
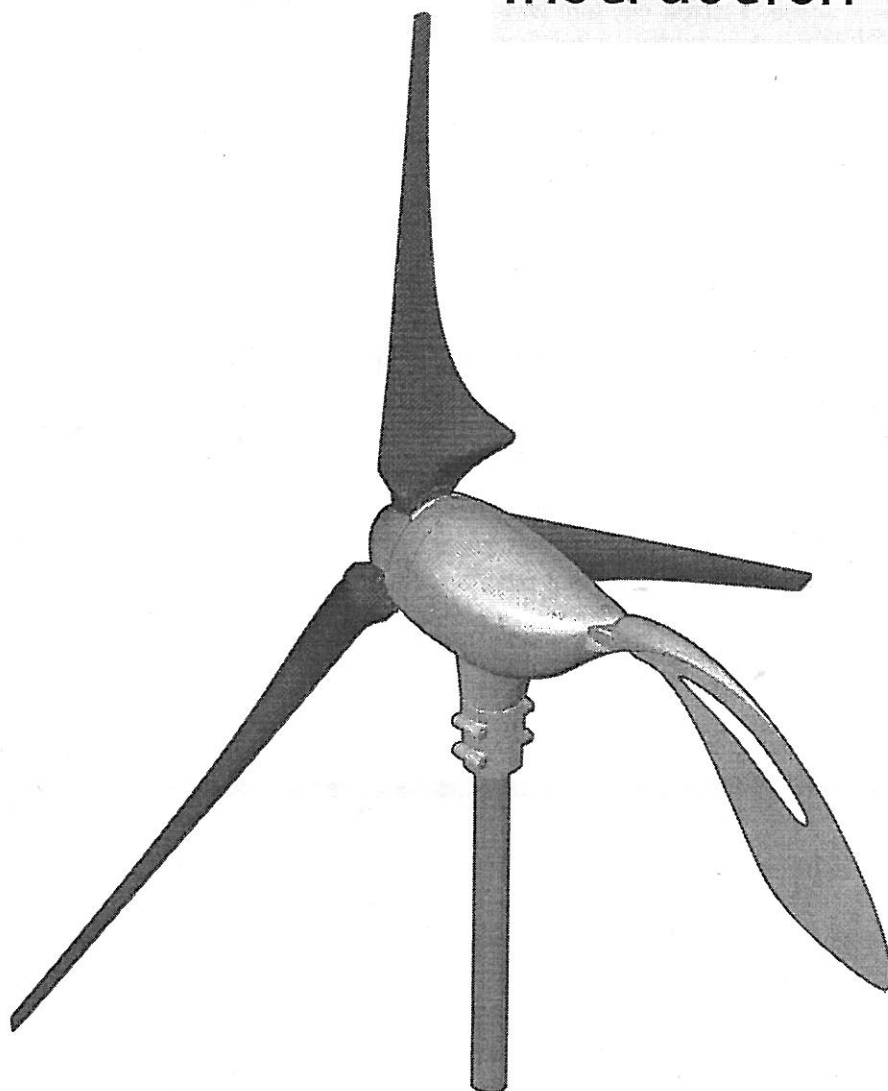


AIRDOLPHIN

 *Mark-Zero* **Z-1000**

Instruction Manual



 Zephyr Corporation

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1. Getting Started

Thank you for purchasing the Airdolphin Mark-Zero (Z-1000).

The Airdolphin's creation is the culmination of Zephyr Corporation's years of experience and technical expertise with small wind turbines.

This turbine is powered by wind, which it harnesses to generate electricity. Since wind is a natural energy source, its output varies in accordance with time, date, and the seasons. Wind conditions may not always be optimal, and can range from no breeze to raging gusts. Although people cannot influence wind force directly, it is possible to adapt to changes in the wind itself. Zephyr Corporation Airdolphin engineering focused on building a system that can adjust to subtle wind conditions in real time, generating the maximum amount of electricity.

We at Zephyr Corporation hope that our products are both fun and useful, contributing to the development of an ecological minded culture by reducing carbon dioxide emissions through the use of natural energy, thus leaving a better Earth for future generations.

This manual provides specific information on the Airdolphin, including its features, instructions for use, safety precautions, maintenance procedures, and peripheral equipment.

It is intended to be read by those who own or work on this product. Read this manual thoroughly and familiarize yourself with this product before attempting to use it.

In the unlikely event that this product does not function properly, prohibit all persons except for trained technicians from handling its internal systems and contact either the dealer from whom you purchased it or Zephyr Corporation customer service department.

- The specifications of this product may change due to improvements without prior notice.
- For purposes of explanation, the illustrations and photographs throughout this manual may differ from the actual product.
- "AIRDOLPHIN" and "Airdolphin" are trademarks of Zephyr Corporation.
- The serial number of the wind turbine is written at the last page of this manual. You will need this information in the event a warranty claim.

Read the following!

- ◆ Certain Airdolphin installation procedures are dangerous. Always have a trained professional perform installation work.
- ◆ Be aware that Zephyr Corporation assumes no responsibility for accidents or damages sustained as a result of not following the procedures and warnings specified in this manual.
- ◆ Be aware that Zephyr Corporation assumes no responsibility for accidents or damage caused by improper installation, use, or attempts to modify this product.
- ◆ This product may suffer salt erosion or other forms of corrosion if installed in a location that places it in direct contact with salt water.
- * Failure to operate this product in accordance with the content of sections labeled "Danger", "Warning", and "Caution" may result in accidental death, injury, fire, or damage to the product itself.

2. For Your Safety (Read before using.)

SAFETY WARNINGS AND SYMBOLS

To ensure proper use of this product, read this section ("Safety warnings and symbols") before attempting to install, operate, or inspect the Airdolphin (Z-1000). Throughout this manual, safety information is divided into three categories: "Danger", "Warning", and "Caution".



DANGER:

This symbol indicates information that could result in death or severe injury if ignored. It is used to indicate information of a particularly dangerous and/or urgent nature.




WARNING:

This symbol indicates information that could result in death or severe injury if ignored.



CAUTION:

This symbol is used to indicate information that could result in death, severe injury, or damage limited to property if ignored.

Be aware that failure to use the product in the manner indicated by  Caution may, depending on circumstances, also have severe consequences. All of the symbols described above indicate important safety information. Obey all safety information when using this product.


This manual contains caution information related to the rotors.

"Rotor" is the term used to describe the three blades when they are attached to the hub. Caution information that describes the rotor gives warnings about the rotating blades.


(See to page 13.)

SAFETY INFORMATION IS INDICATED AS SHOWN BELOW




The  symbol is intended to draw readers' attention to Danger/Warning/Caution information. Specific details on the nature of the threat to safety are indicated inside or beside the symbol.



The  symbol indicates prohibited actions. Specific details on the prohibited action are indicated inside or beside the symbol.



The  symbol indicates instructions that must be followed. Specific details on the mandatory instructions are indicated inside or beside the symbol.



DANGER



Do not install the Airdolphin (Z-1000) before inspecting the durability/quality of the pole to which it will be attached and the area in which it will be installed for safety.

If the pole and the location are not suitable for the installation of this product, the pole may break or fall over, resulting in injury or death.



Install this product so that the tips of the rotor are at least 3.5m away from locations that may be approached by people. After installation is complete, clear away all scaffoldings, making sure that nobody goes near the rotor.



Never touch a moving rotor with your hand or any other part of the body. The rotor is as dangerous as a sword and accidental contact can result in death or severe injury.



The body of the Airdolphin (Z-1000) will also move in accordance with wind direction once it begins to make contact with the wind. Exercise caution if it is necessary to approach the Airdolphin Mark-Zero (Z-1000) to perform installation or maintenance work.

2. For Your Safety

WARNING



Do not install the Airdolphin (Z-1000) in close proximity to electric or telephone lines. A fallen pole or contact between the rotor and electric/telephone lines could result in electrocution, disconnection, or damage to/malfunction of the Airdolphin (Z-1000).



Do not install the Airdolphin Mark-Zero (Z-1000) in close proximity to structures such as smokestacks that attain extremely high temperatures.

The heat could melt the insulation on electrical cables, resulting in electrocution, fire, or other damage.



Do not install the Airdolphin (Z-1000) if the pole to which it will be attached is not standing straight. The Airdolphin (Z-1000) could fall, causing an accident or mechanical damage/malfunction.



Do not use the Airdolphin (Z-1000) for any purpose other than generating electricity from natural wind. Do not attempt to generate electricity by mounting the Airdolphin (Z-1000) on a moving vehicle. Do not use the Airdolphin (Z-1000) in close proximity to an exhaust duct or in any other extremely high-temperature environment. Doing so could result in fire, injury, or damage to the Airdolphin (Z-1000).



Contact either the dealer where you purchased the Airdolphin (Z-1000) or Zephyr Corporation for repairs if the lines or cables are damaged (i.e. exposed wires, cut cables, plug damage). Continued use could result in electrocution, fire, or short circuits.



Do not pull on, excessively bend, or attempt to modify the wires/cables of the Airdolphin (Z-1000). Doing so could result in cord damage, electrocution, or fire.



Never attempt to disassemble or modify the Airdolphin (Z-1000). Doing so could result in electrocution, fire, or Airdolphin (Z-1000) malfunction.



Due to conditions of use, this system may not continuously supply stable electrical power. Do not attempt to use the electricity generated by the Airdolphin (Z-1000) to power medical devices or other equipment related to human life systems support. Do not attempt to use the electricity generated by the Airdolphin (Z-1000) to power personal computers not equipped with batteries or other auxiliary power sources.

CAUTION



Observe all safety precautions when working on the Airdolphin (Z-1000) in high locations. Take care to ensure that hardware and other parts do not fall from the Airdolphin (Z-1000). Falling parts can cause injuries or other accidents.



Before assembling the Airdolphin (Z-1000), secure adequate space to ensure that work can be completed safely. Inadequate space can result in injuries or other accidents.

3. Airdolphin Features

3-1 10 State-of-the-Art Technologies

◆ Extremely Low Mass

The total weight of the Airdolphin Mark-Zero is only 17.5kg. This means it weighs just 17.5g per generated watt (when the continuous rated output is 1kW). Thus, the Airdolphin Mark-Zero tracks wind better in turbulent flows, resulting in more efficient power generation. The light weight also allows the unit to be installed in a wide variety of places.

◆ Newly-Designed Rudder

The rudder of the Airdolphin Mark-Zero uses the newly-developed Swing Rudder System. This system ensures the turbine's superior response to sudden changes in the direction of wind, improving the efficiency of power generation.

◆ Newly-Designed Rotor

The Airdolphin Mark-Zero comes with a new rotor system consisting of:

(1) Three ultra low-mass blades, reinforced by a carbon-fiber skin for superior rigidity. (2) A hub mechanism that uses the newly-developed Multi-Stagger System (incorporating multiple airfoils and lift angles). This technology allows the turbine to capture the wind effectively and respond flexibly to changing conditions, from slight to stormy winds, eliminating the need for pitch controls.

◆ An Innovation for Low Noise Newly-Designed Rotor

The Airdolphin comes with the "Silent Disrupter Blade". This new blade has a number of thin grooves on its surface, which significantly reduces air flow noise. Our designers were inspired by the wings of owls that enables it to fly almost silently and unnoticed while approaching its prey.

◆ No Screw Robust Body

The robust body construction features a "no screw" assembly, inspired by traditional Japanese handicrafts. This construction ensures superb durability in a wide range of weather.

◆ Power-Assist Function

For 10 seconds every minute when there is no wind, the Airdolphin Mark-Zero uses previously-generated power to spin the rotor. This allows the rotor to reach the cut-in point more quickly--even when there is near zero wind, allowing the unit to capture the wind effectively. The Power Assist Function also prevents freezing of the rotor due to low temperatures.

3. Airdolphin Features

◆ New Power Management System

The newly-developed Power Management System is aimed at optimizing the safety and efficiency of power generation.

Non-Stop Operation with Continuous Output

At its upper potential, the Airdolphin can deliver a 2.5kW-3kW output (at 20m/s or more). During strong winds (23-50m/s), the Airdolphin automatically moderates its spinning speed and continues working at a reduced output. However, when the wind speed is over 50m/s, the turbine stops its power output.

Safety Control

Several technologies are applied to keep the turbine from disintegrating and allow it to control its output, even during overheating of the power generator, excessive spinning speed, and other unfavorable situations.

High-Efficiency Operation

To maintain optimum efficiency at a variety of wind speeds, the turbine is controlled by a special computer program coordinated with the Multi-Stagger System of the rotor. An ultra-lightweight rotor, a special propeller design optimized for varying wind speeds, and a power generator with superior efficiency was also developed.

Battery Charge Management

Management of the rechargeable battery, optimized for using the wind turbine as an independent power supply, is controlled by a system based on a 3-step battery recharge. Charge can be managed under a variety of conditions, from arctic to tropical weather. Management includes compensations for wire cable length, temperature, and even current (more than 100 amps of continuous power).

◆ New Power Generator

For the Airdolphin, a newly-developed heavy-duty power generator is used with a max. 4.5kW power output. The magnet used for the turbine is a neodymium iron boron magnet named "NEOMAX" which boasts of extremely high power.

◆ Data Communication System

The Zephyr Communication System was recently invented, which will soon allow you to connect the Airdolphin to the internet. This way, you can check the wind strength, amount of generated power, and other information on your PC remote from the turbine's location. You can also install a GPS receiver to the turbine for confirming the location of each unit.

◆ Fresh Design - Winner of the Good Design Award 2005

The attractive body was designed, using nature's animals as our inspiration. The sleek lines, high power, cleverness and playful responsiveness of this design inspired the name Airdolphin. Our turbine looks alive, eager and ready to catch the wind.

3. Airdolphin Features

3-2 Specification

Wind Turbine Type	Horizontal axis, up-wind
Rotor Diameter	1800mm
Mass	17.5kg
Mount Diameter	48.6mm
Number of Blades	3
Blade Material	Carbon-fiber skin
Blade Mass (per piece)	380g
Blade Retention	Interlock hub mounting
Body Material	Aluminum diecast
Body Construction	Screw-free joints (based on traditional Japanese handi-crafts)
Product Finish	Teflon-based paint
Power Generator	Synchronous-type, three-phase power generator with permanent magnets (neodymium iron boron magnet)
Protection Circuit	Built-in
Data Logger	Built-in
Yaw control	Free yaw (360 degrees)
Direction Control	Original Swing-Rudder System
Output Control	Non-stop output control (incl. Stall Mode)
Start-up Wind Speed	0m/s (Power-Assist Function)
Cut-in Wind Speed	2.5m/s
Cut-out Wind Speed	50m/s
Survival Wind Speed	65m/s
Rated Power	1kW (12.5m/s)
Rated Rotor Speed	1250rpm
Maximum Power	3.2kW (20m/s)
Maximum Rotor Speed	1600rpm (20m/s)
Mass per Watt	17.5g/W (at rated power)
Power per Square Meter	393W/m ² (at rated power)

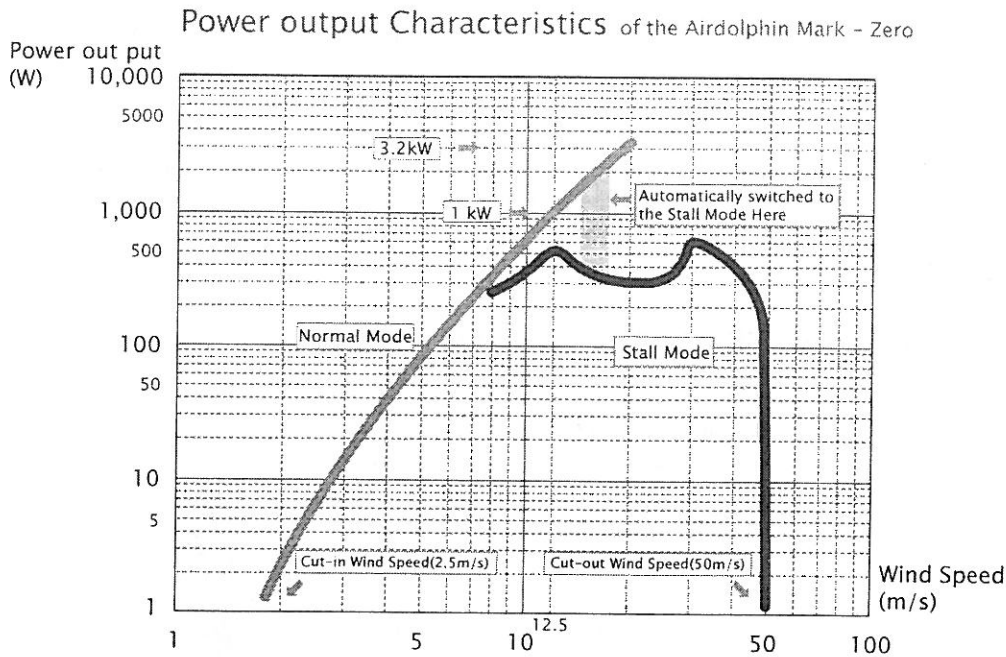
Control System	Built-in Zephyr-Original Power Management System* (ZPMS) with
	1. Power-Assist Function 2. Stall Mode 3. Safety Control 4. Battery Charge Management 5. Data Communication System

Power Generation Features	Normal Mode		
	Wind Speed (m/s)	Power (W)	Rotor Speed (rpm)
	3.5	27	450
	6.5	170	600
	10.0	620	800
	12.5	1000	1200
	15.0	1780	1300
	17.5	2520	1500
	20.0	3200	1600
	Stall Mode		
	Wind Speed (m/s)	Power (W)	Rotor Speed (rpm)
	10.0	380	350
	20.0	320	350
	30.0	600	350
	40.0	400	250
	50.0	0	0
	65.0	0	0

Output Voltage (Normal Mode)	DC25V
Braking System	Regenerative electro-magnetic braking system
Communication System (Signal Output)	RS-485
Recommended Battery Capacity	Off-grid power systems: 500Ah or more Grid inter-tie power system: 100Ah or more

3. Airdolphin Features

3-3 Power Output Characteristics



* Cut-in; wind speed at which the turbine begins to produce power.

* Cut-out; wind speed at which the turbine stops the rotation and shuts down.

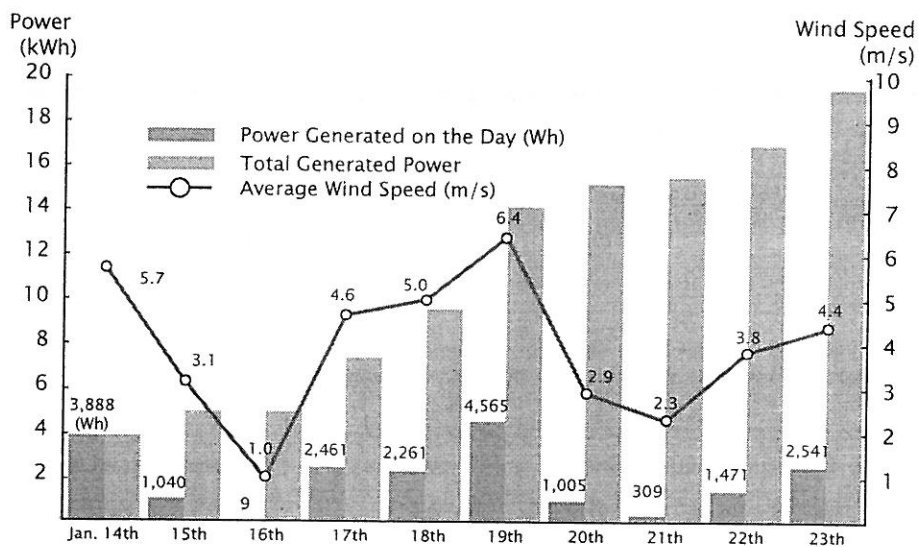
Stall mode;

Stall mode is Zephyr's new control technique when the power output is at the maximum level of 1.7kW to 2.5kW, the rpm is stall controlled until the output is below 600W and continues producing power until 50m/s. After the wind speed falls below the rated wind speed, the operation will go back from stall mode to normal mode automatically.

Generally, a large size wind turbine cuts out around 20m/s and does not operate under strong wind speed conditions. Airdolphin can however produce 60% of its rated power even at 30m/s, and is especially efficient in installation sites with strong wind condition and gust.

3. Airdolphin Features

Power Generating Capability of the Airdolphin Mark - Zero



Site of Installation : Rooftop of Zephyr Corporation Office (Tokyo, Japan)
Duration of Data Collection : 10 days (January 14th - 23rd, 2006)
Total Power Generated in this Period : 19,550Wh
Average Wind Speed : 3.9m/s

4. Installation Environment

1. Safety

Although the Airdolphin (Z-1000) has been engineered to withstand wind speeds of 65m/s, the rotating blades may be damaged by tree branches or other flying objects during strong winds. In addition, unforeseen circumstance may cause the pole supporting the wind turbine to topple or the wind turbine itself to fall. Keep these possibilities in mind when selecting a location for the installation of the Airdolphin (Z-1000).

Although the blades of the Airdolphin (Z-1000) are constructed from carbon fiber and are extremely durable, they can cause severe injury in the unlikely event that they make contact with a human being. For this reason, we recommend that you install the wind turbine in a location away from people. Install the wind turbine in a high location that people cannot reach up and touch it.

2-1.Environmental deterioration (public nuisance)

The wind turbine is a mechanical equipment that rotates at a high rate of speed during periods of strong wind. It is intended for installation outdoors in locations high above the ground. During periods of strong wind, the rotor rotates at a high rate of speed. Although the S.D. blades on the rotor are engineered to minimize the noise they produce, certain individuals may still be disturbed by the noise. The shadows of wind turbines mounted in high locations may also fall on neighboring houses. Be aware of the flickering shadows that the rotating blades may cast when considering the location in which the wind turbine will be mounted.

3. Generation environment

Since the wind turbine's output is proportional to the cube of the wind speed, it is advantageous to optimise the location where wind speed is highest within the possible choices. The wind turbine must be installed in a location free from obstructions that is high above ground level and has unobstructive wind passage.

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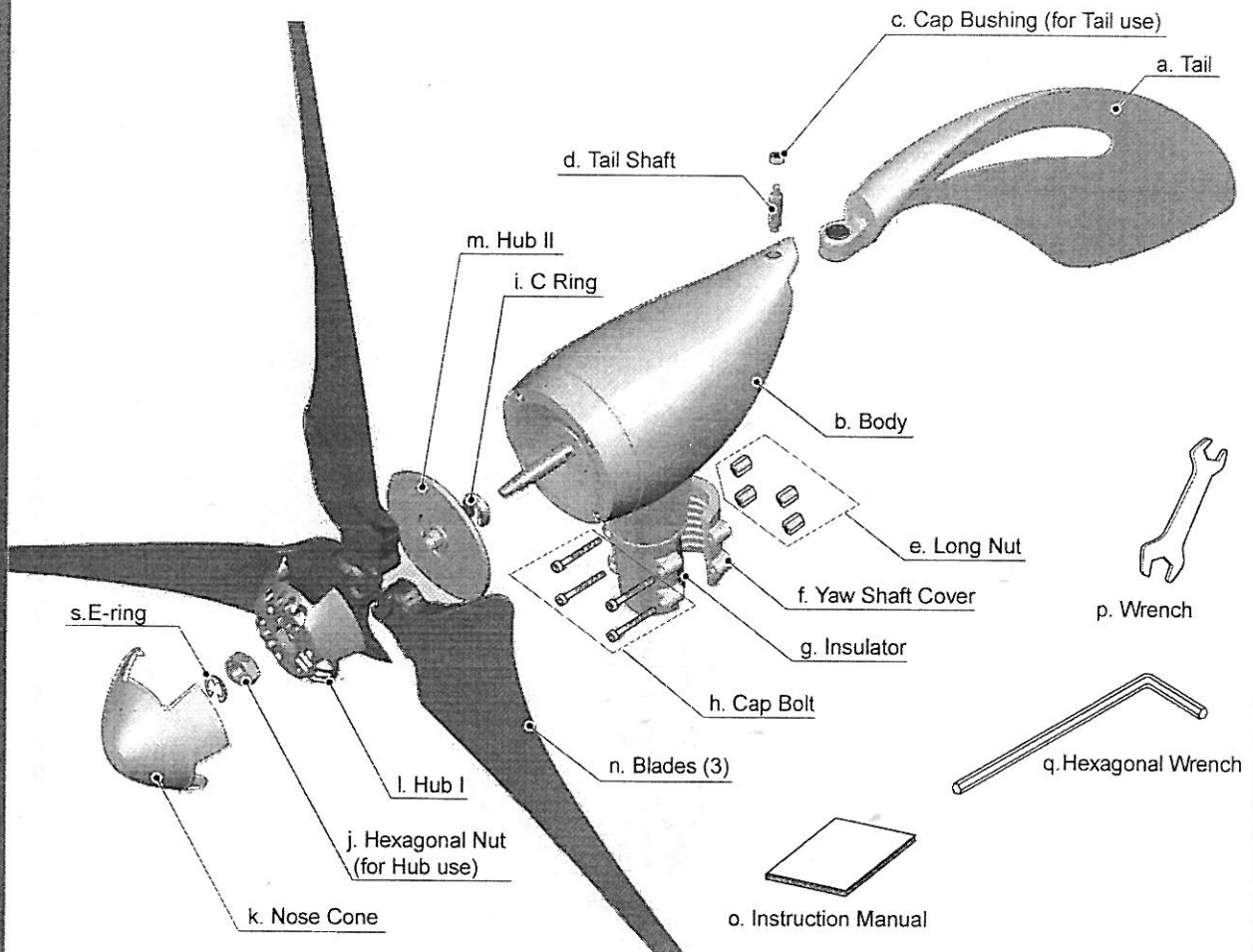
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5. Part Name



	Name	Quantity		Name	Quantity
a	Tail	1	j	Hexagonal Nut (for Hub use)	1
b	Body	1	k	Nose Cone	1
c	Cap Bushing (for Tail use)	1	l	Hub I	1
d	Tail Shaft	1	m	Hub II	1
e	Long Nut (for Yaw Shaft use)	4	n	Blades	3
f	Yaw Shaft Cover	1	o	Instruction Manual (this document)	1
g	Insulator	1	p	Wrench (13mm / 17mm)	1
h	Cap Bolt (for Yaw Shaft use)	4	q	Hexagonal Wrench (6mm)	1
i	C Ring	1	s	E-ring (1pc. for spare)	2

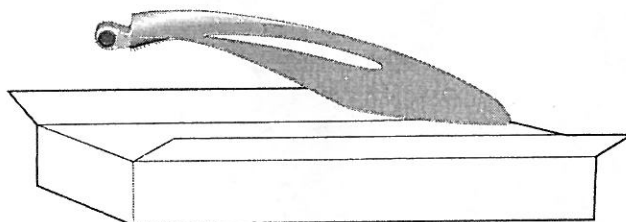
6. Assembling the Airdolphin (Z-1000)

6-1 Verify the following upon purchase

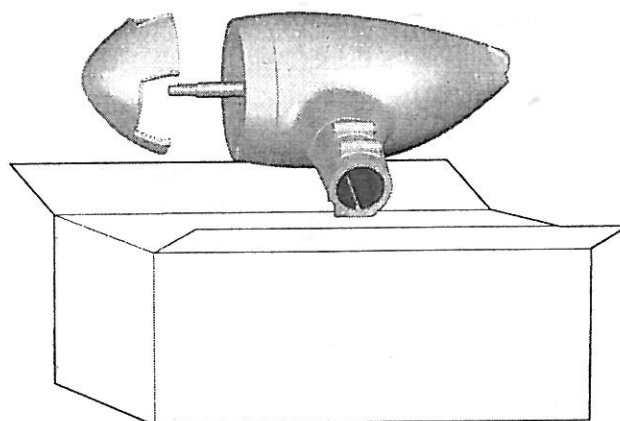
- The Airdolphin consists of the items listed below. Upon opening the package, check the parts against the list shown above in "5. Part Names" to ensure that nothing is missing.
 - * Although Zephyr Corporation verifies the quality of all our products before shipping them, damage may occur during shipping. Check the surfaces of the blades, the tail, and all other components to ensure that they are free from any damage or warping that may affect performance.
- If any parts are missing or damaged, please contact the dealer at which you purchased the Airdolphin for assistance.

Tail Unit

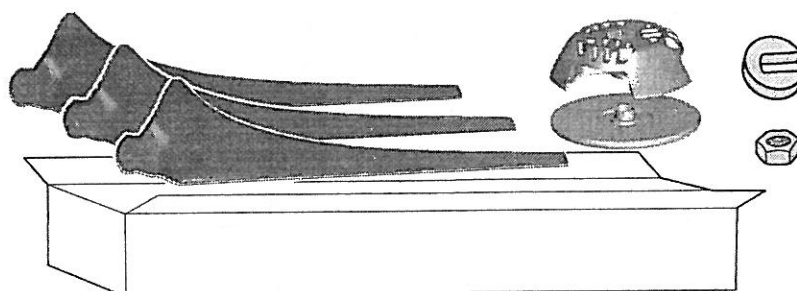
The Body Unit and the tail is in one box.



Body Unit



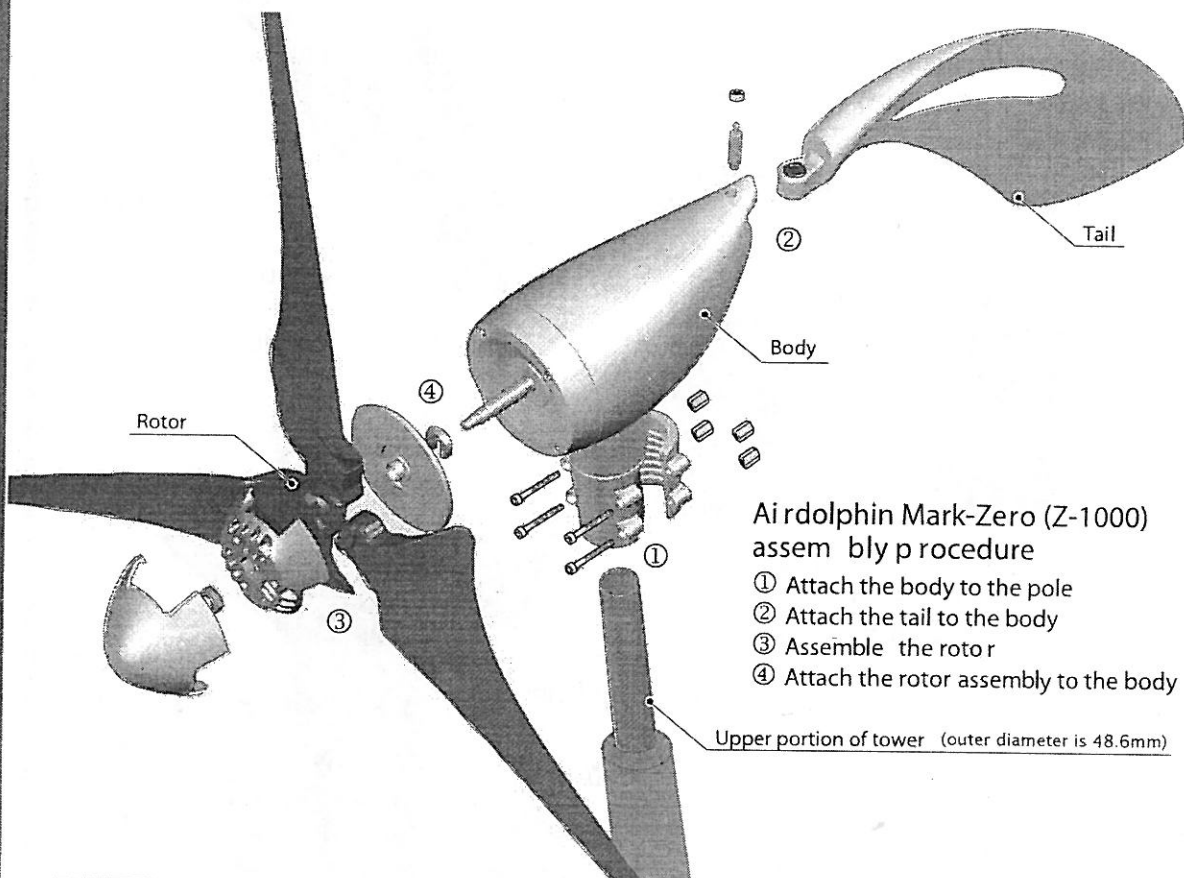
Blades, Hub, and Nuts



6. Assembling the Airdolphin (Z-1000)

6-2 Assembly procedure

Follow steps ①–④ below to assemble the Airdolphin (Z-1000). The assembly procedure for each part is shown on the following and subsequent pages.



OBSERVE THE FOLLOWING SAFETY INSTRUCTIONS DURING ASSEMBLY AND INSTALLATION

- Failure to observe these safety instructions may result in a severe accident or damage to the Airdolphin (Z-1000) or other parts of the system.
- Do not place the Airdolphin body upside down or inclined during installation or maintenance. Water (rain, snow) can leak inside from the joint gap of the body and may cause damage to the turbine. When the body is upside down or inclined and have a possibility of getting wet, put a cover over the body to avoid water.



- Always assemble/install the Airdolphin in accordance with the procedure outlined in this manual.
- Use a tower in which the upper portion has an outer diameter of at least 48.6mm and at least 100mm in length.



- Do not install the Airdolphin if the pole is not standing straight. If the Airdolphin is not mounted in an upright position, it could topple or fall, causing injury or damage to the system.



- Rotor blades are as dangerous as a sharp object. During installation and maintenance attaching the rotor to the tower body is extremely dangerous because the wind could blow while the work is being performed, rotating the rotor and causing a serious accident such as death or injury. After attaching the rotor to the body, fix the rotor in place to prevent it from rotating until the wind turbine has been completely installed.



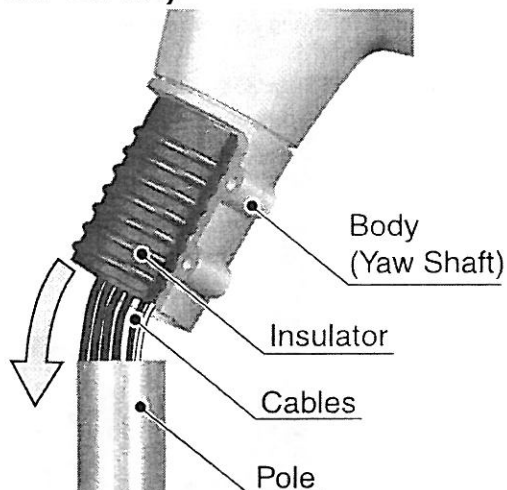
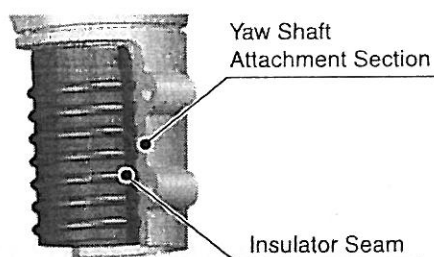
- If the wind turbine has not been completely assembled, a strong gust of wind or similar phenomenon may cause it to fall, causing an injury or other accident.

6. Assembling the Airdolphin (Z-1000)

CAUTION: DO NOT CONNECT TO BATTERIES WHEN INSTALLING.
Airdolphin is in brake mode when disconnected from the batteries.

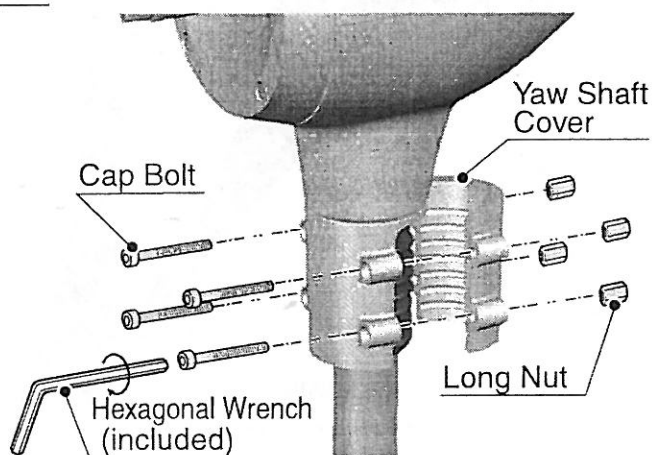
① Fastening the pole to the body (yaw shaft)

1. The wind turbine has six cables. Connect these cables to the extension cable that passes through the pole.
(See page 20.)
2. Connect the pole to the body (yaw shaft).
Lower the yaw shaft until the end of the pole fastens inside the yaw shaft.
- Match the seam of the insulator up with the connection section of the yaw shaft. Affix the insulator in place.



3. With the body pressed down firmly on the pole attach the yaw shaft cover as shown in the figure on the right.
(Tightening torque 22Nm)

Important • All electrical power cables should run inside the tower for protection.
• Cap bolts should be tightened by included hexagonal wrench with the strength of 14 - 16Nm.

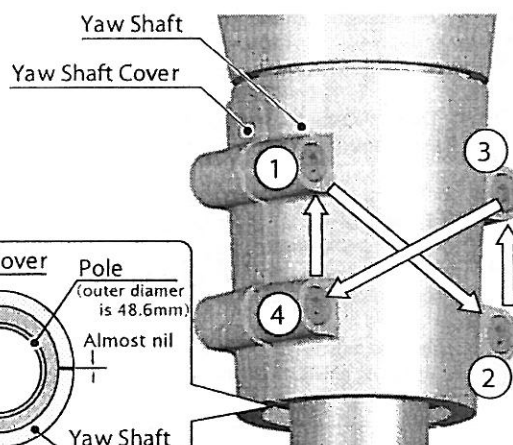
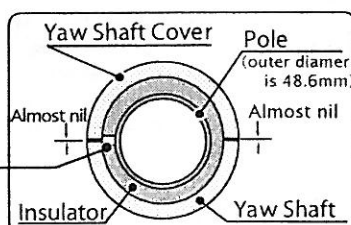


CAUTION: OBSERVE THE FOLLOWING WHEN ATTACHING THE YAW SHAFT

Tighten the cap bolts (①-④) in order incrementally so that all four bolts hold the yaw shaft cover in place with an uniform degree of tightness.
Tighten the cap bolts leaving no space between the yaw shaft and the yaw shaft cover.

- The yaw shaft and the yaw shaft cover are designed to be fastened together tightly around the insulator.

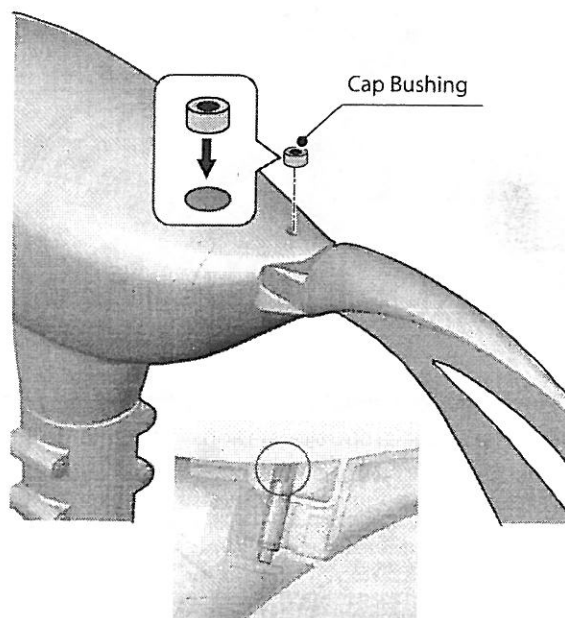
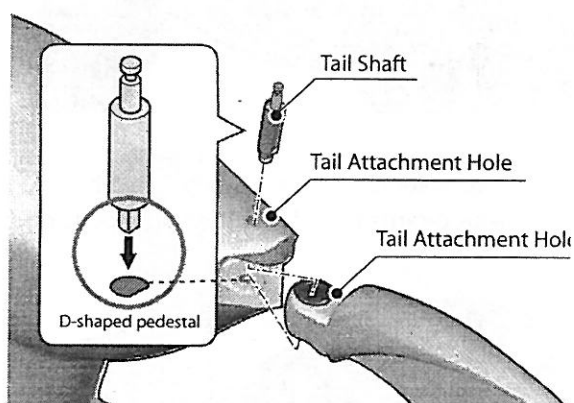
Match the edge line of the insulator with the connection section of the yaw shaft.
Affix the insulator in place.



6. Assembling the Airdolphin (Z-1000)

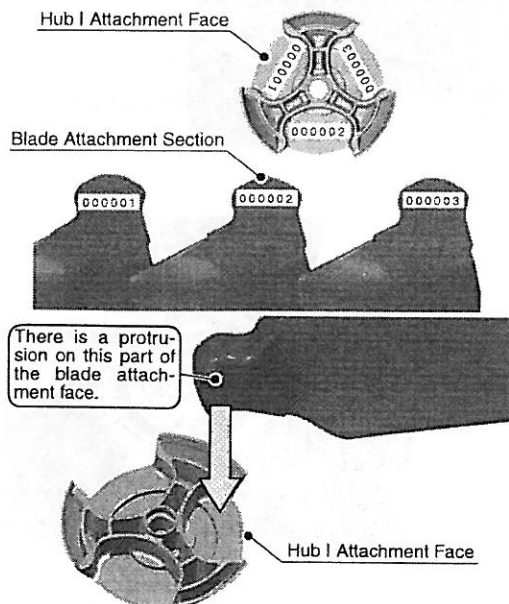
② Attaching the tail to the body

1. Line up the attachment holes on the body and the tail.
2. Make sure you have the tail shaft right side up and then insert it into the attachment hole on the body until it makes contact with the bottom as shown in the figure below.
3. Insert the cap bushing from the top of the tail shaft and then fasten the tail shaft into place.



③ Assembling the rotor

1. Attach the three blades to the blade attachment sections on hub I. There are numbers on hub I and the attachment sections of the blades. Make sure that these numbers match when attaching the blades.

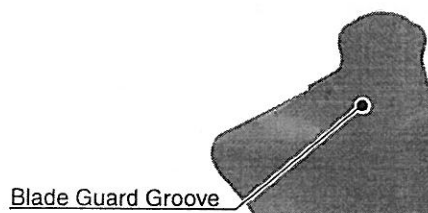


Important

* Attach the blades to hub I so that the corresponding numbers match. Using the wind turbine with the blades attached in the wrong locations will result in degraded performance and may cause damage to the turbine itself.

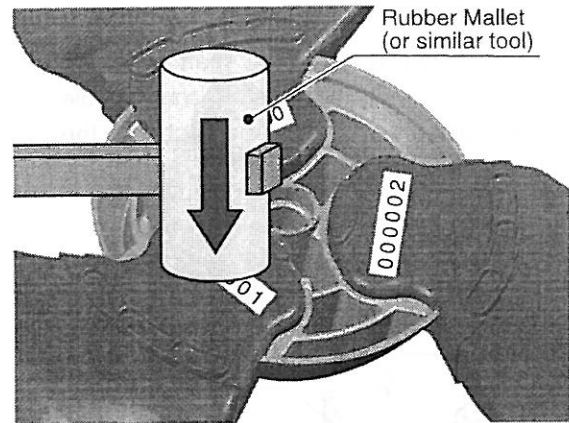
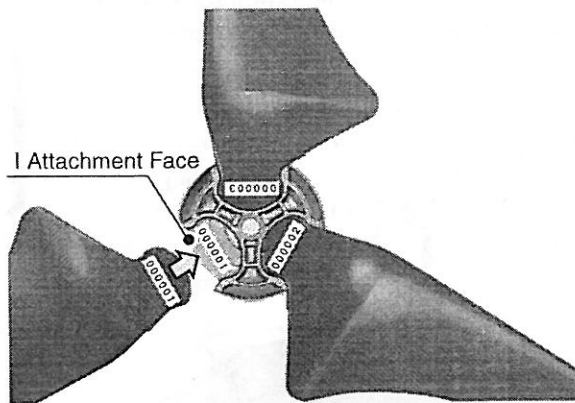
If the numbers on the supplied hub I and the three blades do not match, contact the dealer where you purchased the Airdolphin (Z-1000) and have it exchanged so that the numbers on hub I and the three blades match.

* The rotor is tuned so that it is dynamically balanced. The groove on the blade guard contains a clay-like tungsten substance used for balancing weights. Do not remove the tungsten material under any circumstances.

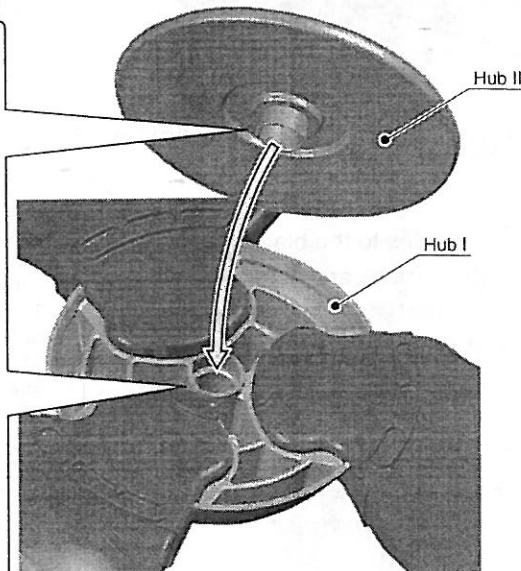
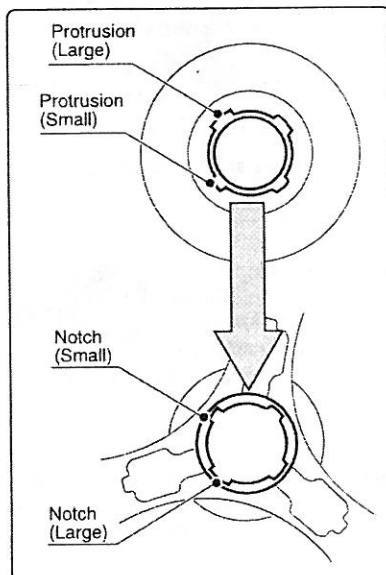


6. Assembling the Airdolphin (Z-1000)

- After attaching the blades, tap them with a rubber mallet or other tool that will not damage them until they are fixed securely in place. The wind turbine could break if the blades are not securely attached to hub I.



- There are four notches, ranging from large to small, in the assembly holes on hub I. On hub II, there are four protrusions, ranging from large to small. These protrusions fit into the corresponding notches, fixing parts securely in place. blades.



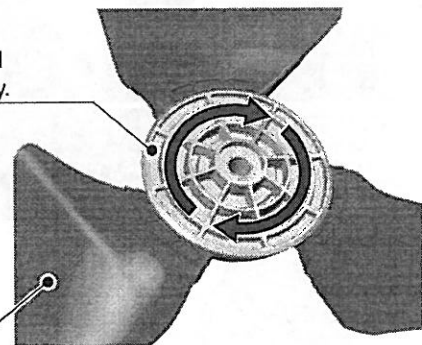
- Rotate hub II while holding hub I (to which the blades have been attached). Hub II will come free. If it rotates, rotor assembly is complete.

Important

In the event that Hub II does not rotate smoothly, return to step 2 above, make certain that the blades are securely fastened, and repeat the assembly procedures.

Verify that hub II rotates smoothly.

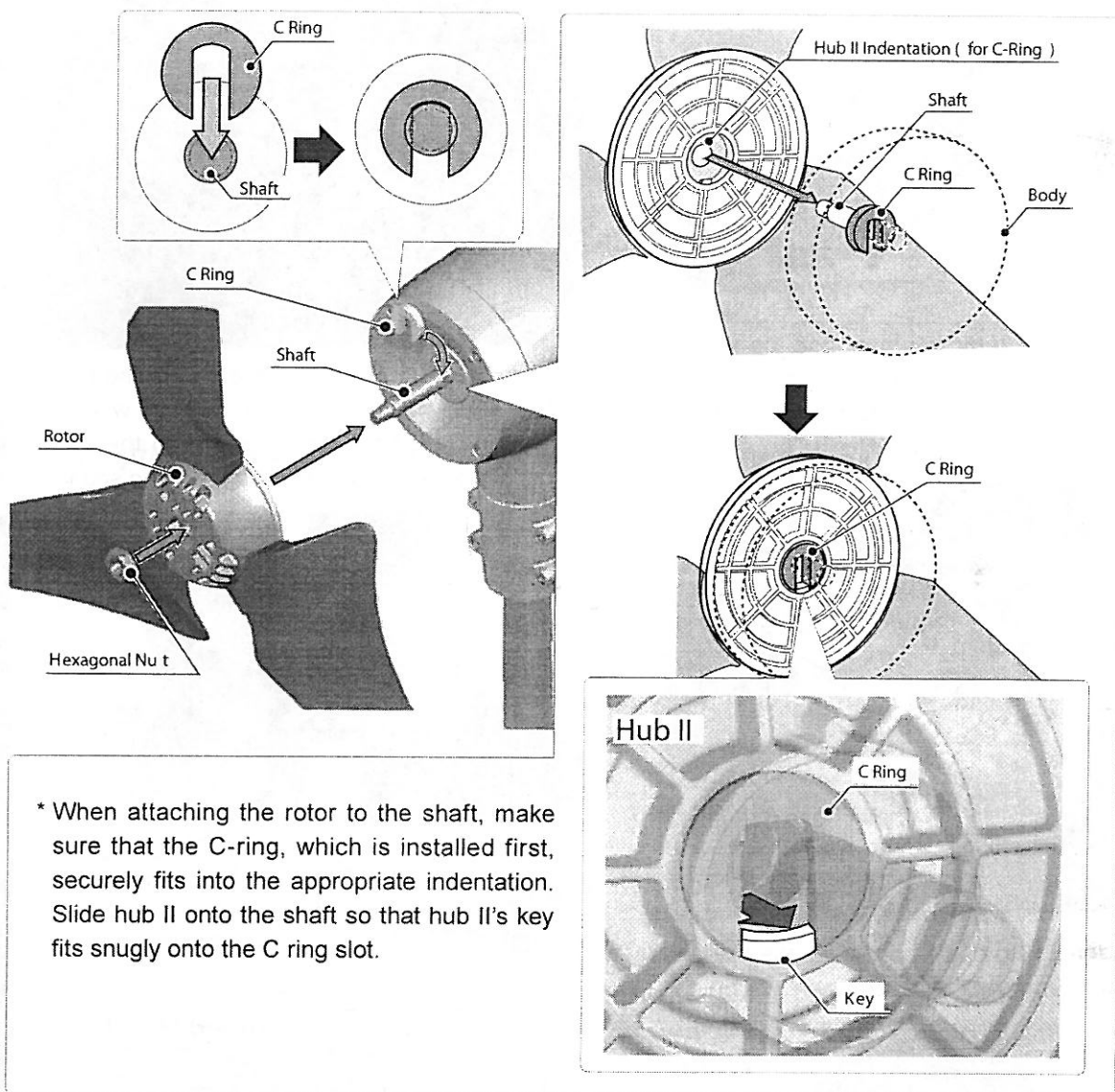
The blades are attached to hub I.



6. Assembling the Airdolphin (Z-1000)

④ Attaching the rotor to the body

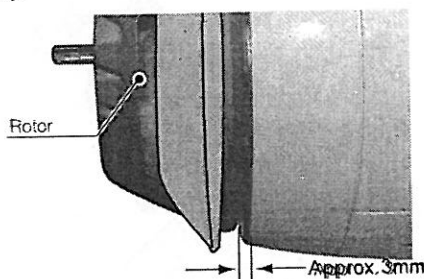
1. Fit the C ring onto the shaft of the body facing downwards as shown as in the illustration below.
2. Referring to the figure shown below, attach the rotor to the shaft.



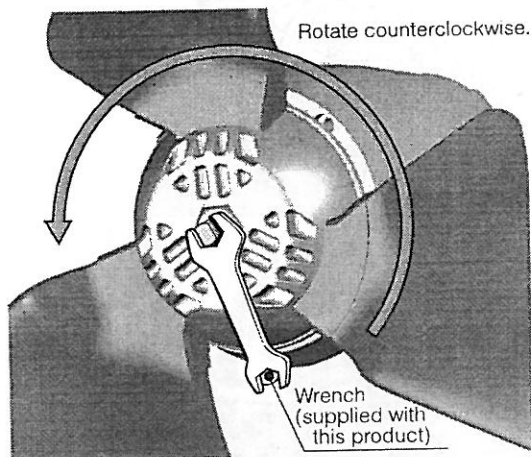
6. Assembling the Airdolphin (Z-1000)

- Once the rotor is in place, use the hexagonal nut to fasten it to the shaft.

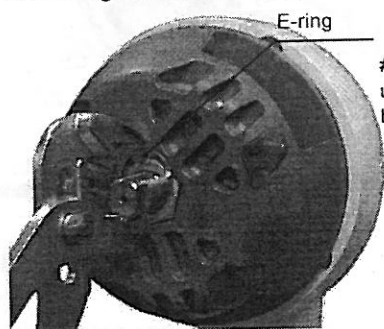
- The rotor will be fixed into place once the gap between the body and the rotor reaches 3mm. Verify that the rotor can rotate smoothly.



- Holding the rotor in place, use the wrench included with this product to grip the nub on the end of the shaft and turn it counterclockwise. (Tightening torque 30Nm)



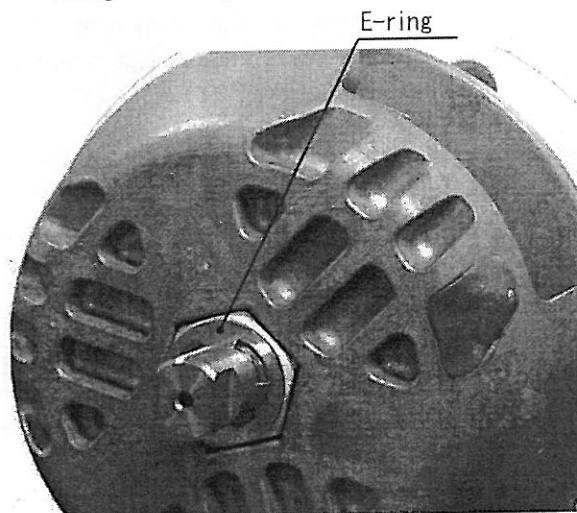
- Fix the E-ring to the shaft. Use the plier etc to fix the E-ring as the below figure.



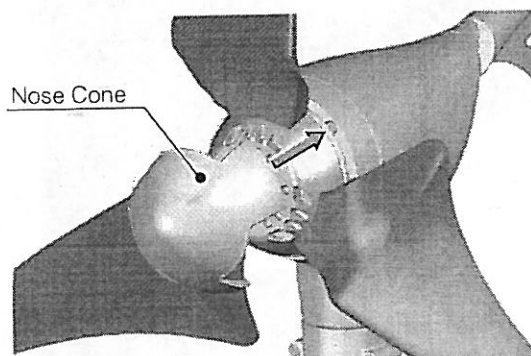
Fix the E-ring as the figure.

#To remove E-ring, use 2 sets of flat blade screw driver.

- Check the Rotor that will rotate smoothly after Fixing the E-ring to the shaft.



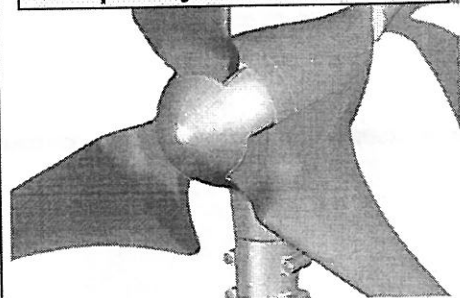
- Slide the nose cone onto the end of the rotor. Lining the fins on the nose cone up with the blades, press the nose cone onto the rotor until it locks into place with a snapping sound.



Important

Verify that all three fins of the nose cone are uniformly attached to hub II.

Completely Assembled Unit



7. Connecting the System

7-1 Before connecting

There are two Airdolphin system configurations—one in which generated electricity is stored and linked to the commercial electricity grid(On-grid system) before being used, and another in which the wind turbine is used as a standalone system(Off-grid system). A 24V battery is required for both systems. The following explains how to connect the Airdolphin power cable (approx. 500mm long) and provides a typical example of a wind turbine system connection.

For On-grid system ,contact dealer or Zephyr Corporation for details.



Important * Pay attention to the + and – terminals when connecting the power cable to the battery. Reverse connection will cause serious damage.

(Be aware that any damage to this product caused by improper connection is NOT covered by the warranty. Connect the cables to the correct terminals.)

7-2 Length of the extension cable that leads from the Airdolphin to the battery

If length of the power cable that connects the Airdolphin (Z-1000) to the battery is within 15 meters, connect the Airdolphin directly to the main battery. If the cable is longer than 15 meters, please refer to page 25 for the details.



Important The Airdolphin Mark-Zero (Z-1000) has an output voltage of 25V. Connect either a single 24V battery or two 12V batteries in a serial connection.

7-3 D.P.D.T.(Double pole double throw) blade switch

To ensure safety, the Airdolphin (Z-1000) is equipped with an emergency stop feature (See page 24.). In the event of an emergency stop, the Airdolphin (Z-1000)'s power supply must be shut off for approximately 10 seconds before being restarted. In order to facilitate turning the power on/off, Zephyr Corporation recommends the installation of a D.P.D.T. BLADE SWITCH between the Airdolphin (Z-1000) and the battery. (See next page.)

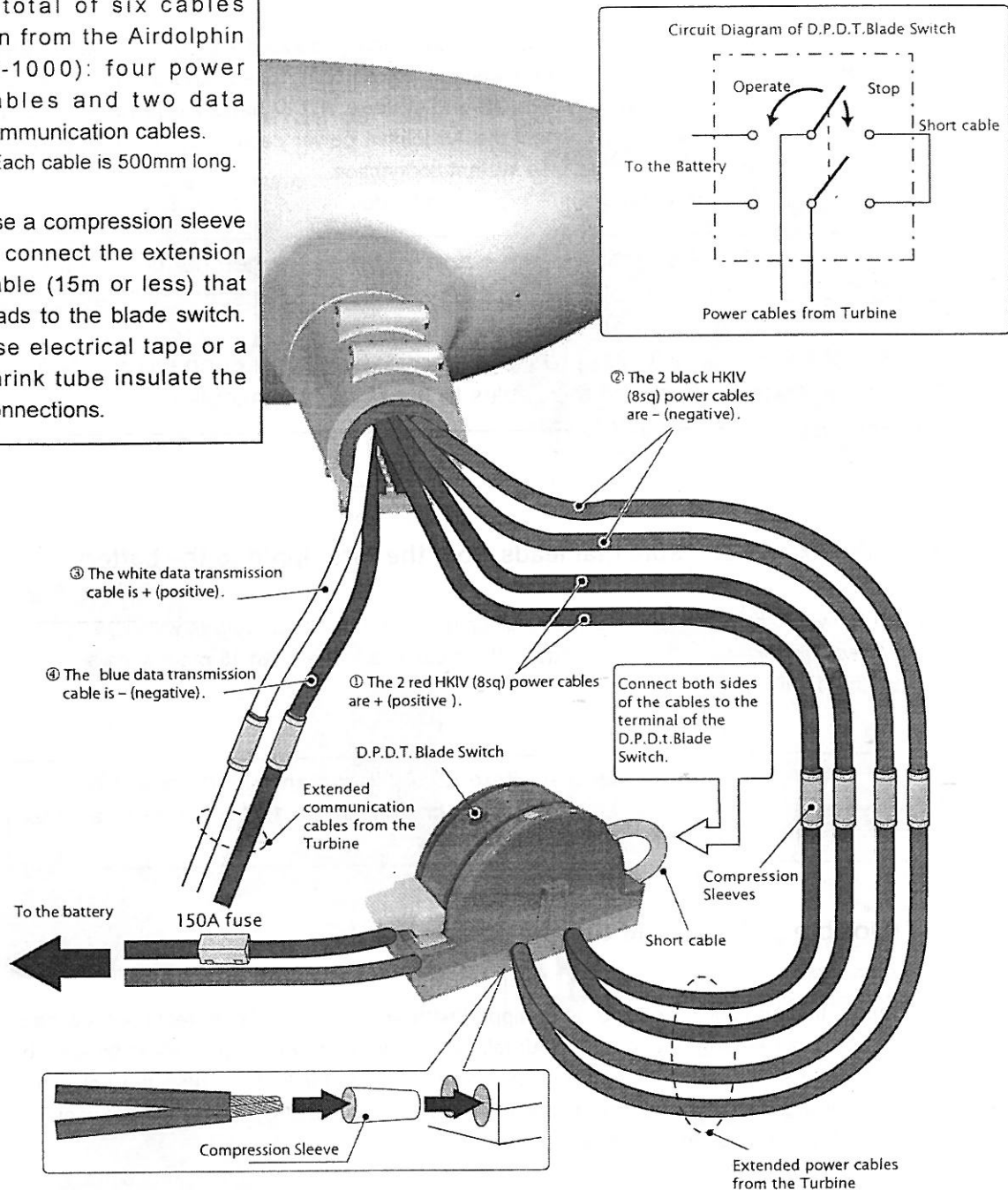
7. Connecting the System

7-4 Connecting the Airdolphin output cable extension

A total of six cables run from the Airdolphin (Z-1000): four power cables and two data communication cables.

* Each cable is 500mm long.

Use a compression sleeve to connect the extension cable (15m or less) that leads to the blade switch. Use electrical tape or a shrink tube insulate the connections.



Important

Refer to All Local and National Codes before Installation.

- Pay attention to the + and - terminals when connecting the power cable to the battery. Reverse connection will cause serious damage.
- Pay attention to the + and - terminals when connecting the data transmission cable(s) to the RS485/RS232C transformer. Reverse connection will cause serious damage.

7. Connecting the System

7-5 Connection example

The Airdolphin can be used in a multitude of configurations. This section shows a typical connection example recommended by Zephyr Corporation.



Caution

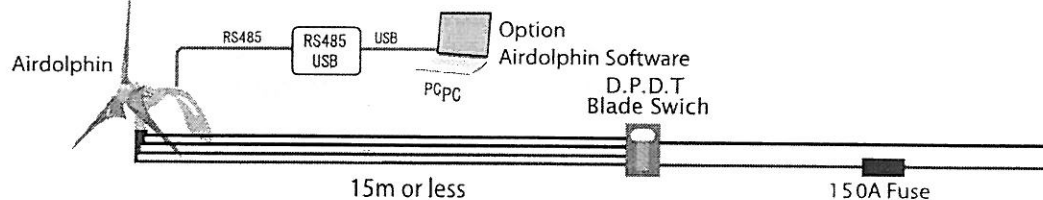
This manual is intended for individuals who have the knowledge and technical skill needed to work with batteries and electrical wiring. If the Airdolphin is used in an inappropriate configuration or wired incorrectly, its use could cause a severe accident and damage the system, including this product.

If you have any questions regarding Airdolphin system configuration, contact either the dealer where you purchased this product or Zephyr Corporation for more information.

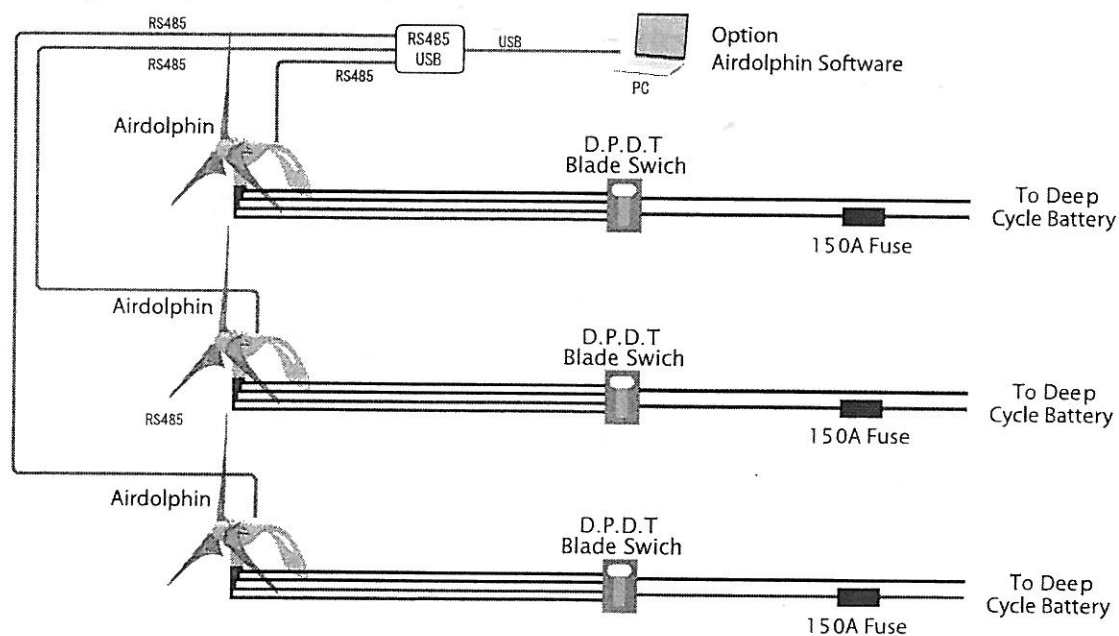
7. Connecting the System

Electricity Generation/ Data Communication End

① Airdolphin Independent Use Example (cable connecting Airdolphin and battery 15m or less)

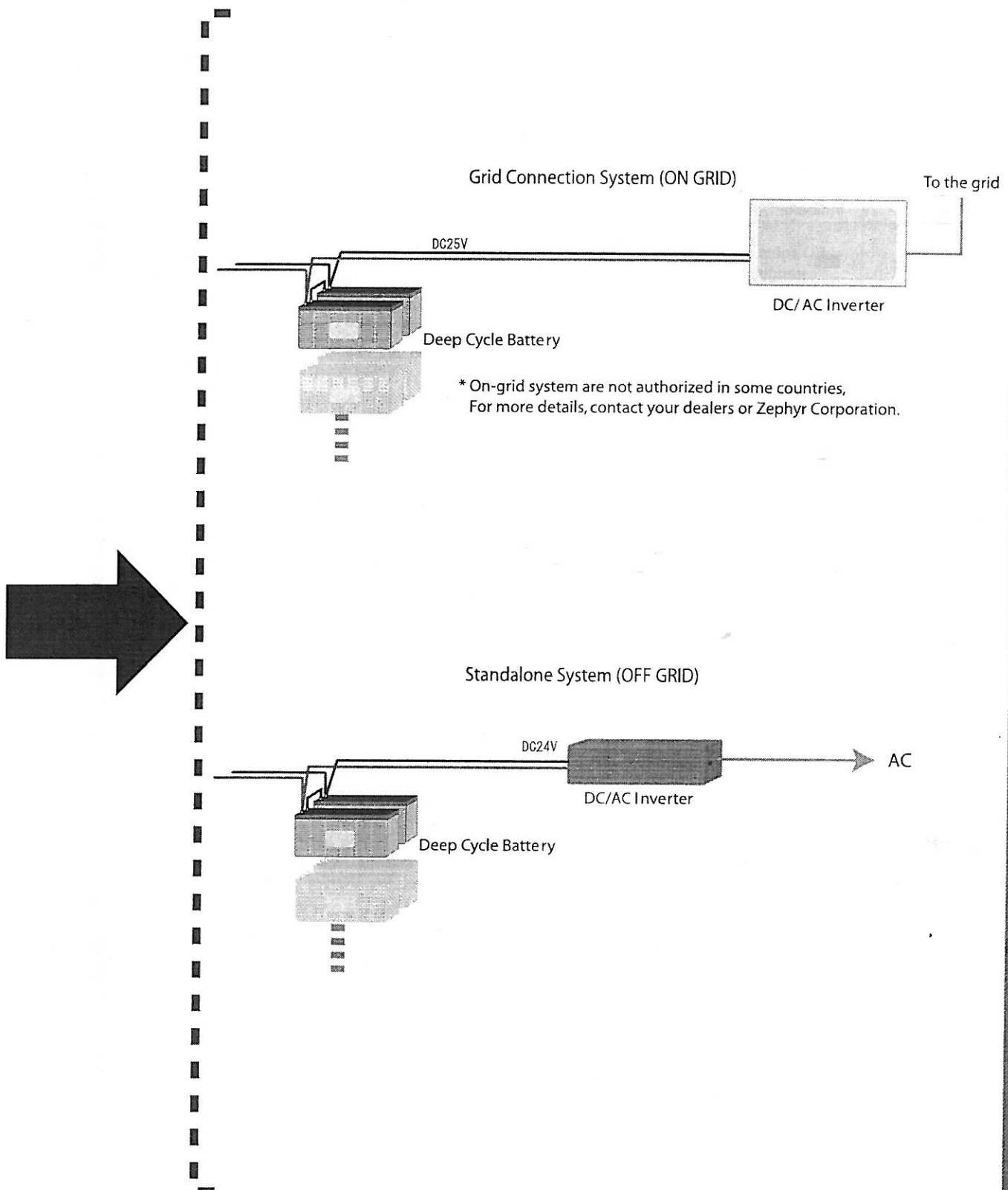


② Airdolphin Independent Use Example



7. Connecting the System

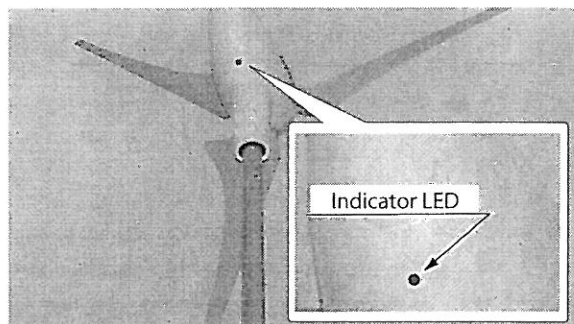
• Load End



8. Explanation of Airdolphin Operations

During operation, the indicator LED on the body of the Airdolphin can be used to check the operating status of the system.

The indicator LED can light up red, green, orange, or blink.



Operating Status List

Mode	Indicator Status	Status	Cause	Following Operation
Power Assist Mode	LED lights up orange ●	Power Assist rotates the Airdolphin at 200rpm in 10-second intervals each minute	No wind for 1 minute	Operating Normally
Normal Mode 250rpm–1099rpm	LED lights up green ●	Generating electricity	Rotor rotating at 250–1099rpm	Operating Normally
Normal Mode 1099rpm or more	LED blinks green ⊙	Generating electricity	Rotor rotating at 1099 rpm or more	Operating Normally
Stall Mode	LED lights up red ●	Generating electricity	a. Maximum rotation speed (1800rpm) exceeded b. Overpower limit exceeded (continuous average 1.7kW output for 10 seconds or output exceeds 2.5kW) c. Battery overcharged (voltage exceeds 28.6V) d. During start/restart	Turbine operated continuously for 1 minute in stall mode at an output of 250W or less
Stop Mode	LED blinks orange at 1-second intervals ⊙	Rotor not rotating Power assist stop	a. Overvoltage (battery voltage exceeds 31V) b. Generator motor ambient temperature increasing (generator motor ambient temperature exceeds 90°C)	a. System returns to stall mode if the battery voltage drops below 25.6V. b. System returns to stall mode if generator motor ambient temperature drops below 60°C
Restart	LED blinks 5 times at 1-second intervals ⊙		Power On/Off	System started install mode

9. Considerations When Choosing Peripheral Materials/Devices

Choosing peripheral materials/devices

Batteries

Zephyr Corporation recommends the use of a deep cycle battery to handle the deep charge/discharge cycles in the wind turbine system. (A car battery cannot be used for repeated deep charge/recharge.)

Connect two 12VDC batteries in a series circuit to attain 24VDC performance.

Recommended battery specifications: 24VDC, standalone system 500Ah or above.

On-grid system: 100Ah or more

Mounting Tower

The mounting Tower that supports the Airdolphin is an extremely important part with respect to safety. We recommend that all locations to which equipment will be attached as well as the foundation must be strong enough to provide adequate safety.

- Location and height of the mounting tower : Select free and safe location where the ample amount of wind flow is obtained. The height of the pole must be 3.5m or more to ensure safety from hazard to people.
- On the tower with an upper portion at least 100mm in length and outer diameter of 48.6mm. The total tower height must be of sufficient height to prevent accidental with body or structures.
- The tower must withstand horizontal wind pressure of 105kg (at a wind speed of 65m/s)
- You should consult with your local dealer or Zephyr Corporation for details.

Cables

A considerable amount of current flows through the devices (batteries, DC load) connected to the Airdolphin Mark-Zero (Z-1000). Use cables specified by Zephyr Corporation or manufactured to recommended specifications.

- Battery Link Cables (for use with Buffer Batteries): Use the cable included with the Airdolphin (Z-1000) that is equipped with a reverse connection prevention 150A fuse.
- Zephyr Corporation recommends the attachment of a KIV 22sq 150A fuse.
- Wire Diameter Sizes

To select the appropriate size wires, measure the distance between the turbine and the batteries. Make sure you include the length of the tower and refer to the following wire size chart.

Case 1; The turbine and the batteries are placed within 15m (49.12 feet) Wire size; cable diameter 8mm²

Case 2; The turbine and the batteries are placed over 15m Place "Buffer Batteries" within 15m from the turbine. Then connect the "Buffer Batteries" and the "Main Batteries" according to the wire size chart.

Distance between Buffer & Main Batteries	Cable diameter (minimum sizes)
~ 10m (32.80 ft)	5.5 mm ²
10m ~ 15m (32.80 ft ~ 49.21 ft)	8.0 mm ²
15m ~ 30m (49.21 ft ~ 98.42 ft)	14.0 mm ²
30m ~ 45m (98.42 ft ~ 147.63 ft)	22.0 mm ²
45m ~ 80m (147.63ft ~ 262.46 ft)	38.0 mm ²

* Cable quality and electricity transfer rate vary in accordance with turbine quantity.

* A multitude of cables with different specifications is also available. For details, contact the dealer where you purchased the Airdolphin (Z-1000) or Zephyr Corporation.



Be aware that the chart shows the minimum size and a larger sized wire will improve the performance.

9. Considerations When Choosing Peripheral Materials/Devices

Inverters

Since batteries are a direct current power source, a DC-AC inverter is needed to convert direct current (DC) to alternating current (AC) when an alternating current device is used to manage the electrical load. Verify the capacity and type of your inverter to ensure that it is appropriate for the load you are using.

* Always use 24VDC inverters.

* Always use inverters equipped with an overvoltage protection circuit.

Fuse

Use a link cable equipped with a 150A fuse for protection against reverse connection to connect the turbine and the battery.

10. Maintaining the Airdolphin System

Perform the maintenance tasks listed below to ensure the safe operation of this system.

10-1 Daily Inspection

Although the Airdolphin is basically a maintenance-free system, Zephyr Corporation recommends visual inspections. (See page 24 for details on the indicator lamp.)

- a) Is the power assist rotating the turbine at the standard speed (250rpm) for 10 seconds each minute?
 - * The power assist will rotate the turbine at a speed slower than the aforementioned standard approximately 10% of the time. This is not a malfunction.
- b) Is the system exhibiting operations listed on the "Explanation of Airdolphin Operations" chart above?
(Example: Indicator lamp is green when the rotor is rotating at a high rate of speed (250-1099rpm), etc.)
- c) Are the blades free from damage?
- d) Is there an approximate 3mm gap between the hub and the main unit face?
- e) Is any debris such as ice, snow, or tree branches jamming the turbine?
- f) Is the joint on the tail moving smoothly?
- g) Is the tail free from any minor damage?



WARNING



CAUTION



If replacement is necessary, only use parts specified by Zephyr International. Use of other parts could cause accidents or malfunction.



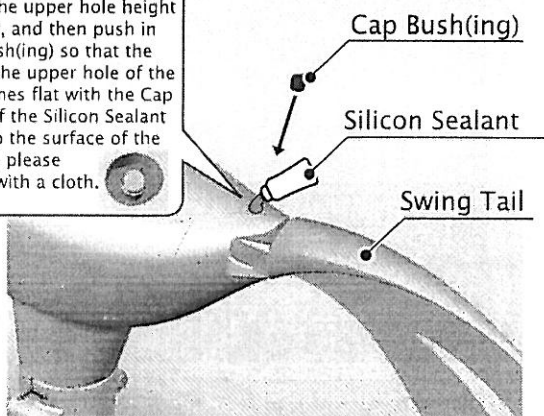
- When strong winds blow, tree branches and other objects may make contact with and damage the wind turbine, its support pole, or its wiring. Continued use of the wind turbine when it is damaged may cause electric shock, fire, a serious accident, or cause the turbine to cease functioning. Inspect all parts of the Airdolphin Mark-Zero (Z-1000) after periods of strong wind.
- Do not place the Airdolphin body upside down or inclined during installation or maintenance. Water (rain, snow) can leak inside from the joint gap of the body and may cause damage to the turbine. When the body is upside down or inclined and have a possibility of getting wet, put a cover over the body to avoid water.



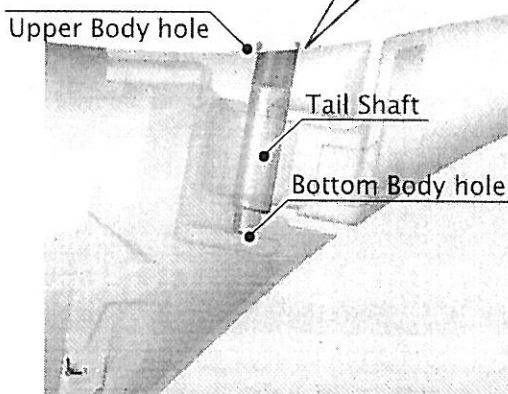
【 Please remember that you fill in Silicon Sealant
after you have inserted the Tail Shaft】

In order to prevent the possibility of the Tail Shaft and the Swing Tail coming off the Airdolphin Body due to excessive vibrations for some reasons even after the Tail Shaft is inserted into the body and the Tail Shaft holes, Silicon Sealant which is readily available at an ordinary home center must always be applied.

After you have properly inserted the Tail Shaft into the upper and bottom hole of the Airdolphin Body and the Swing Tail's hole, apply and fill in "Silicon Sealant" up to the middle of the upper hole height of the Body, and then push in the Cap Bush(ing) so that the surface of the upper hole of the Body becomes flat with the Cap Bush(ing). If the Silicon Sealant leaks out to the surface of the upper hole, please wipe it off with a cloth.



Note: The Tail Shaft must be inserted from the upper hole of the Body through into the hole of the Swing Tail, then to the bottom hole of the Body so that the tip of the Tail Shaft properly fits into the bottom hole of the Body. Make sure that the top of the Tail Shaft sinks into the upper hole of the Body.



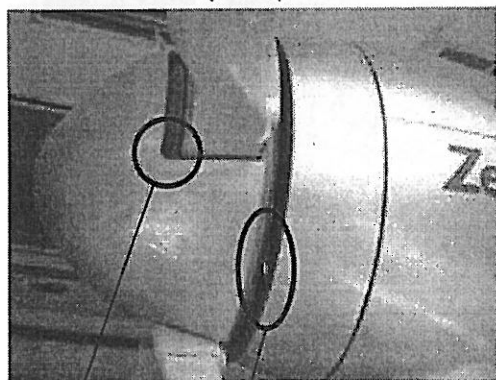
Zephyr Corporation



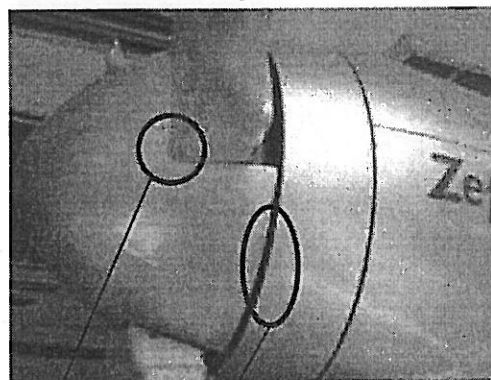
日本語

【ノーズコーン取り付け時に注意してください！】

ノーズコーンを取り付ける時にハブⅡにしっかりとハマっていないとローター回転中にノーズコーンがはずれる恐れがあります。高速回転中のローターにノーズコーンが当たるとローターが破損します！（交換用のローターセットは25万円します）下記の右図のようにしっかりとノーズコーンをはめ込み取り付けを行ってください。



隙間が5mm以上開いている
隙間が開いている



隙間が5mm以内に収まっている
隙間がまったくあいてない



ゼファー株式会社