

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4 General

The main attacking agents considered in this document are micro-organisms including fungi, bacteria, as well as insects, rodents, algae and marine organisms. Hazards due to other agents are considered to be of lesser importance and have been omitted. These include the corrosive action of juices secreted by some plants, the mechanical action due to the growth of the larger trees, which may be sufficiently great to destroy the foundations of a building or to break cables, and the damage caused by animals such as monkeys and elephants. Birds in flight can be a hazard to aircraft, and in the region of bird colonies, widespread droppings can create corrosion problems. In addition, some agents which are mentioned have other modes of action which have not been included; for example both rodents and insects are occasionally responsible for chemical corrosion or soiling.

The frequency of occurrence of fauna and flora with a possibility of damaging products very much depends on conditions of temperature and humidity. In geographical areas with warm damp climates, fauna and flora, especially insects and micro-organisms such as mould and bacteria, will find favourable conditions of life. Moreover, humid or wet rooms in buildings, or rooms for processes producing humidity, are suitable living spaces for rodents, insects and micro-organisms.

Fauna and flora can affect products in various ways, the most important of which are given in the following examples.

a) Deterioration by physical attack: The functioning of products may be affected by physical attacks of fauna and flora. The materials of a product may be attacked by fauna, particularly by rodents and insects, by the actions of feeding from material, gnawing at material, eating into material, chewing material or cutting holes into material. The severe damage arising from the physical attack by termites is especially emphasized in this respect. Among materials susceptible to attack are natural materials such as wood, paper, leather, textiles, but also plastic materials, including elastomers and even some metals such as tin and lead.

b) Deterioration by deposits: The functioning of products may be affected by deposits originating from fauna and flora. These surface deposits affect the products by chemical and mechanical reactions. Deposits from fauna, especially from insects, rodents, birds, etc., may consist of elements such as the presence of the animal itself, the building of nests or settlements, feed stock as well as the metabolic products such as excrements, enzymes. Deposits from all kinds of flora may consist of material such as detached parts of plants (leaves, blossom, seeds, fruits, etc.), growth layers of cultures of moulds or bacteria and effects of their metabolic products.

5 Occurrence of fauna and flora

5.1 Fungi

5.1.1 Background

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The name fungus is used to denote members of a large heterogeneous group of organisms, of which there are about a hundred thousand known species. Most fungi are so small that they can be observed only with the aid of a microscope. The terms 'mould' and 'mildew', although not exactly defined in the biological sense, are used by both biologists and laymen to refer to small non-parasitic fungi, such as those which do not live on other living organisms.

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A fungus can, in general, be divided into two parts: the vegetative and the reproductive. The vegetative part, known as the hypha, is essentially a threadlike filament normally having a diameter between 2 µm and 20 µm and may be several centimetres long. In the simplest fungi the hyphae are merely continuous tubes of living matter; in others they are divided by cell walls, called septa, into separate cells. Collectively the hyphae are referred to as the mycelium. The mycelium, together with the reproductive spores, is commonly observed on mouldy bread, shoes, oranges, etc.

In the vast majority of cases the unit of reproduction is the spore. Normally it is unicellular and microscopic, though occasionally, giants 500 µm in length occur. They may be produced directly via the hyphae or from a structure created for this specific purpose, as in the mushroom. From a functional viewpoint spores may be divided into two classes each of which may be produced by the same organism: those which can be produced rapidly and in large numbers but have little resistance to adverse environmental factors, and those which are comparatively few in number but much more resistant to adverse conditions. The former enable the fungus to spread rapidly during good growing conditions and the latter enable it to survive hard times such as winter or drought and have been known to survive for many years in a dry condition.

5.1.2 Growth and survival factors

In order to adapt themselves to changes in their environment or food supply, most species of fungi can slightly change their characteristics and needs over several generations. This may be a very short time; in many cases the whole cycle from spore to spore can be completed in a few days. In addition, it should be noted that the conditions required for the production and dispersal of spores are generally more exacting than those for growth and survival.

The precise minimum, maximum and optimum temperatures for growth appear to be a matter of debate between the various authorities. This may be because these values vary from one species to another. However, in general, the minimum is 2 °C to 5 °C, the maximum 40 °C to 50 °C and the optimum 22 °C to 27 °C. In addition, there are a few fungi that can grow at and below 0 °C, and one species has been reported growing at a maximum of 62 °C. They are, of course, capable of surviving even greater extremes in a quiescent state.

The optimum humidity for the growth of nearly all moulds is a relative humidity of 95 % to 100 %. If submerged in water, however, most fungi will not grow. Any reduction from this optimum will mean a reduced growth rate and few species will grow in a relative humidity of less than 70 %. Optimum growth conditions also occur in still air.

A suitable source of carbon that can be absorbed as food is essential to fungi for their growth. Almost all naturally occurring carbon containing compounds, together with many synthetic organic compounds of a similar structure can be used by fungi as a source of food. All fungi can utilize an organic supply of nitrogen and a few can also use an inorganic source such as ammonia. Nitrogen, other than as a gas, is essential for the growth of fungi.

Most fungi are strictly aerobic, that is they cannot grow in complete absence of free oxygen. In the small number of cases where fungi grow in water, they always do so in a few centimetres near the surface.

Other elements required for the growth of fungi include sulfur (as sulfate), potassium, phosphorus (as phosphate) and magnesium. In some cases minute traces of iron, zinc, manganese, molybdenum, or calcium are required, though in such small quantities that only in a few fungi is there a clear picture of these requirements. Some fungi also require a supply of certain vitamins for growth.

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Ultra-violet is known to inhibit the growth of most fungi, although daylight normally has no effect. In a very few instances daylight can influence growth and indeed can cause it to increase. However, the production and dispersal of spores is dependent upon the presence of light for many species.

Most fungi grow best in a slightly acid medium within the range pH 5 to pH 6,5. This varies from one species to another, but few will grow at all below pH 3 or above pH 9.

5.1.3 Habitat and geographical distribution

Since fungi can survive adverse growth conditions in a quiescent state and can gradually evolve to survive more extreme conditions, and since new species are still being identified, it is not possible to define exactly the geographical areas in which fungi will grow. There are, however, certain tendencies which are relevant.

Fungi of one sort or another are found in the soil, water and air over a large part of the earth's surface, whilst others live on or upon both living and dead animals and plants. Those found in the air do not grow there, but are in the form of spores. Most live in the soil and only about 2 % live in water; in both cases they grow in the few centimetres just below the surface.

The best conditions for most types of mould growth are in humid tropical areas, although deterioration due to mould is not confined to the tropics. Equally serious damage can occur in temperate regions, though not so rapidly, and at least one species of mould is often found in the form of spores in the air over arctic regions.

Conditions favourable for mould growth may easily be created artificially inside a building or equipment. Those which are parasitic upon particular animals or plants are among the few which are restricted to geographical regions.

The map in Figure 1 shows areas in which climatic conditions are most favourable for fungal corrosion. It is based on an analysis of relative humidity and temperature data from approximately two thousand meteorological stations throughout the world, as follows:

a) Region A – includes areas with at least one month a year in which the mean monthly relative humidity is from 70 % to 75 % in the hours from 12:00 h (noon) to 14:00 h, and with a mean monthly minimum temperature at the same time of not less than 15 °C.

b) Region B – includes areas where the equivalent relative humidity is from 75 % to 80 %, again with the same temperature as Region A.

c) Region C – includes areas where the equivalent relative humidity is greater than 80 %, again with the same temperature as Region A.

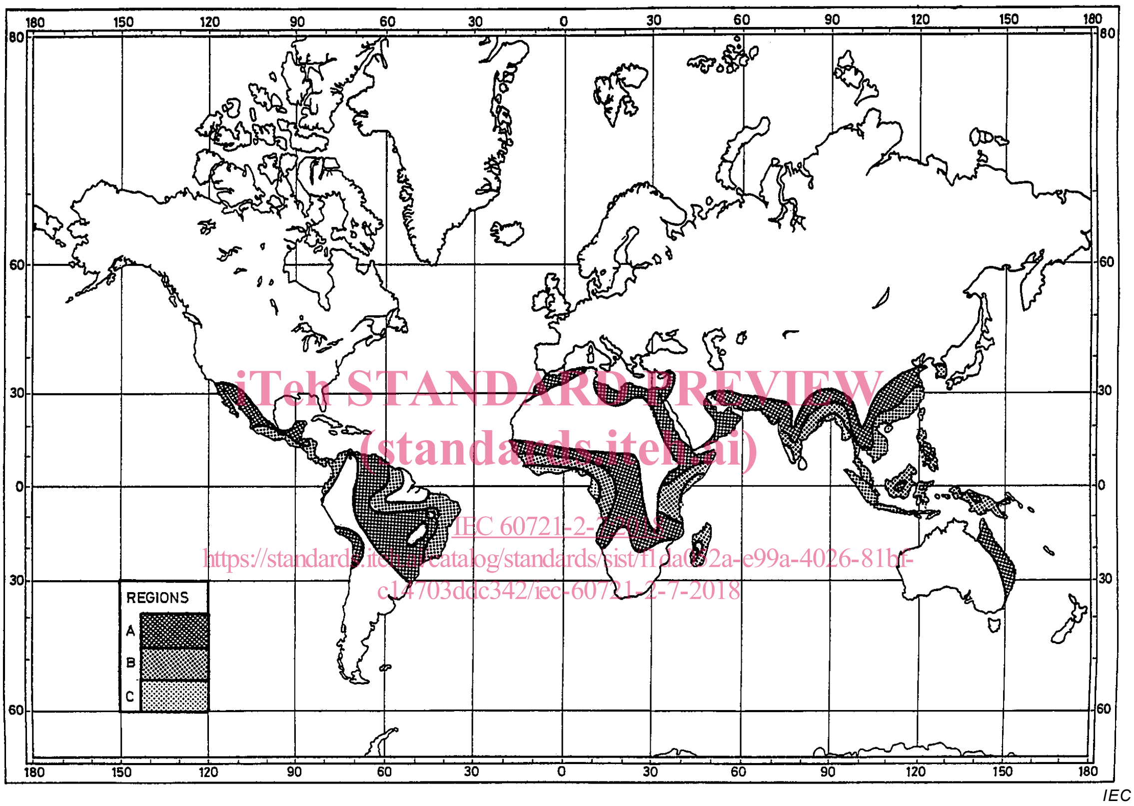

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Figure 1 – Map of regions with different degrees of fungal corrosion

It should be noted that the above climatic conditions do not take account of other naturally occurring factors mentioned earlier, such as air flow. It also does not cover cases where favourable conditions may be artificially induced, inside buildings or containers for example. Nevertheless, within these limits, it does provide a useful indication of the natural liability to attack by micro-organisms.

5.1.4 Effects of fungi on materials

Unlike most plants, fungi contain no chlorophyll, the green colouring matter with which plants utilize the sun's energy to manufacture their food from absorbed raw materials. Thus they have to rely on the food in the substratum on which they grow. However, the structure of the cell walls only allows them to absorb this food if it is in solution. To achieve this, the fungi secrete enzymes via their hyphae. This substance converts the food into a soluble form which can then be readily absorbed.

There are three ways in which fungi may cause damage. Each can occur independently, or in association with one or both of the others:

1) A material may be a food for the fungi, in which case the material is gradually eaten away.

2) The waste products of fungi are excreted as juices, many of which are corrosive and cause damage to the substrate on which the fungi are growing. Thus it is possible for fungi to damage a material even though it is not a source of food. For example the minute impurities in finger prints on glass have been known to support growths whose corrosive waste products have etched the surface of the glass. In addition, the mould coating has the effect of retaining moisture and retarding the drying-out process.

3) Fungus may hinder the efficient operation of equipment, even though it has not caused damage to any material part. Examples of this are soiling in optical equipment, or the formation of undesirable conducting paths in electrical equipment.

The preferred method for controlling fungus growth is by the selection of fungus inert materials. Also acceptable is the treatment of potential fungus nutrient materials or by hermetic sealing. Table 1 lists materials which have a known resistance to fungus growth, whilst Table 2 lists those materials which are potential fungus nutrients.

Table 1 – List of fungus resistant materials

Acrylics	Polycarbonate
Acrylonitile-styrene	Polyester
Acrylonitile-vinyl-chloride copolymer	Polyester-glass fibre laminate
Asbestos	Polyethylene, high density (> 0,94)
Ceramics	Polyethylene terephthalate
Chlorinated polyether	Polyamide
Fluorinated ethylenepropylene copolymer	Polymonochlorotrifluorethylene
Fluorocarbon	Polypropylene
Glass	Polystyrene
Metals	Polysulfone
Mica	Polytetrafluoroethylene
Plastic laminate: silicone glass fibre	Polyvinylidene chloride
Plastic laminate: phenolic-nylon fibre	Silicone resin
Diallyl phthalate	Siloxane-polyolefin
Polyacrylonirile	Siloxane-polystyrene
Polyamide	

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Table 2 – List of potential fungus nutrient materials

ABS (acrylonitrile-butadiene-styrene)	Polyethylene, low density (< 0,94)
Acetyl resins	Polymethyl methacrylate
Cellulose acetate	Polyurethane (ester types are particularly susceptible)
Cellulose acetate butyrate	
Epoxy-glass fibre laminates	Polyricinoleates
Epoxy-resin	Polyvinyl chloride
Lubricants	Polyvinyl chloride-acetate
Melamine-formaldehyde	Polyvinyl fluoride
Organic polysulphides	Rubbers, natural and synthetic
Phenol-formaldehyde	Urea-formaldehyde
Polydichlorostyrene	

A number of materials have a known susceptibility to damage by fungal growth. A number of these are set out below.

a) Wood: Wood in contact with the ground is particularly prone to decay by fungi. If, however, it is kept off the ground in a dry, well ventilated place it is much more resistant, and if the wood contains less than 20 % water it is not attacked at all. Resistance to attack varies from one species to another, and heartwood is always less liable to attack than sapwood. In use, wood is normally coated or impregnated in some manner. This may modify its resistance to fungal attack. Many fungi cause very little mechanical damage to the wood on which they live but are found to discolour it.

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b) Paper and cardboard: Paper, cardboard, and similar products are all susceptible to attack. The basic constituent, cellulose, is affected as well as other substances used during manufacture such as starch, gelatine. The effects are generally revealed as patches of surface discolouration, followed by complete disintegration of the paper. However, mould growth occurs after moisture pick up, and its damaging effects are often considered to be second to those of moisture.

c) Paints and varnishes: Paints and varnishes are made of a complex mixture of oils, cellulose derivatives, solvents, plasticizers, thinners, etc., some of which may be susceptible to attack. Almost all paints will support mould growth under favourable conditions. A few are resistant, but others have been known to support mould even in cold storage rooms. The liability of a paint or varnish to attack is dependent on the type of substance and surface on which it has been placed, and upon climatic conditions, such as sunlight, moisture.

d) Natural cellulose fibres: Natural cellulosic fibres such as cotton, sisal, hemp, flax and jute are all highly susceptible to attack, although protein fibres such as wool and silk are not quite so liable.

e) Synthetic fibres: Synthetic fibres show some variation in their resistance, but are generally superior to natural cellulosic fibres. Fibre forms of cellulose acetate, regenerated protein, polyamides, polyesters, polyacrylonitrile, polyvinylidene chloride, vinyl chlorideacrylonitrile copolymers, vinyl chloride-vinyl acetate copolymers, and glass all have excellent resistance or are inert to fungi. Fibres may have pigment added or be coated, and synthetic fibres may have other additives which can support growth (see also item g) below). In use, when these fibres are in the form of a cloth or cord, they can easily hold moisture and impurities which will nourish moulds.

f) Leather: Tanned leather generally has hygroscopic substances on its surface, such as dextrin, starch, glycerine or sugar, which is often used for dressing, and may support mould growth. Similarly, greases, oils and emulsions used for lubricating leather may also support mould growth. In general, chrome-tanned leather is more resistant than vegetable tanned leather. Mould rarely directly attacks the leather to any significant extent, even