

Southwest Windpower, Inc.
Renewable Energy Made Simple

**Whisper 500
Grid Connect
Owners Manual**



***WHISPER 500 High Voltage
WIND GENERATOR***

with
Magnetek Aurora Inverter
And Aurora Wind Interface



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WIND GENERATOR SERIAL NUMBER _____

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WIND GENERATOR SERIAL NUMBER _____

BEFORE YOU BEGIN:

Read this entire manual. Following the instructions and recommendations in this manual will help assure safe and enjoyable use of your new renewable energy system.

SAFETY INFORMATION: These systems present mechanical, electrical and chemical (battery) hazards that can be life threatening. The tower or support structure could fall and cause injury or death and property destruction. A component of the wind generator could come loose causing injury or death and property destruction. Contact with the high speed rotating machinery can result in severe injury or death. High voltage from the wind generator or the inverter can cause injury or electrocution. A burn injury can result from an electrical short. A severe chemical burn including blinding can occur from a battery explosion or contact with the sulfuric acid in a lead-acid battery.

These conditions are addressed in the following safety messages:

STOP! DANGER! It is your responsibility to obtain all required permits and engineering certifications for your tower and tower location. Soil and wind conditions vary and towers and tower foundations must be designed for your specific location. Tower must not be able to fall on occupied buildings, neighbor's property or power lines. Tower climbing is dangerous and should be attempted only by experienced personnel using proper safety equipment. A fold-over tower can eliminate climbing. Locate your mounting mast (tower) well away from occupied buildings and power lines; a minimum of 100m (300 ft) is recommended.

STOP! DANGER! If the generator appears loose on the tower or is making an unusual sound, the condition must be corrected immediately. A loose generator or component will soon damage itself further and may fall from the tower or lose parts that could be lethal. Never stand in line with an operating blades.

STOP! DANGER! Provide climbing protection against all unauthorized persons or children. Never allow an untrained person or someone without the proper safety equipment to climb the tower. Always stop the propeller before climbing the tower. Both falling from the tower and contact with the spinning blades can be lethal.

STOP! DANGER! High voltage systems (that is, systems with battery voltages of 64 volts and above or the primary side of any system with a transformer) represent a dangerous shock hazard and could be lethal. All high voltage systems should be wired and maintained by a qualified and licensed electrician.

STOP! DANGER! Batteries may emit explosive and irritating gas. Never light a match or make any type of spark near a recently-charged or charging battery. Use protective gloves and safety glasses when working around a battery. Turn off all loads when making a final battery connection.

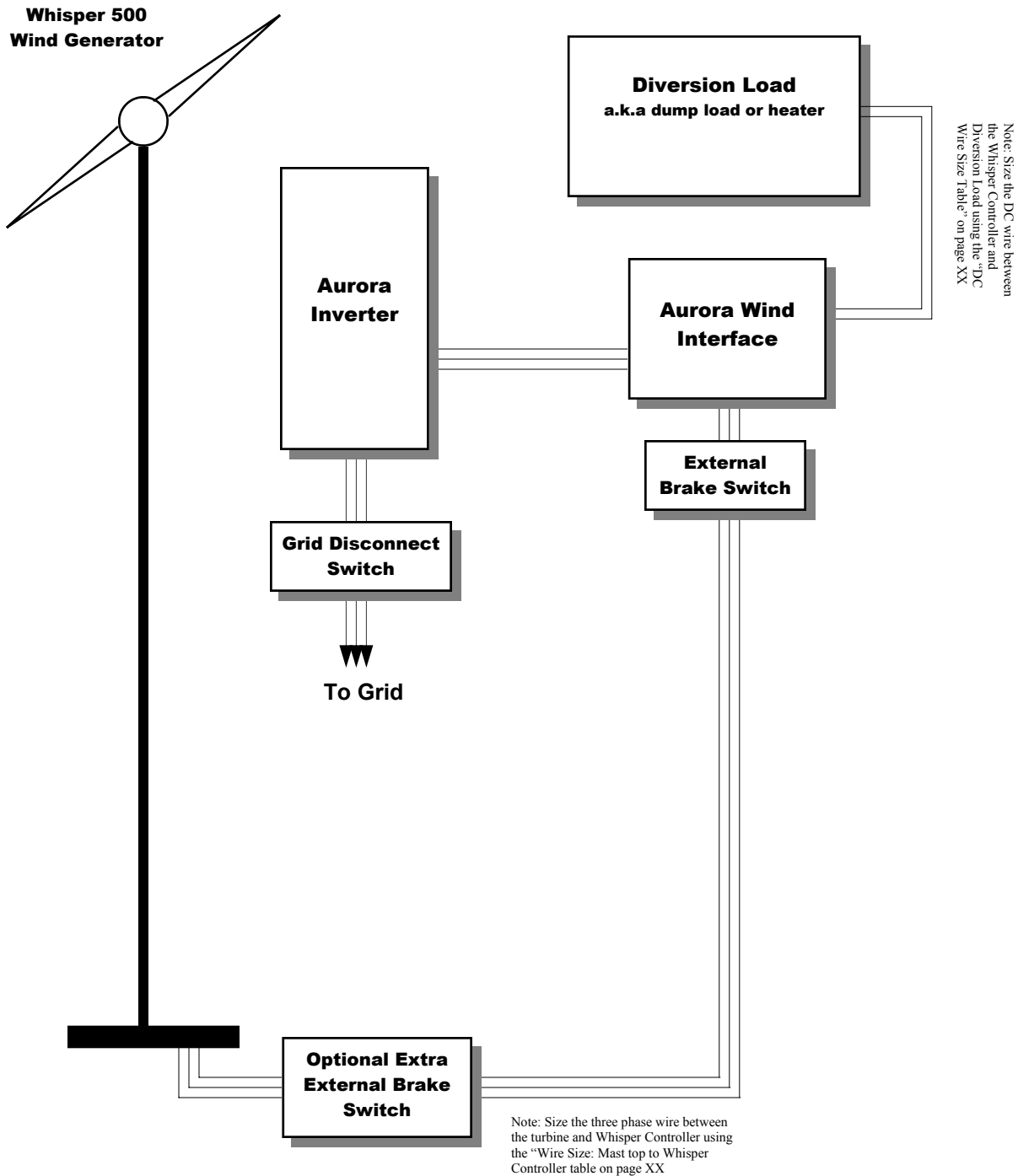
STOP! DANGER! NEVER place objects on top or near the Whisper Controller enclosure, diversion load, transformer, Aurora Wind Interface or inverter, when applicable. These devices must dissipate heat as part of normal operation. FIRE AND FAILURE can result if airflow is blocked.

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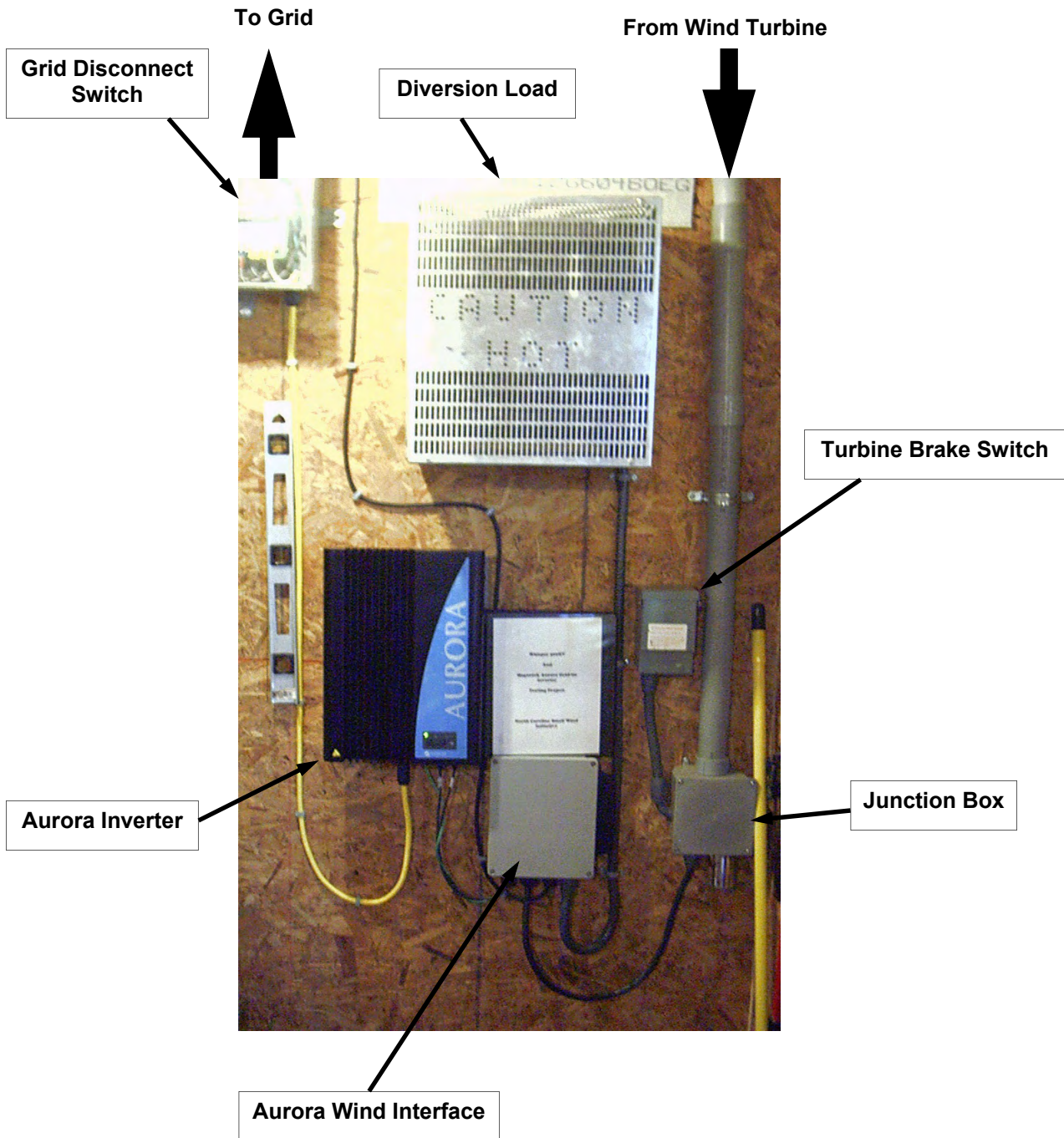
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WHISPER 500 GRID CONNECT SCHEMATIC

You will need to make the electrical connections as shown below.



WHISPER 500 GRID CONNECT TYPICAL INSTALLATION



INSTALLATION

DO THE FOLLOWING STEPS IN ORDER

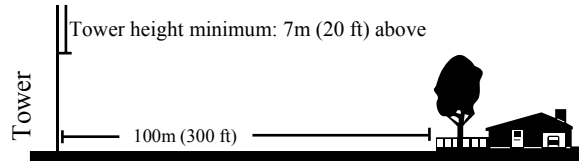
1. INSTALL TOWER & TOWER WIRES *(Install tower following manufacturer's instructions.)*

The turbine is designed to fit on a 5-inch schedule 40 steel pipe. Southwest Windpower recommends a tower height

of 7 meters (20 feet) above trees or obstacles within 100m (300ft).

The highest point on your property is generally best, but wind generator distance to the Wind Interface determine the correct wire size (Refer to wire size table below).

Note; The lateral thrust rating for the Whisper 500 at a wind of 45 m/s (100 mph) is 3.6 kN (800 lbs).



WIRE SIZES: TOWER TOP TO WIND INTERFACE

Use one even size larger for Aluminum wire.

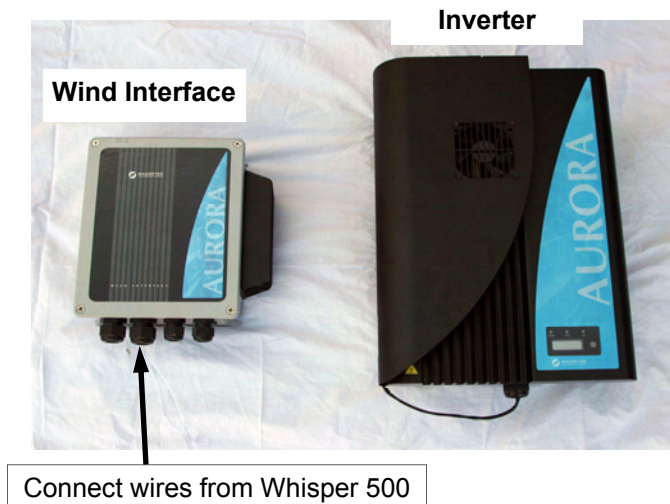
Use 3 wires and add a ground wire from the tower to the house ground. Cut wire length longer than you think it should be to allow for conduits elbows, etc. (it is easier to cut wire later than to add wire later).

COPPER		
WIRE SIZE	FEET	METERS
AWG 14	903	275
12	1442	440
10	2296	700
8	3637	1107
6	5653	1723
4	9037	2753
3	11363	3463
2	14330	4367

2. INSTALL AURORA WIND INTERFACE

Install on heat resistant surface with adequate ventilation and with proper orientation

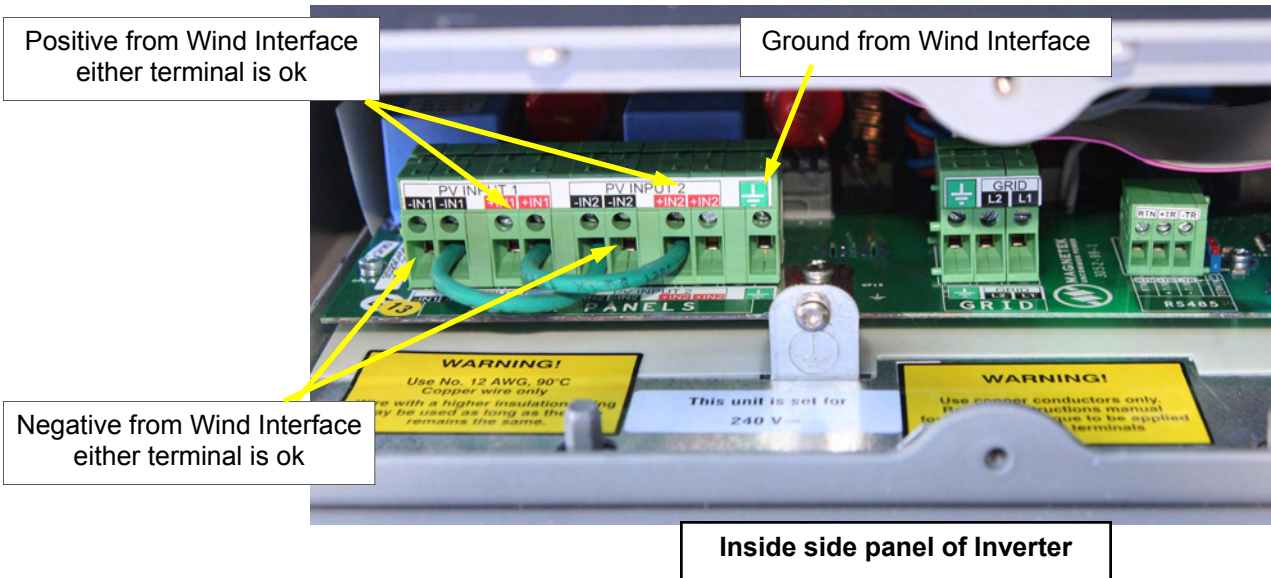
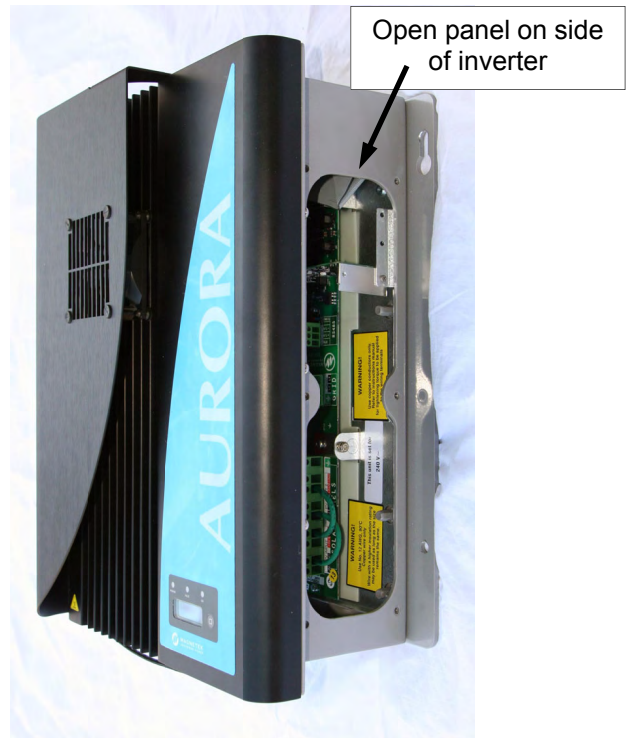
- A) The Wind Interface and the inverter should be mounted next to each other. The long dimension should be vertical as shown in the picture below.
- B) Connect the three turbine wires into the Wind Interface.
- C) Connect the tower ground wire into the Wind Interface.
- D) You may wish to add a junction box before the Wind Interface (see picture on page 5). A junction box makes wiring the brake switch easier, and allows a location for a lightning arrestor.



3. INSTALL AURORA INVERTER

Install on heat resistant surface with adequate ventilation and with proper orientation

- A) Open the side panel on the inverter using the proper sized torx-head driver.
- B) Connect the Wind Interface to the inverter using 12-gauge copper wire. The “BULK OUT” label in the Wind Interface are the terminals to connect to the inverter (see page 7). Note how there are two jumper wires in the inverter connecting the positive and negative terminal blocks (see picture below). It does not matter which terminal block you connect to so long as positive from the wind interface goes to positive in the inverter, and negative from the wind interface goes to negative in the inverter.
- C) Connect a ground wire between the wind interface and inverter.



Positive from Wind Interface either terminal is ok

Ground from Wind Interface

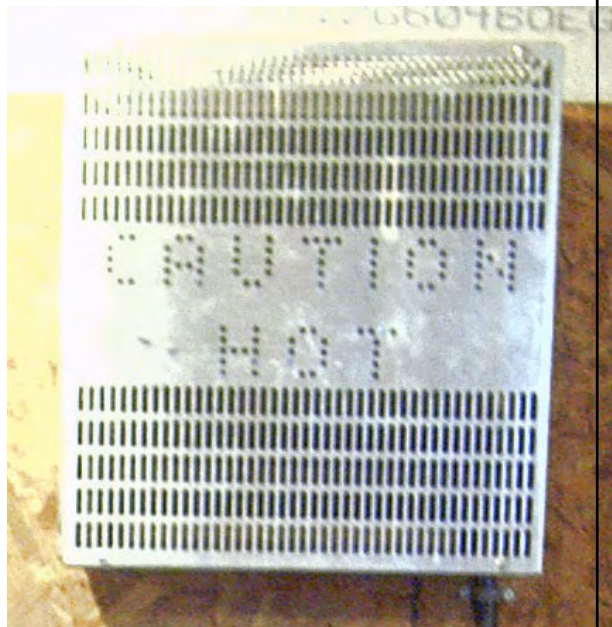
Negative from Wind Interface either terminal is ok

Inside side panel of Inverter

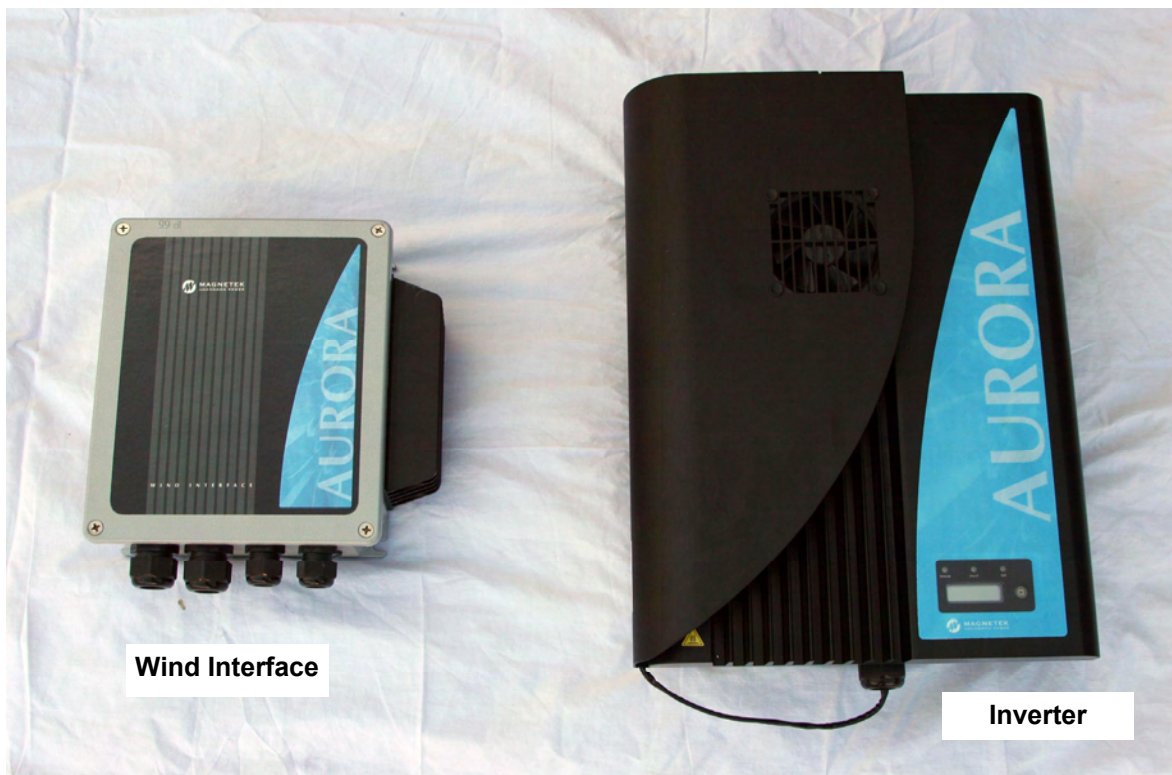
4. INSTALL DIVERSION LOAD

- A) Install diversion load on a heat resistant surface with adequate ventilation.
- B) Connect the pair of wires to from the diversion load to the Wind Interface. Refer to the diagram on page 7. The “BRAKE” label within the Wind Interface are the terminals for the diversion load (see page 7). The order of the wires from the diversion load is not important.

The diversion load will produce heat when there is loss of the grid. Locate the diversion load next to the Wind Interface, or where heat is needed. Heat will rise from the diversion load, so sensitive components such as the Wind Interface and inverter should not be installed above it (see picture on page 5). Most of the time, the diversion load will be cool because the wind’s energy is being converted to usable electricity.



Diversion Load



Wind Interface

Inverter

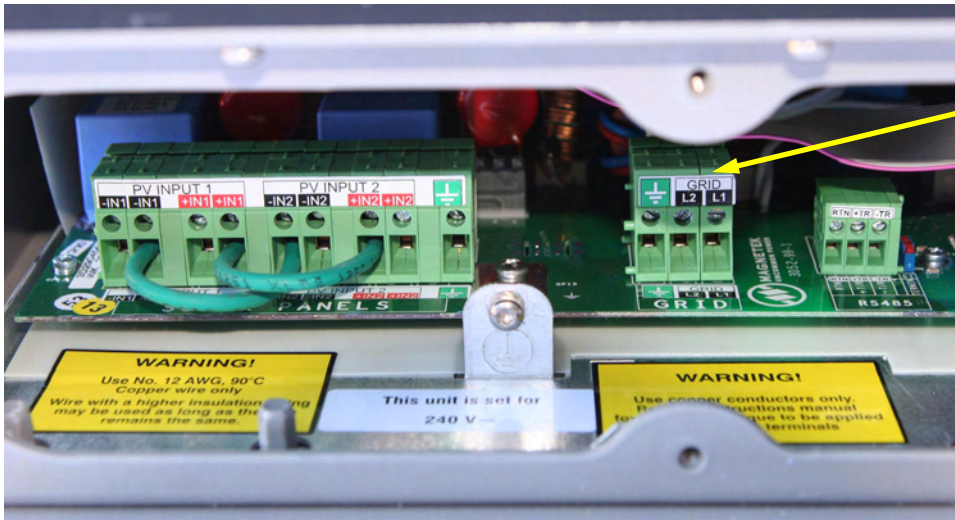
5. INSTALL GRID DISCONNECT SWITCH

A switch is necessary between the inverter and the grid (see picture on page 5).

Refer to the *Magnetek Aurora Inverter Owners Manual* for specifics about this switch.

Connect the inverter to the grid disconnect switch using 12-gauge wire. The picture below shows the terminals inside the inverter that are connected to the grid disconnect switch.

IMPORTANT: At this point, do not engage the switch to the grid.



Connect to grid disconnect switch

Inside side panel of Inverter

6. INSTALL BRAKE SWITCH

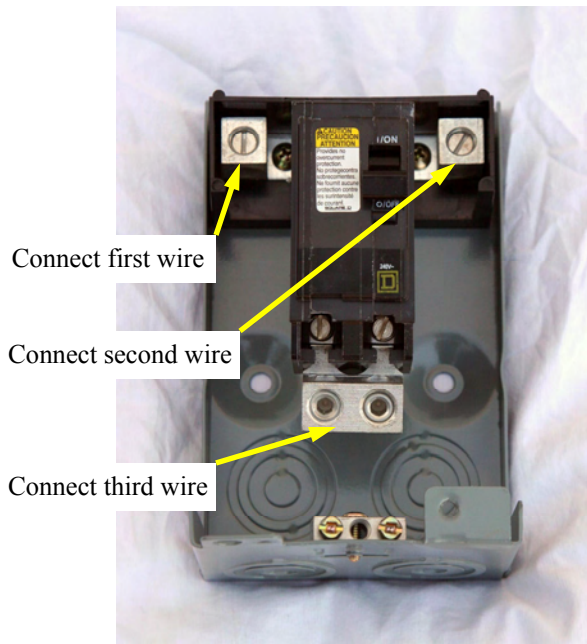
Mount the brake switch next to the Wind Interface. The brake switch should be connected in parallel with the three transmission wires between the wind generator and the Wind Interface. The brake switch operates simply by shorting all three wires together to generate braking torque on the propellers.

Disregard the original “on” and “off” marking on the switch. Moving the switch up is “brake on”, and moving it down is “normal operation”.

Use three #12 AWG wires to connect a wire in parallel with each of the three phases from the Wind Interface. The three wires are connected to the three different terminals indicated on the figure to the right. The order of the three wires does not matter.

You may want to install a junction box between the wind turbine and the Wind Interface. If so, then you can connect the brake switch to this junction box (see picture on page 5).

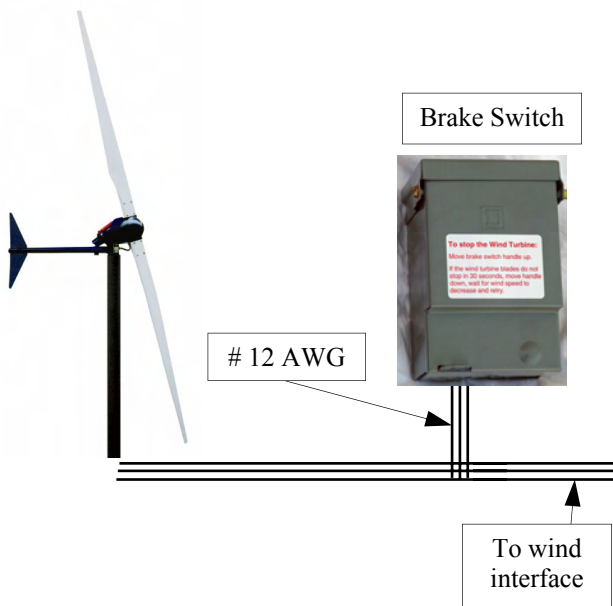
Optional: You may wish to add a second brake switch at the base of the tower. If so, then call Southwest Windpower and ask to purchase a Whisper 500 Brake Switch.



To Stop the Wind Turbine

Move brake switch handle up.

If the wind turbine blades do not stop in 30 seconds. Move handle down, wait for wind speed to decrease and retry.



7. WIND GENERATOR ELECTRICAL TESTS

Complete these tests before mounting blades to rotor, and before installing turbine to top of tower. These tests confirm that the wind generator is functional and ready to install on the tower.

SHORT CIRCUIT



When the wires are shorted together the generator rotor should turn hard and smooth.

GROUND



Check resistance to ground on each wire. Resistance must exceed 10,000 ohms.

OPEN CIRCUIT



When the wires are open the wind generator rotor should spin freely.

8. DRILL TOWER TOP HOLES

Drill the six 1/2" (12.7mm) holes in the top of the tower using the foldout template at the end of this manual. You must use a sharp drill bit and a powerful drill to make these holes in steel pipe. Applying a cutting fluid at the tip of the drill bit can improve the performance and longevity of the the bit. Debur the six holes, and then check the fit of the tower insert in the top of the tower The six holes in the insert should match the six holes you just drilled.

9. INSTALL TOWER INSERT ON YAW SHAFT

<u>Part #</u>	<u>Part Description</u>	<u>Qty</u>
IAC14A	5" tower insert	1
IAR98	M10x55 Grade 10.9 zinc bolt	3
IAR99	M10 zinc lockwasher	3
IAR43	M8x30 SS set screw	3
IAR17	M8 SS nylock hex nut	3
IAR29	4mm short arm allen wrench	1
IAR41	M10x25 SS hex bolt	6
IAR40	M10 SS lockwasher	6

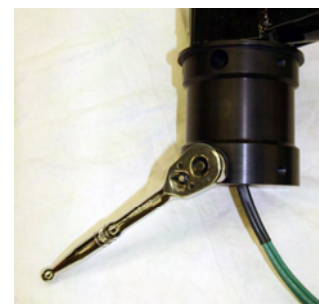


Mounting Instructions

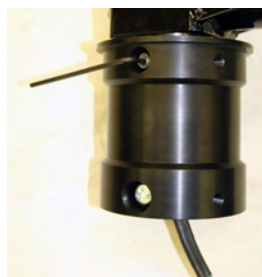
- A) Check the fit and hole alignment of the tower insert inside tower, before installing it on the yaw shaft. The six holes you just drilled in the tower pipe should line up with the six holes in the tower insert. A maximum of 1.5mm (1/16in) play is allowed. Tower Pipe or tube must be tight against insert when the mounting bolts are tightened.



- B) Install the tower insert onto the yaw shaft. Place the three M10x55 screws into the tower insert and thread them into the yaw shaft. Be sure to use the three M10 zinc lock washers on these screws. Tighten with a 17mm socket.



- C) Finger-tighten the nylock nuts over the three M8x30 set screws. Tighten the three M8x30 set screws on the upper holes using the supplied allen wrench. After the set-screw is tightened with the allen wrench, tighten the nylock nut over the set-screw using a 13mm deep socket. You must use a deep socket with this nut because a regular socket will slip off the nut before the nut is fully tight, and result in an unsafe attachment between the turbine and tower.



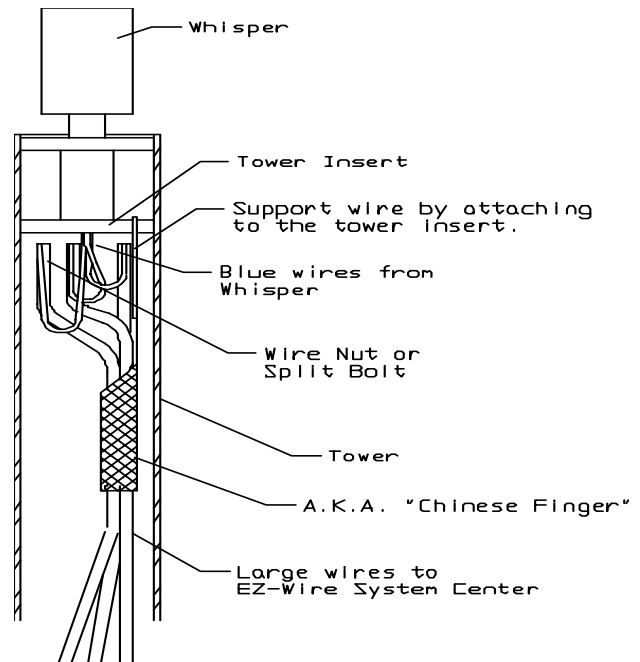
Use 13mm
deep socket

- D) The tower insert should now be fully attached to the yaw shaft..

10. CONNECT WIRES AND MOUNT WIND GENERATOR TO TOWER

Mounting Instructions

- A) Use split bolts to make the electrical connection between the yaw wires and the transmission wires inside the tower. Any of the three yaw wires can go to any of the three transmission wires. Use heat-shrink and electrical tape to fully insulate these connections from each other and any surrounding metal.
- B) Attach some type of wire support (A.K.A. Chinese Finger) inside the tower to support the weight of the wires. See figure on the right. It is important that the full weight of the wires is not being supported by the slip rings on the yaw shaft.
- C) Install the turbine, without the blades, onto to the tower top. Be careful not to pinch or short any of the wires. Rotate the tower insert so the six holes in the tower match the corresponding threaded holes in the tower insert.
- D) Tighten the six M10x25 screws through the holes on the outside of the tower pipe into the tower insert. Be sure to use the lockwasher on each of these screws. Tighten these six screws with a 17mm socket.
- E) The turbine should now be fully attached to the tower top.



11. TEST WIND GENERATOR TO WIND INTERFACE WIRING

Repeat Step 6, WIND GENERATOR ELECTRICAL TESTS. This time use the brake switch to short the wires, and measure the resistance between the phase and ground at the connection to the wind interface.

Short Circuit Test = Brake handle up

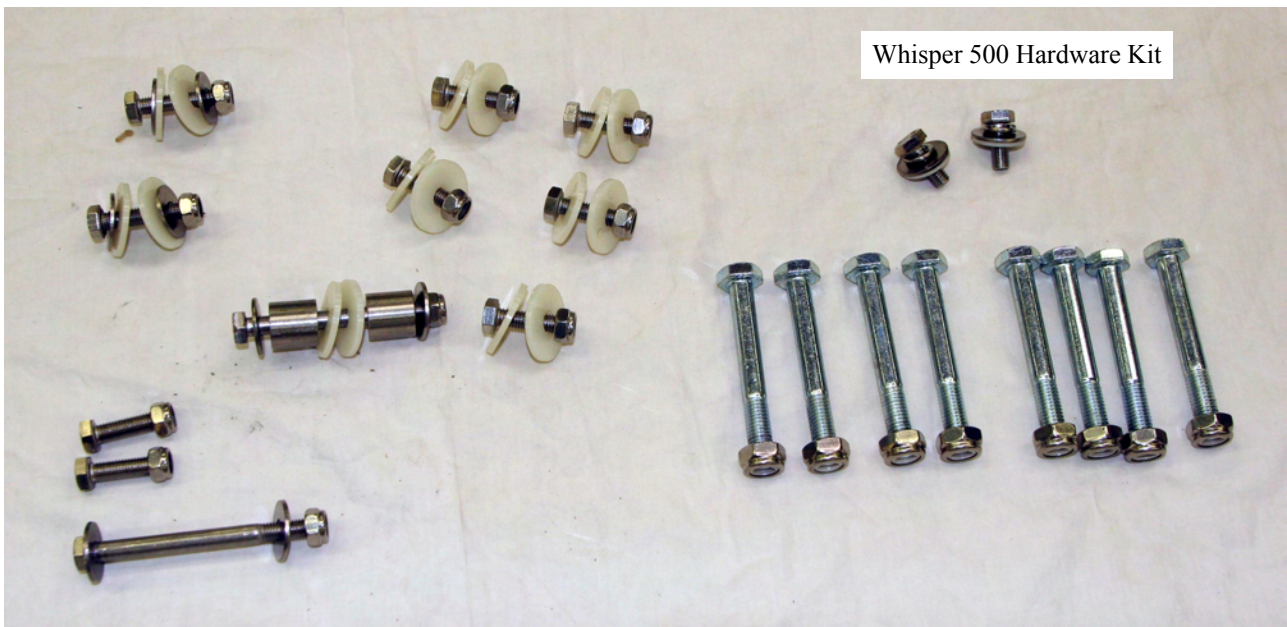
Open Circuit Test = Brake handle down

Do not install the propeller until each of these test OK.

HARDWARE

Lay out the hardware contained in the Whisper 500 Hardware Kit and separate as appropriate. You will need metric sockets and wrenches to complete the installation.

<u>Item</u>	<u>Part #</u>	<u>Part Description</u>	<u>Qty</u>	<u>Place used</u>
1	3-HDWA-201-09	M8x 24 SS flatwasher	10	Tail strap to tail fin & Tail strap to tail boom & Tail boom through-bolt & Nose cone
2	3-HDWA-905	M8x31 nylon flatwasher	16	Tail fin to tail boom & Tail strap to tail fin
3	3-HDWA-907	M8x24 nylon flatwasher	2	Nose cone
4	3-HDBT-2004-066	M8x20 SS hex screw	2	Nose cone
5	3-HDBT-2006-070	M8x30 SS bolt	7	Tail fin to tail boom & Tail boom to lower weldment
6	3-HDBT-2006-080	M8x90 SS bolt	1	Tail boom through-bolt
7	3-HDBT-2007-116	M10x80 zinc bolt	8	Blades
8	3-HDBT-2006-079	M8x80 SS bolt	1	Tail strap to tail boom
9	3-HDBT-2006-072	M8x40 SS bolt	2	Tail strap to tail fin
10	3-HDWA-200-09	M8 SS lockwasher	2	Nose cone
11	3-CMBP-1136	3/4" tube spacer	2	Tail strap
12	3-HDNT-201-02	M8 SS nylock	11	Tail strap to tail fin & Tail strap to tail boom & Tail fin to tail boom & Tail boom through-bolt & Tail boom to lower weldment
13	3-HDNT-201-03	M10 SS nylock	8	Blades

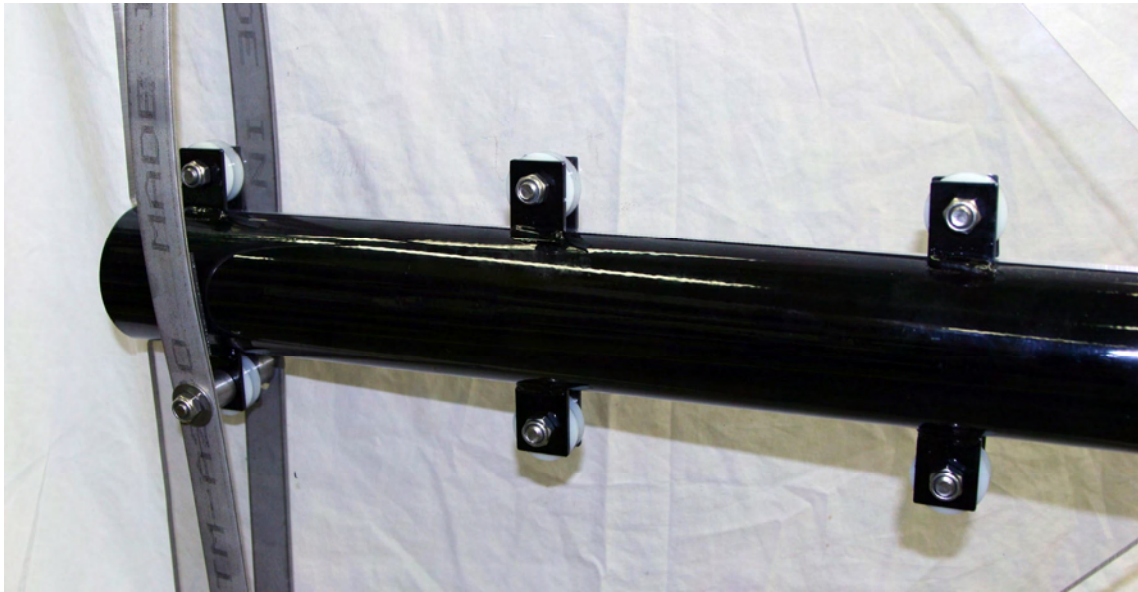
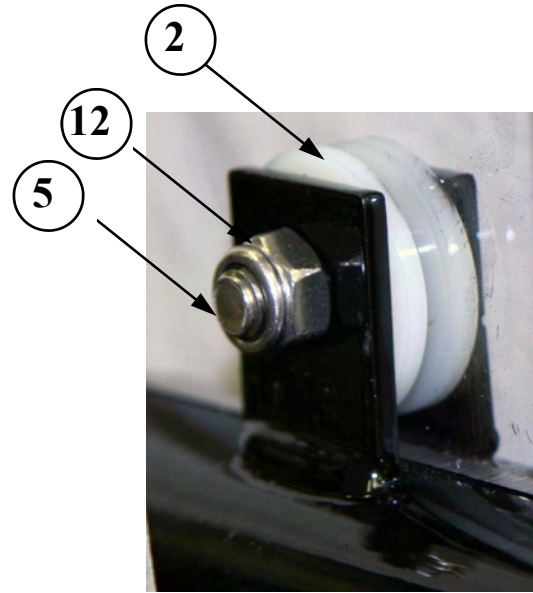


12. INSTALL TAIL FIN AND STRAP

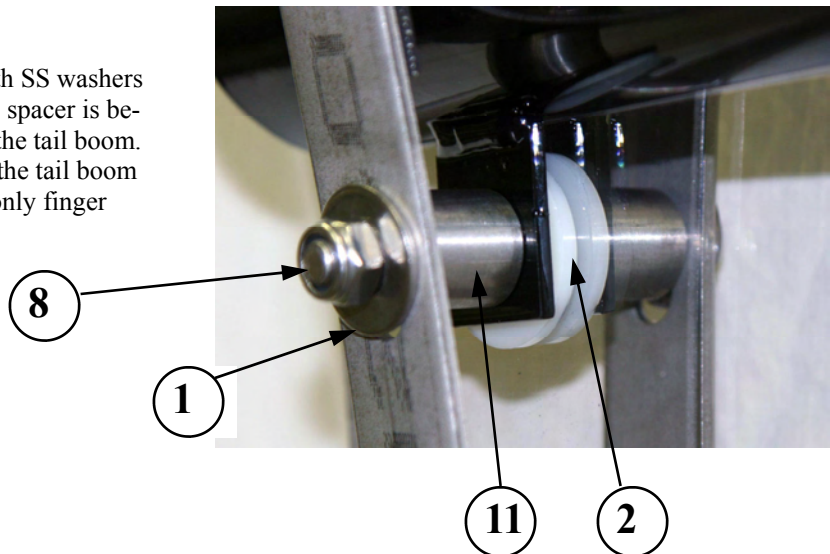
Before installing the tail boom into the lower weldment, install the Tail fin and Tail strap as shown in the following pictures. The numbers with arrows refer to the item number in the table from Step 15.

Mounting Instructions

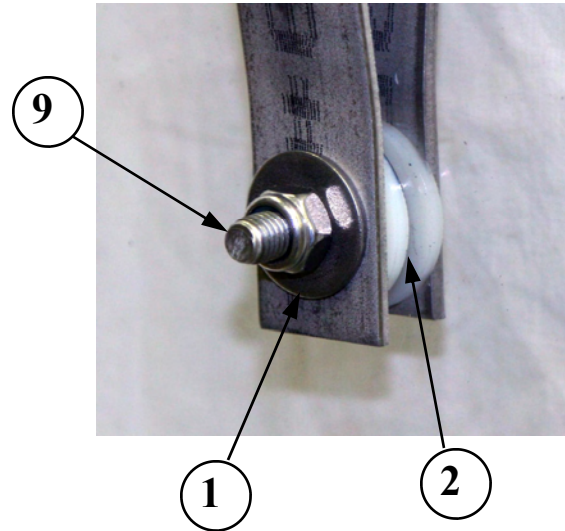
- A) Connect one of the fins to the tail boom with a nylon washer sandwiched between the metal tabs on the tail boom and the tail fin. Repeat so the fin is secured with three bolts
- B) Repeat the above step for the second fin, but use only two of the three holes so the fin looks like the picture below (minus the tail strap).



- C) Attach the through-bolt as show with SS washers outside the tail strap. The 3/4" tube spacer is between the tail strap and the tabs on the tail boom. The nylon flatwashers are between the tail boom tabs and the tail fin. At this point, only finger tighten the nylock nut.



- D) Note how one side of the tail strap has a hole and the other is a slot. Attach the side with the hole to the tail fin as show to the right. A stainless steel washer is used on the outside of the tail strap. A nylon washer is sandwiched between the tail strap and tail fin. At this point, only finger tighten the nylock nut.
- E) Then place the bolt in the side of the strap with the slot. Finger tighten the nylock nut.
- F) Use a 13mm socket and a wrench to tighten all three bolts connecting the tail strap to the tail fin.
- G) The tail fin should now be securely fasten to the tail boom and should look like the last picture on this page.



13. INSTALL TAIL BOOM TO LOWER WELDMENT

The numbers with arrows refer to the item number in the table from Step 15.

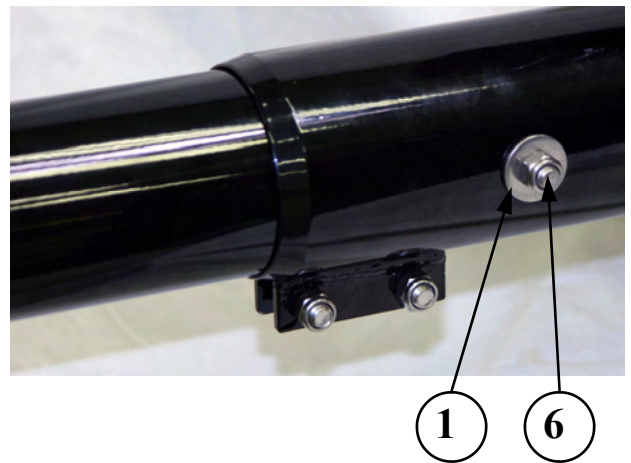
Mounting Instructions

Insert the tail boom into the lower weldment. Be sure the tail fins will be vertical when the tower is raised. You may need to tap the tail boom into the weldment with a rubber mallet or a piece of wood and a sledgehammer.

Insert the tail boom into the lower weldment until the hole in the lower weldment matches the through-hole in the tail boom. If the holes are nearly lined up, but not perfect, then you may want to run a drill through the tail boom so the through-bolt will go through (if it was difficult to get the tail boom inserted into the lower weldment).

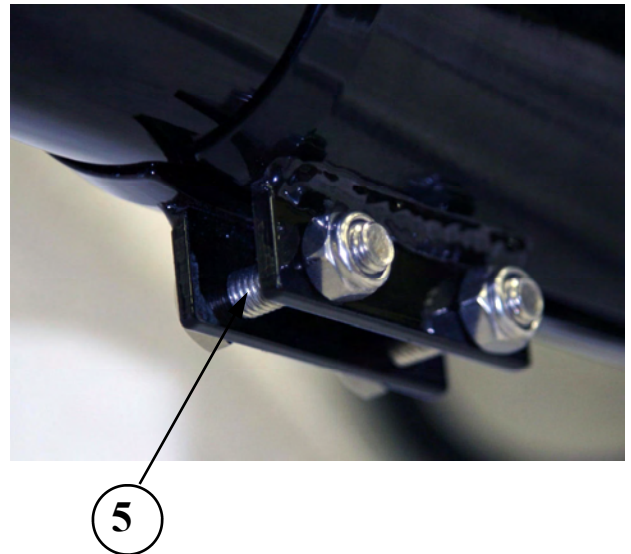


Install the long through-bolt with stainless steel washers and a nylock nut and tighten with a socket and wrench.



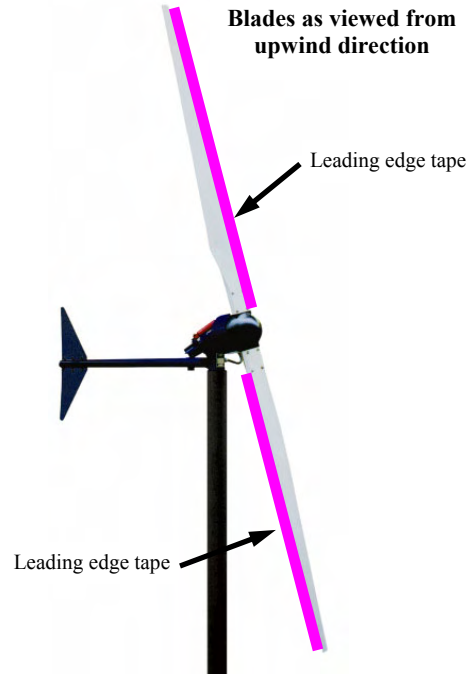
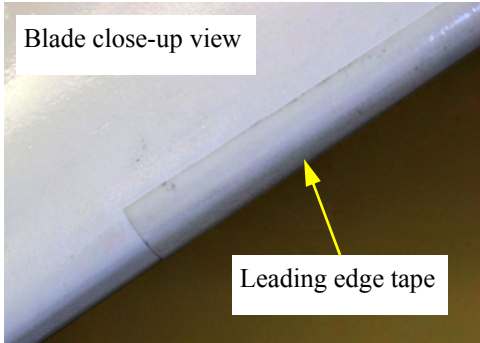
Install the two compression bolts to the lower weldment, and tighten with a socket and wrench.

The tail boom should now be securely attached to the lower weldment.



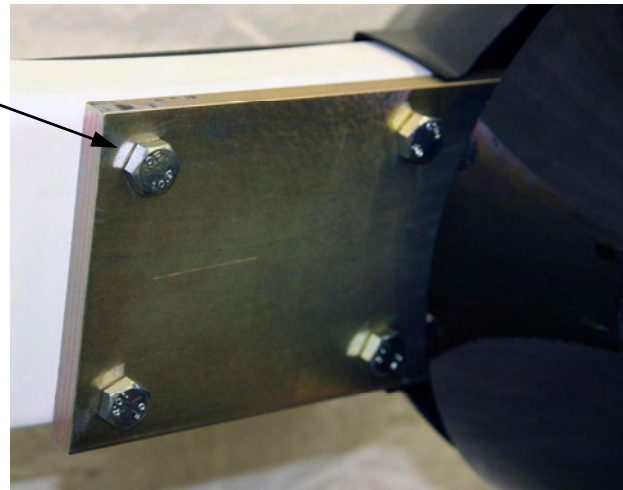
14. INSTALL BLADES, BLADE STRAP, & NOSECONE

It is very important the blades are installed properly and not backwards. When looking at the front of the turbine from an *upwind* position, the leading edge tape should be as shown in the picture to the right. When looking at the blades from an *upwind* position, they will rotate in a clockwise direction.



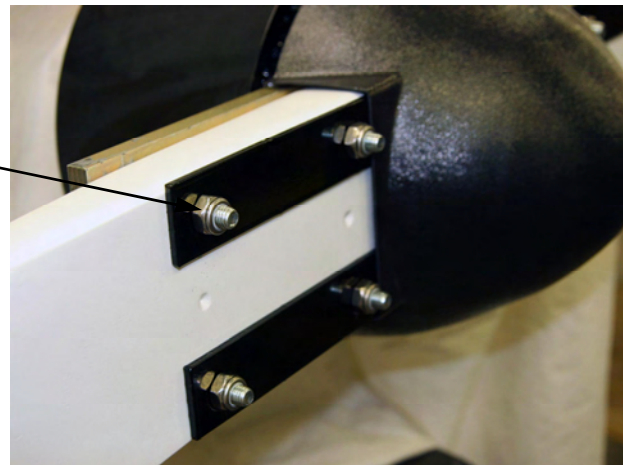
Install the blade bolts with the head of the bolt against the hub plate as shown in the figure to the right. It is important that the threads of the bolts are pointing into the wind.

7

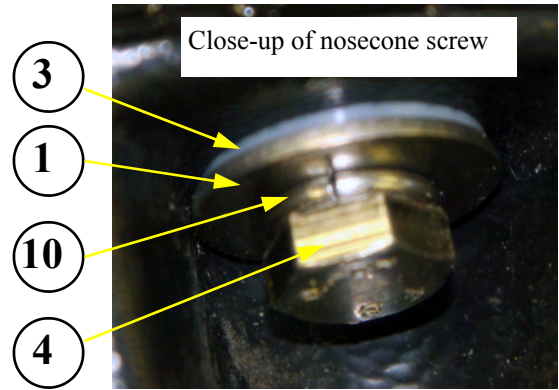


Place the blade straps across the front of the blades, and tighten the nuts to 18 foot-lbs of torque.

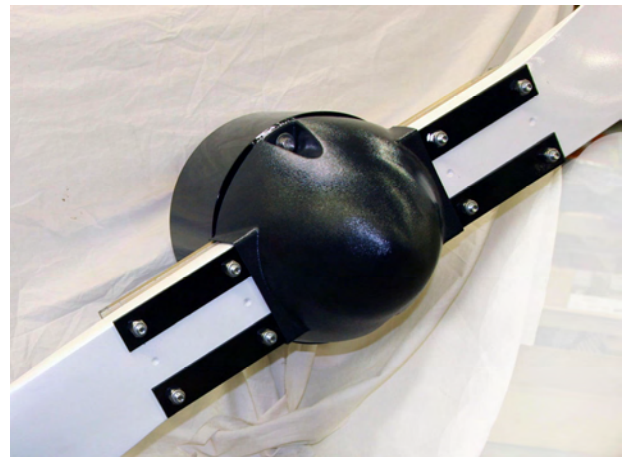
13



Install the nosecone using the two M8x20 stainless steel hex screws. Use a M8 split lockwasher, M8 flat stainless steel washer, and the M8x24 nylon washer, as shown in the close-up view. The nylon washer is sandwiched between the nose cone and the stainless steel flat washer. A removable threadlocking compound should be used on these to screws.



The blades and nosecone should now be securely fastened to the wind generator.



HIGH VOLTAGE!
Never operate the Whisper 500 open circuit.
Do not turn on the wind generator if it is not connected to the Wind Interface.
Do not operate the wind generator without a stop switch properly installed.

15. RAISE TOWER & BEGIN GENERATING ELECTRICITY FROM THE WIND

IMPORTANT: Refer to the *Magnetek Wind Interface Box Owner’s Manual*, and the *AURORA Photovoltaic Inverters, Installation and Operator’s Manual*, for details regarding the normal operation of the inverter and the wind interface. Follow the instructions in those manuals to connect the inverter to the grid.

Raise the tower with the brake switch engaged. Follow the tower manufacturer’s instructions. After the tower is securely raised, and all system connections are double checked, then turn off the brake switch, and begin generating electricity from the wind.

Operation of the wind generator propeller:

In winds below 7-9mph (3-4 m/s) the propeller will not start from a dead stop. In winds above 7-9 mph (3-4 m/s), the propeller will begin to turn slowly, and after 1 to 10 minutes, depending on the wind, it will reach an rpm where the blades are nearly invisible. Once started the propeller will continue operating in winds as low as 2m/s (4mph).

In normal winds the charging current will begin in winds above 7-9mph (3-4 m/s) and increase rapidly with increasing wind speed (in fact, by the cube of the wind speed). In very high winds the charging current will decrease as the machine furls at an angle to the wind to protect itself from damage.

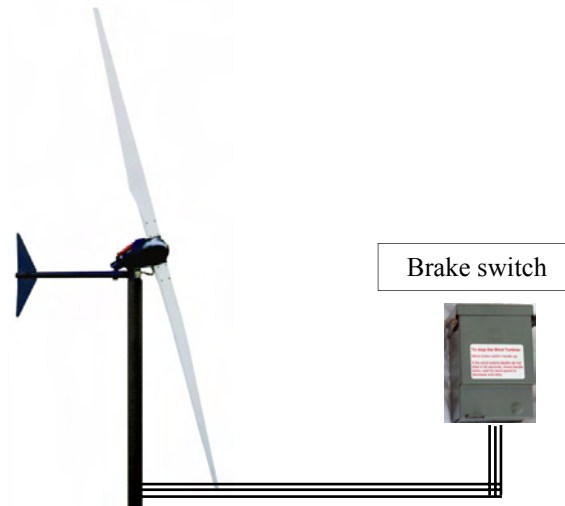
MAINTENANCE-Monthly

1. TEST BRAKE

(This checks electrical wiring.)

STOP THE WIND GENERATOR IN A MODERATE WIND (CHARGING BUT NOT FURLING) No unusual difficulty or noise should be experienced in stopping the propeller. A noise during braking can indicate a disconnected wire.

NOTE: If the propeller does not stop within 15 seconds of activating the brake, then turn it back “on”, and try again later when there is less wind. Attempting to stop the turbine in high winds can damage the alternator.



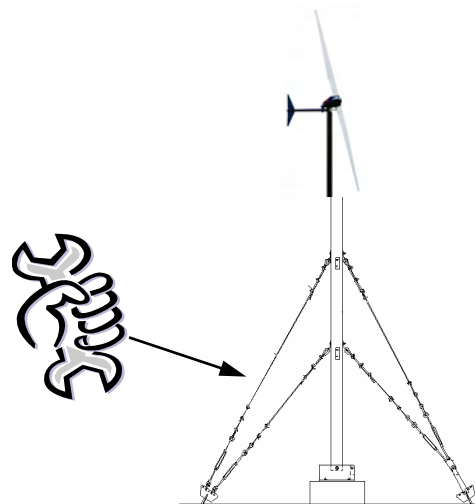
2. CHECK MECHANICAL CONDITION

WATCH AND LISTEN FROM THE TOWER BASE. Use binoculars. There should be no mechanical noise, rattle or vibration. The propeller and tail must not wobble. Lower or climb the tower for inspection, if indicated. There should be no buzzing either heard or felt with your hand on the tower mast. Go to Electrical Problems, if indicated.



3. INSPECT THE TOWER

Follow all inspection and maintenance requirements of the tower manufacturer. Tighten all nuts and bolts, especially wire clips, but do not over-tighten. Check for cracks and bent or broken parts at the anchors and base structure. Check for broken strands and tighten guys.



MAINTENANCE-Annually

1. CHECK THE SYSTEM

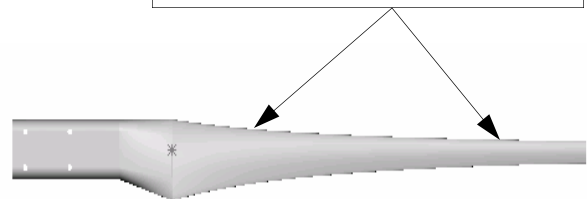
Check the complete inverter/Wind Interface system as described in the *Magnetek Wind Interface Box Owner's Manual*, and the *AURORA Photovoltaic Inverters, Installation and Operator's Manual*.



2. COMPLETE MECHANICAL CHECK

- A) Gain access to turbine and give the turbine a complete mechanical check. Fix or replace any worn or loose parts.
- B) Check tightness of all tower mounting nuts and bolts and propeller mounting bolts.
- C) Check all bearings. Just perceptible play is acceptable.
- D) Clean the propeller with mild scrubbing agent to remove all insect deposits. Replace missing leading edge tape. Fill small surface cracks on fiberglass blades (white) with silicone sealant. Repair or replace all white fiberglass blades if either cracked or damaged. Rebalance the blade after modification.

Clean blade and replace missing blade tape on the leading edge



Maintenance Log

Observe Monthly and Annual Inspection Requirements! Record ALL maintenance and repair work!

Date	Problem/Observation	Action Taken

TROUBLESHOOTING

WIND GENERATOR SYSTEM

Refer to the following two trouble shooting charts. Determine if the problem is mechanical or electrical. If mechanical see table, **Symptoms of Mechanical Problems**.

Electrical problems can be in the generator or the Wind Interface, or the inverter. Determine which as follows:

- a) Wind generator will not start (blades turn slowly as if the brake is on): On a day of moderate wind, disconnect the three wires from the wind generator one at a time at the Wind Interface. If the wind generator starts, then contact Magnetek about a possible faulty Wind Interface.
- b) Wind generator still does not start. On a day of moderate wind, disconnect any two wires. If the wind generator starts, the problem is in the Wind Interface, and contact Magnetek. If the wind generator still does not start the problem is in the tower wiring or the wind generator. Go to Table: Symptoms of Electrical Problems.
- c) Wind generator is running, but may have an electrical problem. See TEST FIXTURE below.



Propeller does not turn = Mechanical Problem
See Table: Symptoms of Mechanical Problems

Propeller turns slowly = Electrical Problem
See Table: Symptoms of Electrical Problems

TEST FIXTURE

In *moderate* winds, read the phase-to-phase AC voltage between each of the three phases from the wind generator with a multimeter. When the blades are spinning at a constant rpm, there should be a balanced reading of the AC voltage readings for each of the three readings.

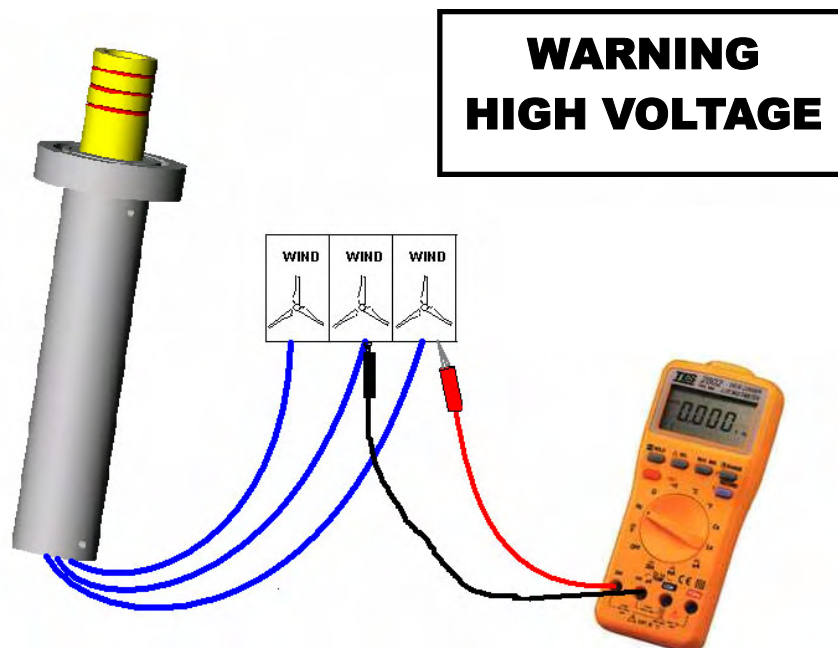


TABLE: SYMPTOMS OF MECHANICAL PROBLEMS

Symptom	Possible Cause	Correction
1. Propeller is stationary, even in high winds	<ul style="list-style-type: none"> a. Ice in generator, or uneven ice on propeller b. Debris between rotor and stator c. Loose or high magnet d. Bad bearing 	<ul style="list-style-type: none"> i. Wait for warm weather i. Turn propeller gently by hand and blow or use piece of paper to dislodge debris i. Remove rotor and re-glue magnet i. Replace bearing
2. Propeller will not turn at all except in high wind, scraping or rubbing sound at low rpm, always stops at same propeller position	<ul style="list-style-type: none"> a. Same as above, except more likely to be high magnet or bad bearing. b. Swelled wire keepers due to high moisture 	<ul style="list-style-type: none"> i. Same as above i. Contact factory. Stator needs re-varnishing.
3. Propeller is harder starting, output is lower & there is more propeller noise than usual. Seems out of balance.	<ul style="list-style-type: none"> a. Ice on propeller b. Dirty propeller c. Eroded leading edge or damaged leading edge tape d. Split, warped or damaged prop e. one or more blades on backwards 	<ul style="list-style-type: none"> i. Prop will eventually shed ice, leave running unless excess vibration i. Clean with soap or bug cleaner i. Refinish prop and replace tape i. Replace or repair propeller i. See blade installation
4. Propeller turns a little, never starts	<ul style="list-style-type: none"> a. Blades on backwards. (See blade installation) 	<ul style="list-style-type: none"> i. Turn blades over. Leading edge advances clockwise from upwind view.
5. Tail, generator and tower vibrate or shake at all or some wind speeds	<ul style="list-style-type: none"> a. Propeller out of balance b. Propeller not tracking c. Rotor (magnet can) out of balance d. blade plate out of balance 	<ul style="list-style-type: none"> i. Balance or replace propeller i. Replace mounting plate ii. Shim at mounting bolts iii. Replace propeller i. Send to factory or balancing shop i. Send to factory or balancing shop
6. Rattle or clunking from generator	<ul style="list-style-type: none"> a. Generator loose in tower b. Loose rotor (magnet can) on shaft loose tail, missing rubber bumper, wires slapping inside of tower, governor pivot bolt loose c. Worn bearings d. Shaft (spindle) broken 	<ul style="list-style-type: none"> i. Retighten mounting hardware, use lock tight or equivalent i. Repair as required i. Replace bearings i. Replace shaft (spindle)

TABLE: SYMPTOMS OF ELECTRICAL PROBLEMS

Symptom	Possible Cause	Correction
1. Propeller turns slowly even in strong wind, but will not start	a. WIND switch is OFF (brake on) b. Short circuit in wiring from generator to Whisper Controller (in tower) c. faulty Wind Interface d. Short circuit in brush card or slip ring assembly e. Short in generator	i. Turn WIND switch ON i. See Installation Step #10 i. Contact Magnetek i. See "BRUSHES AND BRUSH HOLDERS" i. Rewind
2. Propeller runs too fast, may whistle, no output, no unusual mechanical noise	a. Load disconnected b. Two or three wires open between generator and Wind Interface	i. Check all connections. i. See "TEST FIXTURE"
3. Propeller runs too fast, may whistle, output less than 50% for wind speed, growling, buzzing or vibration felt by hand or mast	a. Disconnected wire between the generator and the Wind Interface b. One open or disconnected diode c. One slip ring or brush not making good connection.	i. See "TEST FIXTURE" i. See "TEST FIXTURE" i. See "BRUSHES AND BRUSH HOLDERS"

MECHANICAL REPAIRS AND PARTS REPLACEMENT

BRUSHES AND BRUSH HOLDERS

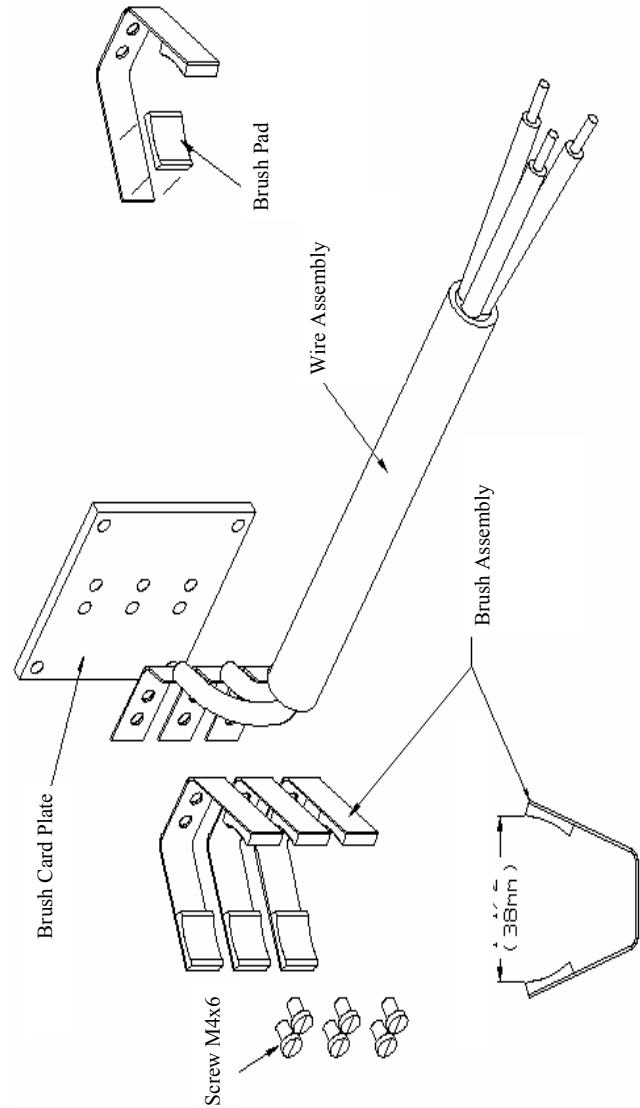
Disconnect the wiring harness in the wiring box, disconnect cord grip nuts and remove the lower frame cord grip body. Remove the four screws retaining the brush card and pull the card and attached wiring harness away from its opening.

Check slip rings which should be dark colored and not pitted. Check for continuity and shorts to ground. Clean with mineral spirits and sand lightly to remove pitting or fretting. Yaw bearings should be smooth with just perceptible play.

Brushes are copper/graphite pads soldered to a beryllium spring and should show 50% or more surface contact. Pads should have a minimum thickness of 1.5mm (1/16in) at the thinnest point and not be pitted or badly scored. Polish pads with fine sandpaper and clean all parts. Mounting screws carry electric power and mating surfaces must be clean and screws tight. Align brushes as shown.

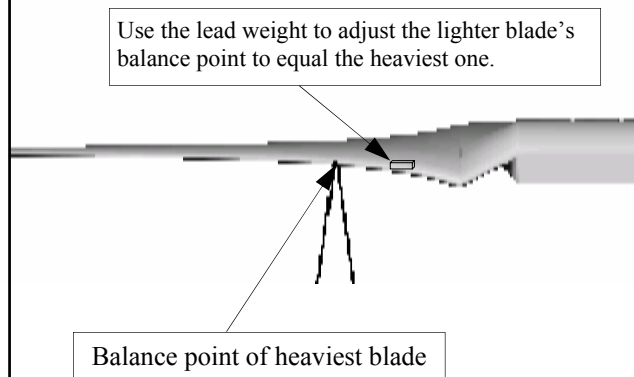
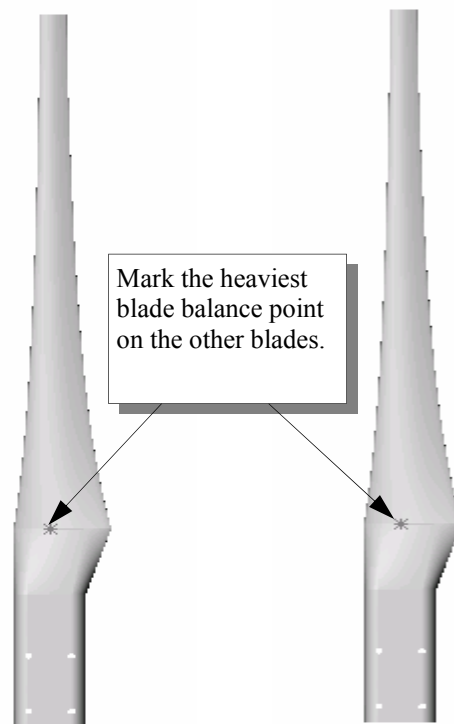
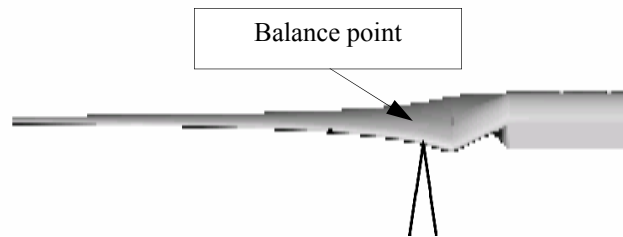
Reassemble in reverse order.

Brush Card Assembly



BALANCING THE PROPELLER

1. Set round side of blade on knife edge with leading edge parallel to table. Mark the balance point precisely.
2. Weigh each blade separately (use a grocery store scale) and mark weight on each blade.
3. Cut one (or two) sheet lead weights equal to the difference in weight between the heaviest and the other blade (or blades).
4. Measure the balance point of the heaviest blade from the butt end and mark this BALANCE POINT on the other blade or blades.
5. Place the lighter blade or blades back on the knife edge at the BALANCE POINT of the heavier blade. Locate the balance weight lengthwise until the blade balances. You now have two blades of identical weight and center of gravity (balance point).



Exploded View Parts List-Whisper 500*Use item # and description when ordering.*

Item	Description	Quantity
1	Rotor	1
2	Spindle	1
3	Stator	1
4	Yaw Housing	1
5	Yaw Shaft	1
6	Brush Card Assembly	1
7	Brush Card Plate	1
8	Wire Box and Gasket	1
9	Spacer	1
10	Hex Head Screw M8x40 CL10.9	6
11	Flat Washer M8x17 TP200	6
12	Retaining Ring 35mm External	2
13	Retaining Ring 72mm Internal	1
15	Bearing 6206-2RS	2
16, 17	Bearing 6207-2RS	4
18	Nylock Nut 7/8-14	1
19	Bolt 7/8-14 x 4 3/4	1
20	Cord Grip 3/4NPT	2
21	Lock Washer M5 SS	2
22	Screw M5 x 16 SS	4
23	Screw M4 x 10 SS	4
24	Screw 8-32 x 1/2 BRASS	1
25	Screw 8-32 x 3/4 BRASS	1
26	Light Amber	1
27	Light Wire	1
29	Blade Plate	1
32	Shock	1
33	Spring	1
34	Shock Spacer	1
35	Light Adapter	1
36	Hex Head Cap Screw	1
37	Nylock Hex Nut 7/16	1
38	Flat Washer 5/8 SS	1
39	Flat Washer 7/16	1

**Whisper 175 Exploded View
Whisper 175 - Vista desagregada**

