

Lely Aircon LA30 Wind turbine



Summary Details for Performance, Duration and
Acoustic Measurements

Lely Aircon 30 Wind Turbine UK MCS Certification Summary



www.lely.com

Lely Industries N.V.

innovators in agriculture

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

List of contents

1. List of included Amendments 3

2. Introduction 4

3. General information 5

4. Tested turbine configuration 6

5. Power Curve 8

6. Annual Energy Production 10

7. Noise Immission 11

8. Duration Test 12

9. Reference Reports 14


List of tables

- Table 1 - Power performance results at sea Level air density, 1.225 kg/m³ (1/2)
- Table 2 - Power performance results at sea Level air density, 1.225 kg/m³ (2/2)
- Table 3 - Reference Annual Energy
- Table 4 - Estimated annual energy production
- Table 5 - Conditions of the wind turbine during duration test
- Table 6 - Results of the duration test

List of figures

- Figure 1 - Tested wind turbine in 26810 Ihrhove, Germany
- Figure 2 - Power curve with combined standard uncertainty
- Figure 3 - Acoustic noise levels
- Figure 4 - Monthly comparison of power production

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 2
				21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

1. List of included Amendments

2015-04-17

- Initial release (11 pages)
- Author: Oliver Hahn Lely Aircon B.V. (Technical Service and Support)

Revision	Author	Number of pages	Date
Rev. 1	Oliver Hahn	11	05.10.15
Rev. 2	Oliver Hahn	14	26.11.15
Rev. 3	Oliver Hahn	15	21.01.16

- Name of authorization (created, approved and released)
For all documents applicable
oh: Oliver Hahn
gr: Gerriet Janssen
rh: Rene Hackmann
vr: Willibald de Vries
br: Kai-Uwe Broek

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 3
				21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

2. Introduction


This document summarizes the results of UK MCS product certification conducted on a Lely Aircon 30 wind turbine.

The tests, which are summarized in this report, are:

- the *Duration Test* carried out by Ingenieurbüro Dr. Ing. Dieter Frey
- the *Power and Performance Test* carried out by Ingenieurbüro Dr. Ing. Dieter Frey
- and the *Report of Acoustical Emissions* carried out by GL Garrad Hassan Deutschland GmbH

(Detailed information to the Report numbers and the entities involved, can be found in chapter 9: Reference Reports)

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.leylaircon.com
	oh	rh	br	Page 4
				21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

3. General information

The list below gives an overview over the general turbine specifications of the Lely Aircon LA30.

- Manufacturer: Lely Aircon B.V.
- Model: LA30
- Reference power: 27,2 kW at 11 m/s
- Rated power: 29,8 kW at 12 m/s
- Maximum output power: 34,2 kW at 16 m/s
- Rotor diameter: 13,12m
- Swept area: 135,1m²
- Switching on wind speed: 3,5 m/s
- Nominal wind speed: 12 m/s
- Switching off wind speed: 25 m/s (10 min average), Peak: 32 m/s
- Survival wind speed: 59,5 m/s
- Rotor rotations per minute: 35-68rpm
- Quantity of rotor blades: 3
- Up/downwind turbine: Upwind
- Design: HAWT
- Tower top weight: 2544kg
- Direction of rotation: clockwise
- Designed durability: 20years
- Small wind turbine class: IEC II A
- Remote control: via GSM or Internet
- Maximum output voltage: 400 VAC/50 Hz
- Maximum output current: 50A per phase
- Declared sound power level at 8m/s: 94,5dB (Report No. GLGH-4286 14 12454 293-A-0004-A)
- Rotor speed regulation: Active stall, controller aided overload regulation
- Brake systems: Hydraulic disc brake, generator overload regulation, and tip-brake system
- Wind tracking: Active controller aided wind tracking
- Supervision: Micro controller
- Generator: Permanent excited synchronous machine
- Operating temperature range: -20°C to +50°C

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 5
				21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

4. Tested turbine configuration

This chapter shows the turbine configuration as verified by the test organization in the duration test:

Model name: LA30

Serial number: LA30A001

Support structure: Lattice tower

Hub height: 26,5m

General description of main components:

- Rotor speed regulation: Active stall, controller aided overload regulation
- Brake systems: Hydraulic disc brake, generator overload regulation, and tip-brake system
- Wind tracking: Active controller aided wind tracking
- Supervision: Micro controller
- Generator: Permanent excited synchronous machine

Rotor diameter (m): 13,12m

Swept area (m²): 135,1m²

Number of blades: 3

Upwind or downwind rotor: Upwind

Design: HAWT

Direction of rotation: clockwise

Cut-in wind speed (m/s): 3,5m/s


Cut-out wind speed (m/s): 25m/s (10 min average) Peak 32 m/s

Observed max. 3 s gust during duration test (m/s): 27,48m/s

Power form: effective power of 29,8kW (400V~, 3 phases)

Observed ambient temperature range during duration test (°C): -4°C to +28°C

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 6
				21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				


Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

The picture below shows the tested turbine with the serial number LA30A001 in 26810 Ihrhove, Germany.



Figure 1: Tested wind turbine in 26810 Ihrhove, Germany

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 7
				21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

5. Power Curve

Table 1, 2 and Figure 2 are presenting the measured power curve of the Lely Aircon 30. The tables and figures presented are the outcome of the power and performance testing carried out by Ingenieurbüro Dr. Ing. Dieter Frey.

POWER CURVE MEASUREMENT DATA					MEASUREMENT UNCERTAINTY		
bin	wind speed	No. of bins	electrical power	power coefficient	Cat. A	Cat. B	Cat. A_B
i	V_{Wind} [m/s]	N	P_{el} [kW]	C_p	Std. Dev. [kW]	Std. Dev. [kW]	Std. Dev. [kW]
1	1,52	71	-0,263	-0,8633	0,025	0,055	0,061
2	2,00	91	-0,385	-0,5614	0,027	0,056	0,062
3	2,56	169	-0,541	-0,3752	0,013	0,053	0,055
4	3,02	332	-0,327	-0,1378	0,010	0,078	0,079
5	3,53	449	0,113	0,0299	0,014	0,115	0,116
6	4,00	545	0,732	0,1325	0,018	0,165	0,165
7	4,50	430	1,560	0,1982	0,026	0,247	0,249
8	4,99	500	2,821	0,2624	0,029	0,361	0,362
9	5,51	537	4,441	0,3074	0,040	0,430	0,432
10	6,00	586	5,976	0,3203	0,043	0,513	0,515
11	6,50	506	7,880	0,3321	0,060	0,673	0,676
12	6,99	473	10,190	0,3452	0,073	0,773	0,776
13	7,49	403	12,390	0,3418	0,097	0,824	0,830
14	8,01	383	14,840	0,3345	0,117	0,989	0,996
15	8,50	358	17,640	0,3320	0,130	1,041	1,049
16	9,01	417	19,960	0,3163	0,126	1,020	1,028
17	9,50	349	22,360	0,3021	0,121	0,978	0,985
18	10,00	274	24,240	0,2807	0,135	0,881	0,891
19	10,49	236	26,010	0,2607	0,147	0,762	0,776
20	10,99	155	27,210	0,2373	0,180	0,736	0,758
21	11,49	116	28,770	0,2195	0,177	0,670	0,693
22	12,00	121	29,620	0,1983	0,174	0,500	0,529
23	12,48	97	30,360	0,1807	0,189	0,485	0,521
24	12,96	107	31,040	0,1651	0,177	0,506	0,536
25	13,51	113	31,900	0,1498	0,184	0,375	0,417
26	13,97	100	31,990	0,1357	0,143	0,396	0,421
27	14,50	85	32,880	0,1249	0,141	0,451	0,473
28	14,99	80	33,140	0,1138	0,157	0,434	0,462
29	15,51	73	33,930	0,1053	0,170	0,464	0,494
30	15,99	80	34,230	0,0970	0,129	0,263	0,293
31	16,47	64	34,150	0,0885	0,156	0,282	0,322
32	16,95	45	33,900	0,0805	0,205	0,247	0,321
33	17,51	42	34,110	0,0736	0,193	0,289	0,348
34	17,96	20	33,530	0,0670	0,398	0,628	0,744
35	18,54	15	32,670	0,0594	0,306	0,679	0,745
36	18,96	9	32,920	0,0559	0,000	0,000	0,000
37	19,40	8	31,720	0,0503	0,000	0,000	0,000
38	20,23	3	31,340	0,0438	0,000	0,000	0,000

the table continues on next page

Table 1 Power performance results at sea Level air density, 1.225 kg/m³ (1/2)

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 8 21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

POWER CURVE MEASUREMENT DATA					MEASUREMENT UNCERTAINTY		
bin	wind speed	No. of bins	electrical power	power coefficient	Cat. A	Cat. B	Cat. A_B
i	V_{Wind} [m/s]	N	P_{el} [kW]	C_p	Std. Dev. [kW]	Std. Dev. [kW]	Std. Dev. [kW]
39	20,50	2	28,630	0,0385	0,000	0,000	0,000
40	21,00	0	0,000	0,0000	0,000	0,000	0,000
41	21,72	1	24,910	0,0282	0,000	0,000	0,000
42	22,00	0	0,000	0,0000	0,000	0,000	0,000
43	22,50	0	0,000	0,0000	0,000	0,000	0,000
44	23,00	0	0,000	0,0000	0,000	0,000	0,000
45	23,50	0	0,000	0,0000	0,000	0,000	0,000
46	24,00	0	0,000	0,0000	0,000	0,000	0,000
47	24,50	0	0,000	0,0000	0,000	0,000	0,000
number of bins = 8445							

Table 2 Power performance results at sea Level air density, 1.225 kg/m³

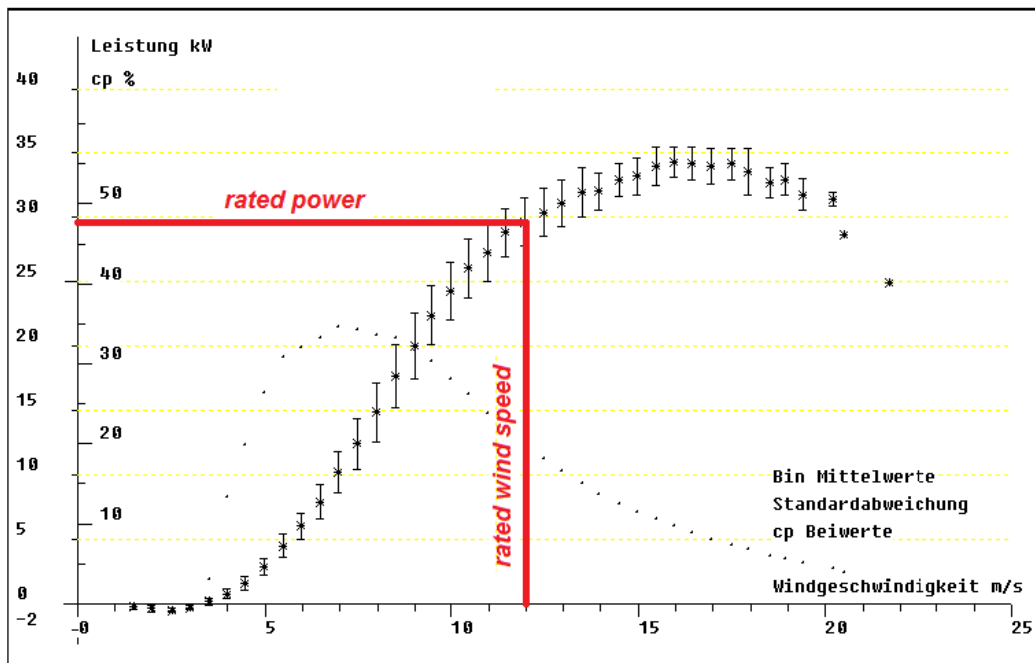


Figure 2 – Power curve with combined standard uncertainty

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

6. Annual Energy Production

Table 3 gives the Reference Annual Energy for the Lely Aircon 30. Table 4 shows the AEP estimations for hub height integer annual average wind speeds from 3m/s, up to the maximum wind speed for the turbine class IEC IIA at sea level air density. The tables presented are the outcome of the power and performance testing carried out by Ingenieurbüro Dr. Ing. Dieter Frey.

Reference Annual Energy@5m/s	48847[kWh]
------------------------------	------------

Table 3 – Reference Annual Energy

Estimated Annual Energy Production Reference Air Density: 1.225kg/m ³ Cut Out Wind Speed: No cut out wind speed but extrapolation taken up to 25m/s						
Wind- Rayleigh distribution	extrapolated			measured		
	Annual production	Uncertainty of the measure (standard deviation)		Annual production	Uncertainty of the measure (standard deviation)	
[m/s]	[kWh]	[kWh]	%	[kWh]	[kWh]	%
3	6958	1417	20,4	6958	1417	20,4
4	24502	2555	10,4	24502	2555	10,4
5	48847	3590	7,3	48842	3589	7,3
6	75877	4295	5,7	75719	4292	5,7
7	102396	4691	4,6	101247	4667	4,6
8	126540	4882	3,9	122450	4797	3,9
9	147302	4957	3,4	137738	4758	3,5
10	164120	4968	3,0	146964	4612	3,1

Table 4 – Estimated annual energy production

Annual Energy Production from 3m/s to 8 m/s is complete (AEP measured is at least 95 % of AEP extrapolated)

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 10
				21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

7. Noise Immission

The noise immission map for the Lely Aircon 30 is presented in Figure 3 below. The plot shows sound pressure levels which are calculated from a declared apparent sound power level for a range of wind speeds and distances to the center of the wind turbine rotor. The figure presented in this chapter is the outcome of the Report of acoustical emissions carried out by GL Garrad Hassan Deutschland GmbH.

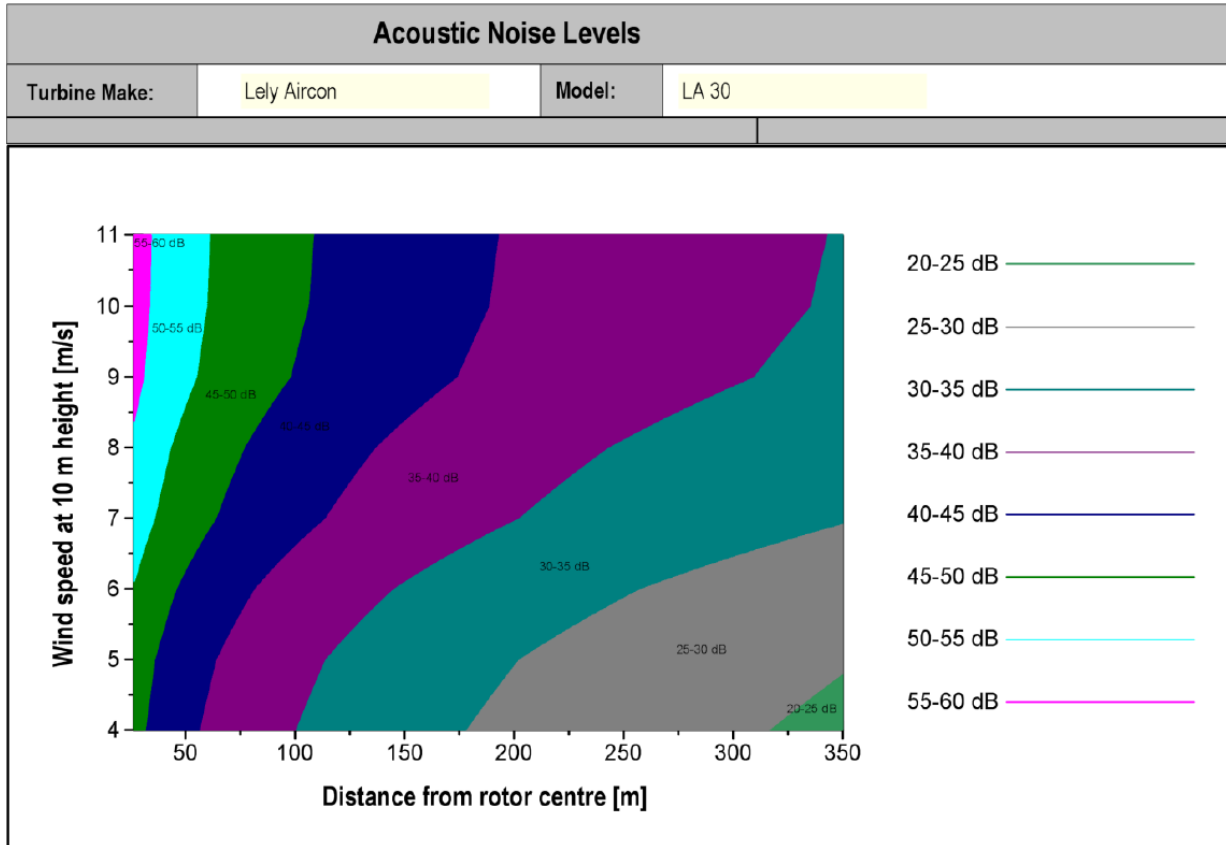



Figure 3 Acoustic noise levels

The measured and declared sound power level at a wind speed of 8m/s is: 94,5dB

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 11
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number : SR02	Summary report Lely Aircon 30	
Rev.: 3		

8. Duration Test

This chapter summarizes the results of the duration test. All the requirements were successfully achieved. The turbine was tested according to the requirements of the IEC 61400-2 Ed.3 turbine class IEC IIA. The tables and figures presented in this chapter are the outcome of the duration test carried out by Ingenieurbüro Dr. Ing. Dieter Frey.

Test data:

Start date/time: 15/04/2014
 End date/time: 01/04/2015
 Mean hub height wind speed: 6.24m/s
 Average turbulence intensity at 15m/s: 10.42%
 Highest instantaneous wind speed: 27.48m/s
 Maximum 1-minute average value: 21.72m/s
 Wind from direction 278°..305° northbound; temperature > 2°

At begin of the period of the duration test is a period of unusual low wind speed from the measurement sector. Therefore the period for determining the power production degradation is between 01/10/2014 and 01/04/2015.

Table 5 shows the conditions of the wind turbine during the duration test. It also presents the availability of the Lely Aircon 30 within the duration test, which is in figures 99,8%. Table 6 is showing the operation hours at different wind speeds.

month	working hours				
	total time [h]	stand still [h]	unknown [h]	excluded [h]	operational time fraction [%]
	T _T	T _N	T _U	T _E	O
Oct. 2014	744	0	0	0	100,0
Nov. 2014	720	8,68	0	0	98,8
Dec. 2014	744	1,22	0	0	99,8
Jan. 2015	744	0,30	10,27	0	100,0
Feb. 2015	672	0	27	0	100,0
March 2015	744	0,02	15	0	100,0
total	4368	10	53	0	99,8

Table 5 – Conditions of the wind turbine during duration test

Month	Number of recorded BINS					max gust	I ₁₅
	> 1,2 * V _{AVE}	> 1,8 * V _{AVE}	> 2,5 * V _{AVE}				
	> 3,5 m/s	> 10,2 m/s	> 15,3 m/s	> 21,3 m/s	> 15,0 m/s	[m/s]	[%]
Oct. 2014	30440	868	21	0	39	18,43	9,44
Nov. 2014	30131	56	0	0	0	12,79	0
Dec. 2014	36971	6418	323	0	488	19,01	11,13
Jan. 2015	36544	6698	920	6	1182	24,81	11,29
Feb. 2015	30446	565	0	0	1	13,27	9,21
March 2015	33203	3874	476	123	481	27,48	10,2
Total	197735	18479	1740	129	2191	27,48	10,32
Total [h]	3296	308	29	2	37		

Table 6 – Results of the duration test

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 12 21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Figure 4 shows the potential power degradation within the measured period.

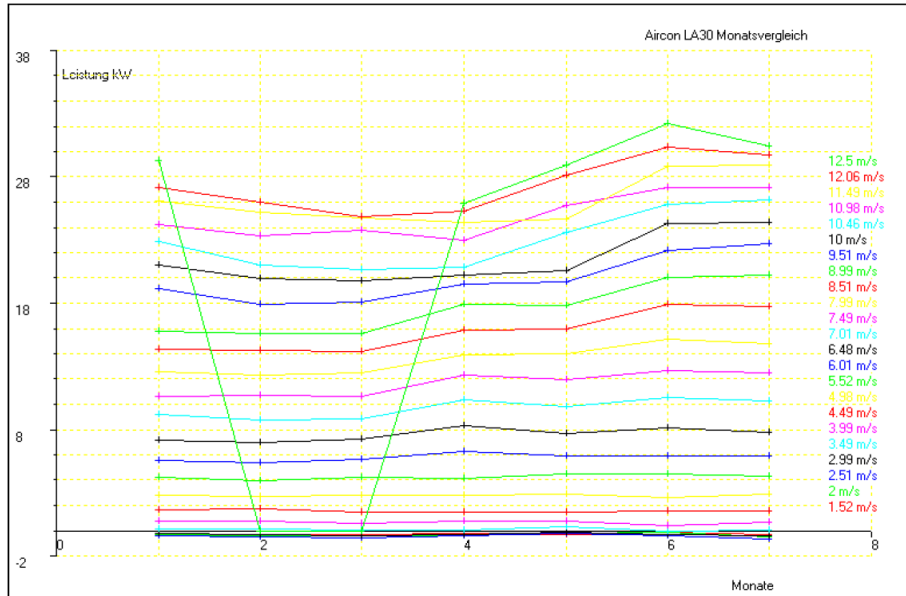


Figure 4 - monthly comparison of power production

Dynamic behavior according to the IEC 61400-2 Chapter 13.4.3 (13.4.4)

To determine the dynamic behavior of the wind turbine, an assessment during strong winds was performed in Dec. 2014. The results of the assessment are shown in the following:

Examination of the wind turbine after eight months of operation, on 20/12/2014

- High winds with 5 m/s to 20 m/s wind-speed in 1-min-average at ca. 8°C - 10°C, rain, wind direction west.
- The wind turbine works calm and stable in temporary stall mode.
- The rotor blades make a quiet hissing noise. The stall mode can be heard clearly.
- Down tower in the lattice strive are light vibrations, with no boundary to the rotor speed.
- In high gusts the tower oscillates in some of its intrinsically frequencies.
- The tower top makes no side or leeward movements in gusts. The tower looks stiff in stormy conditions.
- The nacelle executes no yaw movements with rotational speed of the rotor.
- The turbine follows precise the movements of the wind direction.
- There is no noise from machinery parts.

During the assessment the turbine shows no remarkable behavior.

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 13 21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number :	Summary report Lely Aircon 30	
SR02		
Rev.: 3		

9. Reference Reports

1.) *Power and Performance Test: Tested in Ihrhove/Germany; Report no.: 07x02x2014, Rev. 1, Date: 14/11/2015; Engineering Office Dr.-Ing. Frey*

“The setup and analysis of the measurement are made according to the following guidelines:

- IEC 61400-12-1, First Edition 2005-12
- MCS 006 Issue 2.1 (2014):
- IEC 61400-2 Edition 3.0
- RenewableUK (2014)”

Ingenieurbüro Dr. Ing. Dieter Frey is an accredited company according to the DIN EN ISO/IEC 17025:2005 under number D-PL-11315-01-00

2.) *Duration Test: Tested in Ihrhove/Germany; Report no.: 09x04x2015; Date: 19/11/2015, Rev. 2, Engineering Office Dr.-Ing. Frey*

“The Duration Test is carried out according to the following guidelines:

- IEC 61400-2
- IEC 61400-12-1
- MCS 006 Issue 2.1 (2014)
- MCS 010 Issue 1.5 (2009)
- RenewableUK (2014)”

Ingenieurbüro Dr. Ing. Dieter Frey is an accredited company according to the DIN EN ISO/IEC 17025:2005 under number D-PL-11315-01-00

3.) *Tests to verify design data: Tested in Ihrhove/Germany; Report no.: 11x11x2015, Rev. 0, Date: 14/11/2015; Engineering Office Dr.-Ing. Frey*

“The setup and analysis of the measurement are made according to the following guidelines:

- IEC 61400-12-1, First Edition 2005-12
- MCS 006 Issue 2.1 (2014):
- IEC 61400-2 Edition 3.0
- RenewableUK (2014)”

Ingenieurbüro Dr. Ing. Dieter Frey is an accredited company according to the DIN EN ISO/IEC 17025:2005 under number D-PL-11315-01-00

4.) *Report of acoustical emissions: Tested in Ihrhove/Germany; Report no.: GLGH-4286 14 12454 293-A-0004-A; Date: 17/11/2015; GL Garrad Hassan Deutschland GmbH*

The measurements of the acoustical emissions are performed in accordance with the legacy GL GH management system procedure /2/. This test procedure is integral part of the management system of DNV GL.

All measurements and analysis described in this report were done in accordance with /2/ in combination with IEC 61400: Wind turbines – Part 11: Acoustic noise measurement techniques, Ed.

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 14 21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				

Document number :	Summary report Lely Aircon 30	
SR02		
Rev.: 3		

3 (/1/), as well as the MCS 006 standard /4/, the RenewableUK Small wind turbine standard /5/ and ISO 1996-2 /7/. In this report the sound power level and the tonality are given in the range of wind speeds from 2 m/s to 12 m/s at hub height. Additionally a declared sound power level for 8 m/s is given according to IEC 61400-2 /8/ and IEC TS 61400-14 /6/.

GL Garrad Hassan Deutschland GmbH is an accredited company according to the DIN EN ISO/IEC 17025:2005 under number D-PL-11134-01-00

5.) *Report of safety and function test: Tested in Ihrhove/Germany; Report no.: GLGH-4285 14 12455 258-R-0001-D; Date: 23/11/2015; GL Garrad Hassan Deutschland GmbH*

All measurements and analysis described in this report were done in accordance with /2/ in combination with IEC 61400: Wind turbines – Chapter 9.6: Safety and function, Ed. 3 , as well as the MCS 006 standard, the RenewableUK Small wind turbine standard.

GL Garrad Hassan Deutschland GmbH is an accredited company according to the DIN EN ISO/IEC 17025:2005 under number D-PL-11134-01-00

6.) *Report of power quality characteristics measurement: Tested in Ihrhove/Germany and Arnheim, Netherlands; Report no.: GLGH-4280 14 12626 294-A-0001-A; Date: 11/02/2015; GL Garrad Hassan Deutschland GmbH*

All measurements and analysis described in this report were done in accordance to the grid code VDE-AR-N 4105 /2/. The guideline which describes the needed measurements was the DIN VDE V 0124-100:2012-07 /1/.

GL Garrad Hassan Deutschland GmbH is an accredited company according to the DIN EN ISO/IEC 17025:2005 under number D-PL-11134-01-00

7.) *Report of Rotorblade testing: Tested in Odder, Denmark; Report no.: 2333064-1-e; Date: 14/04/2015; TÜV Süd Industrie Service GmbH*

All measurements and analysis described in this report were done in accordance to 61400-2:2013 in combination with 61400-22:2010.

TÜV Süd Industrie Service GmbH is an accredited company according to the DIN EN ISO/IEC 17025:2005 under number D-ZE-14153-01-02.

Lely Aircon B.V Am Emsdeich 7 26789 Leer	created	approved	released	www.lelyaircon.com
	oh	rh	br	Page 15
				21.01.2016
Pfad: L:\Technische Daten\Zertifikate\Zertifizierung 30 kW\TuvNel\Summary Report				