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(ISO 9001:2008)

TEST SUMMARY REPORT

Manufacturer

Wish Energy Solutions Pvt. Ltd. (formerly
Luminous Renewable Energy Pvt. Ltd.
and UD Energy Systems Pvt. Ltd.)

Wind Turbine

Luminous Whisper 500, Off- grid, 48 V DC

Test Report Number

PT12-PP-34, March 2015

PT12-DT-36, March 2015

PT12-SFT-35, March 2015

1. Introduction: The report summarises the Power Performance measurement, Duration Test and Safety & Function test carried out on Luminous Whisper 500, in accordance with the international standard of IEC 61400-12-1 for “Power Performance Measurements of electricity producing wind turbines” and IEC 61400-2 for “Design Requirements for Small Wind Turbine”. The Luminous Whisper 500 is a two bladed, upwind variable speed turbine. The rotor swept area of the turbine is 15.89 m². The turbine was tested in the battery charger configuration with a charge controller voltage of 48 V DC. The measurements were carried out at Wind Turbine Research Station, Kayathar during the period January 07, 2014 to January 30, 2015.

2. TURBINE RATING BASED ON TEST MEASUREMENT:

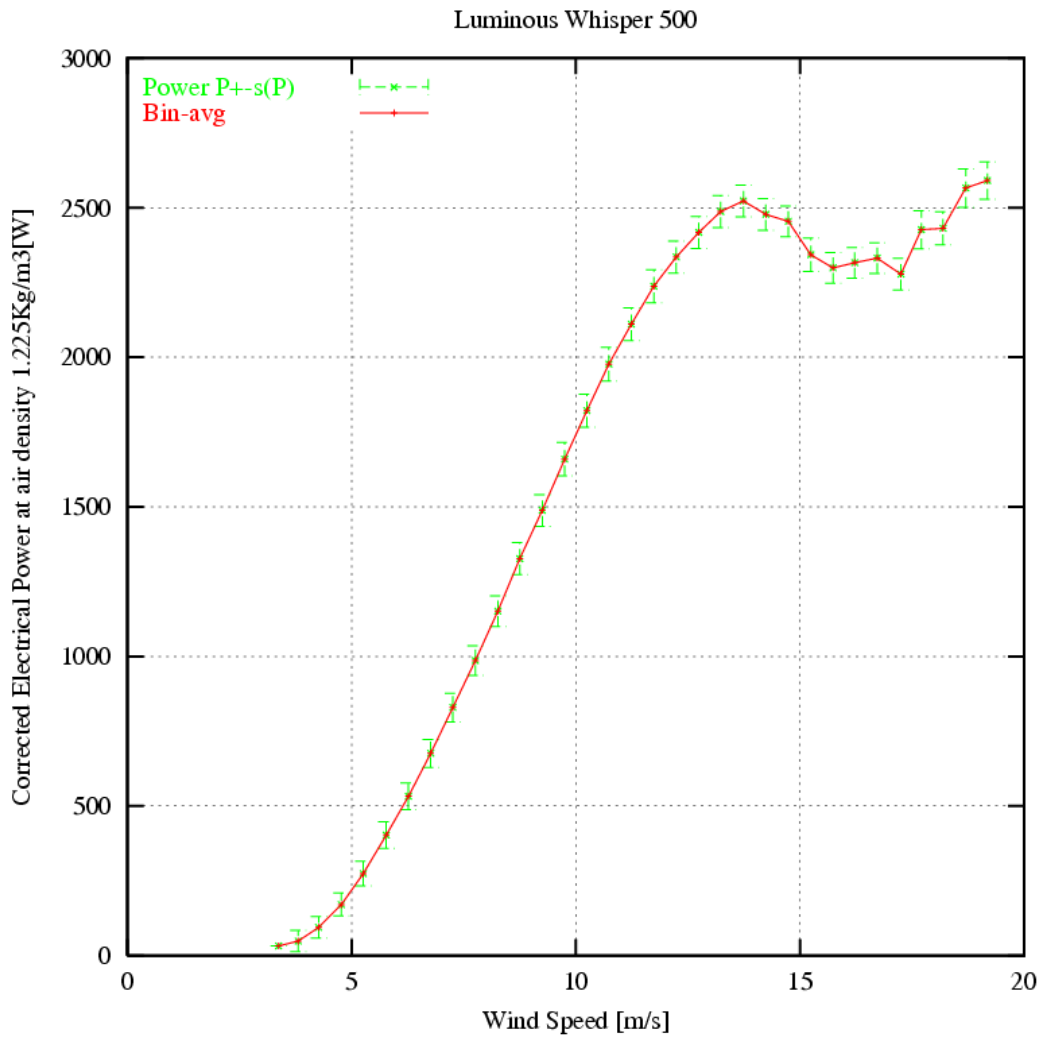
Reference Annual Energy	3673 kWh @ Annual average wind speed 5 m/s
Reference Power	2000 W @ 11 m/s
Peak Power	2600 W @ 19.2 m/s

3. Annual Energy Production (At Sea Level Air Density 1.225 kg/ m³)

Mean Wind Speed (m/s)	AEP Measured (kWh)			AEP Extrapolated (kWh)		
	AEP	Std. Dev	%	AEP	Std. Dev	%
4	1922	211	10.98	1922	211	10.98
5	3673	272	7.41	3673	272	7.41
6	5641	317	5.62	5648	317	5.61
7	7542	348	4.61	7604	349	4.59
8	9155	367	4.01	9392	372	3.96
9	10352	376	3.63	10939	388	3.55
10*	11110	376	3.38	12203	398	3.26
11*	11475	369	3.22	13164	404	3.07

* In-complete as per IEC 61400-12-1 (As per IEC 61400-12-1, estimations of AEP –measured shall be labelled as “incomplete” when calculations show that the AEP-measured is less than 95 % of the AEP- extrapolated.)

4. Power Curve with combined uncertainty (data corrected for standard dry air density of 1.225 kg/m³)



5. Power Curve with Uncertainty Budget

A: Bin no. []

B: Wind speed [m/s]

C: Electrical power, adjusted for density variations [W]

D: Slope of power curve $\Delta P/\Delta v$ [W/(m/s)]

E: $\Delta P/\Delta t$ [W/(degK)]

F: $\Delta P/\Delta B$ [W/(mBar)]

G: Cp []

H: Category A uncertainty [W]

I: Category B uncertainty [W]

J: Total uncertainty [W]

K: Counts []

A	B	C	D	E	F	G	H	I	J	K
1	3.37	32.0	52.23	0.11	0.03	0.09	0.0	0.0	0.0	27
2	3.81	48.6	37.88	0.17	0.05	0.09	3.0	35.3	35.4	310
3	4.26	94.1	100.27	0.33	0.09	0.12	2.4	36.5	36.6	674
4	4.77	170.4	150.82	0.59	0.17	0.16	2.6	38.3	38.4	992
5	5.26	274.0	209.30	0.95	0.27	0.19	2.9	41.1	41.2	1219
6	5.77	402.5	253.34	1.40	0.40	0.22	3.2	43.7	43.8	1581
7	6.27	532.2	260.78	1.85	0.53	0.22	3.4	44.5	44.6	2082
8	6.76	675.4	290.63	2.35	0.67	0.22	3.4	46.7	46.8	2850
9	7.26	829.1	305.20	2.88	0.82	0.22	3.5	48.2	48.3	3681
10	7.76	986.2	314.82	3.42	0.97	0.22	3.5	49.4	49.6	4659
11	8.26	1151.2	332.71	4.00	1.14	0.21	3.6	51.4	51.5	5461
12	8.75	1326.5	352.57	4.61	1.31	0.20	3.7	53.6	53.8	6100
13	9.25	1487.5	323.23	5.16	1.47	0.19	4.0	52.7	52.9	6124
14	9.75	1659.3	347.15	5.76	1.64	0.18	4.2	55.4	55.5	5976
15	10.25	1821.1	324.48	6.32	1.80	0.17	4.6	55.1	55.3	5182
16	10.74	1977.0	316.41	6.86	1.95	0.16	4.8	55.9	56.1	4371
17	11.24	2109.8	264.18	7.33	2.08	0.15	5.2	54.3	54.5	3360
18	11.74	2236.8	256.54	7.77	2.21	0.14	5.5	55.0	55.3	2538
19	12.24	2334.8	195.28	8.11	2.30	0.13	5.5	53.4	53.7	1972
20	12.74	2417.0	165.21	8.39	2.39	0.12	6.1	53.3	53.6	1354
21	13.23	2487.0	142.34	8.64	2.46	0.11	6.6	53.3	53.7	977
22	13.74	2521.9	68.11	8.76	2.49	0.10	6.8	52.2	52.7	746
23	14.24	2477.3	-88.53	8.60	2.45	0.09	8.1	52.0	52.7	545
24	14.74	2453.8	-47.14	8.52	2.42	0.08	9.5	51.2	52.1	412
25	15.24	2342.2	-221.84	8.13	2.31	0.07	11.3	54.5	55.7	335
26	15.74	2298.6	-87.72	7.98	2.27	0.06	10.9	50.1	51.3	312
27	16.22	2315.3	34.50	8.04	2.29	0.06	13.6	49.7	51.5	182
28	16.72	2330.9	31.45	8.09	2.30	0.05	13.7	49.8	51.6	126
29	17.25	2277.7	-100.84	7.91	2.25	0.05	16.7	50.2	52.9	83
30	17.71	2426.1	322.04	8.42	2.40	0.04	20.5	60.1	63.5	56
31	18.19	2430.4	8.85	8.44	2.40	0.04	22.0	50.8	55.4	30
32	18.70	2565.0	260.17	8.91	2.53	0.04	26.5	58.4	64.1	17
33	19.18	2590.1	52.23	8.99	2.56	0.04	33.5	52.8	62.6	11

6. Duration Testing: The turbine has successfully completed the duration test for an IEC Class III turbine during the test period. An operational time fraction of 99.17 % was achieved. The average turbulence intensity recorded at 15 m/s during the test period was 10.3%. The maximum instantaneous wind speed recorded was 19.68 m/s on 12th July 2014.

7. Safety & Function Testing: The turbine successfully completed the tests for Loss of Load and Emergency Stop under normal operation. The turbine performance with respect to power & speed control, over speed protection, battery overvoltage protection and yaw system control were observed to be within manufacturer specified limits.

8. Manufacturer supplied Turbine Specification

General Configuration	Make, Model	Wish Energy Solutions Pvt. Ltd. (formerly Luminous Renewable Energy Solutions Pvt. Ltd.) Luminous Whisper 500
	Rotation Axis	Horizontal
	Orientation	Upwind
	Number of blades	2
	Rotor diameter (m)	4.5
	Hub height (m)	18
Performance	Rated Electrical Power (W)	3200
	Rated wind speed (m/s)	12
	Start-up wind speed (m/s)	3.1
	Cut-in wind speed(m/s)	3.5
	Furling wind speed (m/s)	14
Rotor	Swept area (m ²)	15.9
	Rotational Speed (rpm)	800
	Blade pitch	Fixed
	Direction of rotation	Clockwise
	Over-speed control	Side Furling

Yaw System	Wind Direction Sensor	Furling tail
	Yaw control method	Free yaw
Tower	Type	Tubular pole with guy support
	Height (m)	18
Battery Charger	Model	Luminous Whisper 500
	Manufacturer	Wish Energy Solutions Pvt. Ltd. (formerly Luminous Renewable Energy Solutions Pvt. Ltd.)
	Nominal Battery Voltage (V) DC	48
	Maximum output power (W)	3200
	Maximum Output Current (A)	54