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**Solar energy — Reference solar  
spectral irradiance at the ground at  
different receiving conditions —**

Part 1:  
**Direct normal and hemispherical  
solar irradiance for air mass 1,5**

*Énergie solaire — Rayonnement solaire spectral de référence au sol  
sous différentes conditions de réception —*

*Partie 1: Rayonnement solaire direct normal et hémisphérique pour  
une masse d'air de 1,5*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee 180, *Solar energy*, Subcommittee SC 1, *Climate – Measurement and data*.

This second edition cancels and replaces the first edition (ISO 9845-1:1992), which has been technically revised.

This main changes are as follows:

- the spectral range has been changed to 280 nm to 4 000 nm;
- the spectral resolution has been improved to 2002 wavelengths, the spectra have nonuniform intervals of 0,5 nanometre (nm) between 280 nm and 400 nm, 1 nm between 400 nm and 1 700 nm, 2 nm between 1 700 nm and 1 702 nm, 3 nm between 1 702 nm and 1 705 nm, and 5 nm intervals from 1 705 nm to 4 000 nm;
- the SMARTS (*Simple Model of the Atmospheric Radiative Transfer of Sunshine*) version 2.9.2 (for reference spectra) and 2.9.5 (for subordinate spectra) have been used instead of the BRITTE Monte Carlo radiative transfer code. The reference spectra are provided in an .xls file available at <https://standards.iso.org/iso/9845/-1/ed-2/en/>
- 171 subordinate hemispherical spectral irradiances were added, these subordinate hemispherical tilted irradiance spectra for different atmospheric conditions and receiver orientations are provided in an .xls file available at <https://standards.iso.org/iso/9845/-1/ed-2/en/>

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

Absorptance, reflectance and transmittance of terrestrial solar energy are important factors in solar thermal system performance, photovoltaic system performance, materials studies, biomass studies and solar simulation activities. These optical properties are normally functions of wavelength, which requires that the spectral distribution of the solar flux be known before the solar weighted property can be calculated. In order to compare the performance of competitive products, a reference standard solar spectral irradiance distribution is desirable.

This document greatly expands the original ISO 9845-1:1992, which provides 2 reference solar spectral irradiance and 171 subordinate solar spectral irradiances. The reference solar spectral distributions include direct normal spectral irradiance with a  $5,8^\circ$  field of view centered on the sun and hemispherical solar spectral irradiance on an equator-facing,  $37^\circ$  tilted plane. The subordinate solar spectral distributions include nine atmospheric conditions, 19 tilt angles, and a total of 171 hemispherical irradiance spectra.

Further parts of the standard consider recent improvements in the basic data and modelling techniques leading to better accuracy.



# Solar energy — Reference solar spectral irradiance at the ground at different receiving conditions —

## Part 1:

## Direct normal and hemispherical solar irradiance for air mass 1,5

### 1 Scope

This document provides an appropriate reference spectral irradiance distribution to be used in determining relative performance of solar thermal, photovoltaic, and other systems, components and materials where the direct or hemispherical irradiance component is desired.

This document provides one reference hemispherical irradiance spectrum, one reference direct normal irradiance spectrum and 171 subordinate hemispherical tilted irradiance spectra. The reference spectral irradiance presented in this document defines an air mass 1,5 solar spectral irradiance, for use in solar applications where a reference spectral irradiance is required, for the direct normal radiation 5,8° field-of-view angle and hemispherical radiation on an equator-facing, 37° tilted plane for albedo corresponding to a light sandy soil. The reference spectral irradiance are intended to represent ideal clear sky conditions.

The reference spectra and the subordinate spectral irradiances representing different sky conditions are provided in .xls files available at <https://standards.iso.org/iso/9845/-1/ed-2/en/>

### 2 Normative references

There are no normative references in this document.

### 3 Terms and definitions

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

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

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

#### 3.1

#### air mass

#### AM

measure of the length of the path through the atmosphere to sea level traversed by light rays from a celestial body, expressed with reference to the path length along the vertical