TRUE NORTH POWER NG

WIND ARROW

Installation and Owner's Manual

NA Version 1.62E

WARNING

Small Wind turbines can be easily damaged by incorrect handling, assembly, installation, or use. Also, installation, erection, and maintenance of the Small Wind turbine involves work with steel towers and electrical components, both of which can be extremely hazardous. Prior to assembly, installation, erection or maintenance of the 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 must be conversant with rules, regulations, and bylaws applicable to the local regulatory authorities.

Failure to read and understand this Owner's Manual can be dangerous and may void the Warranty.

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EU DECLARATION OF INCORPORATION
WITH
COUNCIL DIRECTIVE 98/37/EC

Date of Issue:	August 2008
Document #:	WIND ARROW 1kW NA V1.1E (English)
Directive:	Machinery Directive on machinery safety, 98/37/EC
Conforming Machinery:	**Wind Arrow (WIND ARROW)** Model WA1-C-A Serial # (see duplicate sheet included with each Turbine)
Manufacturer:	**True North Power NG Inc.** 53 Northumberland Street Ayr, Ontario N0B 1E0 Canada
Authorized Representative:	David G Cooke Address (as above)
Harmonized Standards Referenced or Applied:	BS EN ISO 12100-1:2003, BS EN ISO 12100-2:2003, BS EN 60204-1:1998, BS EN 61310-1:1995, BS EN 61310-2:1995
Specifications with which Conformity is Declared:	Essential Health and Safety Requirements of Annex 1 of the Machinery Directive
We hereby declare that the machinery described above is intended to be incorporated into other machinery and must not be put into service until the relevant machinery into which it is to be incorporated has been declared in conformity with the essential health and safety requirements of Council Directive 98/37/EC on the approximation of the laws of the Member States relating to the safety of machinery.	
Signed:	
Signatory:	D G Cooke, (CTO) Chief Technical Officer

ESA is an accredited agency in Ontario, Canada and is recognized across North America.

CE

Each turbine and AFC Controller carries both CE and Ontario ESA Certification

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Disclaimer

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It is the responsibility of the user to ensure that the WIND ARROW 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 the manufacturer or the distributor. The entire risk for the use of, or results from, this document remains with the user.

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Introduction

The WIND ARROW turbine is a state-of-the-art small wind turbine designed for use in battery charging, or air or water heating applications. This turbine features remarkably light and quiet Carbon Fiber blades, a three-phase "Wild-AC" permanent magnet "Y" alternator, and an Active Flight Controller (AFC™) which incorporates an SOS mode, a rectifier module, and may also incorporate a load diversion relay as an option. A 6 diode bridge rectifier converts the alternating current (AC) output of the alternator to 24 or 48 volts direct current (DC) depending on the software installed. The AFC™ can also divert excess power to a resistive load when the wind is strong, the demand for energy is low and the batteries are fully charged. Between 30-60mph the AFC firmware will change to Soft Stall Power mode to control the output of the machine within safe levels. If the wind continues to exceed about 60mph the SOS mode (Storm Otto-Shutdown) is activated by software and the turbine is shut down for about a 6hr hour time-out period, before being allowed to restart. The operator can also choose override the controller using a manual RESET at any time.

The light-weight, low-inertia design ensures excellent low-wind-speed and gust performance, and also allows for effective electromagnetic braking of the rotor under storm conditions using the 25Amp (manual and automatic) "normally closed" relay as a brake switch. This safety relay must be energized in order for the turbine to run. Without energy to this relay the turbine will not start in winds exceeding 100km/hr (60mph). The turbine has a rated power output of over 950 watts at 25 mph and a peak power output in excess of 1200 watts or more in higher winds. Unlike other small wind turbines the WIND ARROW, with the advanced controller, needs no mechanical furling mechanism and so has over 40% fewer parts than other similar sized machines. This makes it much more reliable. All models have a clear satin anodized surface to prevent corrosion but are internally identical, with sealed bearings and a sealed alternator unit that does not need greasing or to be opened for normal maintenance.

Specifications and Features

- **Rotor Diameter** – 2.0 meters (78.9 inches)
- **Swept Area** – 3.14 square meters (33.8 square ft)
- Weight – less than 17 kilograms (~38 pounds)
- **Rated Power Output** – 950 watts at 11.2 meters/second
- (40.2 km/h) (25 mph)
- **Peak Power Output** – 1200 watts at 14.0 meters/second
- (50+ km/h) (30+ mph) 100-500W from 30-60mph.
- **Start-up** – 3.5 meters/sec (13 km/h) (<8 mph)
- **Charging** ~4 amps at 24 volts at 4.5 meters/sec (16 km/h) (10 mph)
- Aerospace grade, carbon fiber blades – very stiff and so VERY quiet.
- Aluminum extrusion body, Fully anodized, with all stainless steel hardware
- 3 phase "Y" alternator.
- Rare-earth neodymium iron boron permanent magnets.
- Adjustable software and pitch to match turbine performance to low or high wind regimes
- WIND ARROW has light grey, highly durable "gel-coat", that provides additional protection in harsh, marine, arctic or corrosive environments.
- Optional leading edge tape for the blades can be used in desert or corrosive environments

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Warnings, Cautions, and Notes

Installation, erection, and maintenance of the WIND ARROW 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 Electrical Contractor, familiar with renewable energy systems and components. Specifically, installers must be familiar with battery management, high amperage DC power circuitry, and local electrical codes. In all cases, prior to assembly, installation, erection, or maintenance of the WIND ARROW turbine, individuals 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 damage, serious injury or death.

CAUTION
Hazards or unsafe actions or conditions 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 WIND ARROW turbine. Some appropriate safety considerations are:

- ✓ Plan your work before doing it. Read this entire manual at least once first.
- ✓ 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 hat 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.

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Package Contents and Inventory

The following paragraphs provide a detailed list of components included with the WIND ARROW 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 WIND ARROW Dealer. Have the model number, serial number, and original purchase receipt available. Refer to the Identification Section (write these key numbers on page 8 and then email the page to True North Power NG for additional information regarding the model and serial numbers.

CAUTION
When removing the WIND ARROW Turbine from the packaging, pick it up by the body not the wires coming out of the bottom of the compression coupler. Lifting the wind turbine by the black phase wires may damage the internal connections and may cause the unit to malfunction. Always lift and carry the unit by grasping compression coupler or the main housing or both.

WIND ARROW Turbine Ships in Three (3) Cartons

SHIPPING WEIGHT: 15.1kg - 33.35lbs

BOX 1- TURBINE HEAD 18 X 12 X 8 DOUBLE WALL CORRIGATED	
COMPONENTS	QTY
Nose Cone	1
Vertical Stabilizer	1
Horizontal Stabilizer -Left	1
Horizontal Stabilizer - Right	1
Tail Brace	1
Turbine Head Assembly	1

SHIPPING WEIGHT: 6.36kg - 14.0 lbs

BOX 2- CONTROLLER 12 X 12 X 8 DOUBLE WALL CORRIGATED	
COMPONENTS	QTY
Complete AFC controller	1
Manual	1

SHIPPING WEIGHT: 4.8kg - 10.6 lbs

BOX 3- BLADES 48 X 6 X 6 SINGLE WALL CORRIGATED	
COMPONENTS	QTY
Tail Boom	1
Blades with foam sleeves	3
Front Hub Plate	1
Rear Hub Plate with Torque Ring	1
Puller Plate	1
Upper Tail Block	1
4" Hardware bag containing:	
M16 Low Head	1
M16 WASH	1
M16 LOCK	1
M5 x 8 BHCS	3
M6 x 16 HHCS	2
M6 x 40 HHCS	4
M6 WASH	12
M6 NUTL	18
M6 x 60 HHCS	4
M6 LOCK	4
M6 x 80 HHCS steel	3
M10 x 50 HHCS steel	1
M6 NUT steel	3
M6 x 55 SHCS	6
M6 x 70 SCHS	6

Identification and Markings for Warranty Registration

This is key information you may need in the future. All WIND ARROW Turbines are identified by a Model / Serial Numbers beginning with WA1 followed by a series of characters stamped on the lower extrusion housing as shown in the photo below. European models are exclusively distributed by True North Power NG of Ireland. The serial number will be required in the event of a warranty claim and should be recorded on the next page in the same way they are recorded on the Warranty Registration Cards packaged with the documentation of each unit. The original bill of sale will also be required and therefore should be attached to the following page and kept in a safe place for future reference.

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Warranty Registration Page: Attach your bill of sale or invoice to this page and store in a safe place

Model/Serial Number	WA1 - C - A -
AFC and Brain Board	AFC-1-A- AFB-1-A-
Blade Serial Number	WAM2 -
Blade Serial Number	WAM2 -
Blade Serial Number	WAM2 -

Purchase Date: _____

Purchased From: _____

Address: _____

City: _____ Province: _____ Postal Code: _____

Country:_____

Phone: _____ Email: _____

Installation Date: _____

Installed Location: Address: _____

City: _____ Province: _____ Postal Code: _____

Country:_____

Installed By: _____

Address: _____

City: _____ Province: _____ Postal Code: _____

Country:_____

Phone: _____ Email: _____

Extended Warranty Purchase Date: _____

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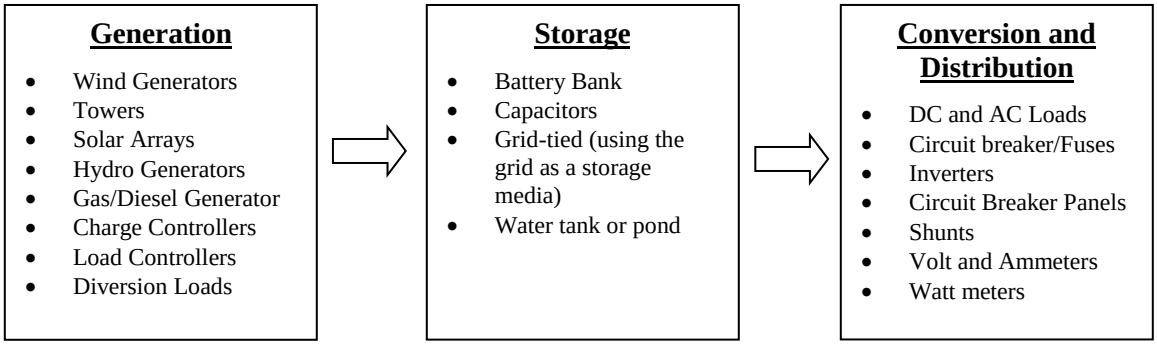
Planning Your Project

Installation of the WIND ARROW turbine 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.

A renewable energy system consists of three main systems – 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.



This manual focuses primarily on the generation component of the renewable energy system and specifically for the WIND ARROW 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. Wind speed increases dramatically with height especially close to the ground so any increase in height above about 7meters can produce significantly more energy annually than below that height. 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 be to site the wind turbine where the wind is the strongest but also where smooth laminar flow air can be assured, ideally in 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, to some degree, by increasing the height of the tower.

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As a general rule, a wind turbine should be installed 10 metres (30 feet) above any object within 100 metres (300 feet) of the tower. Also, you should create a local "wind rose" available from a wind atlas. ie determine where is the dominant wind direction and what obstacles are up-wind of a proposed tower location in that sector? If you are familiar with "google earth" you can place a graphic of the wind rose over the proposed site and make it transparent so you can see what terrain or obstacles are up-wind in the dominant direction(s). To further complicate the decision process, site selection and tower height must also consider the incremental cost of a taller tower, increased line losses as well as cost of the wire which increases 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 visual preferences all warrant consideration. In the end, site selection is always a compromise of many factors. Contact your Authorized WIND ARROW Dealer for further guidance or attend one of their Wind & Solar Hybrid Systems Workshops held several times a year.

Tower Selection

The WIND ARROW 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 approx. 900 newtons (200 pounds) at the "riser" or mast head. This is a tower requirement. The actual lateral load produced by a WIND ARROW in very high wind is less than 100lbs since it will be shut down automatically before that wind speed. A tower and mast riser are separate components and not part of the WIND ARROW Turbine; however, True North Power NG also offers excellent, high quality, low cost, tilt-up, galvanized sleeve coupler tower kit suitable for most applications. For additional information regarding towers, please contact your Authorized WIND ARROW Dealer. For a detailed description the mast riser options refer to the Assembly Section on page 18.

CAUTION

In a 160 kilometer per hour (100 mph) wind, the lateral thrust imparted at the top of the tower by the WIND ARROW Turbine is approximately <360 newtons (<100 pounds) because it will be shut down. To ensure an adequate margin, select a tower that is designed to withstand at least 900 newtons (200 pounds) of lateral force at the masthead; this is more than twice the maximum design thrust of the WIND ARROW Turbine. Due to the lack of mechanical furling design much of the "lateral thrust" at the top of the pole is not present above 40mph because the AFC controller will slow normal flight of the blades. Notwithstanding the turbine's safety margin, and Storm- Otto-Shutdown "SOS Mode", you should consider turning off the turbine before major wind events if the winds are forecast to exceed about 80 km/h (50 mph) to prevent excessive wear or damage. If forecast to exceed 150km/h (90mph) consider lowering the tower to protect the system from flying debris.

WARNING

Installation of towers can be extremely dangerous for the inexperienced installer 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 turbine.

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WARNING
Do not approach an operating turbine within 3 meters radius sphere (20ft diameter ball). Always stop the turbine by unplugging the power supply wall plug, selecting OFF "O" on the FLY/OFF Switch or disconnecting the battery breaker before lowering or climbing the tower it is mounted on or before using a crane or ladder to approach the turbine for maintenance or to do inspections.

System Voltage

The WIND ARROW Turbine can be used to charge 24 or 48 battery packs or, in case of the DIRECT2HEAT version, provide power directly to a 48v resistive load (water/air heater) with no battery or inverter required. Determining the appropriate voltage for a particular installation is a function of both technical and economic factors as well as the peak power current, wires size and protective breakers needed. The 48 volt systems require more battery cells thus usually increasing the overall cost of the installation. Lower 24 volt systems are impacted more by line losses and the high current flow produced that requires different components and larger wire to handle the larger current. For example, 24 volt systems may be a poor choice when the wind turbine is located a significant distance (>100-200ft) from where the power will be used or if the maximum demand for power from the inverter system is be over ~4-5kW. A qualified WIND ARROW dealer may be able to assist in selecting the appropriate voltage for your specific installation.

Optimizing the Performance of the WIND ARROW Turbine's AFC Controller

WIND ARROW Turbines are shipped as 48v stators and the AFC controller is configured to provide the voltage and current needed or available to feed either a 24 or 48v battery pack or a 48v water heater element. All AFC controllers operate on ~ 2watts, either from a wall adapter or battery pack if used. Provisions are made in software to allow the user to optimize the turbine's production for low wind or high wind locations. As well, the SOS time-out period is preset to 3 hour delay but can be can be set from 1 to 24hours on special order. Changes require only the replacement of the control chip and all AFC controllers can be configured to work with all configurations of software.

CAUTION
Do not attempt to make configuration changes to the controller without the approval of True North Power NG. Incorrect configurations can damage the controller and or other equipment attached to it and VOID the warranty. Please consult your authorized True North Power NG Dealer installer if you think the configuration is wrong for your system.

Diversion Loads

The AFC controller can be made to run a diversion load such as an AIR heater as well as a connection to a low voltage water heater (supplied separately). Alternatively you may choose to charge a second battery bank or activate a separate inverter to use excess power. The heater and relay are not part of the AFC standard configuration but the ability to control one is built in.

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The diversion load should be able to continually dissipate all of the maximum instantaneous power produced by the wind turbine. Theoretically, any system diversion load can be installed on either the DC side at the rectifier (before the inverter) or AC side (after the inverter) usually at 120v AC; however, an AC diversion loads cannot protect the turbine in the event of an inverter failure.

The WIND ARROW requires at least 1800 watt diversion load to ensure an adequate margin of capacity in all possible operating conditions. The resistance (in ohms) of the diversion load is also critical and is a function of the maximum operating voltage; specifically, the voltage at which power will be diverted to the diversion load as determined by actual resistance of the load you are diverting to.

If you wish to employ such a diversion load we recommend that you use a pair of edge wound ceramic resistors mounted in a properly vented metal enclosure or some other simple heating device to dissipate excess energy. Alternative low voltage devices such as, air or water, heating elements may be suitable diversion loads provided they are highly reliable and of the correct resistance and power dissipation. For additional information regarding diversion loads, contact you Authorized WIND ARROW dealer/installer.

Battery Bank

A renewable energy system which uses the WIND ARROW Turbine as a source of power generation normally charges a battery bank of the same nominal voltage of 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. However they require a regular maintenance schedule in order to remain in good condition. Lack of maintenance (checking water levels, checking specific gravity and regular equalization are the chief causes for battery failure or poor performance. Absorbed Glass Matt (AGM) or Gel batteries require little or no maintenance and cost more per stored watt but they are more convenient since they require only regular inter-cell voltage checks.

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 WIND ARROW Dealer. Over sizing the battery bank results in unnecessary expense and poor charging; under-sizing the battery bank results in inadequate storage capacity and wasted energy produced by the system.

Power Conversion

The WIND ARROW is a “Y” alternator based system which produces only 48 volt “Wild AC” power. “Wild” because it’s voltage, current and frequency changes dynamically as the wind speed changes. The AC power coming from the turbine in three wires is rectified or changed to a pulsed DC current (now two wires) by the AFC Controller and the “Smoothed-Pulsed DC” output of the controller-rectifier is used to charge or “pump” energy into a 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 but the turbine “gas pump” has a limited rate it can fill your battery bank. But, much larger amounts of energy can be drawn directly from the batteries to power low voltage DC loads or by using an inverter. The inverter can convert energy stored in the batteries to 110/220 volt AC in order 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

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stored electricity as fuel to run your appliances and lights at whatever rate you choose up to it's limit of "peak power " of the inverter. See your inverter manual for that number. The bigger the inverter and the more often you use it, the higher demand for energy and the faster you drain your gas tank.

NOTE

The determining factor on what you can run with your turbine is not necessarily the turbine itself but rather the peak or continuous rated power of the inverter and the size of your battery bank, and how you operate your electrical demand. You may be able to run your whole house for some considerable period even when the wind is not even blowing but the real question is how fast is your engine (inverter) using the stored energy and how long will it take to empty the tank (battery) or refill it?

When you talk about "will this turbine run my house?" you are really asking, "does this turbine produce more energy than I use on a monthly basis", and that is a complex calculation based on, not just on what electrical loads you have but how much or how often you use them and the size of your turbine's blades (cross-section), the amount of storage you have (Battery size) and the type of wind environment your turbine is in. It even comes down to where and how tall your tower is, because every height and every site is different for the same turbine. Going from 30 to 60 feet in height you may expect to capture as much as 40% more energy with the same turbine. 100kWhrs on a 30ft tower or 140kWhrs on a 60ft tower in the exact same location. It just starts sooner and runs longer.

A detailed discussion of power conversion options and the equipment available is beyond the scope of this manual. Consult with your Authorized WIND ARROW Dealer to determine the size, type and options of the equipment most appropriate for your installation or attend a wind and solar workshop.

Wiring from Turbine to Controller

Wiring requirements for the WIND ARROW Wind turbine are dictated by the voltage of the wind turbine, the distance between the wind turbine and the AFC 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. Correct sizing of the cable is important to ensure that the line losses are within acceptable limits while at the same time minimizing the cost of the wire and conduit. 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. The WIND ARROW AFC controller will protect itself from this condition.

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The rectifier module converts the variable frequency alternating current (Wild AC) from the wind turbine to 24 or 48 volt direct current (DC) that is then used to charge batteries or heat water or air.

In other applications, the WIND ARROW Turbine will be used in conjunction with Solar PV and a battery bank as part of a hybrid renewable energy system. In case of very high winds above 40mph the ACF controller may produce 500w or more and automatically shut down the turbine to protect it from damage if the gusts are too strong.

CAUTION
Always consult a qualified electrician before selecting those components. Proper selection of these critical components will also ensure compliance with local electrical codes that vary widely from country to country and state to state. The manufacturer recommends using at least #6AWG NMWU of distances longer than 100feet or 30 meters.

WARNING
Improper wire selection and selecting incorrect circuit breakers can create unsafe, hazardous and dangerous conditions that can result in fire, mechanical injury, physical injury or death. Consult a code qualified electrician in your local jurisdiction.

Note that it is AC power running in the phase wires between the wind turbine and the AFC control panel. AC line losses are less than if it were DC power (as in some other turbines) so wire sizes do not have to be as big as you might select for the DC power going from the AFC or solar controller to the Batteries. True North Power NG recommends the use of at least #8 AWG multi-strand copper wire or even marine grade multi-filament, plain 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 a copper or aluminum wire Energy Losses Table or your Authorized WIND ARROW Dealer or an electrical contractor who is familiar with your installation. Annex A provides information regarding wire types and the maximum length of cable 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 WIND ARROW Dealer, the manufacturers of other system components, the designer of their overall system, and

Lightning Arrestor

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the requirements of the local electrical code for more detailed information regarding the need for, and installation of lightning protection in their area.

CAUTION
Basic principles of lightning protection for residential installations usually 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 from the guy wires and the tower itself to ground in order to minimize the damage from a lightning strike. If your home already has a central grounding point then by default adding a tower that is grounded outside, violates this rule of not allowing a second grounding point. Consult a qualified electrician in your area. Both the DC power panel and the AC power panel should have their own separate and appropriate lightning arrester

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 each other. Doing so may allow large voltage differentials to exist between multiple grounding points during a nearby lighting strike or stray voltage. However, the phase wires coming from the turbine to your AFC controller and the batteries is still there as an alternate path for lightning so it is impossible to conform to the standard electrical code "one ground point for the house rule". Others say that they should be joined to a common ground. Lightning arrestors provide an easy 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. This base of the tower connection makes a handy lighting arrestor connection point and an also serves to allow an easy connection point for the wires coming down the 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. Mark this electrical grounding connection with  .

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 bare copper stranded 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.

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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.

Assembly of the WIND ARROW Turbine

CAUTION
When assembling the WIND ARROW 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 WIND ARROW 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 deep 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
- Hub Puller (supplied with each turbine)
- 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)
- Medium slotted screwdriver
- Medium (No2) Phillips head screwdriver
- 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, steel toed boots or shoes and safety helmets for tower erection

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Pre-Assembly Tests

Prior to assembling the WIND ARROW Turbine, complete the following tests. These and other 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

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 between each of the three pairs of black wire coming from the bottom of the turbine. The resistance should measure approximately 1.9 ohms plus or minus 0.2 ohms

Pre-Assembly Test Two – Static Performance Check

1. Set the multi-meter to read AC voltage in the range of 1-50 volts.
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 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 around 10-20volts of the rated voltage of the turbine. This confirms general output is possible and wiring is 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). Don't worry you can't get a shock from this since you cannot drive the machine by hand fast enough to generate actual power.

CAUTION
Touching the phase wires while turning the drive shaft by hand cannot produce harmful voltages or any significant power. Handling the phase wires when turning the drive shaft by hand is harmless. However, attaching a small hand drill to the driveshaft to can produce in excess of 48volts and more than 100-150 watts of power. DO NOT handle the phase wires during such bench tests to prevent electrical shock.

Pre-Assembly Test Three – Turbine Grounding Check

1. Set the multi-meter to read resistance (Ohms).
2. Connect one of the multi-meter probes to one of the generator output wires and the other multi-meter probe to the aluminum housing.
3. The multi-meter should read a very high resistance (mega ohm or "OL" for over limit).
4. 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.

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If any of the preceding Tests is unsuccessful, please contact your Authorized WIND ARROW Dealer or True North Power directly.

Assembly Stand Using the Periscope Riser

To facilitate easier handling of the WIND ARROW 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 long periscope 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 taller than 107 cm (42 inches) 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 WIND ARROW Turbine is being assembled on the tower it is planned to operate from or on an assembly stand similar to that described in the preceding. If an assembly stand is not being used, extra care should be taken to ensure the correct orientation of installed components.

Fitting the 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 tower you purchased and the turbine you are installing. For a non-guyed tower, a 1-1.5meter mast riser will likely be required to mate the wind turbine to the tower. The WIND ARROW Turbine is designed to fit a 2 inch (nominal) Schedule 40 iron or galvanized steel tubing with an outside diameter of 2.375 (2 and 3/8th) inches. The mast riser should normally not extend more than 1.5 metres (4.5 feet) above the top of the tower due to the large leverage or bending moment produced by the force of wind gusts. The end of the mast riser fits inside the compression coupler yaw shaft of the turbine. The riser top end cut should be machined flat to ensure a clean square end and must not be threaded. The inside of the pipe may need to be reamed to ensure no sharp edges that can cut through wire insulation. A clean square end on the mast riser and a smooth outside pipe diameter will enhance the structural bond between the yaw shaft and the mast riser, make for a quieter running machine and protect the phase wires from chafing. 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. Please contact the tower manufacturer or supplier for guidance.

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CAUTION
The mast riser must not extend more than 1.5 metres (~4.5 feet) above the top of the tower. A longer than required mast riser increases the risk of structural failure due to increased stress concentration between the bottom end of the mast riser and where it attaches to the tower itself due to gust loads.

A simple solution for an effective mast riser known as the "Periscope 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 fins on the sleeve below the riser act as the upper tower guy wire attachment points. A periscope riser telescopes into the tower to allow easy wiring connections.

CAUTION
The mast riser must be able to withstand a lateral thrust of 900 newtons (200 pounds) at the mast head, approx 200-250% greater than the WIND ARROW in high wind. All tower components and couplings must be sized accordingly. Consult a qualified engineer when designing your own mounting system or tower.

Fitting of the wind turbine yaw shaft to the mast riser should be tested prior to mating of the mast riser and the tower. This can be accomplished on a bench or utilizing a large vise to hold the riser or using the Assembly Stand if the stand incorporates the actual periscope riser to ensure a proper fit in the shop rather than when you are standing on top of a tower or out in a field somewhere.

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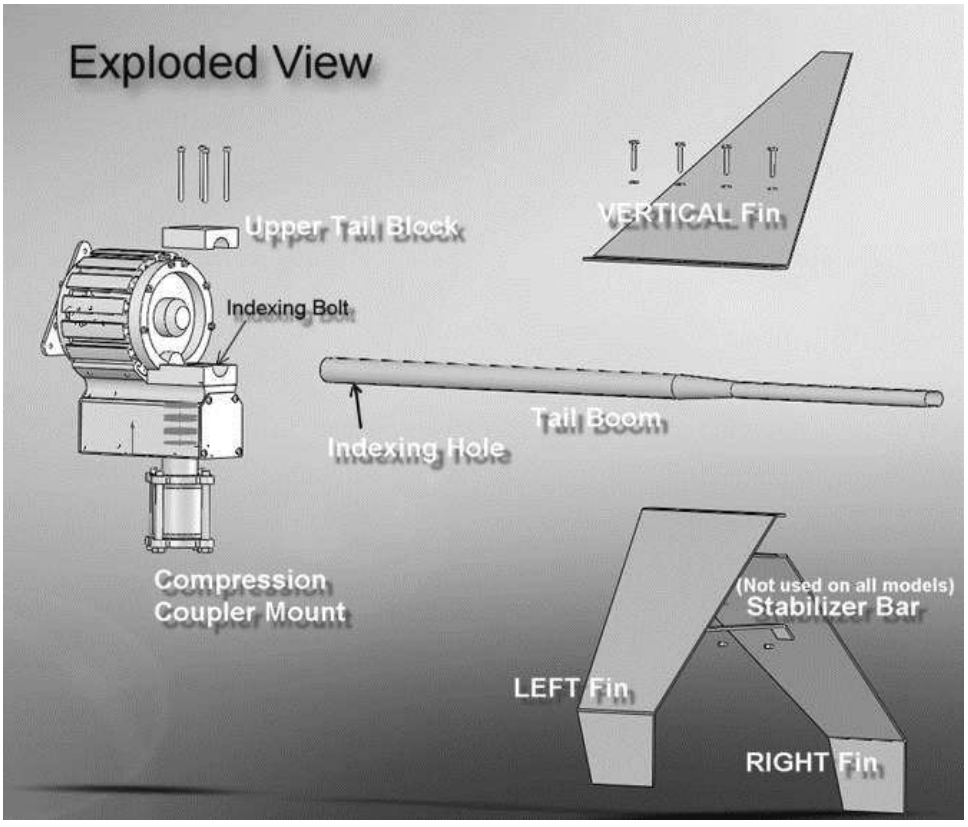
Assembling and Installing the Tail

When assembling and installing the tail attach to the tail boom prior to attaching the tail boom to the wind turbine generator. To assemble the tail fins, attach the fins with the boom oriented so the you can look down through the 4 mounting holes in the flattened end. All three fins mount on top of the boom. Using the 4 x M6 x 40 bolts, 4 x M6 flat washers and 4 x M6 lock nuts put the bolts through the vertical fin first, then through the two lower tail fins then the tail boom and before installing the washer and M6 nylock nut. 2 additional M6 x16 bolts nuts and washers are provided for attaching the stabilizer bar. Do not over tighten the bolts.



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If your model includes it, 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 4 or 6 bolts have been installed, tighten the two cross brace bolts and then the 4 tail boom bolts to a torque to 11 Nm (8 ft lbs) being careful not to crush the tail boom itself.

To install the tail boom, orient the boom with the 2 longer fins pointing down and the hole in the boom lined up with the corresponding bolt head in the upper mounting block of the wind turbine rear housing. Insert the tail boom into the lower housing block such that the hole in the tail boom fits over the bolt head already installed on the lower block. When it is snugly seated with the holes aligned, secure with 4 M6 x 40 bolt, two flat washers (two on each side of the turbine housing) see photo. 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 aft lower housing. Place the tail boom mounting block over the end of the boom and ensure the hole in the tail boom fits over the Cap Head Hex bolt in the lower mounting block . Then install the 4 mounting block bolts. Note, when the 4 bolts are tight there should still be a 1-2mm gap between the upper and lower tail boom mounting blocks. The bolt head sticking up from the center of the lower mounting block is just there to index the tail boom into the correct position and prevent it from turning or slipping out the housing.

Assembling the Blade Array

Assemble the blades on the hub assembly can be done before or after placing the rear hub on the driveshaft. It is recommended to be done before. First place the front and back halves together and install the six M6 x55 Hex Cap hub clamping bolts with nylock nuts on the back. The back hub has captured nut holes so only a single allen key is needed. Only just start the nut so that the two halves are free to separate and insert the blades. With each blade inserted rotate the blade indexing hole to align with the inner of three index holes and install the longer M6 Cap screws and nuts from behind but do not fully tighten yet.

Torque the 6 hub bolts to 112 in Lbs of torque evenly in an alternating sequence then do the same to the indexing bolts. There is a small pitch variance you can achieve of about ½

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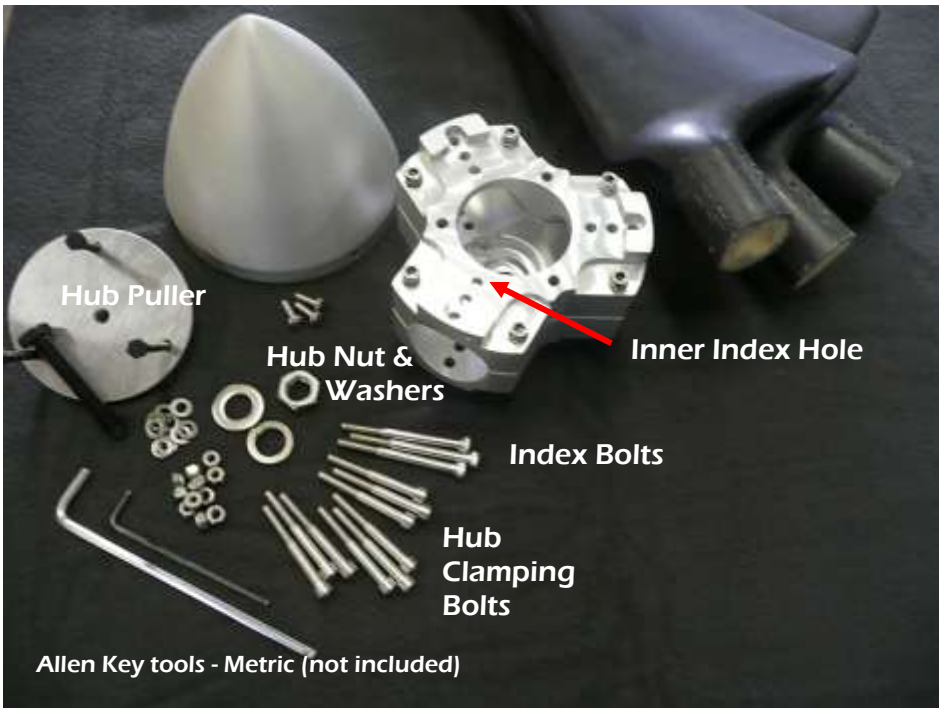
degree by applying pressure to the blade rotation just as you snug it down. Looking outward to the tip of the blade rotating it hard right, clockwise will add about ½ deg POSITIVE pitch. In high wind locations a NEGATIVE bias is recommended. Either way is acceptable to the controller. The concave side of the blade must face to WINDWARD.

NOTE
Since WIND ARROW fits so snugly on the shaft and does not use a torque key as do some other turbines. It requires a "hub puller" to remove the torque ring from the shaft. Hub puller is included.



Blade Array Assembled

Blade Indexing Hole

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CAUTION
DO NOT USE OTHER TOOLS THAN THE HUB PULLER TO REMOVE THE BLADE ARRAY. DOING SO MAY DAMAGE THE HUB OR THE TURBINE OR BOTH. All WIND ARROW turbines are shipped with the correct "hub puller" for easy removal of the hub and blade array system without dismounting the blades. Simply attach the hub puller through the bolt pattern that fits and turn the three outer screws evenly. Then tighten the larger centre bolt to unseat the torque ring. If necessary the blades can be removed first but it is usually more convenient to remove them as a unit. Store the hub puller somewhere where it is handy for maintenance an somewhere where you are not likely to forget it.

Removing the WIND ARROW Hub

The tapered driveshaft/ hub interface is designed to remain solidly fixed without slipping and the blade array hub puller (shipped in the "Blade Box") will be needed to remove it. After removing the nose cone only use this device to remove the blade array and always remove the entire blade and hub assembly as one piece. If it is just for inspection do not remove each blade separately until the entire hub is off the driveshaft. This limits wear and tear on the blade hub interface. Remove the main 16mm hub nut, split lock washer and plain washer and attach the hub puller by screwing in the three smaller bolts by hand. Use a plain or socket wrench then to drive the larger bolt into the end of the drive shaft and the whole blade array will come free. Store the Hub Puller for future use.

AFC™ Installation

CAUTION
Prior to final installation and erection of the True North Power NG Wind turbine, the other components of the renewable energy system (controller, batteries, diversion loads, inverters etc.) should be installed and wired in accordance with the overall system design and each component manufacturer's guidance. Until the AFC™ controller is connected, as a minimum safety procedure, the 3 phase wires must be connected together (SHORTED) at the base of the tower to ensure the turbine cannot start on its own when first installed on the tower. Once the AFC™ is connected the turbine will be under control.

Mounting the AFC™ Controller

The AFC™ controller is an all-in-one control panel incorporating all necessary power management, conversion and diversion load control circuits in one panel. Simply mount the AFC on the wall, vertically only, in a well ventilated area, 0.6 to 2 meters above the floor for easy access, but not too close to overhead structures like shelves or ceiling to allow efficient cooling.

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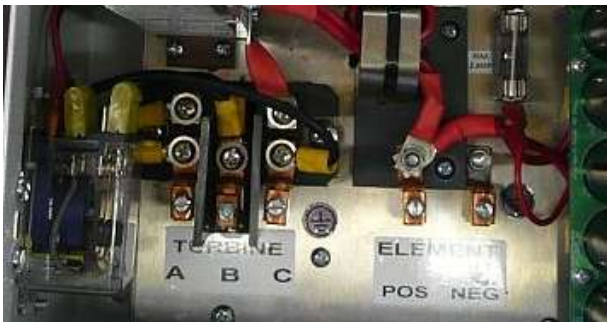
The AFC™ case should be grounded to the nearest house primary grounding point or electrical panel and the ground wire coming from the tower should be connected to the same ground point in the AFC™ controller box.

Connecting the AFC™ Controller (Battery Based)

Connect the turbine phase wires and batteries cables to their terminal blocks on the AFC™, and the three phase wires coming from the turbine to the three (3) terminals labeled PHASE A, PHASE B, PHASE C . It does not matter which wire goes on which Phase terminal.

For battery connections it is VERY IMPORTANT which wire goes on which terminal. The POS RED wire must go to the BAT + terminal and the NEG BLACK wire goes to the BAT – terminal. In the case of WIND2WATER system, it does not matter which wire goes to which of the BAT + - terminals since that power only goes through a simple resistor. Connect the POS NEG battery leads or the heater terminals to the BAT + and BAT - terminals.



CAUTION

For battery connections it is VERY IMPORTANT which terminals you connect to. Check carefully that the POSITIVE (usually RED wire) is actually coming from the battery POSITIVE terminal and that the Battery Breaker is open before connecting it to the AFC™ "BAT +" terminal. Check the NEGATIVE (usually BLACK wire) is actually connected to the battery NEGATIVE terminal before connecting it to the AFC "BAT -" terminal lug. Be sure the ground wire usually YELLOW/GREEN or bare copper (coming in from the turbine with the 3 phase wires) is connected to the grounding screw marked near the BAT – terminal, and this is further connected to primary Ground. Look for the  symbol in the AFC™ controller and near your utility panel or copper water supply pipe grounding connection in the home.

Refer also to the wiring diagram on the next page:

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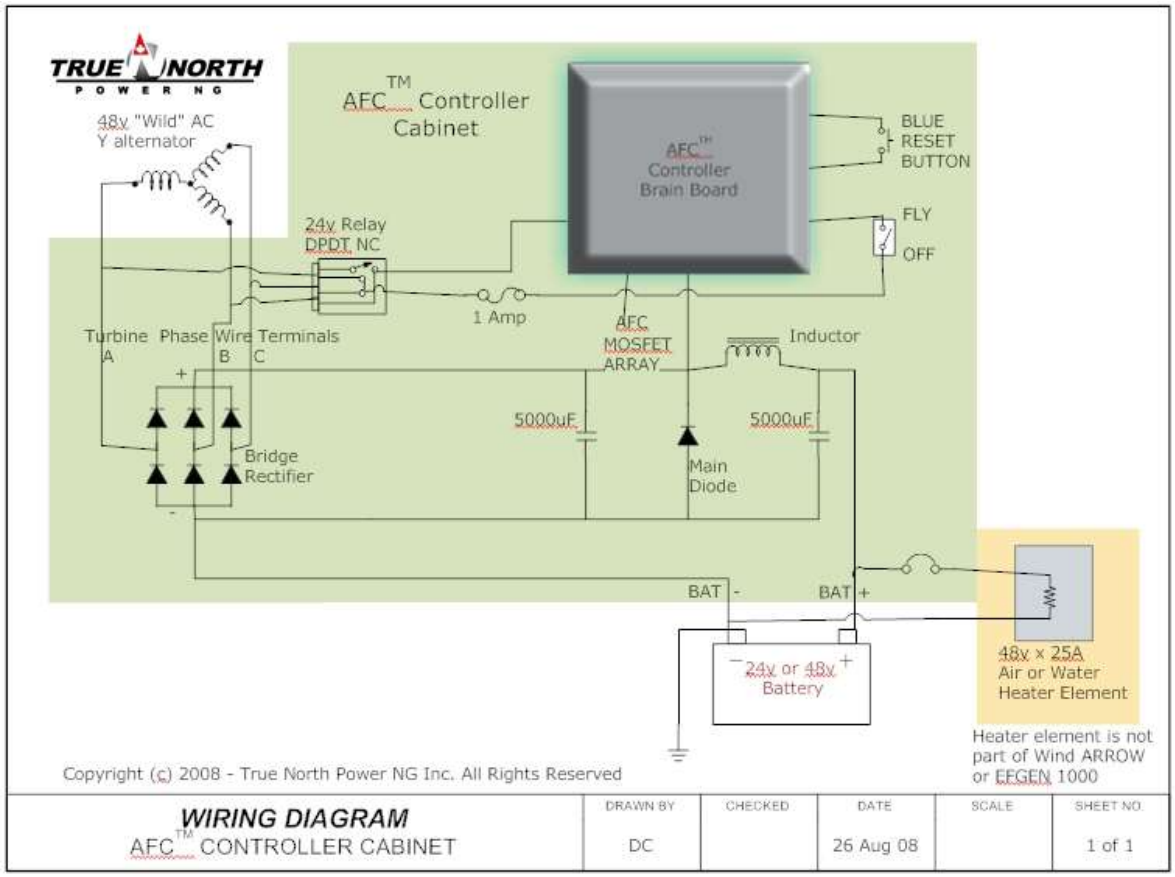

Ensure the circuit breaker for the batteries or the heater to the AFC™ is selected OFF before making these terminal connections. Keep the length of the AFC™ to battery connection or AFC™ to immersion heater connection wires as short as practical to minimize power losses and use wire sizes appropriate to the voltage and circuit breaker selections. Consult an electrician for help with selecting that right wire and breakers. Generally AWG #6 or #8 wire is suitable for 24 or 48v battery based systems with the 60A or 30A breakers already installed in line with the AFC™. In the case of WIND 2WATER a 20A DC breaker should be used with #8AWG wire at least to go with the low voltage 1kw immersion heater. This DC breaker (not included with the controller) is normally located on your DC Power panel and is used to isolate the AFC™ electrically for installation and maintenance.

DIRECT2HEAT – AFC™ notes

Direct2Heat controllers are identical to battery versions except for a couple of jumper wires and different firmware chip. The turbine connects the same way and the heater is connected to the same terminals as the battery version. Since the heater is a simple resister it does not matter which wire goes on which terminal, just ensure there is a no larger than 20A breaker in one leg.

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CAUTION
D2H controllers are preset of use with the approved True North Power NG 48v water heaters and do not require adjustment. DO NOT attempt to adjust the AFC™ jumpers or settings. ONLY use the AFC controller with an immersion heater element if the AFC™ controller says "D2H" on the label and a D2H on the microprocessor chip has been installed. The battery versions of the AFCs look similar inside but are wired differently for each specific purpose and run different software. The microprocessor chip on battery based systems will have a label of either B24 or B48. If you are unsure which version AFC™ controller you have please consult with True North Power NG.

Installation and Operation of the True North Power NG Wind turbine

WARNING
Also, never allow the turbine to FLY without being attached to the AFC controller. And if the turbine has prematurely or mistakenly been allowed to start, never try to attach the 3 phase wires of an operating turbine to the AFC input terminals without first STOPPING the blades by shorting all three phase wires together. This will ensure the AFC is not shocked with an unexpected high voltage when it is not in control of the turbine. Open circuit voltage of an operating turbine with no controller attached can exceed safe limits. Always connect the turbine to a working controller before allowing the turbine to fly.

NOTE
This section provides recommended step-by-step instructions for installation of the 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, before any phase wires are installed. This will make eventual mating of the turbine and tower much easier. Prior to final installation and erection of the 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 manufacturer's guidance. As a minimum, the True North Power NG Wind DIRECT2HEAT controller must be mounted in a suitable location with the "FLY/OFF" Switch selected 'OFF' prior to installing the wind turbine on the riser or raising the tower.

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CAUTION
The True North Power NG Wind turbine must never be allowed to operate without being connected to the Control Panel with either the "FLY/OFF" Switch selected 'OFF' the three phase wires connected together (ie SHORTED). If the wind turbine 'sees' an open circuit, and it's windy it can over speed, even in average wind, and may severely damage the unit with possible personal injury.

Tower Assembly and Test Lift

Ensure that the tilt-up tower is assembled, the Mast Riser installed, and the tower is test raised in accordance with the manufacturer's instructions **PRIOR** to installing the Turbine. Lower the tower and support it at suitable intervals so that the top of the tower is at least 1.2 metres (4 feet) off 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 Turbine must be connected to the AFC controller with three cable runs (phase wires) or a single cable with 3 conductors plus ground in weather proof casing. This is typical buriable wire called NMWU. It can be buried in the ground directly without a conduit. The size and type of wire is dictated by the voltage of the wind turbine, the distance between the wind turbine to the Controller-Rectifier 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. 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 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. The connections in the junction box should not be made until the wind turbine is installed on the mast riser and the excess cable is pulled back down the tower.

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 (whichever is most convenient) and leave sufficient cable exposed at the top of the tower (1 to 2 meters (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,

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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/Suspending the Cables

For most towers, the weight of the cables suspended inside the tower can be significant and must be distributed to the wind turbine yaw shaft or to tower structure rather than borne by wires themselves. This is accomplished by attaching a suspension chain and or grounding wire to the eyebolt in the base of the yaw shaft as shown in the photo below and securely fastening the cables to the chain with heavy-duty wire ties. Whether the cable is suspended from the yaw shaft or from the tower structure, it is essential that the weight of the cables is held by the mechanical structure rather than the phase wires or the ground wire. There should be no tension on the wires. The WIND ARROW comes with a 6 bolt carbon steel or Stainless compression coupler. In this case there is a hook inside the coupler for the suspension system. Grounding can also be done directly through the tower itself by electrically grounding the base of the tower to a grounding point.

Stainless Compression Coupler

Strain relief and grounding hook

Securing the 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 ie the riser is seated inside both brass compression rings. 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. Torque the compression coupler bolts to 25 Nm (18 ft lbs).

Completion of the Cable Runs

When the Turbine has been securely installed on the mast riser, and before the tower is raised or the blades are allowed to move freely, complete the installation of the cable runs from the wind turbine to the AFC Controller-Rectifier Panel. Prior to connecting the cables at the Controller-Rectifier Panel, 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.

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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 controller-rectifier refer to the section entitled 'Wiring the controller'.

After the cables have been connected, ensure that the FLY/STOP I/O switch is selected 'STOP or O' and confirm that it is not able to turn by giving the blades a light spin. If the circuit is indeed open (the SOS RELAY is CLOSED) the blades will immediately come to a stop with only 1/3rd rotation. If not then the blades should coast for nearly full revolution or more.

CAUTION
The AC Phase wires from the wind turbine must be connected to the three terminals in the Controller-Rectifier Panel. **NEVER** connect the AC wires from the turbine directly to the battery bank, a power distribution panel or an inverter.

Turbine Assembly and AFC Installation Check-List

CAUTION
Assembly and installation of the 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.

- ☐ 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 photographs on page 27 to ensure that they are installed in the correct orientation. The lifting surface faces aft.
- ☐ 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/or the AFC Controller Panel (refer to previous pages).

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- ☐ Ensure that the Phase wire cable runs are securely connected at both the AFC Phase terminals and in the tower junction box if used. Check the AFC BAT terminals are wired to either BAT + -or to the 48v immersion heater leads in the case of the Wind2Water system.
- ☐ Ensure that the FLY/OFF I/O switch is selected 'O or OFF' 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 switch OFF when given a good spin by hand. If they go more than a full rotation the switch is in the wrong position or a wire is not connected somewhere.
- ☐ 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.
- ☐ If using a tilt-up tower, ensure that the tower has been assembled and "proven" in accordance with the manufacturer's instructions and test lifted FIRST, without the wind turbine installed. In lieu of specific guidance from the tower manufacturer, a tilt-up tower with a Turbine installed should ideally be erected when the wind is calm or at most no more than 10-12mph.

The 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 wind turbine;'

Normal Operation of the Wind turbine

CAUTION
The 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 AFC controller-rectifier. Always begin with the FLY/STOP switch in the "STOP" position.

Temp sense **AFC LED Indicator Lights**

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NOTE: the TEMP SENSE probe MUST be installed in order for the AFC processor to operate.

8 **RED** AUX Relay – Not implemented
7 Load Relay ON >27.1 or 54.2v OFF <26.1 or 52.2v
6 Dump Relay ON >28.3 or 56.6v OFF <27.2 or 54.4v
5 **GREEN** – Power ON, processor live
4 **GREEN** 28.8v or 57.6v (Upper limit charge state)
3 **RED** 26.8v or 53.6v (Absorption charge battery state)
2 **RED** 25.2v or 50.4 (Full battery charge state)
1 **RED** 23.3v or 46.6 (Low battery charge state)
Blue – steady glow PWM (power is being generated)
Blue ON steady and all other lights OFF. SOS mode has been activated. Either wait for time out (up to 6 hrs) or hit RESET button top right outside of AFC Cabinet.

CAUTION

48v Battery versions require power to be supplied by either a 24v wall plug or a 24v 'tap" off a 24v section of the 48v battery bank. The controller uses barely 2 watts when the FLY STOP relay is activated and less when it is not. Therefore there is little drain on a 48v bank that could imbalance the battery. There is a 12ft RED wire (18 or 20 gauge) with a terminal crimp attached to the controller for that purpose. On end to the FUSE the other to 24v

Starting the Wind Turbine

Prior to starting the turbine, make sure it is connected with a suitable load ie; the water heater or batteries are wired with the circuit breaker OPEN at first.

After you have completed the pre-start testing, provide power to the controller by either plugging in the 24v wall plug adapter or connecting the battery by closing the DC battery breaker on the DC power panel. (The DC breaker or DC load panel is not part of the wind turbine supplied equipment).

There are 9 LEDs on the AFC controller board. The AFC controller GREEN LED (#5) labeled SOS RELAY on the AFC cover, will be activated and from 1 to 4 of the lower RED BATTERY state of charge LEDs numbered (1,2,3,4) will light showing battery voltage which is an indication of how full the batteries are. In Wind2Water systems only the lower RED LED will light. The lit GREEN SOS RELAY LED (#5) shows that the microprocessor program is running and has "authorized" the relay OPEN so the turbine is released to FLY. The FLY/STOP switch on the right side still overrides this processor command and prevents the SOS Relay from opening until it is switched manually to

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FLY. To start the wind turbine, select the 'FLY/STOP Switch' on the RIGHT side of the AFC controller to 'FLY or "I".

If the wind is steady at approximately 10-12 km/hr (6-8 mph), the blades should begin to rotate. Startup depends on how gusty or steady the wind is as well as local turbulence. If the wind is in excess of approximately 12-15 km/hr (8-10 mph) the blades should quickly gain speed to the point where the wind turbine is delivering power to the load. Power is being generated and sent to the battery or the immersion heater when the lower BLUE LED labeled "PWM" is flickering or solid. It will also glow somewhat brighter the more power is being generated. If it is dim or flickering it is likely very light wind and little energy is being generated.

Once "flying", the blades may continue to rotate in very light winds even as the wind falls below the startup 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. The PWM LED may go out entirely. (In a 10-11 km/hr (6-7mph) wind there are only 16 watts per square meter of energy to capture and the Betz limit maximum you could hope to extract is less than 10 watts). Practically speaking you can harvest only 5 or 6 watts per square meter cross section at 10 km/hr (6mph) and a 1 meter blade array offers only 3.14 square meters of cross-section. Operations at 20 mph will gather 80-100 times more energy due to the cubed energy formula of wind speed vs power. Put another way, you can get more energy from 1 hour of operation at 32km/hr (20 mph) than you can from 30 hours of operation at 6mph even though it looks nice turning. The neighbours will be impressed but you don't have to tell them it's not "running the whole house".

Stopping the Wind Turbine

To stop the blades from turning, or prevent them from starting select the FLY/STOP switch down to STOP. The blades can no longer "Fly" and should quickly come to a stop, although they may continue to "rotate" very slowly in a moderate to high wind. In strong steady or gusty winds just above 65-70km/hr (~ 45-50mph) the SOS may engage to prevent over speed and over production. Once stopped, the AFC will not allow the turbine to restart until either a "time-out" limit (up to 6 hrs) is reached or the BLUE RESET button is pressed. (located on the right side of the AFC cabinet. Use a pencil tip or similar object) This restarts the processor and allows the main relay to energize and the turbine to start again. If high winds are still present the system will shut down again for another 6 hrs.

CAUTION
Even though the turbine rotation has been halted, either by operator action or by SOS mode engaging, you should not attempt to restart the turbine if steady winds or gusts are exceeding 70-80km/hr (45-50mph). If the blades are allowed to accelerate rapidly beyond that speed the turbine's electromagnetic braking may not be strong enough to overcome the aerodynamic lift created by the blades. This is an unstable condition and can lead to structural failure. A normal 5-10 sec gust beyond 70-80km/hr (45-50mph) should not present a problem since the SOS mode may halt the blades as soon as the gust dies. If SOS mode has already been engaged under typical storm conditions it is recommended to manually select the FLY/STOP switch to STOP until the storm has eased so that the processor does not command multiple restarts under continuous storm conditions. Restarting under storm conditions only creates unnecessary stress and wear and tear on the

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turbine. The AFC sets an automatic "time out" of 6 hrs and will attempt a RESTART after that time has elapsed.

AT ANY TIME, after heavy winds have subsided or conditions are NOT forecast for severe storms, the SOS stop mode can be over ridden manually by pressing the BLUE RESET button on the right side of the AFC cabinet. This is not recommended unless winds are already below 75-80km/hr (45-50mph). Test show this machine can be safely started and stopped in winds exceeding 60mph (26m/s) and even produce 500-600 watts but it is not recommended.

With the wind turbine has stopped "flying" and the FLY/STOP switch selected to STOP the blades may turn very slowly but well below airfoil operational speeds, even in very high winds above 100km/hr. The best way to protect the machine from storm damage is to safe the wind turbine under manual control with the FLY/STOP selected to STOP. The system is then safe in almost any anticipated weather conditions except for flying debris such as for storage during off-season or in periods when energy is not needed.

AFC Relays and Firmware Set Points

There are three terminal pairs on the AFC Controller board inside the AFC. The primary terminal pair is the 1 STALL relay and there are 2 auxiliary relay control terminals. The STALL relay is built into the system as the main safety feature and is normally closed. It must receive power from the control board (authorized by the AFC Software) to allow the turbine to fly, and only if the FLY STOP switch is in the FLY position. A second LOAD relay control terminal pair is labeled LOAD and + and may be used to control an additional relay (not included) that, at a certain battery voltage or temperature can turn on a fan or lights or divert excess energy to a secondary battery storage bank or any other electrical device. The DUMP Relay control terminals next to it is labeled DUMP and + and this terminal pair will control a third relay at a higher voltage than the LOAD relay.

Settings for theses relay terminals are in controlled in the AFC firmware and cannot be adjusted by the user. If there are exceptional circumstances and the user wishes to have different settings then a special set of set points and firmware control chip may be requested. Contact True North Power NG directly. Factory set points shown below: **The temperature probe must be installed at all times whether battery temperature or water temperature is being sensed:**

STALL RELAY: variable control by the AFC firmware programming
LOAD RELAY: ON with battery voltage is above 55.2v or 27.6v (temperature corrected)
LOAD RELAY: OFF below 55v or 27.0v
DUMP RELAY: ON with battery voltage is above 57.6 or 28.8v (temperature corrected)
DUMP RELAY: OFF below 53.0v or 26.5v

For Wind2Water (heater only) the water temperature set points are controlled by the temperature probe that must be installed on the water tank outer wall inside the insulator jacket. Putting it on the upper outlet where the hottest water exits also works. These temperature set points are not adjustable by the user and will stop the turbine by removing power from the main STALL relay when the temperature probe reaches 60degC. The same software switch will re-power the STALL relay when the probe temperature drops below 55degC. In addition, if your immersion heater comes with it's own thermostat switch then this device must be connected in series with the AFC FLY STOP switch. (See photos). When this thermostat setting is reached and the switch opens, then

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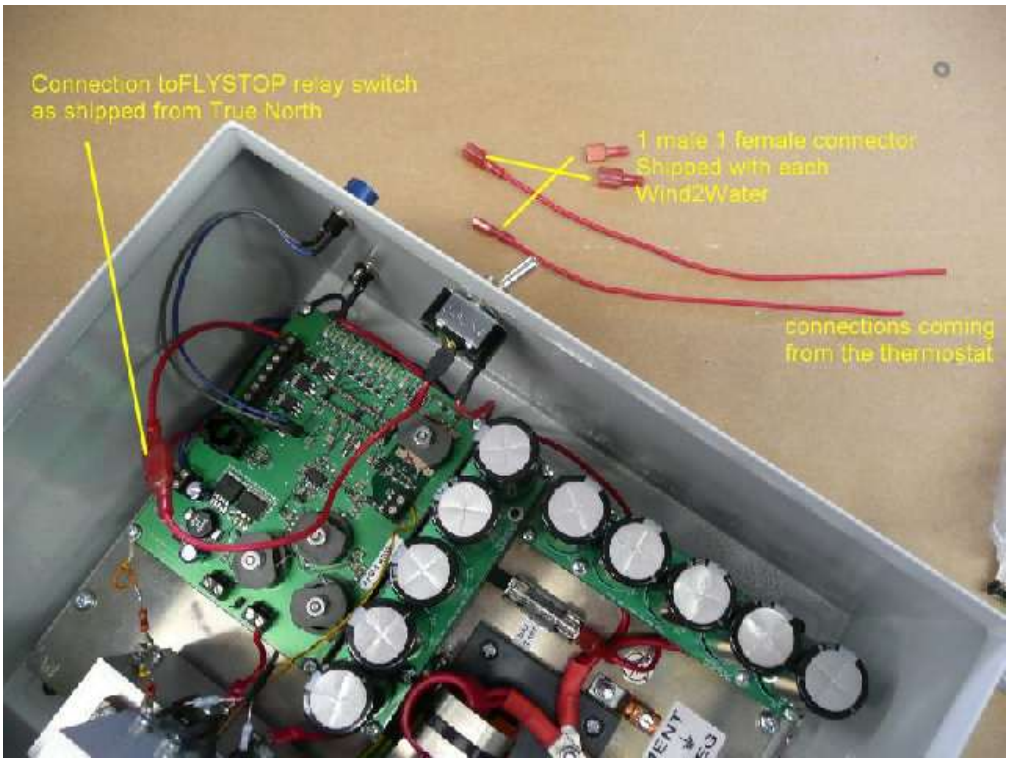
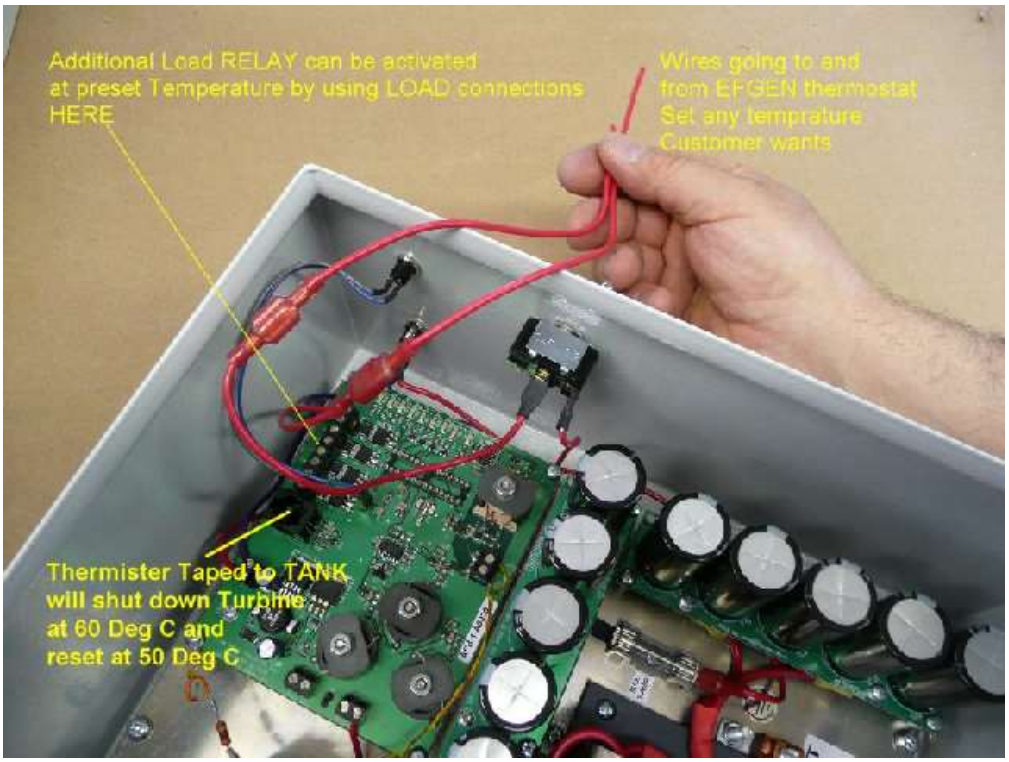
the STALL relay will lose power and CLOSE causing the turbine to stop. It will restart only when the thermostat switch closes again. This device may be set the user.





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Initial In-Service Tests

When the wind turbine is first put into service or after periodic maintenance, a few tests will be helpful to confirm that it is operating correctly. Other tests required may be dictated by the overall design of the renewable energy system; however, the following will confirm the correct operation of the turbine and the AFC controller-rectifier.

In-Service Test One – AC Voltage Check

To complete this test, the turbine must be operating in a reasonable wind – 20 km/h (12.5 mph) should be sufficient

1. Set the multi-meter to read AC voltage in a range appropriate for 40-50v AC reading.
2. Measure the voltage between any two phases on the input side of the AFC controller-rectifier panel. (at the three phase wires connection terminals.) The voltage will depend somewhat on the wind speed and battery voltage, but the nominal value should be around 36-44v AC, and the same between any 2 of the phase wires.

CAUTION

All WIND ARROW turbines generate at 48v DC from the output rectifier but the AFC controller operates on 24v. However, the controller can be configured to command the power section to output either 24v or 48v as needed to match your system voltage. Systems with 48v battery packs should connect the BATTERY terminals normally but provide 24v to the controller board by connecting to terminals that represent half the battery bank (24v) to run the processor.

The processor/relay requires less than 2 watts to run so there is no likelihood it can imbalance even the smallest battery pack. Small on board "jumpers" are used along with a different microprocessor program. All Direct2Heat (D2H) configurations use a 24v wall plug adaptor to power the controller and output 48v to the water heater. Please confirm the correct jumper configuration before connecting batteries or water heaters to the AFC output terminals. See AFC INSTALLATION instructions for details.

In-Service Test Two – DC Voltage Check

1. The DC voltage across the DC output of the AFC Controller/Rectifier and "battery" terminals may not read the same (see CAUTION above) the BAT terminals will read the same as the voltage of the battery bank. With the turbine generating BLUE LED lit, use a multi-meter to confirm the output voltage of the RECTIFIER and the BAT/LOAD terminals (Pos/Neg). In all cases the rectifier should be 38-44volts and the BAT/LOAD terminals should read BATTERY voltage. In a Wind2Water system the BAT/LOAD terminals should show voltage ~40-48v or higher in high winds.
2. In gusty wind conditions with a small battery bank the battery voltage can quickly vary 2-3 volts or more with each gust depending on the state of charge and what loads are running. The larger the AH rating and the fuller the battery bank the less variation there should be in voltage under gusty conditions.

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Periodic Maintenance of the Wind turbine

The Wind turbine requires minimal periodic inspection; 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 each manufacturer.

In-Service Monitoring

When the Wind turbine is first placed into service, monitor it closely for any indications of abnormal performance and any signs of loose fittings, vibration or noise; 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 out of balance 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. Using a pair of binoculars, inspect the turbine motion as it flies. Once in service, the turbine does not need more than an annual inspection. If this is the first turbine you have ever installed, however, after approximately one month of service, the 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 desert environment, the 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 Wind turbine (page 35). You may also choose to isolate the AFC electronically by opening the DC breaker to the battery pack if there is one or unplugging the 24v power adapter on the Wind2Water systems.

- 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.
- Removing the nose cone is optional to 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 nose cone. If the blade array has no "play" in the hub when you vibrate a blade tip then the hub nut is likely still torqued properly and removing the nose cone is unnecessary.
- Check for play in the alternator rotor shaft and the hub attachment by grasping the tip of a blade and applying a fore and aft pressure. It will normally move at the tip but should feel

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directly connected to the hub. If there is excessive play, re-verify that the drive shaft hub nut has been tightened to 19 Nm (14 ft lbs). If the problem persists, contact your authorized True North Power NG Dealer.

- Inspect the alternator casing for signs of damage. If operating a turbine in a corrosive or harsh ocean or desert environment, inspect the protective anodized coating for signs of corrosion and touch up the exposed surfaces using the clear touch-up lacquer available from the manufacturer or a good quality, polyurethane clear coat.
- 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 True North Power NG Dealer. Surface cracks or scratches on the paint surfaces do not present a problem.

Unattended Operation and Extended Dormancy

The WIND ARROW 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 turbine must always be presented with a suitable load and can be severely damaged if the alternator experiences an open circuit on the AC wires coming from the turbine. There must never be a circuit breaker or fuse on these wires. Using one can create an unsafe condition if it trips. There is always an increased risk associated with unattended operation, due to the reduced opportunity for operator intervention, in the event of some unanticipated condition that results in an open circuit. Most often this is due to leaving wires disconnected at the base of the tower or on the AFC input during installation or maintenance.

For unattended operation, provisions must be made to complete the turbine's annual inspection outlined above and to consider lowering the tower if the winds are forecast to approach 160 km/h (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 turbine can be shut down and left dormant for an indefinite period. Simply select the FLY/STOP switch to STOP so that the blades can rotate but is not allowed to "Fly". Shut down other system components in accordance with the applicable manufacturers' guidance. Although not necessary, to avoid unnecessary wear and tear during periods of extended dormancy, the Wind turbine can be removed from the tower and stored in a clean, dry environment.

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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. Consult UK or other European standards when installing your turbine in Europe.

Size	**Temperature Rating of Conductor/System Wires**		
AWG or kcmil	60°C (142°F)	75°C (167°F)	90°C (194°F)
	Types: TW, UF	Types: FEPW, RH, RHW, THHW, THW, THWN, XHHW, USE, ZW	Types: 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

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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 on the next page.

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Line Loss For Wind Generator 24V, 48V System Voltages At 500 Watts Of Power

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**	Recommended size	Resistance per 1000 ft
10.2 m	20.4 m	40.9 m	81.8 m	#4 (420/30)	0.264 Ω at 25 mm^2
16.1 m	32.3 m	64.6 m	129.3 m	#2 (665/30)	0.167 Ω at 35 mm^2
20.3 m	40.6 m	81.2 m	162.4 m	#1 (836/30)	0.133 Ω at 50 mm^2
25.7 m	51.4 m	102.9 m	205.7 m	#1/0 (1064/30)	0.105 Ω at 55 mm^2
32.1 m	64.3 m	128.6 m	257.2 m	#2/0 (3325/34)	0.084 Ω at 70 mm^2

Line Loss For Wind Generator 24V, 48V System Voltages At 1300 Watts Of Power

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**	Recom-mended size	Resistance per 1000 ft
26.6 m	53.2 m	106.4 m	212.8 m	#4 (420/30)	0.264 Ω at 25 mm^2
42.0 m	84.1 m	168.2 m	336.4 m	#2 (665/30)	0.167 Ω at 35 mm^2
52.8 m	105.6 m	211.2 m	422.4 m	#1 (836/30)	0.133 Ω at 50 mm^2
66.8 m	133.7 m	267.5 m	535.0 m	#1/0 (1064/30)	0.105 Ω at 55 mm^2
83.6 m	167.2 m	334.4 m	668.8 m	#2/0 (3325/34)	0.084 Ω at 70 mm^2

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Annex B – True North Power NG Turbine/Tower

Checklist and Installation Overview

CAUTION
Please consult with you local True North Power NG 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 damage to the turbine, or other equipment that are not covered by the warranty and possible injury to yourself or others.

WARNING
DO NOT connect systems electrical components based strictly on this manual. Consult a qualified electrician of 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 serious injury or death.

Install WIND ARROW Turbine Head Assembly (Final Checklist)

- ✓ Phase wires connected and shrink-wrapped butt-splice or taped marrettes
- ✓ Continuity checked at the tower base and at Controller-Rectifier/AFC
- ✓ Strain relief attached, secure and is adjusted shorter than the Phase wires
- ✓ Compression Coupler attached to the tower is fully seated through both compression rings and torqued
- ✓ Hub nut blade array and tail assembly nylock nuts, all have been torqued properly. Do NOT exceed 100ft lbs. Nose cone screws are tight.
- ✓ 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 may have happened during installation or improper (backward) blade installation. (Blade serial numbers face forward and are visible before front hub is installed)
- ✓ Hub bolts go on from Front to back with captured nuts behind.
- ✓ Blade spin test confirms free movement to rotate. Confirm the brake is working and FLY/STOP switch is in STOP.
- ✓ 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.

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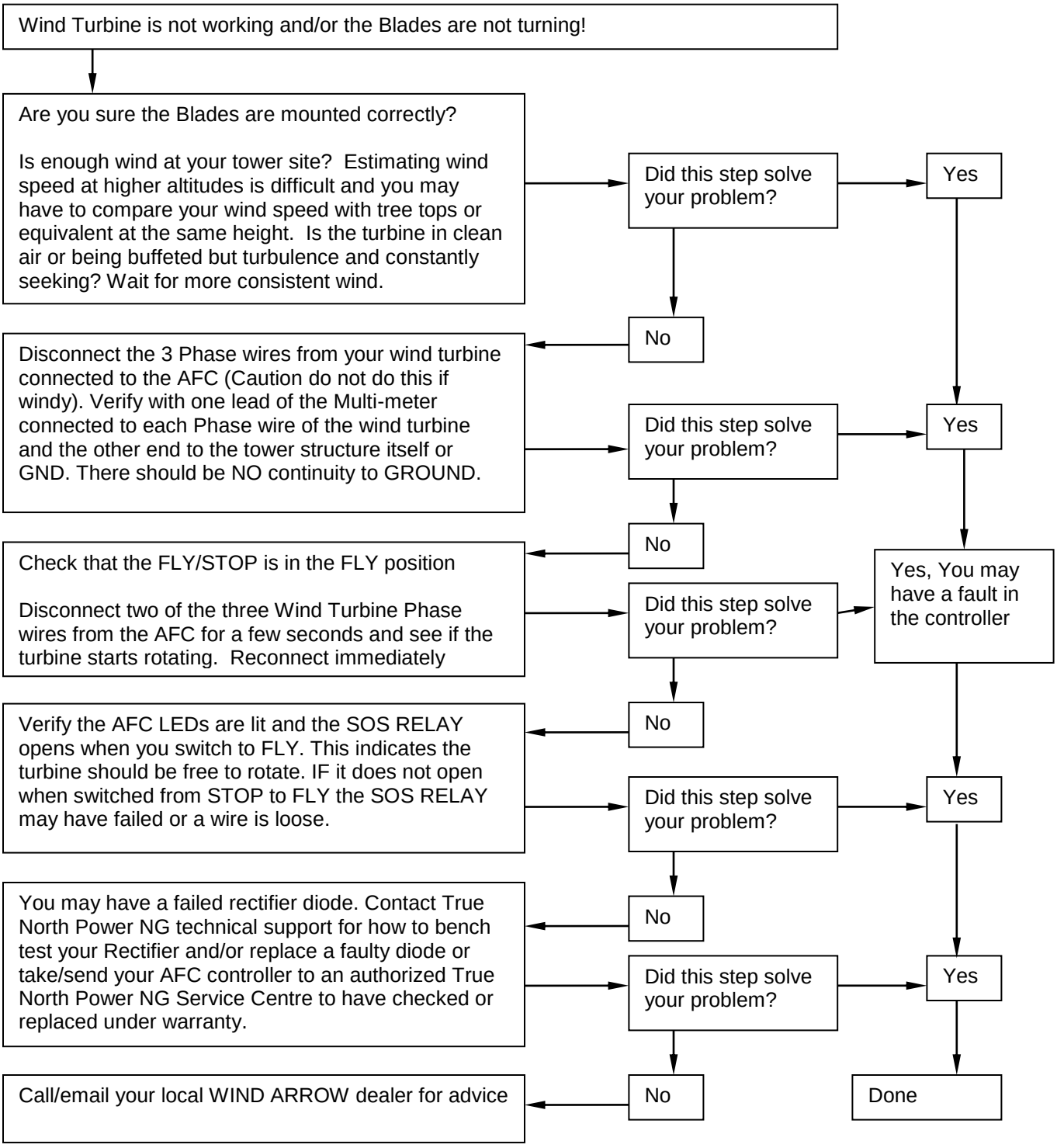
Annex C –Wind turbine Trouble-Shooting



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Annex D - True North Power NG Wind turbine Warranty Notes

The Standard 5 Year Warranty does 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 True North Power NG Inc.
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. Possible examples are installations near refineries or industrial areas that produce corrosive emissions.
7. Damage caused by neglect and or failure to service when the required annual inspection is due as required by the Owner's Manual.
8. Damaged caused by improper connection to the equipment of other manufacturers.
9. Voltage or wiring adjustments to the product not authorized by this 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.
12. Storm damage from sudden thunderstorms downburst or sever frontal wind gusts, hail or tornado, hurricane/cyclone, monsoon, lightning or flying debris.

The Standard Warranty is void if the product is:

1. Damaged is a result of incorrect assembly, misuse, abuse, physical or electrical accident.
2. Utilized in an unauthorized commercial or rental application.
3. Disassembled, modified or repaired by anyone not authorized by True North Power NG.
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 WIND ARROW turbine at any time during the WARRANTY period, contact your nearest Authorized True North Power NG dealer. True North Power NG 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 a copy of page 9 of this manual) is not returned to True North Power NG 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 True North Power NG Turbine then simply send a completed copy of page 9 and your purchase receipt to validate the warranty dates.

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 turbine 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.**

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Torque Settings - Quick Reference:

	Newton Metres	Foot Pounds	Inch Pounds
Compression coupler bolts	**19**	**14**	**168**
Main Hub Nut	**19**	**14**	**168**
Blade Array bolts	**12**	**9**	**108**
Tail Fin bolts	**11**	**8**	**96**
Tail Boom attachment bolts	**12**	**9**	**108**

1kW WIND ARROW STATOR / BRUSH WIRING

48v Connections for WIND ARROW Rear Terminal					UPPER COMPARTMENT
LEFT	Connect to	RIGHT	Phase/Phase Resistance	Tolerance	CRIMP CONNECT
A	Terminal 1	open	7.9 Ohms	+ - 0.2	1+2 Together
B	Terminal 2	open	7.9 Ohms	+ - 0.2	3+4 Together
C	Terminal 3	open	7.9 Ohms	+ - 0.2	5+6 Together
NOTE WHEN NOT WIRED: 2,3 & 6 should have continuity with "O"					"O" Wire (larger) Capped
Wires 1,4 & 5 should NOT have continuity with "O"					

24v Connections for WIND ARROW Rear Terminal					UPPER COMPARTMENT
LEFT	Connect to	RIGHT	Phase/Phase Resistance	Tolerance	CRIMP CONNECT
A	Terminal 1	Wire 2	1.7 ohms	+ - 0.2	
B	Terminal 2	Wire 3	1.7 ohms	+ - 0.2	1, 4 and 5 with "O"
C	Terminal 3	Wire 6	1.7 ohms	+ - 0.2	

NOTES:

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