ECN Wind Energy Industrial Support

SILANT

EWIS

Being one of the leading institutes on wind energy research, ECN established the EWIS (ECN Wind Industrial Support) group in 2009 to better bring the R&D results to the market. During the last three decades, ECN has developed expertise on aerodynamics, structural analyses, turbine control, offshore operation and maintenance, and grid connection. With the growing wind industry, ECN received more requests for assistance and EWIS has become the vehicle to support the wind energy industry in their product developments.

EWIS's focus is on the high end of the market which means that we will make use of tools and knowledge that have been developed in-house and include the latest R&D results!

The EWIS team is a mixture of young professionals and experienced researchers which ensures a fast response and high quality.

More information

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Product description

The Software

The SILANT code calculates the aerodynamic noise emission from wind turbine blades and optionally the corresponding immission. It has originally been developed in 1996 by SPE, NLR and TNO with financial support from NOVEM. It has been supplied to other wind energy parties in the Netherlands, including ECN. Within the European Union project Sirocco, ECN made several improvements to the code and performed a validation. SILANT should be used by wind turbine designers that need to incorporate noise requirements in their design. Recently ECN added the possibility to calculate propagation effects to the code.

The Model

The SILANT code calculates the sound power level of the wind turbine blades and sums it to the overall wind turbine sound power level. For the aerodynamic noise level calculation, the wind turbine blades are divided in a number of elements (usually the number of elements is in the order of 10 to 20). For every blade element, turbulent boundary layer trailing edge noise and inflow noise sources are considered. Tip noise is calculated for the tip element.
The trailing edge noise source is calculated from the model of Brooks, Pope and Marcolini. In this model, both the level and the spectral content of the trailing edge noise can be characterized by the boundary layer displacement thickness at the trailing edge of the airfoil element. The implemented model switches to separation-stall noise for high angles of attack. Inflow noise is due to the turbulence in the oncoming flow, interacting with the blade and is calculated from the model of Amiet and Lowson. Tip noise originates from the interaction of the tip vortex with the tip shape and is calculated using the model of Brooks, Pope and Marcolini. The noise sources are ('acoustically') summed over the elements in order to obtain the total blade and turbine sound power level.

Optionally SILANT calculates the noise immission for specified receiver locations. A geometric model of the turbine is created allowing the prediction of sound pressure level as a function of observer position, rotor azimuth angle and frequency band. Directivity patterns and swish amplitudes can thus be estimated. The propagation model includes geometric spreading, source directivity, convective amplification, Doppler effect, atmospheric absorption and refraction and ground effect.

SP-370 Mei 2011

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Specifications

Description of Software:	• SILANT executable • User manual
Designated sites:	Single user
Licence fee:	€ 6 000
Licence term:	unlimited use
Additional maintenance:	Optional additional maintenance consisting of an update of the software and support for one year with a maximum of 16 man-hours can be requested for € 2 500 per year.
Additional options:	One-day training in the use of SILANT and RFOIL given by ECN experts.

For more information about this service, please contact:

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Usage

The software comes in the form of an executable which has to be invoked from the command line. A main input file is necessary next to a database containing profile data. The content of these files is described below. A more detailed description can be found in the manual.

Input

The input for the code consists of geometrical and aerodynamic data, operational conditions and external conditions. The aerodynamic data includes effective velocity and angle of attack for each element. This data can be obtained using for example Blade Element Momentum (BEM) theory applied to the turbine of interest. The BEM code BLADMODE which is also available from ECN automatically generates an output file that can be used for the purpose of SILANT calculations.
Furthermore a separate database is needed that specifies the boundary layer displacement thicknesses as a function of Reynolds number and angle of attack for the pressure and suction side of each airfoil. This database can be generated using the freely available RFOIL software, a modified version of XFOIL for the purpose of wind turbine airfoil analysis.

Output

The output comes in the form of Power Watt Levels (PWL). The Overall PWL (OAPWL) is specified per element to give an overview of the radial distribution of the noise sources. A breakdown is given of the noise source types. To illustrate the spectral content of the noise, the data is averaged over 1/3-Octave band frequencies. A-weighting is applied to the calculations although non-weighted results are also available.
The immission results are presented in the form of A-weighted Sound Pressure Levels (SPL), specified for each receiver location. The noise variation with azimuth angle and contribution of the sources along the blade can also be outputted.

The Experience

Several wind turbine designers have successfully used SILANT to come to noise reductions in their design. In addition to that, the noise prediction of SILANT has been compared to measured overall noise levels in the Sirocco project. For the two measured turbines, the average deviation in the PWL was less than 1 dBA, thereby giving confidence to the prediction capabilities of SILANT.