Windspire

Owner's Manual

Installation
Operation

Part Number: 150001

Version: 1.16

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Mariah Power

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Dear Customer,

Thank you for your purchase and congratulations on becoming the new owner of a Windspire!

We are excited that you have just chosen to participate in renewable energy generation, with a revolutionary wind turbine designed for operation where people live and work. The Windspire energy appliance is the result of creative thinking combined with years of engineering and collaboration with several major universities in the United States and Canada. The Windspire was developed to let you produce your own electricity in a clean, attractive and cost effective way.

We welcome you to the Mariah Power family and hope that you will be satisfied for years to come. It is our wish that you will eventually spread the word that harnessing wind energy can be fun, exciting and rewarding.

Thank you,

Mariah Power Team

MAC Address _____

(You can find the MAC address on the eight-character sticker at the back of the grid-tie inverter.)

Serial Number _____

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Chapter 1: Introduction

1.1 Safety Instructions

Although helping to save the planet with renewable energy is important, it is never worth risking health or safety. As you use this manual to install, operate and maintain your Windspire, please use caution and do not do anything that might hurt you or anyone else. We hope you will always think twice and consider safety first.

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS—This manual contains important instructions you must follow when installing and maintaining your Windspire.

1. Read this entire manual before installing or operating your Windspire.
2. Save this manual because it contains instructions for installation and maintenance.
3. Adhere to all instructions and warnings.
4. Obtain any necessary building permits before installing your Windspire.
5. Install your Windspire in accordance with all national and local building codes.
6. Install your Windspire in accordance with the National Electric Code.
7. Use proper grounding.
8. Do not erect or lower your Windspire in high wind.
9. Do not make electrical connections to your Windspire when wet.
10. Secure the rotor and disconnect the electrical connection when servicing your Windspire.
11. Do not modify or substitute any parts or components of your Windspire.
12. Discontinue use of your Windspire if it is damaged.
13. Use appropriate equipment whenever lifting or moving heavy components.
14. Use caution whenever working with electricity.
15. Contract installation professionals if you are not certain that you can install your Windspire safely.
16. Above all, be safe.

1.2 Product Description

The Windspire energy appliance is a revolutionary wind turbine designed for operation where we live and work. It is unique among wind turbines in that it does not use a high-speed propeller and it does not require a tower. It is quiet, attractive and employs a simple and durable construction. The Windspire also includes special features that make assembly, operation and maintenance easy.

The Windspire is a vertical-axis wind turbine with a low-speed giromill rotor. Its aerodynamics are engineered to provide high energy-capture efficiency. Unlike propeller wind turbines, the Windspire rotor instantly generates power from wind blowing in any direction. It also spins with a tip speed as much as three times lower than propeller turbines, making it safer and quieter.

The Windspire rotor catches wind energy and drives a high efficiency generator to produce electric power. A built-in, smart grid-tie[1] inverter converts this power into a regulated form that is readily connectable to the electric grid. The more wind, the more power the Windspire supplies to your home or business. If it produces more power than you are using at any time, the excess power is simply channeled into the electric grid, and your electricity meter runs backwards.

1. To install a generator-shorting connector instead of a grid-tie inverter, see Appendix A on page 70.

The Windspire kit was developed to make installation as easy as possible. Once you complete the foundation, a hinged base enables you to raise the Windspire with a winch or your own vehicle. Depending on your local requirements, the electrical connection can be as simple as plugging it in. If you are interested in monitoring your energy generation, an optional Zigbee wireless modem can continuously transmit performance information from the Windspire directly to your computer.

1.3 Technical Specifications

Table 1–1: Technical Specifications

Specification	Value
Rated Capacity	1.2 kW
Height	30 ft (9.1 m)
Weight	624 lbs. (283 kg)
Rotor Size	4.0 ft x 20 ft (1.2 m x 6.1 m)
Swept Area	80 sq ft (7.43 sq m)
Turbine Type	Low-Speed Giromill
Construction	Recycled coated steel and aluminum
Tip Speed Ratio	2.3
Maximum Rotational Speed	420 rpm
Maximum Capacity	1.2 kW
Cut-in Speed	9 mph (4 m/s)
Rated Wind Speed	25 mph (11 m/s)
Survival Wind Speed	105 mph (47 m/s)
Noise	8 decibels above ambient
Braking	Electronic braking system to prevent failure
Monitoring	ZigBee Wireless, 330 ft (100 m)
Output	110 VAC, 60 Hz, 15 Amp, Single Phase, Grid Tied
Grid-tie inverter	Synchronous Inverter
Certifications	Meets UL 1741, IEEE 1547.1
Electrically rated capacity	1.0 kW
Total Harmonic Distortion	2.7% at 1200 W
Frequency Accuracy	+/– 0.02 Hz
Voltage Accuracy	+/– 2.0 V
Surge Rating	IEEE 1547 Surge Rating B
Power Factor	0.95
Manufacturer	Mariah Power Inc.
Manufactured In:	U.S.A.
Origin of Parts:	**98% U.S.A.**

Figure 1–1: Turbine Output

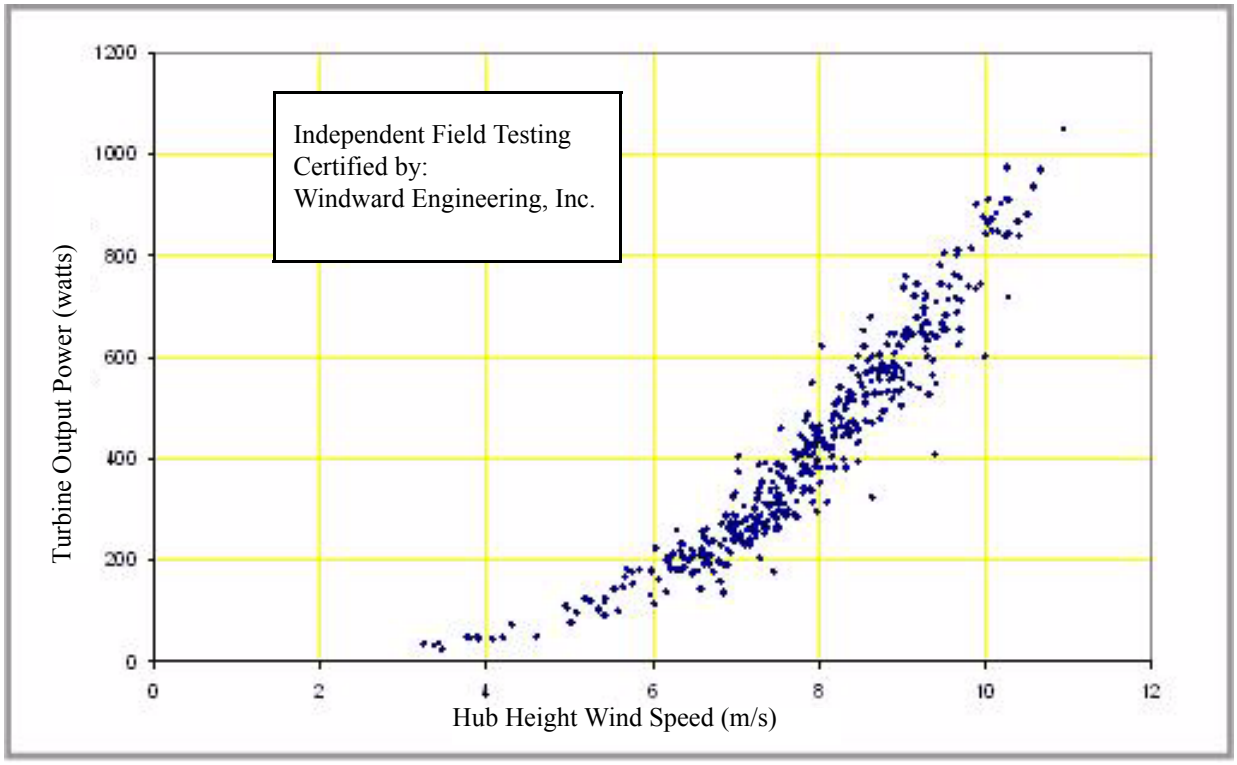
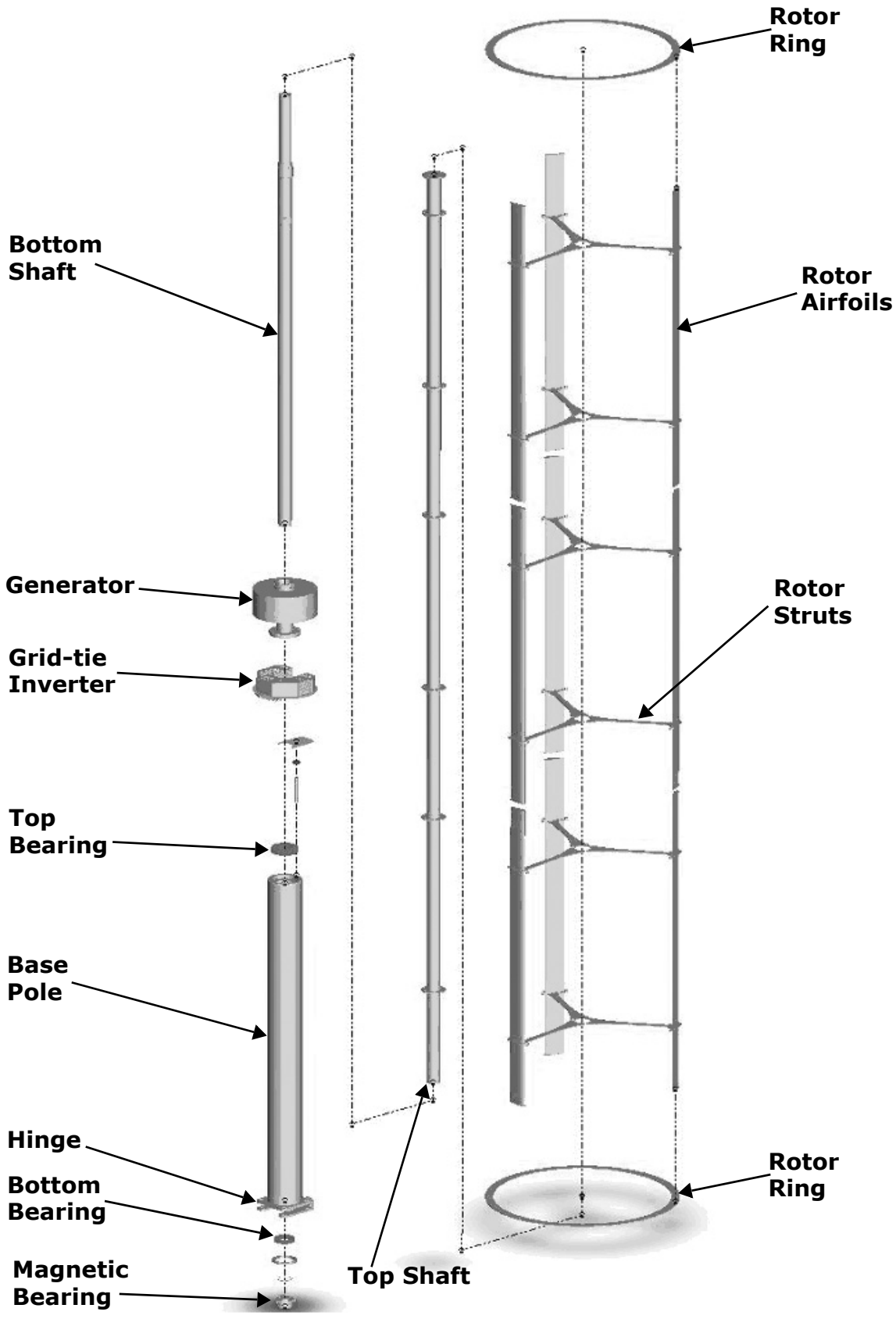


Table 1–2: Dynamic Modeling Values

Condition	Value	Trip Time (seconds)
Voltage Stop Minimum	105.6 V	1.50
Voltage Stop Minimum	132.0 V	0.75
Voltage Fast Stop Minimum	60.0 V	0.117
Voltage Fast Stop Maximum	144.0 V	0.117
Voltage Start Minimum	106.6 V	
Voltage Start Maximum	127.0 V	
Frequency Stop Minimum	59.3 Hz	0.10
Frequency Stop Maximum	60.5 Hz	0.10
Frequency Start Minimum	59.4 Hz	
Frequency Start Maximum	60.4 Hz	

1.4 Schematic Drawing

Figure 1–2: Schematic Drawing



1.5 List of Parts Supplied by Mariah Power

Before you begin installation, please check and verify that there are no missing or damaged parts. The following list comprises all the items, which are shipped as twelve separate packages:

Table 1–3: Parts Checklist

✓	Item	Size		Weight	
		Empirical (ft)	Metric (m)	Empirical (lbs)	Metric (kg)
	1. Foundation Kit Box 1[a]	3.3' x 2" diameter	1.0 x 0.05 diameter	19	8.6
	2. Foundation Kit Box 2[a]	1.0 x 1.0 x 0.5	0.3 x 0.3 x 0.2	12	5.4
	3. Base Pole	7.3 x 0.7	2.2. x 0.2	185	83.9
	4. Generator	1.5 x 1.5 x 1.5	0.5 x 0.5 x 0.5	100	45.4
	5. Bottom Shaft	10 x 0.5 x 0.5	3.0 x 0.2 x 0.2	154	69.9
	6. Top Shaft	20 x 0.5	6.1 x 0.2	122	55.3
	7. Rotor Struts (18)	2.0 x 0.5 x 0.5	0.6 x 0.2 x 0.2	24	10.9
	8. Rotor Airfoils (9)	7.0 x 1.0 x 0.5	2.1 x 0.3 x 0.2	58	26.3
	9. Rotor Ring Segments (6)	4.0 x 0.1	1.2 x 0.2	16	7.3
	10. Grid-tie inverter[b]	1.5 x 1.5 x 0.5	0.5 x 0.5 x 0.2	18	8.2
	11. Hardware Box[c]	1.5 x 1.5 x 1.5	0.5 x 0.5 x 0.5	55	25

a See the *Windspire™ Foundation Manual* for a list of the items this kit contains.

b To install a generator-shorting connector instead of a grid-tie inverter, see Appendix A on page 70.

c The Hardware Box contains all the hardware required to assemble the Windspire, including small components, bearings, top pole clamps, UFB wire, etc. Packing lists in the Hardware Box show all its components.

1.6 List of Optional Parts Supplied by Mariah Power

You can purchase the following optional parts from Mariah Power.

Table 1–4: Optional Parts Checklist

✓	Item	Description
	1. International Transformer	Your Windspire is designed to be compatible for worldwide use. However, it is shipped with an initial configuration for connection to the U.S. electrical system of 110 VAC and 60 Hz. For connection to other electrical systems, you can install an optional international transformer between your Windspire and its power connection. The international transformers are specially designed to provide very high efficiency power conversion. Please notify your local dealer of your electrical requirements. If required, have your local dealer install the correct transformer and the software that supports it. Always check the local regulatory rules and ensure the Windspire meets the required certifications for your area before installing.

	2. Gin Pole Kit	The Gin Pole Kit enables you to raise and lower the Windspire simply and safely.
		The gin pole kit includes the following items:
		• Gin pole
		  • Size = 8.0' x 1.0' x 0.5' (metric = 2.4 x 0.3 x 0.2 meters)
		  • Weight = 46 lbs (20.9 kg)
		• Two loop ended cables:
		  • 5/16" diameter x 30' length
		  • ¼" diameter x 10' length
		• Two spring-snap carabineers
		• One 5/8" opening, 820 lb. rated, eye bolt ½-13 x 3"

	3. Zigbee Wireless Modem + WindSync software	If you want to use your Windspire's wireless link for monitoring power production, you need this modem and software (see Section 2.6 Connecting the Electrical System).

1.7 List of Parts Supplied by Customer

Table 1–5: Customer-Supplied Parts Checklist

✓	Item
	1. Mariah Power supplies 10 feet (3 m) of UFB wire to extend to the bottom of the Windspire. However, the customer must provide any additional wire to run through the footing and the ground to the breaker.
	2. Acetone with paper towels or clean rags
	3. 3–4 foot piece of 2" EMT conduit pipe
	4. Electrical hardware required for termination to business or home, according to regional code requirements (see Section 2.8 Wiring Diagrams on page 58)

1.8 Tools Required

Table 1–6: Required Tools Checklist

✓	Tool
	1. One level
	2. One wire brush
	3. One medium sized Phillips screwdriver
	4. One medium sized flat head screwdriver
	5. One pair of wire cutters
	6. One 3/8" or larger ratchet and metric socket set
	7. One 5 mm Allen head wrench (provided)
	8. One 15 mm open-end wrench
	9. One 30 mm wrench
	10. 13, 15 and 17 mm sockets, with a 3/8" or larger ratchet
	11. 6" socket extension for same size ratchet/socket combo
	12. Mariah Power recommends that you use a 30mm wrench and/or 30mm deep socket for use with the gin pole kit (see Section 2.8 List of Optional Parts Supplied by Mariah Power on page 6).
	13. Dead-blow hammer
	14. Scotch-Brite to clean off rust if on any parts
	15. Tape measure
	16. Fine tip marker pen (permanent marker)
	17. Knife to strip wires
	18. Gin Pole Kit (see the Optional Parts Checklist on page 6)

1.9 Torque Specifications

Table 1–7 indicates the torque to apply when you tighten fasteners during Windspire installation.

Table 1–7: Torque Specifications for Fasteners

Fastener	Dimensions	Torque: ft-lb	Torque: N-m
Inverter insert screw (aluminum)	M6 x 12mm	3	4
Inverter screw (steel)	M6 x 16mm	6	8
Generator clamp screw	M8 x 25mm	25	34
Top-shaft clamp screw	M8 x 35mm	See Step 33.	
Airfoil screw	M8 x 12mm	8	11
Bearing cap screw	M8 x 25mm	18	24

Table 1–7: Torque Specifications for Fasteners (Continued)

Fastener	Dimensions	Torque: ft-lb	Torque: N-m
Generator/magnetic-bearing screw	M8 x 35mm	18	24
Rotor ring screw (button head)	M8 x 25mm	8	11
Rotor ring segment screw (button head)	M8 x 12mm	18	24
Strut bolt	M10 x 25mm	34	46
Strut nut	M10	34	46
Foundation nut	M20	20	27

1.10 Services Required

You require the following services to install your Windspire foundation:

- 24 inch (0.61 m) diameter post-hole digging service
- 1 cubic yard (0.77 cubic m) of concrete delivered

1.11 Itemized Shipping Items

Table 1–8 lists all the items shipped as part of the Windspire delivery and shows their shipping weights.

Table 1–8: Windspire 1.2G Itemized Shipping Items (Sheet 1 of 3)

P/N	Part Description	Qty	UM	Dimensions	Weight (lb)	Weight (kg)
600101	Top Shaft	1	ea.	235"L x 8" dia	122	55.3
800015	Base Pole	1	ea.	88"L x 14" dia	185	83.9
600120	Bottom Hinge Plate (Bottom Hinge Plate Assy)	1	ea.			
500124	Base Pole Hinge Bolt (Bolt,M20x65x2.5,Grade 5)	2	ea.			
500125	Base Pole Hinge Nut (Nut,M20,Nylock)	2	ea.			
800016	Bottom Shaft	1	ea.	120"L x 4" dia	154	69.9
800019	Generator	1	ea.	19"x19"x19"	100	45.4
800021	Inverter	1	ea.	24"x24"x10"	18	8.2
800025	Air Foil	9	ea.	9"x84"x8"	58	26.3
600140	AirFoil, DU06, 5" Chord	9	ea.			
600143	Airfoil End Cap (End Plate Assy, AirFoil D06)	18	ea.			
500148	Airfoil End Cap Screw (SHCS, But Hd M8x16x1.25 Stn. Stl.)	36	ea.			
800101	Foundation Kit Box 1	1	ea.	42"L x 2.5" dia.	19	8.6
300011	24” piece of æ Rigid PVC conduit	1	ea.			
300012	18” piece of æ Rigid PVC conduit	1	ea.			
500121	Foundation Rod (Thrd Rod, M20x2Mx2,5, 47 KSI)	4	ea.			
800102	Foundation Kit Box 2	1	ea.	12"x12"x6"	12	5.4
300009	Grounding Wire (8’piece of 8AWG stranded grounding wire)	8	ft.			
300013	æ PVC conduit coupling	2	ea.			
300014	æ Rigid PVC 90× Elbow conduit	1	ea.			
300018	Grounding Plate, 8-2 AWG, 7.5” dia, Blackburn GP100	1	ea.			
500117	Foundation Nut (Nut,M20,Grade 5)	16	ea.			
500137	Foundation Washer (Washer, 21mm ID x 50mm OD x 3mm)	4	ea.			
600124	Foundation Template	1	ea.			
150002	Windspire Foundation Manual	1	ea.			
800028	Gin Pole Kit				71	32.2
500002	Gin Pole Cable (Cable, 1/4" dia x 10', loop ends, 960 lb rated)	1	ea.			

Table 1–8: Windspire 1.2G Itemized Shipping Items (Sheet 2 of 3)

P/N	Part Description	Qty	UM	Dimensions	Weight (lb)	Weight (kg)
500004	Carabineer (Spring snap 5/8” opening, 820 lb rated)	2	ea.			
500066	Pull-up Cable (Cable 5/16" dia x 30')	1	ea.			
600127	Gin Pole	1	ea.			
800030	Struts/Clamps			6"x24"x6"	24	10.9
600141	Strut, AirFoil DU06	18	ea.			
600142-11	Clamp, Upper, AirFoil DU06	9	ea.			
600142-12	Clamp, Lower, AirFoil DU06	9	ea.			
600148	Rotor Ring Segments Box	6	ea.	45"x15"x2"	16	7.3
Hardware Box 18x18x18				18"x18"x18"	55	25
800103	Hardware Box 8x8x8					
Bag 1						
250008	Retaining Ring (Ret. Ring, Prospect Fastener XD337)	1	ea.			
300004	Wire nuts 1/#10+1#12 Yellow/Inverter	3	ea.			
300010	Wire Clamp (Wire Clip, Screw Connector for 1/2")	2	ea.			
500047	Pipe Grommet (Grommet, Pipe)	1	ea.			
500126	Bearing Cap Screw (Bolt,M8x25x1.25,serrated wash hex hd)	3	ea.			
500129	Generator/Magnetic Bearing Screw (Bolt,M8x35x1.25,serrated wash hex hd)	9	ea.			
500169	Inverter Screw SHCS,M6x16x1,	8	ea.			
Bag 2						
500146	Airfoil Screw (SHCS,M8x12.7x1.25,Fl Hd SL Stn Stl)	36	ea.			
500163	Rotor Ring Screw (SHCS,M8x25x1.5,But Hd)	12	ea.			
500134	Rotor Ring Segment Screw (SHCS, But Hd M8x12x1.25 Blue)	12	ea.			
Bag 3						
500144	Strut Bolt (Bolt,M10x25x1.5,serrated wash hex hd)	36	ea.			
500145	Strut Nut (Nut,M10,Nylock)	36	ea.			
Bag 4						
500112	Grounding Screw (Bolt,M8x16x1.25,serrated wash hex hd)	1	ea.			
500107	Grounding Washer (Wash, 8.4mm ID x 24mm OD x 2mm)	1	ea.			
Bag 5						
500137	Metal Washer (Washer, 21mm ID x 50mm OD x 3mm)	16	ea.			

Table 1–8: Windspire 1.2G Itemized Shipping Items (Sheet 3 of 3)

P/N	Part Description	Qty	UM	Dimensions	Weight (lb)	Weight (kg)
Bag 6						
500170	Foundation Locknut (Nut,M20,Jam, Nylock)	8	ea.			
Bag 7						
700004	Plastic Strips (Polyethylene strips cut 4.5” lg)	15	ft.			
Bag 8						
500171	Rubber Washers (CNFG-Fabreeka Washer, 22mm ID x 50mm OD x 3.2mm Thk)	20	ea.			
Loose						
300032	UFB Wire (10’ piece 10-2 UFB wire with ground)	1	ea.			
200005	Silicone Adhesive	1	ea.			
500140	5mm Bondhus BallDriver L-Wrench	1	ea.			
800104	Tube/Clamp Box 8x8x8					
500126	Generator Clamp Screw (Bolt,M8x25x1.25,serrated wash hex hd)	6	ea.			
500129	Top Shaft Clamp Screw (Bolt,M8x35x1.25,serrated wash hex hd)	12	ea.			
600136	Wire Tube, 1/2" EMT Conduit	1	ea.			
600180	Top Shaft Clamp Wedge	2	ea.			
600181	Top Shaft Clamp Unthreaded Disk	2	ea.			
600182	Top Shaft Clamp Threaded Disk	2	ea.			
200006	Grease (Copper Anti-seize)	1	ea.			
800105	Bearing Box 8x8x8					
250006	Top Bearing (Bearing NSK 1219 Self Aligning)	1	ea.			
250007	Bottom Bearing (Bearing NSK 6017 Shielded)	1	ea.			
500164	Bottom Bearing O-ring (O-Ring, 80mm ID x 1.8mm CS)	1	ea.			
500165	Top Bearing O-ring (O-Ring, 90mm ID x 1.8mm CS)	1	ea.			
600133	Bottom Bearing Cap	1	ea.			
800106	Magnetic Bearing Box 8x8x8					
800032	Magnetic Bearing	1	ea.			

1.12 Technical Support

If you have questions about the products and procedures in this manual, please contact your local dealer. For further questions, contact Mariah Power's technical support at (775) 857-4888.

Chapter 2: Windspire Turbine Installation

Note: Mariah Power uses Grade 5 fasteners in the standard Windspire. If you use materials that do not meet that specification, Mariah Power is not responsible.

2.1 Siting

The *Windspire™ Foundation Manual* describes all siting issues and procedures.

2.2 Installing the Foundation

The *Windspire™ Foundation Manual* describes how to install the Windspire foundation.

2.3 Preparing for Assembly

Never assemble your Windspire using damaged components, especially aluminum parts. For example, do ***not*** install dented airfoils, rotor rings that are out of shape (they must be circular), bent struts, or a top shaft that is bent, dented or deeply scratched. Perform the following steps ***before*** assembling your Windspire.

☐ 1. When Windspire components are delivered, inspect each one to verify it is undamaged. You must replace any damaged components.

Note: Protect the larger bearing that fits to the top of the base pole from dirt and debris during handling and installing. It must *never* get dirt or any other contamination in it. If it does (e.g. you drop it in dirt), you cannot install it; you must return it to Mariah Power for a replacement.

☐ 2. If you find rust on any machined mating surfaces, remove the rust before continuing. Use Scotch-Brite or a similar product that does not remove material other than rust from the metal surfaces.

2.4 Assembling the Windspire

Note: We ***highly recommend*** that you assemble the Windspire during ***dry and calm (low wind)*** conditions to prevent water and dust contamination.

Perform the following steps to assemble the Windspire.

Note: You can assemble the strut/airfoil assemblies (Step 1) before assembling the rest of the Windspire. Perform this step in a sheltered area, based on weather accommodations.

☐ 1. Assemble the strut/airfoil assemblies as follows (estimated assembly time = 4 man-hours):

A. Airfoils have cambered and non-cambered sides (Figure 2–1). Make small marks with a felt pen at 16 1/8" (41 cm) away from each end of the airfoils on the non-cambered side (Figure 2–2).

Figure 2–1: Cross-Section View of an Airfoil

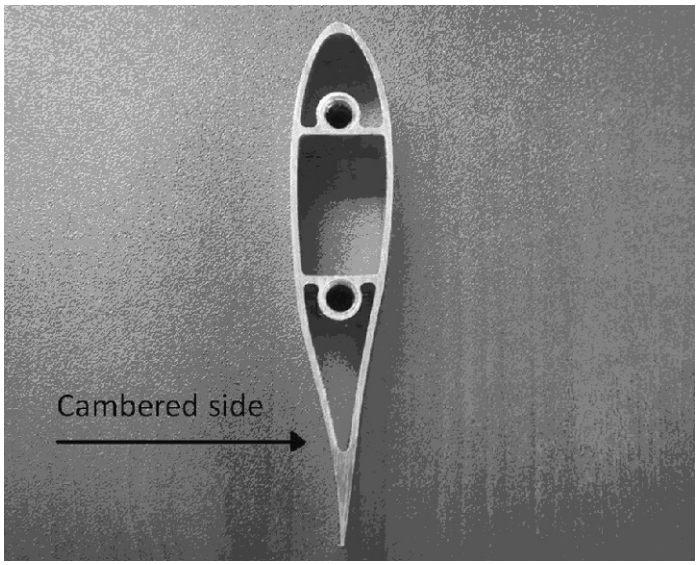


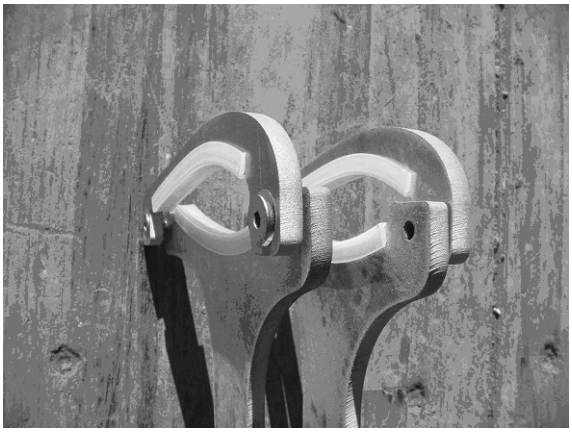
Figure 2–2: Marking the Airfoils

B. Attach the plastic strips to the clamps as shown in Figure 2–3. Note that for each airfoil assembly, you must use the **two *different* clamp parts** shown in Figure 2–3. **One of the clamp parts has a black dot on its side for differentiation.**

Figure 2–3: Attaching Plastic Strips to the Clamps

C. Attach each clamp to a strut with one airfoil clamp screw (M8 x 12mm flat-head stainless steel). Leave the airfoil clamp screws loosely attached. Figure 2–4 shows the strut/clamp assemblies oriented for attachment to the airfoils. The clamps will face the ends of the airfoils.

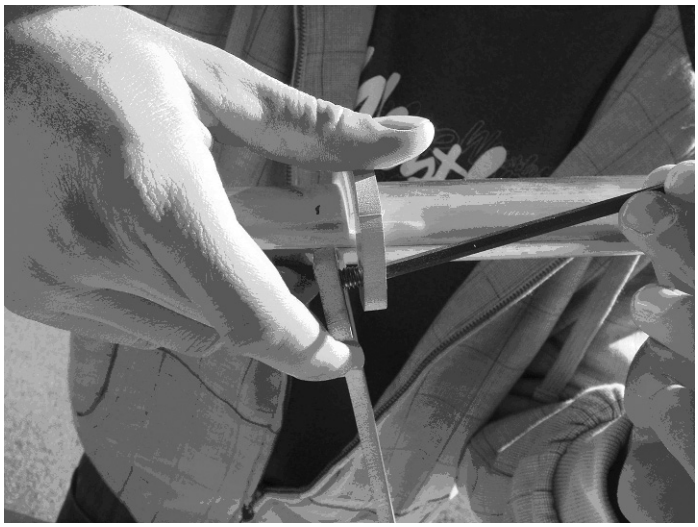
Figure 2–4: Strut/Clamp Assemblies Oriented for Attachment to the Airfoils



2. Perform the following sub-steps for each strut/clamp assembly to attach it to an airfoil:

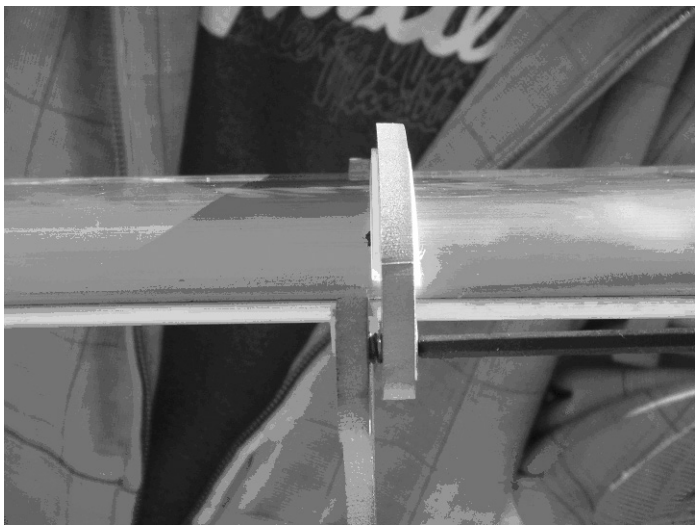
   A. After attaching one airfoil clamp screw, hold the strut at an angle less than 90 degrees from the airfoil and insert the second airfoil clamp screw into the second tapped hole in the strut (Figure 2–5).

Figure 2–5: Attaching a Strut and Clamp to an Airfoil



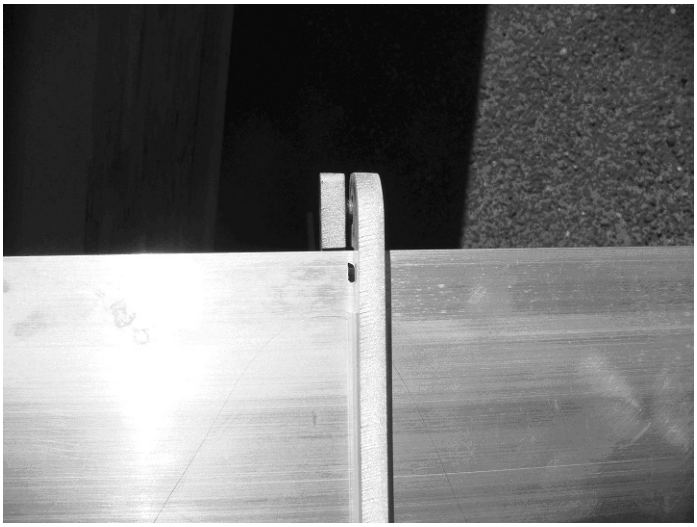
   B. After both screws are started into the threaded holes of the struts, re-orient the struts to the airfoils such that they are at a 90 degree angle. (Figure 2–6).

Figure 2–6: Re-orienting a Strut to an Airfoil



C. Position the strut such that the center of the strut and clamp parts are centered at the marks made on the airfoil (Figure 2–7).

Figure 2–7: Positioning a Strut on an Airfoil



D. Rotate the struts back to 90 degrees from the airfoil.

E. Use the supplied 5mm Allen head wrench to tighten down each screw (Figure 2–8). Torque the screws to 8 ft-lb (11 N-m) or until the Allen wrench tool starts to flex with the tightening pressure (Figure 2–8). Using a ¼" ratcheting wrench with a ¼" drive 5mm bit might facilitate this step (Figure 2–9).

Note: Do ***not*** use a power tool; doing so might over-tighten the screw and strip the aluminum. If you encounter resistance when tightening the screw such that the clamp is not in full contact with the strut, some dirt or other deposits might have accumulated on the interface between the strut and clamp. In that case, you must remove and disassemble the strut and clamp, clean them, and then re-attach them to the airfoil.

Figure 2–8: Tightening a Strut/Airfoil Screw

Figure 2–9: Tightening a Strut/Airfoil Screw with a Ratcheting Wrench

F. After you attach the struts and clamps to the airfoils, apply silicone to the interface of the plastic strips and the airfoils (Figure 2–10).

After assembling all nine strut/airfoil assemblies, you are ready to start installing the base pole and related parts to the foundation. You will attach the airfoils later in the process—once the top shaft is secured to the bottom shaft (Step 22).

Figure 2–10: Silicone Applied to a Plastic Strip and Airfoil

Figure 2–11 shows a completed strut/airfoil assembly.

Figure 2–11: Completed Strut/Airfoil Assembly

3. Attach the base pole to the foundation as follows.

   A. Lower the bottom hinge plate over the foundation rods (Figure 2–12). During this process, you must rest the base pole on a sturdy support, such as a jack stand or stack of lumber (Figure 2–13).

Figure 2–12: Lowering the Bottom Hinge Plate over the Foundation Rods

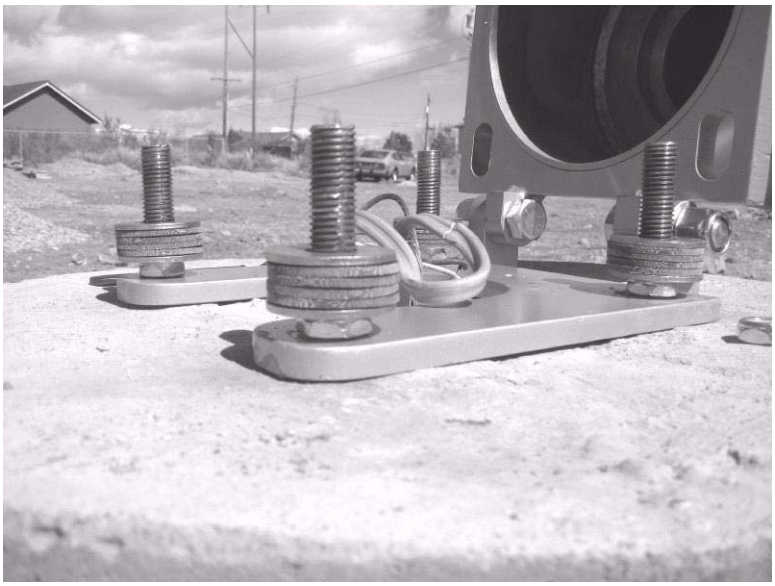
Figure 2–13: Resting the Base Pole on a Sturdy Support

   B. Use the M20 nylon insert lock nuts to tighten the bottom hinge plate to the foundation. Do ***not*** over-tighten the nuts; you might have to loosen them later to level the erected Windspire.

C. Place one metal washer, four rubber washers and another metal washer on top of each nut (Figure 2–14).

Note: ***If you skip installation of any of these washers, the Windspire will not operate as intended.***

Figure 2–14: Washers Installed on the Bottom Hinge Plate



4. Raise the base pole to verify that the foundation rods do not interfere with the hinge's operation (Figure 2–15). If the foundation rods interfere with the top hinge-plate movement, adjust the leveling of the bottom hinge-plate with shim material to enable the hinge to function.

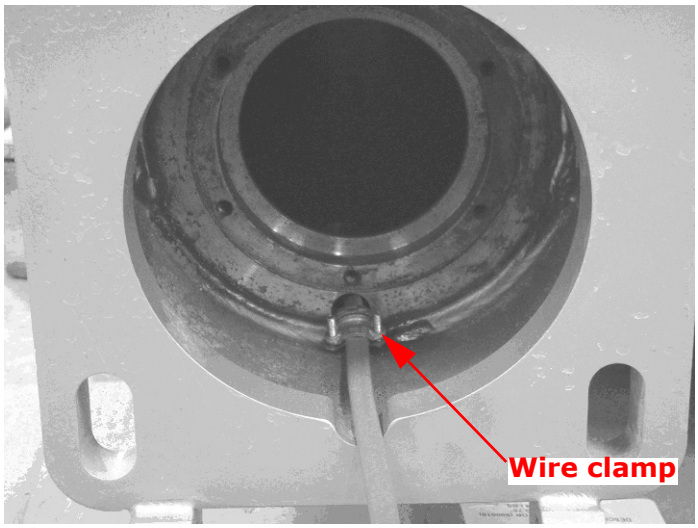
Figure 2–15: Raising Base Pole to Check for Interference from Foundation Rods

5. Lower the base pole to rest horizontally on a sturdy support (Figure 2–16). Cut off any excess conduit that protrudes from the concrete to a level of 1–2" above the concrete surface. You will *not* need to raise the base pole again until the Windspire is fully assembled.

Figure 2–16: Resting the Base Pole on a Sturdy Support

6. Insert the provided 10 foot (3.0 m) piece of UFB wire as follows.
   A. Run the UFB wire through the base pole (Figure 2–17). The wire should extend 12 inches (30 cm) ***beyond both ends of the base pole***.
   B. Use the wire clamp to tighten the wire at 12 inches (30 cm) from the bottom of the base pole.
   C. Pull the wire at the top of the base pole until the wire clamp prevents further movement.

Figure 2–17: Running the UFB Wire Through the Base Pole



7. Install the bottom bearing as follows:

   A. Using acetone and a clean rag or paper towel, wipe clean the area in the base pole where you will install the bottom bearing. **All fitted surfaces must be absolutely clean and free of any dirt**.

   B. Install the bottom bearing into the lower end of the base pole (figures 2–18 and 2–19).

   Tips:

   - Install the bearing carefully and squarely into the bearing seat. If it becomes cocked, ***carefully and lightly*** tap the outer race of the bearing at the least engaged position, ***without contacting the bearing shield***, to re-center and square the bearing on the bearing seat.
   - Before installing the bearing, keep it in a shady or cool place. If the base pole temperature is higher than the bearing temperature, it will be easier to install the bearing. You should be able to slide the bearing into place gently; do not force it.

   Caution:

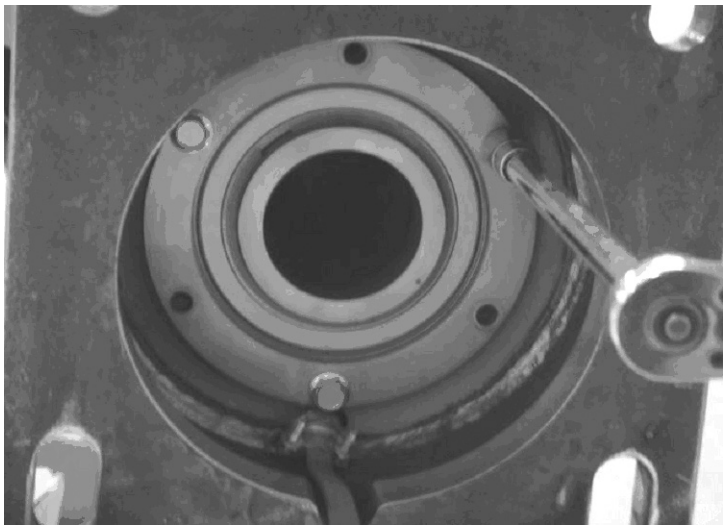
   - **Do *not* hammer the bearing into place.**
   - **Do *not* dent the bearing shields that protect the ball bearings. If you do, the bearing will need replacement.**
   - ***Never* add grease to the bearing; it is already greased for life. The grease in use is a low-friction, wide-temperature-range type that will be damaged if you add standard bearing grease to it.**

Figure 2–18: Installing the Bottom Bearing

Figure 2–19: Installing the Bottom Bearing Cap

C. Tighten the bottom bearing in place with the bottom bearing cap and three bearing cap screws (M8 x 25mm). Torque the screws to 18 ft-lb (24 N-m). The screws that tighten the bearing cap to the bearing must be just as Figure 2–20 shows them.

Figure 2–20: Tightening the Bottom Bearing



8. Install the top bearing as follows.

   A. Using acetone and a clean rag or paper towel, wipe clean the area in the base pole where you will install the top bearing. All fitted surfaces must be absolutely clean and free of any dirt.

   B. Install the top bearing into the top end of the base pole (Figure 2–21).

   Caution:

   - We ***highly*** recommend installing the top bearing during dry and calm (low wind) conditions to prevent water and dust contamination.
   - Protect the top bearing from dirt and debris when handling and installing it. It must ***never*** get dirt or any other contamination in it. If it does (e.g. you drop it in dirt), you must ***not*** install it; you must return it to Mariah Power for a replacement.
   - ***Never*** add grease to the bearing; it is already greased for life. The grease in use is a low-friction, wide-temperature-range type that will be damaged if you add standard bearing grease to it.

Figure 2–21: Installing the Top Bearing

9. Insert the bottom shaft into the base pole as follows:
   A. Using acetone and a clean rag or paper towel, wipe clean the ***entire*** bottom shaft. Pay particular attention to the machined collars, the bottom bearing sleeve, and the retaining ring and O-ring grooves.
   B. Locate the two O-rings from the hardware kit and slide them into place in the O-ring grooves on the bottom shaft. Ensure the O-ring grooves are clean and dry before installing the O-rings into them. There are two O-ring sizes. The smaller O-ring goes into the groove at the bottom bearing location (Figure 2–22). The larger O-ring goes into the groove at the top bearing location (Figure 2–23).

Figure 2–22: Bottom Bearing Groove/O-ring Location

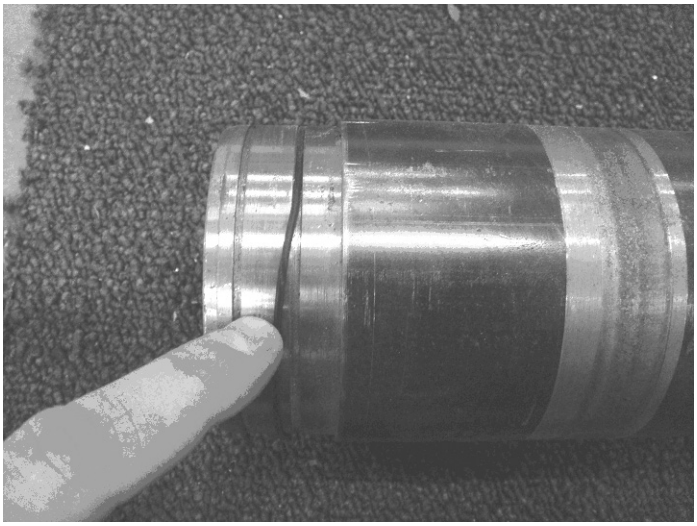
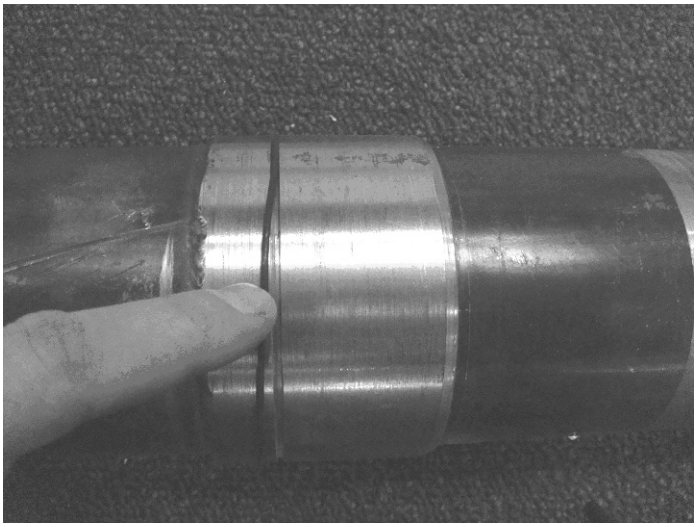


Figure 2–23: Top Bearing Groove/O-ring Location



C. Add a small amount of the supplied grease to the inside diameters of both the top and bottom bearings.

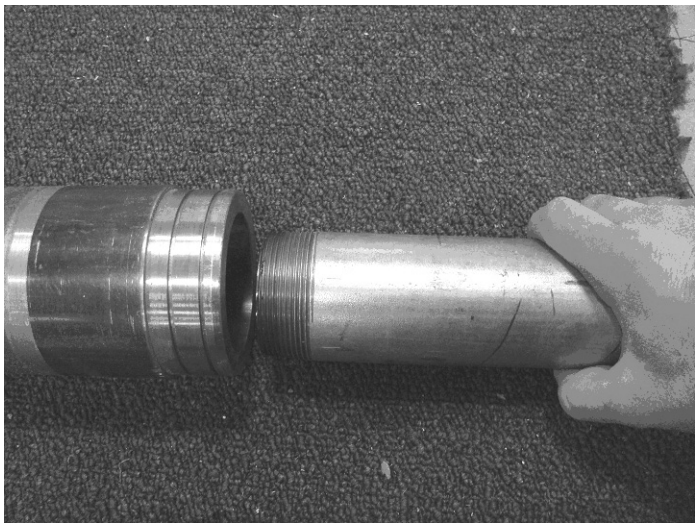
D. Insert the bottom shaft partially into the base pole such that it is near to the bottom bearing (Figure 2–24).

Figure 2–24: Inserting the Bottom Shaft Partially into the Base Pole

E. Insert a clean 3–4 foot piece of 2" EMT conduit or similar tool into the bottom end of the bottom shaft to help guide it through the bottom bearing (Figure 2–25). Rotate the bottom shaft while pushing down and inward to move it into place. Remove the pipe after pushing the bottom shaft into place.

Note: If the top bearing inner race is cocked on the bottom shaft, ***lightly*** tap on the inner race of the bearing at the least-engaged position to align the inner race with the bottom shaft. Do ***not*** contact the ball bearings or use a tool that will contaminate the grease on the top bearing.

Figure 2–25: Pipe Inserted into Bottom End of Bottom Shaft
(The bottom shaft will be inside the base pole but, for illustration purposes, this photo does not show the base pole.)



10. Install the retaining ring into the groove at the bottom end of the shaft to lock the shaft into place (figures 2–26 and 2–27).

Notes:

- When installing, push firmly in a circular motion on the retaining ring until it ***snaps*** in place.
- Do ***not*** bend or expand the retaining ring outward to the point that it deforms the metal.
- The retaining ring must clamp over the bottom shaft in a concentric manner. Its entire circumference must be fully seated in the groove.

Figure 2–26: Installing the Retaining Ring

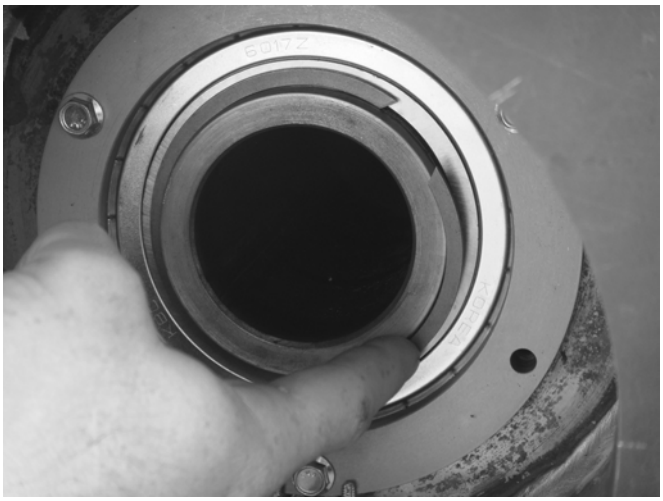
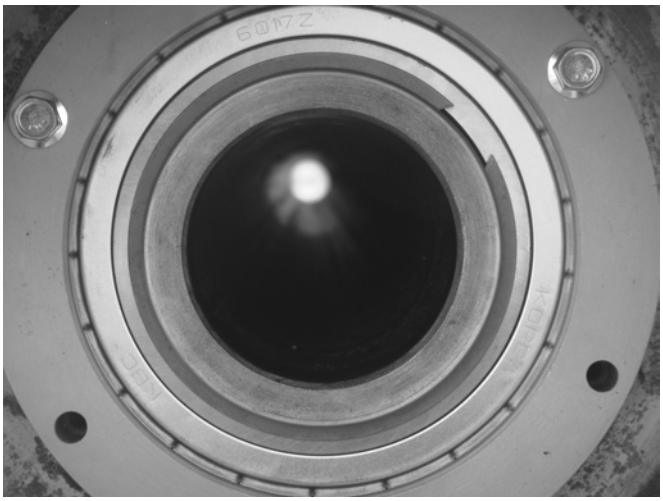


Figure 2–27: Retaining Ring Installed



11. Seal the base pole as follows.
    A. Using acetone and a clean rag or paper towel, wipe clean the entire section of the bottom shaft that protrudes from the base pole. Also pay particular attention to the machined surfaces.

       Note: Avoid contaminating the top bearing with acetone during this cleaning process.

    B. Apply a thin bead of silicone sealant around the bottom shaft sleeve (Figure 2–28).

Figure 2–28: Sealing the Bottom Shaft Sleeve

Caution: Mariah Power delivers the generator clean and shrink-wrapped in its shipping box. Do *not* let dirt or debris (especially metal shavings or ferrous material) fall into the generator during assembly. If such contamination occurs, you must *not* install the generator; return it to Mariah Power for replacement.

12. Install the generator as follows.
    A. Using acetone and a clean rag or paper towel, clean the generator clamp flange (Figure 2–29).

Figure 2–29: Cleaning the Generator Clamp Flange

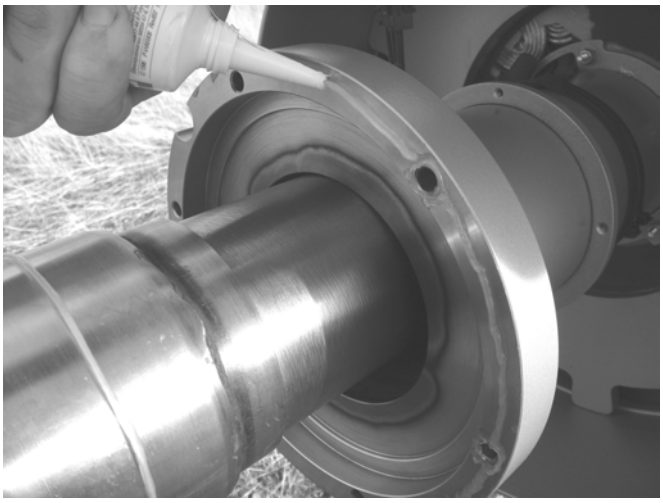
B. Using acetone and a clean rag or paper towel, wipe clean:
   - The inside clamp area of the generator
   - The generator clamp wedge and generator clamp disk

C. Slide the generator into position over the bottom shaft (Figure 2–30). Align the semicircular cut-out on the generator's bottom flange with the hole on the end of the base pole. The orientation of the hole is on the bottom when the base pole is horizontal.

Figure 2–30: Resting the Generator over the Bottom Shaft

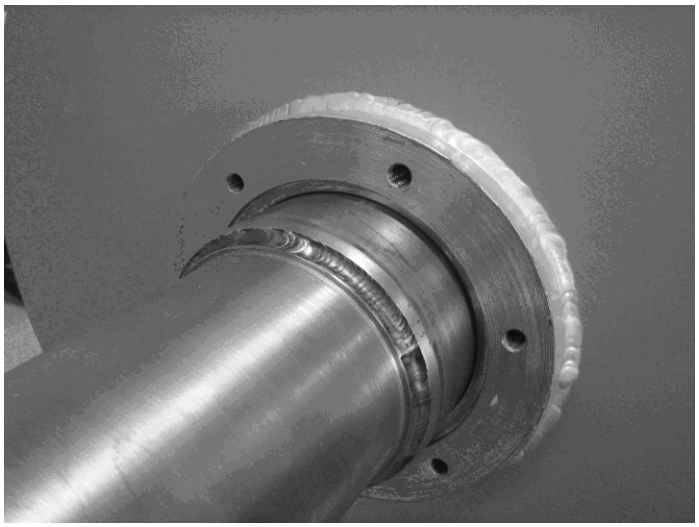
D. At the bottom end of the armature tube flange on the generator, apply a thin bead of silicone at the clamping surface (Figure 2–31).

Figure 2–31: Sealing the Bottom of the Armature Tube Flange



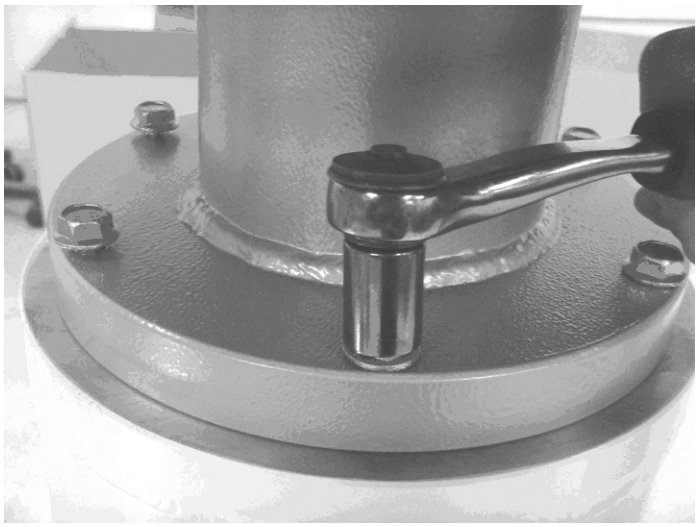
E. Slide the generator into place all the way over the bottom shaft to seal the top bearing with the base of the generator. The generator should be positioned over the generator clamp sleeve of the bottom shaft (Figure 2–32).

Figure 2–32: Sliding the Generator over the Bottom Shaft



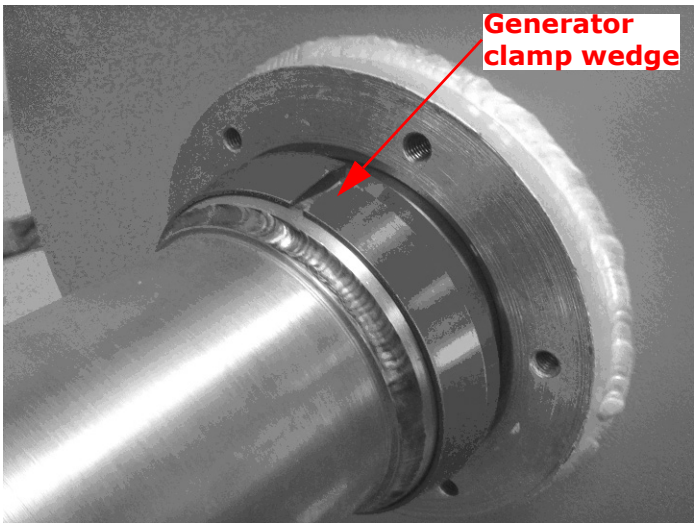
F. Use six generator screws (M8 x 35mm) to secure the generator base to the top of the base pole (Figure 2–33). Torque the screws to 18 ft-lb (24 N-m).

Figure 2–33: Securing the Generator to the Top of the Base Pole



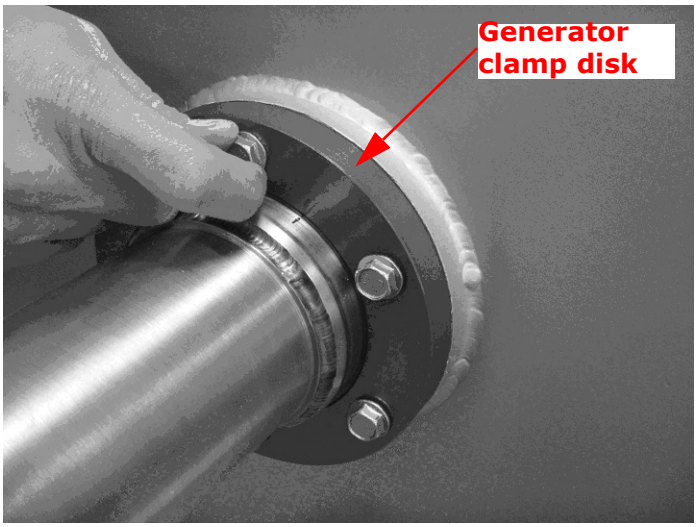
G. Slide the generator clamp wedge over the bottom shaft and insert it into the stepped face of the generator clamp flange (Figure 2–34).

Figure 2–34: Inserting Clamp Wedge into Clamp Flange



H. Insert the generator clamp disk over the generator clamp wedge (Figure 2–35). Use six generator clamp screws (M8 x 25mm) to attach the clamp disk to the generator. Tighten all generator clamp screws finger tight.

Figure 2–35: Attaching the Clamp Disk to the Generator

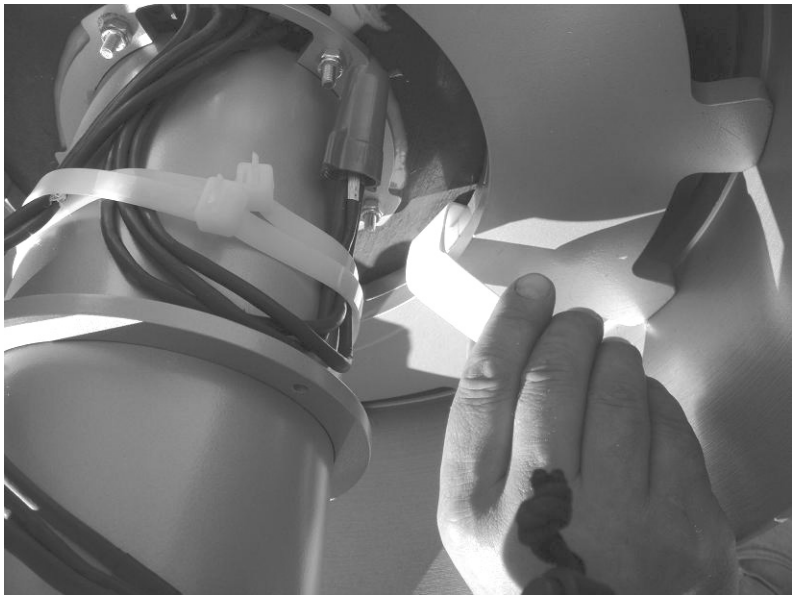


13. The Windspire uses an air-core generator. As such, the generator requires correct gapping of its internal air gaps. Perform the following steps to tighten the generator to the bottom shaft correctly with proper gapping.

    A. Set the generator gap using the three gapping tools as follows.

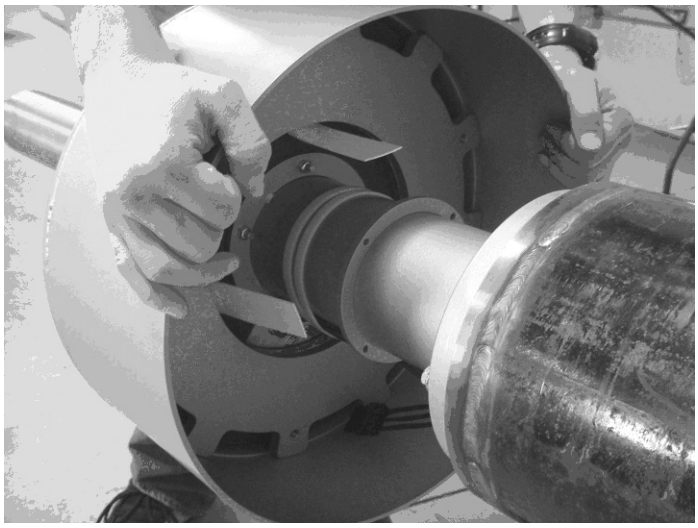
        1) Place the generator gapping tools in the space between the magnets and the plastic armature, placing them into the inside-diameter accessible side of the bottom back iron (Figure 2–36).

Figure 2–36: Gapping Tools



        2) ***Gently*** pull the generator housing towards the top of the bottom shaft to tighten the gap where the gapping tools are placed (Figure 2–37). If too much force is applied to the generator, the armature will bend with the pressure and the gap will be set incorrectly. The gapping tools should be snug within the generator gap, so they won't move when placed in the gap, but not so tight in place that you require force to insert or remove them.

Figure 2–37: Pulling the Generator Housing towards the Top of Bottom Shaft

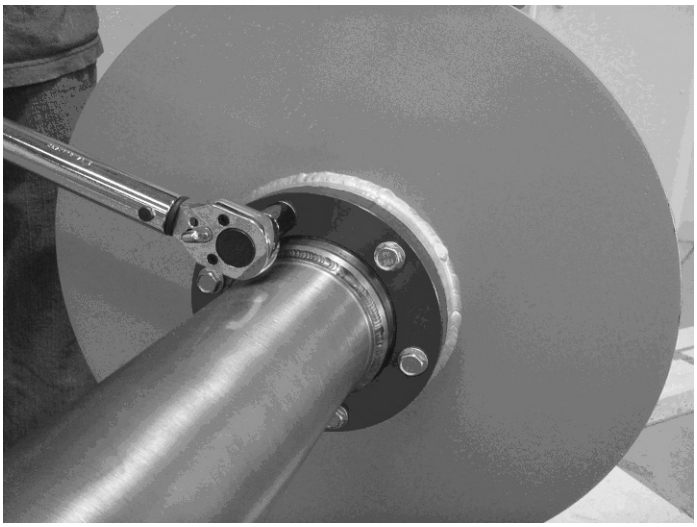


3) While maintaining the proper positioning of the generator, use a socket and wrench to evenly tighten each generator clamp screw in a circular sequence, with ¼ turns for each screw (Figure 2–38). Use a torque wrench to tighten each screw to 25 ft-lb (34 N-m) in a circular sequence. Double-check that all screws are fully tightened by continuing in a circular sequence until all screws are fully tightened.

Notes:

- This step should be done with the magnetic bearing uninstalled, or before the magnetic bearing is installed.
- After you tighten the generator, it should rotate freely and silently without contacting the armature and without wobbling. If any wobbling occurs, fix it by loosening the generator clamp screws and adjusting the generator. Re-check the generator for wobbling after you adjust it.

Figure 2–38: Tightening Generator Clamp Screws



B. Apply a bead of silicone to the interface of the generator's top (Figure 2–39) and the bottom shaft (Figure 2–40).

Figure 2–39: Sealing the Interface between Generator Clamp and Generator

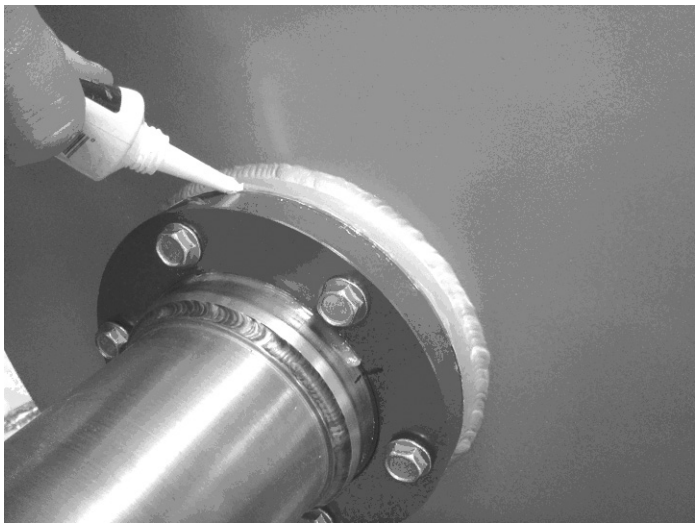
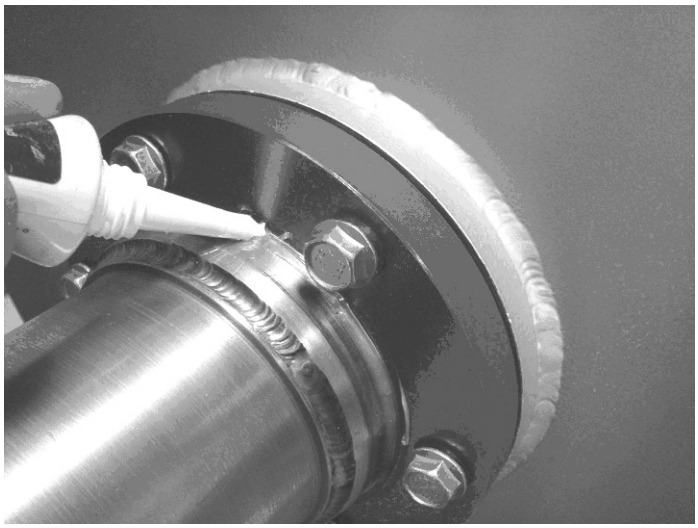
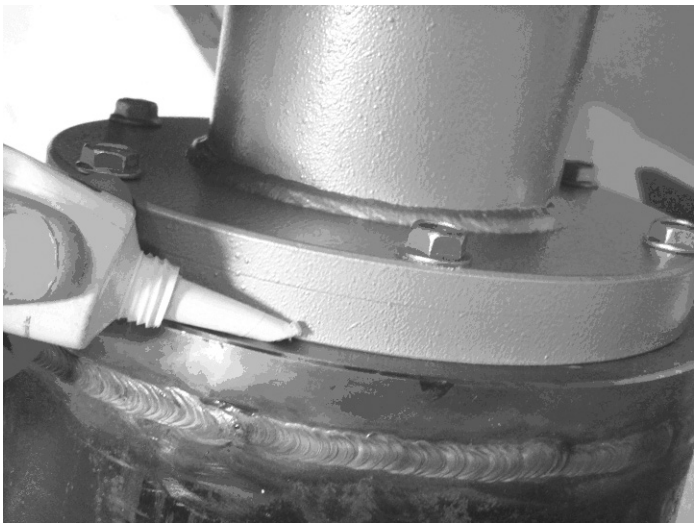


Figure 2–40: Sealing Interface Between the Bottom Shaft and Generator Clamp



C. Apply silicone around the generator base contact to the top of the base pole (Figure 2–41).

Figure 2–41: Sealing Generator Base

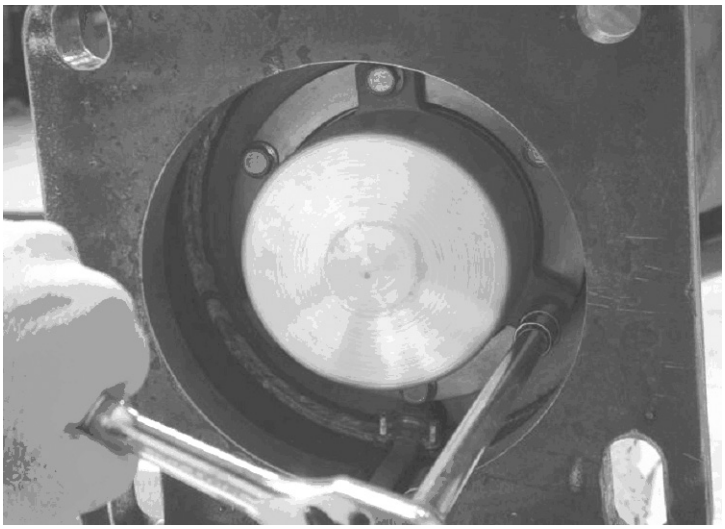


☐ 14. Attach the magnetic bearing to the lower end of the base pole and tighten it in place with three of the generator/magnetic-bearing screws (Figure 2–42). Tighten the bolts evenly around the circumference until all are completely tight.

Tips:

- Finger tighten each screw until they cannot tighten anymore.
- Using a socket with a 6 inch or larger extension, tighten each screw in ½ turns until the magnetic-bearing spider plate contacts the bottom bearing cap at all three tabs of the spider plate. A magnetic field is generated inside the magnetic bearing that attracts the socket tool to it when fully in place.
- Torque the magnetic bearing screws to 18 ft-lb (24 N-m).

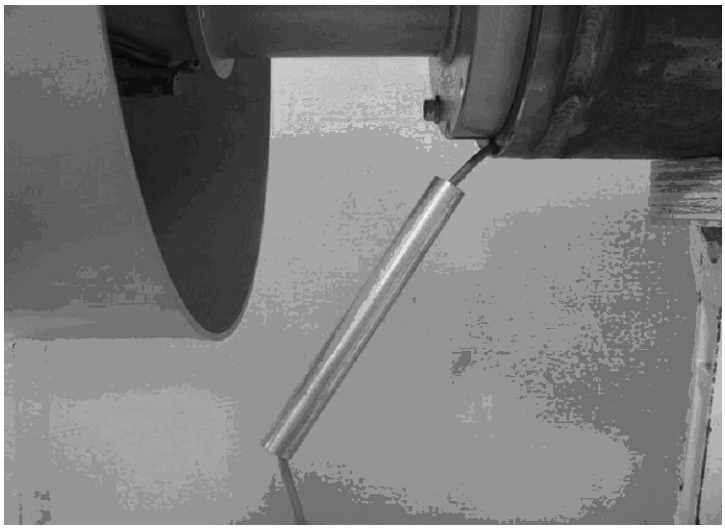
Figure 2–42: Attaching the Magnetic Bearing



15. Attach the wire tube as follows.
    A. Remove the inverter insert plate from the grid-tie inverter[a].
    B. Slide the wire tube over the wire extending from the top of the base pole (Figure 2–43).

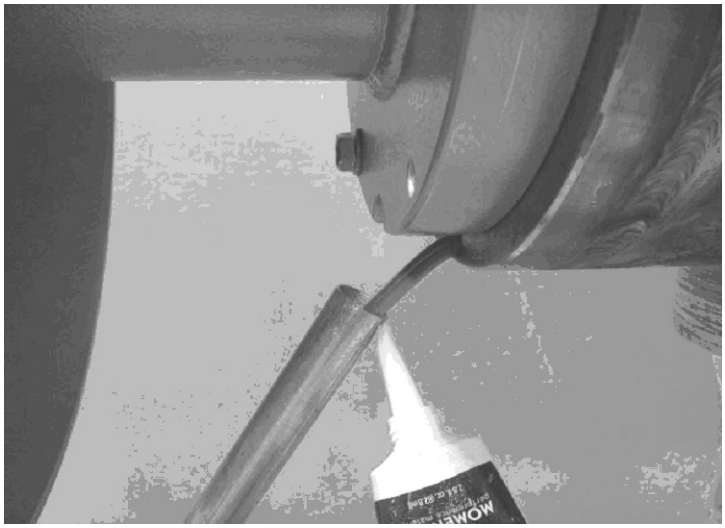
a If you did not install the grid-tie inverter, insert the wire tube with generous silicone at its joint with the base pole. Then tighten the wire clamp over the wire tube.

Figure 2–43: Sliding the Wire Tube over the Wire



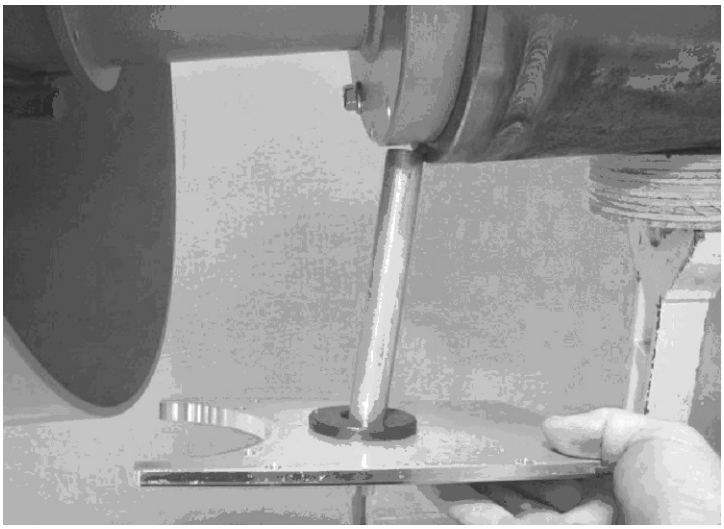
    C. Generously apply silicone to the end of the wire tube that you will insert into the base pole (Figure 2–44).

Figure 2–44: Applying Silicone to End of Wire Tube



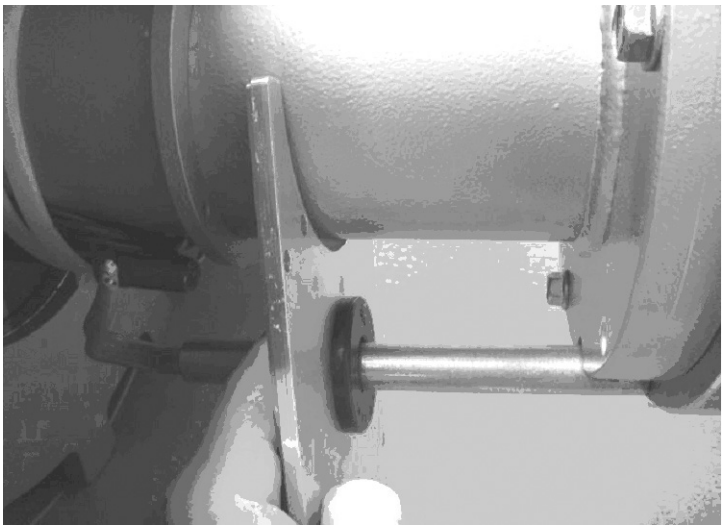
D. Slide the rubber grommet and inverter insert plate over the wire tube (Figure 2–45).

Figure 2–45: Sliding Grommet and Inverter Insert Plate over Wire Tube



E. Position the inverter insert plate against the armature tube and below the inverter mounting flange (Figure 2–46).

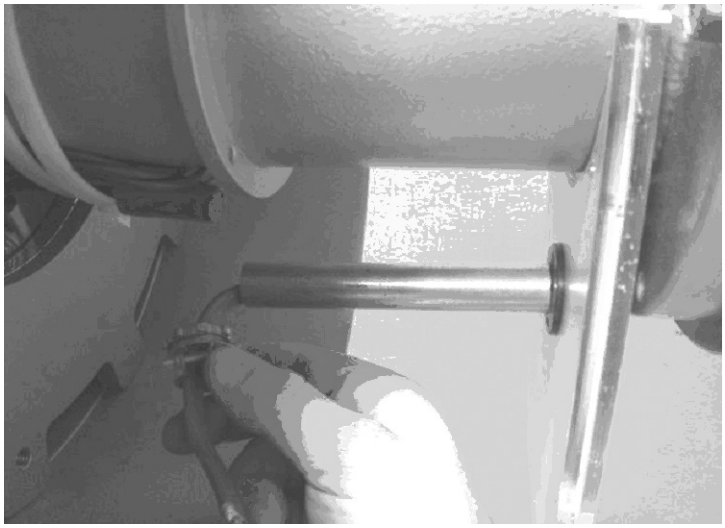
Figure 2–46: Positioning the Inverter Insert Plate Against Armature Tube



F. Push the wire tube into the wire tube hole at the top end of the base pole.

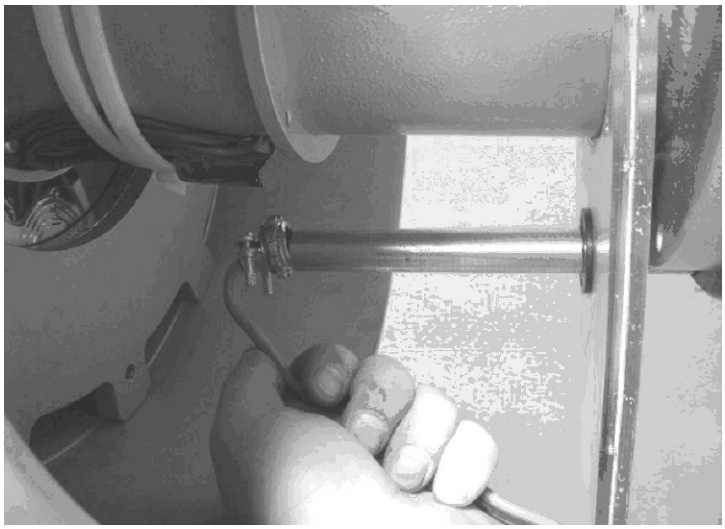
G. Slide the wire clamp over the wire until it is at the top of the wire tube (Figure 2–47).

Figure 2–47: Sliding the Wire Clamp Over the Wire



H. Pull the wire until it has adequate tension, bend the wire to prevent it from sliding back inside the wire tube, and tighten the wire clamp (Figure 2–48).

Figure 2–48: Tightening the Wire



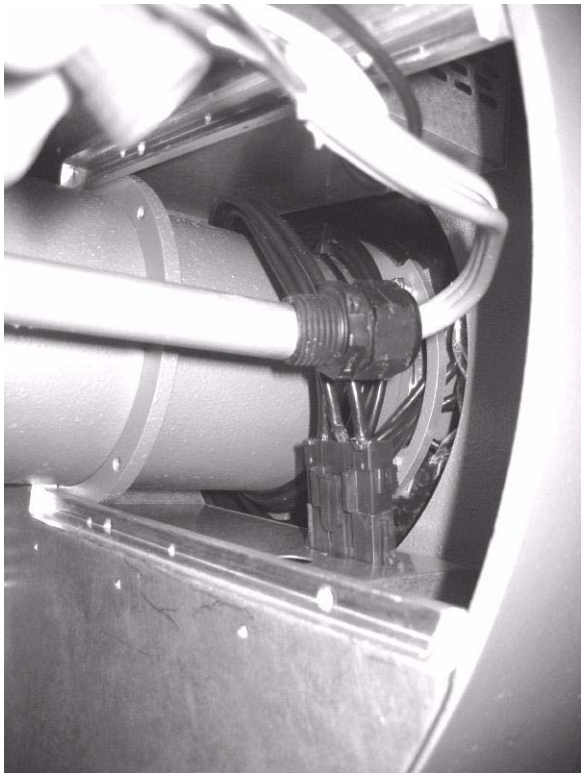
☐ 16. The Windspire grid-tie inverter has an eight-character MAC address on a small white sticker on its back. Record this number on page ii of this manual. You will need the MAC address to set up the wireless communication in Step 36.

☐ 17. Attach the grid-tie inverter to the bottom of the generator (Figure 2–49). Tighten the inverter base plate to the generator with two of the inverter screws (M6x16mm). Torque the screws to 6 ft-lb (4 N-m).

Figure 2–49: Attaching the Inverter Base Plate

☐ 18. Plug the armature wires from the generator into the grid-tie inverter (Figure 2–50).

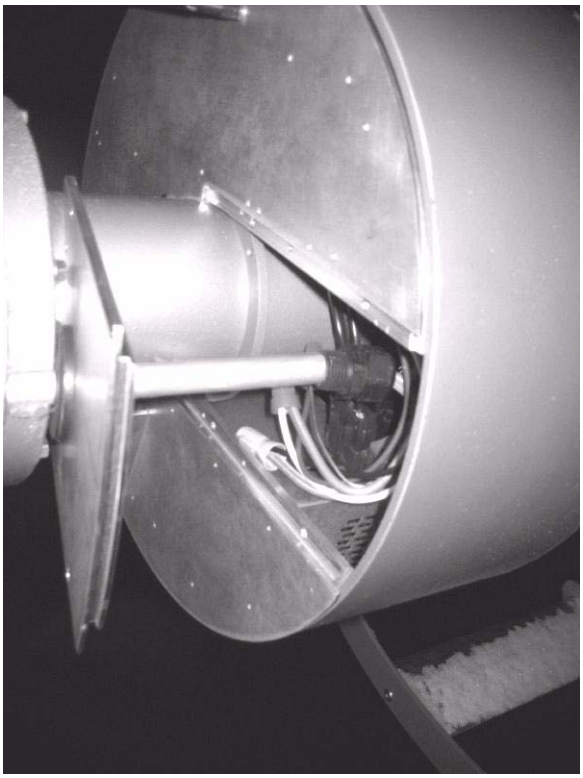
Figure 2–50: Connecting the Wires to the Grid-tie Inverter



19. Connect the three inverter output wires to the wires through the base pole using the wire nuts (Figure 2–51). Connect green to copper ground, white to white (neutral), and black to black (hot). Position the wires such that they do ***not*** touch the outside generator housing or the rotating parts of the generator.

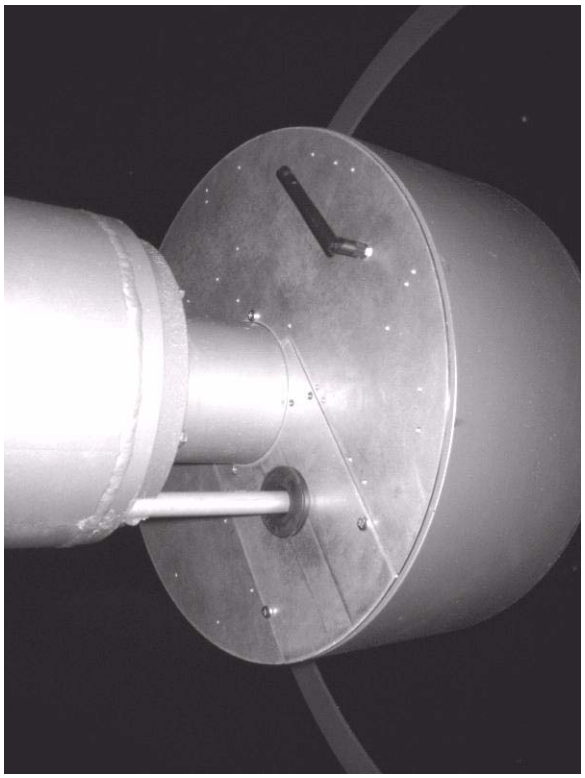
    Note: Double-check that the generator wire connector is connected to the inverter receptacle, and is ***snapped*** into place. Also double-check that the inverter wires are properly matched to the correct colors on the wire. The grid-tie inverter contains the electronic safety brake so you must not erect the Windspire before these connections are secure. You can erect the Windspire if the rotor stall connector is attached to the generator wire connector. For details on the rotor stall connector, see Installing the Generator-shorting Connector on page 70.

Figure 2–51: Connecting Wires Through the Base Pole



20. Install the inverter insert plate as follows (Figure 2–52).
    A. Push the insert plate into place with the inverter base plate.
    B. Tighten the insert and base plates together with four inverter screws (M6x16mm). Torque the screws to 3 ft-lb (4 N-m).
    C. Tighten the insert plate to the generator with two inverter screws (M6x16mm). Torque the screws to 6 ft-lb (8 N-m).
    D. Attach the antenna that is supplied with the grid-tie inverter. Do ***not*** over-tighten the antenna; doing so could damage the grid-tie inverter.

Figure 2–52: Installing the Inverter Insert Plate



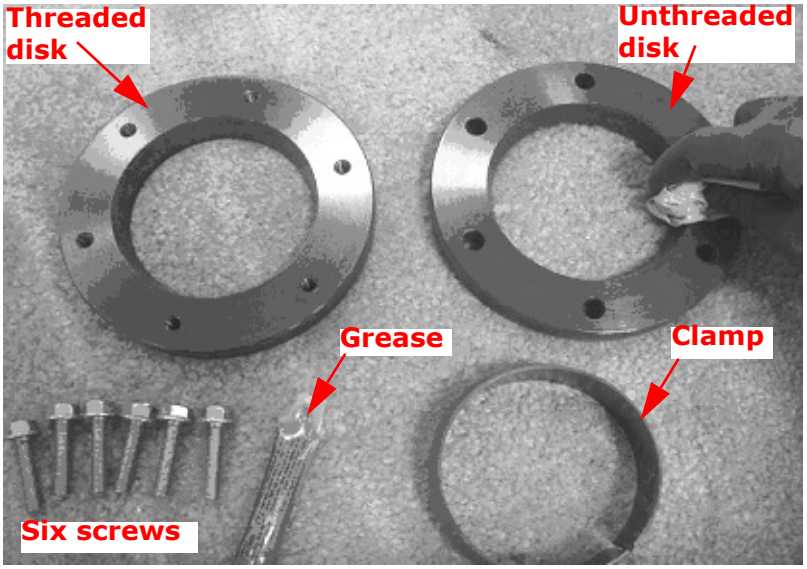
21. Assemble the two top-shaft clamps as follows.

A. Locate the clamp parts (Figure 2–53). Each top-shaft clamp comprises the following:

- One wedge
- One threaded disk
- One unthreaded disk
- Six screws

There is also one packet of anti-seize grease that you use for both top-shaft clamps and for the O-rings (Step 9).

Figure 2–53: Top-shaft Clamp Components



B. Using acetone and a clean rag or paper towel, wipe clean all parts of the top-shaft clamps (Figure 2–53).

C. Using rubber gloves, apply a very thin coating of the anti-seize grease to the outside tapered surfaces of each top-shaft clamp wedge (Figure 2–54).

D. Apply a small amount of anti-seize grease to the threads on the top-shaft clamp screws.

Figure 2–54: Greasing a Top-shaft Clamp Wedge

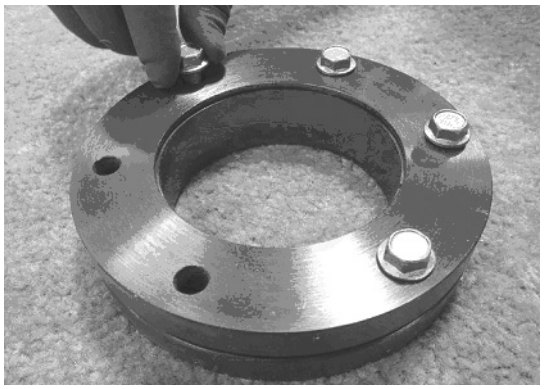
E. Assemble each top-shaft clamp as follows:

1) Place the top-shaft clamp wedge in between the two top-shaft clamp disks.

2) Insert the six top-shaft clamp screws through the unthreaded disk into the threaded disk. (Ensure that the top shaft clamp screw threads are lightly greased with the supplied anti-seize grease.)

3) Finger tighten the screws (Figure 2–55).

Figure 2–55: Assembling the Top-shaft Clamps



F. Remove any excess grease on the top-shaft clamps, paying particular attention to the inside diameter of the top-shaft clamp wedges (Figure 2–56).

Figure 2–56: Removing Excess Grease from Top-shaft Clamps

22. Attach the top and bottom shafts (Figure 2–57) as follows.
    A. Using acetone and a clean rag or paper towel, wipe clean the 18" (46 cm) bottom-shaft sleeve and the inside of the top shaft.
    B. Orient the top-shaft clamps such that the sides with the bolt-heads protruding from each clamp are facing each other, then slide both clamps onto the bottom end of the top shaft.
    C. Raise the top end of the top shaft while pushing it over the bottom-shaft mating surface.
    D. Slide the top shaft ***all the way*** over the bottom shaft and push it into place until the top shaft seats against the step on the bottom shaft.

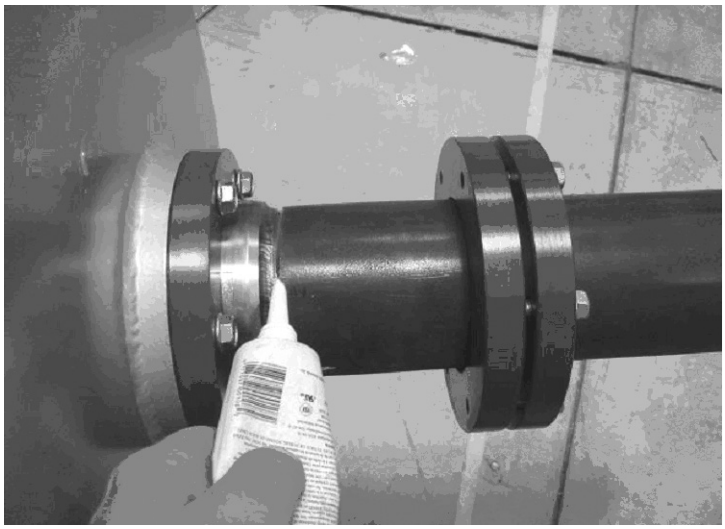
Figure 2–57: Attaching the Top and Bottom Shafts

E. Apply a bead of silicone to the interface of the top and bottom shafts (Figure 2–58).

Notes:

- ***Do not*** put any type of grease or anti-seize material in the interface between the top shaft and the sleeve of the bottom shaft. Doing so will create a failure of the turbine.
- The top shaft and bottom shaft sleeve must be completely clean and dry during assembly.

Figure 2–58: Sealing the Interface of the Top and Bottom Shafts

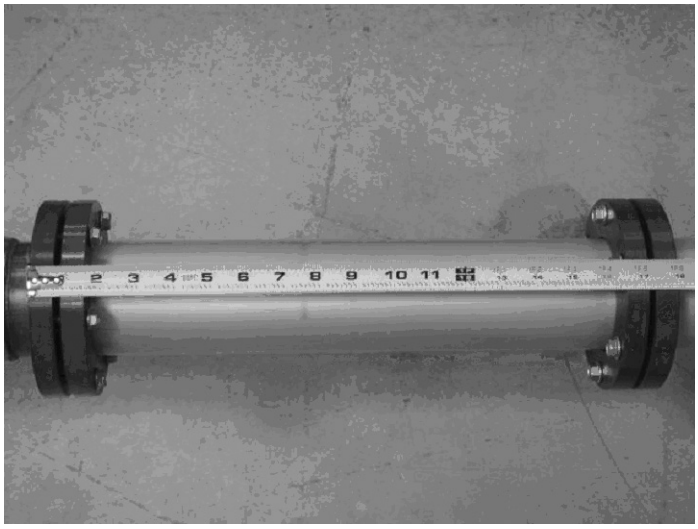


☐ 23. Tighten the top shaft to the bottom shaft as follows (Figure 2–59).

A. Position the first clamp at the lower end of the top shaft.

B. Position the second clamp so the upper end of the first clamp is exactly 18 inches (46 cm) from the lower end of the top shaft.

Figure 2–59: Positioning the Top-Shaft Clamp



C. Use a socket and ratchet to tighten the six screws on both clamps evenly and in quarter turns in a circular direction until the torque increases. Tighten the screws in a circular sequence until they reach 15 ft-lb.

The final torque on the screws will be such that the screw bottoms should be flush with the opposing surface of the threaded disk (Figure 2–60). However, you will perform that final tightening after the Windspire is raised (in Step 33).

To facilitate tightening the screws, attach one strut/airfoil assembly to the top shaft at the bottom-most attachment point. You can hold onto the assembly while tightening the screws (Figure 2–61).

Figure 2–60: Screw Bottoms Flush with Opposing Face of Threaded Disk

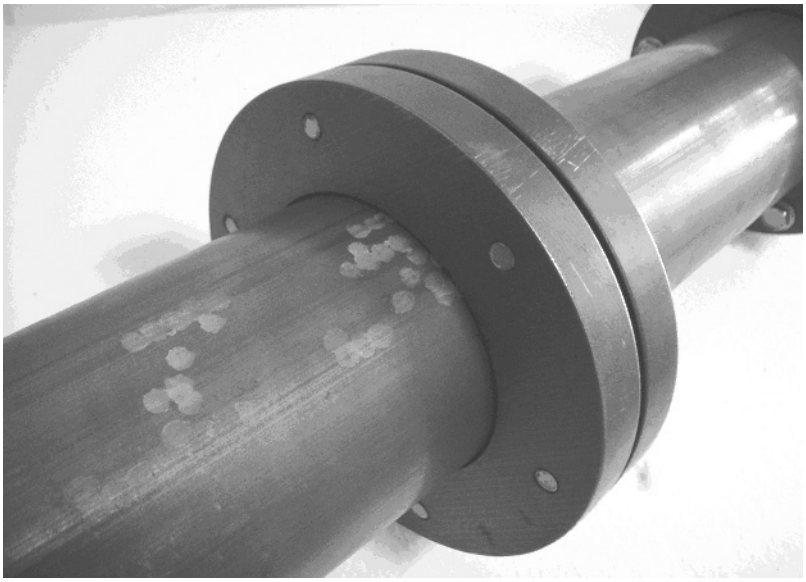
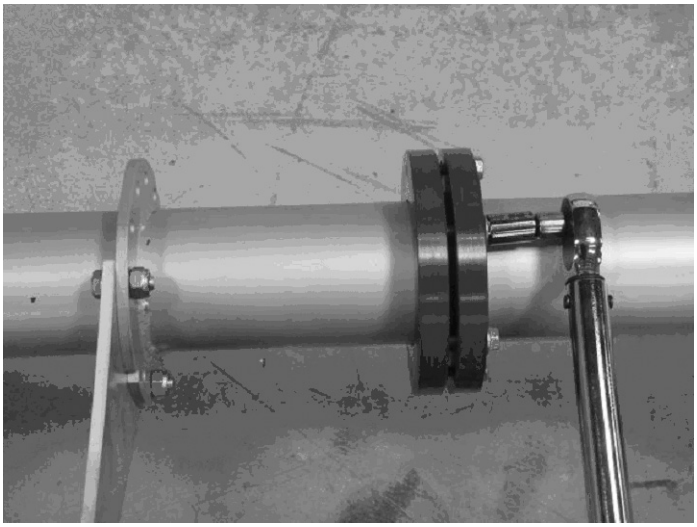


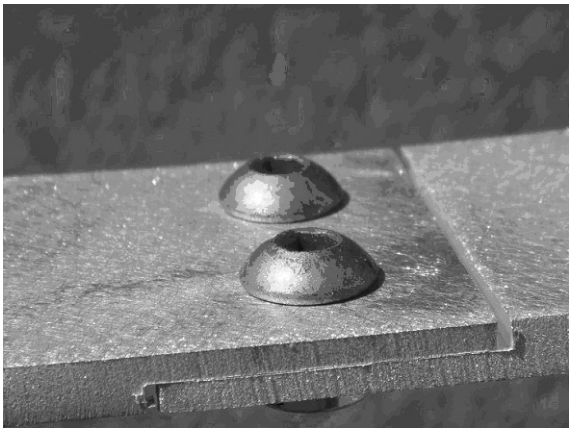
Figure 2–61: Strut/Airfoil Assembly Attached for Leverage When Tightening Screws



24. Attach the strut/airfoil assemblies to the top shaft as follows. Ensure all the airfoils are oriented to rotate in the same direction.
    A. Center the first struts over the V-notch on the top shaft. Ensure the struts are secured above the top shaft flanges.
    B. Insert the strut bolts (M10 x 25) through the struts and then through the top-shaft flange.
    C. On the underside of the top-shaft flange, attach the strut locknuts (M10) to the strut bolts.
    D. Tighten the locknuts onto the bolts such that the clearance between the struts and the top shaft flange is almost snug: about 1/16" of a gap. This helps in later steps.
    E. Repeat steps A–D to attach the remaining strut/airfoil assemblies to the top shaft.
    F. Rotate the rotor until one airfoil is at the bottom (closest to the ground).
    G. Starting with the bottom rotor struts, use the ratchet and 17 mm socket to tighten the strut nuts to the top-shaft flanges while using a 15 mm wrench to hold the strut bolts stationary in relation to the rotor struts. Be sure to tighten each pair of nuts in the same order for all rotor struts, to aid alignment. It will help to wiggle the struts to find the *low* spot. It will also help to have an extra hand push straight down on the airfoil (about 30–40 lb force) to help find the low spot while tightening. The airfoil edges must all be in a straight line with each other after tightening the rotor struts to the top shaft flanges. Torque the nuts to 34 ft-lb (46 N-m).
    H. Repeat steps F–G for the two other airfoils, being sure they are tightened only while in the lowest position (closest to the ground). Verify that the airfoils are parallel to the top shaft. All airfoils should be aligned with each other and parallel to the top shaft after completing these steps. If the airfoils are not aligned properly, loosen, straighten, and re-tighten them.

25. Assemble the two rotor rings as follows.
    A. Locate the 45” x 15” x 2” box containing the six rotor ring segments.
    B. Three rotor ring segments comprise one rotor ring. They attach to each other with six rotor segment screws (M8 x 12mm button-head socket-cap screws). There are a total of 12 screws (six for each rotor ring). Finger tighten each screw as you insert it. Once all the screws are in place for a ring, use the included 5mm ball-driver Allen-head wrench to secure the segments together (Figure 2–62). Torque the screws to 18 ft-lb (24 N-m).

Figure 2–62: Attaching the Rotor Ring Segments Together



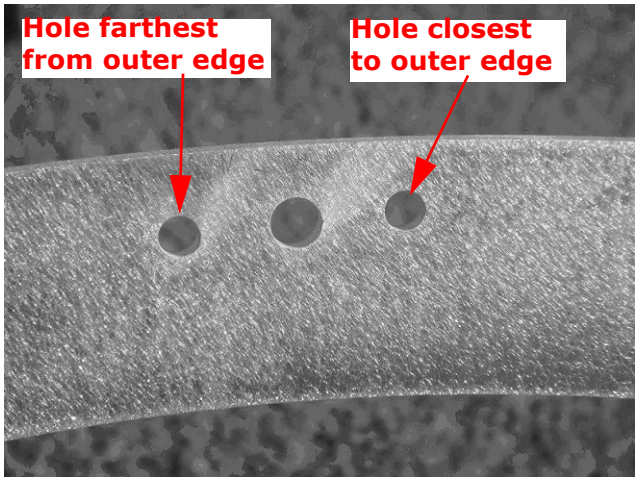
    C. The final assembly of the rotor ring should be a fully connected ring (Figure 2–63). Verify all the screws are fully tightened before attaching rotor rings to the Windspire.

    If you installed all of the strut/clamp assemblies on the Windspire, you can install the rotor ring that attaches to the lower end of the rotor around the Windspire, below the rotor section.

Figure 2–63: Assembled Rotor Ring

D. Use the two smaller holes in a rotor ring to attach it to an airfoil end. Note that the smaller holes are not positioned at the same distance from the outer edge of the rotor ring (Figure 2–64). The rotor rings therefore connect only from one side of the ring to the airfoils, depending on the orientation in which you installed the airfoils. The rotor ring screw that attaches to the leading-edge end of the airfoil will secure to the hole that is closer to the outside of the rotor ring (the right hole in Figure 2–64; the left hole in Figure 2–67).

Figure 2–64: Holes for Attaching a Rotor Ring to an Airfoil



☐ 26. Remove the 12 airfoil end-cap screws from the tops of the top airfoils and the bottoms of the bottom airfoils. You will not reuse the airfoil end-cap screws but you will reuse the end-caps themselves. Figure 2–65 shows an airfoil with an end-cap removed.

Figure 2–65: End-cap Removed from an Airfoil

27. Use the 12 supplied rotor ring screws (Button head SHCS, M8x25mm) to attach the rotor rings to the airfoils. Be sure to install the airfoil end-caps between the airfoils and rotor rings (Figure 2–66). Torque the screws to 8 ft-lb (11 N-m).

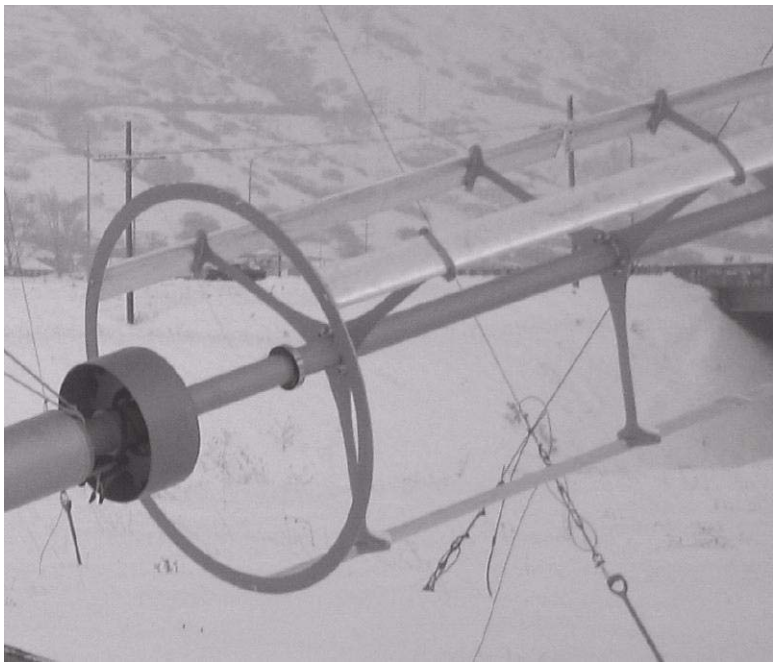
Figure 2–66: Airfoil End-cap Installed between an Airfoil and Rotor Ring

Note that once the rotor rings are secured to the airfoils, the screw hole facing the leading-edge side (the left hole in Figure 2–67) is closer to the outside of the rotor ring.

Figure 2–67: Screw Hole Positions for a Rotor Ring Attached to an Airfoil

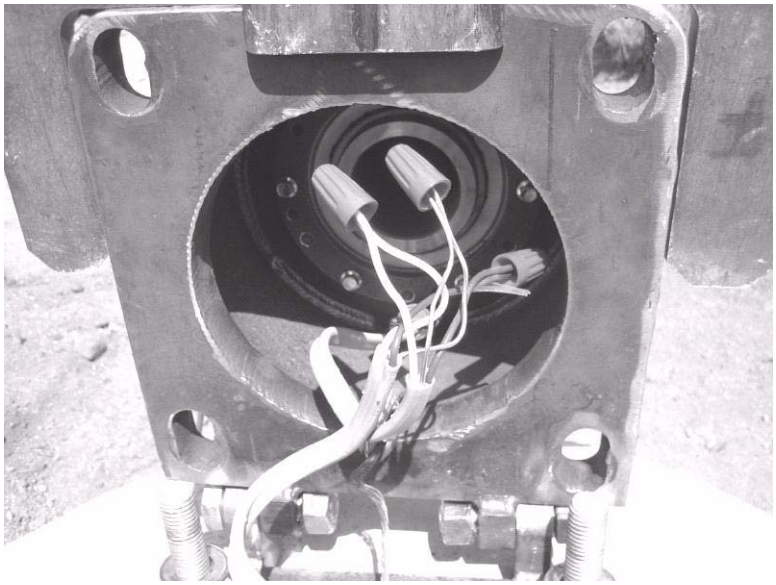
Figure 2–68 shows the bottom rotor ring attached to the airfoils.

Figure 2–68: Rotor Ring Attached to Bottoms of Airfoils



☐ 28. Use the grounding screw (M8 x 16mm) and the grounding washer (8mm fender) to attach the grounding wire to the lower hinge plate at the M8 tapped hole (Figure 2–69). When connecting the base pole and foundation UFB wires with the wire nuts, ensure you match the wire colors: black, white, and ground (bare copper). Push the connections and wire nuts up inside the base pole.

Figure 2–69: Connecting the Base Pole and Foundation Wires



At this point, you are ready to erect the Windspire. The next section describes the procedure.

2.5 Erecting the Windspire

Caution: Do not erect the Windspire unless there are calm or low-wind conditions.

☐ 29. Wrap the smaller 10 foot (3 meter) cable around the armature tube, but not around the wire tube, as it would bend or break. Pull one end of the cable through the spliced loop at the opposite end and pull tight (Figure 2–70). Attach the gin pole to the top hinge plate of the base pole. Attach a carabineer between the eye-bolt on the gin pole and the opposite end of the cable.

Figure 2–70: Wrapping the Gin Pole Cable Around the Armature Tube

30. Wrap the larger 30 foot (9.1 meter) cable around the armature tube in the same manner as in Step 29 except that you place it over the top of the gin pole's V-notch. Attach the second carabineer to the opposite end of the cable and to a vehicle. Be sure to use a vehicle with sufficient weight and traction. The vehicle must have a connection with sufficient strength to raise the wind turbine (Figure 2–71).

Figure 2–71: Connecting the Pull-up Cable Between the Gin Pole and Vehicle

☐ 31. During calm or low wind conditions, drive the vehicle to erect the turbine (Figure 2–72). Drive the vehicle slowly in a straight path away from the turbine while keeping the pull-up cable in line with the gin pole (Figure 2–73). Once the turbine is nearly erect, it will continue on its own until it is fully vertical. ***Do not continue driving the vehicle to pull on the cable after the Windspire is fully erected***.

Notes:

- Do ***not*** try to erect the turbine if the ground has inadequate traction.
- Never stand below a turbine that is being raised or lowered.
- Always keep one foot on the brake while erecting the turbine.
- For the steps to lower the wind turbine, see Lowering the Windspire on page 64.

Figure 2–72: Erecting the Turbine with the Vehicle

Figure 2–73: Driving in a Straight Path from the Turbine

32. Once the wind turbine is erect, tighten the top hinge plate to the foundation rods (Figure 2–74) as follows.
    A. Place a metal washer, a rubber washer, another metal washer and a nut on each foundation rod above the top hinge plate.
    B. Use a 30mm wrench or socket to tighten each nut just enough to be snug: the top washer should not be free to slide.
    C. Release the tension on the pull-up cable with the vehicle.
    D. Remove the cables and gin pole.

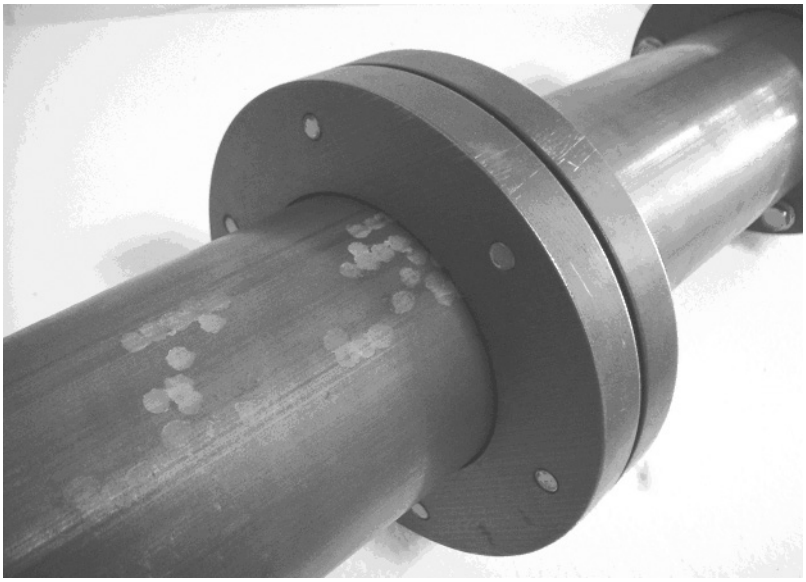
    Note: The turbine installation will now require leveling when there are calm wind conditions. See Step 34 for details.

Figure 2–74: Top Hinge Plate Tightened to the Foundation Rods

33. Complete the final torque on the top-shaft clamp screws. Please note that safety is very important when performing this step. Follow all proper safety measures while using a ladder or elevating equipment. Tighten the screws in a circular sequence until the screw bottoms are flush with the opposing face of the threaded disk (Figure 2–75). Having a helping hand hold onto the rotor to prevent rotation might facilitate the tightening.

    Note: This is a critical step of the installation. You must perform this step as directed or the fitting of the shafts might not be secure. Ensure that the screw bottoms are flush with the opposing face of the threaded disk (Figure 2–75). Also be sure to work safely.

Figure 2–75: Screw Bottoms Flush with Opposing Face of Threaded Disk



34. The Windspire will function properly even if it is not perfectly level. However, for aesthetic reasons, we recommend that you level the Windspire. During calm wind conditions only, complete the turbine erection (Figure 2–76) as follows.
    A. Loosen the top foundation locknuts a couple turns until the top washers are free to move.
    B. Check the leveling of the Windspire by placing a level on the base pole.
    C. Loosen the required ***lower*** locknuts to level the Windspire.
    D. Once the Windspire is level, tighten the upper locknuts to just snug and then tighten them an additional 1/8 turn. Re-verify that the Windspire is level.

Figure 2–76: Erected Windspire

At this point, you are ready to connect the electrical system. The next section describes the procedure.

2.6 Connecting the Electrical System

35. Connect your Windspire to the electrical system in your home or business using the wiring diagrams in Section 2.8 Wiring Diagrams for guidance. Always be sure to follow any and all National Electric Code (NEC) requirements for your area.

You have completed the Windspire installation. Optionally, you can set up the Windspire for wireless communication as described in the next section.

2.7 Setting Up Wireless Communication

36. If you wish to use your Windspire's wireless link for monitoring power production, insert the ZigBee modem dongle into a USB port on your computer (Figure 2–77). Download the latest version of the Mariah WindSync software from www.mariahpower.com. Install and run the application using your computer. You will need the MAC address on the sticker at the back of the grid-tie inverter (recorded in Step 16) to set up wireless communication.

Figure 2–77: Inserting the ZigBee Modem Dongle

2.8 Wiring Diagrams

The following notes apply to the wiring diagrams in figures 2–78, 2–79 and 2–80.

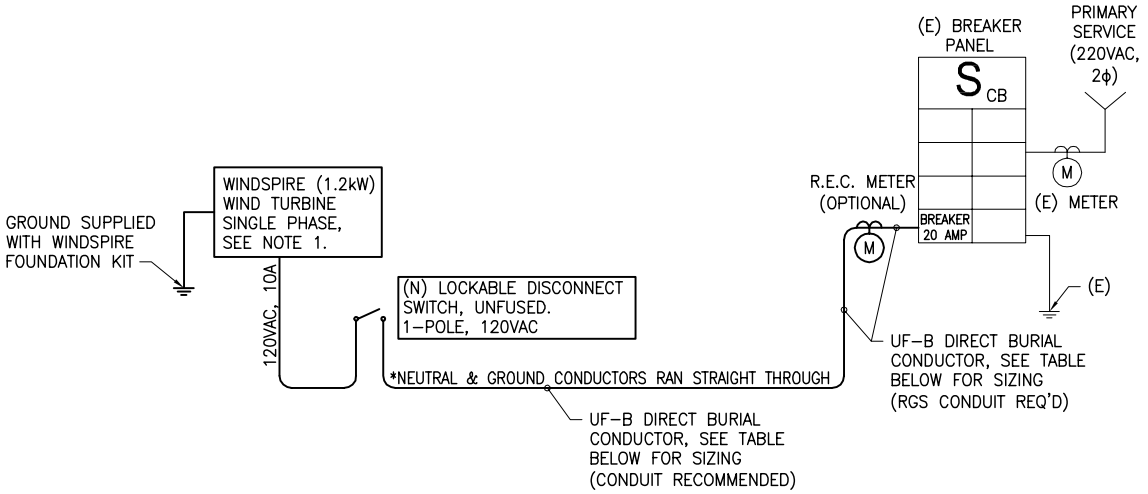
- You must install equipment in accordance with NEC article 705.
- The AC output neutral is not bonded to ground.
- To reduce the risk of fire, connect only to a branch circuit provided with 20 amperes maximum branch-circuit overcurrent protection in accordance with the National Electric Code, ANSI/NFPA 70.
- To reduce the risk of fire, do not connect to an AC load center (circuit breaker panel) with multiwire branch circuits connected.
- To reduce the risk of fire, do not connect to a GFCI protected circuit, outlet or breaker.
- Hardware required for the termination to buildings varies by installation; the owner or installer should provide it.
- Mariah Power recommends, and most utilities require, that you run a dedicated line from the Windspire to the breaker panel to which it will connect.

Figure 2–78: Wiring Diagram—Single Connection, Single Phase

WIRING DIAGRAM

1.2kW WINDSPIRE

SINGLE CONNECTION, SINGLE PHASE



ELECTRICAL NOTES:

1. SELF–CONTAINED INVERTER, UL 1741 LISTING REPORT #3125756CRT–001a, MANUFACTURED BY TECHNOLOGY DRIVEN PRODUCTS.
2. ALL EQUIPMENT IS NEW UNLESS OTHERWISE NOTED.
3. CONDUIT ENTRY/CONNECTION TO ELECTRICAL ENCLOSURES SHALL BE SUITABLE FOR GROUNDING PER NEC 250.97 AND SHALL BE SEALED AGAINST ENVIRONMENT.
4. ALL EXPOSED CONDUIT SHALL BE UV RESISTANT PVC OR RIGID GALV. STEEL (RGS).
5. INSTALLATION TO COMPLY WITH NEC, INCLUDING BUT NOT LIMITED TO SECTIONS 690.64(B)(2) AND 705.12.
6. DEDICATED CIRCUIT BREAKER FOR WIND TURBINE SHALL BE INSTALLED AT EITHER (L) OR (R) BOTTOM CORNER OF CIRCUIT BREAKER PANEL PER NEC REQUIREMENTS.
7. THE SUMMATION OF ALL CUIRCUIT BREAKERS (AMPERAGE) WITHIN THE PANEL, SHALL NOT EXCEED 120% OF THE BREAKER PANEL AMPERAGE RATING.
8. VERIFY WITH LOCAL UTILITY COMPANY REGARDING ANY ADDITIONAL WIRING OR DISCONNECT REQUIREMENTS.
9. ELECTRICAL INSTALLATION SHALL BE COMPLETED BY A LICENSED ELECTRICIAN.
10. DO NOT CONNECT TO AN AC LOAD CENTER (CIRCUIT BREAKER PANEL) THAT IS EQUIPPED WITH MULTIWIRE BRANCH CIRCUITS AND/OR GFCI PROTECTED CIRCUIT.

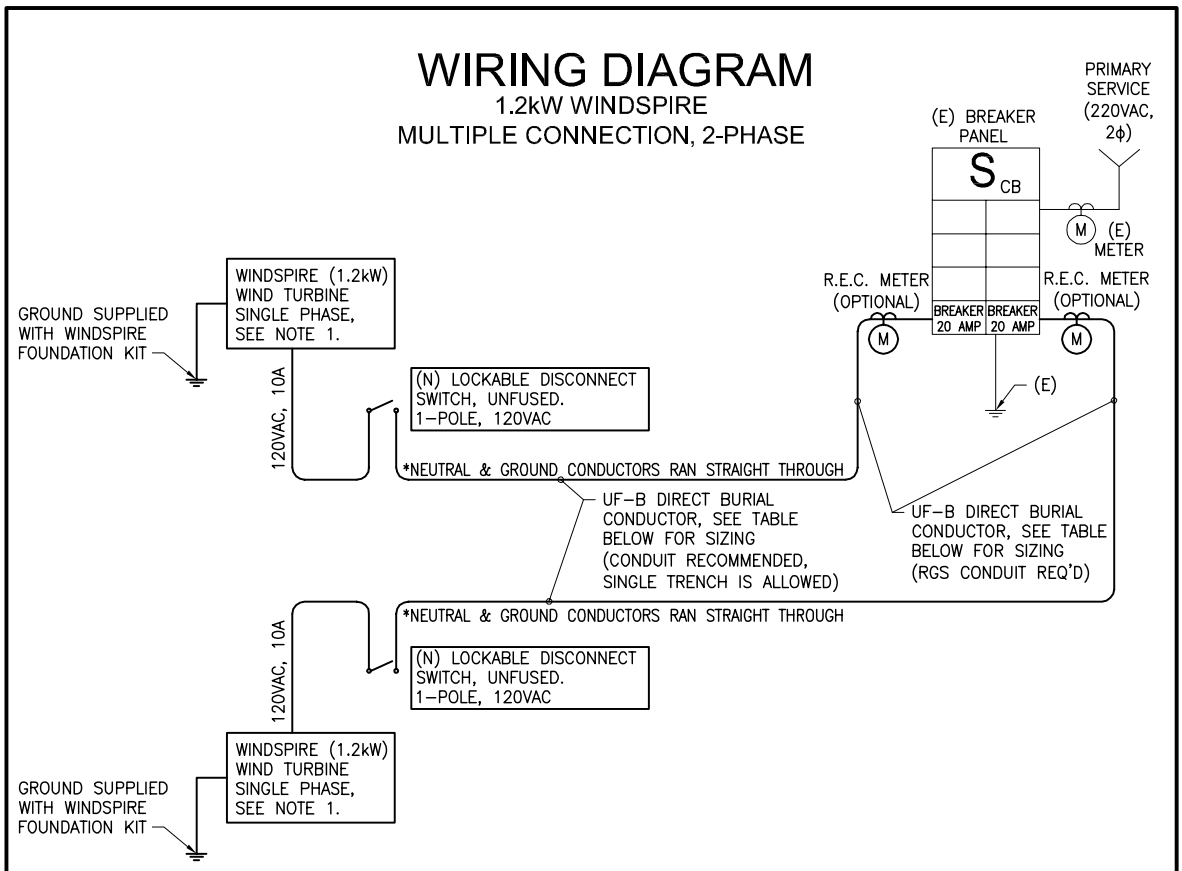
CONDUCTOR MAX. RUN TABLE [1,2]

# OF WINDSPIRE UNITS	CONDUCTOR DESIGN (A)	(V)	CONDUCTOR SIZE (AWG)	MAXIMUM CONDUCTOR RUN (FEET)
1	10	120	10	190
1	10	120	8	290
1	10	120	6	470
1	10	120	4	740
1	10	120	3	920

1. CONDUCTOR (COPPER) RUNS SHALL BE VERIFIED BY ELECTRICIAN OR QUALIFIED DESIGNER FOR SITE SPECIFIC CONDITIONS.
2. CONNECTION OF MULTIPLE WINDSPIRES TO A SINGLE CONDUCTOR RUN, WILL MULTIPLY THE CONDUCTOR CURRENT (A) BY THE NUMBER OF WINDSPIRES AND THUS REDUCE THE MAXIMUM RUN TO BE THE SINGLE UNIT RUN DISTANCE DIVIDED BY THE NUMBER OF UNITS (EXAMPLE: 4 UNITS = 40A; FOR #10 MAX. RUN = 190'/4 = 47.5').

DATE: APRIL 30, 2009	SINGLE WINDSPIRE V.A.W.T. 1.2kW WIRING DIAGRAM	Mariah Power 5450 LOUIE LANE RENO, NV 89511 (775) 857–4888 WWW.MARIAHPOWER.COM
DRAWN: DLM DWG. NO. 100006_P		
REV. A SHEET: 1 OF 1		

Figure 2–79: Wiring Diagram—Multiple Connection, Two-Phase



ELECTRICAL NOTES:

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9. ELECTRICAL INSTALLATION SHALL BE COMPLETED BY A LICENSED ELECTRICIAN.
10. DO NOT CONNECT TO AN AC LOAD CENTER (CIRCUIT BREAKER PANEL) THAT IS EQUIPPED WITH MULTIWIRE BRANCH CIRCUITS AND/OR GFCI PROTECTED CIRCUIT.

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DATE: APRIL 30, 2009		MULTIPLE, SINGLE PHASE WINDSPIRES V.A.W.T. 1.2kW WIRING DIAGRAM
DRAWN: DLM	DWG. NO. 100006_P	
REV. A	SHEET: 1 OF 1	

Mariah Power
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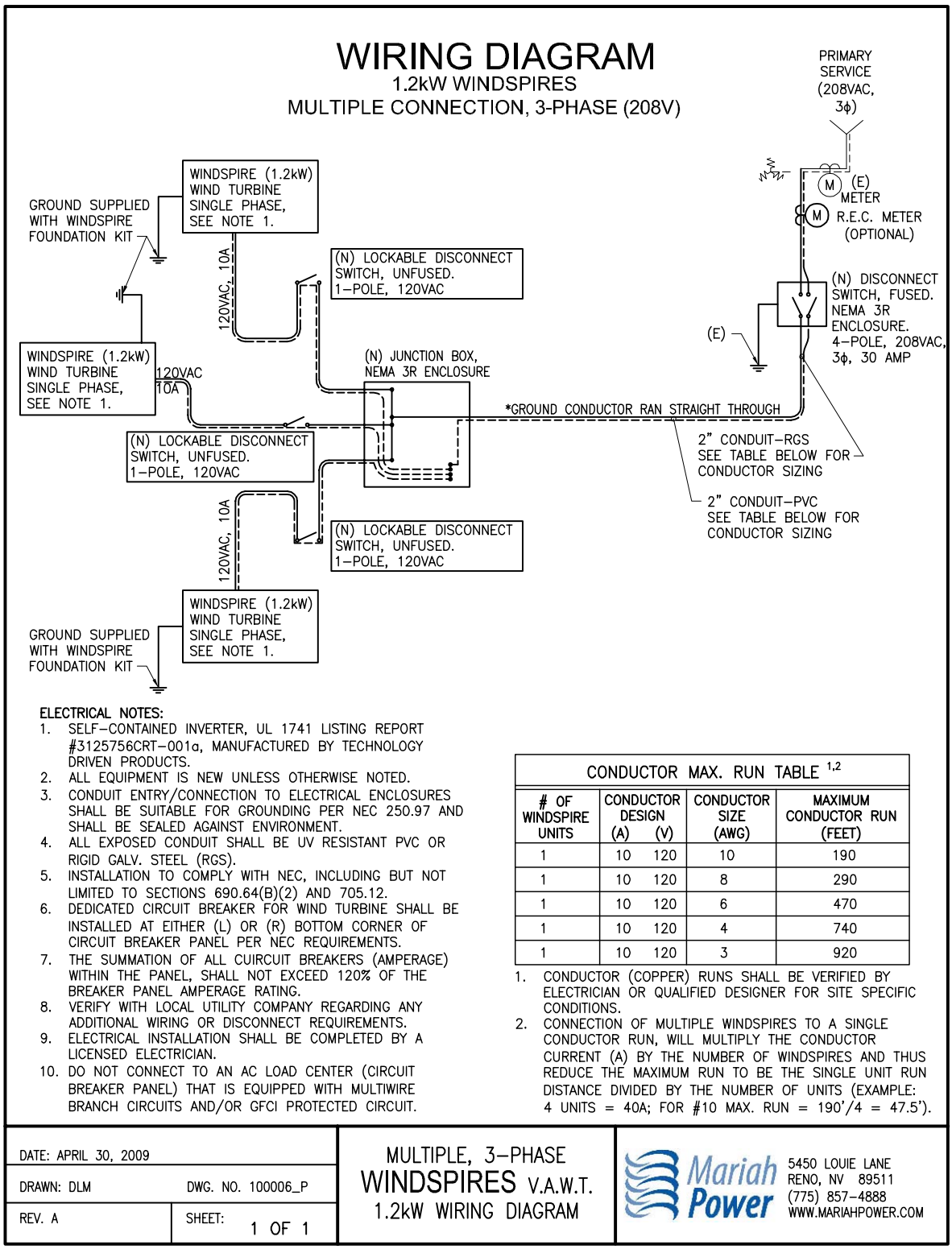
RENO, NV 89511
(775) 857–4888
WWW.MARIAHPOWER.COM

Figure 2–80: Wiring Diagram—Multiple Connection, Three-Phase



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DATE: APRIL 30, 2009
DRAWN: DLM
DWG. NO. 100006_P
REV. A
SHEET: 1 OF 1

MULTIPLE, 3–PHASE
WINDSPIRES V.A.W.T.
1.2kW WIRING DIAGRAM

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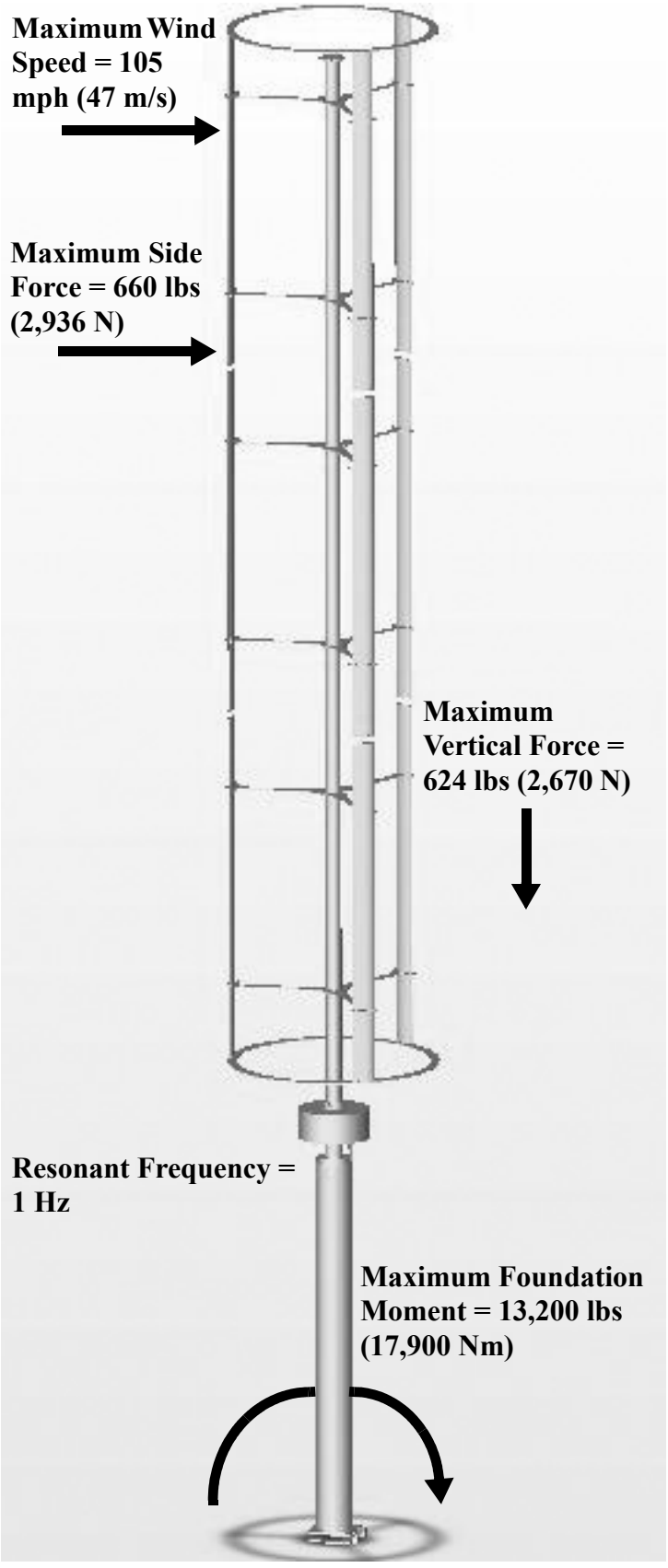
2.9 Load Diagram

Figure 2–81: Load Diagram



Chapter 3: Operation

3.1 Overview

Your Windspire is an efficient energy appliance. It will start rotating with a light breeze. Whenever wind speeds approach about 9 mph (4 m/s), the wind attains sufficient energy worth extracting. Your Windspire then automatically starts providing power to your home or business. Because wind energy is a cubic function of the wind speed, power production increases dramatically with increasing wind speed. As a consequence, you will likely produce more energy on a few higher wind-speed days of each month than on all the other days combined.

The grid-tie inverter performs your Windspire's control and power conversion. The grid-tie inverter is programmed to extract the maximum amount of available energy from the wind by controlling the rotor speed relative to the wind, for optimum aerodynamic efficiency. The grid-tie inverter does this by continuously adjusting the generator's electrical load and the resulting amount of power supplied to the grid. To achieve maximum energy capture, your Windspire rotor is kept operating at a tip speed that is about 2.8 times the wind speed. Upon exceeding the rated wind speed, your Windspire will continue to extract energy and provide a constant 1.2 kW output. During these times, the rotor speed will no longer increase and will be held near its maximum operating rotational speed.

3.2 Safety

Your Windspire is designed to operate safely. It has an electronic braking system to prevent failure and is engineered to safely operate even in high winds. If you anticipate excessive high winds, we recommend that you disconnect power to your Windspire, and/or lower your Windspire to the ground to prevent damage. If you suspect that your Windspire is damaged, we recommend that you secure the rotor to prevent rotation and disconnect the electrical connection until repairs are completed.

The grid-tie inverter in your Windspire is designed to meet safety requirements for connection to the electric grid. These requirements are intended to prevent the risk of electric shock in the event of utility power failure. The grid-tie inverter does this by monitoring the electric utility power and disconnecting power production when a deviation in power quality occurs. Whenever your Windspire is disconnected from the grid, the inverter braking only enables the rotor to rotate freely at slow speed. For safety, never disconnect the inverter connection to the generator when the turbine is erect and the rotor is not secured.

3.3 Performance

Your Windspire is designed to operate near optimal levels regardless of geographic location. Wind energy depends on the wind speed, temperature and elevation. The grid-tie inverter continuously tracks and adjusts operation based on changes in wind speed and temperature. The grid-tie inverter is initially programmed to use an average elevation value of 330 ft (100 m).

3.4 Monitoring

You can monitor your Windspire's performance in two ways:

- The internal wireless modem continuously transmits real-time power production and energy generation history. Any computer within 330 ft (100 m) that has a ZigBee modem can pick up this signal. Installing the provided Mariah WindSync software makes monitoring easy.
- You can monitor directly by installing an optional power meter[1] at your Windspire's power connection.

1. Mariah Power does not provide this item.

Chapter 4: Lowering the Windspire

Important! **When replacing components, always lower the Windspire first (this is optional for the grid-tie inverter). Only lower the Windspire in low or zero wind conditions.**

Mariah Power uses Grade 5 fasteners in the standard Windspire. If you use materials that do not meet that specification, Mariah Power is not responsible.

1. Place the gin pole cable around the armature tube in a slipknot.
2. Attach the gin pole to the top hinge plate at the bottom of the base pole.
3. Use a carabineer to attach the opposite end of the gin pole cable to the eye-bolt on the gin pole.
4. Attach one end of the pull-up cable to the armature tube in a slipknot and attach the other end to a vehicle with the second carabineer.

   Notes:

   - Ensure the cable has 2 feet (61 cm) or less of slack when preparing to lower the Windspire.
   - The vehicle must have sufficient weight and traction for lifting and lowering the Windspire.
5. To maintain the rotor off the ground when horizontal, place a jack-stand or comparable support on the ground at an appropriate location and height to support it.
6. Remove the foundation nuts and washers from the top of the top hinge plate.
7. To initiate lowering the Windspire, push against the base pole.
8. Use the vehicle to lower the Windspire. The pull of the cable will increase as the unit is lowered to horizontal.

   Note the following when lowering the Windspire:

   - Ensure the pull-up cable rests over the V-notch on the gin pole you lower it. Otherwise, your Windspire will be damaged.
   - Always keep one foot on the brake.
   - Stand away from the Windspire, never under it.
   - Never let the pull-up cable get significant slack. Slack can cause the cable to fail.
9. When the Windspire is safely lowered, secure it to the support (e.g. the jack-stand).
10. Release the tension on the pull up cable.
11. Remove the cables and gin pole.

Chapter 5: Frequently Asked Questions

1. Can I do anything to prevent damage to my Windspire from a coming storm with potential excessive wind?

   You have two options:

   - Disconnect the power to your Windspire to activate the slow-speed electronic braking.
   - Lower your Windspire to the ground.

2. What happens if lightning strikes my Windspire?

   Your Windspire has a built-in lightning arrestor in the grid-tie inverter to help prevent damage.

3. Will snow or ice cause any problems for my Windspire?

   Your Windspire is designed to operate with snow and ice. Ice build-up on the rotor blades might temporarily reduce the energy capture efficiency but it should not cause any damage.

4. Will my Windspire provide power to my house when the utility power goes out?

   Your Windspire has a grid-tie inverter designed to meet UL 1741, which requires its power output to shut off whenever utility power is not present, for safety.

5. Can I use my Windspire to provide power for off-grid applications?

   You can convert your Windspire to provide off-grid power by replacing the grid-tie inverter with the optional off-grid battery charger.

6. Will my Windspire harm birds and wildlife?

   Your Windspire uses a rotor that spins at a significantly lower speed than a propeller and about a vertical axis, which we believe makes them more visible and avoidable. Accordingly, we have not observed any wildlife harm.

7. What should I do if my Windspire is operating irregularly?

   We recommend that you disconnect the electrical connection to your Windspire and lower it to the ground. Please call your distributor or Mariah Power for assistance.

Chapter 6: Warranty

6.1 Warranty Coverage

Mariah Power warrants the Windspire and all components of the Windspire generating system to be free from defects in material and/or workmanship for a five-year warranty period, starting on the delivery date. This warranty covers the generating equipment against breakdown or degradation of electrical output of not more than 10% from the originally rated output. Should any of the above components fail during the specified warranty period, Mariah Power will, upon prompt notice and at no cost to the CUSTOMER, diagnose and repair or replace the malfunctioning component of the Windspire or, at the discretion of Mariah Power, repair or replace the entire Windspire structure.

This warranty extends to the original purchaser and to any subsequent purchasers or owners at the same location during the warranty period. For the purpose of this warranty, the terms “purchaser,” “subsequent owner,” and “purchase” include a lessee, assignee of a lease, and a lease transaction.

6.2 Warranty Limitations

1. This warranty will become void if:
   A. The Windspire is not lowered and protected during extreme wind storms with gusts reaching 105 mph (47 m/s) or more.
   B. The Windspire is not installed, operated, maintained, or repaired in accordance with manufacturer's instructions.
   C. Any other structures, other than those Mariah Power sold or recommended, are installed on the top of the unit or are otherwise attached to the unit in such a manner as to alter, modify, or stress the structure.
   D. The Windspire is lowered and raised excessively, meaning over 10 times in any one year.
   E. The Windspire is moved from its original place of installation.
2. This warranty does not apply to damage, malfunction, or degradation of electrical output caused:
   A. By failure to properly operate or maintain the system in accordance with the manufacturer's instructions.
   B. By any repair or replacement using a part or service that the warrantor does not provide or authorize in writing.
   C. During installation by CUSTOMER, reseller, or third-party installer, other than if Mariah Power installs it directly.
   D. By abuse, accident, alteration, improper use, negligence or vandalism, or from ground movement (from any source), earthquake, fire, flood, lightening, tornado, hurricane, volcano, tsunami, or other acts of God.
3. Mariah Power provides no warranty, express or implied, other than those contained herein. No dealer or other person has the authority to make any warranties or representations concerning Mariah Power products. Accordingly, Mariah Power is not responsible for any such warranties or representations.
4. Mariah Power assumes no liability for lost electricity production due to product failure, or any extra cost of electricity associated therewith. Mariah Power assumes no liability for lost time, interruption of business, lost profits, lost data, inconvenience, incidental expenses such as telephone calls, labor, or material charges incurred in connection with the removal or replacement of the equipment, or any other incidental or consequential damages.
5. Mariah Power assumes no liability for any damage or loss to any items or products connected to, powered by, or otherwise attached to the Windspire. The total cumulative liability to CUSTOMER, from all causes of action and all theories of liability, will be limited to and will not exceed the purchase price of the product paid by the CUSTOMER.
6. Defects or failures resulting from mistreatment or neglect by buyer, or warranty claims that are deemed invalid for any reason, shall be repaired or serviced at CUSTOMER’S expense.

6.3 Warranty Procedures

Note: Your dealer will register your Windspire for you.

To obtain the benefits of this warranty, the CUSTOMER must:

1. Notify your local dealer by telephone or in writing as soon as possible following discovery of the defect, but no later than the expiration date of the warranty period for the component, as listed in this warranty, and obtain a Return Authorization number. Notification must include a statement describing:
   - The problem
   - The manner in which the wind generator was used
   - The serial number
   - The original dates of purchase, delivery, and completion of installation
   - The complete name, address and telephone number of the party requesting warranty service
2. Return the defective part(s), as determined in the Return Authorization, at the expense and risk of the CUSTOMER, within 60 days of the issuance of the Return Authorization number. The Return Authorization will become void if the part(s) have not been shipped within 60 days of its issuance. The CUSTOMER is responsible for adequate packaging and insurance during shipping.
3. Returned part(s) that are replaced shall become the property of Mariah Power on the date that the replacement is shipped back to the CUSTOMER.

Contact Information for Mariah Power Warranties:

Customer Service Department

Phone: (775) 857-4888

www.mariahpower.com

Chapter 7: Glossary

- **Airfoils**: Aircraft-grade aluminum foils that attach to and propel the Windspire.
- **Armature**: The generator component that contains the armature wires and is the source of the electrical current.
- **Armature tube**: The generator component that supports the armature and secures the top bearing to the base pole.
- **Armature wires**: The black wires that attach the armature to the grid-tie inverter.
- **Bottom back iron**: The steel spider plate in the generator that supports the lower set of magnets.
- **Base pole**: The main steel pole that supports the Windspire to the foundation.
- **Bottom bearing**: The radial bearing at the bottom end of the cantilever support that enables low-friction rotation for the Windspire.
- **Bottom hinge plate**: The steel plate that supports the base pole to the foundation when raising or lowering the Windspire.
- **Bottom shaft**: The rotating steel shaft that connects the base pole to the top pole in a cantilever support.
- **Bottom shaft sleeve**: Two machined sleeves on the bottom shaft that are mates to the top bearing and generator.
- **Carabineers**: Stainless steel snap rings that attach the gin pole cable to the gin pole and the pull-up cable to a vehicle for raising the Windspire.
- **Bottom bearing cap**: A steel ring that secures the bottom bearing to the bottom of the base pole.
- **Foundation rods**: The four steel studs protruding 3.5" from the surface of the Windspire foundation.
- **Foundation template**: A steel template that positions the foundation rods when pouring the foundation concrete. You remove the template after the concrete cures and before installing the Windspire. The foundation template is reusable and recyclable. See the *Windspire™ Foundation Manual* for details.
- **Generator**: The Windspire component that converts rotational torque to electricity and protects the grid-tie inverter.
- **Generator clamp**: The generator component that secures the generator rigidly to the bottom shaft.
- **Generator clamp disk**: The clamping ring with a tapered inside diameter that bolts to the generator clamp flange and compresses the generator clamp wedge to the bottom shaft.
- **Generator clamp flang**e: The machined surface at the top of the generator that holds the generator clamp wedge and rigidly supports the generator.
- **Generator clamp wedge**: The single, tapered, slotted sleeve that fits between the generator clamp flange and the generator clamp disk.
- **Generator gapping tools**: Reusable strips of HDPE plastic you use to set the generator gap during assembly.
- **Gin pole**: A *required* lever support tool for raising or lowering the Windspire.
- **Ground wire**: Wire supplied with the foundation kit that attaches to the lower hinge plate.
- **Grid-tie inverter**: The electronics of the Windspire. It controls the rotor speed and converts the generator current to a phase-matched 110 VAC current.
- **Inverter base plate**: The aluminum plate that provides support for the electronics and attaches to the armature tube.
- **Inverter insert plate**: The aluminum plate that complements the inverter base plate to fully surround and secure the grid-tie inverter to the armature tube.
- **Magnetic bearing**: The assembly that bolts to the bottom of the base pole and eliminates 95% of the weight from the mechanical bearings.
- **Plastic stripping**: Polyethylene strips that attach to the struts and strut clamps that are an interface to the airfoils.
- **Retaining ring**: A steel ring that secures the bottom shaft to the bottom bearing.
- **Rotor**: The assembly that encompasses all airfoils and rotor rings.

- **Rotor rings**: Aircraft-grade aluminum rings that attach to the top and bottom of the rotor for safety.
- **Rotor struts**: Aircraft-grade aluminum arms that attach the airfoils to the top shaft.
- **Rotor strut clamps**: Aircraft-grade aluminum clamps that secure the airfoils to the rotor struts.
- **Rubber grommet**: A rubber plug-like sleeve that secures the wire tube to the inverter insert plate.
- **Top bearing**: The spherical bearings at the top end of the cantilever support. The bearing supports and allows low-friction rotation of the bottom shaft to the top of the base pole.
- **Top hinge plate**: The bottom flange of the base pole which provides a secure anchorage to the foundation rods.
- **Top-shaft clamp threaded disk**: The clamping ring with a tapered inside diameter that has tapped holes (M8) and opposes the top shaft clamp unthreaded disk.
- **Top-shaft clamp unthreaded dis**k: The clamping ring with a tapered inside diameter that has clearance holes for M8 screws and opposes the top shaft clamp threaded disk.
- **Top-shaft clamp wedge**: The double tapered, slotted sleeve that fits between the two top shaft clamp disks and provides the clamping surface to secure the top shaft to the bottom shaft.
- **UFB wire**: Wire that conducts electricity from the grid-tie inverter to the base of the Windspire.
- **Wire clamp**: The clamps that secure the UFB wire to the top of the wire tube and at the bottom of the base pole.
- **Wire tube**: An upper conduit for the UFB wire between the top of the base pole and inverter insert plate that shields the wire from open air.
- **ZigBee modem dongle**: An optional USB modem that transmits and receives data from the Windspire.

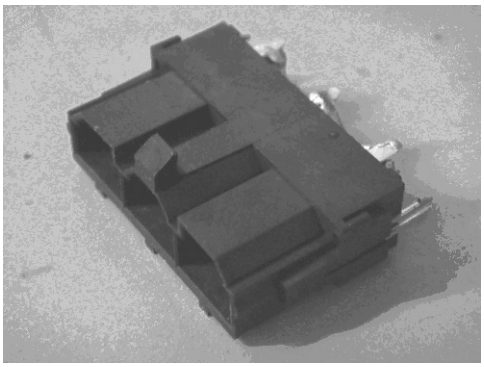
Appendix A: Installing the Generator-shorting Connector

If you did not install the grid-tie inverter, you must install the generator-shorting connector to the generator. After you install the grid-tie inverter, disconnect the generator-shorting connector and insert the generator connector into the grid-tie inverter. Do ***not*** let your Windspire rotate when connecting and disconnecting the generator-shorting connector or the grid-tie inverter to the generator connector.

Note: If you later replace the generator-shorting connector with the grid-tie inverter, you should save the generator-shorting connector; you will need it if the grid-tie inverter requires replacement in the future.

The Windspire should never be allowed to spin without either the grid-tie inverter or the generator-shorting connector attached to the generator connector.

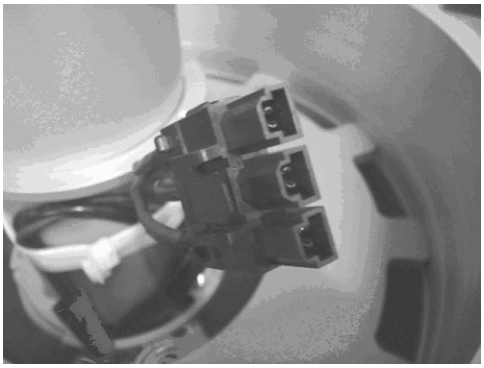
Figure A–1: Generator-shorting Connector



Perform the following steps to install the generator-shorting connector.

1. Locate the male connector on the generator (Figure A–2). The generator is shipped in a 19" x 19" x 19" white cardboard box.

Figure A–2: Generator's Male Connector



2. Attach the generator-shorting connector to the connector on the generator (Figure A–3). Ensure that the connector snaps into place when fully seated (Figure A–4).

Figure A–3: Attaching the Generator-shorting Connector to the Generator

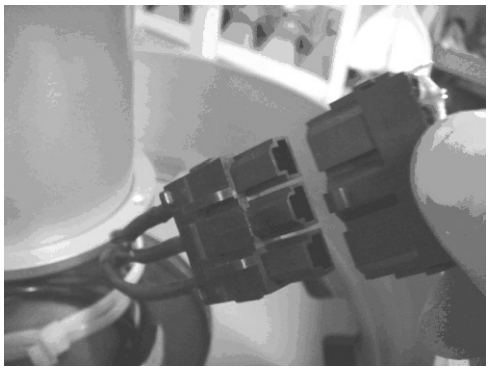


Figure A–4: Generator-shorting Connector Fully Seated