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WIS DATABASE

Data Submission Procedure for Shading and Diffusing Components

Version 1.0

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Data Submission Procedure for Shading and Diffusing Components for the WIS Database

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1 Introduction

The purpose of this document is to provide instructions to manufacturers about the procedures to be followed when submitting information about their products for inclusion in the WIS database. It relates to shading devices of various kinds and to light-diffusing components that cover or replace a standard window glazing. More detailed definitions of the scope of products covered are given in section 2. In section 3 details are given of the format that is to be used in preparing data files and of the information required for different types of shading and light-diffusing components. In section 4 some examples of data files are shown. In section 5 the procedures for data submission and review are explained. Sections 6 and 7 respectively contain the data submission form and check list referred to in section 5.

Parallel documents have been issued that define the information and format required for non-scattering media [1] and the review process to which those data is submitted before acceptance [2]. Those were designed to be compatible with the data submission forms required for the International Glazing Database maintained by the Lawrence Berkeley National Laboratory [3]. The latter does not contain data referring to shading devices and light-diffusing components. Nevertheless, where applicable, we have conformed as far as possible to those definitions and formats.

2 Scope of products covered and definition of terms

2.1 Product types

The types of devices covered in this document include:

* Venetian blinds
* Fixed slat shading devices (louvres)
* Pleated blinds
* Roller blinds and screens
* Light-diffusing monolithic or laminated components

In all cases it is assumed that the blind is mounted parallel to the plane of the window. Blinds, fixed slat shading devices and screens may be *internal* (on the room side of the window), *external* (outside the window) or *integrated* (incorporated within the window). Light-diffusing elements will generally be integrated into or replace the window.

Blinds may be fixed or retractable. In the calculations performed in WIS it is assumed that in the retracted state the whole window aperture is unobstructed, whereas in the drawn state the whole window aperture is covered (i.e. partially drawn blinds are not considered). The two states are actually simulated by two different systems: The retracted state is simulated by a window without the scattering layer.

In WIS the calculations on diffusing components are performed under certain rules and assumptions. From the point of view of the calculations and the data that must be submitted, the types of shading and scattering devices listed above may be reduced to the three categories of products shown in Table 1.

Table 1: Types of blinds and diffusing components to be used for data submission

ID	Type
1	Diffusing devices (Roller blinds, screens)
2	Slat shading devices (Venetian blinds & fixed slat shading devices, louvres)
3	Pleated blinds
4	Diffusing panes and diffusing monolithic or laminated components

The types of product at present not covered include:

* Awnings
* Overhangs
* Slat systems and other shading devices mounted horizontally or at an angle above a window

2.2 Definitions

Venetian blind: a blind composed of parallel evenly spaced slats that can be pivoted to control the amount of light entering the room. The slats may be vertical or horizontal[1].

Fixed slat shading device: a series of parallel (usually horizontal) slats fixed at a given angle spaced evenly across the whole window aperture. Louvred panels fall into this category, but note that at present WIS assumes that the slats extend across the whole window area.

Pleated blind: A retractable blind made of pleated material which when drawn down covers the entire window aperture. The pleats are of even height and usually horizontal. The material may be permeable or non – permeable to air.

Roller blind or screen: A retractable or fixed blind made of a flexible material possibly permeable to air. The roller blind is flat when drawn.

Light-diffusing components: Usually fixed window elements whose optical properties include a diffuse component. Examples include monolithic diffusing panels; glazing with light-diffusing surface treatments; laminated products such as glazing with a light-diffusing film or thermotropic panels or SPD glazing (suspended particle device); patterned glass.

2.3 Positions

Certain products should only be used in certain positions; others might be used in more than 1 position. Table 2 shows the available options and their definition.

Table 2: Position definitions for blinds and diffusing components

ID	Position	Definition
1	Internal	On the internal (room) side of the window
2	External	On the external (ambient) side of the window
4	Integral	Integrated in the window (between panes) or, for light-diffusing components, replacing the panes

As you see the ID numbers are **not** 1, 2 and 3 but 1, 2 and 4. This allows for combinations of possible positions, so when a component may be used on the internal side and the external side, but not integral, the position ID will be 1 + 2 = 3. When a component can be used in all positions, the position ID will be 1 + 2 + 4 = 7.

[1] Vertical slat calculations are not (yet) implemented in WIS. The reason for this is that angular calculations are only performed for different altitude angles. The azimuthal angle is always assumed to be normal to the window plane. Therefore variations in the angle of incidence (variations in the altitude angle) have no effect on the transmission and reflection of vertical blinds.

3 Properties required

The properties requiring definition vary somewhat depending on the component, but can conveniently be grouped into four classes: *product identifiers*, *geometrical*, *optical* and *thermal and other* properties.

3.1 Text file format

Component properties are stored in WIS in a number of fields. Each field is identified by a tag and the field's value is the data stored in it. All data for one shading device should be submitted in one text file. The text file consists of two parts (see also the examples in section 4 below):

* A set of tags and their associated values with product information, such as:

  { Product name: My own product }

  { Thickness: 1 }

* The spectral data given in columns

The set of tags and values can be in any order, so both the following are correct:

{ Product name: My own product }

{ Thickness: 1 }

Or

{ Thickness: 1 }

{ Product name: My own product }

3.2 Product identifiers

The information required is shown in Table 3.

Table 3: Fields required for product identification

Tag	Value	Definition
Manufacturer	Text string up to 50 characters	The name of the company manufacturing the product
Product name	Text string up to 50 characters	Trade name of the product
Product type	Number, use Table 1	One of the categories from Table 1
Position	Number, use Table 2	Defined in section 2.3. Add all relevant numbers
Reference	Text string up to 255 characters	Link to product documentation
Material	Text string up to 50 characters.	The material that the blind or device is made of
Coated side	Neither, both, front, back	The side of the blind that is coated, if any. For Venetian blinds the upper side is equal to the front side
Appearance	Text string up to 255 characters	The products appearance (colour etc)
Info	Text string up to 50 characters	Any other information, such as the half angle used for measurements of the diffuse and direct components

Remarks:

* **Manufacturer**: This field is **compulsory**. Use exactly the same manufacturer name for each submission.

* **Product name:** You may use the same product name for different products from the same product range (e.g. with different colours).
* **Product type**: This field is **compulsory**. Give the number (ID) of the product type, **not** a text string
* **Position**: Give the (added) number of the position ID's, **not** text strings
* **Reference**: You may provide a link to a web site or an address from which more product details, such as illustrations, brochures and detailed specifications, can be obtained.
* **Material**: Do not include subsidiary components such as mounting, etc. that are not relevant to the calculations
* **Coated side**: For materials or diffusing panes with coatings, indicate the side(s) that are coated
* **Appearance**: Terms related to product appearance indicating colour, finish (e.g. blue, red, matt, glossy) etc

3.3 Geometrical information

The units to be used to specify dimensions are mm for length and degree (°) for angles.

3.3.1 Venetian and fixed slatted blinds

Figure 1 shows the geometry assumed in the calculations performed in WIS. The figure can be interpreted as a cross section viewed from the side for horizontal slats or from above for vertical slats.

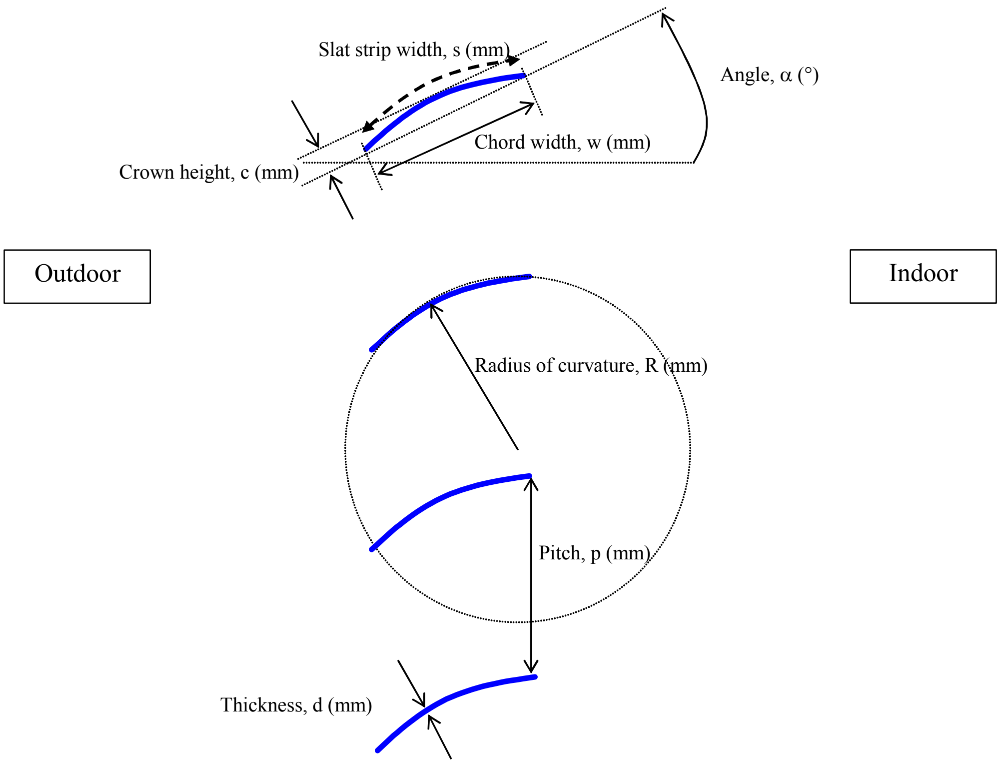

Figure 1: Definition of the geometry for slatted blinds.

The following dimensions are used in WIS to characterize the slats and the blind:

* Slat thickness, *d* (mm)
* Slat chord width, *w* (mm)

* Slat crown height, c (mm)
* Slat angle of rotation, α (°)
* Pitch (distance between slats), p (mm)

Note that crown height, c, has a sign associated with it (plus or minus). A positive value indicates that the blind is designed to be used with the convex surface facing outwards, as shown in Figure 1. A negative value indicates that the blind is designed to be used with the concave surface facing outwards, for example light redirecting blinds.

Manufacturers often specify the width of the flattened strip forming the slat, s, (shown in Figure 1) instead of the chord width across the slat, w. For slats with circular cross section, the crown height, c, and the strip width, s, can be used to define the radius of curvature of the slat, R, by the relation

$$c^2 - 2R\,|c| + R^2 \sin^2\left(\frac{s}{2R}\right) = 0 \qquad \text{(Angle in radians)} \qquad (1)$$

Here $|c|$ indicates the magnitude of c to allow for the possibility that it can be negative. Equation (1) can be solved for R by iteration. The chord width, w, can then be found from

$$w = \sqrt{8R\,|c| - 4c^2} \qquad (2)$$

Or from

$$w = 2R \sin\left[\frac{s}{2R}\right] \qquad \text{(Angle in radians)} \qquad (3)$$

Obviously, for flat slats, $c = 0$ and $w = s$.

For convenience, instead of using equations (1) to (3), the following approximate expression giving w in terms of c and s may be used:

$$w = s\left[1 - 2.668\left[\frac{c}{s}\right]^2 - 4.768\left[\frac{c}{s}\right]^4 - 27.656\left[\frac{c}{s}\right]^6\right] \qquad (4)$$

The relative error in w obtained from equation (4), compared to that obtained from using the exact equations (1) and (2) or (3) is less than 10^{-5} for values of c/s up to 0.2.

Similarly, if s and w are known, R can be obtained from equation (3) and then c from equation (2).

Whatever parameters are used by the manufacturer to specify the blind slats, the values that should be submitted are the chord width, w, and crown height, c, as defined in Figure 1.

The required dimensional information is given in Table 4.

Table 4: Fields required for slatted blinds

Tag	Value	Definition
Orientation	Vertical or Horizontal	Slat orientation
Thickness	Number, greater than 0	Thickness (d) in mm
Width	Number, greater than 0	Chord width (w) in mm
Crown height	Number (positive for convex surface facing outwards, negative for concave surface facing outwards)	Crown height (c) in mm
Angle	-90 ≤ slat angle ≤ +90	Slat angle (for fixed slats only!) in degrees
Pitch	Number, greater than 0	Slat pitch (p) in mm

Remarks:

* All dimensions (except the slat angle) are in mm and all fields are compulsory.
* The slat angle should only be given for fixed slats. For all other slats do **not** include this field in the data submission file.

Note: It is appreciated that many slat designs do not conform to this simple geometry. For example some blinds have slats that are composed of two more or less flat pieces at a fixed angle to each other (often with one piece perforated, the other opaque). Others are solid with both surfaces convex (especially external blinds). There are other variations in the shape of the slats. These cannot be treated exactly in WIS. The user may implement a system that comes closest to the exact geometry using the parameters that define curved blinds in WIS.

3.3.2 Pleated blinds

The information required is shown in Table 5 and illustrated in Figure 2.

Table 5: Fields required for pleated blinds

Tag	Value	Definition
Orientation	Vertical or Horizontal	Pleat orientation
Thickness	Number, greater than 0	Thickness (*d*) in mm
Width	Number, greater than 0	Width (*w*) in mm
Angle	$0 \leq$ angle ≤ 180	Internal pleat angle in degrees

Remarks:

* All fields are compulsory.

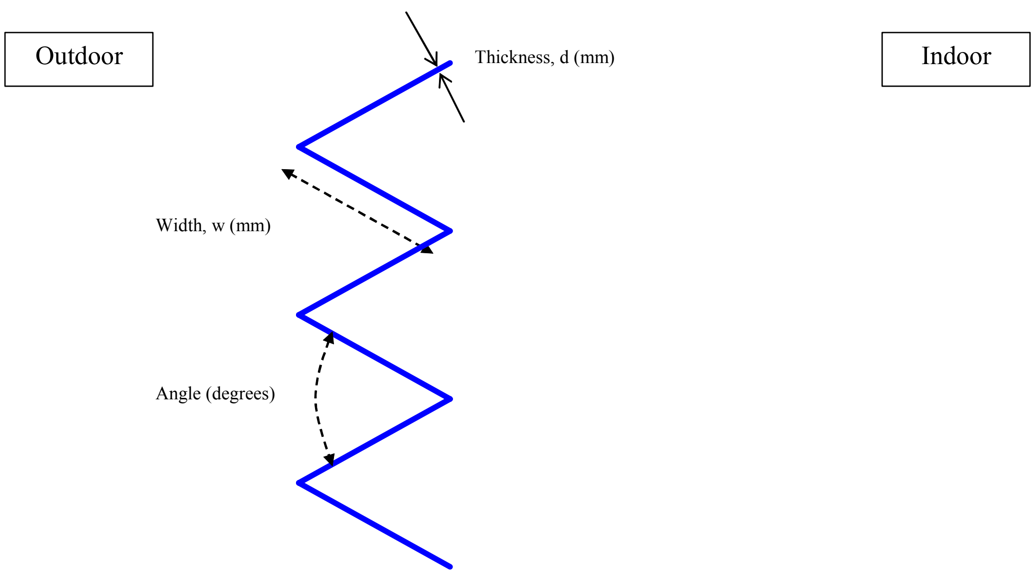

Figure 2: Definition of the geometry for pleated blinds.

3.3.3 Roller blinds and screen

The information required is shown in Table 6.

Table 6: Fields required for roller blinds and screens

Tag	Value	Definition
Thickness	Number, greater than 0	Thickness (*d*) in mm

Remarks:

* This field is compulsory.

3.3.4 Light-diffusing components

The information required is shown in Table 7.

Table 7: Fields required for light diffusing components

Tag	Value	Definition
Thickness	Number, greater than 0	Thickness (*d*) in mm

Remarks:

* This field is compulsory.

3.4 Thermal and other properties

The properties required to calculate heat flows through the window and shading device are shown in Table 8. Also included here for convenience, are the units used for the optical data, section 3.5.

Table 8: Fields required for thermal and other properties

Tag	Value	Definition
Conductivity	Number greater than 0	Thermal conductivity of the material or monolithic diffusing component, in $Wm^{-1}K^{-1}$
Emissivity front	Number greater than 0	Hemispherical emissivity of the material, front surface
Emissivity back	Number greater than 0	Hemispherical emissivity of the material, back surface
IR transmittance	Number greater than or equal to 0	Total hemispherical transmittance in the infrared (5 to 50µm) of the blind/slat/screen material or monolithic diffusing component
Permeability	Number greater than or equal to 0	Air permeability of the material, in $m^3Pa^{-1}s^{-1}$ per m^2 of material; for information (see section 3.4.4)
Units	Nanometers or Microns	The wavelength unit used for the optical data

Remarks:

* All fields are compulsory, except for permeability.

3.4.1 Emissivity and infra red transmittance

For pleated blinds, Venetian blinds, roller blinds and screens the data supplier should submit the hemispherical emissivity and infrared transmittance of the blind material. WIS will calculate the emissivity and the IR transmittance (hemispherical to hemispherical) of the complete blind system[2] from the material properties and the geometry of the blind system.

The emissivity, ε, is defined as the ratio of the energy emitted by a given surface to that of a perfect emitter (black body) at the same temperature. The reference temperature for glass in building is 10°C (283K). At this temperature the spectral range over which the irradiance of a black body is significant is 5 to 50 µm. Both the angular and spectral distributions of the emissivity should be considered. The emissivity, infrared reflectance, ρ, and infrared transmittance, τ, are related by Kirchhoff's law,

$$1 = \varepsilon + \rho + \tau \tag{5}$$

For non scattering materials that are opaque in the infra red, such as glass, τ = 0 and the sum of the emissivity and reflectance is equal to 1. Equation (5) is valid at each wavelength and for the total (i.e. integrated over wavelength) emissivity and reflectance at any angle (e.g. normal incidence or 45°) [4]. It is also valid for the total hemispherical quantities (i.e. further integrated over all angles) [5]. For non scattering materials, according to standards EN 673 [6] and EN 12898 [7], the normal (specular) spectral reflectance $R_n(\lambda)$ is measured in the range 5 to 50 µm and the integration is carried out using the spectral values measured at the centre of 30 wavelength intervals for which the energy of Planck's radiation function is constant (1/30 of total). The total normal emissivity at 283K, ε_n, is then calculated as

$$\varepsilon_n = 1 - \frac{1}{30}\sum_{i=1}^{30} R_n(\lambda_i) \tag{6}$$

EN 673 [6] and EN 12898 [7] also provide a procedure to calculate an emissivity value, called corrected emissivity ε, which takes into account the effect of the angular distribution of emissivity. The corrected emissivity ε is calculated by multiplying the normal emissivity ε_n by a suitable correction coefficient, selected according to the normal emissivity value. The values of the correction coefficients were decided on the basis of extensive measurements of the angular emissivity of uncoated glass, borosilicate glass and glass ceramics and of architectural coated glass [5, 8, and 9]. The corrected emissivity of uncoated float glass, borosilicate glass and glass-ceramics at 283 K was standardized at 0.837 [8].

3.4.2 Emissivity of blinds and shading devices

The definition of emissivity given in section 3.4.1, Kirchhoff's law at all angles and wavelengths and the reference temperature of 283K apply. However, because the materials from which the blinds or shading devices are made usually show scattering it is no longer possible to obtain the emissivity from the material's measured spectral specular reflectance. Due to the lack of comprehensive studies of the angular behaviour of the emissivity of such materials, no correction function is available to derive a corrected from the normal emissivity.

In the case of scattering materials that are opaque in the infrared, the total hemispherical emissivity, ε_h can be obtained from measurements of the total hemispherical reflectance, ρ_h, using equation (5) (with the total hemispherical transmittance, τ_h = 0), or from measurements of the angular emissivity, ε_ϑ, followed by integration over all angles according to

$$\varepsilon_h = \int_0^{\pi/2} \varepsilon_\vartheta \sin(2\vartheta)d\vartheta \tag{7}$$

[2] For pleated blinds, roller blinds and screens, WIS assumes that the emissivity and transmittance of the blind system are equal to the emissivity and transmittance of the blind material. For Venetian blinds the emissivity and transmittance of the blind system depend on the slat angle and slat width.

Both total and spectral measurements are possible. Spectral reflectance and emissivity values can be integrated to total values at 283 K using the 30 selected ordinates described in section 3.4.1.

In the case of non-opaque materials, the total hemispherical emissivity can be calculated from equation (5) and measured values of ρ_h and τ_h, or from their angular values, followed by integration over all angles. There is no reference emissivity value similar to 0.837for uncoated glass.

3.4.3 Emissivity of light-diffusing monolithic or laminated components

When the diffusing element in a laminated component is an interlayer with bulk scattering its surface is normally not accessible. The emissivity of the interlayer is therefore irrelevant. The emissivity to be entered is then that of the non-scattering outer elements of the laminate (e.g. glass), as discussed in section 3.4.1.

In the case of glass panes with rough light scattering surfaces and/or light diffusing films or patterns, the total hemispherical emissivity ε_h is calculated from the measured total hemispherical reflectance using equation (5) with $\tau_h = 0$.

In the case of uncoated glass with a roughened surface a value of 0.837 for ε_h can be used in practice, for lack of more accurate data.

In the case of plastic films with light scattering properties and a significant IR transmittance, equation (5) can be used in conjunction with measured values of ρ_h and τ_h.

EN 12898 [7] suggests a procedure to calculate the total transmittance at 283 K from spectral values with the 30 selected ordinates and a criterion to define a non-infrared transparent glazing component (for which in equation (5) τ is set equal to 0), if its total normal transmittance ≤ 0.05.

3.4.4 Permeability

The air permeability of shading devices may be given for information purposes. It is not used as such in WIS calculations, but a user can interpret the information to incorporate air exchange between layers (by forced or free ventilation) in WIS calculations.

Air permeability should be measured according to the standard EN ISO 9237 [10]. It recommends a pressure drop of 100 Pa for apparel fabrics and of 200 Pa for industrial fabrics. If these pressure drops cannot be achieved or are not appropriate, pressure drops of 50 Pa or 500 Pa may be used. The standard also recommends a test surface area of 20 cm^2 but areas of 5 cm^2, 50 cm^2 or 100 cm^2 may be used. For comparison it is recommended to perform the tests on a series of products with the same test area and pressure drop.

For calculations on shading devices the pressure drops are usually very low and therefore a pressure drop of 50 Pa and a test surface area of 100 cm^2 are recommended. The pressure drop and sample test area used for the measurements should be stated in the Info field (Table 3).

3.5 Optical properties

For the calculations performed in WIS, the spectral, normal-hemispherical optical properties of the blind material are required. It should be noted that in WIS it is assumed that the material's optical properties are uniform. For materials that consist of regions with different optical properties (for example perforated blinds or slats) the measurements should be carried out so as to produce a representative average value over the different regions. A fuller discussion of uncertainties in optical measurements is given in section 3.6 below.

For many types of blinds and screens, the material's transmittance is the result of holes in the otherwise opaque material, and in those cases the transmittance is regular (also referred to as non – scattering or specular or direct) and the same for light incident on either surface. However, for diffusing components it is possible for the normal-hemispherical transmittance to be different for light incident on the front or back surfaces.

The reflectance of most blind materials contains both a diffuse and a direct component. The default method used in WIS to calculate the transmittance and reflectance of the whole blind is based on a view factor analysis for the diffuse component, which is assumed to be Lambertian (equal in all directions in the hemisphere). Many materials exhibit a strong peak in the scattered component around the regular or specular direction. In modelling it has been found that the light scattered through a small angle from the regular ray is more accurately treated as if it were regular than as if it were Lambertian. For that reason, in WIS, the direct component of reflectance is defined as the light scattered within a cone of half angle of 5° around the regular direction. This definition should be taken into account in the measurements. For example, if measuring total and diffuse components using an integrating sphere, the angular width of the aperture through which the direct component is allowed to escape from the sphere in the second measurement should correspond with the above definition. When another value is used, this can be reported in the Info field (Table 3).

An alternative method, based on ray tracing, has been incorporated into WIS primarily to calculate the optical properties of slatted and pleated blinds, although it can also be used for other types of shading devices. In this method diffuse components of both transmittance and reflectance are assumed to be Lambertian.

3.5.1 Nomenclature

The front surface is defined as the surface of the shading device normally facing the outside.

The back surface is defined as the surface of the shading device normally facing the inside.

For example, referring to Figure 1, the convex surface of the curved slat of a Venetian blind would generally face the outside and thus be designated as the front surface.

The following schemes are usually equivalent:

front ↔ outside ↔ surface 1

back ↔ inside ↔ surface 2

The optical properties are designated as follows:

Total normal – hemispherical transmittance, front surface $Tf_{n,\,h}$
- Direct component $Tf_{n,\,dir}$
- Diffuse component $Tf_{n,\,diff}$

Total normal – hemispherical reflectance, front surface $Rf_{n,\,h}$
- Direct component $Rf_{n,\,dir}$
- Diffuse component $Rf_{n,\,diff}$

Total normal – hemispherical transmittance, back surface $Tb_{n,\,h}$
- Direct component $Tb_{n,\,dir}$
- Diffuse component $Tb_{n,\,diff}$

Total normal – hemispherical reflectance, back surface $Rb_{n,\,h}$
- Direct component $Rb_{n,\,dir}$
- Diffuse component $Rb_{n,\,diff}$

3.5.2 Spectral Data Format

The spectral data shall be given in 9 columns, 9 values on each line, separated by a tab, in the order shown in Table 9. To include products when only the total normal-hemispherical properties are known the transmittance will be assumed to be 100% regular (direct) and the reflectance 100% diffuse.

* All values shall be given in 3 decimal places (examples: 0.302 or 0.094)

* The measured data shall preferably start at a wavelength of 280 nm (0.280 μm), but in any case not greater than 300 nm (or 0.300 μm)
* The measured data shall end at a wavelength of 2500 nm (or 2.5 μm) or more

Unlike with non-scattering panes [1] there is no requirement on the wavelength intervals that should be used, but the same wavelength intervals as specified in [1] are recommended. The chosen wavelength intervals must be such as to allow accurate interpolation at 5nm intervals.

Table 9: Contents of the spectral data file.

Column number	Content	Comments
1	Wavelength	
2	$Tf_{n, dir}$	
3	$Tf_{n, diff}$	When equal to zero, it is assumed that the transmittance is regular (all direct).
4	$Tb_{n, dir}$	
5	$Tb_{n, diff}$	When equal to zero, it is assumed that the transmittance is regular (all direct).
6	$Rf_{n, dir}$	When equal to zero, it is assumed that the reflectance is diffuse.
7	$Rf_{n, diff}$	
8	$Rb_{n, dir}$	When equal to zero, it is assumed that the reflectance is diffuse.
9	$Rb_{n, diff}$	

3.6 Uncertainties in measurements of optical properties

As stated in section 3.5, WIS calculations are based on data stored in a database and regard the optical properties of materials as uniform. WIS does not take into account uncertainties in measurement and calculation. Uncertainties in the calculation derive from the propagation of measurement uncertainties combined with the physical model simplification hypothesis (of software and of data acquisition) and mathematical approximation (of software). Measurement uncertainties derive from several sources, the most important are:

* The specimen itself (its stability and properties)
* The measurement conditions and procedures
* The instruments used

It is up to each measurement laboratory to evaluate its own measurement uncertainties considering appropriate procedures [11].

The aim of the following paragraphs is to highlight some difficulties arising in the measurements of optical properties due to the specimen itself and the measurement apparatus. These difficulties should be considered both in evaluating the results obtained with WIS and in estimating the uncertainty.

3.6.1 Diffusing components

The global radiation transmitted (normal-hemispherical; directional-hemispherical, or hemispherical -hemispherical) by a diffusing glazing component can be measured using a large integrating sphere, a relatively small sphere with appropriate complex elaboration algorithms or a goniospectrometer. The last – named instrument can also be used to measure directional-directional and hemispherical-directional parameters.

Two different types of scattering can be highlighted:

* Bulk scattering (typical of glass ceramic plates and translucent interlayers): light is scattered in the whole plate and the shape and dimensions of the incident beam are completely modified. In this case, even when an infinitesimal incident light beam, such as a laser, is used, a large area of the sample becomes bright, making it problematic to collect all the transmitted or reflected beam
* Surface scattering (typical of sand-blasted, acid etched or patterned glass). Also in this case a degree of beam broadening can occur due to inter reflections with the flat surface [12]

In order to perform an accurate measurement, all the light transmitted by the diffusing plate is to be collected inside the sphere or by the goniospectrometer detector.

Consequently, integrating spheres with large entrance ports (and consequently large sphere diameter) or, for directional incidence a large uniform incident beam, must be used. Unfortunately this solution cannot be always achieved for economical and technical reasons. Nevertheless, for diffusing and/or remarkably thick samples, some of the transmitted radiation might be lost and will not contribute to the measured values. The more diffusing is the sample, the higher are the losses.

Goniospectrometric measurements give very useful and complete information, but are difficult and time consuming and some problems nevertheless arise especially when the specimen gives rise to broadening of the light spot and/or border scattering. To overcome the main difficulties, such as stray light influence, detector linearity, border scattering and reference system uncertainty analysis is very hard and time consuming.

Unfortunately there is a lack in the definition of procedures and instrumentation characteristics for a reliable characterisation of glazing units including diffusing components. In fact international standards [13, 14] do not recommend specific procedures for diffusing glazing and traditional instruments are not always adequate.

This lack of recommendations generates some difficulties in the evaluation of results of different laboratories and discrepancies can be very high [15]. In fact, for scattering (glazing) materials, the standard suggests only the use of an integrating sphere of size and aperture big enough to collect all possible diffuse light just to obtain fair average values of glazing behaviour. This is particularly difficult to satisfy for measurements in the solar range.

In order to estimate the losses when the incident beam is small, as in commercial spectrometers, measurements might be carried out with different entrance port diameters. Performing all the measurements with the largest entrance port might not be the best solution, since the influence of the entrance port can be different on different types of diffusing samples [16].

A more accurate solution is the development of mathematical models to obtain a better estimate of the real value [15, 17]. Mathematical models can be developed:

* On the basis of the extrapolation of a set of transmittance values measured by a large integrating sphere as a function of the entrance port diameter and considering the spatial distribution of the transmitted light [18]
* On the basis of the extrapolation of a set of transmittance values obtained with a small port sphere translated along a path allowing to collect the beams transmitted by different parts of the glass surface illuminated by a stationary beam [12]
* Following a detailed physical model of the properties of the diffusing component and the measurement of a set of mechanical and optical parameters [15]

Goniospectrometric measurements are essential in order to validate the models.

3.6.2 Blinds and shading devices

The optical characterization of blinds and shading devices is also a complex exercise. In this case it is also necessary to consider geometrical information and influences of the measurement conditions i.e. tension applied, non-uniformities, dimensions of the incident beam. In fact the WIS software assumes that optical properties are uniform: materials having regions with different optical properties are identified only by average values.

The considerations reported in section 3.6.1 still remain valid but the measurements on materials that exhibit strong intensity gradients (e.g. associated with holes or with the alternating presence of slats and interspaces) involve several additional problems, the most relevant are:

* High signal to noise ratio in the lower signal gradient area
* Instrument linearity
* Instrument sensitivity (when in the same area spike and base line signal are present, the base line cannot be detected)
* Symmetry influences (to extend the measured data to the whole sample/window surface)

Dealing with complex glazing systems, shading devices and/or Venetian blinds together with glass panes, the determination of the daylight and solar parameters and of uncertainty becomes even more complex.

The WIS Algorithm provides the final values of the whole system. As for diffusing flat glass samples, WIS also requires the total hemispherical and the diffuse transmittance/reflectance for shading devices and Venetian blinds as input for the database. Therefore when blinds and shading devices are evaluated and average values of optical properties of strongly non-uniform and diffusing materials are considered, the simulation of energy flows in buildings could be affected by high uncertainties.

4 Examples

In this section an example of a data file is given for four types of systems.

4.1 Example 1: Curved Venetian blinds, convex surface outwards

{ Units: Nanometers }

{ Manufacturer: A well known manufacturer }

{ Product name: A new product ® }

{ Reference: www.mycompany.com\products\downloads.htm }

{ Product type: 2 }

{ Position: 7 }

{ Material: Aluminium }

{ Appearance: Blue }

{ Orientation: Horizontal }

{ Thickness: 0.5 }

{ Width: 50 }

{ Crown height: 2 }

{ Pitch: 48 }

{ Conductivity: 100 }

{ Emissivity front: 0.9 }

(Emissivity back: 0.9 }

280	0.100	0.000	0.800	0.710	0.100	0.000	0.805	0.700
285	0.110	0.000	0.805	0.700	0.105	0.000	0.800	0.700
290	0.130	0.100	0.782	0.690	0.130	0.100	0.780	0.690

…

4.2 Example 2: Roller blinds

{ Units: Nanometers }

{ Manufacturer: A well known manufacturer }

{ Product name: A new product ® }

{ Product type: 1 }

{ Position: 1 }

{ Material: Cotton }

{ Appearance: Front = Shiny Red Back = Blue }

{ Thickness: 1 }

{ Conductivity: 20 }

{ Emissivity front: 0.85 }

(Emissivity back: 0.85 }

280	0.100	0.000	0.800	0.710	0.100	0.000	0.805	0.700
285	0.110	0.000	0.805	0.700	0.105	0.000	0.800	0.700
290	0.130	0.100	0.782	0.690	0.130	0.100	0.780	0.690

…

4.3 Example 3: Pleated blinds

{ Units: Nanometers }

{ Manufacturer: A well known manufacturer }

{ Product name: A new product ® }

{ Product type: 3 }

{ Position: 1 }

{ Material: Pressed paper }

{ Appearance: White grey }

{ Orientation: Horizontal }

{ Thickness: 0.5 }

{ Width: 20 }

{ Angle: 65 }

{ Conductivity: 15 }

{ Emissivity front: 0.9 }

(Emissivity back: 0.9 }

280	0.100	0.000	0.800	0.710	0.100	0.000	0.805	0.700
285	0.110	0.000	0.805	0.700	0.105	0.000	0.800	0.700
290	0.130	0.100	0.782	0.690	0.130	0.100	0.780	0.690

…

4.4 Example 4: Light-scattering glazing

{ Units: Nanometers }

{ Manufacturer: A well known manufacturer }

{ Product name: A new product ® }

{ Product type: 4 }

{ Position: 4 }

{ Coated Side: front }

{ Material: Glass }

{ Appearance: Front = white Back = milky green }

{ Thickness: 6 }

{ Conductivity: 1 }

{ Emissivity front: 0.837 }

(Emissivity back: 0.837 }

280	0.100	0.000	0.800	0.710	0.100	0.000	0.805	0.700
285	0.110	0.000	0.805	0.700	0.105	0.000	0.800	0.700
290	0.130	0.100	0.782	0.690	0.130	0.100	0.780	0.690

…

5 Data submission and Review procedures

For data to be accepted a number of requirements should be met. These requirements can be distinguished in 2 different groups:

1. Administrative requirements
2. Requirements on the data

The exact requirements are listed in the following paragraphs.

5.1 Administrative requirements for data submission

To submit data for the WinDat data base, the following package should be sent by e-mail to the coordinator, Professor Michael Hutchins, E-mail: mhutchins@brookes.ac.uk or to Dr Neviana Kilbey, Email: nkilbey@brookes.ac.uk.

* One or more text files (one file for each product) containing the information and data, as described in the relevant parts of section 3.
* A completely filled in Data Submission Form, see section 6. The form is best suited for the submission of data relating to a group of similar products (for example a series of blinds of the same design but of different colour). If data are submitted for more than one group of products it will be more convenient to fill in a separate data submission form for each group.
* A preliminary checklist (given in section 7) for each data file, confirming that it is complete.

5.2 Requirements on the Data

Data can only be accepted if they comply with the following:

* The format of the required information shall be in accordance with the specifications laid down in section 3 of this document. Examples of the correct format are given in section 4.
* The format of the spectral data shall be in accordance with the specifications laid down in section 3.5.2 of this document.

5.3 Review Process

Text files submitted to the WinDat coordinator will be circulated to all members who participated in the activities of Work Package 2.2, “Component and Window Product Data, Shading devices and diffusing materials”. For any given submission, the coordinator will assign the responsibility for review to two members, but all members are free to respond. The reviewers will check the data submitted for compliance with the requirements set out in Section 5.2 and for internal consistency and submit a report to the coordinator within six weeks. If they have questions about the validity or consistency of the data, their comments will be passed back to the submitter. Data approved by the reviewers will be added to the WIS database for distribution in the next following update release.

It is important to stress that the responsibility for the accuracy of the data (especially the optical data) remains with the submitter, and inclusion of the data in the WIS database does not imply endorsement of the quality of the data. For non scattering materials [2], data submitters have also to satisfy certain criteria to test the accuracy of their measurement methods. This is not feasible in the case of shading devices and diffusing components, since there is no history of round robin inter-laboratory comparisons using standard samples. However, it is clearly in the interest of product manufacturers that data relating to their products used in WIS calculations should yield accurate results and their reputation must therefore be the final guarantor of quality.

6 Data submission form

Company

Name: ______________________________

Postal address: ______________________________

____

____

____

Contact for data submission

Name: ______________________________

Telephone: ______________________________

Fax: ______________________________

E-mail: ______________________________

Data measured by

Name: ______________________________

Telephone: ______________________________

Fax: ______________________________

E-mail: ______________________________

Data files submitted

Filenames: ______________________________

____

____

____

____

____

Submission date: ______________________________

Component information

Type of product ______________________________

Samples

Number of samples per data file

Used in measurements: One / More than one (specify) ______________

Selection method: Random / Other (specify) ______________

Number stored: All / Less then all (specify) ______________

Storage location: At company / Elsewhere (specify) ______________

Sample area(s): ______________________________ mm^2

Optical properties, 0.280 to 2.5 μm

Component optical uniformity (See Section 3.5)

Uniform / Non uniform (specify) ______________

If non uniform, Fraction of component area with property 1 ______________

Fraction of component area with property 2 ______________

Sample optical properties Uniform /Non uniform ______________

If non uniform Fraction of sample area with property 1 ______________

Fraction of sample area with property 2 ______________

Measurements made Direct and diffuse / Total ______________

If direct and diffuse Cone half angle defining direct component ______________ °

Equipment used ______________________________

____

For type 4 components especially, the following information will assist the reviewers to assess the suitability of the measurement procedures.

Sample thickness ____mm

Aperture area (area of sample seen by detector) ____________________________ mm^2

Area of sample illuminated ____ mm^2

If an integrating sphere is used, Diameter of sphere ___________________________mm

Hemispherical emissivity and IR transmittance

Emissivity: Measured / Standard value (specify)____________________

If measured, state method (see section 3.4) and equipment used ____________________

____

____

IR Transmittance: Opaque / Transmitting________________________________

If transmitting, equipment used ____

____

____

Post-measurement data treatment

If more then one sample has been measured to generate one data file, how have the submitted spectral data been selected?

Not applicable / One sample selected / All samples averaged / Other (specify) ______________________________________

____

____

____

Have the data been treated in any other way after the measurement? Please specify:

____

____

____

Signature of contact for data submission

Name: ____

Signature ____

Date: ____

7 Preliminary checks

Before submitting new data for the WIS database the submitter should carry out a preliminary check on the data files to confirm that they conform fully to the requirements set out in section 5.2. The following checklist may be used:

- Product identifier information (Table 3)? ☐
- Geometric information (Table 4 to Table 7)? ☐
- Thermal and other properties information (Table 8)? ☐
- Optical properties format (section 3.5.2, Table 9)? ☐
- Wavelength Units value (Table 8) and values in optical data agree?
  (microns start at ≤ 0.300, nanometers start at ≤ 300) ☐

8 References

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