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RECORD OF CHANGES

Rev.	Date	Author	Description
0	13/03/12	PSEGRS	Original version (Mark I)
1	10/08/12	PSEGRS	Update noise level table
2	23/10/12	PSEGRS	Update noise level table step
3	02/05/13	DSUN	Power curve for density 1.27kg/m ⁻³ corrected
4	25/10/2013	EMATA	Table of validity ranges of power curves added and paragraph of section 4 changed.
5	27/02/2014	EMATA	H=125m and H=80m towers added.

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1 AIM

This document presents the power curves and noise emission levels for the WT G114 IIIA 2.0MW wind turbine.

2 SCOPE

The values shown in this document are applicable to all the existing configurations for the WT G114 IIIA 2.0MW, for standard operation mode and according to tower height. Tonality is not considered.

3 DEFINITIONS AND ACRONYMS

- **WT:** Wind turbine.
- **Power (P):** Expressed in kW, this is the electric power obtained at the generator terminals without considering the losses in the transformer or high voltage cables of the wind turbine, or the occasional power consumption which may exist in the same to supply a component. Averaged every 10 minutes.
- **Wind speed (W_s):** Expressed in m/s, it is the horizontal wind component value at the height of the hub averaged every 10 minutes.
- **Power curve (CdP):** Represents the change in the P in accordance with the W_s for the different WT operating modes.
- **Annual Output / Annual Energy Production (AEP):** Expressed in [MWh], it is the total electrical energy produced in a WT during a one-year period, in accordance with a given CdP and a given wind distribution.
- **Wind distribution:** the Weibull distribution is used for different K-distribution parameters and for annual average wind speed values (W_{ave}).
- **Wind speed W_{10} [m/s]:** The wind speed value, measured at 10m above ground level.
- **Tower height (H):** expressed in meters, is the height of the rotor centre above ground level.
- **Power coefficient:** C_p
- **Thrust coefficient:** C_T
- **Noise level:** The expected sound power level values, expressed in dB(A), represent the sound power that the WT emits at the height of the hub for a given wind speed. In accordance with the IEC standard, the wind speed value (W_{10}) 10 m from the ground is used.

The noise levels shown in this document are average expected values, called L_w in IEC-61400-14. To obtain the L_{wd} value, as defined in IEC-61400-14, an increase of 2 dB(A) shall be considered over said L_w values. This increase depends on the typical deviation of the samples being considered, and since no noise measurements exist for this turbine, the same values obtained for G90 are used in this document.

- **dB(A):** an A type frequency filter is applied, in accordance with the IEC standard.

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4 DESCRIPTION

When not specified otherwise, data in following sections is calculated using the parameters from Table 1. All power curve and annual energy production values in this document are subject to the validity ranges presented in Table 2.

Rated Power	2.0 MW
Frequency	50 Hz/60Hz
Rotor Diameter	114 m
Angle of blade tip	Pitch control regulation
Air density	1.225 kg/m ³

Table 1: Calculation parameter values for the G114 IIIA 2.0MW power curve.

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\% \frac{(0.75v_i + 5.6)}{v_i} < TI_i < 12\% \frac{(0.75v_i + 5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [°]	$-2^\circ \leq \beta \leq +2^\circ$
Grid frequency [Hz]	± 0.5 Hz

Table 2 Validity ranges of Power Curves for the G114 2.0MW CIIIA wind turbine power curve.

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Table 3 shows the electrical power [kW] in function of the horizontal wind speed at hub height W_s [m/s] for different air densities [kg/m³].

P [kW]	Density [kg/m ³]												
W_s [m/s]	1.225	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.18	1.21	1.24	1.27
3	32	21	22	23	24	26	27	28	29	30	31	32	33
4	146	104	109	113	118	122	126	131	135	140	144	148	153
5	342	254	263	273	282	291	300	309	319	328	337	346	355
6	621	469	485	501	517	533	549	565	581	597	613	629	645
7	1008	764	790	815	841	866	892	918	943	969	995	1021	1046
8	1486	1159	1196	1233	1270	1305	1340	1374	1408	1440	1471	1501	1530
9	1836	1590	1626	1659	1689	1718	1744	1768	1789	1810	1828	1844	1859
10	1965	1867	1885	1900	1914	1925	1935	1944	1951	1957	1963	1968	1972
11	1994	1969	1974	1979	1982	1985	1987	1990	1991	1993	1994	1995	1996
12	1999	1994	1995	1996	1997	1997	1998	1998	1999	1999	1999	1999	1999
13	2000	1999	1999	1999	1999	2000	2000	2000	2000	2000	2000	2000	2000
14	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
15	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
16	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
18	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
20	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22	1906	1906	1906	1906	1906	1906	1906	1906	1906	1906	1906	1906	1906
23	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681	1681
24	1455	1455	1455	1455	1455	1455	1455	1455	1455	1455	1455	1455	1455
25	1230	1230	1230	1230	1230	1230	1230	1230	1230	1230	1230	1230	1230

Table 3 Electric power [KW] of the G114 IIIA 2.0MW wind turbine calculated in function of wind speed at hub height W_s [m/s], for different air densities [kg/m³]. (ref: 20120606G114AERPC)

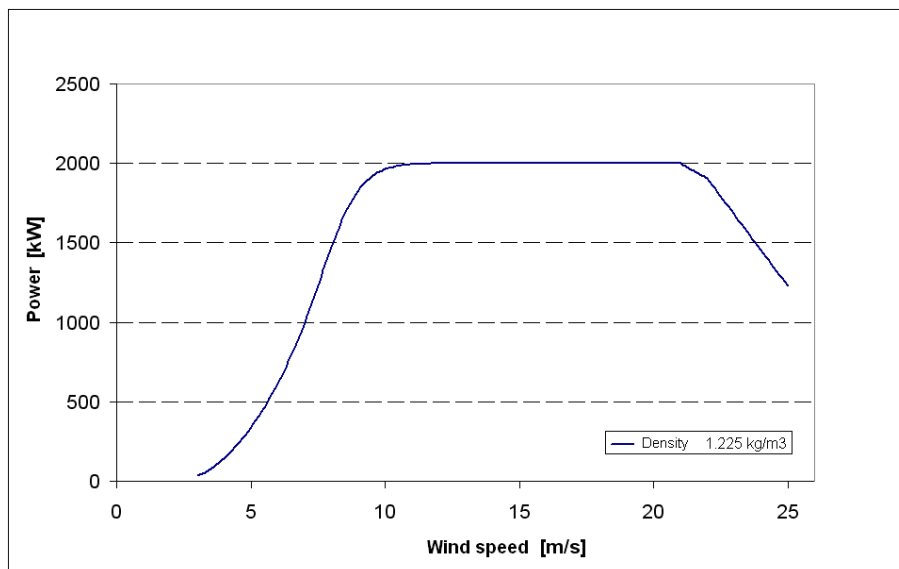
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Figure 1 Power curve of the G114 IIIA 2.0MW wind turbine for an air density equal to 1.225 [kg/ m³].
(ref: 20120606G114AERPC)

5.2 ANNUAL ENERGY PRODUCTION

Table 4 shows the annual output [MWh] for the G114 IIIA 2.0MW wind turbine for different Weibull K-distribution parameter values and annual average wind speeds W_{ave} [m/s]. The values are calculated for 1.225 kg/m³ standard density and 10% turbulence intensity.

P [MWh]		W_{ave} [m/s]				
		5.5	6	6.5	7	7.5
Weibull K	1.5	5756	6520	7219	7848	8406
	2	5769	6751	7667	8507	9269
	2.5	5618	6767	7854	8856	9763

Table 4: Annual energy production [MWh] of the WT G114 IIIA 2.0MW calculated in function of W_{ave} [m/s].
(ref: 20120606G114AERPC)


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5.3 CP AND CT CURVES

Table 5 shows the C_P and C_T values for the G114 IIIA 2.0MW wind turbine.

W_s [m/s]	C_P	C_T
3	0.187	0.934
4	0.366	0.861
5	0.437	0.834
6	0.460	0.824
7	0.470	0.822
8	0.464	0.778
9	0.403	0.621
10	0.314	0.444
11	0.240	0.320
12	0.185	0.240
13	0.146	0.187
14	0.117	0.149
15	0.095	0.122
16	0.078	0.101
17	0.065	0.086
18	0.055	0.073
19	0.047	0.064
20	0.040	0.057
21	0.035	0.048
22	0.029	0.041
23	0.022	0.033
24	0.017	0.028
25	0.013	0.023

Table 5: C_P and C_T values for the G114 IIIA 2.0MW wind turbine.
(ref: 20120606G114AERPC)

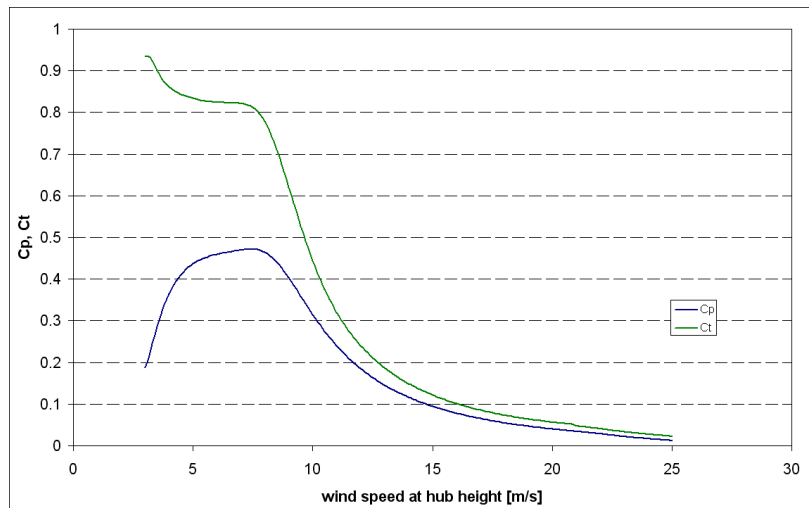


Figure 2 C_P and C_T curves of the G114 IIIA 2.0MW wind turbine.

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5.4 NOISE LEVELS

Estimate of aeroacoustic noise emitted by the rotor of the G114 IIIA 2.0MW wind turbine, simulated for different tower heights (H) and wind speeds at 10m above ground level (W_{10}).

Table 6 includes the numerical values for the estimated L_w noise level in dB(A) for the different wind speeds, from the start-up speed, 3m/s.

	H = 80m		H = 93m		H = 125m	
W_{10}	W_s	SPL	W_s	SPL	W_s	SPL
[m/s]	[m/s]	[dB(A)]	[m/s]	[dB(A)]	[m/s]	[dB(A)]
3	4.2	95.8	4.3	95.8	4.5	95.8
3.5	4.9	95.8	5	95.8	5.2	95.8
4	5.6	96.3	5.7	96.8	6.0	98.0
4.5	6.3	99.0	6.4	99.5	6.7	100.6
5	7.0	101.4	7.1	101.9	7.5	103.0
5.5	7.7	103.6	7.9	104.1	8.2	105.2
6	8.4	105.6	8.6	106.0	9.0	106.0
6.5	9.1	106.0	9.3	106.0	9.7	106.0
7	9.8	106.0	10	106.0	10.5	106.0
7.5	10.5	106.0	10.7	106.0	11.2	106.0
8	11.2	106.0	11.4	106.0	12.0	106.0
8.5	11.9	106.0	12.1	106.0	12.7	106.0
9	12.6	106.0	12.9	106.0	13.5	106.0
9.5	13.2	106.0	13.6	106.0	14.2	106.0
10	13.9	106.0	14.3	106.0	15.0	106.0

Table 6: Noise levels of the G114 IIIA 2.0MW wind turbine for different H [m], W_{10} [m/s] and W_s [m/s].
(ref: 20140227G114AERPCNLEV)