



Standard Table for Reference Solar Spectral Distributions: Direct and Diffuse on 20° Tilted and Vertical Surfaces¹

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INTRODUCTION

This table of solar spectral irradiance distributions has been developed to meet the need for weighting functions to be used in evaluating the broadband transmittance of fenestration systems or the performance of technologies such as building-integrated photovoltaic devices. To compare the relative optical performance of spectrally sensitive products by theoretical simulation, or to compare the performance of products by actual testing under laboratory conditions, separate reference standard solar spectral distributions for direct and diffuse irradiance are required. This table was prepared using version 2.9.2 of the Simple Model of the Atmospheric Radiative Transfer of Sunshine (SMARTS) atmospheric transmission code (**1**, **2**).² SMARTS uses parameterizations of version 4.0 of the Air Force Geophysical Laboratory (AFGL) Moderate Resolution Transmission model, MODTRAN (**3**, **4**). An extraterrestrial spectrum differing only slightly from the extraterrestrial spectrum in ASTM **E490** is used to calculate the resultant spectra. The directional beam and diffuse hemispherical (2π steradian acceptance angle) spectral irradiances on planes tilted 20° (representative of a pitched roof slope) and 90° (tilt of a typical wall) to the horizontal are tabulated. The wavelength range for the spectra extends from 280 nm to 4000 nm, covering the spectral range for which windows or solar collectors respond to shortwave energy. The input parameters used in conjunction with SMARTS for each set of conditions are tabulated. The SMARTS model and documentation are available as an adjunct to this standard.

1. Scope

1.1 This table provides terrestrial solar spectral irradiance distributions that may be employed as weighting functions to (1) calculate the broadband solar or light transmittance of fenestration from its spectral properties; or (2) evaluate the performance of building-integrated technologies such as photovoltaic electricity generators. Most of these systems are installed on vertical walls, but some are also installed on pitched roofs or on other tilted structures, such as sunspaces. Glazing transmittance calculations or measurements require information on both the direct and diffuse components of irradiance. The table provides separate information for direct and diffuse irradiance, and for two different tilt angles, 20° and 90° relative to the horizontal. All distributions are provided at 2002 wavelengths within the spectral range 280–4000 nm. The

data contained in this table reflect reference spectra with uniform wavelength interval (0.5 nanometer (nm) below 400 nm, 1 nm between 400 and 1700 nm, an intermediate wavelength at 1702 nm, and 5 nm intervals from 1705 to 4000 nm). The data table represents reasonable cloudless atmospheric conditions favorable for the computerized simulation, comparative rating, or experimental testing of fenestration systems.

1.2 The data contained in this table were generated using the SMARTS version 2.9.2 atmospheric transmission model developed by Gueymard (**1**, **2**).

1.3 The selection of the SMARTS radiative model to generate the spectral distributions is chosen for compatibility with previous standards (ASTM **G173** and **G177**). The atmospheric and climatic conditions are identical to those in ASTM **G173**. The environmental conditions are also identical, with only one exception (see sections **4.3** and **X1.2**).

1.4 The table defines four solar spectral irradiance distributions:

1.4.1 Separate direct and diffuse solar spectral irradiance incident on a sun-facing, 20° tilted surface in the wavelength region from 280–4000 nm for air mass 1.5, at sea level.

¹ These tables are under the jurisdiction of ASTM Committee **G03** on Weathering and Durability and is the direct responsibility of Subcommittee **G03.09** on Radiometry.

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² The boldface numbers in parentheses refer to the list of references at the end of this standard.