

## Turbine Studio

The turbine geometry has been improved by allowing multiple nacelles (bodies) in the complex geometry format. All turbines in the turbine data base have been updated to the new format.

### Editing the Turbine Geometry

The geometry can be edited by selecting "Geometry" from the Edit menu which activates a 5-page tabbed dialog containing the geometry of the various components. By default, the dialogs are based on a simple geometry, but there are also equivalent complex geometry dialogs that automatically display when a component has been converted to complex.

### Complex Turbine Geometry

The standard editing dialogs are sufficient for most turbine geometries and should generally be used. However, a complex geometry format and editor is available when the simple geometry is insufficient. A complex geometry file can only be created from an existing simple turbine data file.

With a turbine data file open it can be converted to complex by selecting "Convert to Complex or Simple Geometry" from the Edit menu. The dialog displayed allows you to choose which of the tower, blade, hub and / or nacelle you wish to be complex. If a check box is not set then that component will remain simple.

Once the turbine data is converted to complex it cannot be reversed, therefore you must save it as a new file to avoid overwriting the original. This always applies to a complex nacelle, but the tower, blade or hub can be converted to simple from complex providing a tower has 2 or 10 sections, a blade has 5 or 9 sections or a hub has 5 or 6 sections.

A complex geometry can include multiple nacelles, which can sometimes make defining a complex nacelle simpler.

### Using a Spreadsheet

Because the turbine files are text files it is possible to use a spreadsheet to create the data and geometry. An example is the NREL reference turbine NREL\_15-15000-240-RS001.WTD. There is additional information with the turbine data describing the derivation of the data and geometry, which has a particularly complex nacelle. Use this method with care as it is not supported.

### Complex Nacelle Geometry

The complex nacelle page shows one section of the nacelle at a time with the same information as the simple page. The number of sections can be changed and buttons are used to step between sections. There must always be a minimum of 4 sections including the first and last closing sections. If there is a single nacelle body, then removing that section will result in the nacelle geometry being omitted from the turbine file.

The co-ordinates are specified around each of the sections using the "Edit Section Coordinates" button. As you look at the turbine with the (upwind) rotor facing you the X coordinate axis is to the right, the Y coordinate axis is away from you and the Z coordinate axis is up. A normal nacelle is a body made up of a series of sections at nominally constant Y location. It can also be formed of sections at nominally constant X or Z locations. Examples are the EWT turbines in the turbine database, which are similar to a vertical cylinder. Generally the sections should be ordered to be increasing along the nominally constant section.

The first and last sections of a nacelle are used to create a closed body, and each are represented by a single point.

A complex format nacelle can be formed of multiple nacelle bodies.

### Multiple Nacelle Bodies

In the complex format a nacelle can be formed of multiple nacelle bodies. For example, a cooler on top of a nacelle, or a box below a nacelle can be specified as additional nacelle bodies. This can often be simpler than creating a single body. Therefore, the nacelle page allows you to add a nacelle body via a new dialog where the overall dimensions of the body, a simple shape and the number of sections (the minimum is 2, not counting the first and last sections) can be defined. The sections can be formed of constant X, Y or Z sections. The default and most usual is constant Y sections. Each section apart from the first and last

sections will have the same shape. Each body can be given a name, which will aid identification when editing and it can have a different origin to other nacelle bodies. The Position parameters are explained below.

When multiple nacelle bodies are specified, you can remove a selected nacelle body from the group. Removing all the nacelle bodies will result in the nacelle geometry being omitted from the turbine file.

### Rendering Turbines in the Photomontage Module

To aid rendering in the Photomontage module the relative positions of multiple nacelle bodies can be specified in the nacelle dialog. This is Position X, Y and Z. If all nacelle bodies are left at the default settings of (1, 1, 1) then the nacelle bodies will be rendered in the order they appear in the turbine data file regardless of the viewpoint, view direction or the turbine's orientation.

The position relates to the body's location along each axis and increases in the direction of the axis. For example, the first body is usually the main body and, by default, is set to 1, 1, 1. A cooler above the main body will be 1, 1, 2. Two coolers above and on each side of the main body, will be 1, 1, 2 and 2, 1, 2 with the first of these being on the left side looking from the front of the turbine and therefore at a lower X value.

For nacelle bodies below the main body, they should be given a Z value of 0. This signifies to the Photomontage module that the relationship to the top of the tower must be considered when rendering. An example is the Siemens Gamesa turbine file SiemensGamesa\_SG170-6600\_RS001.WTD. This has 2 bodies, the main body, and a simple box below the main body and behind the tower.

## Photomontage

There have been a number of improvements to the Photomontage module:

1. Updated for the new turbine geometry with multiple nacelles.
2. In the Options / Markers and Identifiers dialog there is an option to use the turbine labels from the Designer as the identifiers. Also the gap size (spacing) between marker labels can be specified.
3. In the Options / Turbine Settings and Scale dialog there is an option to generate a pseudo-random blade angle from the turbine's location. This means that providing the turbine is not moved its "random" blade angle will always be the same. It is formulated as:  
$$\text{blade angle} = (\text{east} + \text{north} + \text{specified blade angle}) \bmod 360$$
4. In the Options / Turbine Settings and Scale dialog there is an option to use the specified turbine geometry instead of the simple default turbine to define and draw the schematic (only in the standard version).
5. Labels and markers can be added to locators.
6. Aviation light indicators can be shown on the turbine schematic
7. Wind farms can be copied between viewpoint and photomontage files
8. The auto adjustment of umbrella labels has been improved

Three corrections have been made:

1. When the main wind farm is displayed with markers and identifiers, while the rest are umbrellas, the main wind farm markers will be above the turbines in the main wind farm.
2. The application of colour shift is now made before any fog is applied.
3. The defaults for ridge lines and aviation light specification have been made persistent
4. The line widths when exporting images have been corrected from being too thin

**Locator Labels (only in the standard version)**

The locators can be labelled and a marker drawn. This is controlled from the Label page of the Photomontage run data. Specify the locator text, along with metres above ground for the label and marker ending height. Use the "View/Locator Labels" menu option to toggle the display of the labels.

**Aviation Light Indicators on the Turbine Schematic**

Indicators of the aviation lights can be shown on the turbine schematic drawing. These are controlled in the Multiple Layouts dialog in the wire frame mode and in the Cumulative page of the run data when in photomontage mode. However, aviation lights on the nacelle and tower can only be created in the Cumulative page of the run data. The "Define aviation lights" button in the Multiple Layouts dialog will give a message to this effect.

The "Define schematic aviation lights" dialog controls the display of symbols at the centre of the tower at the height specified for each aviation light. This means that 2 lights at the rear of a nacelle at the same height will only appear as one light. The symbol is drawn after the turbine schematic so that it is always visible. The symbol shape, size and colour for both nacelle and tower lights can be changed. The size can be fixed as a display size (multiples of 0.1mm) or variable as metres at the turbine. The latter will therefore change with distance. The nacelle and tower light indicators can be switched off for each wind farm. For convenience the settings can be applied to all the wind farms' lights.

**Copying Wind Farms**

Because complex layouts may be created with a large number of wind farms, each with its own aviation lights, the copying of wind farms from a viewpoint or a photomontage document to others can be achieved using the "Edit / Copy Wind Farms" menu item. The wind farms in a document are selected and copied to a list of destination documents (replacing or appending to any already existing).

In the dialog displayed select a source document from which the wind farms will be copied and then click on the "Select Wind Farms" button to start the select wind farms dialog. Next create a list of files to which the wind farms will be copied. Do this using the "Add Files" button to add single or multiple files. Alternatively, a group of files from a specified folder can be added to the list. These can be specified using wild cards if necessary. Selected files in the list can be deleted as necessary. The default is to append copied wind farms to the files receiving them. If the check box is not set then all the wind farms in the receiving files are deleted before the copied ones are added. Use the "Copy Wind Farms" button to complete the operation.

**Selecting Wind Farms**

This dialog is activated from the "Copy Wind Farms" dialog. It displays the wind farms contained in the source file in the left hand wind farm list. Select which of these you want to be copied to other viewpoint of photomontage run files and use the "Add" or "Add All" buttons. They then appear in the right hand list. Wind farms can be deleted from this list using the "Delete" or "Delete All buttons".

## Shadow Flicker

**Real World Data**

The Shadow Flicker module can allow for real World data in the shadow flicker analysis but not for map creation. It modifies the duration of shadow flicker events according to data in a text file that specifies the wind speed and direction along with the sun's visibility for the time period, which can be hourly, daily or monthly. The duration of a shadow flicker event is modified by three factors:

1. If wind speed is below cut-in or above cut-out then the shadow duration is set to zero.
2. If the turbine rotor is not directly facing a window then the shadow duration is factored by the absolute value of the cosine of the angle between the line from the window to the turbine and the direction the rotor is facing. This means that when the wind direction is such that a turbine is facing a window the angle is 0 and the factor is 1.0. If the turbine rotor is at 90° then the factor is 0.0.
3. The sun's visibility for each time period can be specified as a percentage from 0% (no sun) to 100% (full sun). It can be regarded as the opposite of cloud cover. The user may have a different interpretation of this factor and it can be set or ignored accordingly. The sun's visibility can also be specified as the number of sun hours in the time period. If daily or monthly sun hours are specified the number of sun hours in the period is divided by the number of daylight hours in the day or month

to give the percentage sun's visibility. The shadow duration is factored by this percentage for each time period.

It should be recognised that the sun's visibility is the average over a time period and it generally comprises periods of no visibility and full sun. As a result because the shadow flicker duration is only a few minutes it could be completely wrong especially when applied over a number of houses and turbines. It should therefore be used with caution.

**Map Creation**

The generation of a map of maximum hours per day has been added to map creation.

**ZVI****Exclusion Zones**

To allow for clearings or lakes within a forest specify them as exclusion zones, but set the height of the zone to the negative of the height of the surrounding forest. Place it after the forest that contains it in the exclusion zone list. The region will not be blanked and a calculation will be made for points within the zone. An island forest within a lake is specified as normal but must be after the lake in the exclusion zone list.

**Designer****Renumbering turbines**

As turbines are added they are given the next higher number as an identifier. Select Renumber from the edit dialog if you wish to change the numbering sequence. A dialog will be displayed that provides you with 2 options.

The first is to renumber by clicking on turbines. In this case the numbers will disappear, and then you click on each turbine in the order that you want them to be numbered. If Renumber is selected again from the edit dialog before numbering is started, the option is provided to automatically renumber the turbines starting at 1. If Renumber is selected after numbering has been started, the rest are automatically renumbered.

The second is to set the numbers from a turbine number (not identifier) to values / identifiers from a specified value / identifier. The sequence of the turbines will not be changed. For example, if the start turbine number is set to 1 and the specified identifier to 101, a set of 7 turbines will be numbered from 101 to 107. If this is then repeated with the start turbine number set to 4 and the specified identifier to 201, turbines 104 to 107 will be numbered from 201 to 204.

If at any time turbines are deleted, then the rest of turbines are not renumbered automatically as this can be confusing.