

QUICK GUIDE – LIFETIME ANALYSIS

Purpose:

The following quick guide shows you how to perform a lifetime analysis according to DNVGL-ST-0262 (2.2 Analytical part) using the LOAD RESPONSE module in windPRO 4.0. This fatigue lifetime calculation provides indicative results and is intended as an initial analysis of the potential for a lifetime extension of the WTG asset.

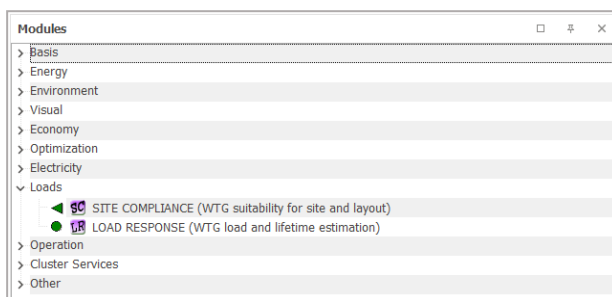
Outline of Guide:

1. Prerequisites for the analysis
2. Setting up the analysis
3. Reviewing results

1. PREREQUISITES FOR THE ANALYSIS

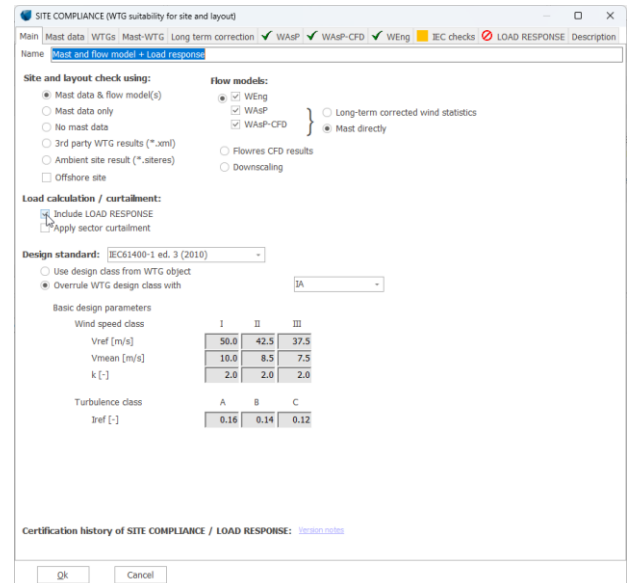
The lifetime analysis in windPRO 4.0 is performed using the LOAD RESPONSE module. As a result, you must ensure that both the SITE COMPLIANCE and LOAD RESPONSE modules are installed, and you have valid licenses for both.

From the “Settings & Help” tab clicking “Show window” all your installed modules can be viewed. If both SITE COMPLIANCE and LOAD RESPONSE are installed and licensed properly you should see the same as shown below.

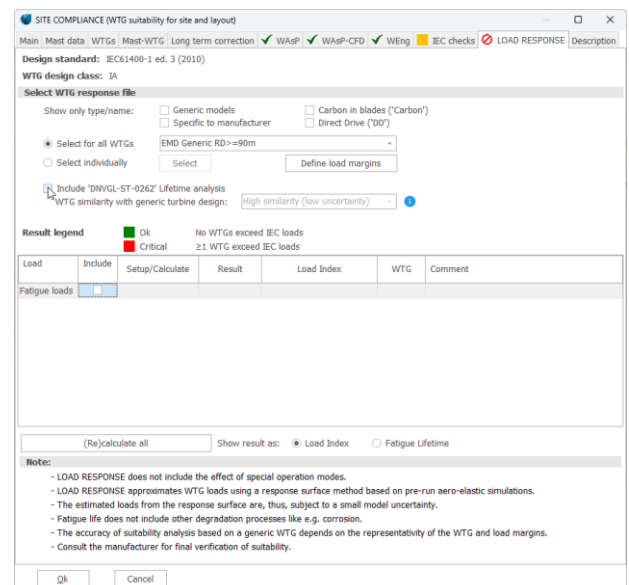


2. SETTING UP THE ANALYSIS

Firstly, a SITE COMPLIANCE analysis must be performed, where LOAD RESPONSE must be included in the main tab.



In the LOAD RESPONSE tab, the lifetime analysis is included by checking the “Include “DNVGL-ST-0262 Lifetime analysis” box.

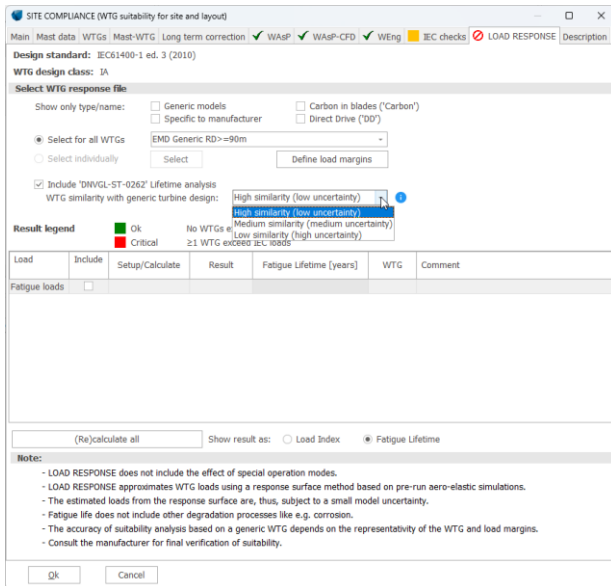


When using a generic WTG response file, you must further specify the similarity of your WTG with the generic turbine model.

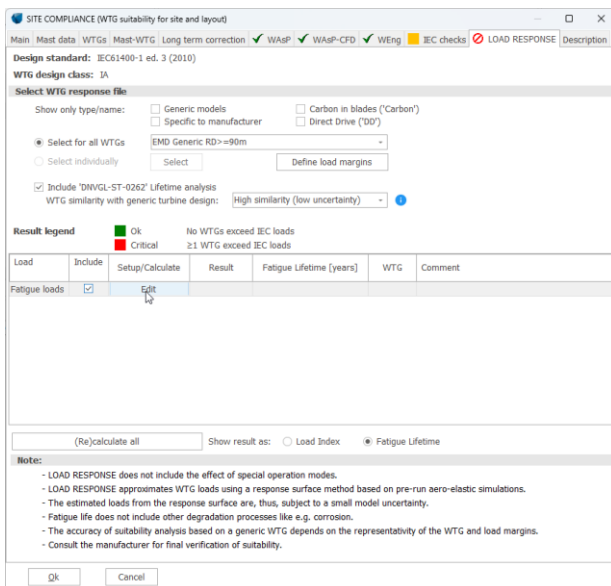
Choosing e.g., high similarity results in a lower amount of uncertainty included in the lifetime assessment. As a result, this decision should be considered carefully to include appropriate uncertainty

Quick Guide – Lifetime Analysis

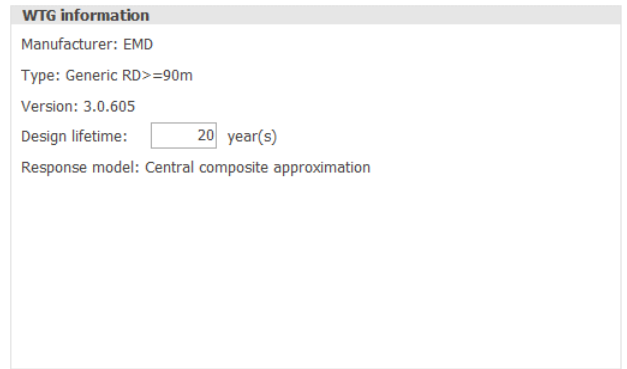
in the fatigue life assessment. The generic turbine model to compare your WTG with is a standard 3-bladed with standard nacelle/hub, steel tower and collective pitch, similar to e.g., NREL 5MW or DTU 10MW.



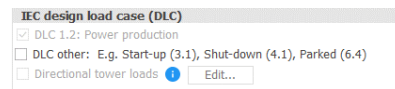
Access the calculation setup by clicking the “Edit” button as shown below.



Verify that the design life in the WTG information window corresponds to your specific WTG. By default, this is set to 20 years.



Consider including the DLC other in the IEC design load case (DLC) window. Since excluding the contributions from start-up, shut-down and parked conditions would result in an overestimation of the lifetime assessment.

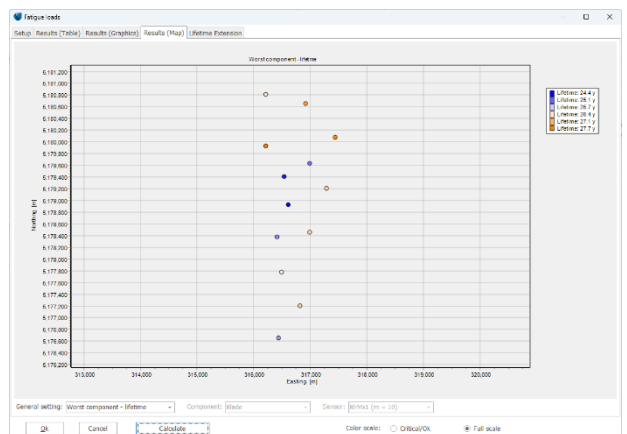


After reviewing the remaining load calculations setup options perform the lifetime analysis by clicking the calculate button.

3. REVIEWING RESULTS

After the calculations are performed (typically only a few seconds) several results tabs will be available.

The lifetime estimates for each WTG can be viewed at the “Results (Map)” tab. The figure visualizes how the fatigue lifetime estimates of the WTGs vary across the site.



In the “Results (Table)” tab the fatigue life and the standard deviation of the fatigue lifetime can be viewed for each sensor included in the WTG response model.

Quick Guide – Lifetime Analysis

Name	Design Class	Component	Sensor	Sensor descript...	W...	L	Fatigue lifetime [y]	Fatigue lifetime st.dev. [y]	Visualize damage matrix
T24	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	28.8	3.0	
T26	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	28.3	2.9	
T27	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	27.8	2.9	
T28	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	28.6	3.0	
T29	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	27.2	2.8	
T30	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	25.6	2.6	
T32	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	26.7	2.8	
T34	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	26.4	2.7	
T35	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	26.7	2.7	
T37	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	27.6	2.9	
T38	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	28.9	2.9	
T39	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	26.7	2.8	
T40	Class 3A	Blade	BIRMc1	Root in-plane bends	1.0	1	29.2	3.0	

Finally, the “Lifetime Extension” tab presents general information about the lifetime analysis. Furthermore, it outlines main assumptions and uncertainties related to the calculations and summaries the expected lifetime extension potential of the WTGs.

Lifetime analysis according to: DNVGL-ST-0262 (2.2 Analytical part)
Analytical method: 2.2.3 Simplified (Generic model)

Deterministic calculation (general uncertainties not accounted for).
 - Only main components/sensors are included. Other sensors/cross-sections or connections may be critical (Full list 2.1.3, Table 2-1).
 - Only fatigue effects are considered. Re-assessment of extreme events is not required in lifetime assessment (2.2.3.4/2.2.4.4).
 Uncertainty of generic WTG model (2.2.3.7):
 - The uncertainty is indicative and the st.dev. is estimated as an order of magnitude.
 - The uncertainty calculation follows ISO/IEC/JCGM guidelines for uncertainty assessment.
 - Bias due to unknown load margins is not included. Known margins can be entered on the Load Response tab.
 - Lifetime uncertainties are strongly amplified compared to uncertainties on load indices due to a highly non-linear relationship.
 - The amplification differs across sensors/components and depends on the wobble exponent [m].
 - The uncertainty accounts only for the structural design. Special controller settings or strategies are not covered.

Lifetime summary
 Number of WTGs: 13

Worst WTG (lowest lifetime)

WTG name:	T34
Worst component/sensor:	Shaft_LSSMc-LDD
Expected sensor lifetime:	24 years
Design lifetime:	28 years
Expected lifetime extension potent	4 years
St.dev. on lifetime (from generic model):	1.5 years

All WTGs (s)

Expected lifetime extension potential

WTG	Expected potential for lifetime extension [y]
4	~2.5
6	~3.5
5	~3.5
7	~2.5

Important note:
 This calculation only covers the Analytical part of the DNVGL-ST-0262 lifetime assessment. DNVGL-ST-0262 ALWAYS requires a Practical part, with detailed physical inspections of WTGs. All lifetimes are truncated to between 2 and 50 years, and lifetime st.dev. between 1 and 20 years.

Disclaimer:
 This fatigue lifetime calculation result is indicative and intended as a first line analysis of the potential for lifetime extension. Results assume that a valid ambient wind climate has been established in Site Compliance, and that all relevant neighbour WTGs are included.

OK Cancel Calculate

It should be noted that the calculation only covers the analytical part of the DNVGL-ST-0262 lifetime assessment which states that there must always be a practical part, with detailed physical inspections of the WTGs in any lifetime extension of a WTG.

Nevertheless, this simple fatigue lifetime assessment can be indicative of the potential of a lifetime extension. As a result, it would provide valuable input to the planning process of any WTG park or as an initial analysis of the potential of a lifetime extension of an existing park.

For more detailed information about the theoretical background for the lifetime analysis please refer to LOADS manual.