Installation and Owner's Manual

LAKOTA 2005-2006 Turbine – and LongBow
Zytech Version 2.8

Disclaimer

This document is provided for information purposes only. Zytech Aerodyne makes no warranties, either expressed or implied, in this document. Information in this document is subject to change without notice.It is the responsibility of the user to ensure that the LAKOTA Wind Turbine and all associated equipment are suitable for the intended purpose and installed in accordance with all applicable rules, regulations, bylaws, and codes. Policies governing the installation of wind turbines may vary dramatically from one jurisdiction to another and are beyond the control of both Zytech Corporation.The entire risk for the use of, or results from, this document remains with the user.

ZYTECH AERODYNE products may have patents, patent applications, trademarks, copyrights, and/ or other intellectual property rights covering subject matter in this document. Except as expressly written, the furnishing of this document does not give the owners of LAKOTA Wind Turbines or anyone installing or using this product any license to these patents, trademarks, copyrights, or other intellectual property.

WARNING

The LAKOTA Wind Turbine can be easily damaged by incorrect handling, assembly, installation, or use. Furthermore, installation, erection, and maintenance of the LAKOTA Wind Turbine involves work with towers and electrical components, both of which can be extremely hazardous. Prior to assembly, installation, erection or maintenance of the LAKOTA Wind Turbine, individuals must read and understand the information contained in this Owner's Manual as well as information provided by the manufacturers of other system components. Furthermore, designers and installers mustbe conversant with rules, regulations, and bylaws applicable to the installation.

Failure to comply with this Owner's Manual will void the LAKOTA Warranty.

Table of Contents

Introduction

The LAKOTA and LAKOTA Longbow wind turbines are state-of-the-art small wind turbines designed for use in wind, solar or hybrid, stand-alone or grid-tied applications. They feature remarkably quiet AERODYNE Stealth-Acousic carbon-fiber blades, a three-phase “Wild-AC” permanent magnet “Y” alternator, and a Controller-Rectifier Panel which incorporates a ‘Brake Switch,’ a rectifier module, and a load diversion regulator (LDR). The rectifier converts the alternating current (AC) output of the alternator to 12, 24, or 48 volts direct current (DC) depending on the model selected. The LDR diverts excess power to a resistive load when the wind is strong, the demand for energy is low and the batteries are fully charged.

The light- weight, low-inertia design ensures excellent low-wind-speed and gust performance, and also allows for effective electromagnetic braking of the rotor in moderate wind conditions using the ‘Brake Switch’ on the all-in-one controller-rectifier-diversion load, that is referred to as the LAKOTA Commander. The turbine has a rated power output of 900 watts at 28.8 mph and a peak power output in excess of 1200 watts or more in high winds. It is designed to auto-furl by tilting back vertically in high winds but will maintain its full power output when furled.

The 2006 LAKOTA SC (which stands for “StormChaser”), comes in two models SC-L for “Land” version and SC-M for “Marine”. The Marine version features a durable white titanium-dioxide, polyurethane aircraft coating to help protect metal surfaces, particularly for marine applications and severe cold climates. The bell housings are intentionally not painted for better heat dissipation. Longbow is a LAKOTA variant with longer blades, improved rotor and stainless compression coupler yaw assembly. All models have sealed bearings and a sealed alternator unit that does not need greasing or to be opened during annual inspections.

Specifications and Features

- Rotor Diameter – 2.1 metres (82.6 inches) – Longbow 2.3 meters (90.55 inches)
- Swept Area – 3.46 square metres (37.24 square feet) – Longbow 4.15 sm (44.67sqft)
- Weight – 18 kilograms (39.6 pounds) – Longbow 21.3 kg (47 pounds)
- Rated Power Output – 900 watts at 12.9 metres/second (46.4 kph) (28.8 mph)
- Peak Power Output – 1200 watts at 17.0 Metres/second (61+ kph) (38+ mph)
- Start-up wind speed – 3 metres/sec (11 kph) (6.8 mph)
- Charging 1 ampere at 12 volts at 4.0 metres/sec (14.5 kph) (9 mph)
- Aerospace grade, uni-directional carbon fiber blades with optional helicopter tail rotor leading-edge protective tape for use in abrasive desert environments.
- Aluminum body with all stainless steel hardware
- 8 pole, 36 slot, 3 phase alternator
- 8 Rare-earth neodymium iron boron permanent magnets

- Adjustable settings to match blade length and turbine performance to different wind regimes
- LAKOTA SC-M has a white UV stabilized, titanium-dioxide, linear-polyurethane aircraft coating that provides additional protection in harsh, marine, arctic or corrosive environments.

Warnings, Cautions, and Notes

Installation, erection, and maintenance of the LAKOTA Wind Turbine involves the physical installation of the wind turbine on a suitable tower and work with various electrical systems and components, both of which can be extremely hazardous. Those who are unfamiliar with renewable energy systems or their installation should seek the assistance of professional tradesmen, most importantly a qualified Electrician, familiar with renewable energy systems and components.

Specifically, installers must be familiar with battery management, particularly high amperage DC power circuitry, and local electrical codes. In all cases, prior to assembly, installation, erection, or maintenance of the LAKOTA Wind Turbine, owners and installers must read and understand the information contained in this Installation and Owner's Manual as well as information provided by the manufacturers of other components that will be incorporated in the overall system. Furthermore, designers and installers must be conversant with rules, regulations, and bylaws applicable to the installation.

Throughout this manual, the terms WARNING, CAUTION, and NOTE are used to highlight hazards or unsafe practices or significant points worthy of emphasis. These terms are defined as follows:

WARNING
Hazards or unsafe practices that could cause serious injury or death.

CAUTION
Hazards or unsafe practices that could cause personal injury or equipment damage to the wind turbine and system components.

NOTE
Notes that will make assembly or operation easier and less prone to error or may avoid poor performance due to improper installation or adjustment.

Safety Considerations – A Common Sense Approach

Common sense and caution should be used in assembling and installing the LAKOTA wind turbine. Some appropriate safety considerations are:

- Plan your work before doing it. Read this entire manual at least once first.
- Consult with your LAKOTA Dealer or the LAKOTA on-line documents available from
- Zytech Aerodyne.www.zytechaerodyne.com
- Work systematically in the order recommended. Don't rush.
- Keep your tools and equipment organized to avoid making mistakes.
- Wearing thin leather or rubber palm gloves may avoid minor cuts and pinches.
- Wear sturdy shoes or steel-toe work boots and construction helmet in case something heavy falls.
- Test for voltage present on electrical connections with a multi-meter or voltage sensing pen before touching or connecting them.

Package Contents and Inventory

The following paragraphs provide a detailed list of components included with the LAKOTA Wind Turbine. Immediately upon receipt of the system, take a few moments to verify that all of the components were included in the shipment. In the unlikely event that one or more items was omitted, lost, or damaged during shipping, contact your Authorized LAKOTA Dealer. Have the model number, serial number, and original purchase receipt available. Refer to the Identification Section of this manual (page 9) for additional information regarding the model and serial numbers (write these key numbers on page 9 and then fax the page to your LAKOTA Dealer).

CAUTION

When removing the LAKOTA Wind Turbine from the packaging, do not lift the wind turbine by the "black rubber handle." It is not a handle but rather an electrical conduit and is not designed to support the weight of the wind turbine. Lifting the wind turbine by this conduit can damage the internal connections and may cause the unit to malfunction. Always lift and carry the unit by grasping the springs or main housing. Careful handling or lifting using one or both of the large furling springs is acceptable.

BOX 1 - LAKOTA Wind Turbine Body Assembly (Approx. 15 kgs (33 lbs))

Documentation

- 1 LAKOTA Wind Turbine Owner's Manual (this document)
- 1 Product Registration Card for the wind turbine head unit and blade array

Alternator and Mounting Components

- 1 Wind turbine alternator head assembly
- 2 Stainless Steel Metric Hex Head Cap Screws M10 x 25
- 1 Stainless Steel Yaw Shaft Clamp (should be attached to the base)
- 4 Heavy-Duty Wire Ties

Tail and Tail Fin Components

- 1 Left Tail Fin
- 1 Right Tail Fin
- 2 Rectangular 3 hole Metal Spacers
- 1 Cross Brace
- 2 Stainless Steel Metric Hex Bolts M6 x 16
- 3 Stainless Steel Metric Hex Bolts M6 x 45
- 10 Stainless Steel Metric Flat Washers for M6
- 5 Stainless Steel Metric Nylon Insert Lock Nuts for M6
- 1 Stainless Steel Metric Hex Bolt M10 x 70
- 2 Stainless Steel Metric Flat Washers for M10
- 1 Stainless Steel Metric Nylon Insert Lock Nut for M10

Hub Components

- 1 Stainless Steel Hub Back Plate
- 1 Stainless Steel Hub Front Plate
- 2 Neoprene Black Triangular Dampers
- 1 Stainless Steel Torque Ring (may be fastened to Hub Back Plate)
- 3 Stainless Steel Metric Flat Head Socket Cap Screws M6 x 12
- 2 Torque Keys (1 spare taped to the alternator drive shaft)
- 1 Stainless Steel Metric Flat Washer for M16
- 1 Stainless Steel Nylon Insert Metric Lock Nut for M16
- 1 Short Arm Allen Key (4mm) for Flat Head Socket Cap Screw M6 x 12

Blade Mounting Hardware

- 9 Stainless Steel Metric Hex Head Cap Screws, M6 x 55
- 18 Stainless Steel Metric Flat Washers for M6
- 9 Stainless Steel Nylon Insert Metric Lock Nuts for M6
- 1 Spinner (Black-S model or White – SC Model)

BOX 2 - Electrical Components (Approx. 12kg - 26 lbs)

- LAKOTA Commander
- LAKOTA Commander Manual

BOX 3 - LAKOTA Blades and Tail Boom (Approx. 2.7 kgs (6 lbs)

- 3 Uni-Directional Carbon-Fiber Blades (Black-L model or White – M Model)
- 1 Stainless Steel Tail Boom

Identification and Markings for Warranty Registration

This is key information you may need in the future. All LAKOTA Wind Turbines are identified by a Model Number and a Serial Number, both of which are stamped on an identification plate located on the main housing of the machine as shown in the adjacent photo. These numbers will be required in the event that there is a need to return the unit for warranty work.

For convenient reference, the numbers and purchase information should be recorded below to be used as the Warranty Registration information for each unit. The original bill of sale will also be required and can be attached to this page for safe keeping. Fax this page to your LAKOTA Dealer to register the warranty.

Model Number	C - 1	-	-
Serial Number	C – 3	-	- Q
Blade Serial Number	C - AQF	-	- A
Blade Serial Number	C - AQF	-	- B
Blade Serial Number	C - AQF	-	- C

Purchase Date: ______________________________

Purchased From: ______________________________

Address: ______________________________

City: ______________ State/Prov: __________ Zip/Post Code: __________

Phone: ______________ Email: ______________________________

Installation Date: ______________________________

Installed Location: __________ Address: ______________________________

City: ______________ State/Prov: __________ Zip/Post Code: __________

Installed By: ______________________________

Address: ______________________________

City: ______________ State/Prov: __________ Zip/Post Code: __________

Phone: ______________________ Email: ____

Extended Warranty Purchase Date: ___________________________

Spain: Fax to Zytech Aerodyne Spain – Europe Service Centre (34) 976-141819

USA and World: Fax to Zytech Aerodyne (Qingdao) – World Service Centre (86) 532-86623633

Planning Your Project

Installation of the small wind or hybrid power system is a substantial undertaking worthy of considerable planning prior to assembly or construction of towers. For both practical and economic reasons, it is important to carefully assess your specific requirements and to design and size your renewable energy system accordingly. The following paragraphs highlight some considerations when planning your project. Those who are unfamiliar with wind energy, should refer to published information available in books, magazines, and on the world wide web.

Youare encouraged to attend a Zytech Aerodyne weekend workshop to understand the theory and application of how to design and install a complete hybrid wind and solar renewable energy system. Visit the Zytech Aerodyne website and click on the TRAINING link for details. You canalso explore the links available on the Aerodyne web-site; go to www.zytechaerodyne.com and click on the KNOWLEDGE link and the FREE Wind News logo on the home page.

In addition, a 25 page illustrated LAKOTA Wind Systems Design Supplement is available $45 USD, including shipping within North America. (add $10 USD for shipping world wide) A renewable energy system consists of three fundamental components – a generation capability which produces the power, a storage medium which stores energy for later use, and a conversion and distribution capability which converts the power to the required voltage and frequency and distributes it to the desired loads.

Included with the generation capability are the components necessary to control the generator and convert the generator output to a suitable voltage and frequency. The following diagram illustrates the fundamental components and lists some of the common subcomponents. Not all components are used in all systems.

Generation

- Wind Generators
- Towers
- Solar Arrays
- Hydro Generators
- Gas/Diesel Generator
- Charge Controllers
- Load Controllers
- Diversion Loads

Storage

- Battery Bank
- Capacitors
- Grid-tied (using the grid as a storage media)
- Water tank or pond

Distri Conversion and bution

- DC and AC Loads
- Circuit breaker/Fuses
- Inverters
- CircuitBreaker Panels
- Shunts
- Volt and Ammeters
- Watt meters

This manual focuses primarily on the generation component of the renewable energy system and specifically for the LAKOTA Wind Turbine. For a detailed discussion of other components, refer to documentation provided by the component manufacturers.

Site Selection and Tower Height

The power available from the wind is proportional to the speed of the wind cubed; therefore a relatively small increase in the average wind speed can make a dramatic increase in power production. Turbulence is also of concern because turbulent air robs the turbine of energy that would otherwise be available in smoother "laminar flow" air.

With this in mind, the goal should always be to site the wind turbine where the wind is the strongest but also where there is smooth laminar flow air, and ideally from all wind directions. This is, of course, much easier in theory than in practice because the wind speed and direction at a particular site and a particular time are affected by both macro and micro environmental factors. Major weather patterns (the macro level) will determine prevailing winds and local topography, barriers (trees, buildings), and surface roughness can have a dramatic affect at the micro level.

These local effects will also vary from season to season as the prevailing winds change. Since the wind speed increases and turbulence decrease with height, local effects can be best overcome by using the tallest practical the height for the tower. As a general rule, a small wind turbine should be installed 10 meters (30 feet) above any object within 100 meters (300 feet) of the tower.

Also consider a local "wind rose" available from a wind atlas. ie where is the dominant wind direction and what obstacles are up wind of a proposed tower location in that sector? Site selection and tower height must also consider the cost of a taller tower, increased line losses in the wire as the distance between the tower and the controller is increased, wiring costs, zoning bylaws, building codes, proximity to obstacles (particularly power lines), concerns of neighbours, and personal preferences.

In the end, site selection is always a compromise of these and other factors. For a more in-depth discussions of site analysis and tower selection considerations, please refer to links on the ZYTECH AERODYNE Power Systems web-site at www.zytechaerodyne.com (follow the "Knowledge" link) or contact your Authorized LAKOTA Dealer for further guidance.

Tower Selection

The LAKOTA Wind Turbine is designed for installation on a freestanding or guyed tower that can accommodate a two-inch diameter tubular mast riser and withstand a lateral thrust of 900 newtons (200 pounds) at the mast head. This is a tower requirement. The actual lateral load produced by a LAKOTA in very high wind is less than 100lbs. A tower and mast riser are separate components and not part of the LAKOTA Wind Turbine; however, Aerodyne offers excellent, high quality, tilt-up, stainless coupler, tower kits suitable for most applications. For additional information regarding towers, please contact your Authorized LAKOTA Dealer. For a detailed description the mast riser options refer to the Assembly Section on page 19.

CAUTION

In a 160 kilometer per hour (~100 mile per hour) wind, the lateral thrust imparted at the top of the tower by the LAKOTA Wind Turbine is approximately 360 newtons (~80 pounds). To ensure an adequate margin, select a tower that is designed to withstand 900 newtons (~200 pounds) of force at the masthead; this is more than twice the maximum design thrust of the LAKOTA Wind Turbine. Due to the upward furling design much of the "lateral thrust" at the top of the pole is actually directed vertically down the pole as the rotor tilts horizontally. Notwithstanding the tower safety margin, you should consider turning off the turbine before such and event or perhaps even lowering the tower, if winds are forecast to exceed 160 kph (100 mph).

WARNING

Installation of towers can be extremely dangerous and must be conducted in accordance with the guidance provided by the tower manufacturer and with due consideration for safety. Consult a qualified mechanical engineer before designing your own tower or consult engineering stress analysis to see if a particular commercially available tower is suitable for the LAKOTA.

System Voltage

The LAKOTA Wind Turbine is available in 12, 24, 48 volts. Determining the appropriate voltage for a particular installation is a function of both technical and economic factors. Higher voltage systems require more batteries thus increasing the overall cost of the installation. Lower voltage systems are impacted more by line losses and the high current flow produced. higher current requires larger more expensive wire. For example, 12 volt system voltage is a poor choice when the wind turbine is located a significant distance (>100ft) from where the power will be used or if the maximum demand for power from the inverter system is over 2500watts.An Authorized LAKOTA Dealer will be able to assist in selecting the appropriate voltage for your specific installation.

Optimizing the Performance of the LAKOTA Wind Turbine

LAKOTA Wind Turbines are preset at the factory for use in a MOD 0 state which is optimum for most locations. your location has consistently lower AVERAGE winds (Class 1 or class 2, you may benefit from a MOD 3 setting. As a general rule, MOD 0 is usually applicable to all locations whether or not they are marine, coastal, high altitude, or high latitude locations. Using a MOD 0 setting in a low to medium wind regime will lower the overall energy production of the wind turbine. If you wish to change the MOD setting of your LAKOTA Wind Turbine, contact your Authorized LAKOTA Dealer directly.

Wind Class	Annual Average Speed		AKOTA MOD Setting
	Kph	Mph	
1	16.3	10.1	Mod 3
2	21.6	13.4	Mod 3
3	24.2	15.0	Mod 0
4	26.1	16.2	Mod 0
5	27.9	17.3	Mod 0
6	30.3	18.8	Mod 0
7	35.9	22.3	Mod 0

The following chart can be used to decide if a different MOD setting or rotor selection may be appropriate. Note: The range of speeds and the boundaries of wind "Classes" vary from source to source. Treat wind classes as an approximation. The chart below refers to speeds in m/s and equivalent mph. LAKOTA is normally shipped in MOD 0, all wind regimes.

Lakota Site Specific Rotor Size and Wind Mod settings		Classes of Wind Power Density at 10 m and 50 m(a) Tower Hub height				
Rotor Array Model		Wind Power Class	Wind Power Density (W/m²)	Speed(b) m/s (mph) at 10 m (33ft)	Wind Power Density (W/m²)	Speed(b) m/s (mph) at 50 m (164 ft)
Extended Area Rotor (EAR)	Mod # 3	1	<100	<4.4 (9.8)	<200	<5.6 (12.5)
Extended Area Rotor (EAR)	Mod # 3	2	100 - 150	4.4 (9.8)/5.1 (11.5)	200 - 300	5.6 (12.5)/6.4 (14.3)
Extended Area Rotor (EAR)	Mod # 3	3	150 - 200	5.1 (11.5)/5.6 (12.5)	300 - 400	6.4 (14.3)/7.0 (15.7)
Extended Area Rotor (EAR)	Mod # 0	4	200 – 250	5.6 (12.5)/6.0 (13.4)	400 – 500	7.0 (15.7)/7.5 (16.8)
Extended Area Rotor (EAR Standard Area Rotor (SAR)	Mod # 0	5	250 - 300	6.0 (13.4)/6.4 (14.3)	500 - 600	7.5 (16.8)/8.0 (17.9)
Standard Area Rotor (SAR)	Mod # 0	6	300 - 400	6.4 (14.3)/7.0 (15.7)	600 - 800	8.0 (17.9)/8.8 (19.7)
Standard Area Rotor (SAR)	Mod # 0	7	>400	>7.0 (15.7)	>800	>8.8 (19.7)

(a) Vertical extrapolation of wind speed based on the 1/7 power law

(b) Mean wind speed is based on the Rayleigh speed distribution of equivalent wind power density. Wind speed is for standard sea-level conditions. To maintain the same power density, speed increases 3%/1000 m (5%/5000 ft) of elevation.

Note: Tower height will substantially affect turbine performance. Fly high for smooth performance and more power

CAUTION

Performance MODs should only be adjusted by a Certified LAKOTA Technician.Opening the LAKOTA alternator casing or failure to comply with this requirement WILL VOID the Standard and/or the Extended Warranty.

Diversion Load

Diversion resistors are built into all LAKOTA Commanders. This integrated diversion load is designed to divert excess energy when the wind is strong, the demand for energy is low, and the batteries are full. Under these conditions the turbine is still producing and the energy must be handled in some way or excess heat will build in the alternator and it may overheat.

The diversion load must be able to continually dissipate all of the maximum instantaneous and sustained power produced by the wind turbine. Theoretically, a diversion load can be installed on the AC side (after the inverter) and power a 120v AC load such as a water heater or fan. But AC diversion loads do not protect the wind turbine in the event of an inverter failure.

Aerodyne recommends only using the LAKOTA Commander or LDR series controller integrated with the LAKOTA rectifier/controller, coupled to an 1800-2000 watt DC resistive AIR heat load.Even though it is only rated at 900Watts the LAKOTA Wind Turbine requires at least 1800 watt diversion load to ensure an adequate margin of capacity in all possible operating conditions. A 24v Commander may have to deal with large transient power surges during highly gusty conditions and output amps may exceed 60-80 Amps for a brief period.

For additional information regarding diversion loads, contact you Authorized LAKOTA Dealer.

Battery Bank

A renewable energy system which uses the LAKOTA Wind Turbine as a source of power generation must also incorporate a battery bank of the same nominal voltage – 12, 24, or 48 volts. Besides storing the energy for later use, the battery bank also serves to condition the power as it is generated.

As a general rule, deep-cycle, flooded lead-acid batteries are used due to their lower cost and recognized durability. They provide the best power density per dollar. Absorbed Glass Matt (AGM) or Gel batteries require little or no maintenance but cost more per stored watt and generally store less energy per pound of battery.

They are more convenient but cost a bit more. Sizing of the battery bank is a critical aspect of the renewable energy system design and warrants detailed consultation with your battery supplier or an Authorized LAKOTA Dealer. Over sizing the battery bank results in unnecessary expense; under sizing the battery bank results in inadequate storage capacity and an inability to make optimum use of the power produced by the wind turbine.

Power Conversion

The LAKOTA Wind Turbine is an alternator based system which produces 12, 24 or 48 volt "Wild AC" power. Wild because it's voltage, current and frequency changes dynamically as the wind changes. The AC power is rectified or changed to a pulsed DC current by the LAKOTA Commander or Controller-Rectifier and the "Pulsed DC" output of the controller-rectifier is used to charge or "pump energy" into a 12, 24, or 48 volt battery bank.

Think of the battery bank as a gas tank and the turbine as a gas pump. The wind is an infinite source of energy (fuel) but the turbine "gas pump" has a limited rate it can fill your battery tank and the tank will only accept so much energy before it is too full. Energy can be drawn directly from the batteries to power low voltage DC loads or by using an inverter can be converted to 110/220 volt AC to power conventional household loads or feed power to the electrical grid in a grid-tied application.

To continue the analogy, the inverter then is the "engine" of your system. It uses the stored electricity as fuel to run your appliances and lights at what ever rate you choose up to the limit of the inverter (note this is not equal to the limit of the turbine but only the inverter and battery combination). The bigger the Inverter and the higher demand there is the faster you will empty your gas tank.

So the determining factor on what you can run with your turbine is not the turbine itself but rather the peak or continuous rated power of the inverter and the size of your battery bank. You may be able to run your whole house for some period when the wind is not even blowing.

The question is how fast is your engine using the stored energy and how long will it take to empty the tank or refill it? A detailed discussion of power conversion options and the equipment available is beyond the scope of this manual. Consult with your Authorized LAKOTA Dealer to determine the size, type and options of the equipment most appropriate for your installation.

Wiring

Wiring requirements for the LAKOTA Wind Turbine are dictated by the voltage of the wind turbine, the distance between the wind turbine and the Commander or controller-rectifier panel (don't forget to include the height of the tower), whether the cable run is over-head or buried, and of course, the requirements of the local electrical code.

Wire insulation is designed for a wide variety of applications so it is important to ensure that the type of wire is appropriate for your specific installation – overhead or buried - with or without conduit – with or without a ground wire – bare ground or insulated ground wire. Correct sizing of the cable is important that the line losses are within acceptable limits while at the same time minimizing the cost of thewire and conduit if conduit is called for.

Using too small a cable is like hooking up a garden hose to a fire truck. The high resistance created in the small wire could burn out either the wire or the turbine or both.

WARNING

If the circuit breaker (the protector) is rated larger than the wire rating then this is dangerous because th wire itself will be the first to fail if too much current flows too quickly. The breaker must be the first to fa (trip) and make the circuit safe.

Remember, it is AC power running in the cable run between the wind turbine and the control panel. This means line losses are less than if it were DC power so wire sizes do not have to be as big as for the DC power going from the Commander to the Batteries. Aeromag recommends theuse of multi-strand copper or tinned copper wire of sufficient gauge to minimize line losses to less than 4% if possible. Losses over 4% may still be acceptable depending on your application. Consult your Authorized LAKOTA Dealer or an electrical contractor who is familiar with your installation. Annex A provides information regarding wire types and the maximum length of DCcable runs for various combinations of wind turbine voltage, wire gauge, and line loss.

Lightning Protection and Grounding

Lightning protection and grounding are of concern when dealing with towers and electrical components. Due to a wide variation in system design and local conditions it is impossible to be specific regarding lighting protection for all installations; however, some general guidelines are provided here. Customers are advised to seek the guidance of a qualified electrician, Authorized LAKOTA Dealer, the manufacturers of other system components, the designer of their overall system, and the requirements of the local electrical code for more detailedn information regarding the need for, and installation of lightning protection in their area.

Basic principles of lightning protection call for connecting all components to a single ground and avoiding multiple grounding points. It also includes the installation of lightning arrestors and the provision of an easy path to ground to minimize the damage from a lightning strike.

If your homealready has a central grounding point then by default adding a tower that is grounded outside, violates this rule as a second grounding point. No clear answer has yet been found to resolve this conflict but some electricians would say these two ground points should not be joined to eachother. Doing so may allow large voltage differentials to exist between multiple grounding points during a nearby lighting strike or stray voltage.

Others say that they should be joined to a common ground. Lightning arrestors provide a path to ground when a greater than normal voltage exists in a conductor thus providing some protection to power lines and other electrical components. The above photo shows a three-phase lightning arrestor connected to the cable runs at the base of a tower.

If the ground is fairly moist or otherwise electrically conductive, once a lightning strike reaches the ground it will quickly dissipate into the conductive soil. In very dry, frozen, sandy or gravely soil, or on bare rock, special effort must be made to minimize the electrical resistance of the connection to the ground. Where possible, connection to the ground can be made by driving a copper or metal grounding rod or iron pipe approximately 2.5 metres (8 feet) into the ground. If there is a limited amount of soil, a ground net or a ring of conducting material such as non-insulated copper grounding wire, can be used to protect the tower, wind turbine, and surrounding structures.

To reduce the probability of damage from a lightning strike, every indoor component in the system must be connected to the common house ground. Metal towers must be solidly grounded and wooden tower structures should have at least a #8 AWG grounding wire running from the wind turbine riser down the outside of the tower to the grounding rod. On guyed towers, each individual guy wire should be grounded especially for concrete anchors which act as an insulator usually, unless the tether or anchor rebar actually goes through the concrete into the ground.

Towers that are mounted on concrete pads and guy wires that are anchored in concrete should each be electrically grounded to individual grounding points that are joined together. The grounding rods can then be tied together with a buried grounding wire to form a secure single ground point. If there are nearby buildings that have lightning protection systems, do not connect the tower grounding system to the lightning protection system of the building.

When installing the lightning protection system, avoid sharp bends in the wiring. A sharp bend presents large electrical impedance to a lightning strike and may cause the lightning to arc away from the wire. Similarly, deliberately introducing sharp bends in the wind turbine cable runs from the tower to the control panel may promote arcing of a lightning strike and actually help protect the overall renewable energy system.

CAUTION

Failure to install a COMMANDER or a proper load diversion capability prior to operating the wind turbine may void your warranty due to an "open circuit" condition being possible that can severely damage the electrical components of the wind turbine. The LAKOTA Wind Turbine is a permanent magnet alternator and must be presented a managed load at all times to avoid damage.

Manual Load Diversion is NOT RECOMMENDED It VOIDs the warranty

Assembly of the LAKOTA Wind Turbine

CAUTION

When assembling the LAKOTA Wind Turbine, it is essential that each step be completed and verified sequentially in accordance with these instructions. Due to the nature of the assembly, it is often impossible to verify previous steps because fasteners and connectors are no longer accessible. Complete each step in its entirety prior to proceeding to the next.

Tools Required

The following tools will be required to complete the system check, assemble, and install the LAKOTA Wind Turbine on the mast riser. This list does not include additional tools that may be required for assembly and erection of the tower or installation of system components provided by other manufacturers; please refer to your tower manual and information provided by the component manufacturers for additional requirements.

- 24 mm or 15/16” box wrench and socket
- 17 mm box wrench and socket
- 10 mm box wrench and socket
- 10 mm nut-driver, ¼ inch drive ratchet with a 10 mm socket
- 4 mm Allen key
- Torque wrench/ratchet with a range of approximately 5-30 newton-metres (4-20 foot- pounds) (50-250 inch-pounds).
- Thread locking compound medium strength, non-permanent (Loctite 242 or equivalent)
- Tape measure, 4 metres (12 feet) or longer
- Multi-meter (Ohm-meter)

- Semi-round metal file
- Medium slotted screwdriver
- Medium (No2) Phillips head screwdriver
- Rubber mallet or hammer and wooden block
- ½ inch heavy duty electrical tape
- Quality leather work gloves and a pair of thin rubber palm gloves for detailed work
- Safety glasses or goggles
- Hard hats or safety helmets for tower work

CAUTION

When removing the LAKOTA Wind Turbine from the packaging, do not lift the wind turbine by the "black rubber handle." It is not a handle but rather an electrical conduit and is not designed to support the weight of the wind turbine. Lifting the wind turbine by the conduit can damage the internal wiring and cause the unit to malfunction. Always lift and carry the unit by grasping the main housing. Carry using only using the large furling springs is acceptable.

Pre-Assembly Tests and MOD settings

Prior to assembling the LAKOTA Wind Turbine, complete the following tests. These tests were conducted at the factory; however, to check for possible internal shipping damage, the tests should be completed again prior to assembling the wind turbine:

Pre-Assembly Test One – Continuity and Stator Ohms MOD Check

1. Set the multi-meter to read resistance (Ohms) and connect each lead to two different alternator output wires. Check there is some small resistance indicating there is continuity in the windings. Then check the actual resistance compared to the following chart to determine if it is wired correctly and which MOD state it is in.

CAUTION

ONLY MOD 0 IS USED NORMALLY. MOD 3 is rarely recommended in very low wind sites that do not often experience sustained winds above 25mph (11 m/s). When there is only a small amount of energy available to capture MOD 3 may be useful.

LAKOTA Stato Ohms Test			
All readings plus or minus 0.2 Ohms		**Annual Avg Wind @10M**	
		<10mph	**>10mph**
Stator	**Unwired**	**MOD 3 12v**	**MOD 0 12v**
12-24v	0.2	0.7	0.2
	0.2	0.7	0.2
	0.2	0.7	0.2
Stator	**Unwired**	**MOD 3 24v**	**MOD 0 24v**
24-48v	0.5	1.7	0.5
	0.5	1.7	0.5
	0.5	1.7	0.5
Stator	**Unwired**	**MOD3 48v**	**MOD 0 48v**
48-96v	2.0	7.9	2.0
	2.0	7.9	2.0
	2.0	7.9	2.0

Use low wind settings ONLY on LOW WIND Sites - or for higher voltage

Turbine Wind Regime - MOD Settings			
Add Phase and small wire when shown		**nual Average Wind Regime**	
		<12mph	>12mph
Small Wire	Phase Wire	**Low Wind**	**High Wind**
		MOD 3	**MOD 0**
A (Red) with 1st		1+2 only	2+A
B (White) with 2nd		3+4 only	3+B
C (Black) with		5+6 only	6+C
		"O" capped	"O"+1+4+5

Note: 2,3 & 6 should have continuity with "O" when check by Ohmeter Wires 1,4 & 5 should NOT have continuity with "O".

Pre-Assembly Test Two – Static Performance Check

1. Set the multi-meter to read AC voltage in the range of 1-50 volts. 0063
2. Connect the multi-meter to any pair of alternator output wires (e.g. wire one and wire two) and slowly turn the shaft of the generator assembly by hand. A small box wrench on the drive shaft works well. As you rotate the wrench it should feel "bumpy" at low speed and the bumps should all feel the same around a complete slow rotation and seem to smooth out at you rotate faster. If you encounter uneven or higher resistance, even on one part of the rotation, there may be a short or

improperly wired configuration of the windings.

3. Turning at about 1 rev per second the multi-meter voltage should read 50-75% or more of the rated voltage of the turbine (ie 15-20v or more for a 24v system) that confirms general output is possible and wiring is likely correct.
4. Repeat steps two and three for the other wire pairs (i.e. wire one and wire three then wire two and wire three)

Pre-Assembly Test Three – Turbine Grounding Check

5. Set the multi-meter to read resistance (Ohms).
6. Connect one of the multi-meter probes to one of the generator output wires and the other multi-meter probe to the aluminum housing.
7. The multi-meter should read a very high resistance (mega ohm or "OL" for over limit).
8. Repeat steps two and three for output wires number two and three to ensure the turbine's output will not be grounded to the case or tower when installed.

If any of the preceding Tests is unsuccessful, please contact your Authorized LAKOTA Dealer or Zytech Aerodyne directly.

Assembly Stand

To facilitate easier handling of the LAKOTA Wind Turbine during assembly, consider building a simple stand similar to the one shown in the adjacent photograph. This will allow the turbine to be oriented in the normal operating position during assembly which is often more convenient than trying to work on a large flat surface. A stand can be easily made using the mast riser (see the following paragraph) or a length of similar sized pipe mounted on a suitable metal or wooden base. If the stand is 107 cm (42 inches) high the wind turbine blades should clear both the floor and an 8 foot ceiling during assembly. Ensure that the base is large and heavy enough to provide a stable platform for working.

NOTE

The following assembly instructions assume that the LAKOTA Wind Turbine is being assembled on an assembly stand similar to that described in the preceding paragraph and that it is oriented in the normal operating position. If an assembly stand is not being used, extra care should be taken to ensure the correct orientation of installed components.

Pre-Fitting the Wind Turbine to the Mast Riser

The mast "Riser" is the top section of the tower that extends above the top guy wire connection point and is used to provide the standoff clearance between the wind turbine blades and the cables that support the tower. It may or may not be part of a tower kit because it depends on the turbine being installed. For a non-guyed tower, a short mast riser will likely be required to mate the wind turbine to the tower. The LAKOTA Wind Turbine is designed to fit a 2 inch (nominal) Schedule 40 iron or galvanized pipe with an outside diameter of 2.375 (2 and 3/8th) inches and an inside diameter of 2.067 (2 and 1/16th) inches.

The mast riser should normally not extend more than 1.22 metres (4 feet) above the top of the tower due to the large leverage or bending moment produced by the length.The end of the mast riser that mates with the yaw shaft of the wind turbine should be cut and machined flat to ensure a clean square end and must not be threaded. The inside of the pipe may need to be reamed to accurately preserve the 2.067 inside diameter.

A clean square end on the mast riser and an accurate inside pipe diameter will enhance the structural bond between the yaw shaft and the mast riser and make for a quieter running machine. The lower end of the mast riser must fasten securely to the top of the tower and the nature of that coupling will depend on the tower design and whether or not your LAKOTA is equipped with a "C-Clamp" yaw axis or a "Compression Coupler" yaw. Please contact the tower manufacturer or supplier for guidance.

CAUTION

The mast riser must not extend more than 1.22 metres (4 feet) above the top of the tower. A longer than required mast riser increases the risk of structural failure due to increased stress concentration at the bottom end of the mast riser. If the turbine base has the "C-Clamp" style insert the turbine should be fitted to the riser prior to installing the riser on the tower and before the phase wires are brought through the tower. This will ensure that once the phase wires are connected at the top of the tower the turbine will be sure to fit properly since it was pre-filed. The "C-Clamp" yaw axis is designed to be filed lightly to assure an accurate fit even though 2" pipe is not always accurately made everywhere in the world.

A simple solution for an effective mast riser known as the "Rocket Riser" is shown below. The two bolts are threaded into the larger tower pipe and jam the riser to one side to assure a secure attachment. The rocket fins on the riser act as the upper tower guy wire attachment points. The C-Clamp yaw fits inside the riser while the Compression Coupler yaw fits over the open

end of the riser.

CAUTION

The mast riser must be able to withstand a lateral thrust of 900 newtons (200 pounds) at the mast head, approx 250% greater than the LAKOTA in high wind. All tower components and couplings must be sized accordingly.

Fitting of the wind turbine yaw shaft to the mast riser should be completed prior to mating of the mast riser and the tower. This can be accomplished on a bench or utilizing the Assembly Stand if the stand incorporates the actual mast riser. The inside diameter of the mast riser may need to be filed and cleaned to ensure a proper fit. The three fins on the yaw shaft of the turbine may also be filed carefully if necessary to facilitate a proper fit. If you do this in the shop BEFORE assembling on the tower it will make installation much easier. The two yaw axis types are shown below. Note that the C-Clamp type carries a suspension chain while the Compression coupler type has an internal suspension eyebolt to act as a stain relief for the cable hanging below the turbine.

C-Clamp Suspension Chain

Compression Coupler Suspension Bolt

CAUTION

If it is necessary to file the fins on the turbine yaw shaft do so with care. Filing the top portion of the fins can be awkward and there is a natural tendency to remove too much material from the lower portion of the fins while trying to file the upper portion. If the fins are filed excessively, the integrity of the coupling will be compromised and the wind turbine could separate from the mast riser under certain conditions. You want a SNUG fit that is not jammed and one that has a smooth flat fit with the machined top edge of the riser.

Assembling and Installing the Tail

When assembling and installing the tail, it is recommended that the fins be attached to the tail boom prior to attaching the tail boom to the wind turbine generator. To assemble the tail fins, attach the fins and the rectangular spacers to each side of the boom using three M6 x 45 bolts, six M6 flat washers and three M6 lock nuts.

The spacers should be between the fins and the boom and the washers should be on the outside surface of the fins. Do not tighten the bolts. Install the cross brace between the longer fins using two M6 x 16 bolts, four M6 flat washers and two M6 lock nuts. When all five bolts have been installed, gradually tighten them sequentially to symmetrically position the fins and then torque to 11 Nm (8 ft lbs).

To install the tail boom, orient the boom with the longer fins pointing down and the hole in the boom lined up with the corresponding hole in the wind turbine housing. Insert the tail boom into the housing and when it is snugly seated with the holes aligned, secure with an M10 x 70 bolt, two flat washers (one on each side of the turbine housing) and an M10 nylock nut. Torque to 75 Nm (55 ft lbs). Put a drop of medium strength lock tight on each thread.

NOTE

The tail boom fits snugly in the wind turbine housing. Attempt to line up the mounting holes prior to seating the boom. If necessary, adjust or remove the boom using a light twisting force on the tail fins. Use caution to avoid bending or damaging the fins. Make sure the end of the boom tube does not have any sharp burrs that could gouge or jam on the inside of the housing and make it difficult to insert.

CAUTION

If the tail fins are installed upside down (with the longer wing up), the blades of the wind turbine may contact the tail fins and damage the rotor blades as well when the machine tilts back in high wind conditions.

Longbow Tail Fins

The Longbow turbine has longer blades and therefore hasadditional stabilizers added to the standard tail assembly.The standard LAKOTA Tail is inverted and two carbon fiber tail fins are added to the smaller fins with bolts and spacer supplied in the main turbine box.

CRITICAL Assembling the Blade Array (if not preassembled)

Normally this procedure should already be done at the factory and is permanent. Correct installation of the torque ring onto the rear torque plate is critical. In case you receive replacement parts and must assemble it yourself use the following method. Place the torque key in the key slot on the drive shaft and then the hub torque ring onto the generator drive shaft ensuring that the hub torque ring is fully seated on the shaft.

Place the aft hub plate onto the wind turbine shaft, ensuring that the large hole in the centre seats beyond the shoulder of the shaft and carefully aligning the three inner holes of the aft hub plate with the three holes on the hub torque ring. Fasten the aft hub plate to the hub torque ring using three M6 x 12 cap screws with a few drops of permanent (red or green sometimes provided in a small vile) thread locking compound applied to the threads of each screw. Using the 4 mm Allen key (provided), tighten the screws evenly until the aft hub plate is securely fastened to the hub torque ring. Torque the screws to 16 Nm (12 ft lbs).

CAUTION

THIS PROCEDURE IS NORMALLY BE DONE AT THE FACTORY AND SHOULD NOT NEED TO BE DONE BY THE INSTALLER

If the torque ring comes preassembled make sure the drive shaft penetrates the torque ring complete when fully seated on the drive shaft and partially penetrates the rear torque plate as well. This will ensure long and safe operation.

THIS IS A MAJOR SOURCE OF SYSTEM FAILURES DUE TO IMPROPER OUT-OF-SEQUENCE ASSEMBLY DON NOT Use Medium Strength or Blue Loctite. It must be RED or Permanent Loctite.

If the back hub plate is mated to the torque ring before fitting to the drive shaft the aft hub plate can catch on the shoulder of the wind turbine shaft, and when you seat the assembled blade array you may hear a solid clunk as it seats and even be able to torque the hub nut fully. The torque ring however, is still not seated and the blades can work loose with serious damage within days. Always pre-fit the torque ring by itself first. Then add the back hub plate as described above.

Blade Array Assembly

Remove the aft hub plate and torque ring from the wind turbine shaft and it place on a large flat protected work surface, to facilitate blade installation.

CAUTION

Carbon fiber blades can be easily damaged by a hard work surface or improper tool use. It is recommended that the work surface be covered with a heavy blanket or quilted moving pad to protect the blades during assembly. Pre- assemble the entire blade array with the six inner blade bolts torqued to the correct setting before installing the hub onto the drive shaft.

Insert nine M6 x 55 bolts with an M6 washer under the head of each through the nine holes in the hub plate. The head of the bolts and the washer should be on the back of the hub plate – the same side as the hub torque ring. Start by placing one of the hub dampers over the six (6) inner hub bolts and onto the front of the aft hub plate. Note that the outer bolts, for the spinner, are inserted only after the blades are place on the hub but BEFORE the bolts are torqued because they serve mostly to secure the spinner and will be difficult to insert if the bolts are already torqued. Install the blades and front damper and plate onto the torque plate and lightly seat the six (nylock blade bolt nuts).

Then insert the outer bolts. Next adjust the blade's radial tip spacing (as described below) and then torque the inner six nuts. Install this "blade array" when you are ready and then the spinner nuts. This order of assembly is the simplest.

Place the root of three wind turbine blades onto the bolts on the hub plate ensuring that the inward curved face (the concave surface) of each blade will face the direction the wind will come from (windward) . Using the following photographs, identify the trailing edge of the blades and ensure that the blades are mounted so that the trailing edge at the root or hub will be closest to the turbine casing when the blade array is installed. See the right hand photo below. There should also be a small printed sticker on the root of each blade identifying the windward or forward surface to make sure you get

CAUTION

The orientation of the blades is important. If one or more of the blades are installed backwards the wind turbine will not function properly.

Correct blade rotation is clockwise when viewed from in front of the wind turbine looking toward the tail. If the blades are not marked in an obvious way, examine the blade root to ensure that the thick leading edge of the blade is forward (toward the wind) and the thin training edge of the blade is aft (toward the alternator).

Place the second hub damper and the second hub plate over the wind turbine blade array. Install an M6 flat washer and an M6 nylon lock nut on each of the nine bolts but do not tighten. Snug up the inner two lock nuts on each blade but allow sufficient play to enable the blades to move "radially". Just finger tighten the lock nuts on the bolts in the apex holes of the triangular hub plate for now; these bolts are primarily used to attach the spinner and will be tightened in a later step. Adjust the orientation of the blades to ensure that they are exactly 120 degrees apart.

This is best accomplished by measuring the distance between the leading edge of one blade to the trailing edge point of the adjacent blade as shown in the following photographs and adjusting the blades until all three measurements are equal. The blade tips are contoured so take special care to use the same points on the tip for each measurement.

After the blades have been accurately adjusted, tighten each of the six inner lock nuts in sequence to a final torque to 12 Nm (9 ft lbs). Be careful so as not to disturb the radial positioning of the blades. Do not tighten the apex nuts as they will have to be removed to install the spinner in a later step, but be sure they are inserted before torquing the inner bolts or you may not be able to insert them later.

Place the assembled blade array onto the wind turbine shaft with the hub torque ring to the rear. Don't forget to install the torque key. Ensure that the hub torque ring and the aft hub plate are properly seated beyond the shoulder of the wind turbine

generator shaft. When properly seated, the narrow portion of the hub torque ring will be recessed into the front of the wind turbine alternator housing as shown in the previous and adjacent photos.

Once again, ensure that the blade orientation is correct as outlined in the preceding CAUTION and then secure the blade array with the M16 flat washer, and the M16 nylon lock nut. Tighten the drive shaft lock nut while preventing the blade array from turning by holding the root of the blades by hand. While firmly holding the body of the wind turbine, wiggle each of the blades fore and aft and then re-torque the drive shaft lock nut. Repeat this process until the hub torque ring is firmly seated. Torque the drive shaft lock nut to 19 Nm (14 ft lbs). When tightened properly, two to three complete shaft threads should protrude past the drive shaft lock nut.



CAUTION

Ensure that the blade array is fully seated as outlined in the preceding paragraphs. If the blade array is not properly seated, it will loosen despite being correctly torqued and can result in complete destruction of the turbine.

To install the spinner, remove the three lock nuts that were loosely threaded onto the bolts in the apex holes of the triangular hub plate. Place the spinner over the three bolts and secure with the M6 flat washer and M6 lock nut. Gradually tighten the three nuts in sequence to a final torque of less than 8 Nm (6 ft lbs). Do not over-tighten, as this may put undue stress on the nose cone and it may crack or break especially under cold operating conditions. These nuts are only there to hold the nose cone. Over tightening these bolts can actually bend the tips of the front hub plate and result in bending the blade tips out of track by over an inch, resulting in blade vibration and unnecessary noise.

Cold weather installations (below -10 deg C) may require re-torquing after the machine has be outside and acclimated to the sub-zero temperatures. After the alternator and blades have been allowed to cool to ambient temperature (30-45 min), recheck the torques on the hub and blades and be very careful with the spinner nuts since the spinner becomes more brittle at sub-zero and does not tolerate bending in cold temperatures.

Springs Coating

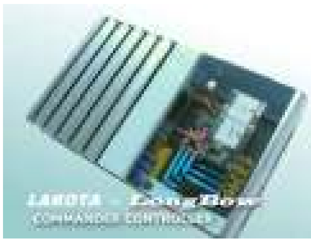
The furling system of the 2006 model are preset on LAKOTA with two "shims" and on the LongBow with no "shim" to assure proper operation of the furling mechanism. The springs are coated with a natural sheep lanolin that should not be handled or removed. Remove the white plastic shipping covers on the lower stabilization bar and tighten the lock nuts on either end.

Installation of Commander

NOTE

Prior to final installation and erection of the LAKOTA Wind Turbine, the other components of the renewable energy system (controller, batteries, diversion loads, inverters etc.) must be installed and wired in accordance with the overall system design and component manufacturer's guidance. As a minimum, the LAKOTA Wind Turbine Control Panel must be installed to ensure that there is a means of preventing the wind turbine from starting when it is first erected. The new LAKOTA Commander control is preferred.

Mounting the LAKOTA Commander



LAKOTA Commander is the current all-in-one control panel incorporating all necessary power management, conversion and diversion load safety circuits in one panel. Simply mount the Commander on the wall, preferably vertically in a well ventilated area, to support the best cooling. Connect the turbine and batteries to their terminal blocks on the Commander, Three phase wires to the blue terminals and POS NEG to the battery terminals.Ensure the circuit breaker on the commander is OFF before making the positive connection.

Keep the battery leads as short as practical to minimize power losses and use wire sizes appropriate to the voltage and circuit breaker selections. An electrician can help you with selecting that right wire. Generally AWG #6 can be used for 24 or 48v systems with the 60A and 30A breakers already installed in the Commander. It is also recommended that there also be an equal sized breaker on your DC Power panel to isolate power from the Commander completely for installation and maintenance.

The breaker on the Commander is mostly for convenience and you don't want to be connecting a "Hot" positive lead when wiring or maintaining the Commander battery terminals. You want to be able to shut off power at the battery side of this wire. For convenience the redundant Commander BATT breaker allows batteries to be isolated at the commander side if it is not co-located close to the battery pack.

Installation of the ORIGINAL LAKOTA Controller/Rectifier Panel or a customer built diversion load is not recommended without consulting Aerodyne Call or visit their website for specifications or further documentation.

CAUTION

Ensure that the circuit breaker used in both cases is higher than the rated power of the turbine. ie for 24v use a slow acting 60A breaker (for 48v use a 30A and for 12 v use a 100A) to ensure that it will not trip under normal high output circumstances. Should either of these breakers trip under normal operating conditions the turbine the LDR must be able to divert all the energy to the resistors. If the LDR were to fail as well then the turbine will become "unloaded" and can seriously over-speed causing major damage to the turbine. These breakers should only trip in response to a short circuit potential fire condition caused by some other fault in the system that is not the turbine.

Setting the Load Diversion Regulator (LDR in the Commander)

As a general rule, the LDR should be set at or above the battery bulk/absorption voltage and the circuit breaker for the diversion load should be opened when charging the batteries from a grid connected inverter charger or other gas/diesel generator, to prevent the unit from diverting energy during charging. Older style LDRs were connected differently and some required voltage sense wires to allow them to work correctly.

Some newer LDRs may still have the small voltage terminal block on them but do not connect them as is recommended on the earlier boards or they will not work correctly and can be damaged. Consult your AERODYNE or LAKOTA Dealer if you are not sure which model LDR you have before making any connections inside the Commander.

LDR Board Setting

Note the small blue diversion voltage adjustment rheostat has Max voltage setting all the way turned to the left and minimum voltage set to the right. The range is approximately the same on all boards 12v range is 13.6-15v 24v range is 27.2-30v range and 48v is 54.40-60v range.

The optimum or ideal setting for this rheostat depends on your system configuration, desired performance and battery type charging recommendations. In general this diversion setting should be higher than normal absorption charge limit of your system as recommended by your battery manufacturer. Most lead acid batteries are often charged at a volt or two higher than AGM or Gel batteries. The LAKOTA LDR is designed to be the "safety valve" for the system and is not normally expected to be the battery charging controller but rather the turbine protection system. When used in simple battery charging systems though, the LDR diversion setting can be the battery absorption limit charge controller. It all depends on your system configuration and how you want the other charging elements (such as solar PV) to behave and how they should interact or NOT interfere with each other.

CAUTION

When first setting up the LDR for Commander or for Original Controller- Rectifiers ensure the LDR is set to MAX setting especially if Solar PV arrays are connected in parallel. If the LDR 'Sees" the PV or a fully charged large battery bank and its diversion voltage setting is below that of the batteries or Solar voltage then the LDR may attempt to dissipate more than 2000 watts and could be damaged. Also, never reattach the 3 phase wires of an operating turbine without the BRAKE switch ON or you could destroy the LDR by introducing a voltage transient that is higher than the design limit of the board. Open circuit voltage of an operating 24v machine can exceed 60-80v.

Installation and Erection of the LAKOTA Wind Turbine

NOTE

This section provides recommended step-by-step instructions for installation of the LAKOTA Wind Turbine on a tilt-up tower. For installation on a non-tilting tower, assemble the tower and wind turbine together on the ground and use a small crane to erect the entire assembly or assemble the wind turbine on the ground and place it on the tower with a small crane. Take time to pre-fit the turbine yaw axis into the mast riser in the shop or on the ground, before any phase wires are installed. This will make the eventual mating of the turbine and tower on installation much easier. Prior to final installation and erection of the LAKOTA Wind Turbine the other components of the renewable energy system (controller, batteries, diversion loads, inverters etc.) must be installed and wired in accordance with the overallsystem design and manufacturer's guidance. As a minimum, the LAKOTA Commander must be mounted in a suitable location with the 'Brake Switch' selected 'ON' prior to installing the wind turbine on the riser or raising the tower.

CAUTION

The LAKOTA Wind Turbine must never be allowed to operate without being connected to the LAKOTA Wind Turbine Control Panel with either the 'Brake Switch' selected 'ON' or a suitable load connected to a working Commander. It need not be connected to a battery bank or other load. If the wind turbine 'sees' an open circuit in the 3 phase AC connection to the Commander, it can over speed, even in average wind, and may severely damage the unit.

Tower Assembly and Test Lift

PRIOR to installing the LAKOTA Wind Turbine, ensure that the tilt-up tower or free-standing tower is assembled and inspected for safety with the Mast Riser installed, and the tower is test raised in accordance with the manufacturer's instructions. Lower the tower and support it at suitable intervals so that the top of the tower is no higher than just over a metre (about 4 feet) above the ground to facilitate installation of the wind turbine. Place the wind turbine head on a bench or table near the top of the tower to facilitate the cable connections.

Installing the Cable Runs

The LAKOTA Wind Turbine must be connected to the LAKOTA Commander with three cable runs (phase wires) or a single cable with 3 conductors plus ground in weather proof casing. The size and type of wire is dictated by the voltage of the wind turbine, the distance between the wind turbine to the

Commander Panel (including the height of the tower), the type of installation (overhead or underground cables), and the local electrical code. Annex A provides some information regarding wire types and the length of cable runs for various combinations of wind turbine voltage, wire gauge, and line loss.

CAUTION

It is the installer's responsibility to ensure that the wire size and type is suitable for their particular installation and that it is installed in accordance with the local electrical code.

To ease the handling of large heavy cables, simplify the installation of the wind turbine on the tower by providing sufficient slack in the cables, it is recommended that a weather-proof 8 x 8 x4 inch deep junction box be installed at the base of the tower, either mounted on the tower itself or mounted near the base as shown in the adjacent photo. Leave an extra 1.0- 1.5meters (~3-4feet) of wire exiting the base of the tower so there is room to make connections in the junction box when the excess cable is pulled back down the tower or when it is pulled up the tower a few feet for servicing.

NOTE

If a tilt tower is used it is helpful to have the Junction Box and the wire exiting the tower both located toward the tilt down side of the tower such that when the tower is lowered the phase wires are not pulled or shorted as the tower is lowered.

Connecting the Cables to the Wind Turbine

At the wind turbine, the cables must be connected prior to the final installation of the wind turbine on the mast riser. Fish the three cables up or down the tower (which ever is most convenient) and leave sufficient cable exposed at the top of the tower (1 to 2 metres (3 to 6 feet)) to facilitate making the connections to the wind turbine. Securely connect the generator output wires to the cables using a substantial connector. The connector must be a minimum of #8 AWG to accommodate the generator output wires; however, a larger connector may be dictated by the size of the wire used for the cable runs. Ensure that the connections are electrically isolated from each other using heat shrink tubing, heavy-duty electrical tape or other materials designed to isolate heavy-duty electrical connections. To ensure the electrical integrity of the cable connections, complete the Pre-Assembly Tests (refer to page

18). In this case, for Test One the multi-meter will be connected to any pair of cables rather than directly to the generator output wires and for Test Two the multi-meter will be connected between the cable and the metal tower or a grounding wire that is common with the mast riser.

Securing the LAKOTA Wind Turbine to the Mast Riser

When the cable runs have been connected to the wind turbine, feed the cables back into the mast riser and slide the wind turbine assembly onto the mast riser until the yaw shaft is fully seated. Simultaneously pulling the excess cable out the base of the tower will make it easier to mate the yaw shaft to the mast riser; however, do not apply excessive tension to the cables. When the yaw shaft is seated snugly, apply some medium thread locking compound to the two M10 x 25 bolts and secure the yaw shaft clamp. Torque the bolts to 58 Nm (43 ft lbs).

LAKOTA Longbow Tower Connection

The LAKOTA Longbow is secured to the riser by a stainless steel compression coupler that fits over top of the 2 1/8th inch OD riser pipe. These bolts should be torqued to 18NM.

Installing Blade Array

Once installed the main hub nut should betorqued to19 Nm (14 ft lbs). When tightened properly, two to three complete shaft threads should protrude past the drive shaft lock nut. Locktite should NOT be used when securing this nut.

After Completion of the Tower Cable Installation

When the LAKOTA Wind Turbine has been securely installed on the mast riser, and before the tower is raised or the blades are allowed to move freely, and prior to connecting the cables at the Commander, it is recommended that Test 2 outlined in Pre-Assembly Tests (refer to page 18) be repeated to ensure the overall integrity of the cable runs. In this case, the multi-meter will be connected to any pair of cables rather than directly to the generator output wires. These readings may not be stable due to the length of cable or the directional movement of the turbine on the tower.

Once the test has been successfully completed connect the cables to the three terminals on the AC input side of the controller-rectifier. For a more detailed discussion regarding the wiring of the Commander refer to the section entitled 'Wiring the LAKOTA Commander' on pgs 29-30.

After the cables have been connected, ensure that the 'Brake Switch' is selected 'ON' and confirm that it is indeed 'ON' by giving the blades a light spin. If the brake is 'ON' the blades will immediately come to a stop within a ½ a turn or less. If the brake is 'OFF' the blades will coast to a stop over a complete revolution at least.

CAUTION

The AC Phase wires from the wind turbine must be connected to the three terminals in LAKOTA Commander. **NEVER** connect the AC wires from the turbine directly to the battery bank or the inverter.

LAKOTA Assembly and Installation Check-List

CAUTION

Assembly of the LAKOTA or LongBow Wind Turbine is now complete; however, the tower should not be raised nor the wind turbine be allowed to operate if installed on a fixed tower until all components of the renewable energy system have been assembled, installed, wired, and tested in accordance with the manufacturer's guidance and the assembly of the wind turbine has been verified using the following Assembly and Installation Check-List. The LAKOTA/Commander combination may be independently tested without the battery by turning OFF the Commander BATT Circuit Breaker.

- Thoroughly review the preceding instructions to ensure that all steps were completed in their entirety, in particular, to ensure that thread locking compound was applied where prescribed, fasteners were tightened to the prescribed torque, and wiring connections were secured and insulated.

- Re-verify that all exposed fasteners are tightened to the prescribed torque (except the nose cone attachment bolts) and that thread locking compound was applied where specified, and NOT on the main hub nut or blade bolts.

- Ensure that the wind turbine is securely fastened to the mast riser and that the yaw shaft clamp bolts have thread locking compound applied and are tightened to the prescribed torque.

- Closely examine the blades with reference to the photograph on page 24 to ensure that they are installed in the correct orientation. The leading edge of a blade pointing at the ground is facing left when you are looking at the turbine from the front.

- Ensure that there is no play in the hub torque plate by grasping the tip of a blade and gently rocking the blade array fore and aft.
- Visually re-inspect the wind turbine, particularly the leading and trailing edges of the blades, to ensure that it was not damaged during assembly.
- Ensure that the 'Pre-Assembly Tests' were completed at the alternator output wires and at the base of the tower and the Commander control panel (refer to pages 15, 27 and 28).
- Ensure that the cable runs are securely connected at the Commander control panel and in the tower junction box if applicable. Check the LDR controller and diversion load is wired correctly. (see pages 27, 28)
- Ensure that the 'Brake Switch' is selected 'ON' and confirm that the brake is indeed 'WORKING' by giving the blades a light spin. They should not rotate more than 1/3 to ½ a turn with the brake ON when given a good spin by hand.
- Ensure that all other components of the renewable energy system have been assembled, installed, wired, adjusted and tested in accordance with the manufacturer's guidance or isolated from the turbine if it is to be tested alone first.
- If using a tilt-up tower, ensure that the tower has been assembled and has been "proven" in accordance with the manufacturer's instructions and test lifted without the wind turbine installed. In lieu of specific guidance from the tower manufacturer, a tilt-up tower with a LAKOTA Wind Turbine installed should ideally be erected when the wind is calm or at most less than 10-12mph.

The LAKOTA Wind Turbine is now ready for operation. If it is installed on a fixed tower, start the machine in accordance with the instructions outlined in the following section entitled 'Normal Operation of the LAKOTA Wind Turbine;'

Normal Operation of the LAKOTA Wind Turbine

WARNING

This section deals only with the operation of the LAKOTA Wind Turbine. Operation of the overall renewable energy system will depend on the design of the system and the specific components installed. To ensure safe and effective operation of the overall system, compliance with the guidance provided by all of the component manufacturers and the local electrical authorities is essential.

CAUTION

The LAKOTA Wind Turbine must always be presented with a suitable load during operation. Prior to starting the wind turbine, ensure that all components of the renewable energy system have been assembled, installed, wired and tested in accordance with the manufacturers' guidance. Presenting the wind turbine with an open circuit will likely cause irreparable damage to the alternator and/or the controller-rectifier. Presenting the wind turbine with an overload demand for power or a short circuit will stall it or prevent it from starting. MOD 3 setting will start in steady wind around 6-8mph. Once started however, the LAKOTA should continue to fly down to 2-3mph if the wind is steady, even though there will be no electrical production.

Setting the Load Diversion Regulator (LDR) Diversion Voltage

Rheostat

Prior to operating the LAKOTA Wind Turbine, the Load Diversion Regulator (LDR) must be adjusted. Refer to the photo on page 27 and note the range of adjustment voltage for your voltage turbine. Normally you will set the diversion voltage to be in the high end of that range near or above the float voltage the batteries will be operating at (ie set 29v when the float voltage is 28.8v) This will ensure the LDR will not divert any energy until the batteries reach at least 0.2 volt above Float. You can quickly check the operation of the LDR by isolating the battery bank (set the Commander battery breaker OFF) and noting the voltage when the green LED is on steady. Turning the blue and white rheostat clockwise will reduce the diversion setting until the small green LDE lights up. You may hear a high frequency hissing sound from the resistors (approx 14kHz) as the diversion begins. Edge wound ceramic resistors may also make a slight "hissing" as they dissipate energy. This is normal.

Starting the LAKOTA Wind Turbine

Prior to starting the LAKOTA Wind Turbine, set the controls of the renewable energy system to ensure that the alternator is presented with a suitable load. That must be a t least a battery connected to the rectifier output as a minimum, and preferably with an LDR in parallel with a resistive diversion load. As well, ensure that a diversion load is available to divert at least 1500W that can be potentially generated by the turbine. If a Load Diversion Regulator is installed, ensure that the diversion voltage is set as described above.

To start the LAKOTA Wind Turbine, select the 'Brake Switch' on the LAKOTA Wind Turbine

Controller-Rectifier Panel to 'OFF'. If the wind is approximately 10 kph (6 mph), the blades should begin to rotate. If the wind is in excess of approximately 12 kph (8 mph) they will quickly gain speed to the point where the wind turbine is delivering power to the load. Once started, the blades will continue to rotate in very light winds below the starting wind speed but the wind turbine will not deliver any significant amount of power because there is simply very little energy per square meter of blade area. (In a 6-7mph wind there is only 16 watts per square meter of energy available in that wind theoretically and the practical maximum you could hope to extract is only less than 10 watts).

Practically speaking you can harvest only 5 or 6 watts per square meter at 6mph. Operations at 20 mph will gather 80-100 times that amount of energy due to the cubed energy formula of wind speed. Put another way, you can get more energy from 1 hour of operation at 20 mph than you can from 30 hours of operation at 6mph.

Stopping the LAKOTA Wind Turbine

To stop the blades from turning, select the 'Brake Switch' 'ON.' The blades should quickly come to a stop, although they may continue to rotate very slowly in a moderate to high wind. In strong winds just below the tilt up governing speed and in very high winds, the braking system may not stop the wind turbine, but it will safely keep the turbine from starting up if it already was stopped when the brake was turned ON. If, after 5 seconds of attempted braking, the rotor cannot be stopped, select the 'Brake Switch' 'OFF' and wait for the wind to die down. You can try this 3-4 times and perhaps wait to "catch it" just as a gust dies down as the blades decelerate. If this fails to work then it is fine to leave the brake OFF and just let it run. Check to make sure the LDR is diverting energy if you are not using it. Turning on useful loads will assist the batteries in shedding load and allow the turbine to not have to work too hard to replace it.

CAUTION

Leaving the 'Brake Switch' 'ON' during high winds with the blades already turning at high speed can destroy the alternator. Only select the 'Brake Switch' 'ON' in light to moderate winds below about 30mph (50kph) to ensure that the wind turbine can be safely stopped without damaging the alternator. If it does not stop within 5 seconds of selecting BRAKE ON, then leave the brake OFF.

When the turbine has already been stopped and with the 'Brake Switch' selected 'ON.' the blades may turn very slowly, but well below airfoil operational speeds, even in very high winds. This is the correct way of placing the wind turbine in a safe non-operational status in almost any anticipated weather of for storage during off season or away periods when energy generation is not needed.

Initial In-Service Tests

When the LAKOTA Wind Turbine is first put into service or after periodic maintenance, various tests are recommended to confirm that it is operating correctly. The specific tests required will be dictated by the overall design of the renewable energy system; however, the following will confirm the operation of the LAKOTA Wind Turbine and Commander or the controller-rectifier.

CAUTION

The following tests must be done with the wind turbine in operation and should be conducted by a qualified installer or electrician. The voltage check and diversion settings test can all be one in the shop prior to installation by using a 10mm socket with a portable hand drill. Place the turbine preferable on it's maintenance stand or simply lying on the bench hooked up to a Commander either with or without batteries. First note the voltage at slow speed and note the voltage when the diversion LED begins to light. Then at full speed (as fast as the hand drill will allow) you can adjust the diversion volts (blue rheostat) control to the desired setting. If you can measure AMPS going to the resistors you may expect to register only 2-3amp for 24v and perhaps 1.5 for 48v. Also Setting LAKOTAs in MOD 1 or 2 (if you know about these settings) is NOT RECOMMENDED and will VOID your warranty

In-Service Test One – AC Voltage Check

To complete this test, the LAKOTA Wind Turbine must be operating in a reasonable wind – 20 kph (12.5 mph) should be sufficient.

- Set the multi-meter to read AC voltage in a range appropriate to the rating of the wind turbine.
- Measure the voltage between any two phases on the input side of the controller- rectifier panel.The voltage will be dependant on the wind speed and MOD setting but the nominal value should be comparable to the rating of the wind turbine. (18-22v for a 24v turbine)
- Repeat step three for the other wire pairs. The three voltages should be essentially equal but may differ between MOD 3 and MOD 0.

In-Service Test Two – DC Voltage Check

- The DC voltage across the DC output of the LAKOTA Controller/Rectifier and "battery" side of the LDR should both read the same as the voltage of the battery bank. If you disconnect the batteries the reading will be that of the diversion setting.
- In gusty wind conditions with a small battery bank the voltage can vary 2-3 volts or more depending on the state of charge. The larger the AH rating and the fuller the battery bank the less variation there should be in voltage under gusty conditions.

In-Service Test Three – Load Diversion Regulator Test

- This test is only applicable for Commanders or if a Load Diversion Regulator (LDR) has been incorporated in the Controller-Rectifier Panel.
- To complete this test, the LAKOTA Wind Turbine should be operating in bench test mode or in a reasonable wind (20 to 25 kph (12 to 16 mph).
- With a small insulated screw driver, lower the diversion voltage setting to the minimum value by turning the adjustment fully clockwise. The light on the LDR will indicate that power is being diverted to the diversion load and if there is sufficient power being diverted, the temperature of the diversion load resistors will increase noticeably within a minute or so. Touching the ceramic resistors will not cause a shock hazard but be careful not to allow jewelry or tools to come in contact with terminals or resistor connections or you may cause a short or spark. In light winds, it may be necessary to measure the voltage across the diversion load to confirm that small amounts of power are indeed being diverted.
- Simply note the voltage across the LDR BATT terminals (as shown on the Commander VOLTS meter) while you change the diversion load setting control (blue rheostat) left to right or right to left. You want the LED to come on and the power to be diverted just above the normal bulk/absorption voltage of the battery bank (consult with your battery supplier for the correct float or bulk voltage. Just two or three tenths of a volt above should be fine. Note that if your batteries are controlled by other sensors or controllers these components may use a temperature compensation circuit which may not show the same voltage as the commander. Better to set the Commander's LDR at least half a volt above other controllers like battery charging equipment or PV controllers. Note also that when diverting, the LDR modulates at around 14 kHz and so the voltage you will read off that side of the terminals, (the Diversion Load terminals) of the LDR board will read less than true RMS voltage, since it is oscillating but the resistors still will get hot and current through them will read higher than BATT terminal readings on the rectifier side.

Periodic Maintenance of the LAKOTA Wind Turbine

The LAKOTA Wind Turbine requires minimal periodic maintenance; however, maintenance requirements of the overall renewable energy system will be a function of the various components incorporated in the system and must be conducted in accordance with the guidelines provided by the various manufacturers.

In-Service Monitoring

When the LAKOTA Wind Turbine is first placed into service, monitor it closely for any indications of abnormal performance and any signs of loose fittings or components; pay particular attention to tower guy wires ensuring that they are all secure and the tensions are correct. Monitor the wind turbine to ensure that it yaws smoothly and aligns itself with the wind; keep in mind that the wind velocity (direction and speed) can vary significantly between ground level and the top of the tower. Listen for abnormal noises or excessive hum or vibration in the tower that could be an indication of loose fittings or components. Put your hand on the tower and under normal conditions you should feel a smooth consistent hum like a new air conditioner.

The tail should not bob or bounce. This is an indication of a poorly balanced blade array. The blade tips are not exactly 180 degrees apart. Refer to page 25 for proper measurement technique. Using a pair of binoculars, inspect the furling springs and ensure that the guy-wire connections are secure. Once in service, the LAKOTA does not need more than an annual inspection. If this is the first turbine you have ever installed, then after approximately one month of service, the LAKOTA Wind Turbine should be thoroughly inspected as per the 'Annual Inspection' outlined in the following paragraph.

Annual Inspection

Annually, or more frequently if installed in a particularly harsh, corrosive or abrasive environment, the LAKOTA Wind Turbine should be thoroughly inspected either by lowering a tilt-up tower or by accessing the wind turbine by climbing the tower or using a crane to get close enough to touch the machine with the brake ON. The following items should be inspected:

CAUTION

Prior to lowering a tilt-up tower or approaching the wind turbine in it operating position, ensure that the system is completely shut down. Refer to Stopping the LAKOTA Wind Turbine (page 34). Isolate the LAKOTA electronically by opening the DC breaker on the Commander.

- Inspect all fittings and components to ensure that they are secure and are not showing signs of wear, weather deterioration or sun damage. If necessary re-tighten any bolts in accordance with the assembly instructions.
- Clean the blades using a clean damp cloth and a mild detergent.
- Optionally, remove the spinner and verify the torque on the drive shaft lock nut. If the torque is less than 19 Nm (14 ft lbs), re-torque the drive shaft lock nut in accordance with the procedure and then reinstall the spinner. If the blade array has no "play" in the hub when you vibrate a blade tip by hand then the hub nut is likely still torqued properly and removing the spinner is unnecessary.
- Check for play in the alternator rotor shaft and the hub attachment by grasping the hub plate of a blade and applying a fore and aft pressure. If there is excessive play, re-verify that the drive shaft lock nut has been tightened to 19 Nm (14 ft lbs). If the problem persists, contact your Authorized LAKOTA Dealer.
- Inspect the furling mechanism to ensure that the eye-bolts are secure and that the eye- bolts and the springs are not exhibiting signs of excessive or abnormal wear. If your turbine is poorly grounded you may see some Aluminum dioxide (black sooty power) around the furling shaft.
- Inspect the alternator casing for signs of damage. If operating an LAKOTA in a corrosive or harsh

ocean environment, inspect the protective polyurethane coating for signs of corrosion and touch up the exposed surfaces using the touch-up paint available from the manufacturer or a good quality, polyurethane paint.

- Inspect the blades for nicks, cracks, or pitting. Minor nicks can be touched up using a good quality, polyurethane paint. Any significant blade damage should be brought to the attention of your Authorized LAKOTA Dealer. Surface cracks on the paint surfaces near the blade root have been noted occasionally but do not present a problem.

Unattended Operation and Extended Dormancy

The LAKOTA Wind Turbine is an ideal power source for battery charging and utility offset for homes and farms, remote locations or seasonal dwellings. It can be operated unattended for extended periods provided that the overall renewable energy system is robust and failsafe. The system must be able to utilize or divert the energy produced by the wind turbine on a continual basis and in the event of a component failure the system must continue to divert the energy to the diversion load. Obviously, the physical installation must be able to withstand the full range of wind speeds that will occur during the period of unattended operation.

CAUTION

During operation, the LAKOTA Wind Turbine must always be presented with a suitable load and can be severely damaged if the alternator experiences an open circuit either before (on the AC) or after the rectifier (on the DC output). There is always an increased risk associated with unattended operation, due to the reduced opportunity for operator intervention, in the event of a component failure that results in an open circuit.

For unattended operation, provisions must be made to complete the LAKOTA Wind Turbine annual inspection outlined in the previous paragraph and to lower the wind turbine if the winds are forecast to approach 160 kph (100 mph) (refer to the Caution on page 11). Please note that other system components such as batteries or inverters may require more frequent inspection and/or periodic maintenance – refer to the applicable manufacturers' guidance.

The LAKOTA Wind Turbine can be shut down and left dormant for an indefinite period. Simply select the BRAKE SWITCH ON so that the blades can rotate but is not allowed to "Fly" and shut down other system components in accordance with the applicable manufacturers' guidance. Although not necessary, to avoid all wear and tear during periods of extended dormancy, the LAKOTA Wind Turbine can be removed from the tower and stored in a clean, dry environment.For remote operations the turbine may be left running continuously as long as it has and assured storage medium and the correctly adjusted LDR controller and diversion load. A LAKOTA turbines under test at the FREE wind

Test Centre in Ontario Canada runs continuously (for nearly 4 years now) with only the LDR controller, resistors and a small capacitor bank instead of a battery with only an annual inspection. With no battery and no inverter and no other loads all energy is consumed by the resistors and the turbine flies under control at all times with no attention or other control. This confirms that with the proper load control, even if all other systems fail, the turbine can be safely operated for extended periods without supervision.

Annex A – Wire Types and Sizing

The following Table provides information regarding the maximum amperage capacity of insulated conductors according to the United States National Electric Code. The Canadian equivalent designations are similar and available on the web.

Size	Temperature Rating of Conductor/System Wires		
	60 ºC	75 ºC	90 ºC
	(142ºF)	**Types:**	**Types:**
AWG or kcmil	TW, UF	FEPW, RH, RHW, THHW, THW, THWN, XHHW, USE, ZW	TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2
	Copper Conductors/System Wires (Amps)		
18	-	-	14
16	-	-	18
14	20	20	25
12	25	25	30
10	30	35	40
8	40	50	55
6	55	65	75
4	70	85	95
3	85	100	110
2	95	115	130
1	110	130	150
1/0	125	150	170
2/0	145	175	195
3/0	165	200	225
4/0	195	230	260

Cable Selection For Various System Voltages

The length of wire used for a typical turbine tower and in inside installation is from 50 up to 300 ft (15-100m) using 3 phase wire to carry the "wild" AC power from the turbine to the Commander. Shorter distances carry the DC current from the Commander to the system DC disconnect that is usually much closer 6-10 feet (2-3 m) and co-located with the batteries.

AC power (with 3 conductors) experiences less line loss than DC power cables and so does not need to be as large. On the AC side typically 6/3 AWG#6 wire can be used with limited line loss in most applications for towers up to 75ft (20m) and a Commander located 50-100 ft (up to 30 m) from the tower. Larger and multi-stranded wire will always provide lower resistance but eventually the cost of the wire becomes the deciding factor. Twelve volt systems may benefit from larger wire but these systems tend to be used in smaller (under 2kW system power) systems.

On the other hand, the much shorter DC connections should consider the charts below.

Line Loss For LAKOTA Wind Turbine Generator 12V, 24V, And 48V System oltages At 1300 Watts Of Power

12 Volts		24 Volts		48 Volts		Multi-strand Wire	
Distance up to, **2% loss**	Distance up to, **4% loss**	Distance up to, **2% loss**	Distance up to, **4% loss**	Distance up to, **2% loss**	Distance up to, **4% loss**	Recom-mended size	Resistance per 1000 ft
2.5 m	5.1 m	10.2 m	20.4	40.9 m	81.8 m	#4 (420/30)	0.264 Ω at 25mm²
4.0 m	8.0 m	16.1 m	32.3 m	64.6 m	129.3 m	#2 (665/30)	0.167Ω at 35 mm
5.0 m	10.1 m	20.3 m	40.6 m	81.2 m	162.4 m	#1 (836/30)	0.133Ω at 50mm
6.4 m	12.8 m	25.7 m	51.4 m	102.9 m	205.7 m	#1/0 (1046/30)	0.105Ω at 50mm
8.04 m	16.08 m	32.1 m	64.3 m	128.6 m	257.2 m	#2/0 (3325/34)	0.084Ω at 70mm²

Line Loss For LAKOTA Wind Turbine Generator 12V, 24V, And 48V System Voltages At500 Watts Of Median Power

12 Volts		24 Volts		48 Volts		Multi-strand Wire	
Distance up to, **2% loss**	Distance up to, **4% loss**	Distance up to, **2% loss**	Distance up to, **4% loss**	Distance up to, **2% loss**	Distance up to, **4% loss**	Recom-mended size	Resistance per 1000 ft
6.6 m	13.3 m	26.6 m	53.2 m	106.4 m	212.8 m	#4 (420/30)	0.264 Ω at 25mm²
10.5 m	21.0 m	42.0 m	84.1 mc	168.2 m	336.4 m	#2 (665/30)	0.167Ω at 35 mm
13.2 m	26.4 m	52.8 m	84.1 m	211.2 m	422.4 m	#1 (836/30)	0.133Ω at 50mm
16.7 m	33.4 m	66.8 m	133.7 m	267.5 m	535.0 m	#1/0 (1046/30)	0.105Ω at 50mm
20.9 m	41.8 m	83.6 m	167.2 m	334.4 m	668.8 m	#2/0 (3358/34)	0.084Ω at 70mm²

Annex B – LAKOTA Turbine/Tower

Checklist and Installation Overview

CAUTION

Please consult with a knowledgeable Dealer/Installer or electrical contractor before purchasing components, attempting system design or layout of components and particularly before installing or connecting the tower or electrical components such as inverters and batteries. Failure to do so can result in destroyed components that are not covered by the warranty and possible injury to yourself or others.

WARNING

DO NOT connect electrical components based strictly on this manual. Consult a qualified lectrician f systems design expert before attempting to install towers and especially high voltage (120/220v) electrical components such as inverters and grid connected systems. Failure to do so could cause erious injury or death.

Install LAKOTA Turbine Head Assembly (Final Checklist)

- Power cables connected and shrink-wrapped
- Continuity checked at the tower base and at Controller-Rectifier/Commander
- Strain relief attached, secure and is adjusted shorter than the electrical cables
- Head Assembly "C-Clamp" is secure, with added rubber gasket and/or set screw through the C-clamp and mast riser. Lots of lock tight in appropriate places
- Hub nut blade array and tail assembly nylock nuts, all have been torqued roperly. Spinner nuts secure not too tight. (over-tightening may crack spinner)
- No hub play (by gently moving the blade tip back and forth)
- Visually inspect the blades and alternator casing one last time, for damage that ay have happened during installation or improper (backward) blade installation. Blade bolts go on from back to front with nuts in front.
- Blade spin test confirms free movement to rotate. Confirm the brake is working and is ON
- Wind less than 5-10 mph or preferably calm for tower lifting
- READY to LIFT TOWER or POWER UP if in position and there is sufficient wind.

Annex C – LAKOTA Wind Turbine Trouble-Shooting

LAKOTA Wind Turbine is not working and/or the Blades are not turning!

Are you sure the Blades are mounted correctly?

Is enough wind at your tower site? Estimating wind speed at higher altitudes is difficult and you may have to compare your wind speed with tree tops or equivalent at the same height. Is the turbine in clean air or being buffeted but turbulence and constantly seeking?

Did this step solve your problem?

Yes

NO

Repeat Wind Turbine System Checks Test 1 and Test 2 without the 3 power cables from your wind turbine connected to the Controller-Rectifier.
Verify Test 2 with one lead of the Multi-meter connected to the power cable of the wind turbine and the other end to the tower structure itself.

Did this step solve your problem?

Yes

Yes, You may have a short in the controller

NO

Check that the 'Brake Switch' is in the OFF position
Disconnect two of the three Wind Turbine input wires from your Controller or Commander for a few seconds and see if the turbine starts rotating.

Did this step solve your problem?

NO

If your LAKOTA Wind Turbine is configured for low wind speed performance or higher system voltage configuration and you performed the modification yourself, re-check to determine that no errors in wiring were made.

Did this step solve your problem?

Yes

NO

You may have a failed rectifier diode. Contact your authorized AERMOAG technical support for how to bench test your Rectifier and/or replace a faulty diode or take your controller to an authorized LAKOTA Service Centre to have checked.

Did this step solve your problem?

Yes

NO

Contact Zytech Aerodyne at
+34-976-141819 or info@zytechaerodyne.com .

Done

Annex D - LAKOTA Wind Turbine Warranty Notes

The Standard and Optional 3 Year Extended Warranties do not cover

1. Damage resulting from negligence, accident, misuse, abuse, or neglect.
2. Damage resulting from failure to follow instructions supplied with the product.
3. Damage resulting from repairs or the substitution of assembly parts by anyone not authorized by Aerodyne.
4. Damage occurring during shipment of the product.
5. Damage to any unit which has been altered or on which the serial number and/or model number has been altered or removed.
6. Damage to or deterioration of the external housings due to excessive, severe, atmospheric degradation from extreme and unusual environments that require exceptional maintenance and refinishing service.
7. Damage caused by neglect and or failure to service when the required annual inspections is due as required by the unit's Owner's Manual.
8. Damaged if improperly connected to the equipment of other manufacturers.
9. Voltage or MOD adjustments to the product as outlined by the Owner's Manual.
10. Cost incurred for de-installation, re-installation and shipping of the product for service.
11. Products damaged by or due to improper or inadequate packaging when returned for warranty service or repair.

The Standard and Optional Extended Warranties are void if the product is

1. Damaged as a result of incorrect assembly, misuse, abuse or accident.
2. Utilized in an unauthorized commercial or rental application.
3. Modified or repaired by anyone not authorized by ZYTECH AERODYNE.
4. Damaged caused by improper use with or connection to the equipment of other fabricators, manufacturers or unqualified installers.

Return Authorization and Carry-In Service

If you experience a problem with your LAKOTA turbine at any time during the STANDARD WARRANTY period, contact your nearest Authorized LAKOTA Dealer or contact ZYTECH AERODYNE Service Centre directly, at (86) 532-86623611 or info@zytechaerodyne.com to determine the nature of the problem.ZYTECH AERODYNE Service Centre will issue a Return Authorization (RA) number to return the turbine or send you the necessary replacement parts. This warranty is VOID if the warranty card (or at least page 9) is not returned to ZYTECH AERODYNE within 90 days from the date of purchase, together with a readable copy of the original purchase receipt. If you did not receive a warranty card with your LAKOTA please send a copy of page 9 when filled out.

Note: The customer must identify the installer of the turbine or this warranty card will be annotated as "Customer Installed" and the customer thereby accepts responsibility for any and all handling damage or errors in installation. Handling damage or failures caused by improper installation, reconfiguration or customer maintenance of the LAKOTA are NOT covered by this warranty.

You are encouraged to retain and use the original shipping container in case of warranty return in order to ensure the unit is not damaged in shipment.

Torque Settings - Quick Reference

	Newton Metres	Foot Pounds	Inch Pounds
Main Hub Nut	19	14	168
Torque ring screws	16	12	144
Blade Array Inner Nuts	12	9	108
Blade Array Spinner Nuts	<8	<6	<72
Yaw Shaft C-Clamp	58	43	516
Tail Fins	11	8	96
Tail Boom	75	55	660

NOTES: You are encouraged to download and read "Daves Notes" v 1.8 or higher, from the www.truenorthpower.com/Downloads.htm website. This document is updated regularly with hints and tips on installing and operating the LAKOTA wind turbine and may save you some grief by avoiding typical mistakes **made by first time installers.**