Class 1
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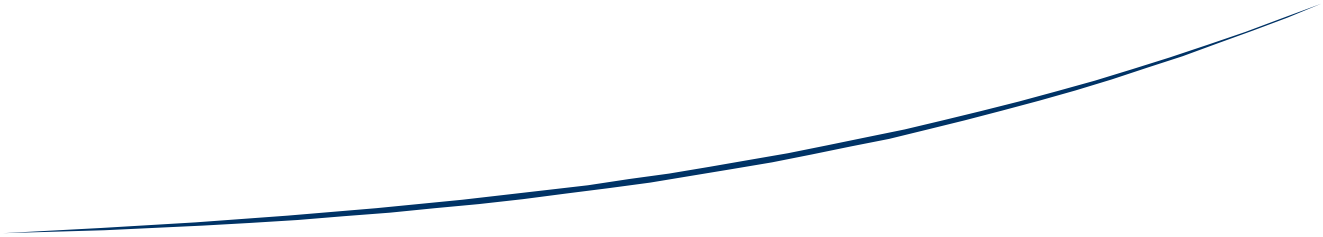
2008-10-08

General Specification
Vestas V52-850 kW
50/60 Hz
OptiSpeed® – Wind Turbine



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1 Wind Turbine Description

The V52-850 kW turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor.

The V52-850 kW turbine with a rotor diameter of 52 m operates using the OptiSpeed® concept. This feature enables the rotor to operate with variable speed of rotation (RPM).

All V52-850 kW turbines are equipped with OptiTip®, the special Vestas pitch regulating system. With OptiTip®, the blade angles are constantly regulated so they are always pitched at the optimal angle for current wind conditions. This optimises both power production and noise levels.

Blades are made of glass-fibre reinforced epoxy (Prepreg). Each blade consists of two blade shells, which are bonded to a supporting beam. Special steel thread inserts, which are glued into the blade root along with bolts connect the blade to the blade bearing. The blade bearing is a 4-point ball bearing bolted to the hub.

The main shaft transmits the power to the generator through the gearbox. The gearbox is a combined planetary and helical gearbox. From the gearbox the power is transmitted via a maintenance free composite coupling to the generator. The generator is a special asynchronous 4-pole generator with wound rotor and slip-rings.

At higher wind speeds, the OptiSpeed® and the pitch regulating OptiTip® system, keeps the power at nominal level regardless of the air temperature and air density. At lower wind speeds the OptiTip® system and OptiSpeed® optimises the power output by selecting the optimal RPM and pitch angle.

The wind turbine brakes by full feathering of the blades. An emergency disc brake system is mounted on the gearbox shaft at the High-speed end.

All functions of the wind turbine are monitored and controlled by several microprocessor based control units. The Vestas Multi Processor (VMP) unit is placed inside the nacelle. Changes in the pitch of the blades are activated by a hydraulic driven system which enables the blades to rotate 95°. The hydraulic system also supplies the necessary pressure for the brake system.

Two electrical yaw gears rotate the yaw pinions which are in mesh with a large toothed yaw ring bolted on the top of the tower. The yaw bearing system is a slide bearing system with built-in friction and an electrical brake on the yaw gear motors.

The glass-fibre reinforced nacelle cover protects all the components inside the nacelle against rain, snow, dust, sunlight etc. Access to the nacelle from the tower is through a central opening.

The nacelle also houses a 250 kg service-crane which is placed in the rear end of the nacelle and operated out through the back door of the nacelle.

Steel tubular towers are supplied for various hub heights and all towers are supplied painted. See section 3.11 ‘Tubular Towers’ for further information.

1.1 OptiSpeed® Description

OptiSpeed®, also called **V**estas **C**onverter **S**ystem (VCS), ensures a steady and stable electric power supply from the turbine.

VCS consists of

- an effective asynchronous generator with wound rotor and sliprings.
- a power converter with *Insulated Gate Bipolar Transistor* (IGBT) switches.
- contactors and protection.

VCS enables variable speed operation in a range of approx. 60 % of nominal RPM. VCS along with the pitch regulation OptiTip®, ensures energy optimisation, low noise operation and reduction of loads on the gearbox and other vital components.

VCS controls the current in the rotor circuit in the generator. This gives precise control of the reactive power and gives an accurate and precise connection between the generator and the grid.

1.2 Type Approvals

The V52-850 kW OptiSpeed® turbine is currently approved according to the following standards:

Country	Design criteria	Conditions	Hub height [m]
Denmark	**DS472 + Teknisk Grundlag**	**Roughness Class 0, 1, 2, 3**	**40, 44, 49, 55, 60, 65, 74**
Germany	**DIBt**	**Zone III**	**60, 65**
		Zone II	**60, 65, 74, 86**
Holland	**NVN11400/0**	**Class II_A**	**36.5, 40, 44, 49, 55, 60, 65, 70**
IEC	**IEC 61400-1**	**Class I_A**	**40, 44, 49, 55, 60, 65**
IEC		**Class II_A**	**55, 60, 65, 74**

1.3 Climatic Conditions

The V52-850 kW OptiSpeed® turbine is as standard designed for operation in ambient temperatures ranging from -20°C to +40°C. The turbine will be put in PAUSE-mode outside these temperatures. Restart-temperatures after stop on lower/upper ambient temperature limit are -20°C and +38°C accordingly.
Special precautions must be taken outside the standard operating temperatures. See section 1.7 "General Reservations" as well as Low Temperature (LT) appendix (Vestas doc. no. 946507) and High Temperature (HT) appendix (Vestas doc. no. 951614).

The turbines can be placed in wind farms with a distance of at least five times the rotor diameter (260 m) between the turbines. If the turbines are placed in one row, perpendicular to the predominant wind direction, the distance between turbines must be at least 4 rotor diameters (208 m).

A relative humidity of 100 % is acceptable max. 10 % of the time.

General corrosion classes, nacelle:
Protection against internal corrosion, according to ISO 12944, Class C3/High.

Protection against external corrosion, according to ISO 12944, Class C4/High + C5-M/High.
See section 3.11 "Tubular Towers" concerning corrosion protection of towers.

1.4 Previous Earthing System

Intermittent or rapid power fluctuations of utility grid frequencies may cause serious damage to the wind turbine. Steady variations within +1/-3 Hz (50 Hz) or within +2/-3 Hz (60 Hz) are acceptable. The voltage operational range must be within ±10% of nominal.

Grid dropouts should only take place once a week as an average over the lifetime of the turbine.

Grounding (earthing) connection of maximum 10 Ω must be present. Furthermore, it is recommended that the turbine is connected to a TN-grid.

The earthing system must be adapted to the local soil conditions. The resistance to neutral earth must be according to the requirements of the local authorities.

In case of small independent grids, it will be necessary to check the actual conditions.

1.5 Vestas Earthing System

Intermittent or rapid power fluctuations of utility grid frequencies may cause serious damage to the wind turbine. Steady variations within +1/-3 Hz (50 Hz) or within +2/-3 Hz (60 Hz) are acceptable. The voltage operational range must be within ±10% of nominal.

Grid dropouts should only take place once a week as an average over the lifetime of the turbine.

The earthing system for the turbine must be made according to the Vestas Earthing system concept.

For more general information on the Vestas Earthing system, see Vestas document no. 0000-3388.

1.6 Terrain Conditions

If the terrain is outside the below listed rules or the terrain otherwise seems complex, particular considerations may be necessary and Vestas must be contacted:

- A maximum slope of 10° within a radius of 100 m from the turbine.
- A maximum slope of 15° within a radius of 100 to 500 m from the turbine.
- A maximum slope of 20° outside a radius of 500 m from the turbine.

1.7 General Reservations

Vestas Optispeed® technology is not available in United States of America and Canada.

In connection with heavy icing-up, interruptions in operation may be expected.

In certain combinations of high wind, high temperature, low air density and/or low voltage, power de-rating may occur. This is to ensure that the thermal conditions of the main components such as gearbox, generator etc. are kept within limits.

It is generally recommended that the grid voltage is as close to nominal as possible. In connection with grid dropout and very low temperatures, a certain time for heating must be expected, before the turbine can restart to operate.

If the wind turbine is placed at more than 1000 m above sea level, a higher temperature rise than usual may occur in the generator, in the transformer and in other electrical components. In this case a periodic reduction of rated power may occur, even if the ambient temperature is within the specified limits.

Furthermore, at sites at more than 1000 m above sea level, there is an increased risk of icing-up.

Due to continuous development and updating of our products, Vestas reserves the right to change the specifications without previous notification.

2 Main Data

2.1 Wind Climate

Turbulence is a factor to describe the short-term wind variations / fluctuations.

In the table below are the design conditions for the Vestas V52-850 kW OptiSpeed® turbine.

V52-850 kW OptiSpeed® Wind speed and turbulence rates at hub height level according to IEC I_A		
Parameter	**Unit**	**Value**
Annual average wind speed (V_{Ave})	[m/s]	10.0
Weibull shape parameter C	[-]	2
Turbulence rate at 15 m/s	[%]	18
Reference wind speed for: 10 min., 50 years	[m/s]	50
Reference gust speed for: 3s., 50 years	[m/s]	70
Wind gust max. acceleration	[m/s^2]	10
Cut-in wind speed	[m/s]	4
Cut-out wind speed	[m/s]	25
Restart wind speed (After cut-out)	[m/s]	20

2.2 Power Tables and Curves

Power tables and curves are calculated on basis of NACA63 and FFA-W3 blade profiles.

Parameters for calculating the power curves/tables are the following:

Frequency	:	50/60 Hz
Rotor diameter	:	52 m
Tip angle	:	Pitch regulated
Turbulence intensity	:	10 %

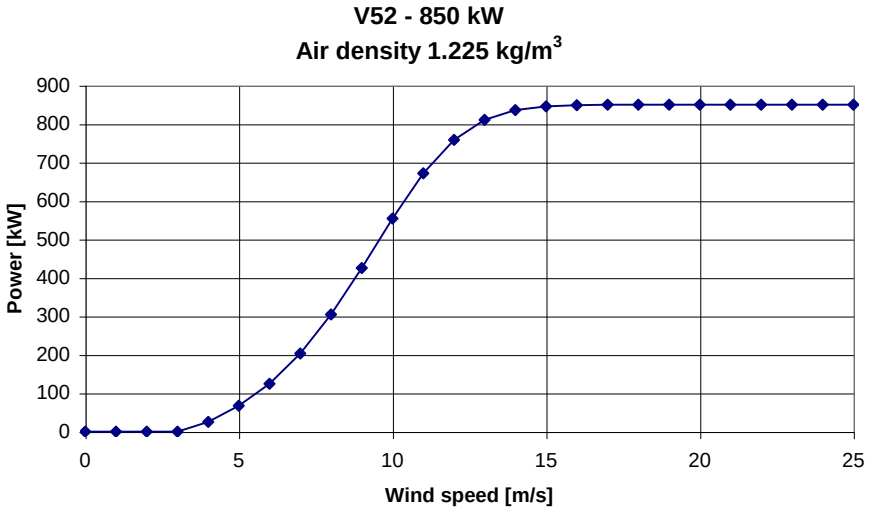
Wind speed calculated as 10 minutes average value at hub height and perpendicular to the rotor plane.

The power curve is measured at the ground controller on the low-voltage side of the transformer. Losses in transformer and high voltage cables are therefore not included in the measurements.

In order to meet the site specific demands for low noise, it is possible to program the turbine noise emission levels before installation. Lowering the noise emission level, will influence negatively on the kWh-production compared to standard setting 104.2 dB(A).

2.2.1 Power Table (kW) and Curve for Noise Level: 104.2 dB(A)

104.2 dB(A) @ h = 10 m	Density / Speed	1.060 [kg/m³]	1.090 [kg/m³]	1.120 [kg/m³]	1.150 [kg/m³]	1.180 [kg/m³]	1.210 [kg/m³]	1.225 [kg/m³]	1.240 [kg/m³]	1.270 [kg/m³]
	4 [m/s]	20.4	21.3	22.3	23.2	24.1	25.1	25.5	26.0	27.0
	5 [m/s]	56.6	58.6	60.5	62.5	64.5	66.4	67.4	68.4	70.4
	6 [m/s]	106	109	113	116	119	123	125	126	130
	7 [m/s]	173	179	184	189	195	200	203	206	211
	8 [m/s]	260	268	276	284	292	300	304	308	317
	9 [m/s]	365	376	387	398	409	420	425	431	441
	10 [m/s]	480	494	507	521	534	547	554	561	572
	11 [m/s]	595	610	624	637	651	665	671	679	688
	12 [m/s]	696	709	720	731	742	753	759	765	770
	13 [m/s]	770	780	787	794	800	807	811	814	817
	14 [m/s]	815	820	824	827	831	834	836	838	839
	15 [m/s]	837	839	841	842	843	845	846	846	847
	16 [m/s]	846	847	847	848	848	849	849	849	849
	17 [m/s]	849	849	849	849	850	850	850	850	850
	18→25 [m/s]	850	850	850	850	850	850	850	850	850

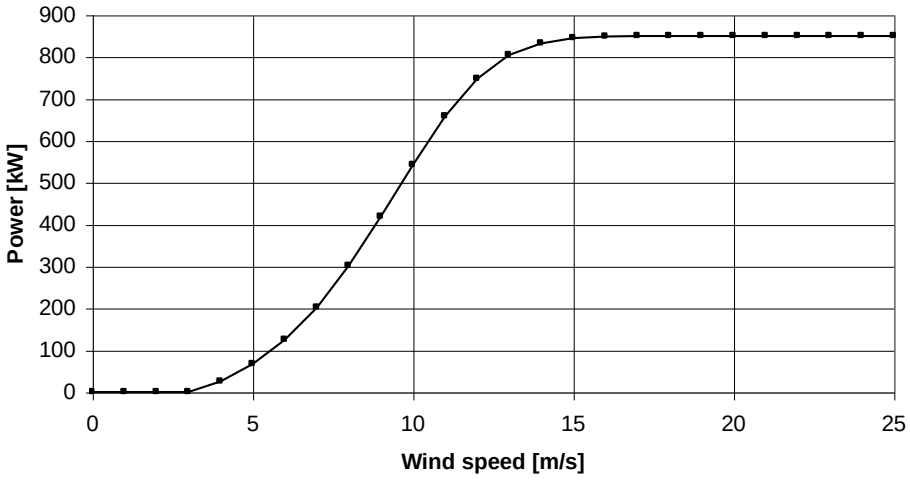


Noise level 104.2 dB(A)

2.2.2 Power Table (kW) and Curve for Noise Level: 103.0 dB(A)

103.0 dB(A) @ h = 10 m	Density / Speed	1.060 [kg/m^3]	1.090 [kg/m^3]	1.120 [kg/m^3]	1.150 [kg/m^3]	1.180 [kg/m^3]	1.210 [kg/m^3]	1.225 [kg/m^3]	1.240 [kg/m^3]	1.270 [kg/m^3]
	4 [m/s]	20.4	21.3	22.3	23.2	24.1	25.1	25.5	26.0	27.0
	5 [m/s]	56.6	58.6	60.5	62.5	64.5	66.4	67.4	68.4	70.4
	6 [m/s]	106	109	113	116	119	123	125	126	130
	7 [m/s]	173	178	183	189	194	200	202	205	211
	8 [m/s]	258	266	274	282	290	298	302	306	314
	9 [m/s]	359	370	381	391	402	413	418	424	435
	10 [m/s]	470	484	497	510	523	536	543	549	562
	11 [m/s]	584	598	612	625	638	652	658	665	678
	12 [m/s]	686	700	710	721	732	742	748	753	764
	13 [m/s]	763	773	780	787	794	801	804	807	814
	14 [m/s]	811	817	821	824	827	831	832	834	837
	15 [m/s]	835	838	839	841	842	844	844	845	846
	16 [m/s]	845	846	847	847	848	848	848	849	849
	17 [m/s]	849	849	849	849	849	850	850	850	850
	18→25 [m/s]	850	850	850	850	850	850	850	850	850

V52 - 850 kW
Air density 1.225 kg/m^3

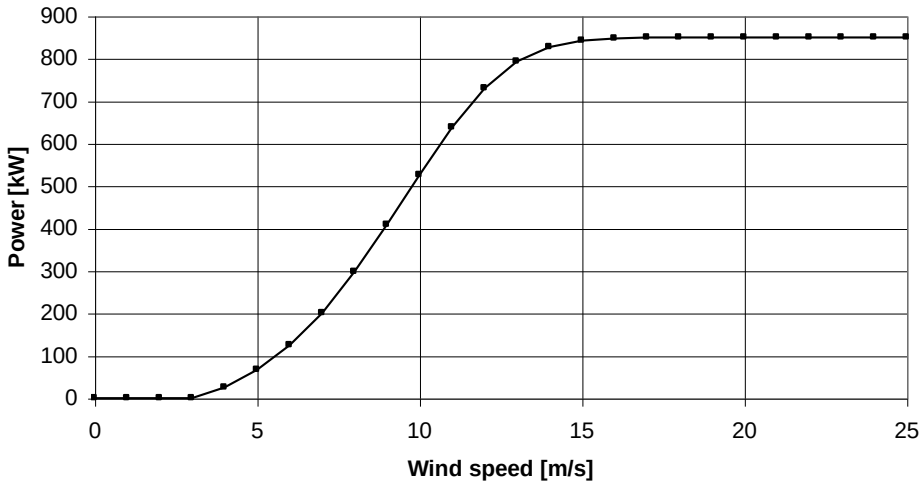


Noise level 103.0 dB(A)

2.2.3 Power Table (kW) and Curve for Noise Level: 102.0 dB(A)

102.0 dB(A) @ h = 10 m	Density / Speed	1.060 [kg/m³]	1.090 [kg/m³]	1.120 [kg/m³]	1.150 [kg/m³]	1.180 [kg/m³]	1.210 [kg/m³]	1.225 [kg/m³]	1.240 [kg/m³]	1.270 [kg/m³]
	4 [m/s]	20.4	21.3	22.3	23.2	24.1	25.1	25.5	26.0	27.0
	5 [m/s]	56.6	58.6	60.5	62.5	64.5	66.4	67.4	68.4	70.4
	6 [m/s]	106	109	112	116	119	123	124	126	129
	7 [m/s]	172	177	182	188	193	198	201	204	209
	8 [m/s]	254	262	270	278	286	293	297	301	309
	9 [m/s]	350	360	371	382	392	403	408	413	424
	10 [m/s]	454	467	481	494	506	519	525	532	544
	11 [m/s]	561	577	593	606	619	631	638	644	657
	12 [m/s]	663	678	694	704	715	725	730	735	745
	13 [m/s]	744	756	770	776	783	789	792	796	802
	14 [m/s]	799	807	815	818	822	825	826	828	831
	15 [m/s]	829	833	837	838	840	841	842	842	844
	16 [m/s]	842	844	846	846	847	847	848	848	848
	17 [m/s]	848	848	849	849	849	849	849	849	850
	18→25 [m/s]	849	850	850	850	850	850	850	850	850

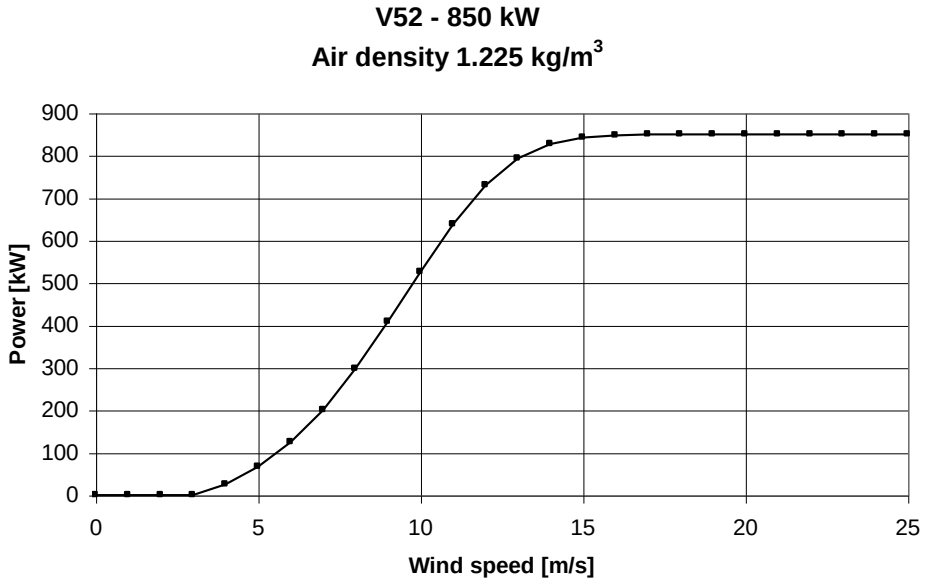
V52 - 850 kW
Air density 1.225 kg/m³



Noise level 102.0 dB(A)

2.2.4 Power Table (kW) and Curve for Noise Level: 101.0 dB(A)

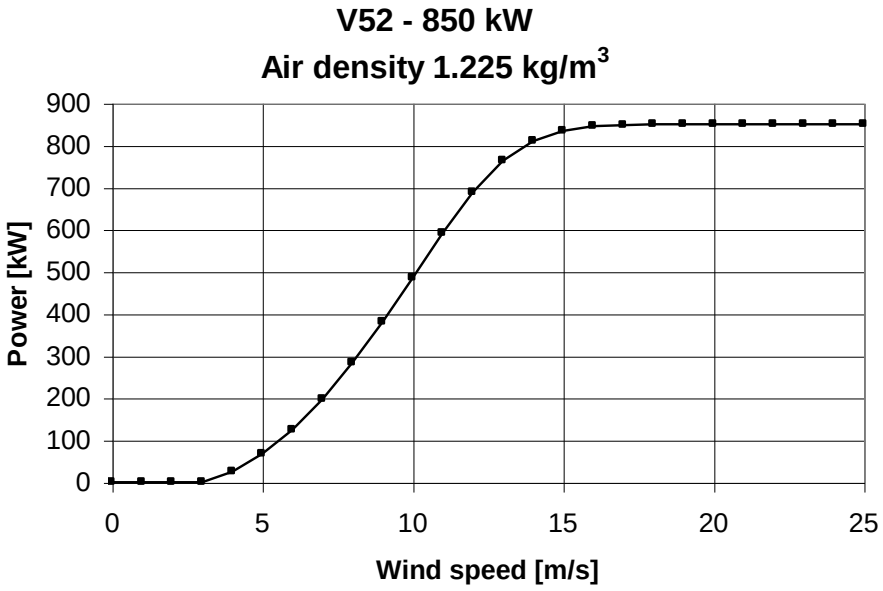
101.0 dB(A) @ h = 10 m	Density / Speed	1.060 [kg/m^3]	1.090 [kg/m^3]	1.120 [kg/m^3]	1.150 [kg/m^3]	1.180 [kg/m^3]	1.210 [kg/m^3]	1.225 [kg/m^3]	1.240 [kg/m^3]	1.270 [kg/m^3]
	4 [m/s]	20.4	21.3	22.3	23.2	24.1	25.1	25.5	26.0	27.0
	5 [m/s]	56.6	58.5	60.5	62.5	64.4	66.4	67.4	68.4	70.4
	6 [m/s]	105	109	112	115	119	122	124	126	129
	7 [m/s]	170	175	181	186	191	197	199	202	207
	8 [m/s]	249	257	265	272	280	288	292	296	303
	9 [m/s]	340	350	360	371	381	391	396	402	412
	10 [m/s]	438	451	464	477	490	502	508	514	527
	11 [m/s]	540	555	570	585	600	612	619	625	637
	12 [m/s]	640	655	670	684	699	709	714	719	729
	13 [m/s]	726	737	749	761	772	779	782	785	791
	14 [m/s]	787	794	801	809	816	820	821	823	826
	15 [m/s]	822	826	830	834	838	839	840	840	841
	16 [m/s]	840	841	843	844	846	847	847	847	847
	17 [m/s]	847	847	848	848	849	849	849	849	849
	18→25 [m/s]	849	849	849	850	850	850	850	850	850



Noise level 101.0 dB(A)

2.2.5 Power Table (kW) and Curve for Noise Level: 100.0 dB(A)

100.0 dB(A) @ h = 10 m	Density / Speed	1.060 [kg/m³]	1.090 [kg/m³]	1.120 [kg/m³]	1.150 [kg/m³]	1.180 [kg/m³]	1.210 [kg/m³]	1.225 [kg/m³]	1.240 [kg/m³]	1.270 [kg/m³]
	4 [m/s]	20.4	21.3	22.3	23.2	24.1	25.1	25.5	26.0	27.0
	5 [m/s]	56.5	58.5	60.5	62.4	64.4	66.4	67.4	68.4	70.3
	6 [m/s]	105	108	112	115	118	122	124	125	129
	7 [m/s]	168	173	178	184	189	194	197	200	205
	8 [m/s]	243	251	258	266	273	281	284	288	296
	9 [m/s]	327	337	347	357	367	376	381	387	397
	10 [m/s]	416	429	441	454	466	479	485	491	503
	11 [m/s]	512	527	541	555	570	584	591	598	611
	12 [m/s]	608	625	640	653	667	681	688	695	706
	13 [m/s]	696	712	724	735	746	757	763	768	777
	14 [m/s]	764	776	786	793	800	806	810	813	819
	15 [m/s]	808	816	822	825	829	832	834	836	839
	16 [m/s]	833	837	839	841	842	844	845	845	846
	17 [m/s]	844	845	847	847	848	848	848	849	849
	18→25 [m/s]	848	849	849	849	849	850	850	850	850



Noise level 100.0 dB(A)

2.3 Annual Production Figures

Below are annual production figures in MWh (x1000) for different noise levels for the V52-850 kW OptiSpeed®. Roughness classes are in accordance with DS472. Noise is according to DS measured at 10 m height above ground level and a wind speed of 8 m/s.

Danish Roughness Class with Beldringe site correction. Annual Production in MWh (x1000) - 45 m hub height and 8 m/s wind speed				
Roughness Class	**0**	**1**	**2**	**3**
Noise level 104.2 dB(A)	3.210	2.224	1.843	1.309
Noise level 103.0 dB(A)	3.171	2.195	1.819	1.292
Noise level 102.0 dB(A)	3.122	2.158	1.789	1.272
Noise level 101.0 dB(A)	3.073	2.121	1.757	1.251
Noise level 100.0 dB(A)	2.996	2.063	1.710	1.219

The following three tables shows annual production figures in MWh (x1000) for different combinations of mean wind speed and noise levels calculated with different Weibull distributions (C=1.5, C=2 and C=2.5).

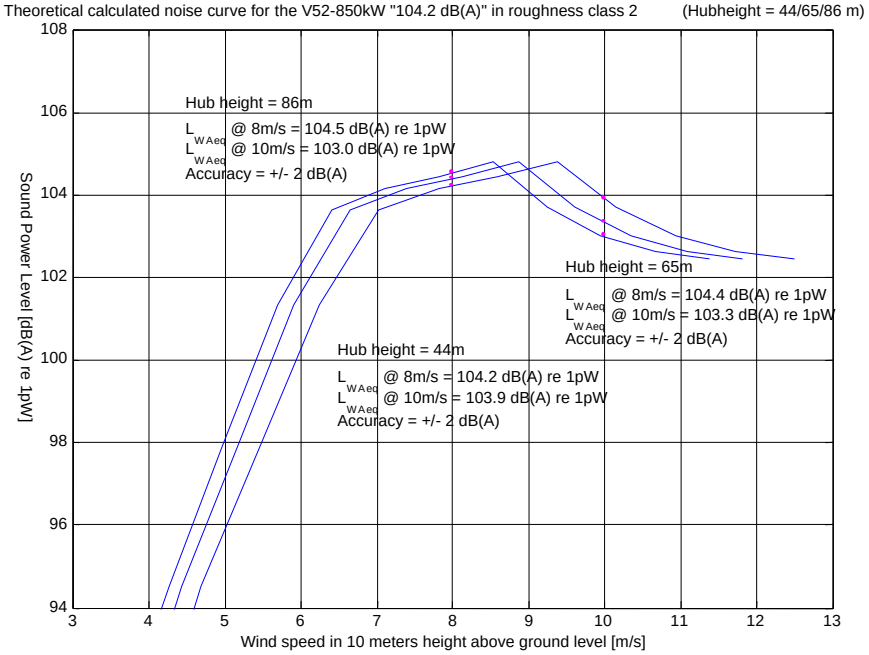
Weibull Shape factor C = 1.5						
Mean wind speed	**5 m/s**	**6 m/s**	**7 m/s**	**8 m/s**	**9 m/s**	**10 m/s**
Noise level 104.2 dB(A)	1.315	1.879	2.407	2.864	3.235	3.519
Noise level 103.0 dB(A)	1.299	1.857	2.380	2.835	3.205	3.489
Noise level 102.0 dB(A)	1.279	1.830	2.347	2.799	3.168	3.451
Noise level 101.0 dB(A)	1.259	1.802	2.314	2.763	3.130	3.414
Noise level 100.0 dB(A)	1.228	1.758	2.262	2.706	3.071	3.353

Weibull Shape factor C = 2						
Mean wind speed	**5 m/s**	**6 m/s**	**7 m/s**	**8 m/s**	**9 m/s**	**10 m/s**
Noise level 104.2 dB(A)	1.098	1.733	2.388	3.005	3.549	4.002
Noise level 103.0 dB(A)	1.086	1.711	2.357	2.969	3.510	3.963
Noise level 102.0 dB(A)	1.070	1.683	2.319	2.923	3.461	3.914
Noise level 101.0 dB(A)	1.053	1.653	2.279	2.878	3.414	3.866
Noise level 100.0 dB(A)	1.029	1.609	2.219	2.806	3.337	3.788

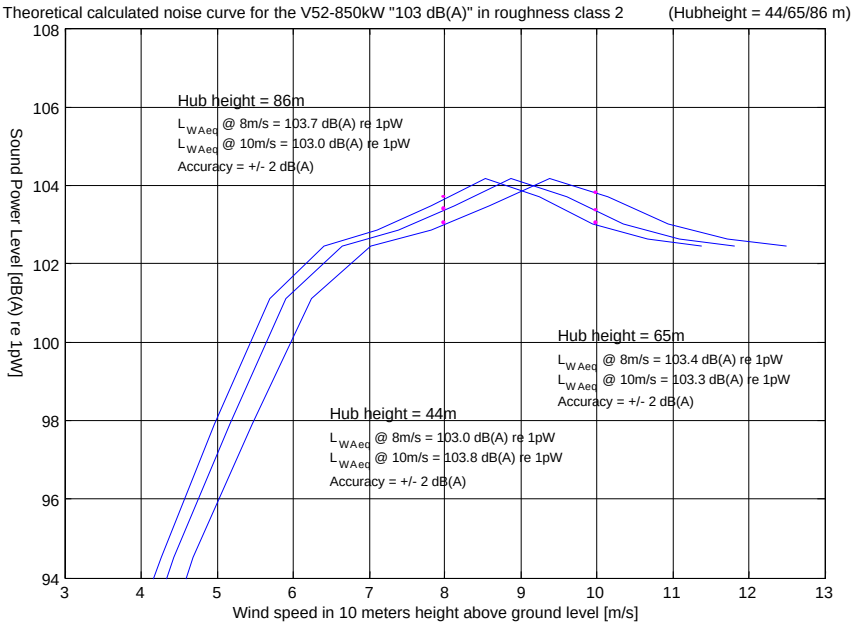
Weibull Shape factor C = 2.5						
Mean wind speed	**5 m/s**	**6 m/s**	**7 m/s**	**8 m/s**	**9 m/s**	**10 m/s**
Noise level 104.2 dB(A)	946	1.595	2.317	3.031	3.685	4.251
Noise level 103.0 dB(A)	938	1.574	2.284	2.989	3.639	4.204
Noise level 102.0 dB(A)	928	1.549	2.243	2.937	3.580	4.144
Noise level 101.0 dB(A)	916	1.522	2.201	2.884	3.522	4.085
Noise level 100.0 dB(A)	898	1.482	2.137	2.802	3.431	3.991

2.4 Noise Emission Plots

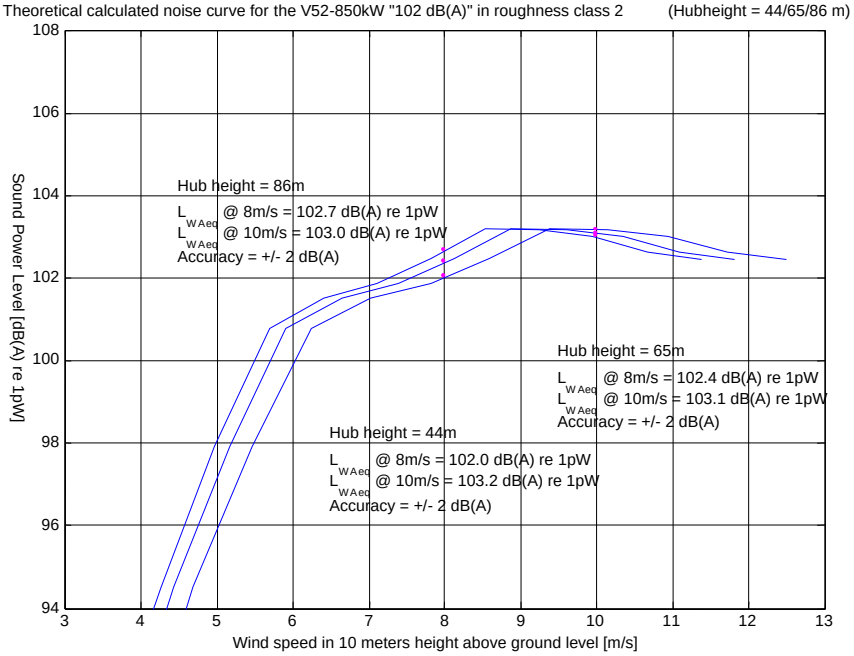
2.4.1 104.2 dB(A)



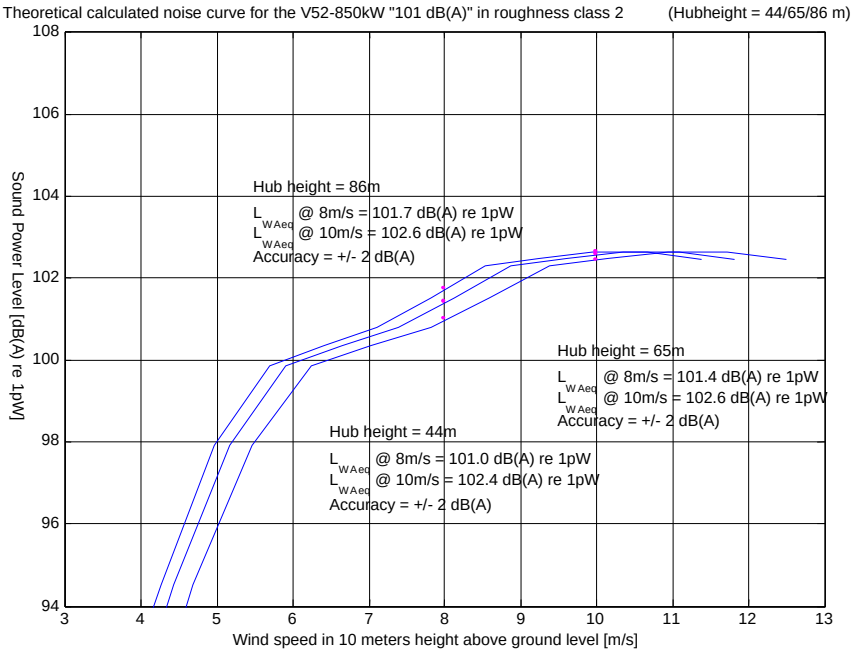
2.4.2 103.0 dB(A)



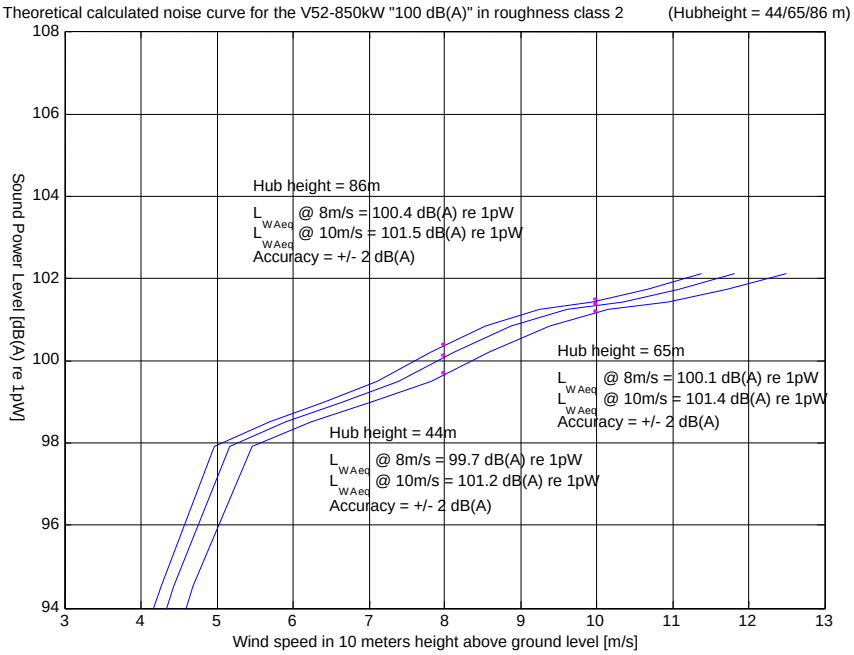
2.4.3 102.0 dB(A)



2.4.4 101.0 dB(A)



2.4.5 100.0 dB(A)



3 Technical Specifications

3.1 Rotor

Diameter:	52 m
Swept area:	2124 m^2
Rated rotor speed:	26 RPM
Rotor speed range:	14.0 - 31.4 RPM
Rotational direction:	Clockwise (front view)
Orientation:	Upwind
Tilt angle:	6°
Blade coning angle:	3°
Number of blades:	3
Aerodynamic brakes:	Full feathering of blades

3.2 Blades

Principle:	Shells bonded to supporting beam
Material:	Glass-fibre reinforced epoxy (Prepreg)
Blade - bearing connection:	Steel root thread inserts + bolts
Profiles:	NACA63 and FFA-W3
Length:	25.3 m
Chord (width) - blade root/blade tip:	2.3 m/0.33 m
Twist (blade root/blade tip):	16°/0°
Weight:	Approx. 1900 kg each excl. blade bearing

3.3 Blade Bearing

Type:	4-point ball bearing

3.4 Blade Hub

Type:	Cast ball hub
Material:	EN-GJS-400-18U-LT / EN1563

3.5 Main Shaft

Type:	Forged hollow shaft
Material:	34CrNiMo6 Q+T / EN10083

3.6 Main Bearing Housing

Type:	Cast construction
Material:	EN-GJS-400-18U-LT / EN1563

3.7 Main Bearings

Type:	Spherical roller bearings Front bearing – 23064 Rear bearing – 23160

3.8 Machine Foundation

Type:	Welded steel plate construction
Material:	S235 J2G3 + S275 J2G3 / EN10025
	Or
Type:	Cast construction
Material:	EN-GJS-400-18U-LT / EN1563

3.9 Yaw System

Type:	Slide bearing system with built-in friction
Materials:	Yaw ring: 34CrNiMo6 Q+T alt. 42CrMo4 Q+T / EN10083 Slide bearings: PETP
Yawing speed:	< 0.5°/s.

3.10 Yaw Gears

Type:	3 step planetary and 1 step worm gear
Motor:	2.2 kW, 6-pole asynchronous with electrical brake

3.11 Tubular Towers

Type:	Conical, tubular multiple parted steel towers
Material:	S235 JO/JRG2/J2G3 + S355 J0
Surf. treatment – Inside/Outside:	Painting
Corrosion class, outside:	According to ISO 12944-2, Class C4 alt. Class C5-M if the turbine is installed near a coast line.
Corrosion class, inside:	According to ISO 12944-2, Class C3 alt. Class C4 if the turbine is installed near a coastline.
Top diameter for all towers:	2.1 m

	Hub height*	**Bottom diameter**
Single-part tower:	36.5 m	3.0 m
2-parted modular tower:	40 m	3.0 m
2-parted modular tower:	44 m	3.0 m
2-parted modular tower:	49 m	3.3 m
2-parted modular tower:	55 m	3.3 m
3-parted modular tower:	60 m	3.6 m
3-parted modular tower:	65 m	3.6 m
3-parted modular tower:	70 m	4.0 m
3-parted modular tower:	74 m	4.0 m
4-parted modular tower:	86 m	4.0 m

***** Hub height = Tower height + 0.4 m from foundation section to earth + 1.5 m from tower top to hub centre.

3.12 Gearbox

Type:	1 Planetary stage / 2 Helical stages
Ratio:	1:62 at 50 Hz - 1:74.4 at 60 Hz
Cooling:	Oil pump with oil cooler
Oil heater:	1.5 kW
Manufacturer:	Vestas has more sub-suppliers of gearboxes. All gearboxes comply with Vestas' specifications.

3.13 Couplings

Main shaft to gearbox:	Hydraulic shrink-disc, conical
Gearbox to generator:	Composite coupling, maintenance free

3.14 Generator

Type:	Asynchronous with wound rotor, slip rings and VCS
Rated power:	850 kW
Voltage:	690 VAC
Frequency:	50/60 Hz
Number of poles:	4
Protection Class:	IP54
Rated speed:	1620 RPM (50Hz) and 1944 RPM (60 Hz)
Rated current:	711 A
Rated power factor - Default:	1.0
Power factor range:	$0.98_{\mathbf{CAP}}$ - $0.95_{\mathbf{IND}}$ (Optional) See section 1.7 'General Reservations'.
Manufacturer:	Vestas has more sub-suppliers of generators. All generators comply with Vestas' specifications.

3.15 Mechanical Brake

Type:	Disc brake, hydraulic
# of callipers:	3
Disc diameter:	600 mm
Disc material:	VWS-GJV-300-2U-D

The brake is supplied with a battery backup. The backup consists of a battery box which is connected to the top controller unit. The backup of the brake saves the turbine the stress during braking caused by grid dropouts.

3.16 Hydraulic Power Unit

Pump capacity:	8.7 l/min.
Max. pressure:	200 bar
Brake pressure:	44 bar
Oil quantity:	60 l
Motor:	4 kW – 50/60 Hz

3.17 Anemometer and Wind Direction Sensor

Type:	Ultrasonic sensor with built-in heating element to prevent it from being covered with ice.

3.18 Control Unit

Power current:

Voltage:	3 x 690 VAC - 50/60 Hz
Lockable circuit breaker:	800 A
Power supply for lightning –Standard:	1x10 A – 230 VAC – 50/60 Hz
Power supply for outlets – Standard:	1x13 A – 230 VAC – 50/60 Hz

Other voltages can be supplied on request.

Computer:

Communication:	ArcNet
Program memory:	EPROM (flash)
Programming language:	C++
Configuration:	Modular
Operation:	Numeric keyboard + Function keys pad
Display:	4 x 40 characters

Supervision/control:

Active power
Reactive power
Yawing
Hydraulics
Environment (Wind, Temperature)
Rotation
Generator
Pitch system
Grid
Remote monitoring: Possibility of connection of serial communication

Information:

Operating data
Production
Operation log
Alarm log

Commands:

Run/Pause
Man. Yaw start/stop
Maintenance routines

Both top and bottom controller unit has as a standard built-in 400 W heating element to heat up the computer and the panel at low temperatures in the nacelle and the tower respectively.

3.19 Safety Systems

The V52-850 kW turbine is equipped with both mechanical and aerodynamic brakes which will be activated in case of an emergency situation. The turbine furthermore has an independent electrical emergency circuit which will be activated by an over-speed situation.

3.20 Total Weights for Vestas V52-850 kW incl. Tower

To calculate the total weight of the WTG, add the weight of the rotor (10000 kg) and the nacelle (22000 kg) to the weight of the appropriate tower from the table below.

NB!: General tolerances for all tower weights = +/- 5%.

Weights, towers for Vestas V52-850 kW						
Hub height [m]	**DS 472**	**IEC I_A**	**IEC II_A**	**DIBt III**	**DIBt II**	**NVN II_A**
36.5	÷	÷	÷	÷	÷	36 t
40	39 t	39 t	÷	÷	÷	39 t
44	43 t	43 t	÷	÷	÷	43 t
49	51 t	51 t	÷	÷	÷	51 t
55	58 t	58 t	58 t	÷	÷	58 t
60	70 t	70 t	70 t	70 t	÷	70 t
65	77 t	77 t	77 t	77 t	÷	77 t
70	÷	÷	÷	÷	÷	85 t
74	95 t	÷	95 t	÷	95 t	÷
86	÷	÷	÷	÷	111 t	÷