ARE442-HV (10kW) Wind Generator
Grid-Connect

Owner’s Manual
Installation, Operation, & Maintenance
Version 5.1

Manufactured in the USA by:
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1. **SAFETY WARNING!**

- **Electrical shock hazard:** The wind generator can produce high voltages – sometimes more than 600 volts. These voltage levels can cause serious injury or death. No wires or electrical connections should be touched or handled without ensuring that the wind generator has been braked to a complete stop and the AC power to the inverter and Voltage Clamp (grid-tie controller) is off. After these steps are taken, approximately five (5) minutes is required for system voltage to decay to safe levels.

- The **ARE442** is a powerful machine and can cause injury if not assembled and erected properly (according to the instructions and using appropriate equipment).

- Do not approach the machine while the blades are spinning – they can cause serious injury!

**Please Note:**

**ABUNDANT RENEWABLE ENERGY** has made every effort to ensure that the information presented in this manual is accurate but assumes no responsibility for any errors or omissions. Users of this information and **ARE** products assume full responsibility and risk.
2. Introduction

This manual provides the information needed to assemble, operate, and maintain the ARE442 (10 kW) wind generator with a direct grid connection. Please read it thoroughly and keep for future reference.

The ARE442 provides a very long life with very little maintenance due to its relatively low rotational speeds (low RPM), its rigorous design utilizing a minimum number of moving parts, and its rugged construction. Its large swept area, high-efficiency blades, purpose-built alternator, and optimized power electronics ensure maximum energy capture from a wide range of wind speeds. The simple, upwind side furling system (with gravity return) protects the wind turbine by reliably swinging the rotor out of winds higher than 11 m/sec (25 mph).

Figure 2.1. ARE442 wind generator
3. Wind Generator Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration</td>
<td>Three-blade upwind</td>
</tr>
<tr>
<td>Over-Speed Control, Mechanical</td>
<td>Side furling with gravity return</td>
</tr>
<tr>
<td>Over-Speed Control, Electrical</td>
<td>Pulse-width modulated resistor loading</td>
</tr>
<tr>
<td>Rated Power</td>
<td>10 kW (10,000 watts)</td>
</tr>
<tr>
<td>Rotor Diameter</td>
<td>7.2 m (23.6 ft)</td>
</tr>
<tr>
<td>Swept Area of Blades</td>
<td>41 m² (442 sq. ft.)</td>
</tr>
<tr>
<td>Cut-in Wind Speed</td>
<td>2.2 m/s (5 mph)</td>
</tr>
<tr>
<td>Start-up Wind Speed</td>
<td>4.5 m/s (10 mph)</td>
</tr>
<tr>
<td>Rated Wind Speed</td>
<td>12 m/s (25 mph)</td>
</tr>
<tr>
<td>Blade Quantity, Construction</td>
<td>Three (3), molded fiberglass</td>
</tr>
<tr>
<td>Blade Rotational Speed</td>
<td>0–140 rpm</td>
</tr>
<tr>
<td>Alternator Type/Construction</td>
<td>Neodymium permanent magnet</td>
</tr>
<tr>
<td>Alternator Electrical Output</td>
<td>3-phase, variable voltage (0 - 410 VAC)</td>
</tr>
<tr>
<td>Tower-Top Weight</td>
<td>725 kg (1600 lbs.)</td>
</tr>
<tr>
<td>Maximum Lateral Thrust</td>
<td>725 Kg (1600 lbs.)</td>
</tr>
</tbody>
</table>

*Table 3.1. ARE442 specifications*

![ARE442 (10kW) Wind Generator](image)

*Figure 3.1. ARE442 power curve*
Figure 3.2. ARE442 monthly energy estimates graph

4. Equipment Supplied

<table>
<thead>
<tr>
<th>Qty.</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ARE442-HV Alternator (Grid-tie)</td>
</tr>
<tr>
<td>6</td>
<td>Hex Head Cap Screw - M20-2.5 x 45mm (zinc) - Alternator to mainframe</td>
</tr>
<tr>
<td>6</td>
<td>Washer Set, Nordlock Safety - 9/16 (zinc) - Alternator to mainframe</td>
</tr>
<tr>
<td>2</td>
<td>Eyebolt - M24-3.0 (zinc) - For lifting alternator</td>
</tr>
<tr>
<td>1</td>
<td>ARE442 Yaw Head (a.k.a. Main Frame)</td>
</tr>
<tr>
<td>2</td>
<td>Bolt - 5/8-11 x 2&quot; (zinc) - Mainframe to yaw bearing (to replace lag bolts after uncrating)</td>
</tr>
<tr>
<td>2</td>
<td>Bolt, Lag - 1/2&quot; x 6&quot; (zinc) - Mainframe to crating material (used only for shipping)</td>
</tr>
<tr>
<td>24</td>
<td>Bolt - 5/8-11 x length is dependent on tower top thickness (zinc) - Yaw bearing to tower top flange</td>
</tr>
<tr>
<td>26</td>
<td>Washer, Split Lock - 5/8&quot; (zinc) - Yaw bearing to tower top flange</td>
</tr>
<tr>
<td>3</td>
<td>Blade - 3.6m</td>
</tr>
<tr>
<td>6</td>
<td>Blade-Mount Stud - Outer (with M22-2.5mm x 45mm &amp; M24-3mm x 22mm threaded ends)</td>
</tr>
<tr>
<td>3</td>
<td>Blade-Mount Stud - Inner (with 2 x M22-2.5mm x 45mm threaded ends)</td>
</tr>
<tr>
<td>9</td>
<td>Nut, Nylok - M22-2.5 (zinc) - Blades to blade-mount studs on alternator</td>
</tr>
<tr>
<td>1</td>
<td>Blade-Mount Ring, Outer (23&quot; OD / 10-3/8&quot; ID)</td>
</tr>
<tr>
<td>1</td>
<td>Blade-Mount Ring, Inner (10-1/4&quot; OD / 5&quot; ID)</td>
</tr>
<tr>
<td>1</td>
<td>ARE442 Nose Cone</td>
</tr>
<tr>
<td>3</td>
<td>Bolts - M8-1.25 x 20mm - Nose cone mount</td>
</tr>
<tr>
<td>3</td>
<td>Washer, Flat - 5/16&quot; USS (zinc) - Nose cone mount</td>
</tr>
<tr>
<td>3</td>
<td>Washer, Split Lock - 5/16&quot; (zinc) - Nose cone mount</td>
</tr>
<tr>
<td>Qty.</td>
<td>Item Description (Continued)</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>1</td>
<td>ARE442 Tail Boom, Inner</td>
</tr>
<tr>
<td></td>
<td>Tail Pin - Ø1&quot; (stainless steel)</td>
</tr>
<tr>
<td>1</td>
<td>Washer, Flat - 1” USS (stainless steel)</td>
</tr>
<tr>
<td>1</td>
<td>Retainer Clip - 1” heavy duty (plain steel)</td>
</tr>
<tr>
<td>2</td>
<td>Hex Head Cap Screw - M16-2.0 x 65mm (zinc) - Inner tail boom adjustment</td>
</tr>
<tr>
<td>2</td>
<td>Nut, Nylok - M16-2.0 (zinc) - Inner tail boom adjustment</td>
</tr>
<tr>
<td>4</td>
<td>Hex Head Cap Screw - M14-2.0 x 40mm (zinc) - Inner tail boom adjustment</td>
</tr>
<tr>
<td>4</td>
<td>Washer, Split Lock - M14 (zinc) - Inner tail boom adjustment</td>
</tr>
<tr>
<td>2</td>
<td>ARE442 Tail Boom, Outer (square tube 3” x 3” x 55.5”L)</td>
</tr>
<tr>
<td>4</td>
<td>Socket Head Cap Screw - M12-1.75 x 100mm (zinc) - Outer to inner tail boom</td>
</tr>
<tr>
<td>4</td>
<td>Washer, Flat - 1/2” USS (zinc) - Outer to inner tail boom</td>
</tr>
<tr>
<td>4</td>
<td>Nut, Nylok - M12-1.75 (zinc) - Outer to inner tail boom</td>
</tr>
<tr>
<td>1</td>
<td>ARE442 Tail Vane, Standard (with ARE symbol)</td>
</tr>
<tr>
<td>1</td>
<td>Tail Stiffener Set Upper and Lower (aluminum)</td>
</tr>
<tr>
<td>12</td>
<td>Hex Head Cap Screw - M8-1.25 x 20mm (zinc) - Tail stiffener mount</td>
</tr>
<tr>
<td>12</td>
<td>Nut, Nylok - M8-1.25 (zinc) - Tail stiffener mount</td>
</tr>
<tr>
<td>12</td>
<td>Washer, Flat - 5/16” USS (zinc) - Tail stiffener mount</td>
</tr>
<tr>
<td>10</td>
<td>Hex Head Cap Screw - M12-1.75 x 30mm (zinc) - Tail vane to boom</td>
</tr>
<tr>
<td>20</td>
<td>Washer, Flat - 1/2” USS (zinc) - Tail vane to boom</td>
</tr>
<tr>
<td>10</td>
<td>Nut, Nylok - M12-1.75 (zinc) - Tail vane to boom</td>
</tr>
<tr>
<td>1</td>
<td>VCL442-HV Voltage Clamp (grid-tie controller)</td>
</tr>
<tr>
<td>2</td>
<td>Inverter - SMA Windy Boy 6000US</td>
</tr>
<tr>
<td>2</td>
<td>Resistor Loads in enclosures</td>
</tr>
</tbody>
</table>

Table 4.1. Equipment Supplied with grid-connect ARE442 wind generators

To Be Purchased from Other Suppliers:
- Appropriately sized wiring, as described in Section 9 ("Wire Size Recommendations") and in Section 7 ("Electrical Schematic")
- Sub-panel or AC circuit breakers

5. Required Installation Tools
- Ratchet for sockets
- 8" extension for ratchet
- Metric sockets / box wrenches: 10, 13, 19, 21, 22, 24*, 30mm*
- English sockets / box wrenches: 3/4", 15/16"
- Wrench, Allen/hex – 10mm
- Wrench, adjustable – 8" (opens to 1.25")
- Screwdrivers – Phillips (#2) & flat-head (3/16” max width blade 6” over all length)
- Wire Strippers (6 AWG – 16 AWG)
- Torque wrench – range: 10–410 N-m (7–300 lb-ft)
- Locking pliers (Vise-Grips)
- Thread-locking compound (e.g. Loctite® 242® Threadlocker, Med-Strength/Removable)
- Hole saw or stepped drill bit for 1/2” conduit (suggested size)

*For sizes above 22mm, standard wrenches can be used in some locations or a large adjustable wrench. The drawback is that an accurate torque value cannot always be determined.
6. Choosing Sites for Wind Generators

To attain optimal performance from your wind generator, an appropriate site must be chosen for the installation. Buildings, trees, rocky outcrops and other obstructions can disrupt the smooth flow of wind and increase “wind shear”. This creates significantly lower wind speeds and more turbulence close to the ground. Turbulence is swirling air that causes the turbine to yaw continually; this greatly increases wear and tear on mechanical components, and reduces the useful life of this equipment.

As a general rule, wind turbines should be mounted at twice the height of any sudden upwind obstructions. Alternatively, turbines may be located at least 10 meters (30 feet) plus the blade length above the tallest trees, buildings, or other such obstructions within 150 meters (500 feet). The power (P) obtainable from the wind is proportional the cube of the wind speed ($v^3$), and wind speed increases with height (H) from the ground. $[P \propto v^3$ and $v \propto H]$. According to this principle, a 26% increase in wind speed from a higher tower will yield a 100% increase in power from the turbine. *A little more money spent on a taller tower harvests the same power as two (2) machines!*

Preference should be given to the prevailing wind direction, but please note that tall features downwind of the generator can also slow wind flow passing through the turbine’s blades.
7. Electronics Installation

*Installation Instructions*

It is suggested that a piece of 3/4” plywood be mounted to the wall where the wind turbine electronic equipment will be installed. This will provide a secure substrate to which to mount equipment. It also provides for adequate flexibility for mounting the equipment without the need to rely on stud spacing or special wall anchors.

A. *Resistor Loads*

The two resistor load enclosures supplied with your ARE442 system must be mounted so that the resistors are lengthwise horizontal and that the terminal block is in the lower right hand corner. Do not locate this device near flammable substances or loose cloth. Ensure a minimum of 12” clearance below the enclosures, 18” clearance above the enclosures and 3” to the sides enclosures, as air must be permitted to flow freely through the box. Each enclosure weighs about 40 lbs. (see Figure 7.2 for the resistor load enclosure dimensions and mounting hole locations)

*Figure 7.1. RES442-HV resistor load*
Figure 7.2. Dimensions of resistor load enclosure

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B. Inverter
Your ARE442 system utilizes two (2) SMA Windy Boy 6000US inverters. Follow the instructions included with the SMA Windy Boy inverter for mounting procedures and requirements.

Pay special attention to clearances around the enclosure, the wire size requirements and location relative to the main power line.

**CAUTION:** The SMA Windy Boy inverter is heavy (approximately 63 kg / 140 lbs.) and requires proper mounting. Please see SMA installation instructions.

![Figure 7.3. SMA Windy Boy inverter](image)

C. Voltage Clamp
The ARE Voltage Clamp should be mounted on a vertical surface in a dry location. It should be mounted in suitable location to provide easy access to the red “STOP” button and so that the enclosure door may be opened fully. Conduit holes are provided in the bottom of the Voltage Clamp (see Figure 7.5 for enclosure dimensions).

![Figure 7.4. VCL442-HV Voltage Clamp](image)
Figure 7.5. Dimensions of Voltage Clamp Enclosure
See the electrical schematic (Figure 7.7) for proper connections and wire sizes. Ensure all wiring is in accordance with local codes and regulations. Wire the Windy Boy inverter to the “– OUT” and “+ OUT” slots of the Voltage Clamp’s din-rail mounted terminal block (pictured below in Figure 7.6).

**Torque specification** on the terminal blocks is 18 in-lbs. Use a 3/16” wide flat screwdriver.

**POLARITY IS IMPORTANT!** Wiring the Windy Boy inverter with reverse polarity will damage the equipment and result in an expensive repair bill. See your SMA Windy Boy manual for instructions on wiring and operating the inverter.

![Figure 7.6. Close-up of Voltage Clamp terminal blocks](image)

After all electrical equipment has been installed and all connections have been made, press the “STOP” button to ensure that the brake is engaged. **Also turn off the circuit breakers to the inverter and to the Voltage Clamp.** This will ensure that the equipment will not be energized while the wind turbine is being installed.
D. Electrical Schematic

Figure 7.7. ARE442-HV electrical schematic
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8. Towers & Rigging

An appropriate wind turbine tower should be chosen and prepared very carefully; this can be the most difficult and most crucial aspect of a wind energy equipment installation. ARE assumes no responsibility for assuring the suitability of towers provided by other suppliers. Consult with ARE for assistance with tower selection and qualification.

9. Wire Size Requirements

The following table lists the recommended MINIMUM wire gauge, based on the one-way wire run distance from the tower top to the building entrance (where it connects to system electronics). These recommendations are intended to limit the voltage loss to 5% or less. Ensure that wire insulation is rated for outdoor use and for at least 600 volts.

NOTE: The Voltage Clamp’s main terminal block does not accept wire sizes larger than 6 AWG. If a larger (> 6 AWG) wire size is used in the wire run from the wind turbine to control electronics, then this larger wire should be connected – via a terminal block inside a junction box (not provided by ARE) – to two smaller (< 6 AWG) wires prior to connecting to the Voltage Clamp. Two terminal blocks are provided for each wind turbine lead (A, B, & C) in the Voltage Clamp to accommodate this potential requirement. Ensure that the total cross-sectional area of the two smaller wires is equal to or larger than the cross-sectional area of the single, larger wire.

<table>
<thead>
<tr>
<th>Minimum wire size for runs up to:</th>
<th>280 feet</th>
<th>445 feet</th>
<th>700 feet</th>
<th>1130 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 AWG</td>
<td>6 AWG</td>
<td>4 AWG</td>
<td>2 AWG</td>
<td></td>
</tr>
</tbody>
</table>

Table 9.1. Wire size recommendations

Please consult the SMA Windy Boy manual for wire sizes between the inverter and the utility grid.
10. Turbine Assembly Instructions

Although one person can assemble the machine with mechanical aids, it is advisable to have an assistant, as many components are heavy and cumbersome to maneuver into position.

A. Uncrate & Inspect Yaw Head Assembly

Remove the top and sides (if required) of the yaw head crate. Remove the two (2) 1/2” lag bolts securing the yaw head to the base of the crate. Replace the lag bolts with two (2) 5/8"-11 x 2" bolts and split lock washers. Bolts should be snug at this step but will be fully tightened in a later step. Use the lifting eyes to hoist the yaw head (only).

CAUTION: These lifting eyes are provided only for lifting the yaw head. **DO NOT USE THEM FOR LIFTING THE ENTIRE TURBINE ASSEMBLY**

Remove the two (2) lag bolts (heads painted orange), which hold the yaw head to the pallet during shipping (3/4” wrench). Install two (2) 5/8”-11 x 2” bolts and lock washers in place of the lag bolts (15/16” wrench).

Figure 10.1. ARE442 yaw head with access doors

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Remove all covers and inspect the yaw head, brake resistors, slip rings, and drop cable for any damage which may have occurred during shipping. Please notify ARE of any damage before installing your turbine.

**Figure 10.2a. Top view of yaw head and brake resistors**

Inspect brake resistors, ensuring all wire connections are secure and that ceramic isolators are not chipped or cracked.

**Figure 10.2b. Yaw head power & control channel brushes**

- Yaw head power channel brushes (7 total)
- Yaw head control channel brushes (4 total)

**Figure 10.2c. Drop cable below yaw head**

Inspect drop cable for any damage to the cable casing.
B. Uncrate Alternator

Keep the alternator covered as long as possible to prevent dirt or metal objects from entering the alternator and becoming lodged between the magnets and rotor. Please notify ARE of any damage before installing your turbine.

Two (2) M24 eyebolts are provided to facilitate lifting the alternator. Install one (1) M24 eye bolt into the threaded hole on the alternator’s stator side (see Figures 10.3a & c).

Remove the sides of the crate. This will allow sufficient room to lift the alternator with the one eye and stand it on edge.

Thread the other eye bolt into the front of the alternator’s stator side (see Figures 10.3b & d). Using these two eyebolts, the alternator can be lifted and installed as described in Section 10.E.

**Figures 10.3a-d. Alternator lifting eyebolt locations**
C. **Uncrate Blades**
Remove top of blade crate and inspect each blade for any damage during shipping. Inspect the leading and trailing edges, the blade root, and blade tip. Please notify **ARE** of any damage before installing your turbine.

![Blade anatomy diagram](image)

*Figures 10.4. ARE442 blade anatomy*

D. **Inspect Inner Tail Boom & Adjustment Assembly**
Ensure that the parts appear to be undamaged. Please notify **ARE** of any damage before installing your turbine.

![Inner tail boom diagram](image)

*Figures 10.5. Inner tail boom*
E. **Inspect Outer Tail Boom & Tail Vane**
Inspect the tail vain for dents and bends, and examine the outer tail vane for damage. Please notify ARE of any damage before installing your turbine.

*Figures 10.6a-b. Tail vane & outer tail boom*

F. **Inspect Nose Cone**
Inspect the nose cone for any cracking, chipping or de-lamination (splitting of layers). Please notify ARE of any damage before installing your turbine.

*Figures 10.7. ARE442 nose cone*
G. Mechanical: Mount Yaw Head to Tower Top

Attach the yaw head to the tower top flange using (24) 5/8"-11 bolts and lock washers.

**NOTE:** These fasteners are provided with the nominal length of 2 inches. Please ensure ARE knows how thick the tower flange is so the proper bolts can be substituted if necessary, (see table for bolt lengths).

Fasteners should be tightened to **163 N-m (120 lb-ft) torque.** Ensure that the electrical wires are not pinched between the top flange and the yaw head mounting flange (see Figure 10.8 below).

<table>
<thead>
<tr>
<th>Tower Top Flange Thickness</th>
<th>5/8&quot;-11 Mounting Bolt Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot;</td>
<td>2&quot;</td>
</tr>
<tr>
<td>1&quot;</td>
<td>2.5&quot;</td>
</tr>
<tr>
<td>1-1/4&quot;</td>
<td>2.5&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>2.75&quot;</td>
</tr>
</tbody>
</table>

**Figure 10.8. Mating the tower top to the yaw head flange**
Secure the fasteners that attach the yaw head to the yaw bearing at this time. Tighten (18) 5/8"-11 x 2" bolts to **163 N-m (120 lb-ft) torque**. **NOTE:** All but (2) of these fasteners are factory-installed but not tightened to the recommended torque.

*Figure 10.9. Tightening yaw bearing bolts*
H. Electrical: Connect Yaw Head to Tower Top Junction Box

Drop cables of 4-conductor 8 AWG and 4-conductor 14 AWG are provided from the factory (extending below the yaw head 5 feet).

In a junction box (typically near the tower top), splice the drop cable wires – three (3) power wires, one (1) ground wire, and the (4) control wires – to corresponding wires, which will run down the tower. Ensure all wiring and connections are appropriately insulated for 600 volts.

If a junction box is not available a “quick link” (see Figure 10.10 below) is provided to for attachment of cable supports. Use cable supports to bear wire weight and remove tension from wire splices.

NOTE: Each cable should be supported individually

Examine all slip ring brushes to verify firm contact with the slip rings (see Figure 10.11 below).

Reattach and close the yaw head access doors, if removed in prior step (see yaw head access door in Figure 10.1). While closing the access door, make certain that wires are not pinched and do not interfere with the slip ring mechanisms.

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I. **Mechanical: Mount Tail Boom to Yaw Head**

Install the two (2) aluminum tail stiffening angle brackets to the side of the tail vane without graphics. Orient stiffeners with each bracket’s perpendicular leg away from the tail vane’s center. The stiffeners are mirror images of each other. Mount each stiffener bracket with six (6) M8-1.25 x 20mm bolts with washers and self-locking nuts. Install washers and bolt heads on the graphics side of the vane (see Figure 10.12 below). Tighten the M8 fasteners to **10 N-m (8 lb-ft) torque**.

*Figure 10.12. Mounting tail vane stiffeners*

Mount the tail fin to the outer tail boom section (galvanized square tube), using ten (10) M12-1.75 x 30mm bolts with washers and self-locking nuts. Install washers on the vane side only (see Figure 10.13 below). Tighten M12 fasteners to **35 N-m (25 lb-ft) torque**.

*Figure 10.13. Mounting the tail vane to outer tail boom*
Insert the outer tail boom into the inner tail boom, and secure with four (4) M12-1.75 x 100mm socket head bolts, 1/2” washers, and self-locking nuts (see Figures 10.14 and 10.15 below). Tighten the M12 fasteners to **35 N-m (25 lb-ft) torque.**

*Figure 10.14. Assembling the outer & inner tail booms*

*Figure 10.15. Attach inner & outer tail booms with socket head bolts*
Install the inner tail boom & adjustment plate assembly to the yaw head as shown below. Use two (2) M16-2.0 X 65mm bolts with Nylok nuts to secure the Inner Tail Boom & Adjustment Plate Assembly to the Yaw Head (see Figure 10.16 below). Bolt heads should be oriented to the outside, as shown. Do not fully tighten the nuts at this time.

Figure 10.16. Yaw head & adjustment plate assembly

Locate the side adjustment plate as shown below. Align the second set of holes on the adjustment plate with the aft set of holes on the yaw head (this...
corresponds to 10° of tilt in Figure 10.19. Install two (2) per side M14-2.0 x 40mm bolts with split lock washer (see Figures 10.18a & b below). Tighten the M14 fasteners to **81 N-m (60 lb-ft) torque** and the M16 fasteners from the above step to **163 N-m (120 lb-ft) torque**.

**PLEASE NOTE:** Figure 10.19 is provided for reference only. Utilization of configurations other than that shown in Figure 10.18b – without the written consent of ARE – will void the ARE442 product warranty.

**Figure 10.19. Vernier-style tail plate adjustment guide (for reference only)**
J. **Mechanical: Mount Alternator to Yaw Head**
Align the alternator mount holes with the yaw head front. **CAUTION: The alternator weighs approximately 270 kg (600 lbs.) and is very awkward to handle, so this step should be planned carefully.**

Use the M24 eyebolts provided to hoist the alternator into position similar to the manner shown in Figure 10.20 below.

![Figure 10.20. Lifting the ARE442 alternator](image)

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Align the bolt holes, as shown, using holes marked 1, 3, and 5. Pass the alternator lead wires through the hole provided, taking care not to pinch the lead wires between mating surfaces.

Install the six (6) M20-2.5 x 45mm bolts with **Nord-Lock** washers and tighten to a **390 N-m (298 lb-ft) torque** (see Figures 10.21 & 10.22 below).

---

**Figure 10.21. Bolting the yaw head to the alternator**
The key to the effectiveness of Nord-Lock bolt securing systems is the difference in angles. Since the angle $\alpha$ is larger than the angle $\beta$, the pair of washers expand more than the corresponding pitch of the thread. Nord-Lock washers positively lock the fastener in a joint which is subjected to extreme vibration or dynamic loads.

This unique bolt securing system uses tension to make the bolt self-locking. Do not use in combination with a flat washers which are not locked in place.

*Figure 10.22. Nord-Lock® bolt securing systems explanation*
K. **Electrical: Connect Alternator to Yaw Head**

Connect the alternator lead wires to the terminal strips mounted inside the yaw head. Match the label of each wire to labels on the terminal strip (see Figure 10.23 below). Alternator power output leads are labeled A, B, C. The center tap lead is Z.

**Torque specification** on the terminal blocks is 18 in-lbs. Use a 3/16” wide flat screwdriver.

**CAUTION:** *Never connect the lead wire labeled “Z” to the ground stud, as this will prevent the alternator from turning.*

The Z lead wire is used with ARE’s optional Lightning Protection System and must be attached to the terminal marked Z (see Figure 10.23 below).

The ground stud is to be used **ONLY** with ARE’s optional Lightning Protection System.

*Figure 10.23. Yaw head terminal block wire connections*
Figure 10.24a. Yaw head wiring diagram, alternator and slip rings
Figure 10.24b. Yaw head wiring diagram, brake resistors and brake relay enclosure
Figure 10.24c. Yaw head wiring diagram, surge suppressor
L. **Mechanical: Install Blades & Nose Cone**

*NOTE:* There are two different blade mounting studs – six (6) of one type (M24 threads on one end) for the outer bolt circle and three (3) of another type (M22 threads on both ends) for the inner bolt circle (see Figure 10.25 below).

Apply **thread-locking compound** and screw the M24 side of the six (6) outer blade studs into the outside set of threaded holes on the front (rotor side) of the alternator drum. **IMPORTANT:** Use only the shorter (M24) threaded section of each outer stud to screw into the alternator drum (see Figure 10.25 below).

Apply **thread-locking compound** and screw the three (3) blade studs with M22 threads into the inside set of threaded holes on the front (rotor side) of the alternator drum.

*Figure 10.25. Mounting blade studs to alternator*
Install the three (3) blades onto the blade studs. The vent holes are between the blades. Orient the blades so that the blue leading edges will rotate clockwise (CW – see Figure 10.26 below).

**Figure 10.26. Blade edges & rotation direction**

After placing the three (3) blades, install the inner blade clamping plate over the three (3) blade studs and the outer blade clamping plate over the six (6) outer blade studs with the nose cone mounting brackets between the blades and pointing toward the alternator (see Figure 10.27 below). Secure the plate with M22-2.50 self-locking nuts, tightened to 20 N-m (15 lb-ft) torque *beyond the prevailing torque of the nylon insert*. (30mm wrench)

**Figure 10.27. Nose Cone mounting holes on clamping plates**
Install the nose cone and secure with three (3) M8-1.25 x 16mm bolts, washers and lock washers tightened to **14 N-m (10 lb-ft) torque** (see Figure 10.28 below).

![Figure 10.28. Nose cone installation](image)

Rotate the blades slightly about the alternator's axis to verify that the rotor can turn freely. Verify that all fasteners and electrical connections are secure.

**IMPORTANT:** Ensure that the **STOP** button on the Voltage Clamp is pressed. This will engage the brake and keep the turbine from rotating during the turbine installation. Ensure that the tower is vertical so that the turbine can properly yaw (turn to face into the wind).
11. Generator Start-up, Shut-down, & Reset

**CAUTION:** ALLOWING THE WIND GENERATOR TO ROTATE UNLOADED CAN RESULT IN VERY HIGH VOLTAGES WHICH CAN CAUSE INJURY OR DEATH AND CAN DESTROY EQUIPMENT.

**A. Prior to Generator Start-up (Verify the Following):**
- All electronic equipment installed per Section 7 of this manual.
- All electronic equipment wires double-checked for proper location.
- Circuit breakers to electronic equipment placed in the **OFF** position.
- **STOP** button on the Voltage Clamp is in the depressed position.
- Wind turbine installed per Section 10 of this manual.
- Wind turbine and tower erected and properly secured per tower instructions.

**B. Generator Start-up Procedure:**
1. Turn **ON** the circuit breaker for the **SMA Windy Boy** inverters. Turn **ON** the circuit breaker for the Voltage Clamp. **NOTE:** The Windy Boy inverter will not immediately show signs of turning on, as its display only energizes once the turbine starts to run.
2. Rotate the **STOP** button clockwise (CW) 1/6th of a turn and release. This will start a 5 minute wait period. The **GREEN** and **YELLOW** lights will flash. **NOTE:** If **STOP** button is still depressed, the **RED**, **YELLOW**, and **GREEN** lights will flash simultaneously.
3. After the 5 minute wait the flashing **YELLOW** light will turn off. The **GREEN** light will continue flashing. Once sufficient wind is available, the turbine blades will start to spin.
4. When the generator’s rectified voltage reaches approximately 180 V DC, the Voltage Clamp will perform a test to verify proper installation and functioning of the resistors (load and brake). Upon successful test results, the **GREEN** light will illuminate steadily and the **YELLOW** light will flash.
5. The Voltage Clamp will attempt to maintain a generator output range of 300-325 V DC while the Windy Boy inverter comes online and synchronizes waveforms with the utility grid (between one and five minutes). The Voltage Clamp will perform a test approximately twice per minute to verify that the inverter is connected to the grid. During this time the **YELLOW** light will flash and the **GREEN** light will illuminate steady on.
6. After the **Windy Boy** inverter is connected to the utility grid, the turbine will enter the “**RUN MODE**” and the **YELLOW** light stop flashing.
7. The system will operate automatically, and monitoring is not required.

**C. Generator Shut-down & Reset Procedures**
To shut down the wind energy system at any time, press the **RED** mushroom emergency **STOP** pushbutton. The button will lock into a depressed position. To reset the system, depress the **STOP** button, then rotate the **STOP** button clockwise (CW) 1/6th turn and release.
# 12. Voltage Clamp Operation & Faults

<table>
<thead>
<tr>
<th>Mode / Fault Description</th>
<th>Solution / Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>START UP MODE: The system is initializing and going through system checks.</td>
<td>Brake will release within five minutes.</td>
</tr>
<tr>
<td>TEST: The system is waiting for the turbine to start. When the wind speed reaches 12 to 15 MPH, the turbine should start turning and then the system will perform some safety tests then enter Soft Start Mode.</td>
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<tr>
<td>SOFT START MODE: The generator’s rectified voltage has reached approximately 250 VDC, and the Voltage Clamp is performing a test to verify the inverters are transferring energy to the utility grid.</td>
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<tr>
<td>RUN MODE: The system is producing energy, which is being used by domestic loads or being sent to the utility grid.</td>
<td></td>
</tr>
<tr>
<td>RESISTOR LOADING: The system voltage is approaching the upper limits of the WB inverter's acceptable range. The load resistors are absorbing excess energy.</td>
<td>Depending on the wind speed the yellow light may be steady on, or may flash on and off as the resistor loads are turned on and off as required.</td>
</tr>
<tr>
<td>STOP: The STOP push button has been pressed. The turbine brake is applied to the system.</td>
<td></td>
</tr>
<tr>
<td>OVER-VOLTAGE FAULT (540 Vdc): The rectified system voltage has exceeded 540 Vdc, and the brake has been applied.</td>
<td>After a 5 minute delay, the system will automatically reset.</td>
</tr>
<tr>
<td>OVER-TEMPERATURE FAULT: One of the bi-metallic temperature switches has tripped and the turbine’s brake has been applied. Temperature switches inside the Voltage Clamp are set at 60°C (140°F). Temperature switches inside the Diversion Loads are set at 90°C (195°F).</td>
<td>The system will not reset until the temperature decreases to below the set-point of all bi-metallic switches, and a 5 minute cool-down period has expired.</td>
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<tr>
<td>LOSS OF GRID POWER: If at any time the grid power to the system is lost, the Windy Boy inverter will disconnect from the grid and the Voltage Clamp will activate the brake.</td>
<td>When grid power is restored the system will start up automatically and follow the “START UP MODE” procedure detailed above. Because the electronics in the voltage clamp require stable AC current to operate, it automatically shuts down in the event of a power loss.</td>
</tr>
</tbody>
</table>
SYSTEM/LOAD/BRAKE FAILURE:  The system has encountered an internal error.  Check the brake and load resistors and try again.  (On some controllers this also indicates a load or brake resistor failure and you will not see the Load/Brake resistor test failed code).

LOAD/BRAKE RESISTOR TEST FAILED:  The test performed by the Voltage Clamp to verify proper connection and function of load & brake resistors has failed.

CALIBRATION:  The system has entered a special calibration mode.  Please power cycle – power off the Voltage Clamp’s circuit breaker for 10 seconds and restore power – to clear this message.

TIMEOUT:  This is an internal error.  Please power cycle – power off the Voltage Clamp’s circuit breaker for 10 seconds and restore power – to clear this message.

Table 12.1. Voltage Clamp Operation & Faults

* TO MANUALLY RESET THE SYSTEM:
Depress the STOP button, then rotate the STOP button clockwise (CW) 1/6th turn and release.

13. Troubleshooting

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Possible Causes</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine fails to turn (or turns very slowly) in significantly windy conditions</td>
<td>Shorted wires or alternator windings</td>
<td>Not field serviceable – please consult factory</td>
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<tr>
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<td>Shorted diodes</td>
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<td></td>
<td>Failed bearings</td>
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<td></td>
<td>Foreign body in generator</td>
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<tr>
<td>Low output</td>
<td>Insufficient wind</td>
<td>Improve tower location/height</td>
</tr>
<tr>
<td>Turbine vibrates excessively</td>
<td>Blades out of balance</td>
<td>Check blades for water intrusion</td>
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<tr>
<td>Turbine fails to swing into the wind</td>
<td>Tower top not vertical</td>
<td>Adjust guy cables</td>
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<td></td>
<td>Yaw bearing worn</td>
<td>Replace yaw bearing</td>
</tr>
<tr>
<td>Turbine running at high speed no output</td>
<td>Cables disconnected</td>
<td>Fix cables</td>
</tr>
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<td></td>
<td>Slip Rings Failed</td>
<td>Replace Slip Rings</td>
</tr>
<tr>
<td>Voltage Clamp RED light illuminates (solid)</td>
<td>See “Voltage Clamp Operation &amp; Faults” section above.</td>
<td></td>
</tr>
</tbody>
</table>

Table 13.1. Troubleshooting Guide
14. Inspection & Maintenance

A. Ongoing Inspection/Maintenance
   • Listen for unusual alternator or blade noise, and look for excessive vibration. If detected, such warning signs should prompt a detailed inspection.

B. Annual Scheduled Inspection/Maintenance
   1. Interface Fasteners
      • Inspect and retighten the (24) 5/8"-11 x 2" bolts and lock washers between the yaw head and the tower top flange, **163 N-m (120 lb-ft) torque**. (ref. Section 10.B) *(15/16” wrench)*
      • Inspect and retighten the (18) 5/8"-11 x 2" bolts and lock washers between the yaw head to the yaw bearing, **163 N-m (120 lb-ft) torque**. (ref. Section 10.B) *(15/16” wrench)*
      • Inspect and retighten the (2) M16-2.0 X 65mm bolts *(24mm wrench)* with Nylok nuts and (2 per side) M14-2.0 x 40mm bolts *(21mm wrench)* with split lock washer between the inner tail boom & adjustment plate assembly to the yaw head, tighten the M14 fasteners to **81 N-m (60 lb-ft) torque** and the M16 fasteners to **163 N-m (120 lb-ft) torque**. (ref Section 10.D)
      • Inspect and retighten the (6) M20-2.5 x 45mm bolts *(30mm wrench)* with Nord-Lock washers between the alternator and the yaw head, **390 N-m (298 lb-ft) torque**. (ref. Section 10.E)
      • Remove the nose cone and inspect the M22-2.50 self-locking nuts, tighten to **20 N-m (15 lb-ft) torque** *(beyond the prevailing torque of the nylon insert)*. (ref Section 10.G)
      • Inspect the nose cone for cracks or de-lamination (splitting of layers). Reinstall the nose cone and secure with (3) M8-1.25 x 16mm bolts *(13mm wrench)*, washers and lock washers tightened to **14 N-m (10 lb-ft) torque**. (ref Section 10.G)

   2. Slip Rings
      • Inspect slip ring brushes for proper alignment. Ensure that any wear is even and not excessive between one brush to another. Inspect all electrical splices and wires to ensure good connections. Ensure no wires have any frayed jackets.

   3. Interface Welds
      • Visually inspect the welds between the following interfaces for any signs of cracking or other types of failure.
         - Yaw Bearing Interface Flange to Yaw Head Main Tube
         - Alternator Support Arm to Yaw Head Main Tube
         - Tail Support Arm to Yaw Head Main Tube
         - Inner Tail Boom Flange to Outer Boom Support Tube
         - Adjustment Plate Support to Tail Support Arm
         - Adjustment Plate
Figure 14.1. Interface welds on yaw head

Figure 14.2a-b. Interface welds on inner tail boom
4. Blades
   • Visually inspect each turbine blade. Inspect the leading edge, trailing edge and the tip for any cracking pitting or de-lamination (splitting of layers).

5. Tail Pin & Bearings
   • Visually inspect Tail Pivot pin and the bearings on the rod ends. The tail pin may show a slight wearing but it should not be more than 0.0625”.
   Inspect the bronze bearings for any indications of excessive wear resulting in elongation of the bore.

![Figure 14.3. Tail pin & bearings](image-url)
6. Tail Stop Bumpers
   - Visually inspect each stop bumper, and replace any worn components.

   *Figure 14.4. Tail stop bumpers*

7. Grease the Yaw Bearing
   - Use general purpose lithium grease. Pump in two or three squirts of grease with a grease gun into the grease fitting on the inside diameter of the yaw bearing.

   *Figure 14.5. Year bearing grease fitting*
8. Check Wiring

- Visually inspect all wiring for cracked insulation, fraying, loose connections, taughtness or other damage. Replace any damaged wires.
- Tighten any loose connections in any terminal blocks or breaker boxes between the turbine and the electronic controls.
- Check that all connections on the user side of the terminal blocks in the Voltage Clamp are securely tightened to 18 inch pounds of torque.
16. Component List & Drawing

*NOTE*: Exploded drawing and component list to be added in an addendum.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Qty</th>
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*Table 16.1. Component list*
Five-Year Warranty for
ABUNDANT RENEWABLE ENERGY
Wind Generators

WARRANTY AGREEMENT
In order to validate this Warranty Agreement, the Customer must detach, complete, and return the ARE Mail-in Warranty Form (page 2 of this Agreement) within one (1) month of installation or seven (7) months of receipt of warranted ARE products, whichever occurs first.

Abundant Renewable Energy (ARE) warrants that the wind turbines it manufactures will be in good working order, in accordance with ARE standard specifications, upon delivery to its customers and for a period of 66 months from the date of delivery or 60 months from the date of installation, whichever occurs first. During the warranty period ARE will, at its sole discretion, repair, replace, or refund the purchase price of defective components and assemblies. Repair parts or replacement product may be new, remanufactured, or refurbished, at the sole discretion of ARE. ARE is not responsible for any costs associated with the installation, removal, reinstallation, or transportation to ARE (or to an ARE dealer) of defective ARE products. Return freight to the customer will be provided by ARE. Product or components returned to ARE, which are not defective or which sustained damage not covered under this warranty, will be tested and/or repaired at ARE’s standard labor rates. Only warranty claims submitted to ARE in writing within 15 days of problem origin will be honored.

GOVERNING LAW AND DISPUTE RESOLUTION
This Agreement will be interpreted and enforced according to Oregon state laws or U.S. federal laws, whichever has jurisdiction. Oregon law, without reference to conflicts of laws principles, shall control the interpretation and enforcement of this Agreement.

In the event that any dispute, controversy, or claim between the Parties arising out of or relating to this Agreement cannot be settled by negotiation or mediation, the parties agree to have the dispute, controversy, or claim settled by Arbitration Service of Portland, Inc. Any arbitration is to be conducted in Portland, Oregon. The Parties agree that any determination by the arbitrator(s) shall be final and binding and that judgment upon the award may be entered in any court having competent jurisdiction. The arbitrators shall have no authority to award punitive damages.

EXCLUSIONS
This warranty does not cover the following:
- Towers, equipment, materials, or supplies not manufactured or supplied by ARE (Towers manufactured or sold by ARE are covered by their own separate warranty.)
- ARE equipment which has been improperly installed or modified without approval from ARE
- Damage or loss from winds in excess of 45 m/s (100 mph)
- Lightning damage or other “acts of God”. (The ARE lightning protection package provides its own individual warranty related to lightning damage to wind generators and related controls)
- Incidental or consequential damages
- Damage to product incurred during shipping

PRODUCT CHANGES
ARE reserves the right to make design changes, improvements, or additions to its products without obligation to install such changes or improvements in existing products.

Turbine Warranty, Rev. 02/06/06

© 2008 Abundant Renewable Energy, LLC
ARE Wind Generator
Warranty Agreement Form

Customer / End User Name ________________________________________________

Customer Address _______________________________________________________
____________________________________________________________________
____________________________________________________________________

Customer Phone ________________________   Email __________________________

ARE Dealer / Installer Name & State (if applicable) __________________________
____________________________________________________________________

Product Part Number (e.g. ARE110) ________________________________________

Alternator Serial # ______________________________________________________

Mainframe / Yaw Head Serial # ___________________________________________

Controller / Voltage Clamp Serial # _______________________________________

Inverter Serial # (grid-tie systems only) ___________________________________

Resistor Load Serial # ___________________________________________________

Date Product Received _________________    Installation Date _________________

Dealer Signature (if applicable) ___________________________________________

End User Signature _____________________________________________________

Send Completed Form to:
ABUNDANT RENEWABLE ENERGY
22700 NE Mountain Top Road
Newberg, OR 97132
Phone: (503) 538-8298
Fax: (503) 538-8782
Email: info@AbundantRE.com
Website: www.AbundantRE.com

Turbine Warranty, Rev. 02/06/06

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