TEST SUMMARY REPORT

Manufacturer	**Wish Energy Solutions Pvt. Ltd. (formerly Luminous Renewable Energy Pvt. Ltd. and UD Energy Systems Pvt. Ltd.)**
Wind Turbine	**Whisper 200, Off- grid, 48 V DC**
Test Report Number	**PT1-PP-01, December 2009** **PT1-SFT-02, December 2009** **PT1-DT-03, April 2010**

1. **Introduction:** The report summarises the Power Performance measurement, Duration Test and Safety & Function test carried out on Whisper 200, 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 Whisper 200 is a three bladed, upwind variable speed turbine. The rotor swept area of the turbine is 5.8 m^2. 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 Test Station, Kayathar during the period June 5, 2008 to October 16, 2009.

2. **TURBINE RATING BASED ON TEST MEASUREMENT:**

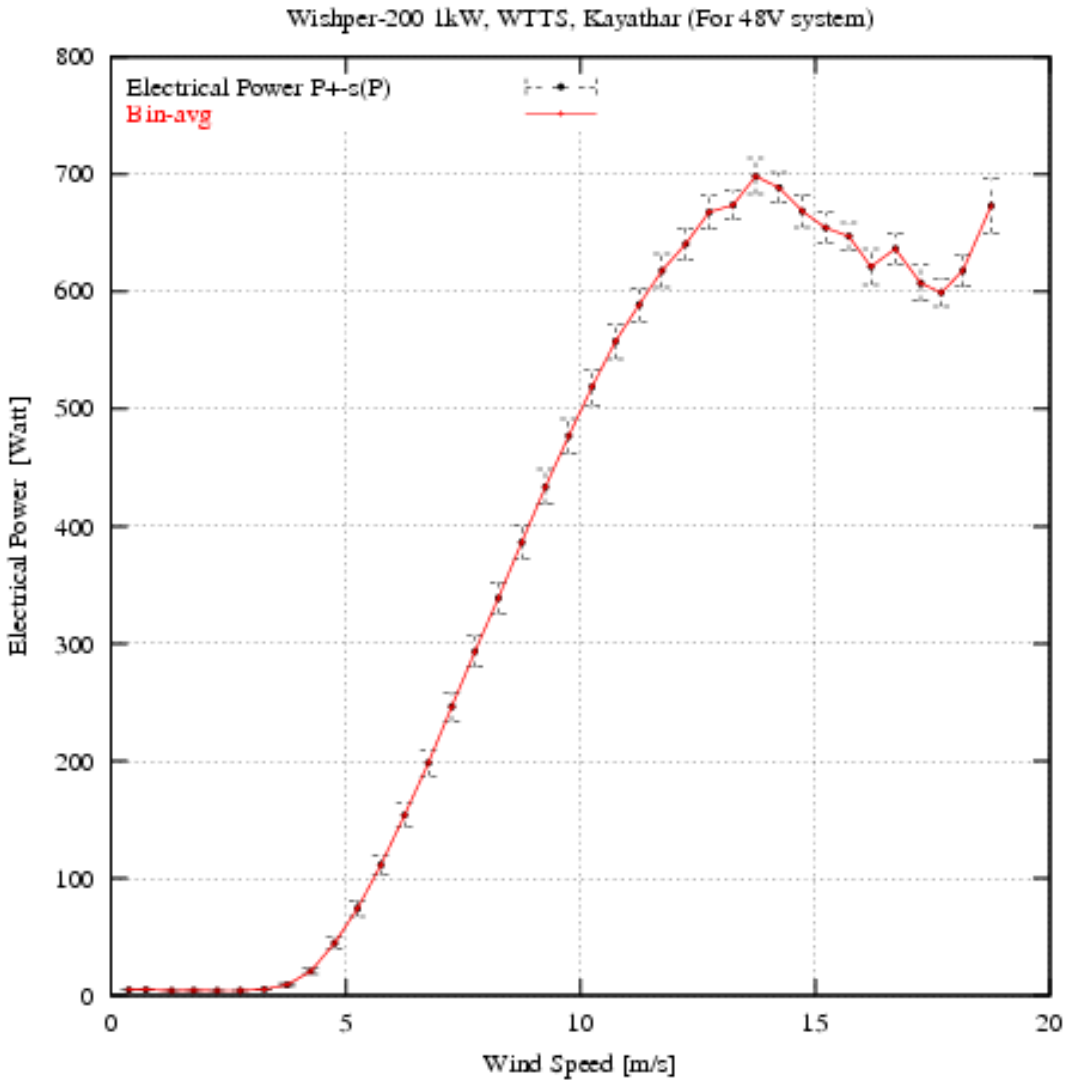
Reference Annual Energy	1063 kWh @ Annual average wind speed 5 m/s
Reference Power	570 W @ 11 m/s
Peak Power	700 W @ 13.7 m/s

3. **Annual Energy Production (At Sea Level Air Density 1.225 kg/ m^3)**

Mean wind speed m/s	AEP Measured in [KWh]			AEP Extrapolated [KWh]		
	AEP	std.dev	%	AEP	std.dev	%
4	563	37	6.57	563	37	6.57
5	1063	55	5.17	1063	55	5.17
6	1616	70	4.33	1619	70	4.32
7	2139	80	3.74	2160	81	3.75
8	2569	87	3.39	2645	89	3.36
9*	2876	91	3.16	3057	94	3.07
10*	3057	92	3.01	3386	98	2.89
11*	3132	91	2.91	3631	100	2.75

* 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
1.00	3.75	9.3	7.65	0.03	0.01	0.32	0.0	0.8	0.8	1411
2.00	4.25	20.9	23.46	0.07	0.02	0.27	0.0	2.6	2.6	1366
3.00	4.76	44.8	47.22	0.16	0.04	0.26	0.0	5.3	5.3	1425
4.00	5.25	74.3	60.00	0.26	0.07	0.25	0.0	6.9	6.9	1620
5.00	5.75	111.5	74.13	0.39	0.11	0.25	0.0	8.8	8.8	1855
6.00	6.25	153.9	84.95	0.53	0.15	0.25	0.0	10.4	10.4	1834
7.00	6.76	198.5	87.66	0.69	0.2	0.24	0.0	11.2	11.2	1964
8.00	7.26	246.4	95.56	0.86	0.24	0.23	0.0	12.6	12.6	2110
9.00	7.75	293.4	95.29	1.02	0.29	0.22	0.0	13.2	13.2	2216
10.00	8.25	338.8	91.35	1.18	0.33	0.21	0.0	13.3	13.3	2522
11.00	8.75	386.4	95.01	1.34	0.38	0.19	0.0	14.4	14.4	2395
12.00	9.25	433.6	94.46	1.51	0.43	0.18	0.0	15.0	15.0	2370
13.00	9.75	476.9	86.98	1.66	0.47	0.17	0.0	14.9	14.9	2258
14.00	10.25	518.8	83.84	1.8	0.51	0.16	0.0	15.2	15.2	2117
15.00	10.75	557.6	77.59	1.94	0.55	0.15	0.0	15.2	15.2	1854
16.00	11.25	589	62.63	2.05	0.58	0.13	0.1	14.2	14.2	1632
17.00	11.74	617.9	58.33	2.15	0.61	0.12	0.1	14.3	14.3	1309
18.00	12.24	640.6	45.85	2.22	0.63	0.11	0.1	13.6	13.6	1021
19.00	12.74	667.8	54.4	2.32	0.66	0.10	0.1	14.9	14.9	867
20.00	13.25	673.7	11.52	2.34	0.67	0.09	0.2	12.2	12.2	619
21.00	13.73	698.4	50.62	2.42	0.69	0.09	0.2	15.2	15.2	533
22.00	14.23	688.6	-19.63	2.39	0.68	0.08	0.2	12.8	12.8	383
23.00	14.72	668.7	-40.28	2.32	0.66	0.07	0.3	14.0	14.0	280
24.00	15.22	654.4	-28.71	2.27	0.65	0.06	0.4	12.8	12.8	162
25.00	15.72	647	-14.96	2.25	0.64	0.05	0.3	11.9	11.9	121
26.00	16.19	621.2	-55.05	2.16	0.61	0.05	0.6	15.3	15.3	49
27.00	16.71	636.4	28.89	2.21	0.63	0.04	0.6	12.7	12.7	24
28.00	17.25	607.2	-54.25	2.11	0.6	0.04	1.3	15.3	15.4	8
29.00	17.69	599.2	-18.33	2.08	0.59	0.04	2.2	11.4	11.6	2
30.00	18.15	617.9	40.49	2.15	0.61	0.03	0.9	13.9	13.9	2
31.00	18.75	672.9	91.29	2.34	0.66	0.03	0.4	22.8	22.8	2

6. **Duration Testing:** The turbine has successfully completed the duration test for a IEC Class III turbine during the test period. An operational time fraction of 99.95 % was achieved. The average turbulence intensity recorded at 15 m/s during the test period was 9.87%. The maximum instantaneous wind speed recorded was 23.3m/s on 11th Sep 2008.

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	Made Model, Serial No.	Wish Energy Solutions Pvt. Ltd. (UD Energy Systems Pvt Ltd, WHISPER 200)
	Rotation Axis	Horizontal
	Orientation	Upwind
	Number of blades	3
	Rotor diameter (m)	2.72
	Hub height (m)	18
Performance	Rated Electrical Power (W)	1000
	Rated wind speed (m/s)	11.6
	Cut-in wind speed(m/s)	3.1
	Cut-out wind speed (m/s)	15
Rotor	Swept area (m^2)	5.8
	Rotational Speed (rpm)	1200
	Blade pitch	fixed
	Direction of rotation	Clockwise
	Over-speed control	Electronic Torque control
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	Whisper 200
	Manufacturer	UD Energy Systems Pvt. Ltd.
	Nominal Battery Voltage (V)	48
	Maximum output power (W)	1000