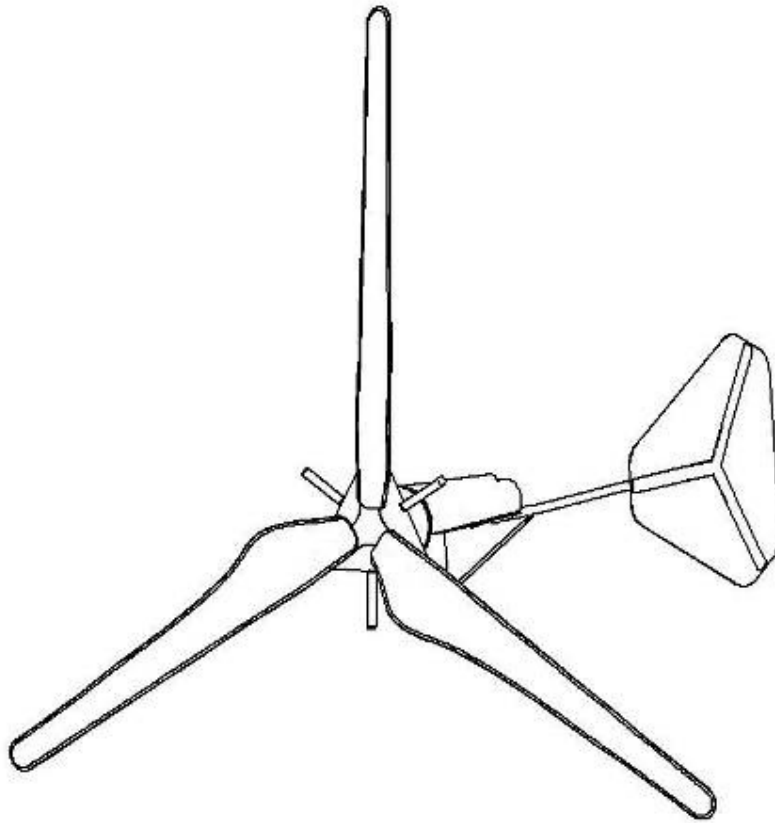


TechnoSpin Inc.



PowerSpin TSW 2200

Owner's Manual

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Important Note

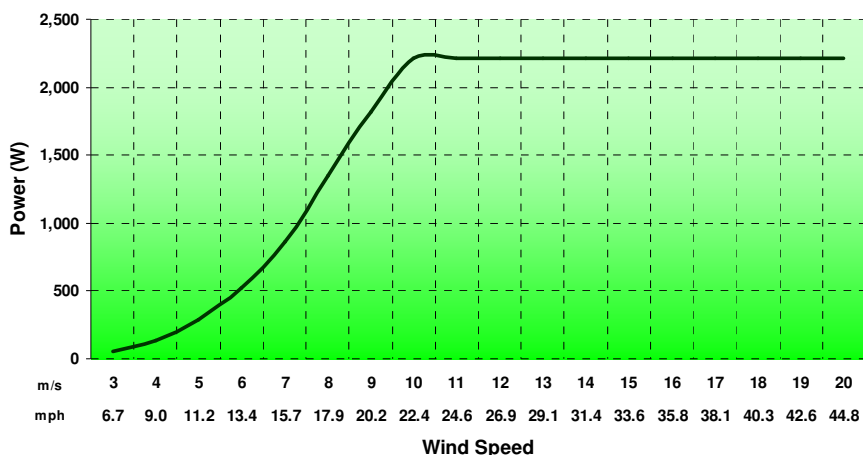
A TechnoSpin wind turbine is a complicated piece of machinery. While no special skills are required to operate the turbine, it should be installed, connected and dismantled by qualified installers only

Technical Specifications Review

Technical Specifications

Rotor Diameter	3.5 m (11.5 ft)
Weight	55 kg (121 lb)
Rated Power	2.2 kW
Rotor Efficiency	up to 45%
Swept Area	9.6 m ² (103 ft ²)
Tip Speed Ratio	6
Number of blades	3
Type	Upwind, Yaw Control
RPM	up to 550
Yearly Energy Output	4,400 kWh at average wind speed of 5 m/s (11.2 mph)
Start-up Wind	2.5 m/s (5.6 mph)
Survival Wind	55 m/s (123 mph)
Generator	Permanent Magnet Generator
Voltage for Battery Charging	12-48 V DC
Voltage for Grid Connection	Adjusted to requirements of inverter
Over speed Protection	Mechanical and Electrical System
Temperature Range	-40 to + 70 C (-40 to 158 F)
Stub Dimensions	Outer diameter 106mm (~4.2")
Top Tower Dimensions	Inner diameter 107-110mm (4.2"-4.3")
Maximum Axial Load	150 Kg force (330 lb)
Separate Tower Height	Minimum 6 m (19.7 ft)
Installation	Rooftop or tower
Product Design Life	30 years
Warranty	5 years

Power Curve



* Power curve data measured with appropriate load. Power data at exit from turbine.

Electric Specifications

Generator:

High Voltage PMG Generator.

Electronics:

- Off-grid installation
 - Tailor-made Charge Controller with MPPT, LVD (Low Voltage Disconnection) and over voltage protection – for 24/48V
- Grid-tie installation
 - High voltage rectifier for grid-tie inverter configuration.
 - Grid-tie Inverter (not supplied): Any Grid-tie inverter approved by TechnoSpin
- Cable: Recommended 3-wires 2.5mm² (13 gauge) each or more – must be **flexible**.

Lightning protection:

The following are lightning protections required for the components:

- The turbine: Grounding – see appendix.
- Grid-tie Inverter (not supplied) - must have Lightning Protection.
- Charge Controller: transformer based input.

Important: all electric connections must be performed by a certified electrician.

Mechanical Specifications

Total weight

Assembled turbine - 55 kg (121 lb).

Total package weight (for grid-tie application) - 64 Kg (141 lb).

Total package weight (for off grid application) - 110 Kg (242 lb).

Recommended tower height

Minimum 6 m (19.7 ft); in any case it must be 2.8 m (9.2 ft) above any close object. Top 2 m (6.5 ft) of the tower tube (measured from generator axis) should be clear of any structural additions.

Furling:

Wind furling by over pressure sensing.

Survival Systems:

Mechanical Furling and Electronic brakes (dump).

Connection to tower:

Adaptor for 107 mm (4") ID is supplied. (See mounting drawing).

Tower strength:

The tower must withstand a horizontal force of at least 150 kgF (330lbF) at its tip. In case the tower is not constructed solely from 4" structural steel piping, the top end of the tower must be a 4" pipe with an inner diameter of 107-110mm (4.2"-4.3") and recommended to be at least 2m (6.5 ft) long.

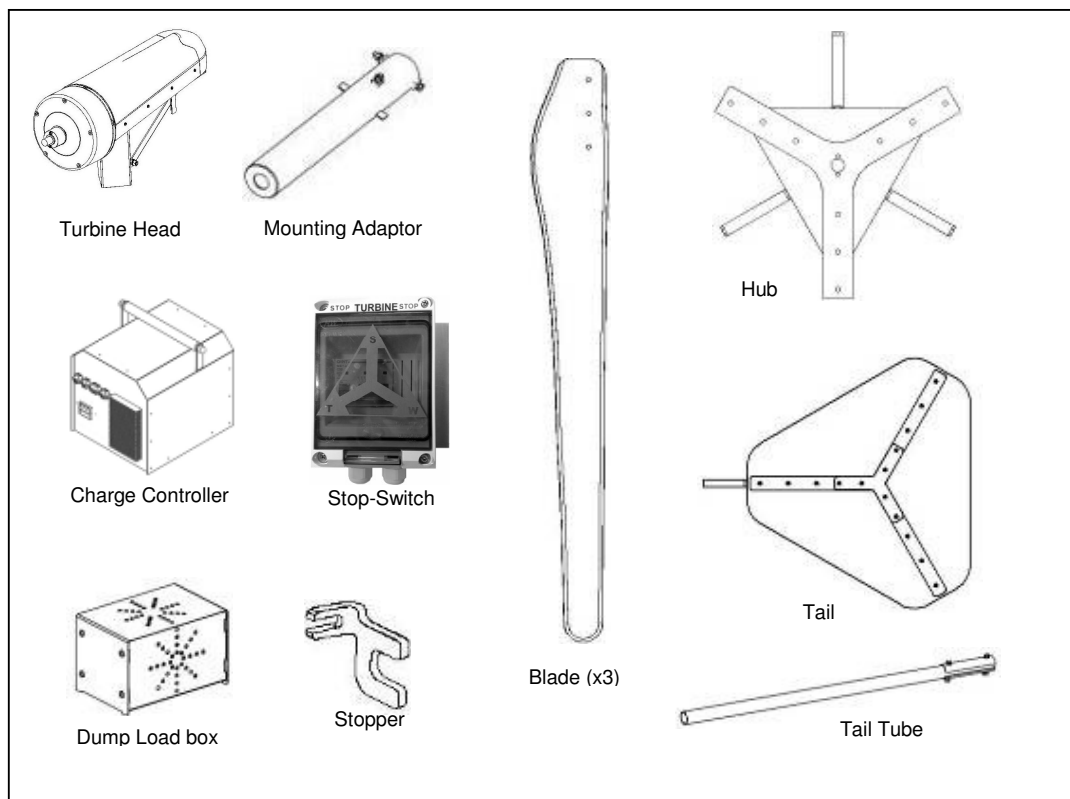
Assembly Preparation

Delivery Contents:

The following are the parts supplied for the PowerSpin TSW 2200:

Turbine Head, Charge Controller + Dump Load box (supplied with off-grid turbine version), Mounting Adaptor and Stop-Switch / Rectifier, Tail and Tail Tube, Blades (three) attached to hub.

Package Contents



Notes:

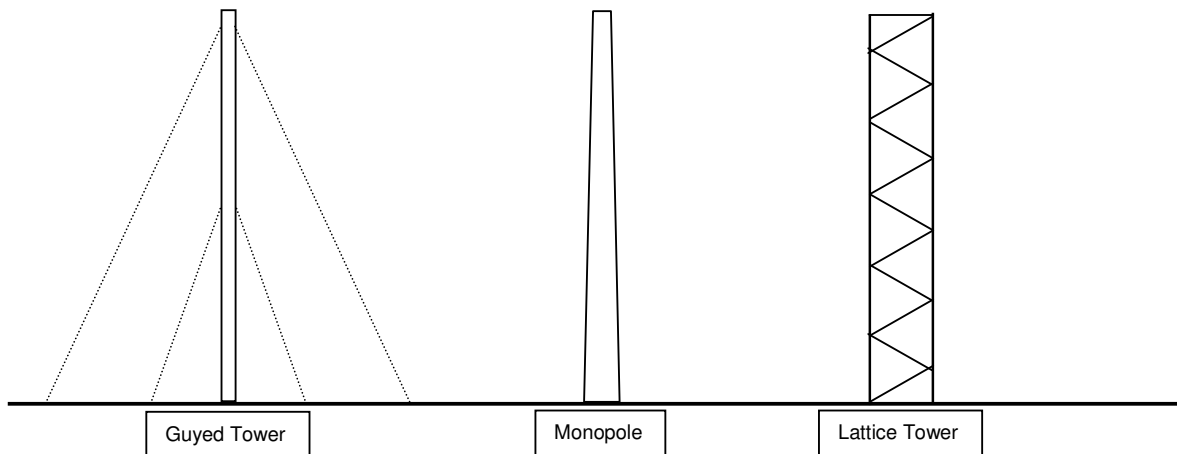
- Images of box contents are not scaled.
- Charge controller and dump load box supplied for off-grid installation only.
- All bolts, nuts etc. are already in their designated places and in proper order.
- Always refer to the manual when assembling.
- All nuts may be fastened with an electric powered screw driver.

Choose the Site for TechnoSpin's Wind Turbine

Selecting a site to locate the PowerSpin TSW 2200 is extremely important and greatly affects overall performance. Take care when selecting the installation site, attention should be given to high obstacles such as trees, buildings and hills which affect wind flow and may reduce wind speed. It is also recommended to survey the site and identify the prevailing wind direction. Installing the PowerSpin TSW 2200 while taking these considerations in account, will improve performance.




Tower Types

TechnoSpin's wind turbine can be mounted on several different types of towers: guyed tower, monopole or lattice tower.



Assembly procedure

Required tools for assembly:

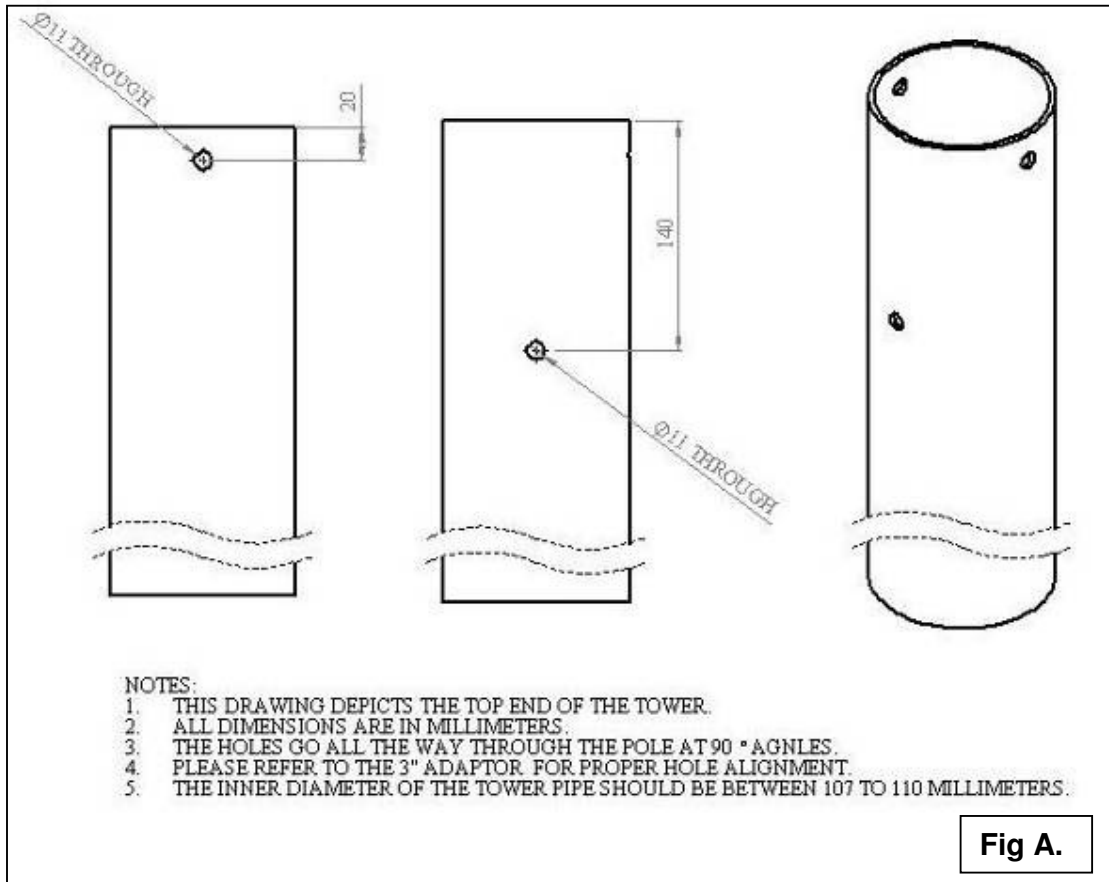
-  • Flat head screwdriver (4mm).
-  • Wrenches / Spanners: 7,10,14,17,19,36 (mm).
-  • Philips screwdriver (PH3).

Unpacking

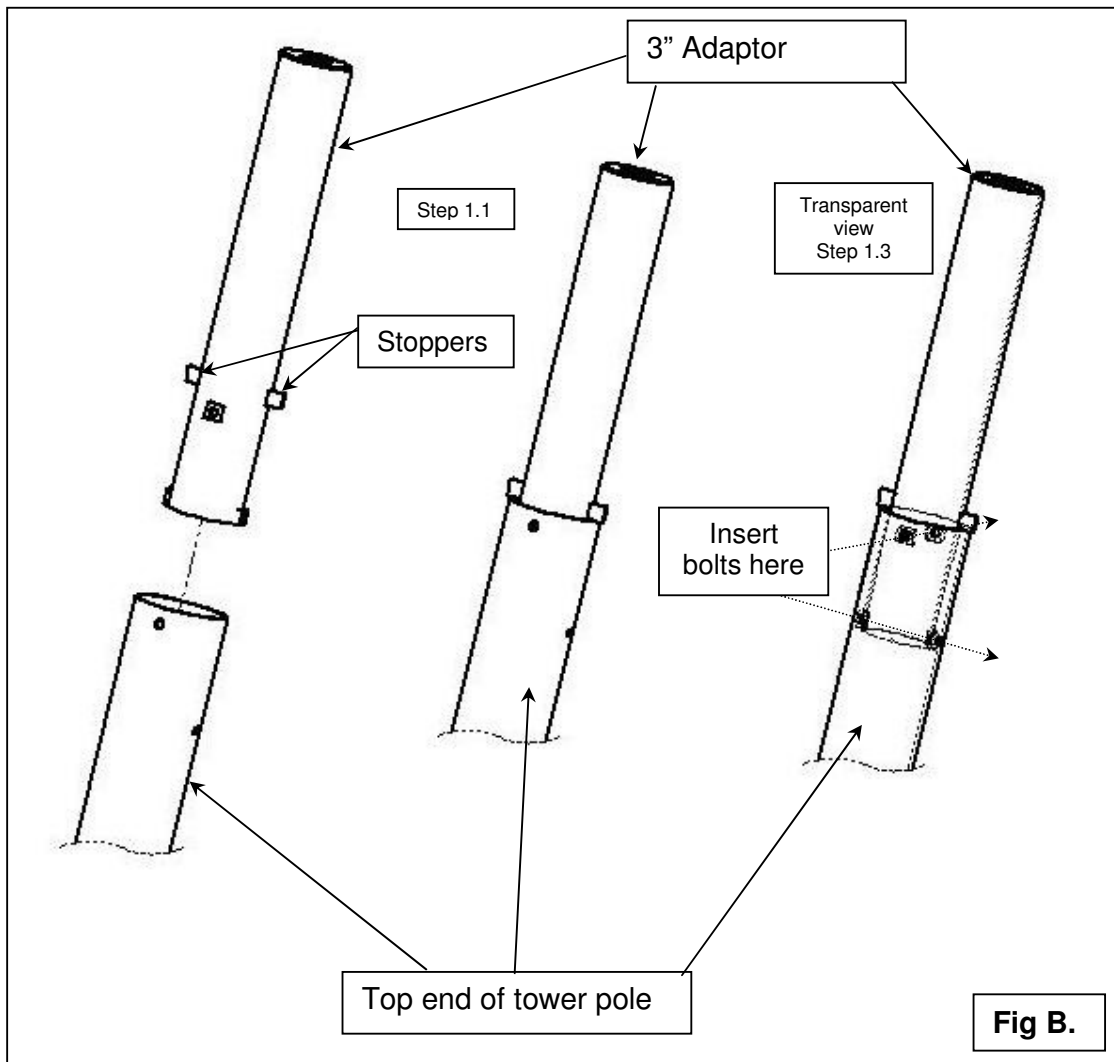
Before you begin, inspect the contents of each package to make sure that none of the parts were damaged during shipping and that no parts are missing. If any of the components are missing or damaged, please contact TechnoSpin or your local TechnoSpin dealer immediately. If you have any questions, contact TechnoSpin or your local TechnoSpin dealer before continuing the assembly procedure.

1. Attach the 3" adaptor to the 4" tube part of the tower (top of tower):

Two holes ($\varnothing 12 \pm 1 \text{ mm}$) must be drilled in the designated pole (see Fig A).

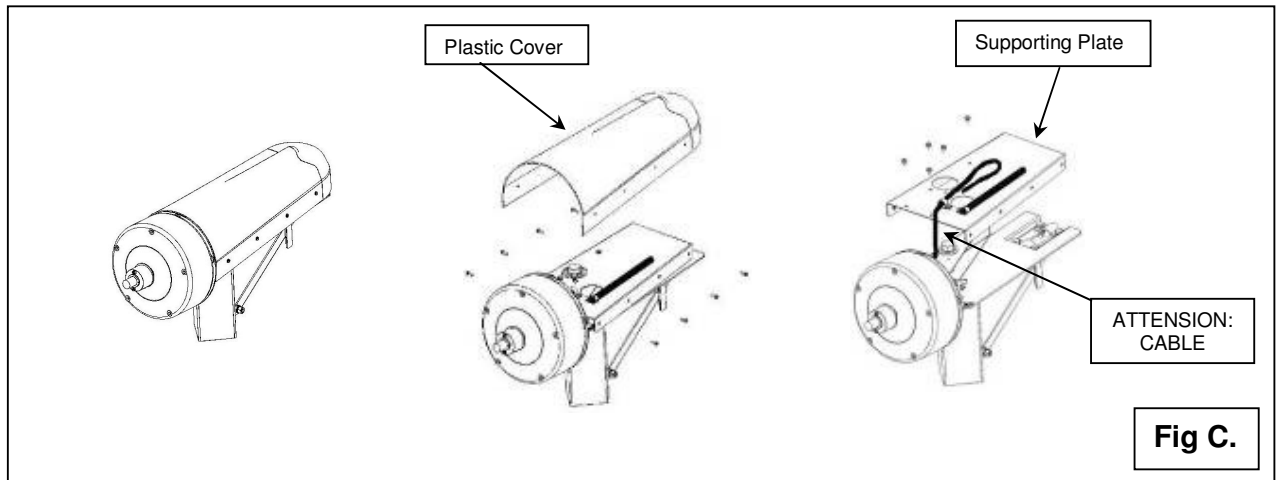


- 1.1 Insert the 3" adaptor into the top end of the designated pole (not supplied by TechnoSpin) up to the two protruding stoppers as shown (Fig B).
- 1.2 Follow by aligning the crossing holes in both the adaptor and pole.
- 1.3 Insert the two supplied M10x140mm bolts and fasten them tightly.



2. Cover removal:

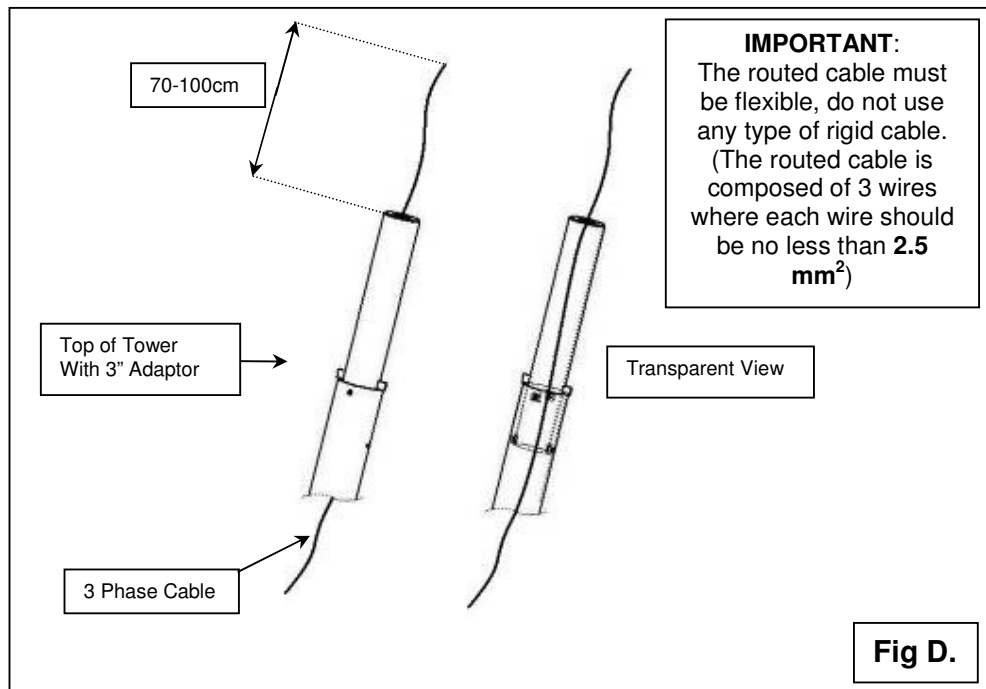
- 2.1 Remove the screws holding the plastic cover (8 screws) and remove the cover (Fig C).
- 2.2 Remove the screws holding the metal supporting plate (5 screws), and remove the plate as shown (pay attention to the cable that is attached to the plate, and do not disconnect any of the wires).



3. Cable routing:

- 3.1 Route the cable that is to be connected to the designated electric equipment (cable not supplied by TechnoSpin) through the tower pole so that a length of 70-100cm (2.3 - 3.3 feet) of the cable will protrude from the top end of the tower (Fig D).

Note: It is recommended to route from top to bottom.



4. Mounting the hub and blades:

Note: Hub and blade installation may be done in several ways, we recommend the following option:

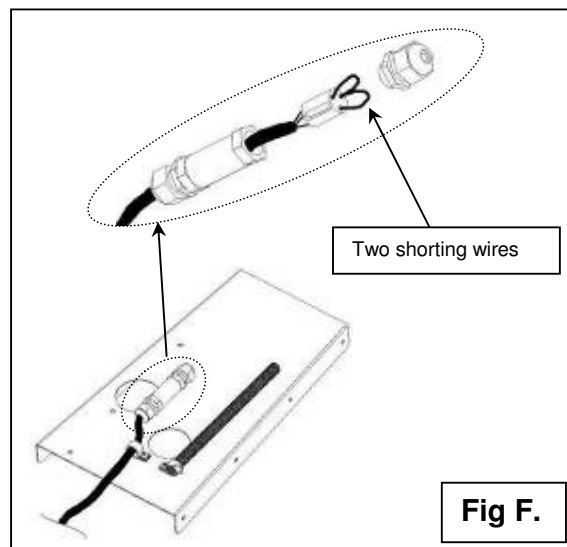
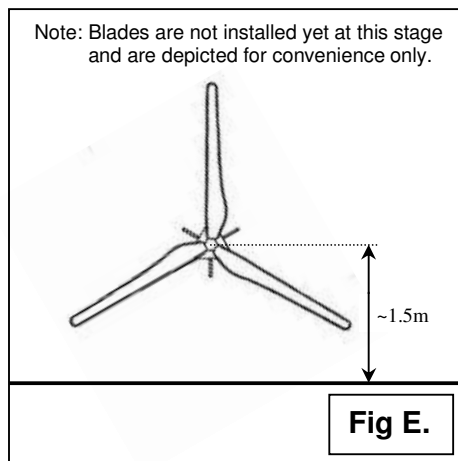
- 4.1 Place the turbine head on a temporary pole, high enough so that after the blades will be installed they will be clear of the floor and verify that no obstacles are in the vicinity (Fig E.).

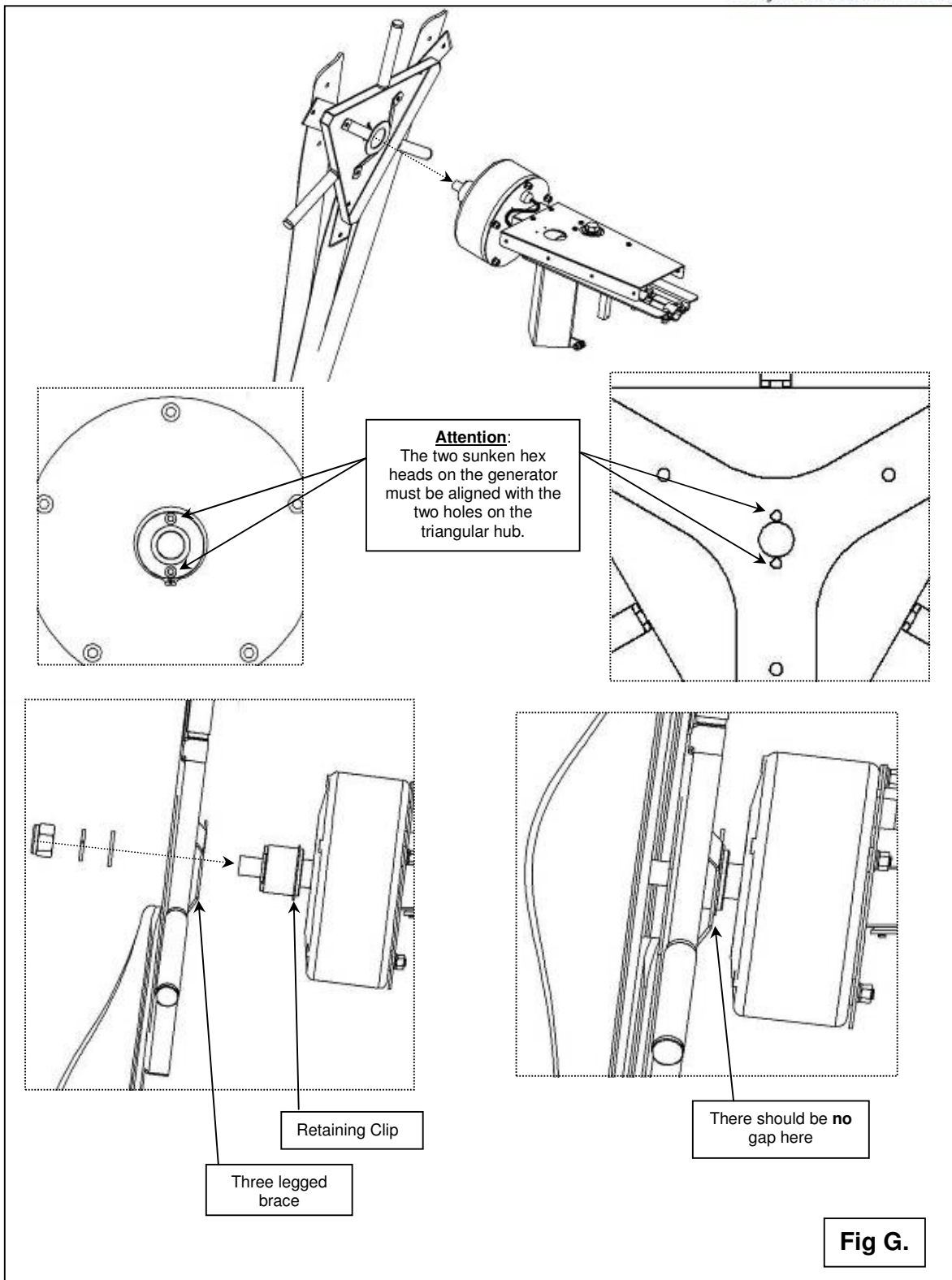
Generator Test:

- 4.1.1 At this stage perform a generator test by turning the generator axis manually (it is recommended to wear a protective glove) before attaching the hub. The axis must provide resistance.
- 4.1.2 Follow by removing the two shorting wires from the three phase connector on the metal support plate (Fig. F) and repeat step 4.1.1. The axis must now turn freely. **Replace the shorting wires afterwards.**
- 4.1.3 If you experience different results from the above mentioned, please contact TechnoSpin or your local TechnoSpin dealer.
- 4.2 Mount the triangular hub and blade assembly onto the generator axis as shown, and fasten the M20 nut tightly (Fig G). Make sure that the three legged brace is in contact with the retainer clip (Fig G), if not please contact TechoSpin or your local dealer.

Note: Regularly the blades are packed while connected to the hub in the correct order. If for any reason the blades and hub arrive separately refer to step 4.3, otherwise skip this step.

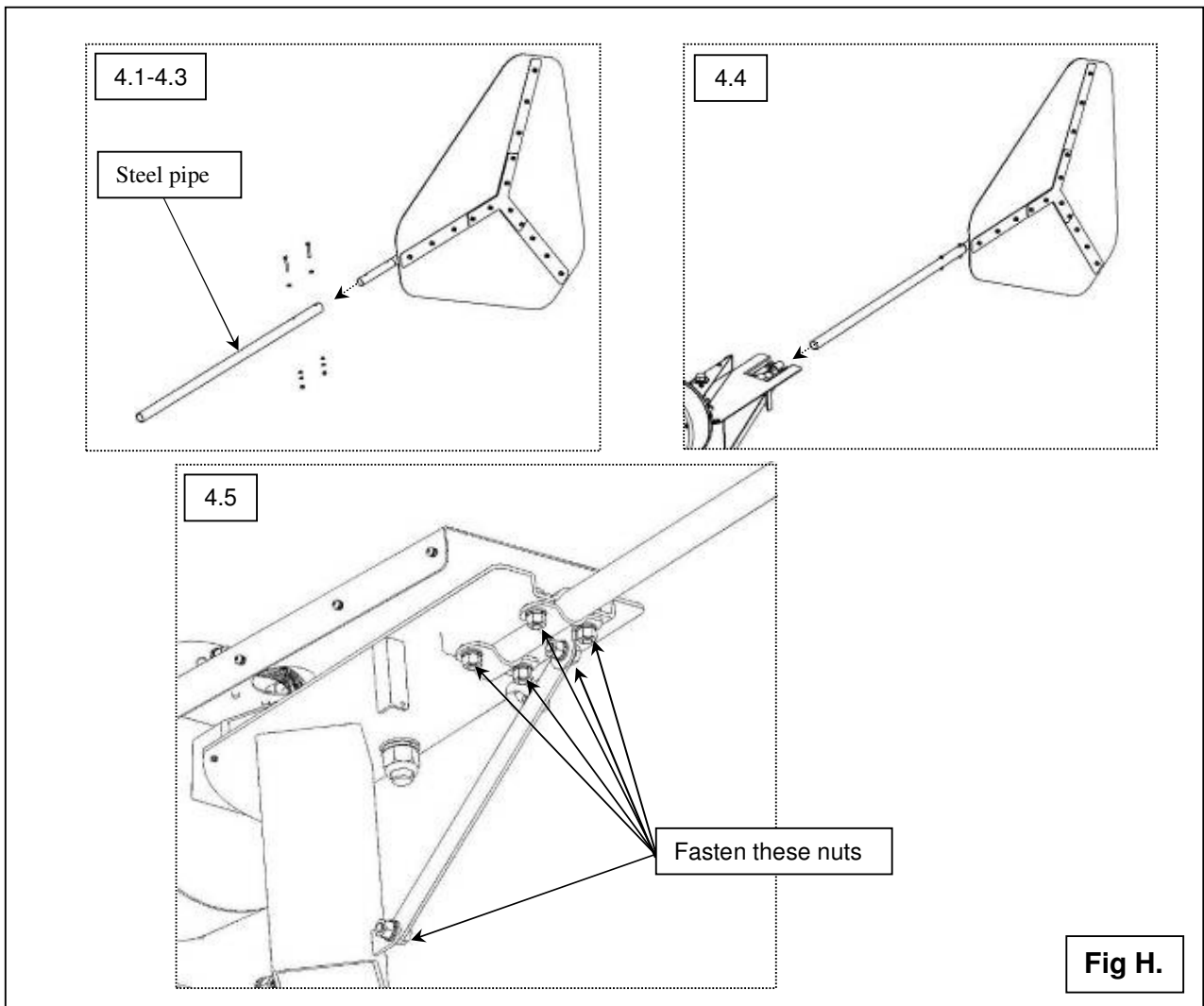
- 4.3 Mount each of the marked blades onto its corresponding mount (blade #1 to mount #1, blade #2 to mount #2... etc).
- 4.4 Fasten the three nuts of each blade tightly.
Note: Do not use any form of extension on the wrench handle while tightening the blade nuts.
- 4.5 Place the black plastic caps on top of the three bolt heads on each blade.





4 Tail assembly:

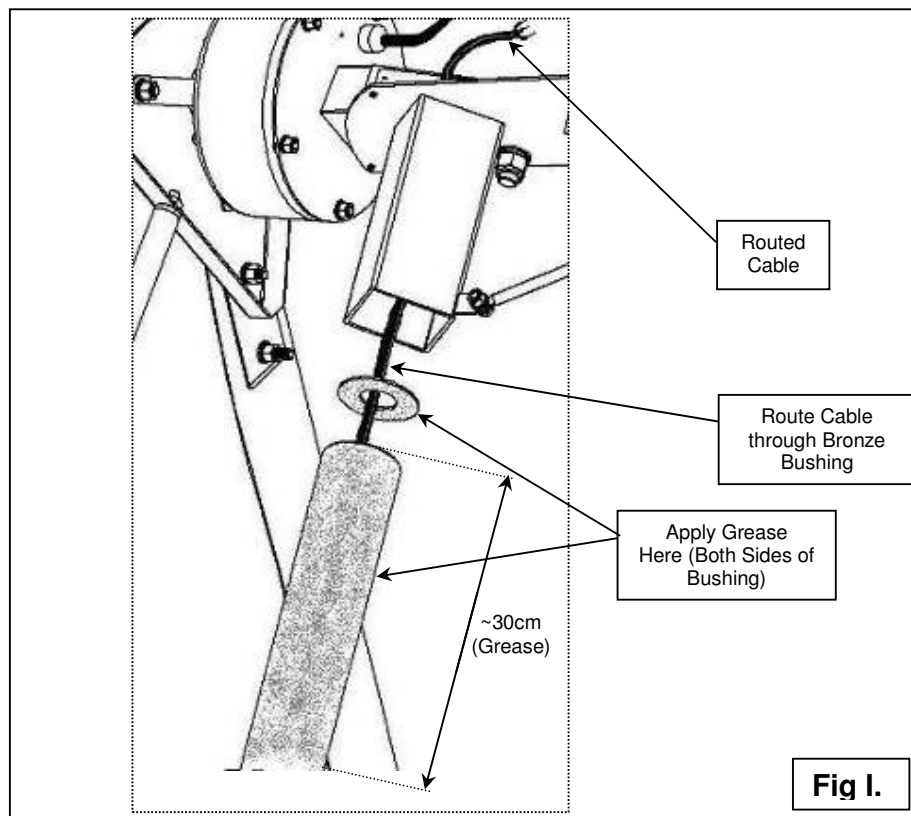
- 4.1 Insert the partially assembled tail fin into the steel tail pipe as shown (Fig H).
- 4.2 Align the two holes in the fin assembly and in the pipe, and insert the two bolts.
- 4.3 Fasten the two nuts.
- 4.4 Insert the steel tail pipe into the two fasteners at the back of the turbine body as shown in Fig. H., make sure the fin will be vertical once the turbine is erected.
- 4.5 Tighten all six nuts tightly to insure tail fixture.



5. Mounting the turbine:

You must short-circuit the generator prior to mounting the turbine (see p.24 “Turbine stopping procedure”). Only after a load is connected and all persons are clear of the turbine, may it be released.

- 5.1 Apply grease to the bronze bushing, and to the pole (actually the grease is applied to the assembled 3" adaptor at the top of the pole) (Fig I).
- 5.2 Mount the turbine onto the pole while routing the cable running up the pole through the turbine exit hole as shown (Fig. I), make sure that you first route the cable through the bronze bushing and that the bushing is placed between the pole and the turbine.
- 5.3 Pull the cable from the bottom of the pole or clip the remaining cable at the top of the pole leaving 50cm (1.7 feet) at the top. You must also have at least 1m (3.3 feet) of cable at the bottom of the pole.
- 5.4 Insert the red stopper as shown in Fig. J. Make sure you fasten the nut tightly and that the upper lip of the stopper is resting on the metal plate (see Fig J). During this procedure the turbine cable will also be present in the hole and should not pose a problem.
- 5.5 Route the cable through the spring sheath as shown in Fig. K. Pay attention to the extra routing loop at the edge of the spring and pass the cable through this loop as shown.
- 5.6 Connect the three wires (three phases) of the cable running through the pole to the three phase connector as shown in Fig. K. after disconnecting and removing the two shorting wires (Fig F), order of connection is of no importance.
- 5.7 Replace the support plate and fasten the appropriate screws (reverse step 2.2).
- 5.8 Replace the plastic cover and fasten the appropriate screws (reverse step 2.1).



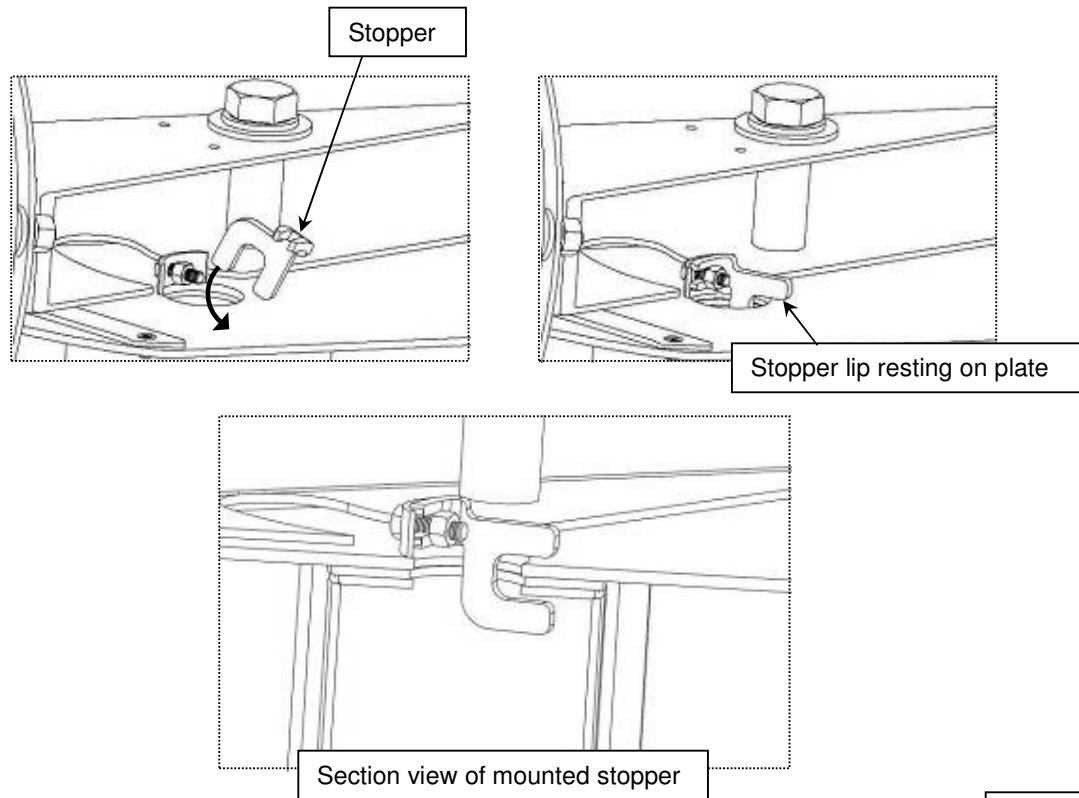


Fig J

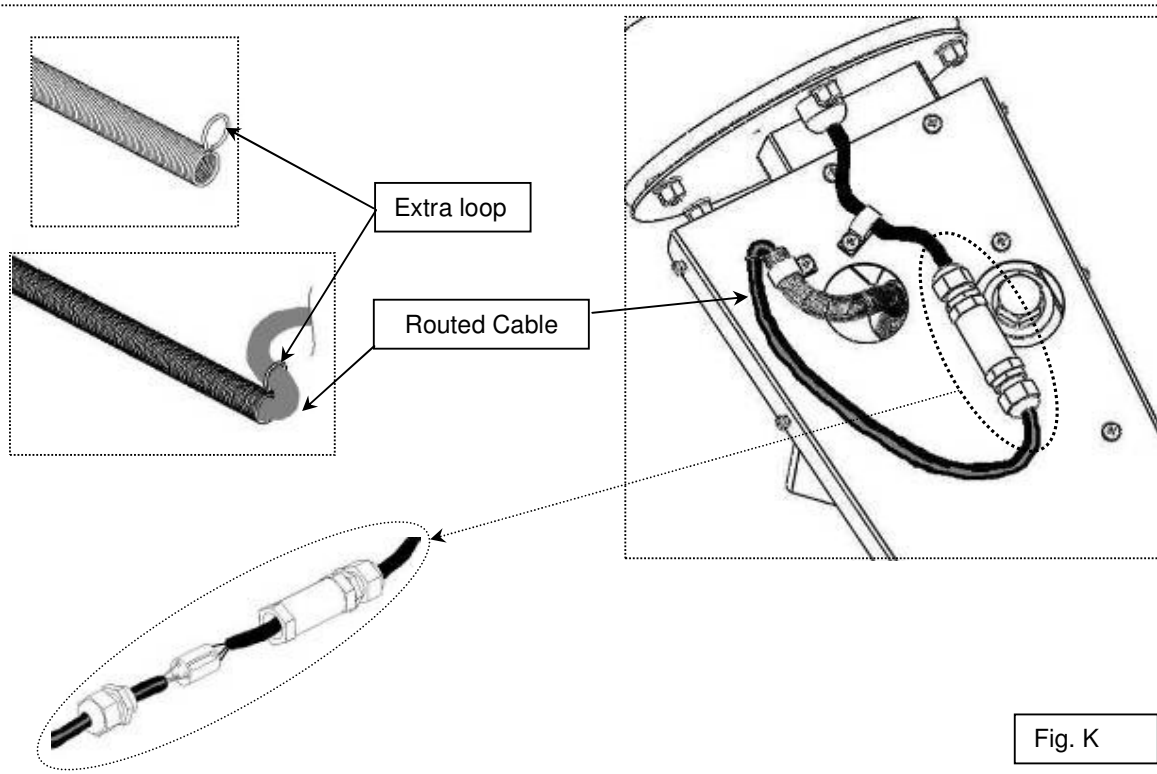


Fig. K

Electrical Connections

Please pay attention to the following titles and note which are relevant to your turbine installation (grid-tie or off-grid).

In any case, always remember that the turbine is the last component to be connected to any electrical setup, and in case disconnection of any connection is required, then the turbine must be disconnected first in accordance with the stopping procedure described herein (page 24).

Grid-tie installation: Grid-tie Inverter connection

Important: The connection of the grid-tie inverter to the turbine and to the grid should be performed according to the requirements of the inverter manufacturer.

Depending on the inverter ordered, TechnoSpin will provide a stop switch with a rectifier in order to connect it to the turbine, since some of the approved inverters require a rectifier.

The rectifier converts the 3-phase output of the turbine to DC voltage. The box has three input connectors and two output connectors going to the inverter. (See electrical connections for a grid-tie).

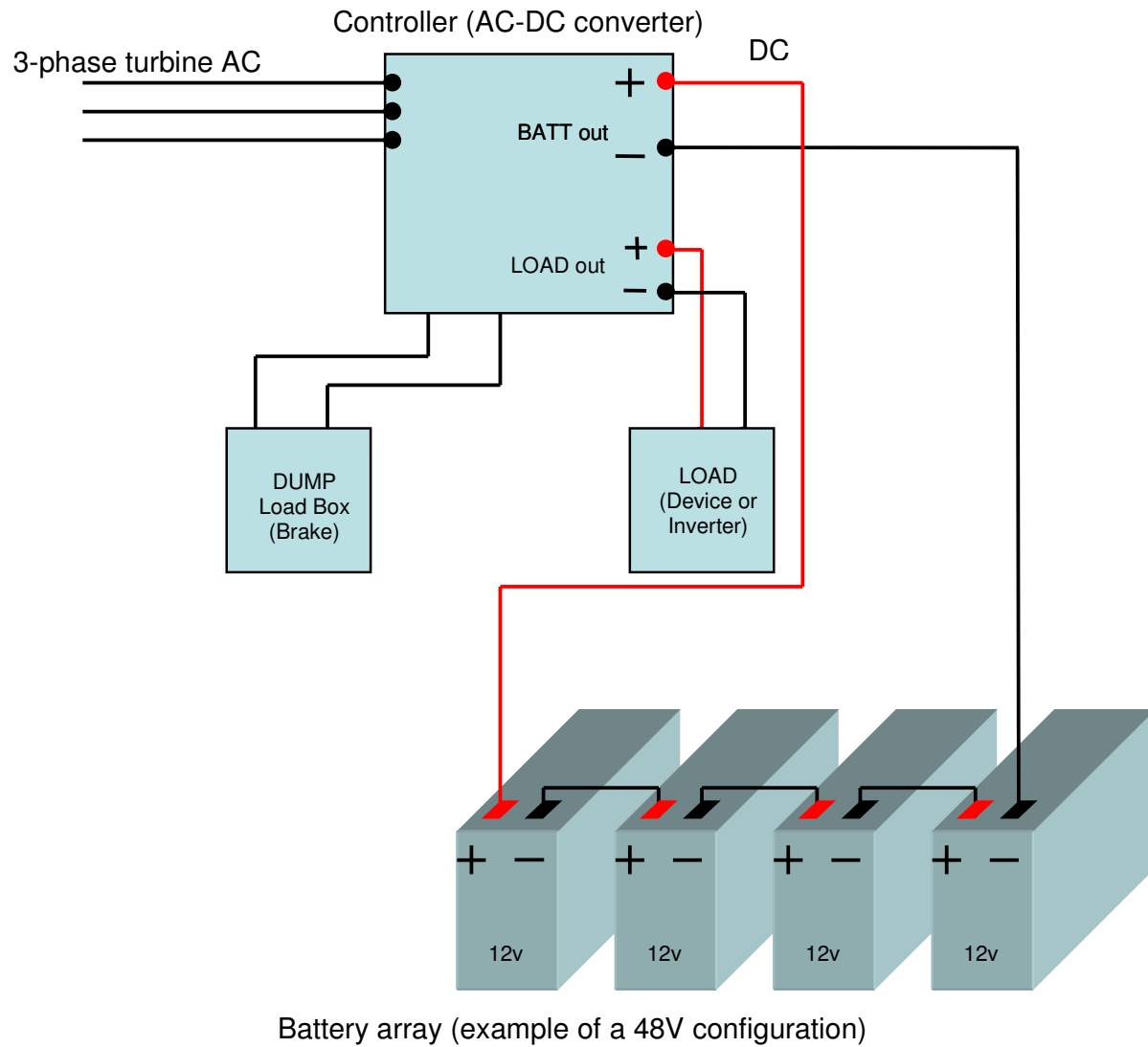
Off-grid installation: Charge Controller connection

For an off-grid installation, the battery charge controller should be connected as described below.

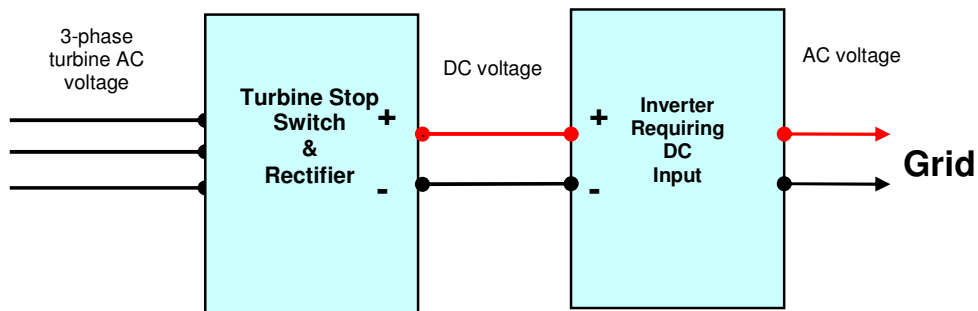
Both charge controller and dump-load box should be placed on a solid surface, **indoors** and out of reach of children (the controller may be wall mounted). The dump-load box may generate heat and should not be placed in proximity to heat sensitive equipment or flammable materials.

Important: Order of connection procedure is **critical**. Disconnection should be performed in the exact opposite order.

Electrical connection diagram of an off-grid installation



Electrical connection diagram of a grid-tie installation

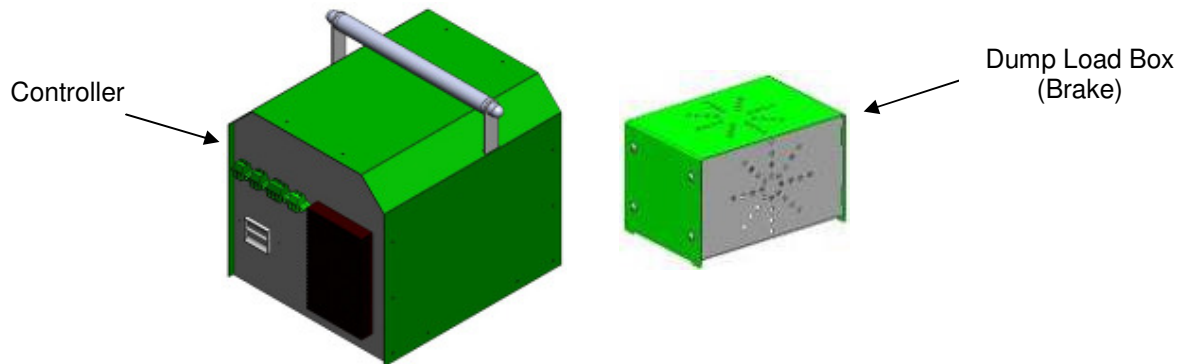


Note: As mentioned, some inverters do not require a rectifier and can be connected directly to the turbine.

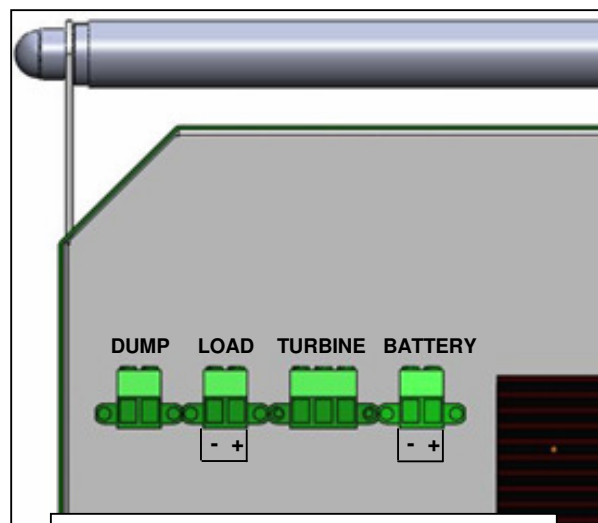
Off-grid Connection Procedure:

REMEMBER, THE TURBINE MUST BE CONNECTED LAST!!

1. Connect the dump load box (brake) to the controller using wires of no less than **2.5 mm² (13 gauge)**. The dump load boxes have **no** polarity.



2. Connect the battery bank to the controller. **Mind polarity!**
Wire gauges (keep these wires as short as possible):
For 48v array should be no less than **4.2 mm² (11 gauge)**.
For 24v array should be no less than **8.4 mm² (8 gauge)**.
3. Connect the load (appliance, inverter etc...) to the controller. **Mind polarity!**
Wire gauges (keep these wires as short as possible):
For 48v array should be no less than **4.2 mm² (11 gauge)**.
For 24v array should be no less than **8.4 mm² (8 gauge)**.
4. Connect the turbine to the charge controller with wires of no less than **2.5 mm² (13 gauge)**.
Connection order is insignificant. In case the required cable length is more than 50m (165 ft) in length, use wires of no less than **4 mm² (11 gauge)**.



Connect devices to the appropriate terminal, as shown here.

Indicators:

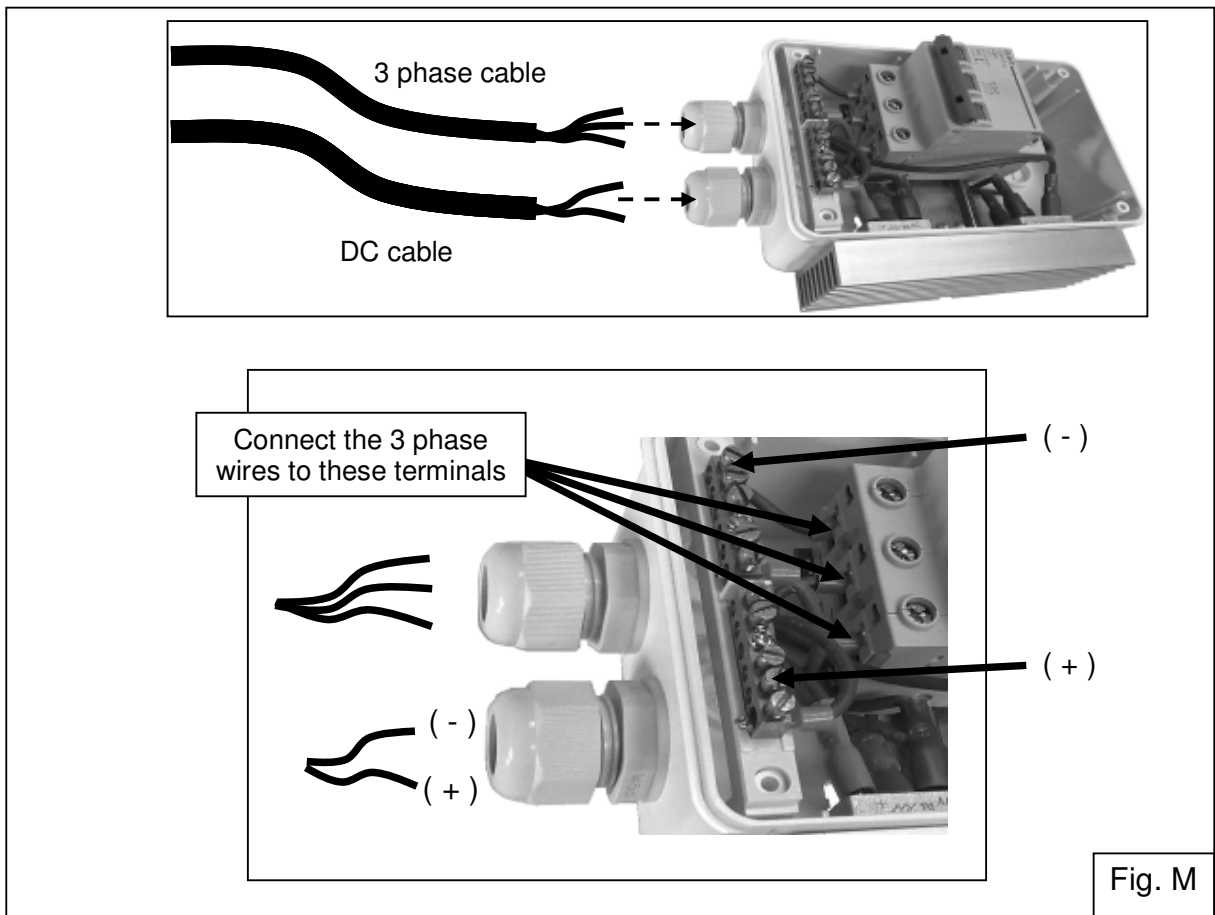
- Green LED: Batteries are charged, load is active.
- Red LED: Batteries are overcharged ($>15\text{v}$); load is active and dump-load is on.



Grid-tie Connection Procedure:

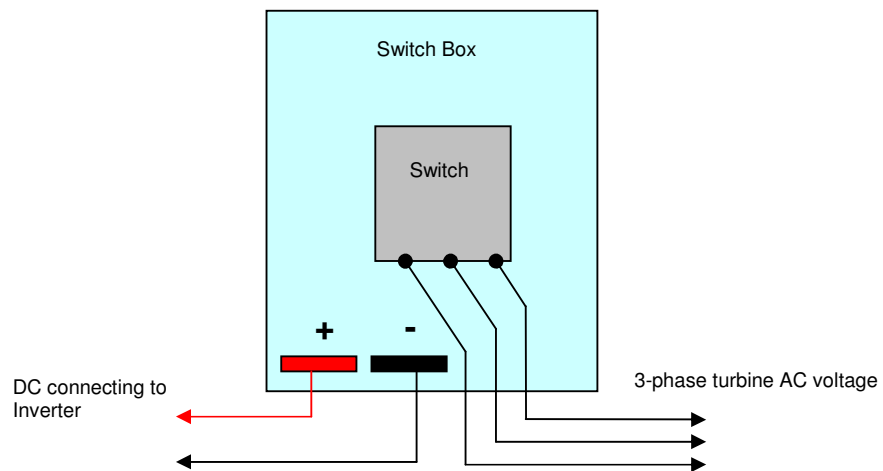
REMEMBER, THE TURBINE MUST BE CONNECTED LAST!!

1. Connect the inverter to the grid. (Please refer to the inverter manual).
2. Connect the turbine to the supplied stop-switch box as shown in Fig. M (3 phase wire) and in the connection diagrams (p. 23). Wire connection order is insignificant. Cable wires should be 2.5 mm² (13 gauge) or more.
3. Connect the DC output wire (that is to be connected to the inverter) as depicted in Fig. M, pay attention to the polarity symbols and connect the DC wires accordingly (+ to + , - to -). Cable wires should be 1.5 mm² (16 gauge) or more.



4. Connect the DC cable to the inverter. (Refer to inverter manual).

Stop-Switch connection diagram



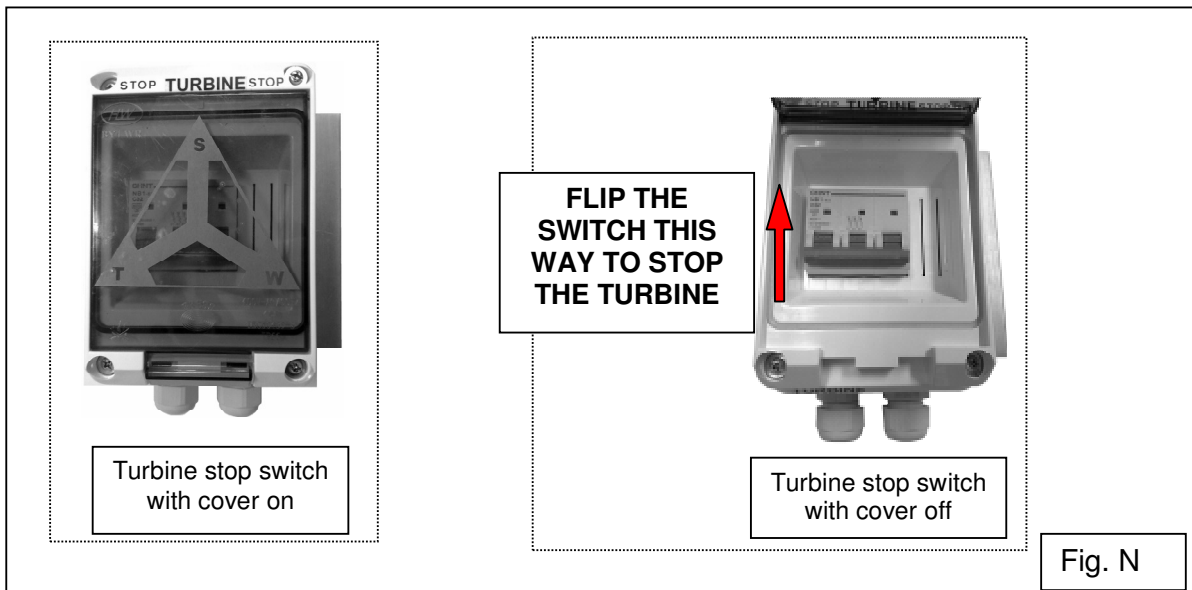
Turbine Stopping Procedure:

Important:

The turbine stopping procedure should be performed only by a certified electrician. Stopping the turbine should only be performed at a wind speed lower than 4 m/sec (9 mph).

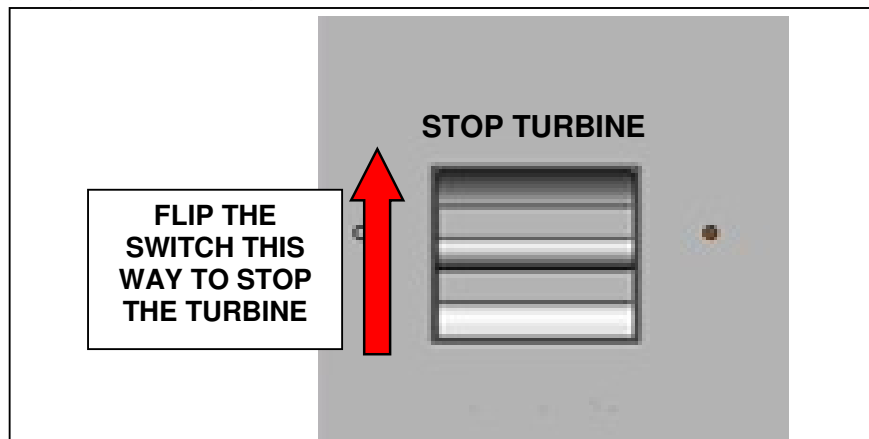
Grid-tie Installation:

In order to stop the turbine, TechnoSpin has included a switchbox. In case stopping the turbine is required, flip the switch as shown in Fig. N.



Off-grid installation:

In order to stop the turbine flip the controller switch marked “STOP TURBINE”.



The PowerSpin TSW 2200 is now ready to be lifted to its working position.

Non-Standard Applications:

TechnoSpin's Turbines are compatible with a variety of special applications, such as hybrid systems with PV (solar) panels and diesel generators, parallel connection of more than one turbine, connection into a local grid etc. For more information please contact support@tswind.com

Minimum wire thickness according to connection in mm² (in American wire gauge):

	Turbine Generator	Controller Box	Battery Bank	Inverter	Dump-load	Stop switch	Load
Turbine Generator		2.5 (13)*		2.5 (13)*		2.5 (13)*	
Controller Box	2.5 (13)*		**		2.5 (13)		**
Battery Bank		**					
Inverter	2.5 (13)*					1.5 (16)	2.5 (13)
Dump-load		2.5 (13)					
Stop switch	2.5 (13)*			1.5 (16)			
Load		**		2.5 (13)			

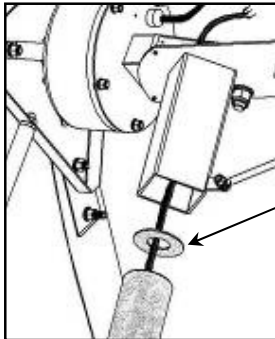
* Use 4mm² (11 gauge), in case the cable length exceeds 50m (165 ft).

** For 48v battery array **4.2 (11)**.
 For 24v battery array **8.4 (8)**.

Maintenance guidelines

Ongoing Inspection:

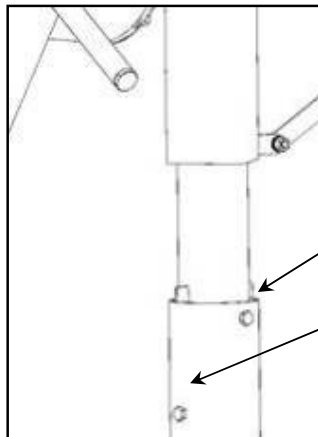
1. Yaw bushing: In case the turbine emits noise while yawing, apply grease to the bronze bushing. (See exploded view below).



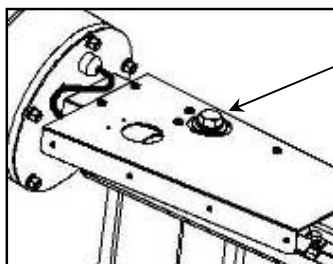
2. Pay attention to any unusual noises or other radical turbine behavior. If detected, contact the installer.

Annual Maintenance:

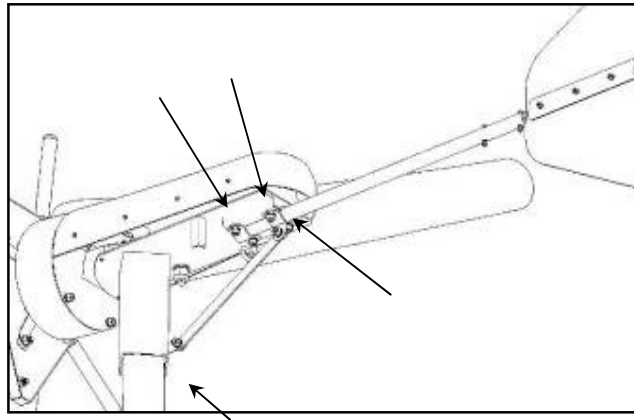
1. 3" adaptor: Tighten the two screws connecting the adaptor to the tower as needed. Tightening torque should not exceed 130 Nm



2. Furl axis: Check furling axis bolt and tighten if needed.



3. Tail pipe: Tighten the screws as needed.
Tightening torque should not exceed 130 Nm



4. **Off-Grid installations:** Examine battery bank, and verify that none of the cells have signs of corrosion. Also examine the insulation of all wires attached to the cells and other electrical components and verify that they are not charred, frayed or damaged. Replace wires if needed in accordance with the wire specifications in this manual.

ATTENTION: DO NOT DISCONNECT THE BATTERY BANK FROM THE TURBINE UNLESS THE TURBINE IS STOPPED.

5. Guyed tower: If your turbine is mounted on a guyed tower, verify the tension in all the cables and adjust if needed.
6. TechnoSpin Inc. recommends stopping the turbine and performing a visual inspection for any irregularities including: loose bolts & nuts, large corrosion stains, and cracks.

Appendix – Grounding

Tower grounding

- 1) This manual contains important instructions for tower grounding.
- 2) Read these instructions in their entirety before beginning.
- 3) Do not start installation unless all required equipment is on site.

Introduction

This document provides recommendations for grounding small wind turbine systems with rated line currents of less than 200A to achieve compliance with the 2005 USA National Electrical Code (NEC) as well as IEC (International Electrotechnical Commission) standard 60364-5-54 Selection and Erection of Electrical Equipment- Farthing Arrangements, Protective Conductors and Protective Bonding Conductors.

Please refer to the aforementioned NEC and IEC standards for complete detailed information.

Information contained in this document is provided as a reference.

Grounding Techniques

This manual describes two of the most prevalent tower grounding techniques compliant with NEC and IEC standards:

- a) Copper clad electrodes driven into the soil.
- b) Electrodes encased in the concrete of the tower foundation.

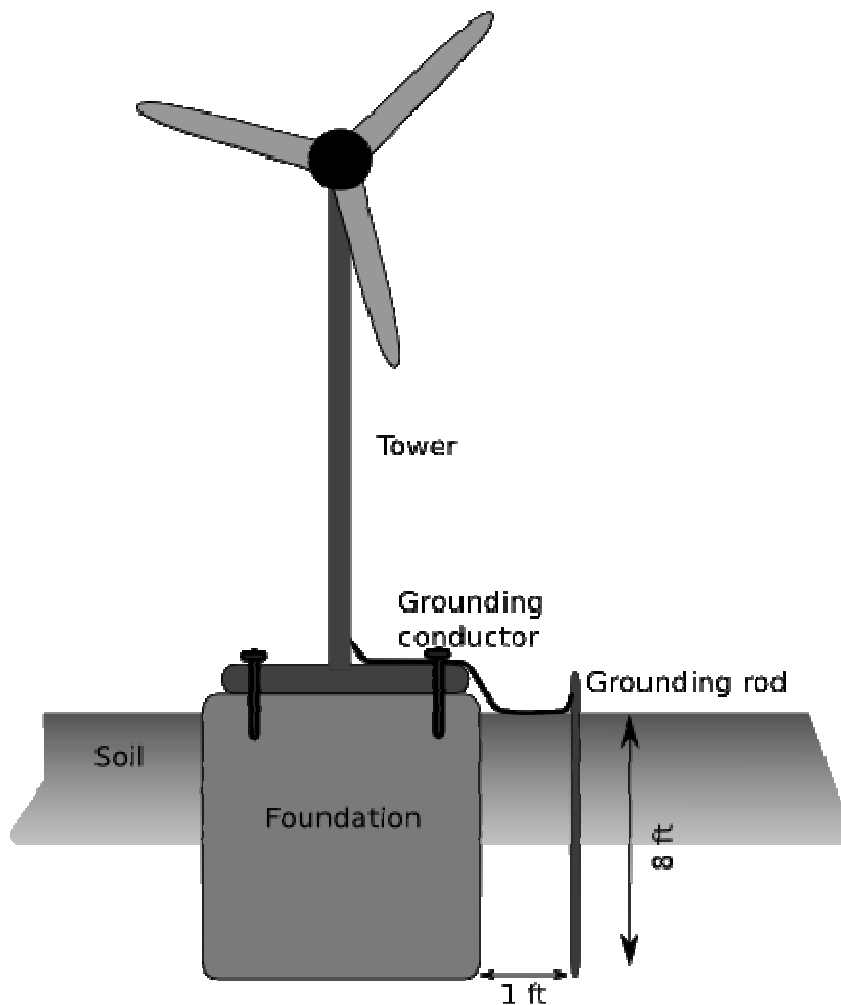
Copper Clad Electrodes Driven Into the Soil

Fig. 1 shows a typical grounded tower using an electrode driven into the soil.

- a) Electrodes of pipe or conduit shall not be smaller than metric designator 21 and where of iron or steel, shall have the outer galvanized or otherwise metal-coated for corrosion protection.
- b) Electrodes of rods of iron or steel shall be at least 16 mm (5/8 in) in diameter. Stainless steel rods less than 16 mm (5/8 in) in diameter.
Nonferrous rods shall not be less than 13 mm (1/2 in) in diameter.

Other grounding electrode types may be used as recommended in 2005 NEC section 250.52.

Fig 1. Electrode driven into ground



Grounding Electrode Installation

The following information is excerpted from the 2005 NEC article 250.53 (G). Refer to code for additional detailed information.

The electrode shall be installed such that at least 2.44 m (8 ft) of length is in contact with the soil. It shall be driven into undisturbed soil within 305 mm (1 ft) of the tower foundation. It shall be driven to a depth of not less than 2.44 m (8 ft) except that, where rock bottom is encountered, the electrode shall be driven at an oblique angle not to exceed 45 degrees, the electrode shall be permitted to be buried in a trench that is at least 750 mm (30 in) deep. The upper end of the electrode shall be flush with or below ground level unless the aboveground end and grounding electrode conductor are protected against physical damage as specified below (quoted from 2005 NEC article 250.10):

- a) In installation where they are not likely to be damaged.
- b) Where enclosed in metal, wood, or equivalent protective covering.

Electrode Resistance to Ground

The resistance to earth of a single ground rod can be calculated using Dwight's equation:

$$\Theta = \left(\frac{r}{2\pi a} \right) \times (\ln(4a/R) - 1)$$

r-soil receptivity

a-length of the rod buried inside the earth

R-radius of the rod

Grounding Electrode Conductor:

Material, Size, Bonding to electrode and Bonding to Tower.

Material (Ref. 2005 NEC article 250.62, 250.96(A)):

The grounding electrode conductor shall be of copper, aluminum, or copper-clad aluminum. The material selected shall be resistant to any corrosive condition existing at the installation or shall be suitably protected against corrosion. The conductor shall be solid or stranded, insulated, covered or bare. Any non-conductive paint, enamel, or similar coating shall be removed at threads, contact point, and contact surfaces or be connected by means of fittings designed so as to make such removal unnecessary.

Conductor Size

(Ref. 2005 NEC article 250.66 A)):

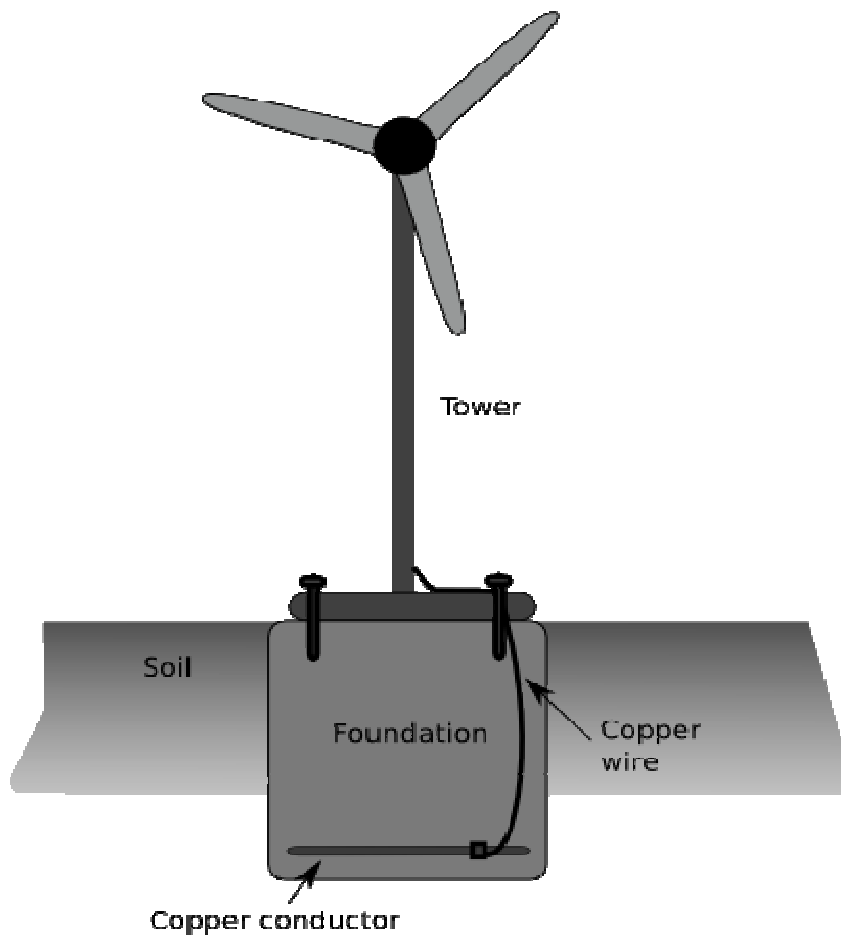
Where the grounding electrode conductor is connected to rod, pipe or plate electrodes, that portion of the conductor that is the sole connection to the grounding electrode shall be a minimum of 6 AWG copper wire or 4 AWG aluminum wire.

Bonding the Electrode Conductor to the Earth Electrode

(Ref. 2005 NEC article 250.70):

The grounding or bonding conductor shall be connected to the grounding electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps, or other listed means. Connections depending on solder shall not be used. Ground clamps shall be listed (approved) for the material of the grounding electrode and the grounding electrode conductor and, where used on pipe, rod or other buried electrodes, shall also be listed for direct soil burial.

Fig.2
Concrete
encased
electrode



Electrodes encased in the concrete of the tower foundation

(Ref. 2005 NEC article 250.52 (A)(3)):

A grounding electrode may also be encased in the concrete of the tower foundation. The electrode is located at the bottom of the foundation and connects to the tower mounting “J” bolts and to the tower base by means of a grounding conductor.

Because the grounding electrode will be encased in concrete it should be inspected and approved prior to pouring the foundation to avoid conflicts with local constriction inspector.

Two types of electrodes, their locations and their connection to the electrode grounding conductor are described below:

- a)** The Electrode must be at least 6m (20 ft) of one or more (electrically connected by steel tie wires) bare or zinc galvanized steel or other electrically conductive coated steel reinforcing bars or rods of not less than 13 mm (0.5 in) in diameter, located near the bottom of the concrete foundation that is in direct contact with the earth. The electrode must be encased by at least 50 mm (2 in) of concrete as show in figure 2. The reinforcing bars, if bare, must not be rusted at the time of installation to prevent bad electrical connection between bars and with the grounding electrode conductors. The reinforcing bars must be electrically connected to the anchor bolts either using the steel tie wires or using the grounding electrode conductor. The grounding electrode conductor must not be smaller than 4AWG cooper and must be electrically bounded to the bottom reinforcing bars using listed/approved means that is suitable for concrete encasement. Sufficient extra length of the conductor must be available to bring it out of the foundation op and at least 457 mm (18 in) above the foundation top.
- b)** The Electrode must be least 6 m (20 ft) of bare copper conductor not smaller than 4AWG. The cooper conductor, which may be in the form of a coil, must lie at the bottom of the foundation with either a 50 mm (2 in) thick (maximum) tamped fill of earth covering the grounding coil or covered in concrete a maximum of 50 mm (2 in) above the soil at the bottom of the foundation. Sufficient extra length must be present in the copper conductor to bring it at least 457 mm (18 in) above the foundation top where it should be bounded to the tower. On its way up, the copper conductor must also be bounded to the tower anchor bolts using a clamp listed or approved means that is suitable for concrete encasement and also suitable for connecting cooper to steel. This listed clamp is generally tin plated and must be of the type to prevent direct contact between cooper and steel to prevent corrosion.

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