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**Windows as Renewable Energy Sources for Europe  
Window Energy Data Network**

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## **WIS version 3.0.1 Help file - converted to PDF document**

**Richard Versluis**

**TNO Building and Construction Research**

P.O.box 49

NL 2600 AA Delft, The Netherlands

Email: [R.Versluis@bouw.tno.nl](mailto:R.Versluis@bouw.tno.nl)

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**Contact:**

**On WIS, WIS data and WIS help:**

Richard Versluis, TNO Building and Construction Research, Delft, The Netherlands

Email: [wishelp@bouw.tno.nl](mailto:wishelp@bouw.tno.nl)

**On Thematic Network WinDat:**

WinDat coordinator: Dick van Dijk, TNO Building and Construction Research, Delft, The Netherlands

Email: [H.vanDijk@bouw.tno.nl](mailto:H.vanDijk@bouw.tno.nl)

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## Introduction

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## **General introduction**

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## Acknowledgements

Without the efforts of the members of [WinDat](#) and the [European Commission](#) the realisation of WIS would never have been possible.

*WINDAT and WIS were financially supported by the [European Commission Directorate General for Energy and Transport](#).*

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## Installation of WIS

### Setup information

WIS requires that certain software for data access be installed on your system. Three components are involved. Which components you need to install depends on your operating system and the presence of Microsoft Access 2000:

- Support for Microsoft Access 2000 databases (ART2000).

This is automatically available if you have Microsoft Access 2000 (part of Microsoft Office 2000 Professional) installed on your system. If not, you need to install a copy of Microsoft Access Runtime 2000 (ART2000) before using WIS. ART2000 is available as a separate package on the WIS website.

- Support for Microsoft Universal Data Access (MDAC).

This is part of the operating system in Windows ME, Windows 2000 and Windows XP. For Windows 98 and below, the WIS setup programme offers the possibility to install MDAC version 2.7SP1. For more recent version and more information about MDAC see the [Microsoft data access website](#).

- Support for the Microsoft Jet Engine (JET).

This is part of the operating system in Windows ME, Windows 2000 and Windows XP. Probably, it also installed as part of Microsoft Office 2000 Professional or ART2000. So under normal conditions, a separate installation of JET is not required. However, if WIS does not work properly after a setup without JET, the WIS setup programme offers the possibility to explicitly install JET version 4.0SP3. Just reinstall WIS. For more recent versions and more information about Microsoft Jet see the [Microsoft website](#)

Installation of WIS 2.0.1 in the default folder will not uninstall the previous version.

### Installation of Microsoft Access Runtime 2000 (ART2000)

- Download the setup file [ART2KMin.exe](#) (approximately 30 MB!) and save the file in a temporary directory.
- Open [ART2KMin.exe](#) for extracting its contents to an installation directory (default c:\art2kmin setup\):
- Open the Windows Explorer and go to the temporary directory where you have saved [ART2KMin.exe](#).

- Double-click on the file *ART2KMin.exe*. A small window opens, with caption *WinZip Self-Extractor [ART2Kmin.exe]*.
- Click in this window on the button *Unzip*. This will extract the installation files to directory *c:\art2kmin setup\*. Optionally, you can enter another directory in the text box labeled *Unzip To Folder*. A message box indicates the end of the extraction process.
- Click on *OK* in the message box.
- Click on *Close* in the window labeled *WinZip Self-Extractor [ART2Kmin.exe]*.
- The file *ART2Kmin.exe* is no longer needed and can be deleted.
- Open *setup.exe* in the installation directory (default *c:\art2kmin setup\*) and follow the instructions:
- Use the Windows Explorer to go to the installation directory (default *c:\art2kmin setup\*).
- Double-click on the file *setup.exe*. A window opens, with caption *Microsoft Access 2000 Runtime: Ready to Install*.
- Click on the button *Install Now*. ART2000 will be installed on your system. Optionally, you can change the installation directory by clicking on button *Customize....* After changing the directory path, you return to the previous window.
- The installation is completed. You can safely delete the installation directory and all its files (default *c:\art2kmin setup\*).

### ***Installation of WIS***

- The WIS setup programme will install WIS version 3.0.1 on your computer, and optionally supporting software for data access. NOTE: Before installing the optional software, please check whether your system requires the software (see also section Setup information).
- Download the setup file *WIS\_Setup.exe* (approximately 15 MB) and save the file in a temporary directory.
- Open *WIS\_Setup.exe* for extracting its contents to an installation directory (default *c:\wis201 setup\*):
- Open the Windows Explorer and go to the temporary directory where you have saved *WIS\_Setup.exe*.
- Double-click on the file *WIS\_Setup.exe*. A small window opens, with caption *WinZip Self-Extractor - WIS\_Setup.exe*.
- Click in this window on the button *Unzip*. This will extract the installation files to directory *c:\WIS\_Setup\*. Optionally, you can enter another directory in the text box labeled *Unzip To Folder*. A message box indicates the end of the extraction process.
- Click on *OK* in the message box.

- Click on *Close* in the window labeled *WinZip Self-Extractor - WIS\_Setup.exe*.
- The file *WIS\_Setup.exe* is no longer needed and can be deleted.
- Open *setup.exe* in the installation directory (default *c:\WIS\_Setup\*) and follow the instructions:
- Use the Windows Explorer to go to the installation directory (default *c:\WIS\_Setup\*).
- Double-click on the file *setup.exe*. A window opens, with title *Welcome to the WIS 3.0.1 Setup Wizard*.
- Click on the button *Next*. A new page shows information about the WIS setup.
- PLEASE READ THIS INFORMATION CAREFULLY! It explains which additional software you need to select on the following pages depending on your system.
- Click on the button *Next*. A new page shows the options for additional software that you can install in addition to WIS.
- Select the appropriate options (*Microsoft Data Access (MDAC)* and/or *Microsoft Jet Engine (JET)*).
- Click on the button *Next*. A new page asks for the installation folder for the WIS software (default *c:\Programs Files\TNO\WIS 3.0.1\*).
- Accept the default directory or enter a directory in the text box labeled *Folder*, either directly or through the button *Browse....* For additional information, the button *Disk Cost...* shows the available and required disk space on all drives.
- Indicate also whether WIS should be available for every user of this computer (*Everyone*) or only for you (*Just me*).
- Click on the button *Next*. A new page asks you to confirm the installation. Click *Cancel* if you do not want to proceed.
- Click on the button *Next*. The installation process starts and a new page shows the progress.
- If you selected the installation of MDAC under point k :
- A new window opens with caption *Microsoft Data Access Components 2.7 Setup*. The window shows the license agreement for MDAC. You have to accept the agreement in order to proceed.
- Click on the button *Next*. The MDAC setup checks whether the amount of disk space is sufficient.
- On the next page, click *Finish* to start the installation of MDAC.
- After the installation is completed, click *Close* on the final page.
- If you selected the installation of JET under point k :
- JET is automatically installed.

- After the installation of WIS is completed, click *Close* on the final page to end the installation process.
- The installation is completed. You can safely delete the installation directory and all contained files (default *c:\wis301 setup\*).
- If you choose during the installation process to install the additional data access software, then the directory in which WIS has been installed (default *c:\Programs Files\TNO\WIS 3.0.1\*) contains a subdirectory *setupdb*. This subdirectory was only used for the installation process, so you can safely delete this directory and all its files.

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## **System requirements**

WIS does not support installation on networks, only on stand alone computers. WIS can be installed under Windows 98, Windows ME, Windows 2000, Windows NT and Windows XP.

WIS will require about 60 MB of free disk space, but more disk space may be needed for installation of supporting software (ART2000, MDAC and JET).

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## Downloading WIS

WIS can be downloaded from the [windat website](#). Clicking WIS software will forward you to the WIS website. Do not forget to register the software (for free!) to make use of all the benefits such as being notified about future updates of the database.

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## **Installation of WIS**

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## Registration

You are strongly encouraged to become a registered user of WIS.

**Registration is for free.** Registered users will receive regular updates and information related to WIS and will also receive future updates to the database.

How to register:

- Go to [the WinDat website](#)
- Click on WIS software. This will open a new browser window
- Click on registration
- Fill in the registration form. Under WIS version type: 3.0
- You will receive an automatically generated e-mail with your *registration code* that matches your *user name* and *organisation name*
- When you start WIS you will see a form that allows you to register the software with this information, [see Starting WIS](#)

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## Starting WIS

### Starting WIS

You can start WIS in the following ways (it is assumed that *path* is the folder where you installed WIS, default: "C:\Program Files\TNO\WIS 3.0.1"):

- In your computer explorer go to *path* and double click on *WIS.MDE*
- On your keyboard, click on the Windows icon (or on your screen click on the Start button). Under *programs* goto to *WIS 3.0.1* and click on *WIS*.
- If you have created a shortcut on your desktop, click on the shortcut for WIS

Note: It is important to start WIS by running WIS.MDE, **not** wisexe.exe

### Changing the registration

When you start WIS for the first time, you will get the following screen. Unregistered users always get this screen when they start WIS and get a pause screen for 10 seconds. This screen is to remind you that you should register in order to make use of all the options in WIS, [see registration](#).

# Welcome to WIS

## Unregistered version

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[Change](#)

By clicking on change you will get another screen where you can supply your user name, your organisation name and your registration code.

### **Unregistered version**

Unregistered users will get a 10 seconds pause screen every time they start WIS:

**This is an unregistered version of  
WIS version 2.0.1**

[www.windat.org](http://www.windat.org)

If you like this program and want to avoid this screen,  
please register at the website.

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**WIS will pause for 10 seconds**

## De-installation of WIS

WIS can be removed by going to your Windows control panel and start the "add or remove Programs" component in Windows:

**Windows START button --> Settings --> Control Panel --> Add or remove programs**

Select WIS 3.0.1 and click Remove.

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## **WIS Licence and Disclaimer**

WIS Consortium

WIS Software License Agreement

WIS version 3.0.1

May, 2004

1. The WIS Software. The materials presented here embody the WIS package and associated documentation, version 3.0.1, and are referred to as "the WIS Software".
2. The WIS Consortium. The WIS Software was originally developed within the European RTD collaboration project "WIS" (1994-1996) carried out under contract JOU2-CT94-0373 to the European Union in the DG Research JOULE programme, by eight European research organisations, co-ordinated by TNO (The Netherlands Organisation for Scientific Research) and is being further developed within the European Thematic Network WinDat (2001-2004) under contract NNE5-2000-122 of the Energy Programme of DG Transport and Energy of the European Commission. The WinDat Network comprises about 40 European research and industry partners and is co-ordinated by TNO. For the purposes of this licence, the teams contractually or de facto involved in the development and/or distribution of WIS are collectively referred to as "the WIS Consortium".
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## Why use WIS to calculate the thermal and solar properties of windows

The thermal and solar properties of a window system are a function of the composition of a number of components and the assumptions concerning its environment. The main components are the transparent part and the window frame.

The transparent part consists of panes (either or not coated or structured, glass or plastic or this foil), gas or air filled gaps and shading elements parallel to the panes. The gaps may be ventilated or not.

In case of a temperature difference between inside and outside, heat will be conducted through the transparent part by conduction, convection and thermal (IR) radiation.

The panes and shading elements transmit, absorb and reflect solar radiation. Absorbed solar heat is in its turn transported to inner and outer surface of the system by conduction, convection and thermal (IR) radiation. In particular the shading elements will to some extent transmit thermal radiation and thermally driven or forced circulating air.

The typical, first simplifying assumption is that the thermal and solar properties of a transparent system may be considered as one-dimensional, perpendicular to the pane surface.

Where this is an obvious oversimplification the two-dimensional effects are taken into account in a special way. This is for instance the case for the thermally driven ventilation and the edge effect where the transparent part and the window frame meet.

Within the window frame the heat is also transferred by conduction, convection and thermal radiation. Due to the geometry of the frame the heat transfer is usually typically two (or even three-)dimensional. The challenge is to reduce the two-dimensional heat transfer characteristics into a one-dimensional property.

On top of that, there is a close interaction between the edge of the transparent system and the frame. In particular in case of metal spacers in sealed double or triple glazing units, the spacer and the glass edges may act as thermal

bridges for the frame, and/or vice versa.

The indoor environment is defined by an air temperature, a mean surface temperature (for thermal radiation exchange), humidity and a certain air movement in the boundary layer of the window.

The outdoor environment is in general characterized by such variables as air temperature, temperatures of sky, surrounding buildings and ground, humidity, wind speed and direction and solar radiation. The solar radiation reaches the window as direct radiation from the sun, diffuse radiation from the (overcast) sky and ground reflected radiation.

It is arbitrary under which category the following elements should fall.

- the orientation and tilt angle of the window
- external shading devices like window rebate, awnings, etc.

We chose to place them in the category of environment, because the window responds to it similarly as it responds to a change in environment conditions.

Finally, the choice of the calculation method may -and usually will- depend on restrictions of practical and/or legislature nature: availability of necessary input data from components, calculation rules dictated by (inter)national standards, simplifications in case of complex products, simplifications in case of complex boundary conditions.

In short: there are (too) many choices to make. The actual choice in a certain situation depends on the type of user and his/her goal.

### **The WIS software tool:**

The WIS tool aims to combine the wide range of applications into one software package with different in-built choices.

In order to offer to the different categories of users a tool which is suited to their demands, with a minimum risk of improper use, a number of measures have been built in, such as different access restrictions, component data protection and validity checks.

One of the main applications, is the use of WIS to calculate window properties according to CEN calculation rules, using CEN environment conditions and certified component data as input. This has been facilitated by the introduction of a special mode for 'CEN only' calculations.

### **Data protection:**

To prevent unwanted editing of supplied certified manufacturers data and representative sets of generic data, these input data are protected against editing or erasing.

**Validity checks:**

To prevent the use of physically, practically or computationally impossible data, or the creation of physically, practically or computationally impossible combinations a high number of validation checks have been built in. The user receives an on line warning at the occasion. For instance: a gap or pane width of zero mm; a gasmix not adding up to 100 percent; etcetera.

Similarly, protections are built in to check whether the available data are suited for the requested type of calculation. For instance: if the spectral data in the visible part of the spectrum are absent or insufficient, a warning will inform the user that the visual properties cannot be calculated due to incomplete data.

**No guarantee:**

Of course these protections are in no way a guarantee against any misuse that may be provoked by the high number of possibilities offered by WIS. They are mainly meant to protect against often made minor mistakes. For instance, it is possible to place a pane with a vulnerable softcoating at the weather exposed side of the transparent system.

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## The WinDat Thematic Network

WinDat aims to make available and freely distribute a European software tool for the calculation of the thermal and solar properties of commercial and innovative window systems on the basis of known component properties and thermal and solar/optical interactions between the components.

The Network membership comprises research and educational organisations, industry, consulting engineers and designers. Together, they represent all interested parties in Europe from research through development to manufacture and distribution.

A complete list of the members of the winDat Thematic Network and other information can be found on the [windat website](#).

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## What is WIS

WIS is a uniform, multi-purpose, PC based European software tool to assist in determining the thermal and solar characteristics of window systems (glazing, frames, solar shading devices, etc.) and window components. The tool contains databases with component properties and routines for calculation of the thermal/optical interactions of components in a window.

The WIS tool has been developed in the 'Advanced Windows Information System (WIS)' project of the European Commission Directorate General XII for Science, Research and Development.

WIS contains features often not found in other software packages including routines for the characterisation of the performance of solar shading devices and ventilation in glazing cavities.

WIS enables calculations according to the latest (draft) European standards, calculations using advanced routines for innovative products and customised calculations using appropriate routines such as for determining window properties under specific design conditions.

WIS is a user-friendly tool, prepared for a wide variety of users including: consulting engineers, manufacturers, building designers, researchers and those involved in standardisation, building regulation and education. It has been developed with an open, object-oriented structure to enable it to respond to future developments.

Through its variety of calculation routines and databases, WIS forms an ideal platform for bringing together international research on innovative window systems and contributes to an effective and coherent dissemination of research results. Similarly, there is a close interaction between the development of WIS and European standardisation activities within the framework of CEN.

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>>

## Filter by excluding selection

1. In a field on a form find one instance of the value you want records **not** to contain in order to be included in the filter's results.
2. Select the value, and then click on the menu **Records|Filter By Excluding Selection**. How you select the value determines what records the filter returns. For more information on selecting values, see [here](#).

Unlike filtering by selection, filtering by excluding selection returns all records that do not contain the selected value.

Repeat step 2 until you have the set of records you want.

See also:

[Filtering records](#)

[Filter by selection](#)

[Ways to select values for a filter to affect what records are returned](#)

## Ways to select values for a filter to affect what records are returned

You can select all or part of a value in a field. How you select the value determines what records the filter returns.

1. Selecting the entire contents of a field (or placing the insertion point in a field without selecting anything) finds records in which the entire contents of that field matches the selection.
2. Selecting part of a value starting with the first character in a field finds records in which the value in that field starts with the same characters you selected.
3. Selecting part of a value starting after the first character in a field finds records in which all or any part of the value in that field contains the same characters you selected.

*Example 1: You select the value "Product A" in the Name field. The filter returns all records with Product A as the name.*

*Example 2: In the Name field containing the value "Product A," you select only "Prod" The filter returns all records that have a name starting with "Prod" such as Product B and Product C.*

*Example 3: In the Name field containing the value "A fine product," you select the letters "fine." The filter returns all records that have "fine" anywhere in the Name field, such as "afina".*

## Filtering records

Filtering data limits the number of records shown in a window to the set of records that match certain criteria. There are various ways to filter data:

[Filter by selection](#)

[Filter by excluding selection](#)

Advanced filter/sort

See also:

[Sorting records](#)

[Browsing through records](#)

[Finding records](#)

## Filter by selection

1. In a field on a form find one instance of the value you want records to contain in order to be included in the filter's results.
2. Select the value, and then click on the menu **Records|Filter By Selection**. How you select the value determines what records the filter returns. For more information on selecting values, see [here](#).  
Repeat step 2 until you have the set of records you want.

See also:

[Filtering records](#)

[Filter by excluding selection](#)

[Ways to select values for a filter to affect what records are returned](#)

## Sorting records

You can sort the records on a form in ascending or descending order for one of the fields. To sort records perform the following steps:

1. [Open the window with data that you want to sort.](#)
2. Move the focus to the field that you want to sort on (e.g. the name or the ID) by clicking in that field with your mouse cursor.
3. From the menu select **Records|Sort Ascending** or **Records|Sort Descending**.

See also:

[Filtering records](#)

[Browsing through records](#)

[Finding records](#)

## Opening and closing windows

When you first start WIS you will see the so-called switchboard (see picture below).

Clicking one of the buttons on the switchboard will open the corresponding window, e.g. clicking the **Window System** button will open the Window System form. The window system form (or any form) can be closed by clicking the standard close button in the right top hand corner [x] or by clicking the **Return** button on that form.

Another way to open a form (but not all forms that can be opened through the switchboard) is by selecting **Database** on the menu and then select the corresponding form.

Note: Closing the switchboard will close WIS.

\*\* insert picture of switchboard here when it is finalized \*\*\*

See also:

[Using the menu](#)

## The WIS menu

By using the menu you can open various forms or perform various actions. Click one of the links below to get more help on a certain topic.

File menu Commands to close WIS or print the screen or a current record  
Edit menu Commands related to copying and pasting records, finding records based on the contents of a certain field or replacing the contents of a certain field

View menu Commands related to change the settings of WIS

Records menu Commands related to inserting or saving records and filtering and sorting of records

Database menu Commands related to opening forms representing data in the database

Window menu Commands related to sizing windows

Help menu Commands related to getting help

### File menu

[Page Setup](#)

[Print...](#)

[Exit](#)

### Edit menu

[Cut](#)

[Copy](#)

[Paste](#)

Paste append

Delete

[Delete Record](#)

[Select Record](#)

[Select All Records](#)

[Find](#)

### View menu

Settings

## **Records menu**

[Insert New Record](#)

Save Record

[Filter by Selection](#)

[Filter by Excluding Selection](#)

[Sort Ascending](#)

[Sort Descending](#)

Advanced Filter/Sort

Apply Filter/Sort

[Remove Filter/Sort](#)

Refresh

## **Database menu**

Main

Window System

Frame

Transparent System

Pane

Shading

Gas Mix

Gas

Environment

## **Window menu**

## **Help menu**

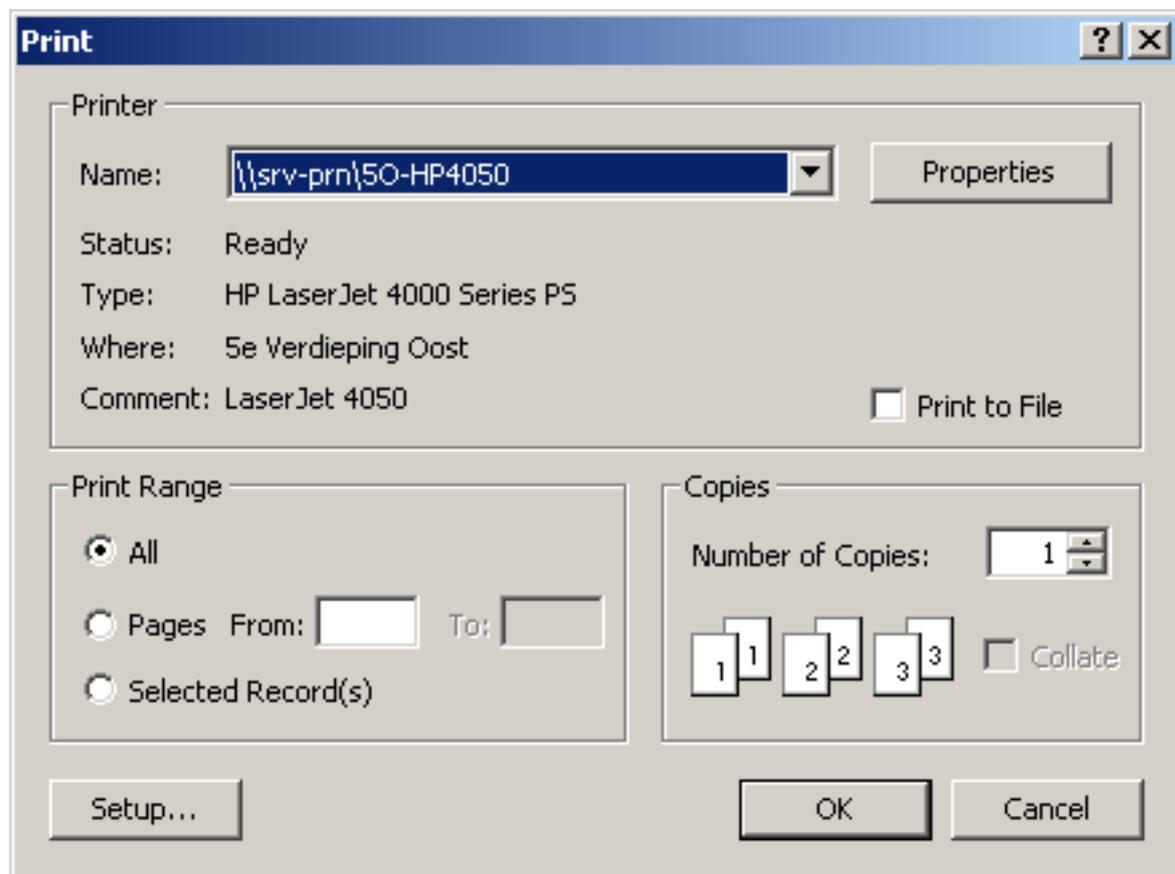
## File|Page Setup

Select the **Page Setup** item from the **File** menu to open the page setup dialog. For more information on the page setup dialog see Windows Help.

## File|Print

Select the **Print** item from the **File** menu to open the printer dialog to print the current screen or a selected record.

This will bring up a standard printing dialog box (as shown below). Choose **All** to print the screen or **Selected Record(s)** to print the selected record.



## File|Exit

Select the **Exit** item from the **File** menu to close WIS.

## Edit|Cut

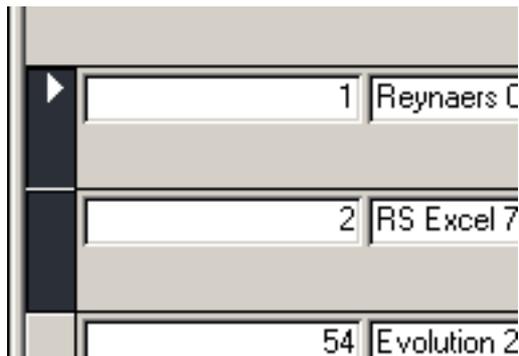
Select the **Cut** item from the **Edit** menu to cut text from a text box to the clipboard or to cut a record from the database to the clipboard.

To cut text, select text in a text box or part of the text in the text box first.  
To cut a record, select that record first, [see selecting records](#)

## Selecting records

Sometimes you will have to select a complete record, e.g. when you want to [delete](#) a record or [copy](#) a complete record. You can select a record in two different ways:

- By selecting **Select Record** or **Select All Records** from the **Edit** menu. This will select the current record or all records of that component type (e.g. all frames)
- By clicking on the *record selector bar* on the left side of the record (in the figure below two records are selected by holding down the Shift button and selecting the first two records)



See also:

[Sorting records](#)

[Filtering records](#)

[Browsing through records](#)

[Finding records](#)

## **Deleting records**

Records may be deleted by selecting the records you which to delete and clicking the delete button on your keyboard. When data is referred to by systems (e.g. you try to delete a pane that is part of a transparent system, deleting the record will not allowed)

## Edit|Copy

Select the **Copy** item from the **Edit** menu to copy text from a text box to the clipboard or to copy a record from the database to the clipboard.

To copy text, select text in a text box or part of the text in the text box first.

To copy a record, select that record first, [see selecting records](#)

## Edit|Paste

Select the **Paste** item from the **Edit** menu to paste text from the clipboard to a text box or to paste a record from the clipboard to a new record.

To paste text, select a text box first to paste the text to.

## Finding records

You can search for records that fit a certain criterium using the standard windows Find (and Replace) control. The Find control is opened by clicking **CTRL+F** on your keyboard or by selecting **Edit|Find** from the menu. The find control can only be opened when a window with searchable data is opened ([see opening and closing windows](#)).

When you have an open form, take the following steps to look for certain data:

1. Move the focus to the field that you want to search by clicking on that field (e.g. the name of a product).
2. Open the find control (see above)
3. In the "find what:" field type in the data that you are looking for (part of the name or the whole name)
4. The find control has some standards to refine your search, such as "case matching", looking for part of a field etc.

Note: With the find option you are limited to looking for the first record that matches your criteria and your search criteria is also limited. To look up more records that match your search criteria and to use more advanced criteria (such as values greater than a certain limit), use [filtering](#).

Note: It is **strongly advised** not to use the replace option. This option is not tested and can lead to unforeseen errors or a corrupt database.

See also:

[Sorting records](#)

[Filtering records](#)

[Browsing through records](#)

## Browsing through records

When you open a window with data, you can browse through all the records in the order they are sorted in. To browse through the records you should use the record navigator located at the bottom of most forms:



The single arrow will move the current displayed record to the next  or previous  record. The double arrows will move the current displayed record to the first  or last  record. The arrow with a star  is used to add a new record, see [adding records](#). The numbers show you which record is currently selected out of the total number of records (in the picture record number 1 out of 177 records)

Another way to browse through the records is to use the drop-down box with all records in the table:



Select from the list of names the product that you want to see.

Note: The browsing is not only influenced by the sorting order, but also by any filtering you may have applied ([see filtering records](#)). When you have filtered the records according to certain criteria, you can only browse through the filtered subset of data.

Note: when you have a filtered set of data, the drop-down box will you show you **all** the records (not only of the filtered subset). When the data is filtered and you select a name that is not present in the filtered subset, the selected record will not be displayed. In that case you should remove the filter.

See also:

[Sorting records](#)

[Filtering records](#)

[Finding records](#)

## Adding records

Records may be added by selecting **Records|Insert new record** from the menu.

## Removing filters or sorting order

To remove a filter or sorting order select **Records|Remove Filter/Sort** from the menu. This will show all records in the dataset.

Note: removing the filter from the data will not actually delete the filter. You can re-apply the filter by selecting **Records|Apply Filter/Sort** from the menu.

## Using WIS

[How to start WIS](#)

[How to close WIS](#)

[How to work with WIS in general, the user interface](#)

[How to open or close forms showing \(component\) data](#)

[How to select components, transparent systems and windows](#)

[Window systems](#)

[Transparent systems](#)

[Specular layers](#)

[Scattering layers](#)

[Frames](#)

[Spacers and edges](#)

[Gasmixes](#)

[Gasses](#)

[Changing the calculation settings](#)

## The user interface

WIS actually consists of two important parts.

1. The data and the interface are stored in a compiled Microsoft Access Program. All data manipulation (selecting records, sorting, filtering, etc.) is done by using standard Access routines. If you are familiar with Access you will recognize this.
2. Most of the calculations are done in a separate DLL, written in C++. This DLL may call some other specific DLL's to perform specific tasks, like ray-tracing calculations.

When you start WIS you will see the so-called switchboard (see opening and closing windows). Clicking any of the buttons will open secondary forms with data. On the forms you will see other buttons, e.g. to calculate the properties of a data component or to display the results in a (text file) report. A number of functions can be accessed in various ways. As an example: deleting a record can be done through the menu or by selecting a record and pressing the Delete button on your keyboard.

When you have opened a window, e.g. to look at certain component data, you can go back to the previous button by either clicking on the RETURN button or by closing the window.

It is important to realize that most data in WIS is **linked** to each other, [see working with data](#).

## Working with data in WIS

### Tables

All data in WIS is stored in tables:

- Environment --> table with environmental boundary conditions
- Gas --> table with properties of gasses
- Gas mix --> table with properties of gas mixes
- Specular pane --> table with properties of specular panes
- Transparent system --> table with properties of transparent systems
- Window system --> table with properties of window systems
- ...etc

The data in the tables can be accessed by [opening the corresponding window](#) and locating the record(s) you are interested in (see below)

### Locating records

The data for one product (one specular pane) is stored in a record. You can look up the information of one product (one record) in various ways:

- [by browsing through records](#) (in the sorted order)
- [by looking for a specific record based on a search criterium](#) (such as the name)
- [by filtering the records based on more complex criteria](#) (such as all panes with a thickness greater than 10 mm)
- [by sorting the records in specific order to assist the browsing process](#) (such as by productname)

### Selecting records

Reasons for selecting a complete record (e.g. a pane) could be to remove a record or to copy a record. This done by [selecting a complete record](#).

### Adding records

You can add new records to the tables, e.g. when you have data of new components that you want to use in WIS or when you create a new window system or new transparent system.

## Deleting records

You can [delete records of components or systems](#) that you are no longer interested in, but deleting records can never be undone.

## Changing records

The user is allowed to change the properties of a component stored in a record, but not in all cases. Some data may be protected by WIS (such as gas properties of air, argo, krypton and SF6 according to EN673), while other data may be frozen by the user to avoid accidental changing of the data. In most cases you can simply change data (e.g. the name) by selecting that field and type in a new value. Some properties (such as spectral data or calculated properties) cannot be changed.

## Freezing records

Records in the pane database and shading database may be frozen by the user to avoid accidental changing of the records. Some notes:

1. Freezing can never be undone. Once frozen the records cannot be unfrozen
2. Some data in the database is already frozen (data supplied by glass and shading manufacturers)
3. Freezing venetian blinds will freeze all fields except for the slat angle. This field can always be changed.

## Tables are linked

It is important to realize that all of **these tables are linked** to each other !! This means that when you change for instance the properties of a specular pane all transparent systems and window systems that have this pane as one of their components are changed as well. These changes will **not** be automatically reflected in the calculated properties. You will have to go to the other windows that have this component and recalculate each of these components. If you want to change only the component of one window, but it is used by another window, you should make a copy of this component and change the copy to leave the original as it is.

Example: A window system "W" consists of two panes "P1" and "P2" with a gap "G" in between. The calculated U-value of "W" is 1.5. When the user opens the specular panes form and changes for instance the conductivity of pane "P1" the U-value of "W" has become incorrect. The user should then open the Window systems form and re-calculate the properties of that window system.

Another example: All systems are linked to a certain environment (see

environment table). When you change the properties of a certain environment (e.g. change the indoor temperature from 20°C to 10°C) you will have to recalculate all systems that are linked to this environment to determine the properties for that environment. If you want to calculate the properties of one system for two different environments it is therefore always better to create two different environments. First you link the system to the first environment and calculate its properties. Then you link the system to the second environment and calculate its properties. This way no system that is linked to the first environment will be affected.

## Window system

The window system is a combination of transparent system, frame and spacer. By opening the window system form ([see opening and closing of forms](#)) the properties of the window system are displayed. In this form the properties of whole window systems, including frames and possibly spacers, can be imported, viewed, edited and calculated.

The window dimensions can be specified in the bottom left corner.  
The window components can be selected in the bottom right corner.  
The calculated window properties are shown in the top area (under results).

The height and width of the Window system should include the Frame

Click one of the links below to get more information on different subjects:

[The window system as combination of transparent system, frame and spacer](#)

[The main calculated properties of a window system](#)

[Changing a window system](#)

[Calculating the properties of a window system](#)

## **The window system as combination of transparent system, frame and spacer**

The thermal and solar properties of a window system are a function of the composition of a number of components and the assumptions concerning its environment. The main components are the transparent part and the window frame.

The transparent part consists of panes, gas or air filled gaps and shading elements parallel to the panes.

In case of a temperature difference between inside and outside, heat will be conducted through the transparent part by conduction, convection and thermal (IR) radiation.

The panes and shading elements transmit, absorb and reflect solar radiation. Absorbed solar heat is in its turn transported to inner and outer surface of the system by conduction, convection and thermal (IR) radiation. In particular the shading elements will to some extent transmit thermal radiation and thermally driven or forced circulating air.

The typical, first simplifying assumption is that the thermal and solar properties of a transparent system may be considered as onedimensional, perpendicular to the pane surface. Where this is an obvious oversimplification the twodimensional effects are taken into account in a special way. This is for instance the case for the thermal effects at the edge where the transparent part and the window frame meet.

Within the window frame the heat is also transferred by conduction, convection and thermal radiation. Due to the geometry of the frame the heat transfer is usually typically two (or even three-)dimensional. The challenge is to reduce the twodimensional heat transfer characteristics into a onedimensional property. This process is described elsewhere.

There is a close interaction between the edge of the transparent system and the frame. In particular in case of metal spacers in sealed double or triple glazing units, the spacer in case of multiple glazing units and the glass edges may act as thermal bridges for the frame, and/or vice versa: the frame may act as a thermal bridge for the edge of the transparent part.

In international standards the interaction between frame and transparent part is represented by the onedimensional heat loss parameter PSI. See elsewhere.

## The main calculated properties of a window system

The main properties of a windows system that are calculated in WIS are:

- Geometric factors (Projected Frame Area, Visible Area Transparent System & Frame Perimeter Length)
- U-value
- g-value
- solar direct transmittance, light transmittance and UV transmittance

The geometric factors (visible area of the transparent system and frame perimeter length) are calculated from the geometry of the frame and the transparent system, see [Calculation of the geometry factors of a window system](#)

The U-value of the window system is obtained as a combination of U-value of transparent part and U-value of frame, weighted with their respective projected areas plus the PSI-value ( $\Psi$ ) of the spacer multiplied by the perimeter length of the transparent system. For the calculation of the U-value WIS needs the properties of its components. The U-values and the PSI-value are obtained as result of the calculations on the transpa-rent part and frame, see [Calculation of the U-value of a window system](#)

The g-value and optical transmittance values of the window system are a very simple conversion from the values calculated for the transparent part, weighted by the area of the window system compared to the area of the transparent part, see [calculation of the g-value of a window system](#)

. Obviously one should be well aware whether a g-value is defined for the whole window area or only for the transparent part. Similarly for the optical transmittance values.

## Calculation of the geometry factors of a window system

The geometric data are obtained as:

**window system area ( $A_w$ ):**

$$A_w = h \times b$$

with:

$h$ ,  $b$  is the height and width of the window system, specified as property of the Window System in the input (m).

**Visible area of the transparent system ( $A_{tr}$ ):**

$$A_{tr} = (h - 2 \times df) \times (b - 2 \times df)$$

with:

$df$  is the thickness of the frame, projected in the plane of the pane(s) and specified as property of the frame (m)

**The perimeter of the frame ( $L$ ):**

$$L_f = 2(h - 2 \times df) + 2(b - 2 \times df)$$

## Calculation of the U-value of a window system

To be included....

Note: The U-value of the window system is determined from the U-value of the transparent system, which **depends on the tilt-angle of the transparent system**.

## Calculation of the g-value of a window system

The g-value and optical transmittance values of the window system are a very simple conversion from the values calculated for the transparent part, weighted by the area of the window system compared to the area of the transparent part. For the g-value:

$$g_w = g_{tr} \times A_{tr}/A_w$$

Note: The g-value of the window system is determined from the g-value of the transparent system, which **depends on the tilt-angle of the transparent system**. The optical properties however are calculated for normal incidence and do **not** depend on the tilt angle of the transparent system.

## Changing a window system

### Selecting a window frame

The window frame can be selected by either clicking on the drop down arrow next to the frame name or by clicking on the **select** button next to the frame name (this will bring up the frames window where you can select a new frame and click on **select** to return to the window system form).

### Select the transparent system

The transparent system can be selected by either clicking on the drop down arrow next to the name or by clicking on the **select** button next to the name (this will bring up the transparent systems window where you can select a new transparent system and click on **select** to return to the window system form).

### Selecting the PSI value

The PSI value (linear thermal transmittance for spacers; see EN 30077-1) can be either directly typed in by the user or selected using the **suggest** button which opens the PSI calculation form.

### Selecting the environment

The transparent system can be selected by either clicking on the drop down arrow next to the name or by clicking on the **select** button next to the name (this will bring up the environment window where you can select a new environment and click on **select** to return to the window system form). The environment cannot be selected in CEN only mode.

### Changing the dimensions

The dimensions of the window system can be changed in new values for height, width etc.

## Calculating the properties of a window system

The properties of the window can be calculated by clicking on the calculate window. Select the properties that you want to have reported in a text file and click create. The properties of the window system will be calculated and shown in the window system form and shown in the text report.

Note: when calculating the properties of a window system or transparent system, all components will be calculated. When you include a scattering layer in the system and the calculation setting are set to ray-tracing the calculation may take a long time.

## Transparent system

Click one of the links below to get more information on different subjects:

[The transparent system as combination of layers](#)

[The main calculated properties of a transparent system](#)

[Changing a transparent system](#)

[Calculating the properties of a transparent system](#)

[Ventilated gaps](#)

## The transparent system as combination of layers

In the *Transparent System form*, properties of transparent systems, (not including frames and spacers) can be created, viewed, edited and calculated. The layers contained by the *Transparent System* can be selected using the drop down buttons. For each layer one selects either a *gap, pane or shading*.

Panes and shadings should **always** be separated by gaps and two gaps should always be separated by a pane or scattering layer.

There may be reasons to place the pane in the transparent system in **reverse direction** ('inside-out'), e.g. to ensure that the coated surface remains inside a closed cavity if the pane switches from first to second pane in a double glazing unit. The pane in the transparent system can be flipped with the 'flipped' check box.

## **The main calculated properties of a transparent system**

The main calculated properties are the U-value, solar factor (g-value), (direct) solar, visual and UV transmittance and the colour rendering index all for perpendicular angle of incidence.

## **Changing a transparent system**

A transparent system can be changed by selecting different layers, flipping layers or changing the tilt angle.

## Calculating the properties of a transparent system

The properties can be calculated by clicking on the calculate button.

The here selected *Environment* is **only** used for the calculation on the *Transparent System*. If the same *Transparent System* is selected for a *Window System* calculation the *Environment* selected in the *Window System* form will be used.

The **tilt angle** (default: vertical) affects only the convection and thermally induced air circulation ventilform inside a cavity, according to EN 673]refman. In the current WIS version, the tilt angle does not affect environment conditions as e.g. sky radiation and incident solar radiation.

If the button next to the g-value field is activated by mouse click, the **detailed solar transmittance form** is opened. This form shows the quantities which determine the solar factor (g).

If you apply a solar shading device, WIS will always require angle dependent properties for *each component* (e.g. pane) in the system, even if you ask for a calculation of properties at normal incidence only. This can be explained as follows (see also WIS Reference Manual): in general, a solar shading device will show not only direct, but also some scattered ('diffuse') solar transmission plus reflection. This radiation may reach the other components, either directly or after multiple reflections, but no longer at normal incidence. The calculation of the transmission and reflection at these other components therefore requires the properties at other than normal incidence.

## Ventilated gaps

Both *forced* and *free (thermally driven)* cavity ventilation can be modeled by WIS. The *ventilation form* will be opened if the *Ventilation button* is activated by mouse click.

The ventilation is always assumed to be from bottom to top or vice versa. The equations for natural and forced ventilation in cavities are in accordance with ISO 15099:2003.

The input of ventilation data should be **used with care**, because it is not (yet) protected against physically impossible input; e.g.: an incoming air flow unequal to the outgoing airflow.

For ventilation calculations input of the **width and the height** of the gap are required in combination with the origin of the incoming air\*). If the outgoing air is **going to indoors** the check box "To ind." should be checked.

In this case the amount of heat brought into the room by this air circulation is taken into account in the calculation of U-value and g-value.

For a **forced ventilated gap**, the input of the ventilation flux through the gap is required. The flux is the air flow rate per m width of the gap.

For a **free ventilated gap**, the width of the top opening (d1), bottom opening (d2) and side openings (d3) can be given. At least two of the above variables should be given to invoke ventilation.

WIS will not allow a gap which is *both* forced and free ventilated.

Free ventilation between two gaps is also allowed.

\*) : Forced ventilation between two gaps filled with other gasmix than air is possible; e.g. in case of two gaps at both sides of a blind incorporated in a argon filled double glazing unit.

## Specular layer

The type of pane is selected using check boxes:

The "single layer" check box should be checked if the pane is a single layer as for instance a sheet of float glass. The check box should be checked off, if the pane is a multi layered pane as for instance a sheet of coated glass (*Non single layered Pane*).

If the "single layer" check box is checked the checkboxes beneath become gray meaning that their status is not relevant and thus can not be checked. This because these selections are not relevant for single layered panes (position of coating and method/input to be used for the calculation of incident angle dependent properties)

For *Single layered Panes* WIS computes incidence angle dependent properties using only input for perpendicular incidence angle; therefore only properties for perpendicular incidence angle are required.refman

Click one of the links below to get more information on different subjects:

[The main calculated properties of a specular layer](#)

[Changing a specular layer](#)

[Calculating the properties of a specular layer](#)

[Calculating the corrected emissivity from the normal emissivity](#)

See also:

[Coating code reference](#)

## **The main calculated properties of a specular layer**

The main calculated properties of a specular layer are the solar, visual and UV reflectance and transmittance values

## Changing a specular layer

The properties of a specular layer, such as thickness, emissivity etc. can be changed by typing in the new values.

### **Single layer, non-spectral pane**

To input the data for a *Single layered, Non spectral pane* the corresponding form is opened if the check boxes are selected as above and the *Input button* is activated by mouse click.

The properties can be typed in and after "pushing" the *Return button* the solar properties are displayed in the *Pane* form

### **Single layered, Spectral Pane**

To input the data for a *Single layered, Spectral Pane* the corresponding check box combination should be checked.

The corresponding form will be opened if the check boxes are selected and the *input button* is activated by mouse click.

In this form the spectral data can be viewed and optionally edited. Spectral data should be imported with the WIS database management program.

### **Non single layered, Non spectral Pane using properties for 0, 30 and 60 degrees**

For *Non single layered* Panes, angle dependent calculations can be calculated if input data is available for 0, 30 and 60 degrees of incidence angle.

Properties for intermediate angles are calculated using a specifically developed fit routine. Also for spectral data. To input the data the corresponding combination should be "checked". For the *Non single layered Pane* reflectance is required for both indoor and outdoor side. If only properties for perpendicular angle of incidence are available WIS will compute only properties for perpendicular incidence angle, for any transparent system containing this pane.

### **Non single layered, Non spectral Pane with approximation of angle dependent properties**

If **no data for 30 and 60 degrees** is available, but angle dependent properties

are needed (e.g. for combinations with shading devices; see above), WIS offers a method which will calculate the angle dependent properties assuming the pane is single layered, separately for both sides and averaging the calculated transmittances for both sides. This method only provides an estimation and should be used with great care; therefore a warning is included in the report.

To input the data the corresponding combination should be "checked". The corresponding form (same as in previous case) is opened if the check boxes are selected and the *Input button* is activated by mouse click. For the *Non single layered Pane* reflectance is required for both indoor and outdoor side. Using this method only data for (near) perpendicular incidence angle are required.

### **Non single layered, Spectral Pane**

For a *Non single layered, Spectral Pane*, WIS offers three methods to calculate the angle dependent properties:

- using input of data for 0 30 and 60 degrees interpolating this data with a special fitting module (as for non spectral panes)
- using input of data for total system and for substrate calculating angular properties
- using simplified method using curves for single layered pane (as for non spectral panes; see above)

### **Non single layered, Spectral Pane using properties for 0, 30 and 60 degrees**

In order to calculate incidence angle dependent properties for the *Non single layered, Spectral Pane*, spectral properties for 0, 30 and 60 degrees of incidence angle are required. The spectral data can be read in as for the *Single layered, Spectral Pane*.

### **Non single layered, Spectral Pane using properties of substrate and substrate + film**

For *Non single layered* Panes, angle dependent calculations can also be calculated if spectral input data is available for both the substrate and for the film for perpendicular incidence angle.

In this case, properties are required for both substrate (e.g.) float glass substrate and film as unit both for perpendicular angle of incidence. (WIS calculates the refraction index and extinction coefficient of both the substrate and the film with which properties for all incidence angles can be computed). To input the data the corresponding check box combination should be selected.

The corresponding form will be opened if the check boxes are selected and the *input button* is activated by mouse click.

### **Non single layered, Spectral Pane with approximation of angle dependent properties**

If no data for 0, 30 and 60 degrees is available nor is data for substrate and substrate + film, WIS offers a method which will calculate the angle dependent properties assuming the pane is single layered, separately for both sides and averaging the calculated transmittances for both sides. This method only provides an estimation and **should be used with great care**. Therefore a warning is included in the report.

To input the data the corresponding combination should be "checked".

## Calculating the properties of a specular layer

The properties can be calculated by clicking on the calculate button.

In the report selection form the properties to be reported can be selected using the shown check boxes.

If the *Basics* check box is selected, basic Pane properties are reported as name, width, conductivity and solar properties as transmittance and reflectance for the total solar, visual and UV range together with the colour rendering index.

If the *Angular* check box is selected, angular Pane properties are reported as transmittance and reflectance for the total solar, visual and UV range.

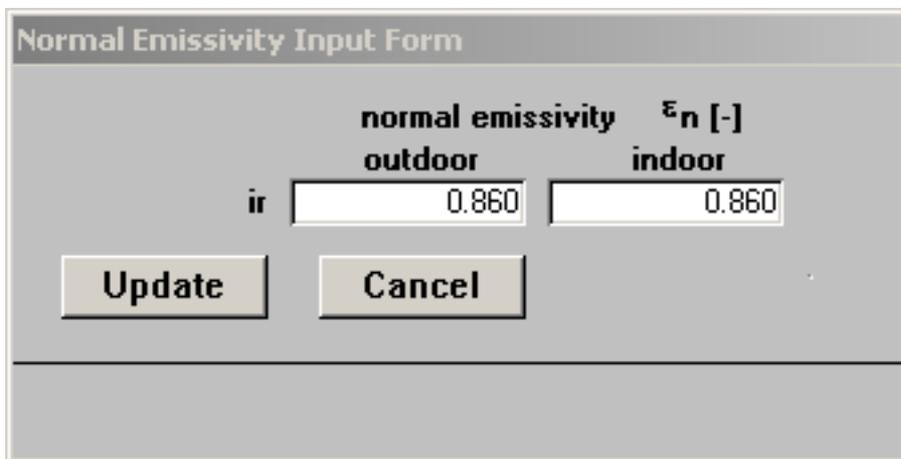
If the *Spectral* check box is selected, spectral Pane properties are reported as transmittance and reflectance for the total solar, visual and UV range for perpendicular incidence angle.

If the *Angular Spectral* check box is selected, spectral Pane properties are reported as transmittance and reflectance for the total solar, visual and UV range for various incidence angles.

Clicking on the *Create* button will activate the WIS calculation module to create a text file containing the selected output and activating a text editing module (Notepad) opening with this file. This file can be printed and copied to a user defined file for further use.

## Calculating the corrected emissivity from the normal emissivity

To calculate the corrected emissivity from the normal emissivity for specular panes, click on the small button on the right side of the IR properties on the Pane form. This will bring up another window. In this window you can type in the normal emissivity values. Clicking update will result in a calculation of the corrected emissivity values and the values in the pane form will be updated.



The image shows a dialog box titled "Normal Emissivity Input Form". It contains a table with two columns: "outdoor" and "indoor", both under the heading "normal emissivity  $\epsilon_n$  [-]". The "ir" label is positioned to the left of the input fields. Both input fields contain the value "0.860". Below the table are two buttons: "Update" and "Cancel".

normal emissivity $\epsilon_n$ [-]	
outdoor	indoor
0.860	0.860

ir

Update Cancel

Note: This can only be done for panes which are not frozen.

## Coating codes of specular panes

The coating code of specular panes is defined in EN1096:

The coating code is set as combination of two letters AU or UC or etc.

The letters A, B, C, D, S, X denote the coating class.

The position of the letters in the combination corresponds to the orientation of the pane in the pane database:

The first letter in the combination corresponds to the outdoor facing side of the pane

The second letter in the combination corresponds to the indoor facing side of the pane

The letter U denotes that the surface of the glass is uncoated.

The coating class is explained in the list below:

**Class A:** The coated surface of the glass can be positioned on the outer or inner face of the building.

**Class B:** The coated glass can be used as monolithic glazing but the coated surface shall be on the inner face of the building.

**Class C:** The coated glass shall be used only in sealed multiple glazing units and the coated surface should be facing into the unit cavity.

**Class D:** The coated glass shall be incorporated into sealed units, with the coated surface facing into the unit cavity, as soon as they are coated. They are not available as monolithic glass.

**Class S:** The coated surface of the glass can be positioned on the outer or the inner face of the building but these types of coated glasses can only be used in specifically defined applications e.g. shop fronts.

**Class X:** The coated surface of the glass is of an unspecified type.

## Scattering layer

A scattering layer can be part of a [transparent system](#). Unlike a specular layer a scattering layer may transmit the incident light in more than one direction and/or may re-direct the light in another direction. Examples of scattering layers are: Venetian blinds, roller blinds and screens, light diffusing glass, screen printed glass etc.

WIS distinguishes 4 different types of scattering layers:

- \* slat type blinds (Venetian blinds or louvers)
- \* pleated blinds
- \* roller blinds and screens
- \* generic scattering layers (anything that does not belong in one of the other categories, such as light diffusing glass)

For each type of scattering layer you can use/provide spectral data or integrated values.

Click one of the links to get more information on the specifics of each of these categories of scattering layers, or [click](#) one of the links below to get more information on different subjects on using scattering layers in WIS.

[The main calculated properties of a scattering layer](#)

[Changing a scattering layer](#)

[Calculating the properties of a scattering layer](#)

## The main calculated properties of a scattering layer

The main properties of a scattering layer are:

- [The layer's emissivity and IR transmissivity](#)
- The layer's solar, visual and UV optical properties (Transmittance, Reflectance, both on the external side and internal side, both for Beam\_to\_Beam, for Beam\_to\_Diffuse and Diffuse\_to\_Diffuse)

## Calculation of the IR properties of layers

Calculation of the IR properties depends on the type of layer. Click one of the links below to get more information about each of them.

[Calculation of the IR properties of gas layers](#)

[Calculation of the IR properties of specular layers](#)

[Calculation of the IR properties of venetian blinds](#)

[Calculation of the IR properties of pleated blinds, roller blinds and other diffusing devices](#)

For more background information about the IR properties of specular and scattering layers, [see also here](#).

## **Calculation of the IR properties of gas layers**

All gas layers are assumed to have a IR transmissivity of 1 and an IR absorptivity of 0.

## Calculation of the IR properties of specular layers

For specular panes, the user or data submitter should provide the *corrected emissivity* value according to EN 673 and EN 12898. For most glass layers the IR transmittance is equal to zero.

In case the user knows only the *normal emissivity*, WIS provides an option to [calculate the corrected emissivity from the normal emissivity](#).

The corrected emissivity value is used to determine IR radiation exchange between two layers.

## Calculation of the IR properties of venetian blinds

Because Venetian type blinds have regions that are open (except for completely closed blinds), the IR properties of a blind layer depend on the geometry of the blind (slat angle, slat pitch, etc.).

The layer IR transmissivity and layer emissivity are calculated from the slat IR transmissivity, the slat emissivities (front and back) and the geometry of the system (**using the radiosity method**).

See also:

[Background information on the emissivity](#)

## Emissivity of materials

### 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 from the material properties and the geometry of the blind system.

The emissivity,  $e$ , 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  $\mu\text{m}$ . Both the angular and spectral distributions of the emissivity should be considered. The emissivity, infrared reflectance,  $r$ , and infrared transmittance,  $t$ , are related by Kirchhoff's law.?

For non scattering materials that are opaque in the infra red, such as glass,  $t = 0$  and the sum of the emissivity and reflectance is equal to 1. Kirchhoff's law 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°). It is also valid for the total hemispherical quantities (i.e. further integrated over all angles). For non scattering materials, according to standards EN 673 and EN 12898, the normal (specular) spectral reflectance  $R_n(\lambda)$  is measured in the range 5 to 50  $\mu\text{m}$  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,  $e_n$ , is then calculated as a weighted sum over the selected ordinates.

EN 673 and EN 12898 also provide a procedure to calculate an emissivity value, called corrected emissivity  $e$ , which takes into account the effect of the angular distribution of emissivity. The corrected emissivity  $e$  is calculated by multiplying the normal emissivity  $e_n$  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. The corrected emissivity of uncoated float glass, borosilicate glass and glass-ceramics at 283 K was standardized at 0.837.

## **Emissivity of blinds and shading devices**

The definition of emissivity by 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,  $e_h$  can be obtained from measurements of the total hemispherical reflectance,  $r_h$ , using Kirchhoff's law (with the total hemispherical transmittance,  $t_h = 0$ ), or from measurements of the angular emissivity,  $e_J$ , followed by integration over all angles. Both total and spectral measurements are possible. Spectral reflectance and emissivity values can be integrated to total values at 283 K using the a number of selected ordinates. In the case of non-opaque materials, the total hemispherical emissivity can be calculated from Kirchhoff's law and measured values of  $r_h$  and  $t_h$ , or from their angular values, followed by integration over all angles. There is no reference emissivity value similar to 0.837 for uncoated glass.

## **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).

In the case of glass panes with rough light scattering surfaces and/or light diffusing films or patterns, the total hemispherical emissivity  $e_h$  is calculated from the measured total hemispherical reflectance using Kirchhoff's law with  $t_h = 0$ . In the case of uncoated glass with a roughened surface a value of 0.837 for  $e_h$  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, Kirchhoff's law can be used in conjunction with measured values of  $r_h$  and  $t_h$ . EN 12898 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)  $t$  is set equal to 0), if its total normal transmittance is smaller than or equal to 0.05.

For more information see the WinDat data submission document for scattering materials.

## **Calculation of the IR properties of pleated blinds, roller blinds and other diffusing devices**

For pleated blinds, roller blinds and other difusing devices it is assumed that the layer emissivity and layer IR transmissivity is identical to the IR properties of the material.

## Changing a scattering layer

When a scattering layer is not frozen you can change the properties of the scattering layer (such as thickness, pitch, etc) by typing in the new values in the appropriate fields.

The properties of each scattering layer are grouped together in 4 categories:

1. Product info
2. Geometry
3. Thermal properties
4. Optical properties

For each type of scattering layer you can use/provide spectral data or integrated values.

For more information about these properties please refer to the data submission guide for scattering data.

## Calculating the properties of a scattering layer

Calculating the properties of a scattering layer, or calculating the properties of a transparent system or window system that includes a scattering layer must **always be done with extreme care** because of the many options that exist, see below.

To calculate the properties of a scattering layer

1. Select that layer in the scattering layers window.
2. Set the correct input parameters (slat angle, pitch, slat width, curvature, etc.)
3. Click on the *Calculate* button
4. This will bring up a second window to choose which properties should be displayed in a text report (you should select at least one option when doing a calculation).
5. In the scattering layer window, the IR properties are automatically updated. All other properties can only be found in the output text report.

Below an overview of the calculation rules.

### IR properties

- For slatted blinds the IR properties depend on the geometry (slat angle etc.). The IR properties of a slatted blind are **always** calculated using the radiosity method (even when ray-tracing is selected), because the emissivity and transmissivity of the blinds are assumed to be diffuse.
- For all other types of blinds the IR properties of the blind are assumed to be equal to the properties of the material and do not depend on the geometry. For pleated blinds this is just an approximation but there are no better methods available to determine the IR properties of these systems from their geometry.

### Solar, visual and UV properties

The calculation of these properties depend on the calculation settings (see changing the calculation settings). The following applies:

- For slatted blinds you can select either ray-tracing or radiosity calculations. For blinds with only diffuse properties, the radiosity method is much faster. For blinds with specular properties, the radiosity method assumes that these properties are diffuse too.

- For pleated blinds, you should **always set the calculation method to ray-tracing**. When you set the calculation method to radiosity, WIS will simply assume the data is for a venetian blind and will calculate random results !!!
- For roller blinds, screens and generic scattering devices, WIS assumes that the given properties are that of the layer itself. Therefore there is no effect of either selecting ray-tracing or radiosity calculation.

## Frames

The *Frame form* contains frame related variables as name, material type, U-value and width (parallel with the panes).

In the WIS package there is a limited version of the two dimensional steady state finite difference calculation tool **Kobra** (Physibel , Belgium) included and directly linked containing a database with a selection of representative European frame cross sections. This Kobra version can be accessed directly using the *Kobra* button. For Kobra license holders it is also possible in WIS to link a full version of Kobra. For **EuroKobra** license holders it is possible in WIS to link to the extensive "Eurokobra" database developed by the EEIG Eurokobra.

Similarly WIS is prepared for the inclusion of the finite element program **Therm** developed at the Lawrence Berkeley National Laboratory (LBL, California). Please consult the respective software publishers / publications for further details about their software.

## Spacers and edges

The *Spacers and edges form* contains spacers related variables. This data is supplied as information only and is not used in the calculations yet. The data can be used to determine the appropriate PSI value for specific combinations of glazing, frame and spacer.

## Gas mixes

The *Gas* and *Gasmix forms* contain properties concerning air or gas captured in gap(s) between for instance two glass panes of double glazing.

The *Gasmix form* enables the user to mix Gases using the data stored in the *Gas forms*.

A gasmix can simply be composed using the *Gasmix form*. The gases to be included in the gasmix can be selected by first clicking on the button of the *Gasmix form* and clicking again on the gas to be included visible on the pop up menu which by then has appeared.

Before WIS computes the properties of the gasmix (Conduction, Dynamic viscosity ... for the various temperatures) WIS will check if the total percentage of the gases is 100%.

See also:

[Gasses](#)

## Gasses

The *Gas* and *Gasmix forms* contain properties concerning air or gas captured in gap(s) between for instance two glass panes of double glazing.

In the *Gas form* values of various gases can be viewed, stored, edited etc. The first 4 records contain properties of air, argon, krypton and SF6 according to EN673. The values of these first view records are unchangeable by the user to avoid unwanted changes.

These properties however can be copied to new records for editing and further use.

See also:

[Gasmixes](#)

## View|Calculation Settings

Select the **Calculation Settings** from the **View** menu to change the calculation settings for current calculations with WIS.

There are two calculation modes, the CEN only mode and expert mode. In CEN only mode all calculations are performed according to (draft) European standards. In expert mode all calculations are performed according to the physical principles which are the basis for the European standards used in CEN only mode.

Click here for more details about the [two calculation modes](#).

## Calculation modes

WIS can be used to calculate the properties of components, transparent systems and windows in two different calculation modes:

- [CEN only mode](#)
- [Expert mode](#)

The light transmittance and reflectance are calculated for illuminant D65 (see EN 410).

Click on one of the above links to get more information on the specifics for each mode.

See also:

[Changing the calculation settings](#)

[Referenced standards](#)

## CEN only mode

In CEN only mode all calculations are performed according to (draft) European standards. For detailed information about the algorithms in the referenced standards, please refer to the standard itself.

In CEN only mode WIS calculates:

- ... (for product comparison) the **solar factor (g-value), light and UV transmittance and general colour rendering index (Ra) of single glazings and multi-glazing systems without solar shadings** according to the procedures and [boundary conditions in EN 410](#)
- ... (for product comparison) the **U-value of single glazings and multi-glazing systems without solar shadings** according to the procedures and [boundary conditions in EN 673](#)
- ... the **U-value of a window consisting of a combination of multi-glazing and a frame with known U-value, including the effect of different types of (metal or insulating) spacers in the multi-glazing unit**, according to **ISO 10077-1**
- ...the **surface temperatures of the centre parts of each pane** to determine the condensation risk

In CEN only mode WIS will not calculate:

- ...angle dependent properties, because EN410 prescribes near normal radiation incidence
- ...the properties of window systems with solar shadings, because these calculations are not standardized

See also:

[Changing the calculation settings](#)

[Referenced standards](#)

## Boundary conditions in EN410

In CEN only mode certain properties are calculated using EN410. In that case not only the algorithms in EN410 are followed, but also the (boundary) conditions that are defined in EN410 are used. Systems that cannot comply with these conditions cannot be calculated according to EN410.

Because the purpose of EN410 is to provide basic information on the performance of the glazing, conventional conditions have been stated in the standard for simplicity:

- The calculations are performed for quasi-parallel near normal radiation incidence using the radiation distribution of illuminant D65 and the solar radiation and UV radiation in accordance with the standard
- The position of the glazing is vertical
- External heat transfer coefficient  $h_e = 23 \text{ W/m}^2\text{K}$
- Internal heat transfer coefficient  $h_i = 3.6 + (4.4 * \epsilon_i / 0.837)$  where  $\epsilon_i$  is the corrected emissivity of the inside surface.

Note: for uncoated soda lime glass and borosilicate glass  $\epsilon_i = 0.837$  and  $h_i = 8 \text{ W/m}^2\text{K}$ .

Note: the secondary heat transfer of a multi-layer glazing calculated with EN410 uses the thermal conductance  $\Lambda$  which is determined according to EN673.

See also:

[Changing the calculation settings](#)

[Referenced standards](#)

## Referenced standards

- EN 410: Glass in buildings - Determination of luminous and solar characteristics of glazing. March 1998
- EN 673: Glass in buildings - Determination of thermal transmittance (U-value) - Calculation method. October 1997
- ISO/DIS 15099: Thermal Performance of Windows, Doors and Shading Devices - Detailed Calculations. Date: 18.07.2001
- prEN 13363 -2 E: Solar protection devices combined with glazing - Calculation of total solar energy transmittance and light transmittance - Part 2: Detailed calculation method. February 2004.
- EN ISO 10077-1: Thermal performance of windows, doors and shutters - Calculation of thermal transmittance - Part 1: Simplified method." Date: July 2000
- prEN ISO 10077-2: Thermal performance of windows doors and shutters
- prEN 572-9: Glass in building - Basic soda lime silicate glass product - Evaluation of conformity
- prEN 1096: Glass in buildings - Coated glass
- prEN 1279-1: Glass in Building - Insulating Glass Units, Date: December 1997
- prEN 14351: Windows and external pedestrian doors - Product standard, Date: December 2002

## Boundary conditions in EN673

In CEN only mode certain properties are calculated using EN673. In that case not only the algorithms in EN673 are followed, but also the (boundary) conditions that are defined in EN673 are used. Systems that cannot comply with these conditions cannot be calculated according to EN673.

Because the purpose of EN673 is to provide basic information on the performance of the glazing, conventional conditions have been stated in the standard for simplicity:

- The temperature between bounding glass surfaces  $\Delta T = 15 \text{ }^\circ\text{C}$
- Mean temperature of gas space  $T_m = 283 \text{ K}$
- External heat transfer coefficient  $h_e = 23 \text{ W/m}^2\text{K}$
- Internal heat transfer coefficient  $h_i = 3.6 + (4.4 * \epsilon_i / 0.837)$  where  $\epsilon_i$  is the corrected emissivity of the inside surface.

Note: for uncoated soda lime glass and borosilicate glass  $\epsilon_i = 0.837$  and  $h_i = 8 \text{ W/m}^2\text{K}$ .

See also:

[Changing the calculation settings](#)

[Referenced standards](#)

## Expert mode

In expert mode all calculations are performed according to the physical principles which are the basis for the European standards used in CEN only mode.

In Expert mode WIS calculates:

- ... (for design purposes) the **solar factor (g-value), light and UV transmittance and general colour rendering index (Ra) of single glazings and multi-glazing systems with or without solar shadings under user-defined conditions**, such as extreme or typical summer or winter specific solar radiation incidence angles
- ... (for design purposes) the **U-value of single glazings and multi-glazing systems with or without solar shadings under user defined conditions** such as extreme or typical summer or winter environment temperatures and/or surface heat transfer coefficients
- ...the **U-value of multi-glazing systems with films or other layers which are permeable for thermal radiation** (in accordance with the CEN TC89 WG7 reference method under preparation)
- ...the **U-value of a window with shutters or blinds and the effect of thermally driven air circulation** (in accordance with draft CEN TC89 WG7 reference method under preparation)
- ...as above with **forced air circulation with known air exchange rate**
- ...the **surface temperatures of the centre parts of each pane and/or shutter or blind** to determine the condensation risk
- ... (for design purposes) the above properties of a **tilted window**
- ...At this moment WIS offers the opportunity to use a solar spectrum with air mass 2 as an alternative (acc. ISO 9050;1990).

Furthermore there are some optional calculations that cannot be performed in CEN only mode but only in expert mode:

- **Fitting** optical properties **for angles-** between measured properties at angles 0, 30 and 60 degrees
- Use of optical properties of a substrate and a substrate plus a film at normal incidence angle to obtain **angle dependent film properties**

- Choice between two different air mass solar spectra

### Scattering layers

Scattering layers are a special category that can only be used in expert mode. In expert mode you have a choice between view factor method and ray tracing method. This choice only relates to Venetian blinds and Pleated blinds.

Pleated blinds should **always be** calculated using the ray tracing method.

Screens and generic diffusing layers are assumed to be planar layers and their LAYER optical properties are given (not their material optical properties, such as width venetian blinds and pleated blinds).

Scattering Layer	View factor method	Ray tracing method	Other method
Venetian blind	YES	YES	NO
Pleated blind	NO	YES	NO
Screens	NO	NO	YES
Generic diffusing layer	NO	NO	YES

See also:

[Changing the calculation settings](#)

[Calculating scattering layers](#)

[Referenced standards](#)

## Reference

Reference information can be used to get more detailed information about certain algorithms, etc.

## Records|Insert new record

Select **Insert new record** from the **Records** menu to insert a new record (a new Window system, new transparent system, new pane etc). The new record will have no data or will have default values for certain data.

## Records|Save record

Select **Save record** from the **Records** menu to save the current record.

## **Database|...**

Select the database menu to show the forms with data for the window system, transparent system, panes etc.

## **Window|...**

Contains options to change the size of the window, etc.

## **Help|...**

Select this menu option to show the help file and information about WIS.

## Terms and symbols

This section contains the definition of the main terms and symbols found in the WIS user interface.

Where there are no contradictions they are in accordance with-

- ISO standard 7345/1, Thermal Insulation - Vocabulary - Part 1
- 
- and the relevant vocabulary used in:
- CEN PrEN 832, Thermal Performance of Buildings - Calculation of Energy Use for Heating - Residential Buildings (1992)

### Symbols

A area m<sup>2</sup>

c specific thermal capacity J/(kg.K)

d depth, thickness m

G incident solar radiation intensity W/m<sup>2</sup>

g total solar energy transmittance -

h surface coefficient of heat transfer W/(m<sup>2</sup>.K)

k extinction coefficient -

n refraction index -

PSI linear thermal transmission coefficient W/(m.K)

Q heat flow W

q heat flux density W/m<sup>2</sup>

R thermal resistance m<sup>2</sup>.K/W

Ra Colour rendering index -

T temperature °C (or K)

t time s,h

U heat transmission coefficient W/(m<sup>2</sup>.K)

V volume m<sup>3</sup>

β solar incidence angle rad, degree

Δ difference -

$\lambda$  thermal conductivity W/(m.K)  
 $\psi$  see PSI  
 $\rho$  reflectivity -  
 $\rho$  specific density kg/m<sup>3</sup>  
 $\Theta$  temperature °C  
 $\phi$  solar incident angle rad, degree  
 $\tau$  transmissivity -

### **Subscripts**

a air  
av average  
c convection, conduction  
calc calculated  
B beam  
D direct  
d diffuse  
e external  
h hemispherical  
meas measured  
n at normal incidence  
r radiation  
s surface  
tot total  
w window  
10 at 10 °C

### **Definitions**

Definitions of the main terms:

U is the heat transmission coefficient: the density of heat flow rate in the steady state divided by the temperature difference between the surroundings on each side of the system or component, in W/(m<sup>2</sup>.K);

$\tau$  is the transmissivity: the density of transmitted solar radiation through a component divided by the intensity of incident solar radiation, non-dimensional;

g is the total solar energy transmittance: the density of heat flow rate leaving the component at the inside surface, under steady state conditions, caused by solar radiation at the outside surface, divided by

the intensity of incident solar radiation on the component, non-dimensional.

PSI is the linear heat transmission coefficient of a linear thermal bridge: the heat flow rate in the steady state per unit length of the component, divided by the temperature difference between the surroundings on each side of the component, in  $W/(m \cdot K)$ .

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## Usefull links

[The WinDat Thematic Network homepage](#)

[TNO Building and Construction Research homepage](#)

[The International Glazing Database homepage](#)