



# SUMMARY REPORT SWCC-10-16



## ICC-SWCC™ Small Wind Turbine Certification Program

Eveready Diversified Products (Pty) Ltd.  
T/A Kestrel Renewable Energy  
CERTIFIED MODEL: Kestrel e400nb  
CERTIFICATION NUMBER: SWCC-10-16

[www.smallwindcertification.org](http://www.smallwindcertification.org)

3060 Saturn St., Suite 100, Brea, CA 92821 USA

A Program of the ICC Evaluation Service (ICC-ES)

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

This report summarizes the results of testing and certification of the Eveready Diversified Products (Pty) Ltd T/A Kestrel Renewable Energy (Eveready) Kestrel e400nb in accordance with AWEA Standard 9.1-2009. The Kestrel e400nb is a 3-blade, upwind, horizontal axis wind turbine with a swept area of 12.6 m<sup>2</sup>. The tested and certified system comprised of the Kestrel e400nb turbine and an ARE 12m (39 ft) monopole tower with a Power One Aurora 3.6 grid tie inverter. All field testing was conducted by TUV-NEL at their Myres Hill test site in East Kilbride, Scotland. Power Performance testing was performed from July 28, 2011 to September 22, 2011. Acoustic testing was performed on May 15, 2012 and September 17, 2012. Duration testing was conducted from July 28, 2011, to May 1, 2012.

## 1. TURBINE RATINGS

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

<b>AWEA Rated Annual Energy @ 5 m/s</b>	3,930 kWh
<b>AWEA Rated Sound Level</b>	55.6 dB(A)
<b>AWEA Rated Power @ 11 m/s</b>	2.5 kW
<b>Peak Power @ 19.5 m/s</b>	3.0 kW

Please verify certification is active on the ICC-SWCC website: [www.smallwindcertification.org](http://www.smallwindcertification.org)

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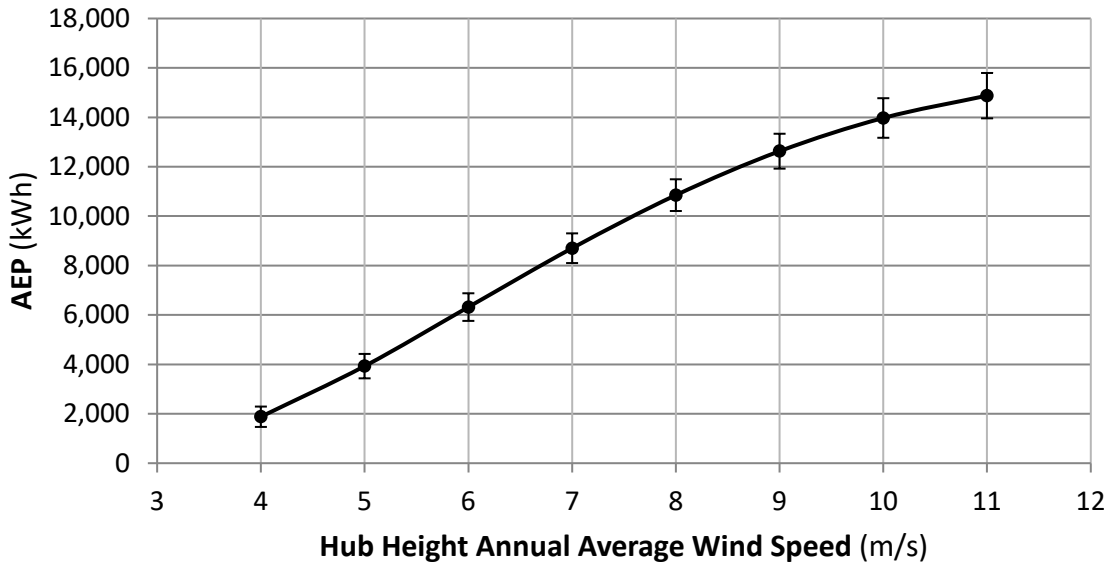
## 2. TABULATED ANNUAL ENERGY PRODUCTION (AEP)

Hub Height Annual Average Wind Speed	AEP Measured	Standard Uncertainty in AEP		AEP Extrapolated*
		(kWh)	(%)	
(m/s)	(kWh)	(kWh)	(%)	(kWh)
4	1,880	412	22%	1,880
5	3,929	494	13%	3,929
6	6,319	559	9%	6,320
7	8,702	601	7%	8,715
8	10,850	642	6%	10,920
9	12,629	706	6%	12,843
10	13,973	801	6%	14,439
11	14,877	918	6%	15,686

\*Corrected to a sea level air density of 1.225 kg/m<sup>3</sup>

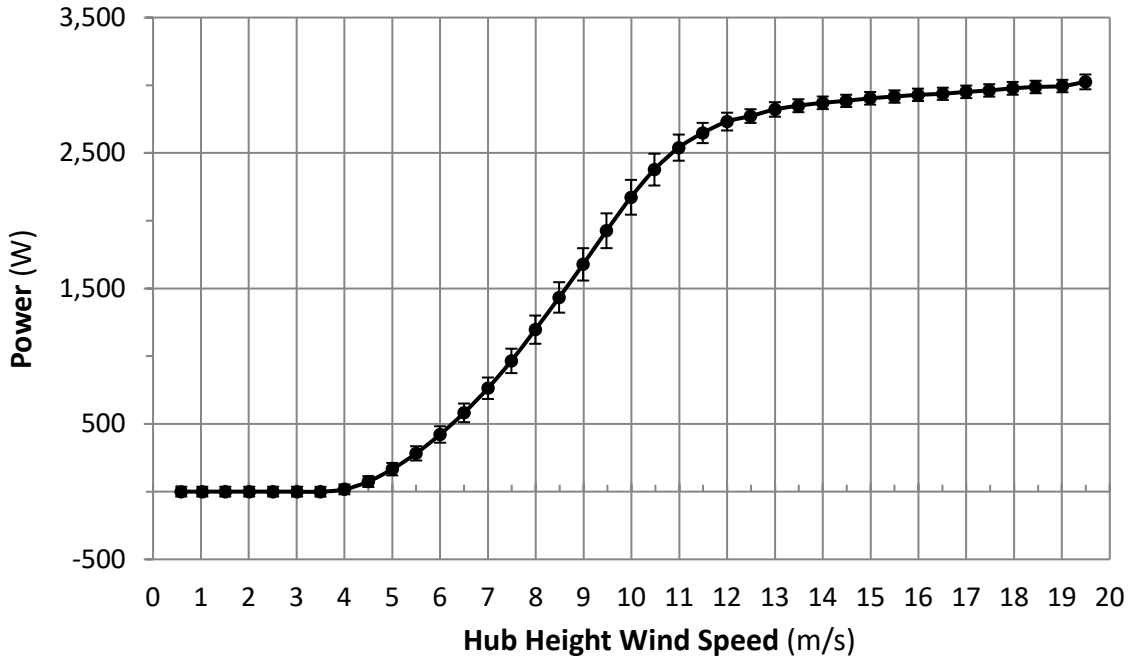
## 3. ANNUAL ENERGY PRODUCTION CURVE

**Estimated Annual Energy Production**  
(AEP-measured) with Standard Uncertainty  
**Kestrel e400nb**  
Reference air density: 1.225 kg/m<sup>3</sup>



#### 4. POWER CURVE

**Power Curve**  
with Combined Standard Uncertainty  
**Kestrel e400nb**  
Reference air density: 1.225 kg/m<sup>3</sup>



## 5. TABULATED POWER CURVE

Corrected to a sea level air density of 1.225 kg/m <sup>3</sup>					Category A	Category B	Combined
Bin No.	Hub Height Wind Speed	Power Output	Cp	1-minute samples	Standard Uncertainty, Si	Standard Uncertainty, Ui	Standard Uncertainty, Ci
	<i>m/s</i>	<i>Watts</i>			<i>Watts</i>	<i>Watts</i>	<i>Watts</i>
1	0.59	0	0	269	0	36	36
2	1.03	0	0	792	0	36	36
3	1.51	0	0	1283	0	36	36
4	2.01	0	0	2000	0	36	36
5	2.51	0	0	2515	0	36	36
6	3.01	0	0.00	2554	0	36	36
7	3.50	-1	0.00	2862	0	36	36
8	4.00	17	0.03	3418	0	36	36
9	4.50	74	0.11	3597	1	40	40
10	5.00	166	0.17	3194	1	46	46
11	5.50	282	0.22	3248	1	53	53
12	6.00	422	0.25	3427	2	61	61
13	6.50	582	0.27	3505	2	69	69
14	7.00	763	0.29	3175	2	79	79
15	7.49	965	0.30	2739	3	90	90
16	7.99	1196	0.30	2449	3	104	104
17	8.49	1434	0.30	1989	4	112	112
18	8.99	1678	0.30	1592	5	119	119
19	9.48	1926	0.29	1345	5	128	129
20	9.99	2173	0.28	1084	5	128	129
21	10.48	2377	0.27	871	6	117	118
22	10.99	2540	0.25	685	5	96	96
23	11.49	2648	0.23	570	5	75	75
24	12.00	2732	0.20	495	4	66	66
25	12.49	2773	0.18	407	4	50	51
26	13.00	2822	0.17	359	3	54	54
27	13.49	2849	0.15	289	3	48	48
28	14.00	2871	0.14	203	3	46	47
29	14.49	2885	0.12	200	3	45	45
30	14.99	2904	0.11	131	3	46	47
31	15.50	2917	0.10	94	4	45	46
32	15.99	2930	0.09	82	3	46	46
33	16.51	2937	0.08	67	4	45	45
34	17.00	2952	0.08	59	4	46	46
35	17.48	2962	0.07	42	5	46	46
36	17.97	2978	0.07	23	7	47	47
37	18.45	2987	0.06	28	6	46	46
38	19.01	2995	0.06	20	8	45	46
39	19.49	3025	0.05	11	11	54	55

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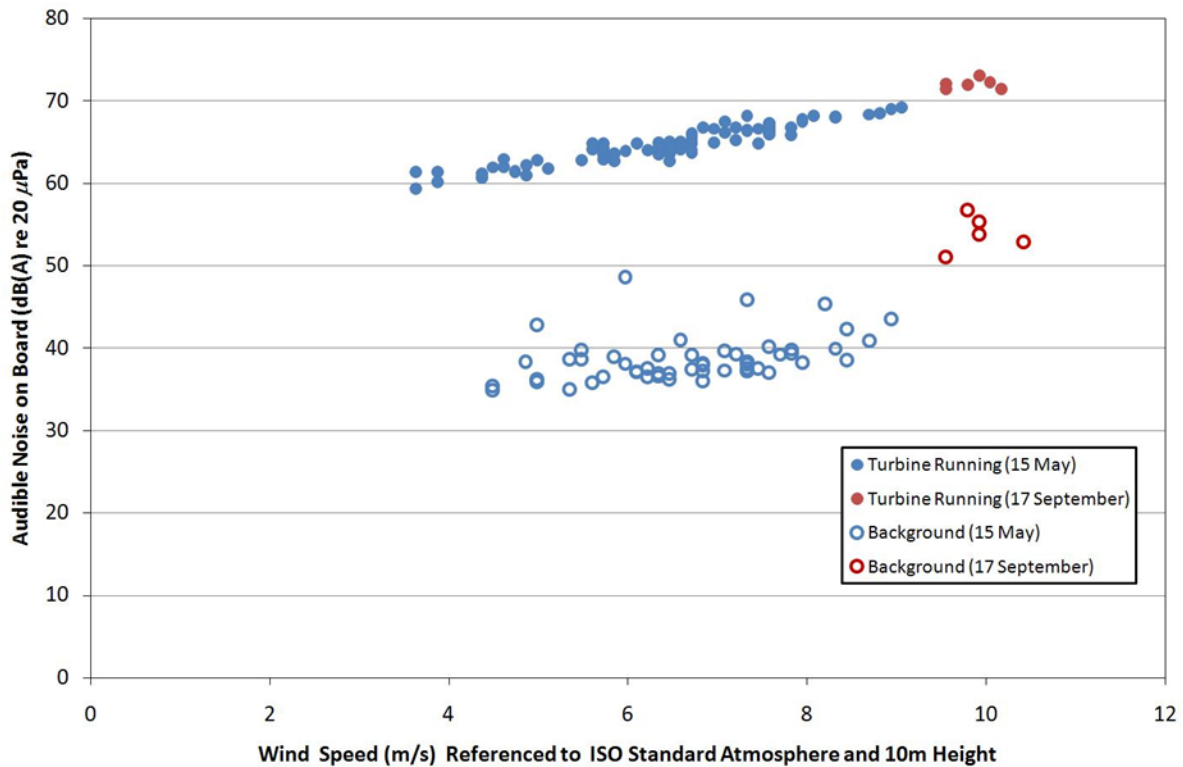
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## 6. TABULATED ACOUSTIC DATA

The e400nb 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>
6	94.8	1.0
7	96.6	2.0
8	98.3	1.7
9	99.9	2.0
10	102.9	1.0

## 7. GRAPHICAL ACOUSTIC DATA



## **8. DURATION TESTING**

As a result of the particular wind distribution that occurred during the test period, it was not possible to demonstrate IEC Class I wind conditions. The Kestrel e400nb successfully completed a Duration Test for an IEC Class II Small Wind Turbine with an Operational Time Fraction of 100%. The average turbulence intensity at 15 m/s (33.5 mph) was 16.3%. The highest recorded instantaneous wind speed was 42.3 m/s (94.6 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.

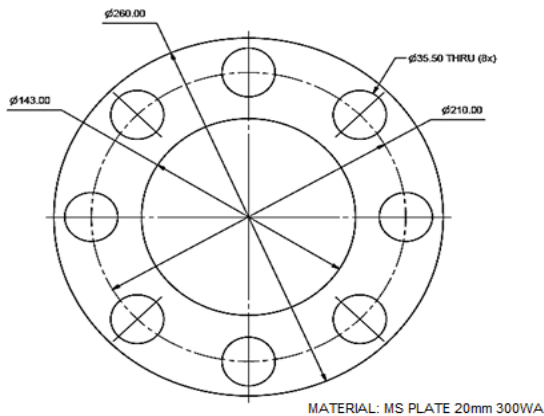
## **10. SAFETY AND FUNCTION TESTING**

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

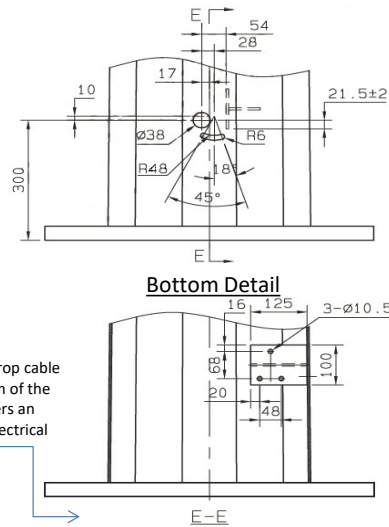
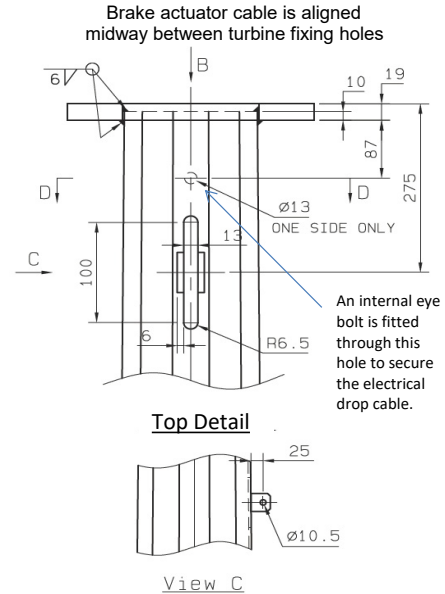
## **11. MANUFACTURER TOWER DESIGN REQUIREMENTS**

**PLEASE NOTE:** The Tower Design Requirements information provided below is provided for reference only. Please obtain the current and applicable Tower Design Specifications document from Eveready. ICC-SWCC is not responsible for any errors in the document below, which is provided by the manufacturer

BASIC TOWER DESIGN REQUIREMENTS Kestrel e400nb Wind Turbine	
Preferred tower heights 12m (40 ft), 18m (60 ft), 24m (80 ft)	
Turbine model	e400nb
Power rating	3500 W
Tower top mass	250 kg (551 lb)
Rotor diameter	4 m (13.12 ft)
Number of blades	3
Rotor swept area	12.56 m <sup>2</sup> (135.2 ft <sup>2</sup> )
Reference design wind speed	50 m/s (112 mph)
Extreme wind speed Ve1 (one year occurrence)	52.5 m/s (117 mph)
Extreme wind speed Ve50 (fifty year occurrence)	70 m/s (156 mph)
Lateral thrust at Ve50 wind speed and pitch control	3521 N (792 lbf)
Lateral thrust at Ve50 wind speed (parked rotor)	5000 N (1124 lbf)
Distance mounting flange face to rotor axis	0.39m (15 inch)
Thrust offset from tower centre axis	0m
Turbine mass offset from tower centre	0m
Axial fatigue loading range on generator (normal operation)	607 N (136 lbf)
Torsional fatigue load range on generator shaft (normal operation)	113 Nm (83 lbf ft)
Bending moment range on generator shaft (normal operation)	318 Nm (235 lbf ft)
Maximum shaft braking torque	230.2 Nm (170 lbf ft)
Rotor speed at rated power	55 rad/s
Rotor speed maximum	57 rad/s
Single blade rotational frequency range	0 - 8.8 Hz
Combined blade rotor frequency	0 - 26.4 Hz
Maximum tower top deflection at Ve50 as a percentage of height	2.50%
Natural frequency range	0.75-1.50 Hz
Maximum pipe diameter behind any part of the blade	141mm (5.56")
Top pipe size for any tower: 125mm (5") nominal OD 141.3mm (5.563") SCH 40 wall 6.55mm (0.258")	
Top tower flange: OD 260mm (10.24") Thickness 20mm ( 0.79") with 8 x Diameter 35.5 (1.4") through holes Item No. 31804	



Flange dimensions for e400nb  
The turbine is supplied with a resilient mounting kit that is fitted between the tower flange and turbine flange.



**IMPORTANT NOTE:**

The Kestrel e400nb is fitted with a mechanical brake. The tower is fitted with a mechanical winch and cable that connects to the brake mechanism. Consult the factory for further details.