# QUICK GUIDE – LOAD RESPONSE

## Purpose:

To check if the loads for a specific turbine or generic IEC turbine class are acceptable for the site and layout conditions.

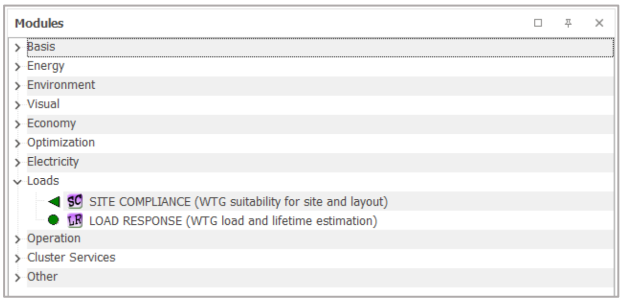
LOAD RESPONSE calculates structural wind turbine loads based on a response surface approach according to the design load cases (DLC) in IEC 61400-1 ed. 3 (2010).

## Outline of Guide:

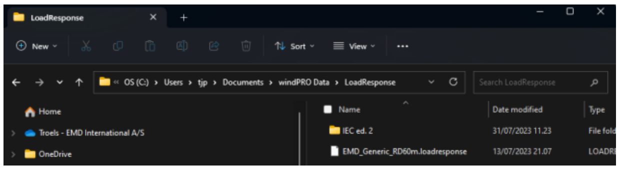
1. **Installation of LOAD RESPONSE**
2. **Setup input data for LOAD RESPONSE**
3. **Calculations in LOAD RESPONSE**
4. **Result in LOAD RESPONSE**

## 1. INSTALLATION OF LOAD RESPONSE

Install windPRO 4.0 on your computer and check that you have license for LOAD RESPONSE indicated by the green circle.

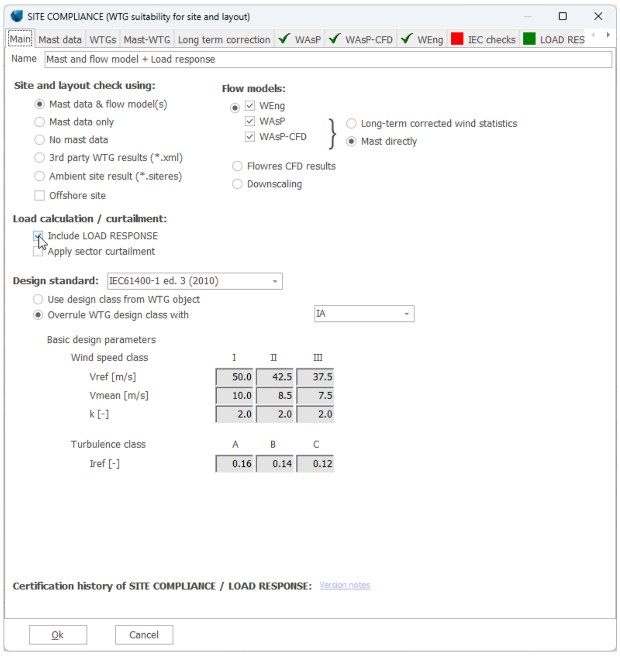



Check that one or several wind turbines are available for calculation. The response files for the individual wind turbines should be available in the folder “LoadResponse”, which on a Windows PC normally is located at the path: “C:\Users\XX\Documents\WindPRO Data\LoadResponse”. The wind turbines will be named “XX.loadresponse”.




## 2. SETUP INPUT DATA FOR LOAD RESPONSE

Before using LOAD RESPONSE, a SITE COMPLIANCE analysis must be performed. The load calculation is included on the “Main” page.



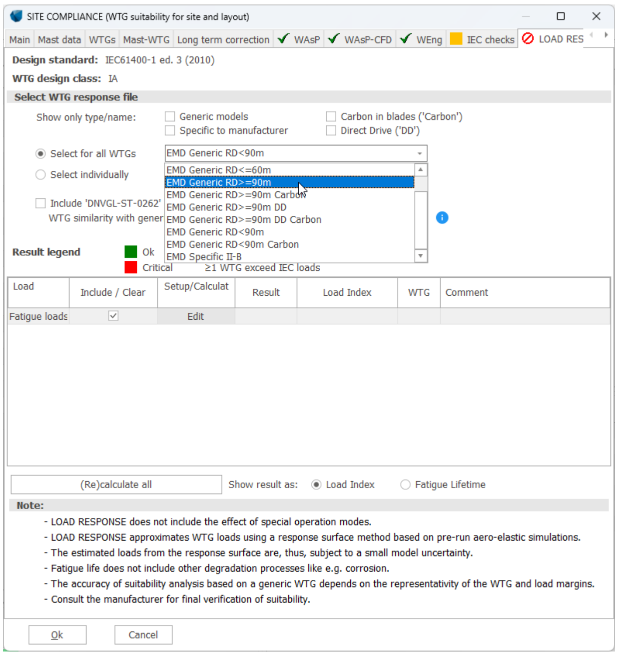

To determine the wind climate parameters at each WTG, position a normal SITE COMPLIANCE analysis must be performed. In general, all the main checks in the page “IEC checks” should be calculated.


## 3. CALCULATIONS IN LOAD RESPONSE

### 3.1 Select WTG response file

Select for all WTGs a specific or generic wind turbine from the dropdown menu.

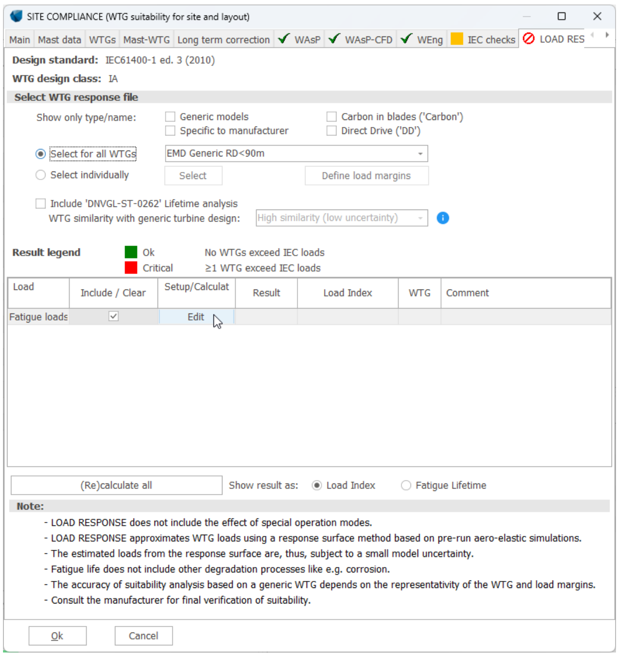
If a layout contains several types of wind turbines, this can be selected by pressing the button "Select individually".




The wind turbines in the dropdown menu correspond each to an "XX.loadresponse" file. This file contains general information about the wind turbine and wind turbine loads for different wind climate conditions.

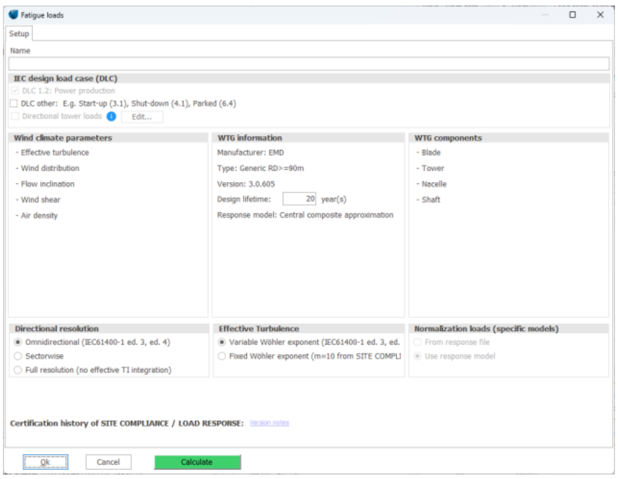
### 3.2 Include fatigue loads

Include the fatigue loads by pressing "include" marked by yellow and press the "Edit" button in order to setup the calculation.




### 3.3 Setup fatigue load calculation

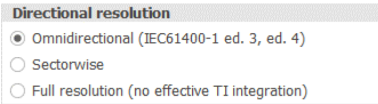
The "Setup" tab shows first the included design load cases from IEC 61400-1 ed. 3 (2010). The wind climate parameters which influence this design load case(s) are listed. The names refer to the IEC-checks in SITE COMPLIANCE. General WTG information is shown in the middle and the WTG components included in the fatigue load calculations are listed to the right.



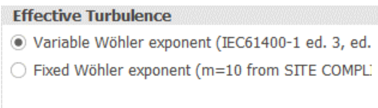
### 3.4 Advanced calculation settings

When wind turbines are implemented in LOAD RESPONSE pre-defined values for the advanced settings are selected. It will therefore normally not be necessary to change these. However, in the following a short description is given.

The directional resolution "Omnidirectional" or "Sectorwise" describes whether omnidirectional or sectorwise wind climate parameters should be used for the load calculation. According to IEC 61400-1 ed. 3 (2010) omnidirectional wind climate parameters should be used. However, more accurate results can be obtained by using sectorwise wind climate parameters. The sectorwise wind climate parameters are only available in WindPRO if a WAsP or WEng calculation has been performed. In addition, the option "Full resolution (no effective TI integration) can be used to account for variation in wind climate parameter at each single directional degree.

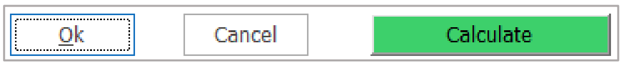



The effective turbulence is obtained by combining the ambient turbulence and the wake added turbulence using the Wöhler exponent. In SITE COMPLIANCE this is often done using a Wöhler exponent on m=10. In LOAD RESPONSE the effective turbulence can either be calculated using the component specific Wöhler exponent (denoted "variable Wöhler exponent") or the Wöhler exponent used in SITE COMPLIANCE (denoted "fixed Wöhler exponent"). The first approach is recommended in IEC 61400-1 ed. 3 (2010).




### 3.5 Calculate fatigue loads

By pressing the "Calculate" button the calculation is started. The calculation time should normally only take few seconds.




## 4. RESULTS IN LOAD RESPONSE

### 4.1 Results (Map)

The results are shown on a map. Green circles indicate turbines with acceptable load level, whereas red circles indicate turbines with load level higher than normally accepted. The accepted load level is for a generic turbine the load level corresponding to the IEC-class wind climate. For a specific turbine the acceptable load level will normally correspond to the certification loads.

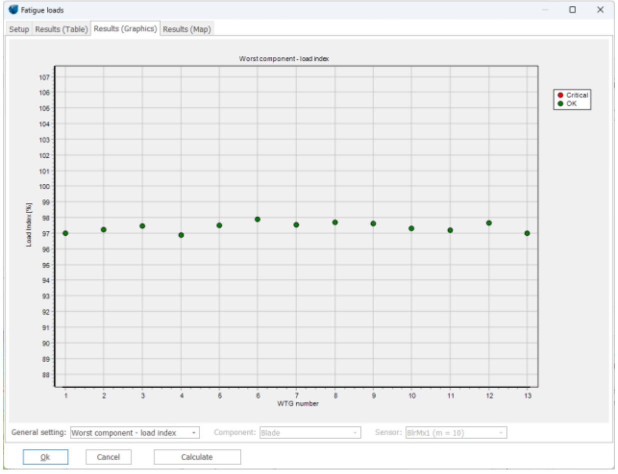
Using the dropdown menus marked by red individual components and sensors in the wind turbine can be selected. By default, the results for the worst component and worst sensor for each turbine is shown.

The radio button marked by yellow shows the results by a color legend. This gives a better indication of which turbines in the layout are subjected to the highest loads.

### 4.2 Results (Graphics)

The results are shown in a graph, where the load index is shown for each turbine. A load index ≤100% correspond to an acceptable load level (green), whereas a load index >100% corresponds to a load level higher than normally acceptable (red).

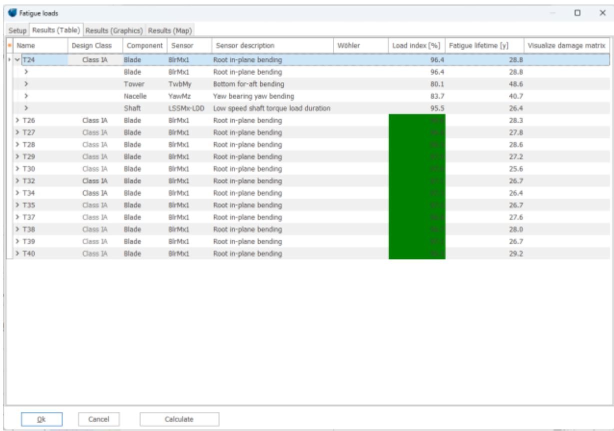
Similarly, using the dropdown menus each individual components and sensors in the wind turbine can be selected.




## 4.3 Results (Table)

The results are shown in a table, where the load index is given for each turbine. By expanding the table, the load index is shown for each component (e.g., blade, tower, nacelle, shaft). By expanding the table further, the load index is shown for each sensor along with the respective Wöhler exponent.

The fatigue life in years is also shown for each component. Note that the fatigue life is relative to the design lifetime for the turbine and does not include other degradation processes like e.g., corrosion.



| Name | Design Class | Component | Sensor | Sensor description | Wöhler | Load index [%] | Fatigue lifetime [y] | Visualize damage matrix |
|---|---|---|---|---|---|---|---|---|
| T24 | Class IA | Blade | BlrMx1 | Root in-plane bending | | 96.4 | 28.8 | |
| | | Blade | BlrMx1 | Root in-plane bending | | 96.4 | 28.8 | |
| | | Tower | TwbMy | Bottom for-aft bending | | 80.1 | 48.6 | |
| | | Nacelle | YawMz | Yaw bearing yaw bending | | 83.7 | 40.7 | |
| | | Shaft | LSSMx-LDD | Low speed shaft torque load duration | | 95.5 | 26.4 | |
| T26 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 28.3 | |
| T27 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 27.8 | |
| T28 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 28.6 | |
| T29 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 27.2 | |
| T30 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 25.6 | |
| T32 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 26.7 | |
| T34 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 26.4 | |
| T35 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 26.7 | |
| T37 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 27.6 | |
| T38 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 28.0 | |
| T39 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 26.7 | |
| T40 | Class IA | Blade | BlrMx1 | Root in-plane bending | | [illegible] | 29.2 | |