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ICC-SWCC™

SUMMARY REPORT SWCC-16-05

Manufacturer: Bergey Windpower Company
Wind Turbine Model: Excel 15 (240 VAC, 1-phase, 60 Hz)
Certification Number: SWCC-16-05



The above-identified Small Wind Turbine is certified under the ICC–SWCC Small Wind Turbine Certification Program to be in conformance with the AWEA *Small Wind Turbine Performance and Safety Standard* (AWEA 9.1–2009). For the ICC-SWCC Certificate visit: www.smallwindcertification.org.

This report summarizes the results of testing and certification of the Bergey Windpower Company Excel 15 in accordance with AWEA Standard 9.1-2009. The Excel 15 is a 3-blade, upwind, stall-regulated, horizontal axis wind turbine with a rotor diameter of 9.6 m and swept area of 72.4 m². All testing was performed on a turbine system utilizing a Bergey Powersync III grid-tied inverter and a Bergey 30 m (100') guyed lattice tilt-up tower at the Bergey Windpower Company manufacturing facility in Norman, OK.

Power Performance testing was performed from 23 March 2017 through 24 March 2017 and 16 March 2018 through 17 April 2018. Duration testing was performed from 23 March 2017 through 30 April 2018 with additional data collected during the winter and spring of 2019. Safety and Function testing was performed from 13 April 2018 through 15 May 2018. Acoustic testing was performed on 2, 3, 9, and 11 June 2018 and on 30 March 2019.

1. Turbine Ratings

The Excel 15 performance testing was conducted in accordance with Section 2 of AWEA Standard 9.1-2009. The resulting turbine ratings, tabulated graphical Annual Energy Production (AEP), and graphical and tabulated power curve are given below.

AWEA Rated Annual Energy @ 5 m/s	29,800 kWh
AWEA Rated Sound Level	48.5 dB(A)
AWEA Rated Power @ 11 m/s	15.6 kW
Peak Power @ 16 m/s	20.6 kW

2. Tabulated Annual Energy Production (AEP)

Corrected to a sea level air density of 1.225 kg/m³

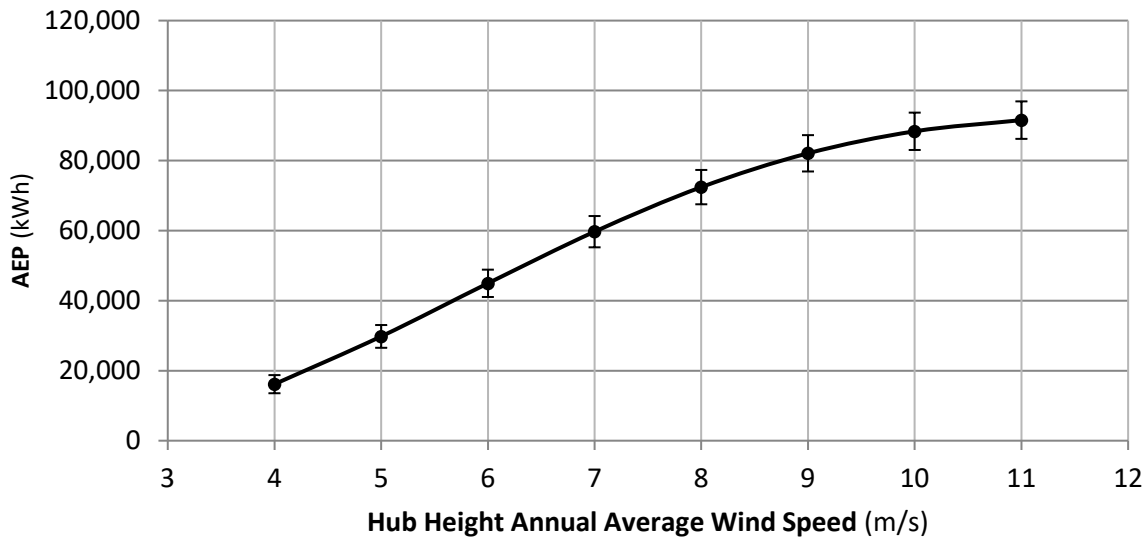
Hub Height Annual Average Wind Speed (m/s)	AEP Measured (kWh)	Standard Uncertainty in AEP (kWh)	Standard Uncertainty in AEP (%)	AEP Extrapolated (kWh)
4	16,144	2,591	16.08%	16,144
5	29,786	3,253	10.92%	29,788
6	44,951	3,904	8.68%	45,005
7	59,704	4,468	7.46%	60,158
8	72,433	4,903	6.70%	74,214
9	82,091	5,190	6.21%	86,532
10	88,376	5,334	5.87%	96,705
11	91,569	5,354	5.63%	104,514

3. Annual Energy Production Curve

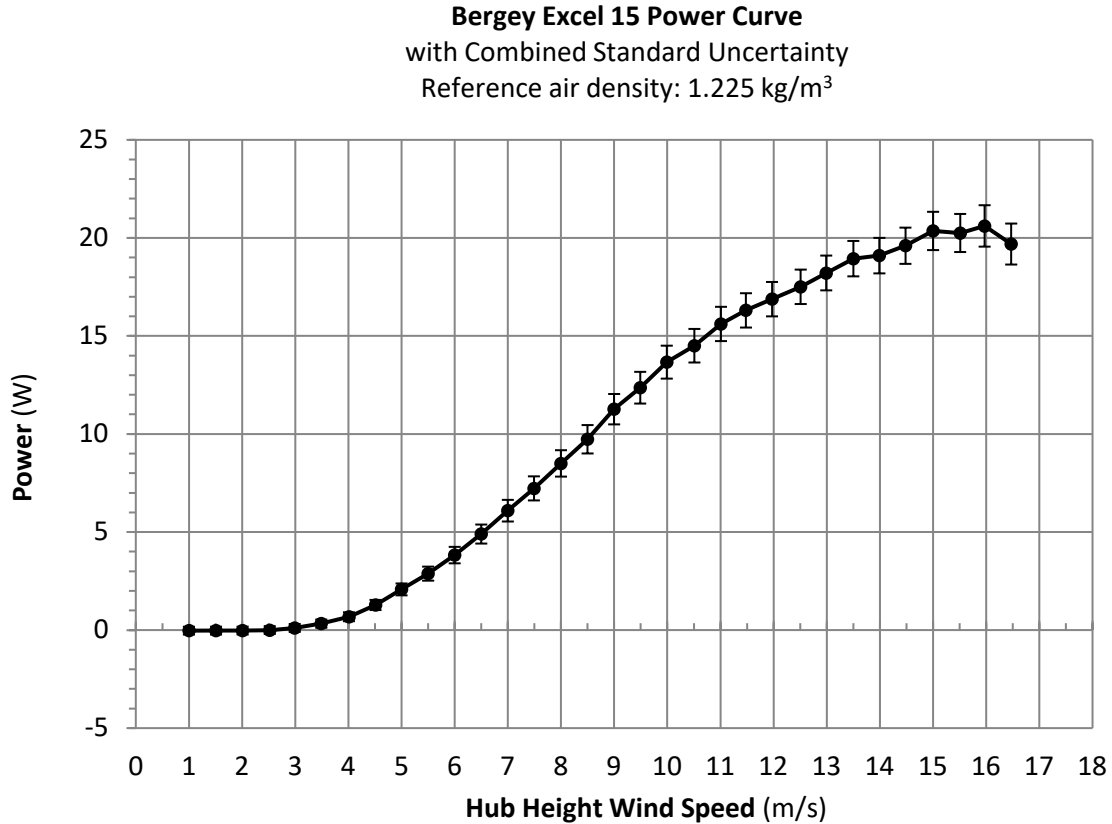
Estimated Annual Energy Production
(AEP-measured) with Standard Uncertainty

Bergey Excel 15

Reference air density: 1.225 kg/m³



4. Power Curve



5. Tabulated Power Curve

Corrected to a sea level air density of 1.225 kg/m ³					Category A	Category B	Combined
Bin	Hub Height Wind Speed	Power Output	C _p	1-minute samples	Standard Uncertainty, S _i	Standard Uncertainty, U _i	Standard Uncertainty, C _i
	<i>m/s</i>	<i>kW</i>			<i>kW</i>	<i>kW</i>	<i>W</i>
1.0	1.00	-0.029	-0.64	221	0.0003	0.200	0.200
1.5	1.51	-0.028	-0.18	265	0.0003	0.200	0.200
2.0	2.01	-0.025	-0.07	371	0.0004	0.200	0.200
2.5	2.52	0.000	0.00	508	0.0011	0.200	0.200
3.0	2.99	0.108	0.09	616	0.0031	0.202	0.202
3.5	3.49	0.328	0.17	605	0.0067	0.209	0.209
4.0	4.01	0.679	0.24	572	0.0129	0.226	0.227
4.5	4.51	1.280	0.31	646	0.0199	0.257	0.258
5.0	5.00	2.074	0.37	777	0.0269	0.302	0.303
5.5	5.50	2.878	0.39	782	0.0346	0.356	0.358
6.0	6.00	3.824	0.40	765	0.0458	0.417	0.420
6.5	6.50	4.897	0.40	687	0.0587	0.481	0.485
7.0	7.00	6.089	0.40	631	0.0751	0.546	0.552
7.5	7.49	7.226	0.39	538	0.0973	0.606	0.614
8.0	8.00	8.500	0.37	483	0.1174	0.663	0.673

8.5	8.50	9.731	0.36	432	0.1335	0.712	0.724
9.0	9.00	11.265	0.35	393	0.1497	0.761	0.775
9.5	9.49	12.361	0.33	368	0.1640	0.792	0.809
10.0	9.99	13.664	0.31	339	0.1734	0.822	0.840
10.5	10.51	14.502	0.28	290	0.1892	0.834	0.856
11.0	11.01	15.612	0.26	266	0.1955	0.852	0.874
11.5	11.48	16.304	0.24	259	0.1938	0.854	0.875
12.0	11.97	16.876	0.22	210	0.2156	0.851	0.877
12.5	12.51	17.506	0.20	202	0.2076	0.853	0.878
13.0	12.99	18.212	0.19	156	0.2198	0.859	0.887
13.5	13.50	18.942	0.17	125	0.2386	0.871	0.903
14.0	13.99	19.096	0.16	77	0.2680	0.864	0.905
14.5	14.48	19.600	0.15	56	0.2992	0.874	0.924
15.0	15.00	20.355	0.14	40	0.3864	0.897	0.976
15.5	15.51	20.251	0.12	23	0.3944	0.887	0.971
16.0	15.97	20.611	0.11	21	0.5583	0.897	1.056
16.5	16.47	19.687	0.10	14	0.6013	0.855	1.045

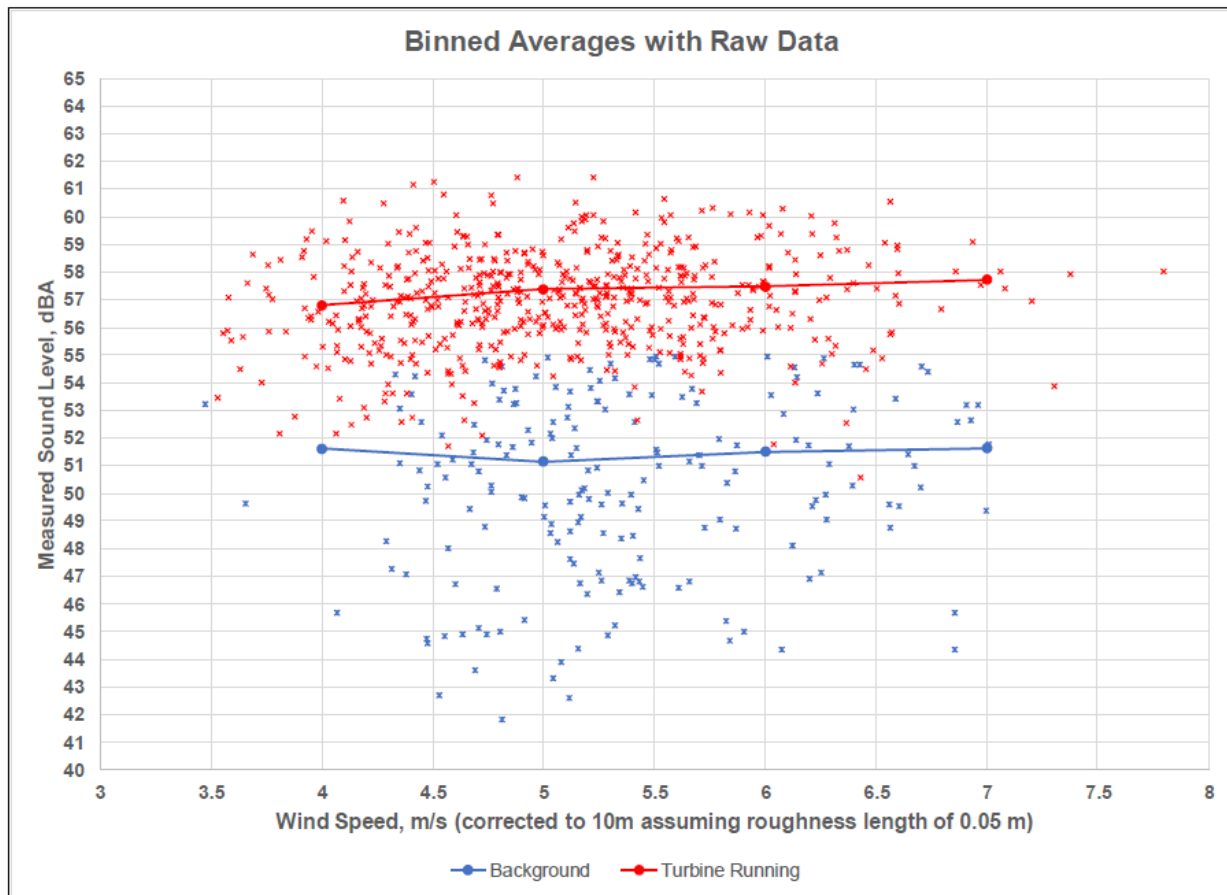
6. Tabulated Acoustic Data

The Excel 15 was tested in accordance with Section 3 of AWEA Standard 9.1-2009. The tabulated Sound Power Level is provided for specific wind speed bins.

Wind Speed at 10m Height <i>m/s</i>	Apparent Sound Power Level <i>dB(A)</i>	Combined Uncertainty <i>dB(A)</i>
4	93.7	2.0
5	94.6	1.8
6	94.5	1.8
7	94.8	2.2
8	94.4	2.6
9	95.2	2.7
10	95.1	2.2

The apparent sound power level at 9.8 m/s was measured as 95.1 dBA. At the 60 m observer distance this provided an AWEA Rated Sound Level of 48.5 dBA.

7. Graphical Acoustic Data



8. Duration Testing

The Bergey Excel 15 successfully completed a Duration Test for an IEC Class III Small Wind Turbine. The testing was performed from 17 March, 2017 to 24 April, 2018 with additional data collected through April 2019. The Operational Time Fraction was 97.4% and the average turbulence intensity at 15 m/s (33.6 mph) was 11.7%. The highest recorded instantaneous wind speed was 33.1 m/s (74.0 mph).

9. Mechanical Strength Analysis

The mechanical strength analysis was found to be in conformance with IEC 61400-2 as modified by section 4 of AWEA Standard 9.1 – 2009 for an IEC Class II Small Wind Turbine.

10. Safety and Function testing

Safety and Function testing was found to be in conformance with sections 4.3 and 4.4 of AWEA Standard 9.1 – 2009.

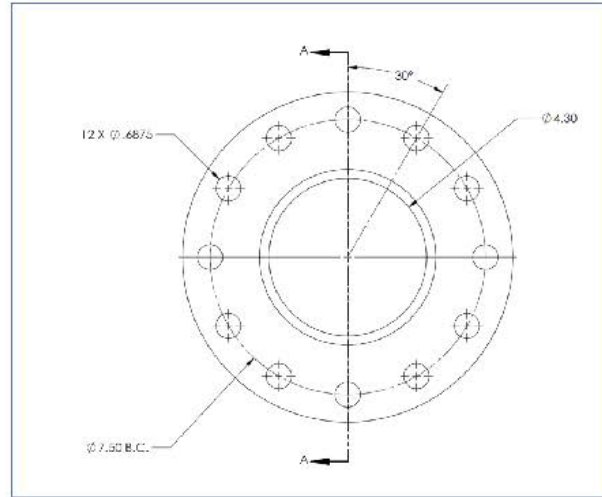
11. Manufacturer Tower Design Requirements

(ICC-SWCC is not responsible for any errors in the document below, which is provided by the manufacturer).

BASIC TOWER REQUIREMENTS for the BWC EXCEL 15 WIND TURBINE

Customer supplied towers for the BWC EXCEL 15 should meet the following requirements:

Tower Height:	60 ft (18 m) minimum, 80 ft (24 m) or higher recommended
Design Wind Speed:	120 mph (54 m/s)
Turbine Weight:	1350 lb (612 kg)
Turbine Thrust Load:	2500 lb (11.1 kN) @ any wind \geq 40 mph (18 m/s)
Distance, Blade Tip to Tower Centerline	60 inches (1.52 m)
Blade Clearance:	The top 15 ft (4.6 m) of the tower must not extend beyond a 22 inch (0.57 m) radius from the tower centerline.
Tower Plumb Tolerance:	Up to 0.25° tolerance from plumb allowed.
Tower Stiffness:	Tilt at the top of the tower should be no more than 2.0°. Deflection of monopole towers at 50 mph should be no more than 1.0% of tower height; at 120 mph no more than 2.5% of tower height. (For a 120 ft tower this would be 14.4 in and 36.0 in, respectively.) Overly flexible towers can cause vibration and/or fatigue problems. A civil engineer should approve the tower and foundation design.
Turbine Center of Mass:	5.1 inches (0.13 m) forward (upwind) of tower center and 16.5 inches (0.42 m) above the tower top
Tower Design Loads	Fx: 2,500 lbs (11.1 kN) Fy: 210 lbs (0.94 kN) Fz: 1,400 lbs (6.2 kN) Mx: 7,150 ft-lbs (9.7 kN-m) My: 4,130 ft-lbs (5.6 kN-m)
Frequencies to Avoid:	1.2 – 2.5 Hz (1P) 3.5 – 7.5 Hz (3P) Note: Blade first flap frequency is 5.5 – 6.0 Hz
Stall Regulation Speed:	150 RPM
Maximum Rotor Speed:	170 RPM
Turbine Mounting:	<ul style="list-style-type: none">○ Provisions shall be made for connecting turbine, providing tower wiring strain relief and mounting tower climbing anti-fall equipment.○ Tubular towers will require a 5" diameter access port ~5" below the tower top.○ The top of the tower shall be designed to allow the connection of the power cable through a 2" or larger hole in the center of the tower top plate.○ Hardware for attaching the wind turbine to the tower are NOT supplied with the turbine and must be supplied separately.○ Tower connection shall be made using twelve (12) 5/8" bolts per the turbine mounting details drawing provided below:



This sketch shows the bottom flange of the Excel 15 tower adapter. The 4.3" center hole in the flange is larger than required in the top plate of the tower.

Turbine Output Wiring: The output is a 3-phase AC. Tower wiring is three conductor. There is no neutral or bond wire required for the tower wiring.