PROVEN 2.5

GRID CONNECT

INSTALLATION MANUAL

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1.0 Introduction

1.1 System Description

The PROVEN 2.5 Wind turbine generator has a rated output of 2500W at 300V A.C.

The PROVEN 2.5 is downwind three bladed wind turbine. It comprises a steel turbine frame mounted on a steel tower assembly. The turbine frame supports encapsulated windings and bearings that in turn support a rotating shaft and permanent magnet rotor assembly. One end of the shaft has a propeller blade assembly comprising three glass polypropylene blades that are hinged on a rotor plate. The blades are held in their correct position by Zebedee springs that allow the blades to form a cone shape in high winds. In this shape, the turbine is able to limit its overspeed. The turbine frame also houses a service brake assembly that acts upon a brake attached to the rotor shaft.

The turbine is supplied with a self supporting tilt up tower which is connected to the turbine frame. The tower has a steel baseplate that incorporates a raising and lowering hinge mechanism. A winch mounted inside the tower is connected to the service brake in the turbine frame.

The top of the tower has a yaw bearing and yaw rubber assembly that permits the turbine frame to rotate. Thus turbine is able to rotate freely into the wind as the wind direction changes. The speed of rotation of the blades is depended on wind speed.

The generator encapsulated stator windings are connected to a slip ring unit at the top of the tower for onwards connection to a certified junction box.

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1.2 System Components

The main system components for the PROVEN 2.5 wind turbine generator are:

- Turbine frame & generator including junction box
- Glass polypropylene blades (3 off)
- Slip ring unit
- 6.5m or 11m tilt up self supporting tower
- Brake Assembly

Contained within the hollow tower section are the following components:

- Turbine brake rope – 3mm Diameter Stainless Steel Wire rope
- Brake winch
- Power cable - Between slip-ring unit at the tower top and the junction box at the bottom: 1 x 3 core 10sq mm cable

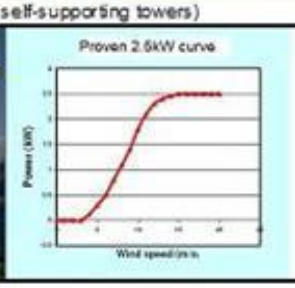
1.3 System Specifications

PROVEN 2.5 (2.5kW wind turbine)

PROVEN TM650 / TM1100 (6.5m / 11m self-supporting towers)

Rotor Speed Control

Above 12m/s the blades cone to self-adjust the rpm



High Build Quality

Most components are hot-dip galvanised steel, stainless steel or plastic

Performance	
Cut-in wind speed	2.5 m/s 5.6 mph
Cut-out wind speed	> 70 m/s 155 mph
Rated wind speed	12 m/s 26 mph
Rotor	
Type	Downwind, self-regulating
Number of blades	3
Blade material	Glass thermoplastic composite
Rotor diameter	3.5 m
Rated speed	300 RPM
Rotor trust	10 kN
Generator	
Type	Brushless, direct drive, permanent magnet
Output	Grid connect 300V DC, battery charging 48V DC direct heating 240V switch DC
Rated power	2500 W
Annual output	2,500 – 5,000 kWh

Low Speed Equals Durability

Low rotor speed (half of the speed of comparable machines) ensures extended durability of blades and bearings. It also means that Proven wind turbines are the quietest in the world!

Tower	
Type	Self-supporting, hinged, tapered
Hub height	6.5 m or 11 m
Foundation size	1.6 x 1.6 x 1.0m or 2.5 x 2.5 x 1.0m concrete
Noise	All readings taken with an ATP SL-25 portable meter
40 dB	At 5 m/s
60 dB	At 20 m/s
70-80 dB	Car 15 m away speeding at approx 40 mph
Weight	
Proven 2.5	200 kg
TM650	241 kg
TM1100	445 kg

Sample of Commercial Customers

British Telecom / Scottish Youth Hostel Association / Saudi Aramco
Irish Lighthouse Authority / Welsh Water / British Rail
Shell Exploration / T-Mobile / Orange

1.4 Health and Safety Information

Please refer installation and servicing to qualified service personnel only. High currents are produced by this wind turbine system and incorrect installation or use may result in

- risk of electric shock or fire
- mechanical damage

Warning!

Installation of the turbine involves handling heavy components such as the turbine nacelle, blades and covers. Appropriate work wear (e.g. gloves, helmets, safety footwear and eye protection) appropriate lifting gear, techniques and appropriate number of personnel should be used at all times.

Personal Precautions

Proven recommend a two person team as a minimum for mechanical installation of a Proven Wind Turbine – they should use standard protective clothing.

Use only certified lifting straps and strops.

Weather

The turbine should be installed in periods of wind speeds less than 12 m/s (25 mph or 43 km/h) and generally calm weather conditions.

2.0 Electrical Installation

The Proven 2.5/300 is specially designed for connection to LV network at 230Vac 50Hz nominal by means of the WB-2500 grid connect inverter (SMA Windy Boy).

It is suitable for domestic, agricultural and SME applications and will produce from 2,500 – 5,000 kWh per annum depending on the wind resource available. A description of the main electrical component parts of the system is as follows:

2.1 Schematic for Connection

Please refer to the electrical schematic. The main elements are:

- Proven 2.5 wind turbine containing GW2500 3-phase AC synchronous variable speed alternator
- Proven grid connect inverter & controller package comprising
  - DC Disconnect – allowing the turbine to be isolated from the grid connect inverters.
  - ECM2504ME/300 controller which displays turbine voltage and current, rectifies AC input from the turbine and outputs DC power to the grid connect inverters
  - WB-2500 SMA Windy Boy grid connect inverter of the self commutating static type.
- AC Disconnect Lockable – allowing the grid to be securely isolated from the inverter.

The output from the AC lockable disconnect is normally connected to a spare fuse or breaker at the customer distribution board rated at 10A.

2.2 GW2501

The Proven 2.5 contains a purpose built permanent magnet generator which is directly driven by the rotor at variable speed according to wind conditions. All of the technical information on the GW2501 below is provided for information only – the only bit of the system that is "seen" by the grid system is the grid connect inverter (see following sections).

2.2.1 Type of Generator

The GW2501 is a permanent magnet synchronous 3-phase AC alternator suitable for variable speed operation.

2.2.2 Selected Operating Characteristics

The output voltage open circuit is proportional to RPM of the turbine. The output voltage during normal operation is dependent on the load placed on the generator.

The output of the generator is connected to the ECM2504ME/300 control box which contains a 3-phase rectifier.

GW2500	RPM	Approx Wind Speed	GW2500 Output Voltage Vac under normal operating conditions Vop AC	GW2500 Output Voltage Vac if grid fault (inverters disconnected from grid) Voc AC	Input DC Voltage to grid connect inverter under normal op conditions Vop Dc	Input DC voltage to grid connect inverter if grid fault (inverters disconnected from grid) Voc DC
Minimum Speed	0	0-5 mph	0	0	0	0
Maximum Speed	300 rpm	>25mph (blades feather at higher wind speeds to maintain this max shaft rpm)	225Vac 3-ph	450Vac 3-ph	300V DC	500V Dc
Typical Speed (during operation)	150-300 rpm	5-25mph	200 – 225 Vac 3-ph	400 – 450 Vac 3-ph	240-300V DC	400V DC – 500 V DC

There are no touching parts or brushes in the machine and it is maintenance free. The GW2500 has 8 poles and has a nominal AC frequency of 20Hz @ 300 rpm.

The generator can be disconnected at any load without any problems – in this case the winding voltage rises and the turbine will speed up slightly until the blades mechanically govern to the maximum rpm. On reconnection of load, the turbine winding voltage will fall gradually to normal operating value due to the intelligent switch-on strategy of the inverters used (after the switch on delay period has passed).

2.3 ECM2504ME/300 Control Box

The ECM2504ME/300 has the following functions

- Converts output 3-phase AC variable voltage of the turbine to DC variable voltage for input to the grid connect inverters.
- Isolation point for the turbine.
- Displays V, I (DC) from the turbine.

2.4 WB-2500 Grid Connect Inverter

The WB-2500 grid connect inverter has the following functions

- Conversion of variable voltage DC input to synchronised 230Vac 50Hz nominal
- 180s delay after grid fault until re-connect to grid
- Trip out on over/under voltage
- Trip out on over/under frequency

The WB-2500 inverter has been type tested for suitability for use under G83/1 regulations.

2.4.1 Description of Typical System Commissioning Procedure

At the start of a typical commissioning procedure the following should be the situation

- The turbine is mechanically braked
- The turbine is isolated from the grid connect inverters
- The grid connect inverter is isolated from the grid

The typical start up sequence is:

- Connect the 3 phase ac supply from wind turbine to the inverters by switching on the 3 pole disconnect in the ECM2504ME/300 controller.
- Release the wind turbine mechanical brake. The turbine starts to rotate if wind conditions are more than about 5mph. The inverter waits until input DC voltage is >250V before starting its self test and safety procedures at which point the ORANGE LED on the front of the inverter will flash approx once per second.
- Connect the inverters to grid AC by turning the lockable AC disconnect to the **ON** position. At this point the inverters start monitoring grid AC voltage, frequency and impedance. After a few seconds the GREEN LED starts to flash. First the inverter checks voltage and frequency are within allowed ranges and that grid impedance is >1.25Ω. If all is OK then it waits 180 seconds (required by G83/1 and G59) and then starts its "connect to AC network" procedure. After completion of this procedure (will take approx 5 minutes depending on wind conditions the GREEN LED will stay on continuously.
- If the inverter input DC voltage is <180VDC for >300 seconds then there is not enough wind power available and the inverter shuts down and goes into sleep mode (All LEDs off).. Higher input DC voltages will wake it up when wind speeds increase and it will then repeat this connection procedure.

2.5 Description of Typical System Operation

A typical operating strategy during a **windy period** is summarised by:-

- Continuous and automatic monitoring of Vac and fac by the inverter.
- Inverter will disconnect from grid network in <0.5 seconds should V_{ac} or f_{ac} go out of their allowed ranges under the connection settings chosen.
- Inverter continuously adjusts output AC amps to match the wind energy available.

A typical operating strategy during a **calm period** is summarised by:-

- Inverter goes into sleep mode after disconnecting from grid network.
- If wind increases then the inverter will start up as described in the commissioning section above.

A typical operating strategy during a loss of mains is summarised by:-

- Inverter disconnects from grid network in < 0.2s and monitors V_{ac} and f_{ac} continuously. At this point the wind turbine will speed up slightly and the generator winding voltages will rise as described in section 4.1.2.
- Should V_{ac} and f_{ac} return to allowed ranges then the inverter will start up as described in the commissioning section 4.4 above.

2.6 Method of Disconnection from Grid

The WB-2500 inverter contains an independent disconnection device consisting of the following

- Excerpt from WB-2500 manual: *"For maximum safety this independent disconnection device consists of two separate MSDs (Mains monitoring with allocated Switching Devices) that are connected in series. Each of these MSD constantly monitors the grid quality by checking the frequency, voltage and impedance.The redundant circuit and automatic self test on each system start up ensure a reliable function of the disconnection device."* For use with a wind turbine or solar system this means that the disconnection device will be tested around 1-10 times per day on average.

- The allocated switch device for the MSDs is the Matsushita DE1A 16A single pole relay. One relay is provided Live and one for Neutral. The MSDs are energised from the dc source (wind or solar power). In the case that there is no wind or solar power then the MSDs are unpowered and the relay status is open/safe.

2.7 Electrical Wiring

Proven recommend that electrical wiring and installation are carried in accordance with the Energy Saving Trust publication CE72 – 'Installing small wind – powered electricity generating systems' and BS7671 – ' IEE Wiring Regulations for Electrical Installations'.

The schematic drawings provided in appendix A have been provided to assist in wiring components to the above mentioned standards.

3.0 Mechanical Installation

3.1 Tools Required

Number	Description	Used for
2	10 mm spanners (1 open ended)	Slip rings
2	13 mm spanners (1 open ended)	Blade and spring fixings
2	17 mm spanners (1 open ended)	Blade fixing bolts Spring U-bracket fixings
2	19 mm spanners (1 open ended)	Lower yaw bearing
2	24 mm spanners (1 open ended)	Upper yaw bearing Main shaft bearing at generator end – normally factory tightened
1	5 mm allen key	Yaw bearing grub screw
1	Pair of wire snips	Trimming cover cable ties
1	30 mm or 36 mm spanner (e.g. 36 mm socket with drive ratchet, suitable extension and 4"-6" socket extension)	TM650 M20 tower bolts TM1100 M24 tower bolts
1	Torque wrench and torque multiplier if required	Tightening the tower bolts. All fixings should be tightened to a torque value where stated
1	Tube of glazing silicon and gun	Cover sealant
1	Loctite studlock A118 or similar	All fixings – **must be used with all stainless steel nuts and bolts**
1 set	Pliers, wire strippers, large crimping tool, assorted crimp lugs etc.	Wiring
1	Hacksaw	Removing locked stainless steel nuts (this can sometimes happen)
1	Flat file	Removing any galvanising drips to allow tower fitting with yaw bearing

3.2 Frame and Tower Assembly

Proven TM1100 is an 11m tilt up self supporting galvanised steel tower.which is supplied in two sections. Proven TM650 is a 6.5m single section tower.

3.2.1 Procedure

- Lift parts off vehicle
- Take tower section(s) to foundation
- The tapered sections (TM1100) need to be fitted together
- Fit the bottom section of the tower to the base plate of the foundation using hinge pins provided

Advice

Ensure the mast is locked in position for safety before proceeding with rest of the installation.

Important

Mechanical and electrical installations will be required in the nacelle of the turbine.

Also if the turbine head is above normal working heights, provision will have to be made for scaffolding or other access means.

3.3 Fitting the Turbine Head to the Tower Top

3.3.1 Procedure

Note: The down cable and brake rope can be fitted at this stage when fitting the slip ring assembly.

- Prepare tower for fitting with the head

- Carefully slide the turbine head frame onto the tower as shown

- Fit bearing on to spigot ensuring grease nipple is accessible and push turbine head fully home. If slip ring brushes are fitted then be careful not to damage brushes when pushing head fully home.

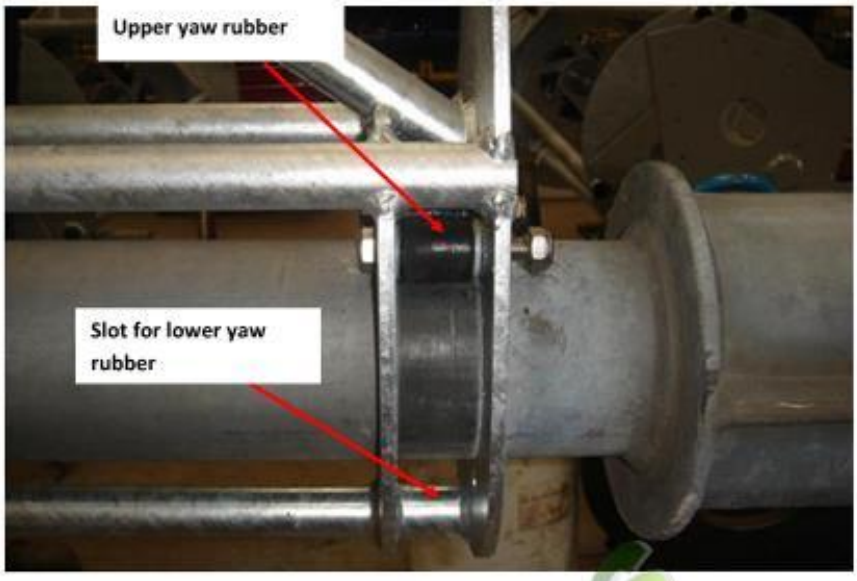
- The yaw bearing fixing bolts (M16) can now be tightened. The turbine head can now rotate around the tower. Withdraw the head assembly back off the tower approximately 50mm, Spread some thread locking compound (loctite A118) onto the spigot and push head fully home. Tighten bearing grub screw using a 5mm allen key. The thread lock compound ensures a secure fit between the spigot and the bearing. It is also recommended to glue in the grub screws to stop them vibrating loose.


M16 bolt being tightened with a wrench

- Prepare yaw rollers and bolts for fixing by greasing the bolts and rubber ends.

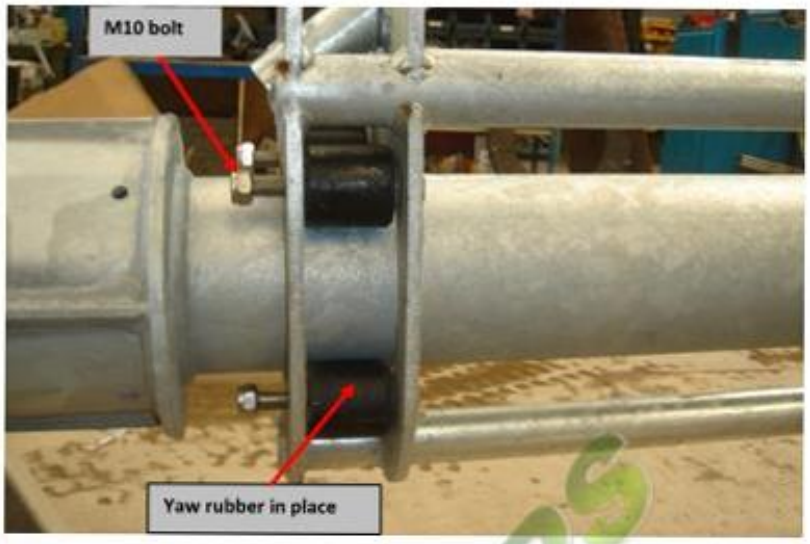

Greased yaw rubbers & fixings

- **Fit the two upper yaw rubbers first.** Slot bolt through yaw frame hole as shown below, and guide it through the rubber and nylon washer and through the lower frame hole.



- Using a plastic or wooden wedge pry up the frame to make it easy to fit the two lower yaw rubbers.

- Tighten the yaw rubber bolts using a 17mm ratchet and spanner. Do not overtighten the rubbers so that they can rotate.



- Check everything is tight and that the turbine will freely rotate within its yaw axis.

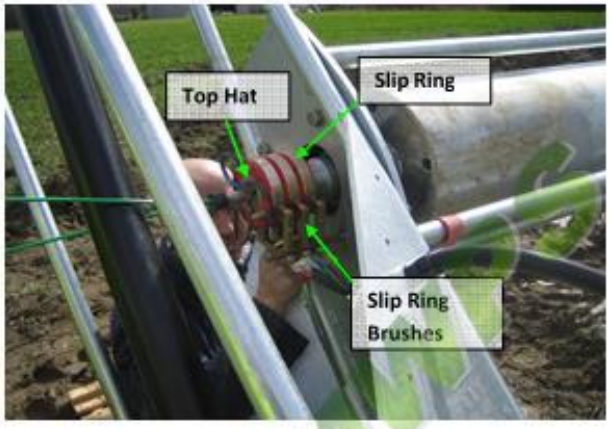
- Finally spin the rotor by hand to check that nothing rubs. If the turbine has been roughly handled then the domed generator cover can get pushed against the magnet plates. If this is the case gently tap the cover back into position and reseal if necessary with silicone.

3.4 Slip Ring Assembly

3.4.1 Description

A slip ring is an electromechanical device that allows continuous electrical connection and transmission of power from a stationary to a rotating structure. Additionally, the slip ring helps prevent the down cable and brake rope from twisting. The slip ring assembly consists of:

1. Slip ring (3-ring) with 2 grub screws
2. Mount stand for slip ring brushes
3. Slip ring brushes for each ring



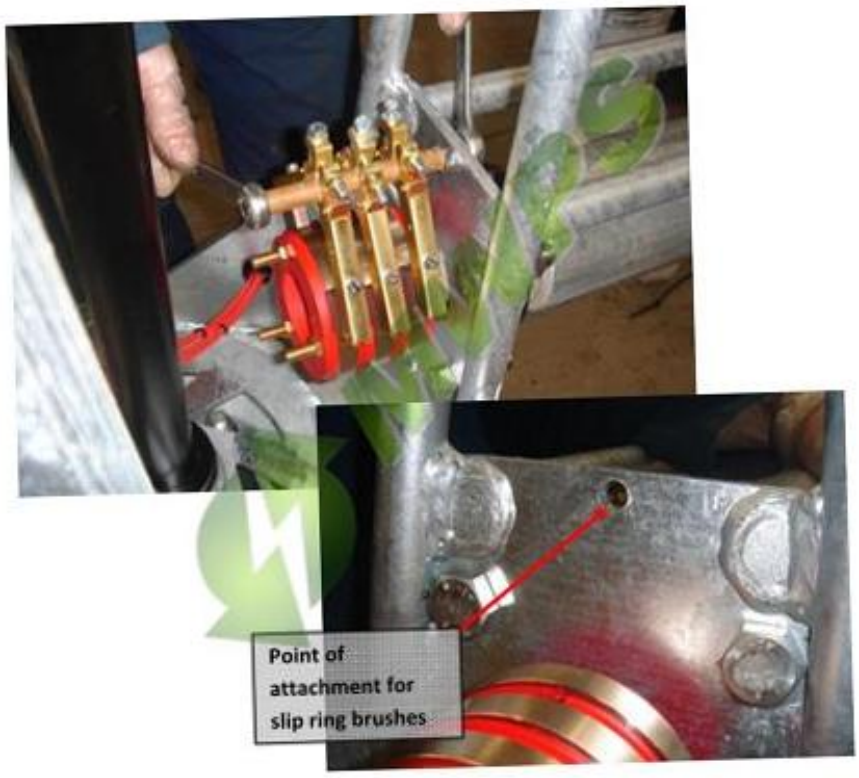
3.4.2 Procedure

- Smoothen the tower spigot surface to be fitted with the slip ring with a sand paper.

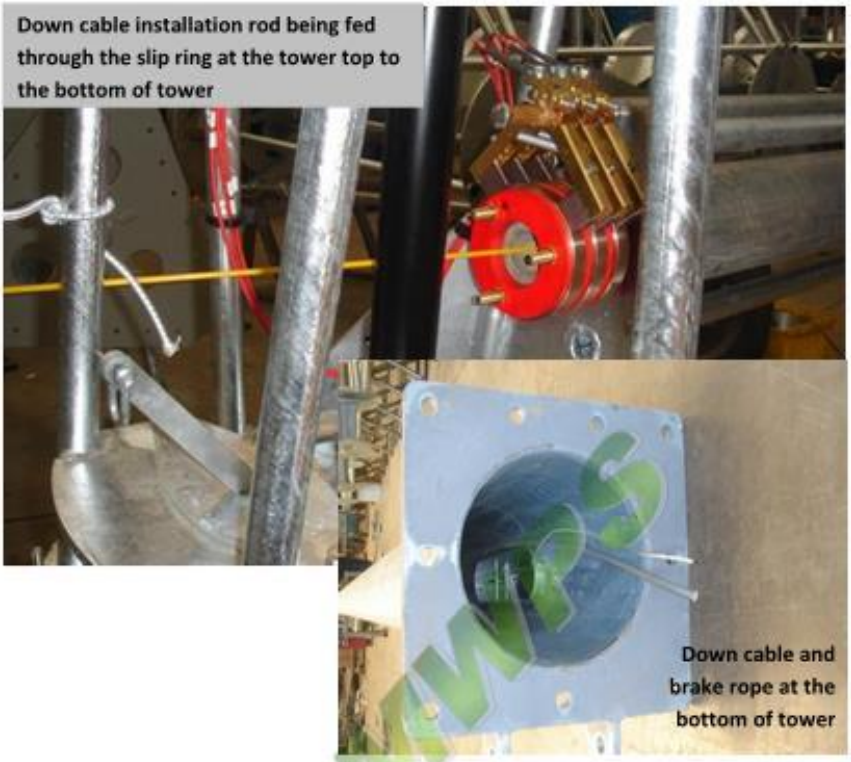
- If cable is fitted at this stage then feed cable through the slip ring and top hat. If not the fit slip ring onto spigot, fit top hat into the end of slip ring so that it butts up against the end of the tower top. This is the position the slip ring should be secured in. Slide back the slip ring and top hat and apply loctite to the spigot and then re-fit and secure using the grub screws. Use a 3mm allen key to fix grub screws in place - use A118 on grub screws.

- Assemble down cable installation rods (not supplied) so they are long enough to match tower height. Alternatively a draw string or other suitable methods can be used to pull cable down from the top of tower to the bottom.

- Now using two 17mm spanners attach the slip ring brushes to the turbine frame. Again be careful not to over tighten as the insulation tube could split.



- Feed the assembled installation rods (now a long rod) through the slip ring at the tower top to the bottom of the tower.



Down cable installation rod being fed through the slip ring at the tower top to the bottom of tower

Down cable and brake rope at the bottom of tower

- With a 10mm spanner loosen the bolts on the brushes till the brushes can be moved freely. Position the brushes in the middle of the rings. Adjust for good contact and then tighten bolts.

- Using an adhesive tape, attach the brake rope and down cable (power cable) to the assembled installation rod. Pull the end of the rod at the bottom of the tower till other end with the attached rope appears. Now detach the rod from the down cable and brake rope.

- Feed the end of the down cable at the top of the tower through one hole of the top hat and similarly feed the remaining hole with the brake rope.

Advice

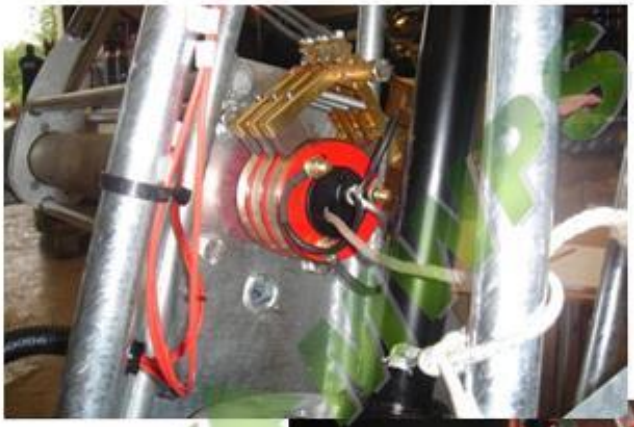
Tie the end of the down cable with a cable tie to prevent it slipping through the hole.

- Now fit the top hat to the slip ring.

Slip Ring Connections:

This assumes brake rope and cable are in position and are fitted through top hat assembly

- Loosen the 3 stud nuts on top of the slip ring unit and connect the down cable ends at the top hat to the 3 studs. Tighten the stud nuts with a 13mm spanner. Do not over tighten as you may shear the copper stud. Vibration washers are included to ensure a secure fit. Note any cable can be connected to any stud.



- Connect the generator lead out wires to the top of the brushes and tighten using a 10mm socket.

3.5 Brake Rope Installation

The mechanical brake assembly is made up of the following components located in the nacelle of the turbine:

1. Brake disc
2. Brake pads
3. Brake lever, which is already factor fitted,
4. Steel shackle which is fitted to the end of the lever.
5. Steel shackle which is fitted to the brake cable guide bar.

Other components located in the tower section are:

6. Worm geared winch mechanism, (this includes a short webbing strap).
7. Two shackles and a swivel bearing, (these are connected to the winch webbing.
8. Socket 'T' Bar Wrench.

Brake is applied by using socket 'T' bar wrench on M12 nut attached to drive spindle.

3.5.1 Procedure

- Fit winch assembly to the tower door flange, secure using supplied nuts and bolts.
- Attach the end of the brake cable from within the tower to the shackle on the end of the winch webbing strap.

- The free end must be attached to the winch end (as shown below) using a swivel and a shackle, the wire should be fed through and around the pin of the shackle and adjusted to suit, finally being secured with the two wire rope grips supplied. Make sure that the brake winch is payed out before the cable is secured.

- Using 3mm rope - two grips are required to secure the end of the rope.

- The grips should be fitted in such a way that the correct tightening of the grip does not damage the outer wires of the rope grip.

- Position the clips and apply light tension on the rope and tighten all nuts evenly, alternating until reaching the specified torque.

- Length of rope to turn back: 85mm – Tightening torque for nuts: 6.1 Nm.

Due Care & Attention Required

3.5.2 Brake Operation

- Using tower door key remove tower access door
    - Brake is applied by using socket "T" bar wrench on M12 nut attached to drive spindle.

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3.6 Fitting the Covers

The turbine is supplied with the following covers:

1. Generator cover
2. Yaw cover
3. Nacelle cover (or the rotor shaft cover)

The covers are made from black or black U.V. stabilised polypropylene plastic. They are fitted to the wind turbine frame using cable ties.

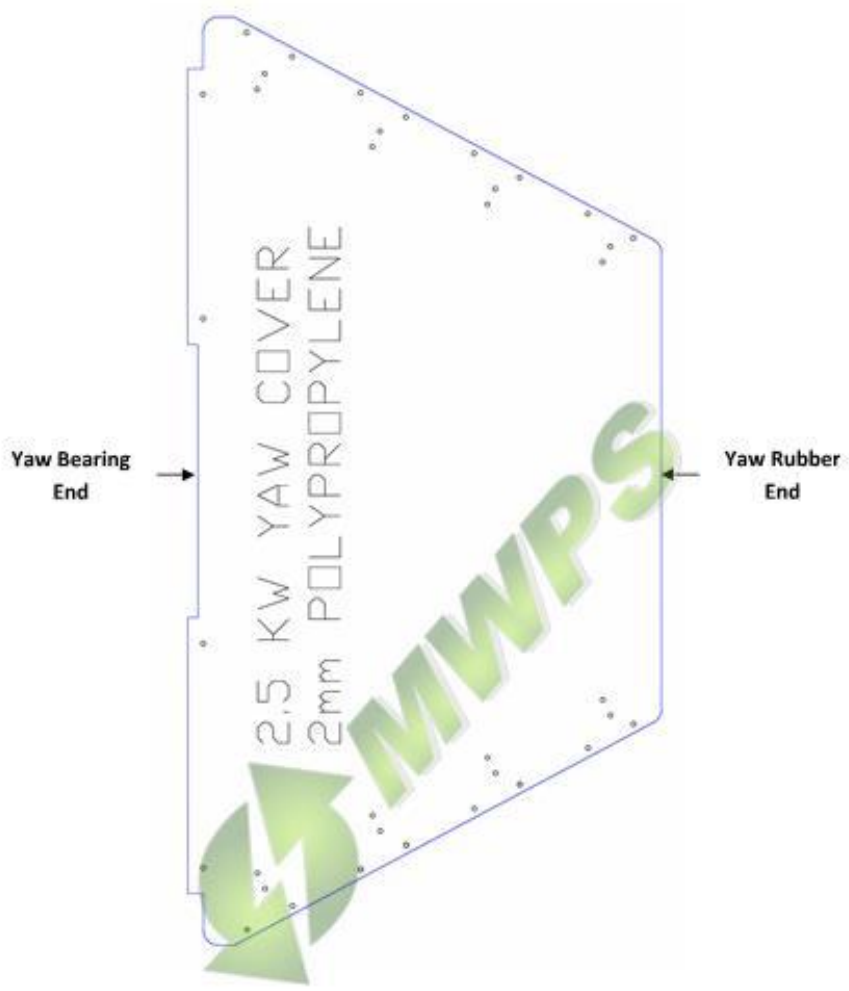
The yaw cover is fitted **first!**

3.6.1 Fitting the Generator Cover

The generator cover is secured over the electrical generator by means of an SS "Jubilee clip". The generator is supplied with the cover already fitted.

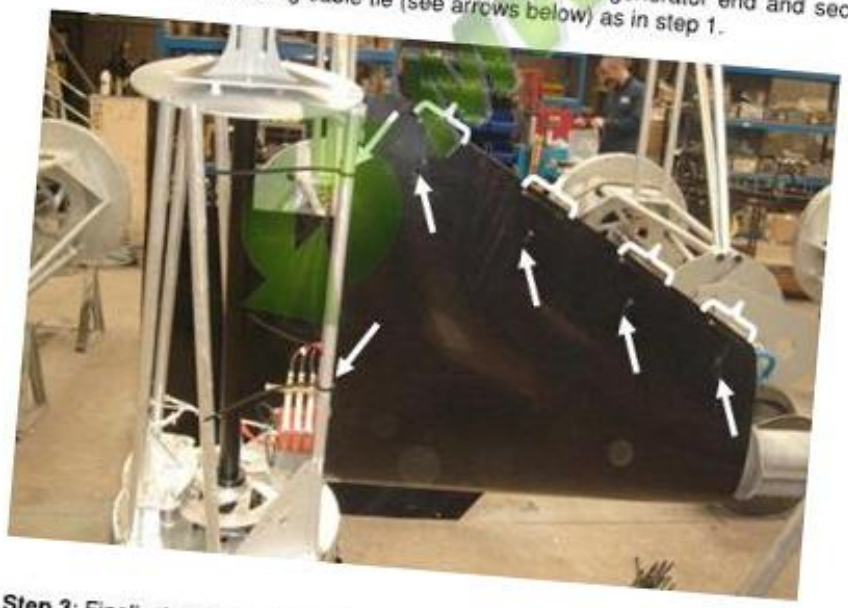
3.6.2 Fitting the Yaw Cover

Procedure



Step 1: Offer up yaw cover to the frame and attach (see arrows shown below) using the cable ties. Feed cable tie from front through cover around the steel bar and back through the other hole, secure tie but **do not** fully tighten until all ties have been fitted.

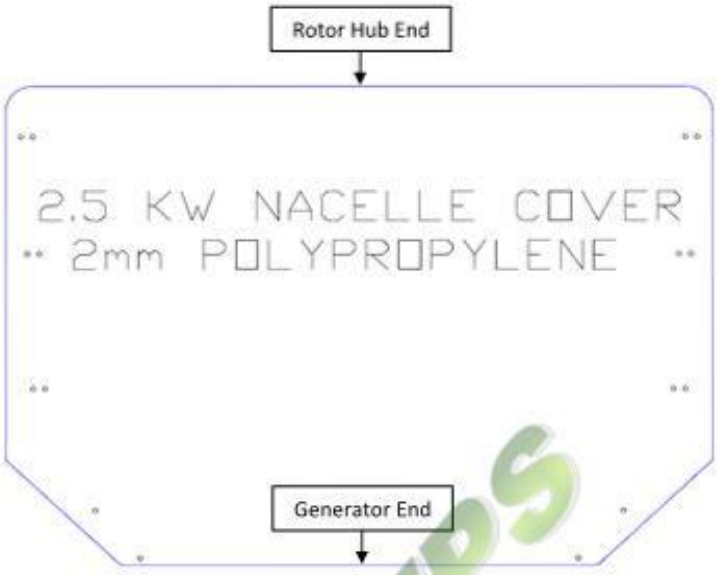
Step 2: Fold the cover around the frame under the generator end and secure the cover to the frame using cable tie (see arrows below) as in step 1.



Step 3: Finally tighten all ties and trim

3.6.3 Fitting the Nacelle Cover

Procedure



Step 1: Fold the cover over and around the nacelle frame and secure with cable ties. It may be necessary to join cable ties together to get the required length. Tighten all cable ties and trim.

3.7 Blade Assembly

Caution!

- Treat the blades with exceptional care – especially the leading and trailing edges of the airfoil.
- The blades are supplied as a balanced and matched set of three. Ensure each balanced set is keep and used together at all times.

3.7.1 Blade Description

The blades are made of the following parts

1. Airfoil – polypropylene
2. Zebedee hinge at blade root – polyurethane (PU)
3. Root of blade – Galvanised steel

These three parts are supplied already assembled.

Information

The blades are bolted to the hub plate by means of:
1. SS bolts provided
2. Galvanised steel clamp plates provided
3. Polypropylene clamp washer provided.

3.7.2 Fitting the Blades

Procedure

- Put polyprop (plastic) washer on top of hub (NB. back end of hub)
- Place PU (rubber) hinge of blade on top of washer
- Place further washer on top with metal clamp plate as final layer
- Secure blade using M8 bolts and lock nuts provided. It is good practice to use threadlocking compound (A118 or similar) to lubricate **and** secure fixings against vibration. Use only a **small** amount on each bolt.
- Check to ensure all fasteners are tight (25Nm for blade fixings).
- Repeat for the remaining two blades.

3.8 Zebedee Spring Assembly

3.8.1 Description

The Zebedee spring assembly consists of the following **per blade:**

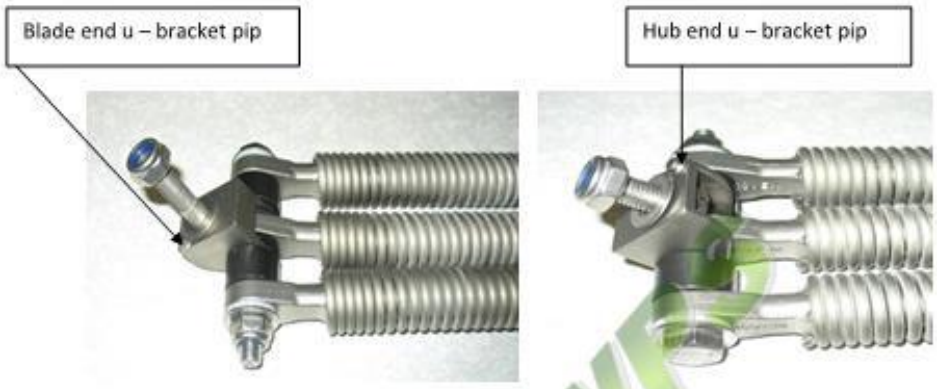
1. Three (3) individual springs.
2. U-bracket with M10 x 25mm bolt for connection to spring hub plate.
3. U-bracket with M10 x 45mm bolt for connection to blade root.

These three items are supplied already fitted together.

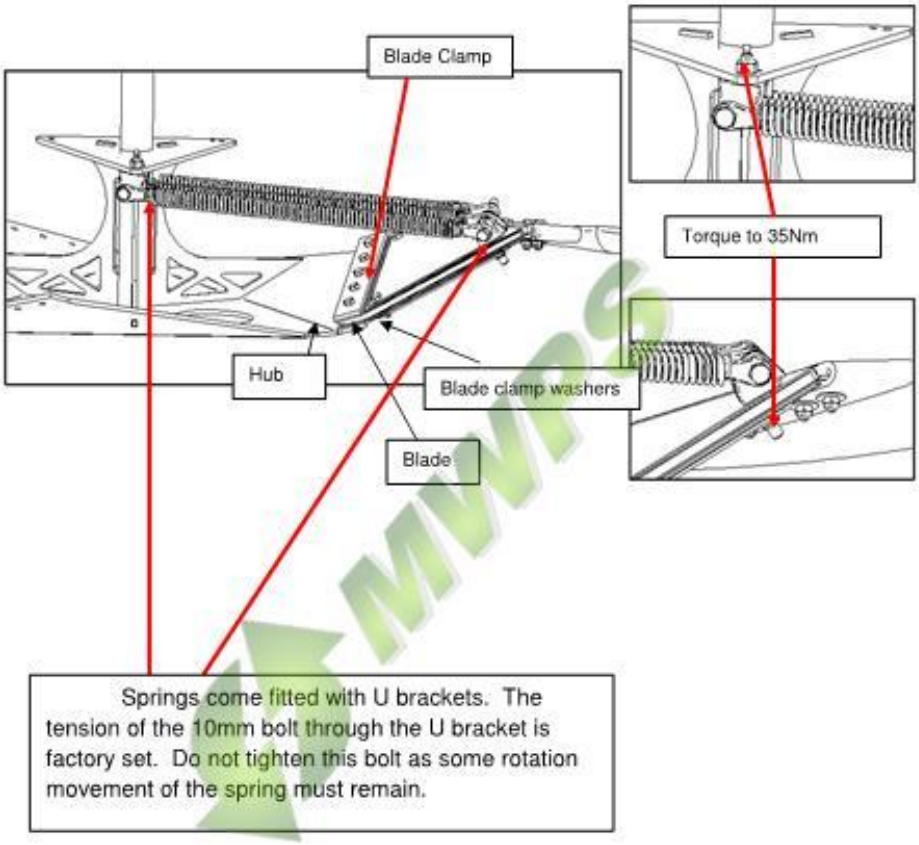
Fitting the Zebedee Spring Assembly

3.8.2 Procedure

- Bolt the U-brackets to the blade root plate and spring hub plate respectively via the
  U-bracket retaining bolts fitted. Ensure the pips on both U –brackets seat within the location holes on both plates.



- It is **very** important that the M10 fixing bolts running through the spring ends are not fully tightened as they are already factory tightened. This allows the spring ends to freely rotate during normal operation. However, there should be no lateral movement of the spring ends within the spring bracket.
- Check to ensure that all fasteners are tight (35Nm for hub end and blade end u – bracket bolts).
- Repeat for the remaining set of springs.



Springs come fitted with U brackets. The tension of the 10mm bolt through the U bracket is factory set. Do not tighten this bolt as some rotation movement of the spring must remain.

3.9 Raising the Turbine

Procedure

- Check hinge pin is in position and split pins at each end.
- Fit gin pole to bottom of pole to bottom of pole and strut to mid pole bracket – check nuts are tight on bolts.
- Hook Tirfor wire rope to mid pole bracket. Hook Tirfor to winch anchor, feed rope through Tirfor as per Tirfor instructions.
- Check that cables will not be trapped under pole base.
- Apply wind turbine parking brake
- Pull wind turbine up slowly with Tirfor.
- When upright keep tension on rope. Fit the tower flange bolts with spherical washers under the bolt heads. Use both parts of the spherical washers with the curved surfaces facing each other. Initially torque the tower flange bolts evenly to 200Nm. Use shims if there is a gap between the underside of the tower flange and the top of the base plate. Tighten all base bolts to correct torque (see appendix D). When base bolts are tight, release rope. Dismantle tackle and gin pole.
- If putting into service, release wind turbine and check rotation is OK, if breezy

Caution!

Clear lifting area of all non - essential personnel. Do not allow anyone to be in the vicinity of the wind turbine whilst raising and lowering. The turbine brake should be applied by means of the brake lever at the base of the tower and force applied to try and turn the rotor. The turbine brake should be left in the **ON** position prior to raising the turbine.

3.10 Lowering the Turbine

Procedure

- Apply wind turbine parking brake. Place trestle or support to offer support lowered to pole.
- Fit gin pole and rope tackle as for raising. Check all shackles, bolts and fittings are secure – check again before lowering.
- Take up slack in Tirfor.
- Put handle in lowering position. Make sure hinge pin and its splits are in place.
- Take out base fixing bolts
- Pay out a little rope and lift end of gin pole to tilt wind turbine over balance point until strain comes on Tirfor.
- Now lower wind turbine gradually with Tirfor.

4.0 Wind Turbine Maintenance

Your PROVEN 2.5, like all Proven Energy turbine models, require minimal maintenance. We recommend an annual service and regular visual inspection to spot any unusual occurrence.

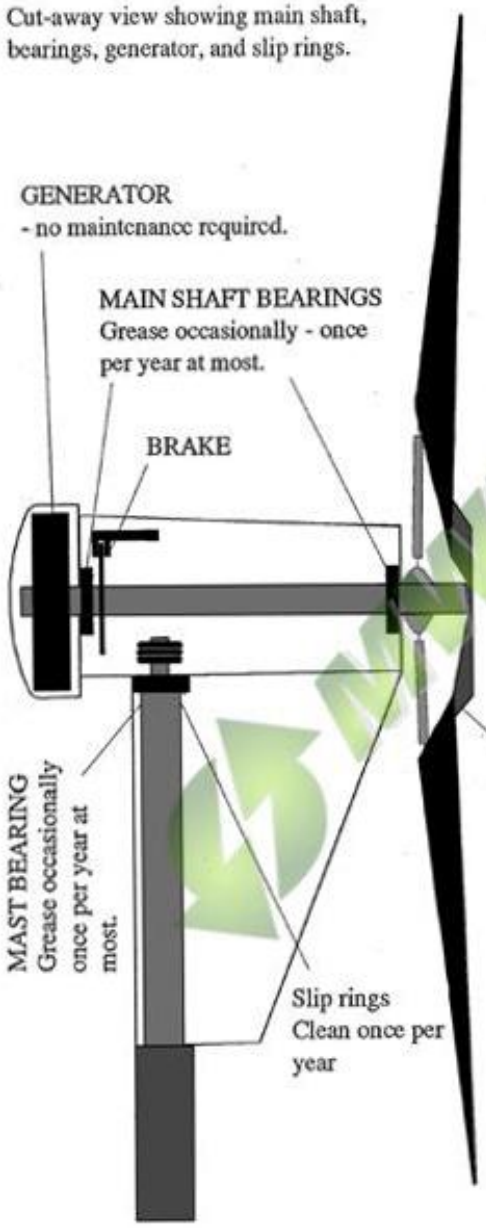
Caution!
Any damaged or cracked blade should be repaired or replaced immediately.

4.1 Annual Maintenance:

- Lower wind turbine as described previously
- Grease (Lithium EP – 2 multi purpose grease recommended) main rotor bearings and yaw bearing housing. 1 or 2 pops is recommended.
- Clean slip-ring assembly with emery cloth
- Check flange bolts and tower base bolts for tightness
- Listen for any abnormal noises or excessive vibrations, if any exists check for possible loose fittings or components
- Check brake pad thickness is more than 2mm and replace if worn beyond 2mm
- Check brake operation before raising wind turbine
- Check for general wear and tear and replace any worn parts
- Pay particular attention to the blades, especially the blade root. A damaged or cracked blade should be repaired or replaced immediately.

PROVEN WT2500 2.5KW WIND TURBINE

Cut-away view showing main shaft, bearings, generator, and slip rings.



Maintenance Schedule

Once per year:
Grease the three bearings,
Clean slip rings
Check Brake pads
Check nuts and bolts.
Check springs

Operation

No action is required during normal running
the system is self regulating and automatic with passive fail-safe speed and power control.

Proven Patent Passive Blade control system

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4.2 Wind Turbine Maintenance Schedule

TASK	TYPE OF SERVICE CHECK			
	INITIAL 3 MONTHS	QUARTERLY	ANNUALLY	10 YEARS AFTER
Check for smooth running	√	√	√	√
Check tower bolts	√	√	√	√
Check ph-ph voltage	√	-	√	√
Check brake operation	√	-	√	√
Check blades	√	-	√	√
Clean slip rings	-	-	√	√
Check slip ring brushes	-	-	√	√
Grease shaft bearings	-	-	√	√
Check yaw rubbres			√	√
Grease yaw rubber bolt			√	√
Grease yaw bearing	-	-	√	√
Check covers	-	-	√	√
Check welds	-	-	√	√
Check springs	-	-	√	√
Change blades	-	-	-	√

4.3 Maintenance Check List

KEY:

- X = Check
- C = Clean
- G = Grease
- R = Replace if need be
- A = Adjust if need be

TOWER / BASE			
1 GENERAL CONDITION	X		
2 FOUNDATIONS	X		
3 NUT / BOLT TIGHTNESS	X	A	
4 S/S SHIM	X	A	
5 WELDS / FILLETS	X		
6 HINGE BOLTS	X		
7 GIN POLE ASSEMBLY	X		
SLIP RING ASSEMBLY			
8 SLIP RING CONNECTIONS	X		
9 SLIP RING BODY	X	C	
10 SLIP RING BRUSHES	X	A	R
11 TOPHAT	X		
12 NUT / BOLT TIGHTNESS	X	A	
13 TOPHAT	X		
BLADES & SPRINGS			
14 BLADE CONDITION	X		
15 P.U. HINGES	X		
16 BLADE FIXINGS	X		
17 SPRING FIXINGS	X		
18 SPRING CONDITION	X		
19 NUT / BOLT TIGHTNESS	X	A	
20 WEDGES	X		
21 WASHERS / CLAMPS	X		
BRAKE SYSTEM			
22 BRAKE ASSEMBLY PARTS	X		
23 BRAKE OPERATION	X		
24 BRAKE PADS	X	R	
25 SHACKLE / ELASTIC	X		
26 BRAKE ROPE CONDITION	X	R	
27 BRAKE LEVERS	X		
ELECTRICAL SYSTEM			
28 CONTROLLER OPERATION	X		
29 V & I METER OPERATION	X		
30 CABLE CONNECTIONS	X	A	
31 CONDITION OF WIRING	X		
32 INVERTER OPERATION	X		
COVERS & OTHER CHECKS			
33 GENERATOR COVER CONDITION	X		
34 YAW COVER CONDITION	X		
35 NACELLE COVER CONDITION	X		
36 CABLE TIES	X	R	

4.4 Recommended Spares

- BL2501 Set (3) of Turbine Blades with Fixings
- YRO2501 Set (4) of Yaw Rubbers with Fixings
- ZB2501 Set (3) of Zebedee Springs with Fixings
- BRK2501 Set (2) of Brake Pads
- SLR2501 Slip Ring with Brushes and Fixings

5.0 Trouble Shooting

Problem	Possible Cause(s)	Diagnosis	Remedy
Louder than quoted noise level	- Loose fittings or components	- Check to see if all fittings and components are tightly fitted	- Tighten loose fittings or components
Turbine fails to turn in good wind	- Shorted cables - Shorted diodes - Failed bearings -Foreign object in generator	- Check connections	- Repair short circuit - Replace faulty diodes - Replace bearings - Remove obstruction
Turbine turns slowly in good wind	- Partial short in cables - Diode short	- Check connections	- Repair short circuit - Replace diode
Low output	-Low wind speeds -Obstructions around turbine -High power usage	- Measure wind speed - Check siting of turbine - Check power usage	- Site turbine in a better location or height - Economise power use
Turbine vibrates excessively	-Blades incorrectly fitted or out of balance -Yaw bearing worn	- Check blade fittings	- Fix blade properly and balanced - Replace yaw bearing
No output though turbine turns at high speed	-Cables disconnected -Battery fuse blown -Controller ammeter open circuit	- Check connections	- Fix cables - Replace fuse - Replace meter

6.0 Wind Turbine Operation

Once installed and commissioned the Proven 2.5 (WT2500) operates automatically. Power output will vary with wind speed according to the power curve.

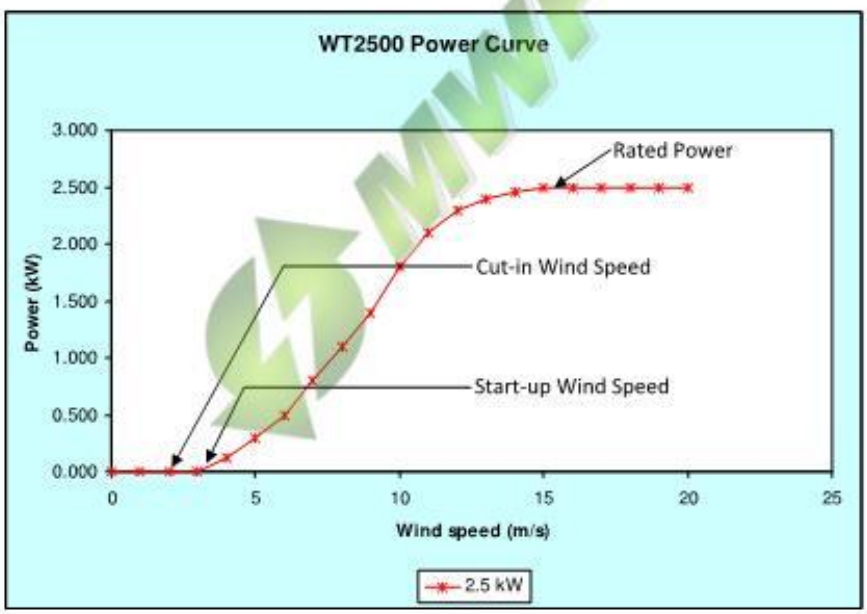
6.1 Power Curve

The power Curve is a graph that illustrates how the power output of the wind turbine varies with wind speeds. The power curve has been developed from collating a number of data logs obtained through standard testing procedures for a year.

Cut-in Wind Speed: Is that wind speed at which the wind transfers enough force to turn the rotor blades.

Start-up Wind Speed: Is that wind at which the turbine just begins to produce power. At start-up, the rotor blades turn fast enough and have adequate torque to enable the generation of power.

Although cut-in and start-up wind speeds are fairly close, they should not be mistaken to be the same.



Rated Wind Speed: Is the wind speed at which the turbine attains rated power. That occurs around 12m/s for a WT2500 and therefore ideally the power output should be 2.5 kW.

Rated Power: Is the optimum power output of the wind turbine which is 2.5 kW for the WT2500.

The Zebedee furl mechanism in place ensures that the output is regulated to the rated output at wind speeds above the rated wind speed.

The power output from the turbine can be determined from the meters installed. This is done by multiplying the instantaneous voltage reading in Volts on the voltmeter and the instantaneous current reading in Amperes on the ammeter to obtain the instantaneous power in Watt. Note that 1 kilowatt (kW) = 1000 Watt (W).

6.2 Vibration

The turbine should run smoothly at all wind speeds. Any significant vibration of the turbine and tower assembly should be reported to Proven Energy and the turbine stopped.

6.3 Noise

Virtually every device with a moving part makes noise and turbines are no exception. The turbine noise is produced by swishing sound from the blades as they rotate in the wind and is generally proportional to the wind speed and turbulence level. Noise is measured in decibels (dB). The noise the wind turbine creates is expressed in terms of sound power level which is a measurement of the noise power emitted by the turbine.

Proven Wind turbines have low noise levels because they have no gearboxes which are a major source of turbine noise. For example at 5m/s the emitted noise level is 45 dB (A) which lower than that of a car passing 20m away at a speed of 40mph (70 – 80 dB (A)). It is therefore perfectly normal to stand underneath the turbine and practically have a conversation without shouting. At the rated speed however i.e. the speed where the blades cone in to limit power output to rated, the noise level will increase slightly.

Other than that any non-air noise should be reported to Proven Energy.

7.0 Appendices

Appendix A: Electrical Schematic Drawings

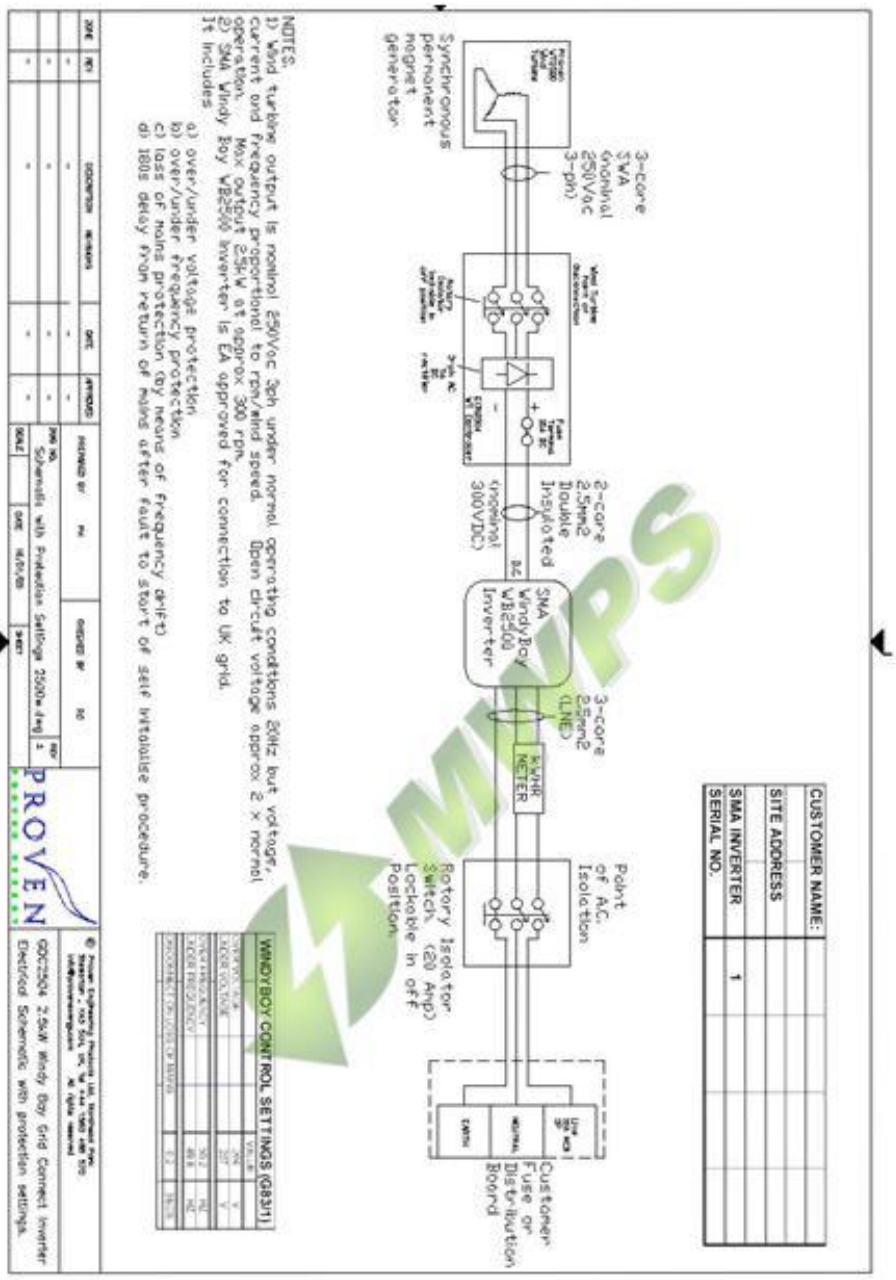
Appendix B: Proven Warranty Statement

Appendix C: Delivery, Storage and Handling of Proven Wind Turbines

Appendix D: Bolt torque table

Appendix A

Electrical Schematic Drawings


CUSTOMER NAME:
SITE ADDRESS
SMA INVERTER SERIAL NO.
1
Synchronous permanent magnet generator
3-core SWA nominal 250Vac 3-ph)
2-core 2.5mm2 Double Insulated nominal 300VDC)
SMA WindyBoy WB2500 Inverter
3-core 2.5mm2 (LINE)
kWHR METER
Point of A.C. Isolation
Rotary Isolator Switch (20 Amp) Lockable in off Position.
Customer Fuse or Distribution Board
NOTES:
1) Wind turbine output is nominal 250Vac 3ph under normal operating conditions 20Hz but voltage, current and frequency proportional to rpm/wind speed. Open circuit voltage approx 2 x normal operation. Max output 2.5kW at approx 300 rpm.
2) SMA Windy Boy WB2500 inverter is EA approved for connection to UK grid.
It includes
a) over/under voltage protection
b) over/under frequency protection
c) loss of mains protection (by means of frequency drift)
d) 180s delay from return of mains after fault to start of self initialise procedure.
WINDYBOY CONTROL SETTINGS (G83/1)
QDC2504 2.5kW Windy Boy Grid Connect Inverter Electrical Schematic with protection settings.
PROVEN

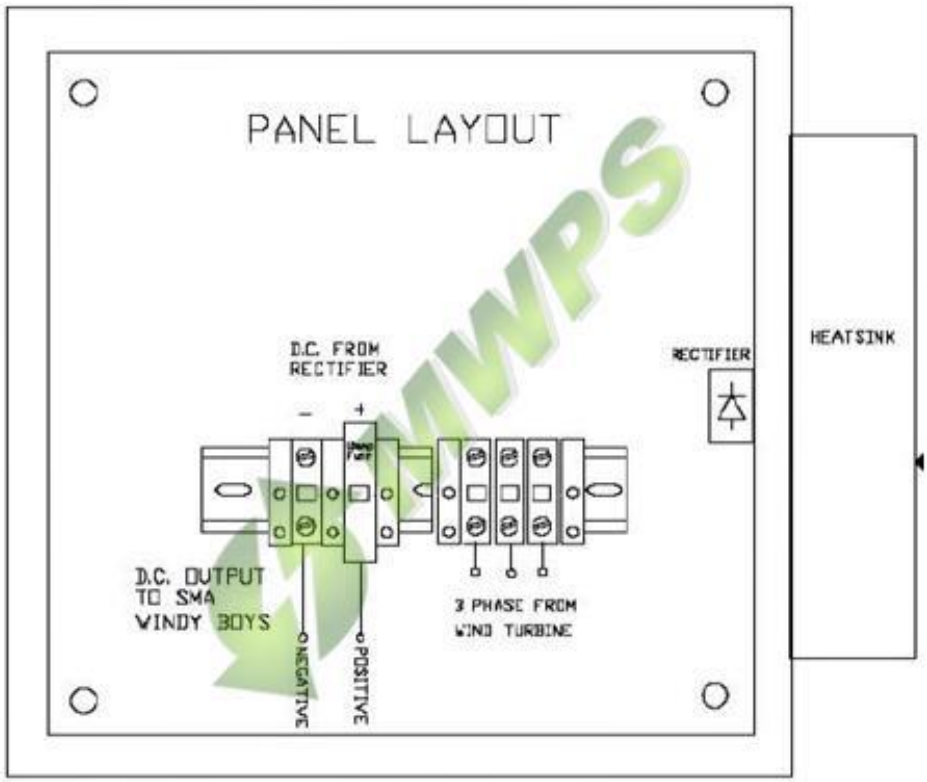
PROVEN 2.5 INSTALLATION USING WINDY BOY 2500

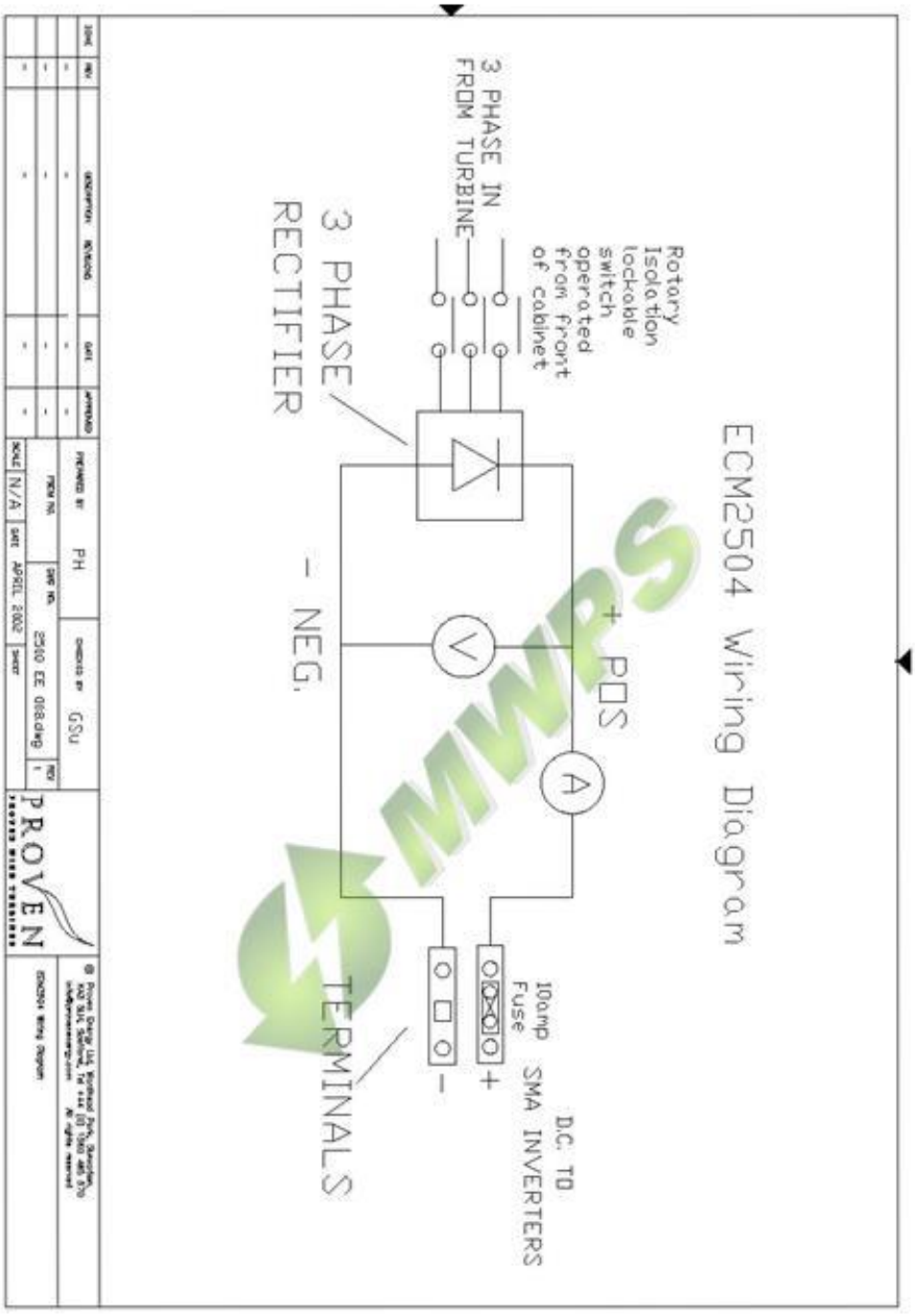
PROVEN PARAMETER SETUP LIST (UK) FOR WINDY BOY 2500

PARAMETER	VALUE
Upv–Start	250.000v
T–Start	180.000S
T–Stop	3000.000s
Usoll-Konst	600.000v
P Max	2500W
P Limit	2550W
I-NI TEST	0.00mA
Uac-Min	209.000v
Uac-Max	264.000v
AcVtgRPro	263.000v
Vac-Tavg	80.000ms
Fac-Delta -	3Hz
Fac-Delta +	0.5Hz
Fac-Tavg	80.000ms
dFac-Max	0.25Hz/s
dZac-Max	350.0mOhm
Udc Wind Start	260.000v
Udc Wind Mid	280.000v
Udc Wind Max	288.000v
KP-Wind Reg	0.015
KI-Wind Reg	0.005
Fac-Start delta	1.000Hz
FacLimit delta	2.000Hz
P-Wind-Ramp	500.000W
P-Wind-Mid	1400.000W
Betriebsart	Turbine
Memory Function	keine Function
* Default	GB/G83
Storage	Permanent

NB: Please change the default settings first to GB/G83 before proceeding to change the rest of the parameters.

ECM2504 Panel Layout




ECM2504 Wiring Diagram
Rotary Isolation lockable switch operated from front of cabinet
3 PHASE IN FROM TURBINE
3 PHASE RECTIFIER
+ POS
- NEG.
TERMINALS
10amp Fuse
D.C. TO SMA INVERTERS
+
-
V
A
PROVEN
PH
GSU
N/A
APRIL 2002
2510 EE 018.dwg
ECM2504 Wiring Diagram

Appendix B

Proven Warranty Statement

Proven Energy Universal Warranty

Products designed and manufactured by Proven Energy Limited ("Proven") or its sub-contractors acting under its control are carefully designed, manufactured, tested and inspected. In consequence we undertake to replace any part found to be defective in material or workmanship free of charge for a period of five years from installation date on the terms set out below. This warranty applies only to those products designed and manufactured by Proven or its sub-contractors acting under its control and supplied by Proven or its authorised re-sellers and does not apply to parts and materials sourced from suppliers other than Proven and its authorised re-sellers (even if supplied with Proven products), nor does it apply to any element of installation, responsibility for which rests solely with the installer.

Warranty

Subject to the terms set out below, Proven warrants to any end-user who purchases new products designed and manufactured by Proven or its sub-contractors acting under its control from Proven or from an authorised Proven re-seller (but not from another end-user) that such products will be free from defect in material or workmanship in normal use for a period of five years from installation date (the "Warranty Period").

If a defect arises and a valid claim is received within the Warranty Period, at its option and to the extent permitted by law Proven shall either (1) repair the defect at no charge, using new or refurbished replacement parts or (2) exchange the product with a product that is new or which has been manufactured using new or serviceable used parts or (3) refund the purchase price or a reasonable proportion of the purchase price.

A replacement product or part, including an end-user-installable part that has been installed in accordance with instructions provided by Proven, assumes the remaining Warranty Period of the original product or one (1) year from the date of replacement or repair, whichever provides longer coverage for the end-user.

When a product or part is exchanged, any replacement item becomes the end-user's property and the replaced item becomes Proven's property. Parts provided by Proven in fulfillment of its warranty obligation must be used in products for which warranty service is claimed. When a refund is given, the product for which the refund is provided must be returned to Proven and becomes Proven's property.

Exclusions:

This warranty does not cover damage to Proven products resulting from:

- Improper transportation or storage of products prior to installation
- Unauthorised alteration or modification of the products
- Misuse of the products.
- Improper installation of any kind (see below concerning use of Proven wind turbines with mast or towers manufactured by others).
- Improper operation.
- Failure to conduct periodic inspections and maintenance.
- Damage caused by flying debris, bird strike, lightning or other unforeseen acts.
- Damage occurring during periods of wind speeds exceeding 70m/s for the 2.5kW and 6kW turbines
- Damage occurring during periods of wind speeds exceeding 54m/s for the 15kW turbine
- Acts of God.
- Reasonable wear and tear.

This warranty does not apply to:

- consumable items unless damage is caused to them due to defects in materials or workmanship, or
- cosmetic damage of any kind.

Conditions:

Unless we confirm otherwise in writing, this warranty may only be enforced by the party who purchased the relevant products new from Proven or from an authorised Proven re-seller and not by any party who acquired the relevant products from a third party after the date of first installation of the relevant products.

For this warranty to apply:

- Proven's wind turbine and associated equipment must be installed only by individuals who have each attended a Proven training course for the installation of the turbine and equipment in question.
- Proven's wind turbine must be connected in a manner that meets the relevant national electrical code requirements of the installation country and must be installed by an electrician properly licensed under the legal and regulatory requirements of the installation country.
- The warranty must be registered in the manner set out below.

Warranty registration:

To register the warranty, Proven requires the following details to be submitted within one calendar month of the time of installation:

- Date of installation with full site address and contact details, including email.
- Full details of system installed along with tower installed and electrical schematic drawings.
- List of device(s) under warranty with the serial number(s) if present.
- Digital photographs of the turbine and tower installed including panoramic view of site.
- Digital photographs of the electrical installation.
- Name and address of installer.
- Name and address of supplier of Proven equipment (if different from installer).

Ideally, registration will take place via the Proven web site, www.provenenergy.com but otherwise the required documentation, using the postcard provided with the relevant products, should be sent to Proven at the headquarters address shown on that web site.

Proven will use all reasonable endeavours to contact the end-user within a month of receiving the registration details, using the contact details provided by the end-user, to confirm warranty cover and/or to ask for clarification or for additional or missing details to be provided.

Use of Proven Wind Turbines with Mast or Towers manufactured by others:

Poor mast or tower design may cause vibration and/or failure both in the mast and the wind turbine. Faults arising from poor mast design shall be classed as improper installation. Where a Proven wind turbine has been used with a non-Proven mast or tower, the onus shall lie with the owner to show their mast or tower has not caused the fault.

Shipping and Transport Costs:

Where practical, warranty repairs will be made at the installation site. Where this is not practical, repairs will be made at the premises of Proven Authorised Representatives or our factory. The end user or installer must return the defective component(s) properly packed, and with all freight and insurance charges prepaid. No goods must be returned without first obtaining a returns authority and number from Proven. All freight, shipping and insurance costs including duties, taxes and import charges incurred in returning Proven products are to be met by end user.

Labo(u)r Costs:
Where a repair is being carried out under the terms of this warranty by someone other than Proven itself, the cost for such repair must be agreed, in writing, with Proven before work commences and under no account will Proven accept charges for work in excess of the cost as agreed, or other than that strictly required to effect the repair.

Disclaimer:

Proven shall not be liable for any incidental or consequential damages resulting from the proper or improper use, for any purpose whatsoever, of Proven products. For the avoidance of doubt, Proven will not be liable for costs, directly or indirectly associated with any loss of production caused through product failures covered under this, or any other, warranty.

Statutory rights and limitations:

This warranty in no way diminishes the end user's statutory or legal rights.

This warranty gives the end user specific legal rights, and the end user may also have other statutory rights, which vary from country to country.

Proven's responsibility for defects is limited to the repair or replacement service as determined by Proven.

All express and implied warranties, including but not limited to any implied warranties and conditions of merchantability and fitness for a particular purpose, are limited in time to the term of this limited warranty.

Save to the extent permitted by law no warranties, whether express or implied, will apply after the expiration of the limited Warranty Period.

No Proven reseller, agent, or employee is authorized to make any modification, extension, or addition to this warranty.

If any term is held to be illegal or unenforceable, the legality or enforceability of the remaining terms shall not be affected or impaired.

Except as provided in this warranty and to the extent permitted by law, Proven is not responsible for direct, special, incidental or consequential damages resulting from any breach of warranty or condition, or under any other legal theory, including but not limited to loss of use; loss of revenue; loss of actual or anticipated profits (including loss of profits on contracts); loss of the use of money; loss of anticipated savings; loss of business; loss of opportunity; loss of goodwill; loss of reputation; loss of, damage to or corruption of data; or any indirect or consequential loss or damage howsoever caused including the replacement of equipment and property.

The foregoing limitation shall not apply to death or personal injury claims, or any statutory liability for intentional and gross negligent acts and/or omissions.

Some countries do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to the end user.

Actions in the Event of a Defect Occurring During Warranty Period:

In the unlikely event of a defect arising, **first ensure the safety of people and equipment by electrical disconnection and application of the wind turbine brake, as appropriate.** Please notify the supplier of your Proven equipment immediately who will advise on the correct procedure for making a claim under this warranty.

Minor Faults:

If the fault is a minor one and can be rectified by replacing components which could be simply fitted by the end user or installer, then a replacement part will be sent as soon as possible by post or courier. Proven will meet the costs of postage or courier in the event that the warranty claim is valid.

Serious Faults:

In the unlikely event of a serious fault, Proven or a Proven Authorised Reseller will arrange for an engineer to attend the site, if required, and rectify the fault. The work will be charged at standard rates if the conditions of the Proven Warranty as set out above do not apply.

If it is not practical to correct the fault at the installation site, the defective components must be returned to Proven or Proven's authorised representative on the basis set out above under the heading "Shipping and Transport Costs".

Appendix C

Delivery, Storage and Handling of Proven Wind Turbines

Delivery, Storage and Handling of Proven wind turbines

1. Delivery

Before delivery, Proven wind turbine and its various components should be protected to ensure the components remain in good condition until they are ready for installation. All materials for delivery should be verified against the delivery document. All required accessories should be delivered together with the main components (excluding the foundation kit which should be delivered prior to the wind turbine shipment). Materials could be packed in either wood pallets or wood/carton boxes. Upon delivery on site, the materials should be checked for damages during transportation and that the delivered materials are in compliance with the specifications. Any damaged or incorrect materials should be returned to Proven Energy.

2. Storage

Delivery of materials should be carefully planned according to the installation schedule as to minimise the storage time on site where the possibility of damages is higher. Proper site storage is important in preventing damages to the Proven wind turbine and it's components. A suitable storage location should be:

- sheltered from weathering and fallen objects; and
- located for ease of material handling and movement.

Components should be placed so that there is no direct contact with the ground. In addition, the various components should be arranged according to the installation sequence to facilitate ease of retrieval, i.e. to minimise searching and unnecessary shifting of materials which may lead to damages. For ease of installation all blades with PU hinges should be stored away from direct sunlight to avoid thermal expansion of the hinge.

3. Handling

All handling should be performed in accordance with the Proven wind turbine installation manual using only approved lifting equipment and slings suitable for the load. Exceptional care should be given to the blades – especially the leading and trailing edges of the airfoil. Even minor dents can cause a noise issue when the turbine is operational.

Appendix D

Bolt Torque Table

Foundation Bolt Torques Nm

Size	Grade	
Medium viscosity oil	8.8	10.9
M20	320	460
M24	550	800
M30	1100	1600
M36	1900	2750