

Classification of environmental conditions —

Part 2: Environmental conditions appearing in nature —

Section 2.4 Solar radiation and temperature

(Implementation of CENELEC HD 478.2.4 S1)

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the General Electrotechnical Standards Policy Committee (GEL/-) to Technical Committee GEL/15, upon which the following bodies were represented:

- Directorate of Telecommunications
- EEA (the Association of Electronics, Telecommunications and Business Equipment Industries)
- Electronic Components Industry Federation
- Ministry of Defence
- National Supervising Inspectorate
- Society of Environmental Engineers
- Society of Motor Manufacturers and Traders Limited

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National foreword

This Section of BS 7527 has been prepared under the direction of the General Electrotechnical Standards Policy Committee. It is identical with IEC Publication 721-2-4:1987 “*Classification of environmental conditions — Part 2: Environmental conditions appearing in nature. Solar radiation and temperature*” as amended by Amendment No. 1 (1988), published by the International Electrotechnical Commission (IEC).

The changes added by Amendment No. 1 (1988) are indicated by a single vertical line in the margin.

This Section of BS 7527 implements CENELEC Harmonization Document (HD) 478.2.4 S1. For the purposes of this British Standard, any references to IEC page numbers in the text should be ignored.

Other Parts of this British Standard are as follows.

- *Part 1: Environmental parameters and their severities;*
- *Part 2: Environmental conditions appearing in nature;*
- *Section 2.1: Temperature and humidity;*
- *Section 2.2: Precipitation and wind;*
- *Section 2.3: Air pressure;*
- *Section 2.5: Dust, sand, salt mist;*
- *Section 2.6: Earthquake vibration and shock;*
- *Section 2.7: Fauna and flora;*
- *Part 3: Classification of groups of environmental parameters and their severities;*
- *Section 3.0: Introduction;*
- *Section 3.1: Storage;*
- *Section 3.2: Transportation;*
- *Section 3.3: Stationary use at weatherprotected locations;*
- *Section 3.4: Stationary use at non-weatherprotected locations;*
- *Section 3.5: Ground vehicle installations;*
- *Section 3.6: Ship environment;*
- *Section 3.7: Portable and non-stationary use.*

Cross-references

International standard	Corresponding British Standard
IEC 721-1:1990	BS 7527 Classification of environmental conditions Part 1:1991 Environmental parameters and their severities (Identical)
IEC 721-2-1:1982	Section 2.1:1991 Temperature and humidity (Identical)

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This part of the standard presents a broad division into types of solar radiation areas. It is intended to be used as part of the background material when selecting appropriate severities of solar radiation for product applications.

All types of geographical areas are covered, except areas with altitudes above 5 000 m.

When selecting severities of solar radiation for product applications, the values which are given in IEC Publication 721-1: Classification of Environmental Conditions, Part 1: Classification of Environmental Parameters and Their Severities, should be applied.

2 Object

To define limiting severities of solar radiation to which products are liable to be exposed during transportation, storage and use.

3 General

Solar radiation can affect products primarily by heating of material and their environment or by photochemical degradation of material.

The ultraviolet content of solar radiation causes photochemical degradation of most organic materials. Elasticity and plasticity of certain rubber compounds and plastic materials are affected. Optical glass may become opaque.

Solar radiation bleaches out colours in paints, textiles, paper, etc. This can be of importance, for example for the colour coding of components.

The heating of material is the most important effect of exposure to solar radiation. The presentation of severities of solar radiation is therefore related to the power density radiated towards a surface, or irradiance, expressed in watts per square metre.

An object subjected to solar radiation will attain a temperature depending primarily on the surrounding air temperature, the energy radiated from the sun, and the incidence angle of the radiation on the object. Other factors, for example wind and heat conduction to mountings, can be of importance. In addition, the absorptance α_s of the surface for the solar spectrum is of importance.

An artificial air temperature t_s may be defined, which, under steady-state conditions, results in the same surface temperature of an object as the combination of the actual air temperature t_u and the solar radiation of the irradiance E .

An approximate value can be obtained from the following equation:

$$t_s = t_u + \frac{\alpha_s \cdot E}{h_y}$$

The coefficient h_y is the heat transfer coefficient for the surface, in watts per square metre and degree Celsius, and includes thermal radiation to the surroundings, heat conduction and convection due to wind.

The absorptance α_s depends on the thermal colour, the reflectance and the transmittance of the surface.

Typical clear sky values are: $\alpha_s = 0.7$

$$h_y = 20 \text{ W/(m}^2 \cdot ^\circ\text{C)}$$

$$E = 900 \text{ W/m}^2$$

resulting in an "overtemperature" due to solar radiation of about 30 °C. It can then be seen that an error of 10 % in the estimation of the intensity of the solar radiation will influence the temperature involved by less than 5 °C. Therefore, there is no need in this classification for extremely accurate severities of solar radiation and minor factors affecting the heat radiated have therefore been disregarded here.

The heating effect is caused mainly by short-term radiation of high intensity, i.e. the solar radiation around noon on cloudless days. Such values are presented in Table I.

It may also be of interest to identify the lowest possible values of atmospheric radiation during clear nights in order to determine the "undertemperature" of products exposed to the night sky.

Such values are given in Figure 1, page 4.

4 Solar radiation physics

The electromagnetic radiation from the sun to the Earth covers a rather broad spectrum from the ultraviolet to the near infra-red. Most of the energy reaching the surface of the earth is in the wavelength range of 0.3 μm to 4 μm with a maximum in the visible range around 0.5 μm . Typical spectra are shown in Figure 2, page 5.

The amount of radiant energy from the sun which falls upon unit area of a plane normal to the sun's rays just outside the atmosphere at the mean distance from Earth to sun is called the solar constant. Its value is approximately 1.37 kW/m².

The distance from Earth to sun varies during the year, and consequently the radiation varies from approximately 1.41 kW/m² in January to approximately 1.32 kW/m² in July.