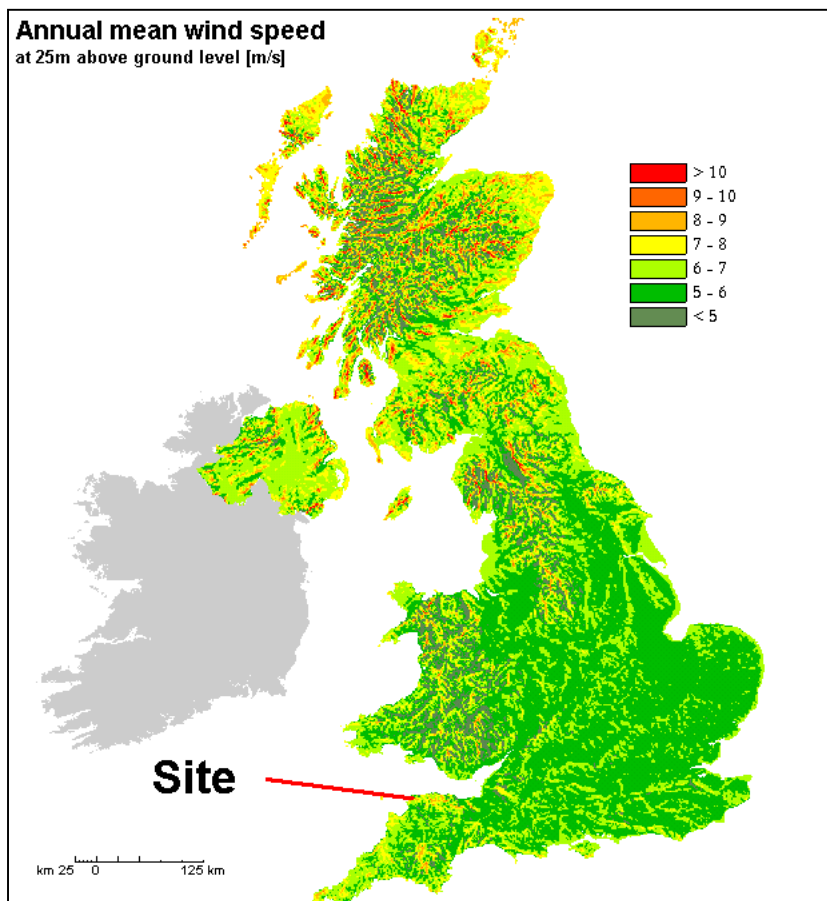


# Prototype 11Kw Wind turbine

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Date: 12/12/2005

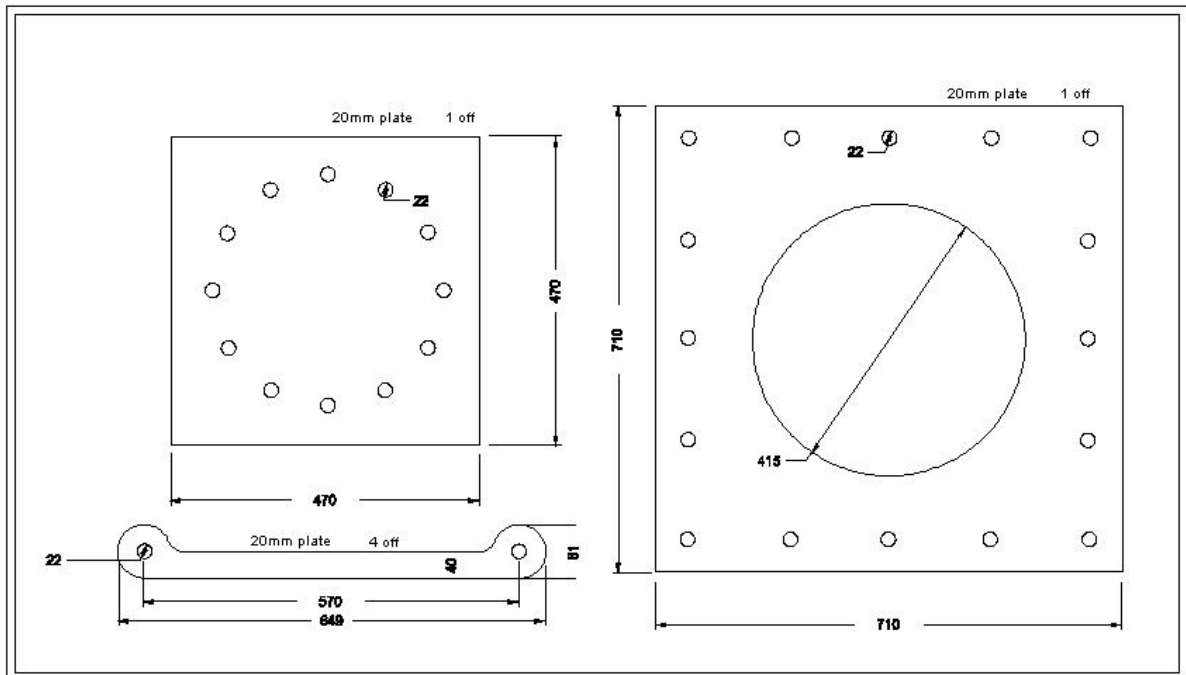
## The site

The site is on the cliffs on the south West coast of England. The average wind speed is 8.5 meters per second. Height above sea level is 210meters above see level. The turbine is in clean clear air.



## The base

The base was dug into the shale rock and a concrete block 2-meters by 2-meters and 2-meters deep tapering to 1-meter square at the top was laid. Set into this was 1.5 meter by 20mm bars threaded at the top. A hinge was constructed out of 20mm plate so the tower could be lowered with a winch or tractor.





## Tower

This is constructed of standard steel water or steam line pipe and flanges. 15mm webs were welded on the flange to stiffen the joints. 22mm 8.8 hardened steel bolts were used to join the three sections together.

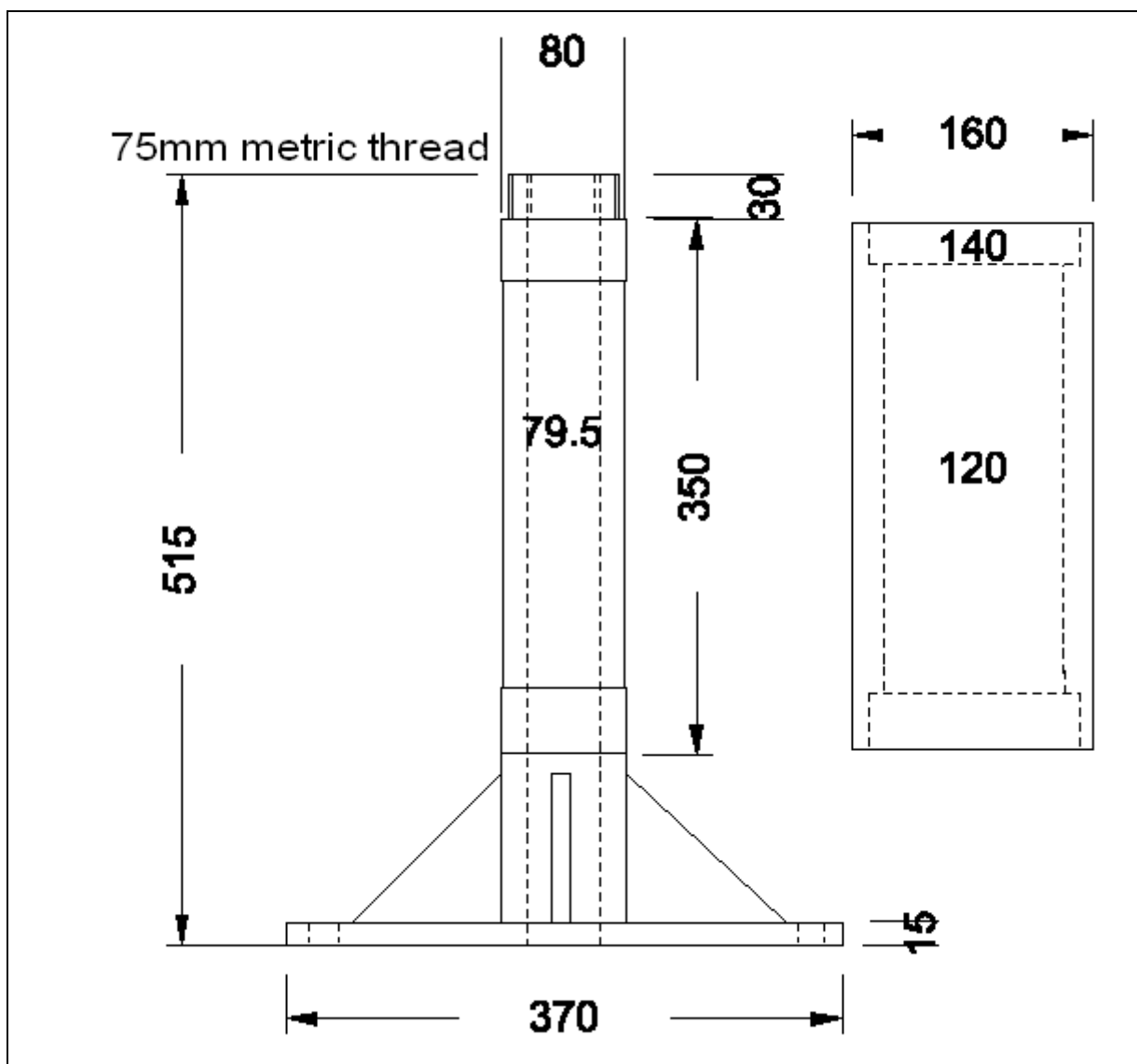
Section 1	3-meter length of 16-inch pipe
Section 2	3-meter length of 14-inch pipe
Section 3	3-meter length of 12-inch pipe

Total height 9 meters 4 guy ropes of 16mm steel rope connected at the top of section 2 connected at the other end to a 1 cubic meter block of concrete set into the ground. 6 meters square from the base.



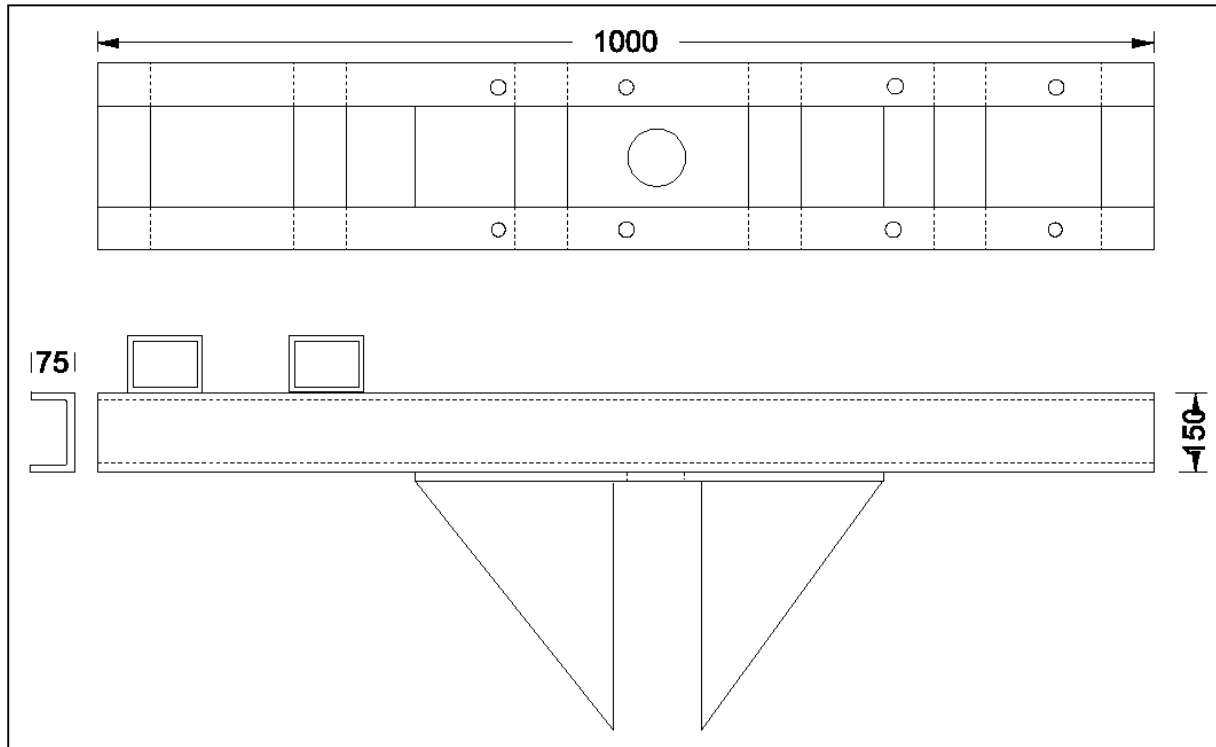
## Yaw Bearing

A 12-inch standard steam flange plate was used as the base to weld the yaw post to. Stiffening webs of 100 by 15mm was welded to the post and the flange. The base had a 30mm hole bored in the centre to take the hydraulics and power down the tower. A length of thick wall pipe was machined to take taper bearings and the top threaded internally and externally. The external threads had two lock nuts to adjust the taper bearings and the internal to accept the slip ring unit. The bearings used were single row taper thrust bearing part number 30216, which is 80mm by 140mm by 30mm. The lock nuts were tightened to get free movement with no vertical movement. The bearings were packed with grease.

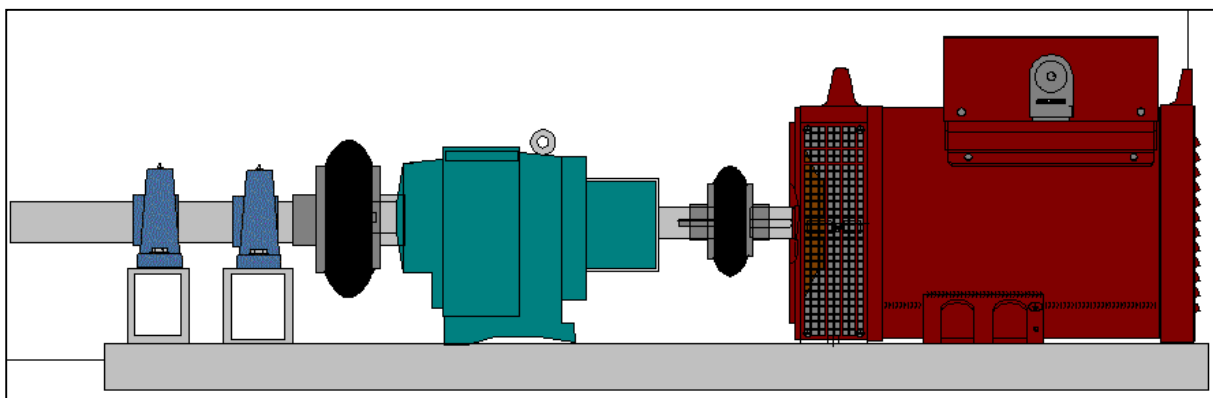


## Motor frame

This is made from 75mm x 150mm by 6mm channel two lengths were welded to the separating webs and then welded to a 15mm plate to fix to the yaw bearing post. 15mm plate webs were welded to the frame and the yaw post to strengthen it. 100mm x 100mm box section fitted to the front to take the main shaft pillar bearings.



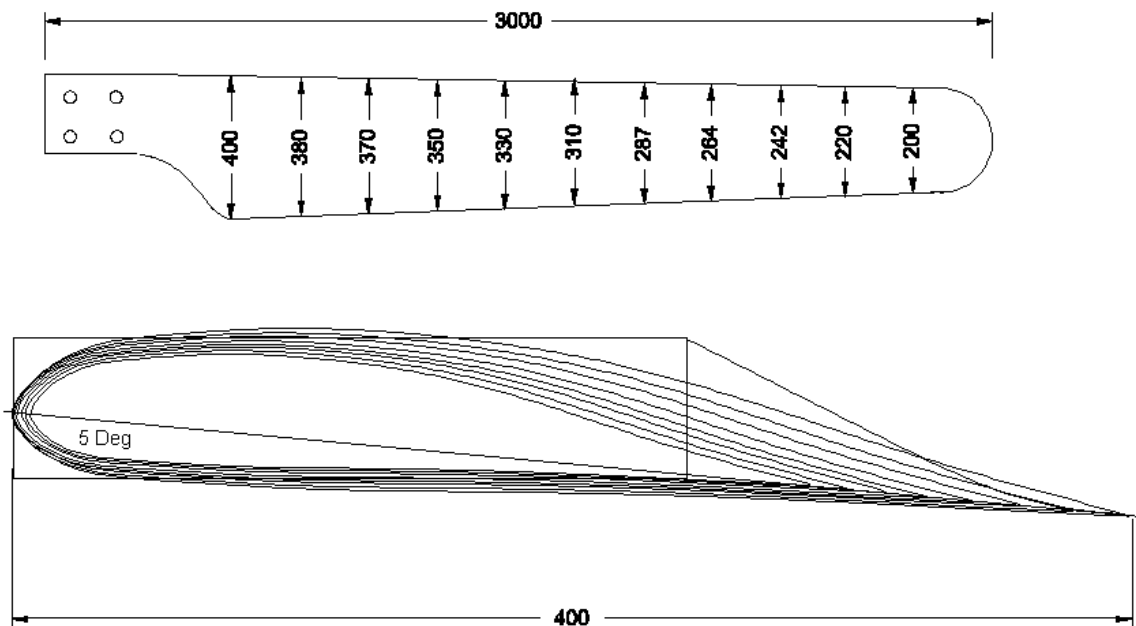
The motor, gearbox and main bearings were fitted to the frame with 10.2 strength bolts and nyloc nuts. Packing shims were fitted below the gearbox and main bearing blocks to get them in line. 30Kw flexible couplings were fitted between the gearbox and motor plus the main drive shaft.



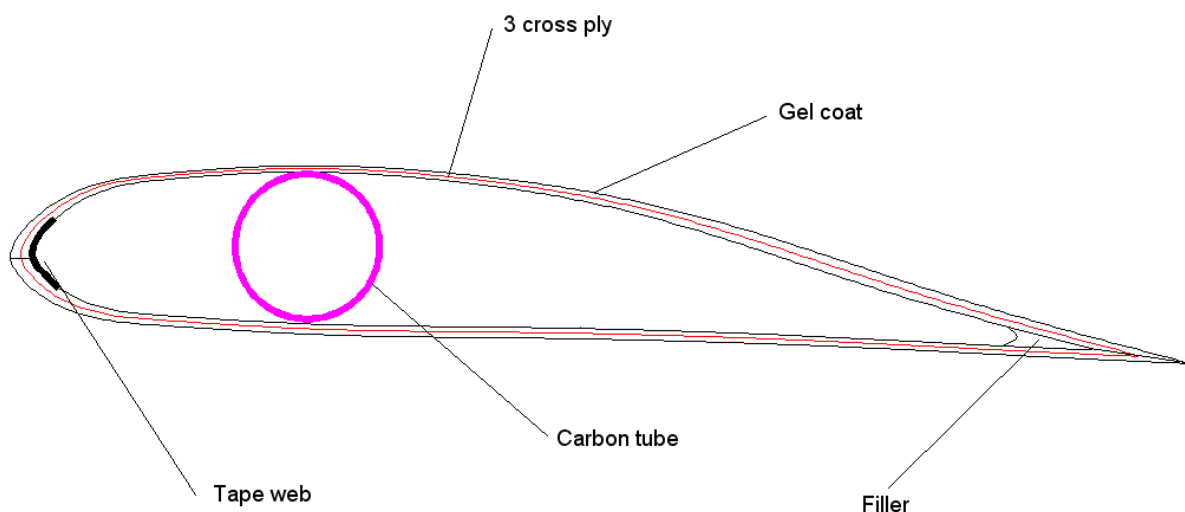
### Spec of main parts:

Main motor	11Kw 3 phase 415V PTO generator.
Gearbox	9.86:1 inline helical cut four-stage gearbox.
Main bearings	Deep groove self-aligning bearings 6412 60mm.
Couplings	Fennar type type couplings with two taper locks.
Slip rings	5 off 100mm X 10mm copper rings

### Blades

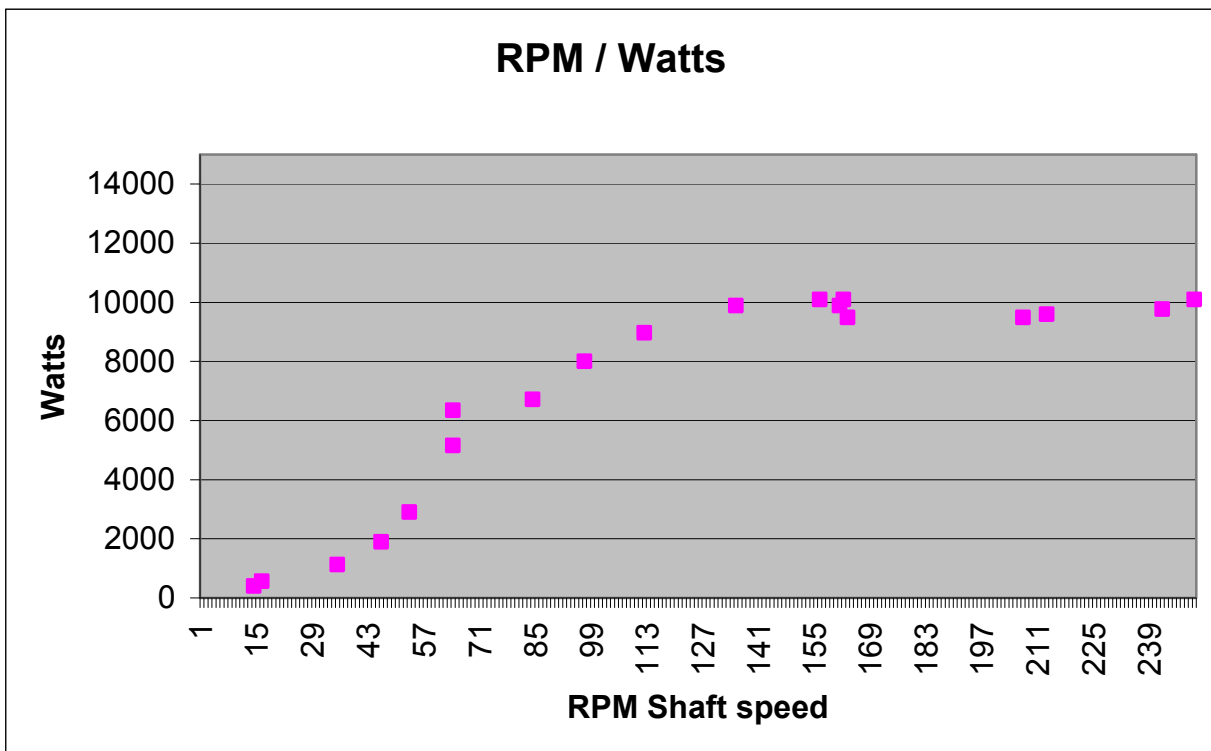
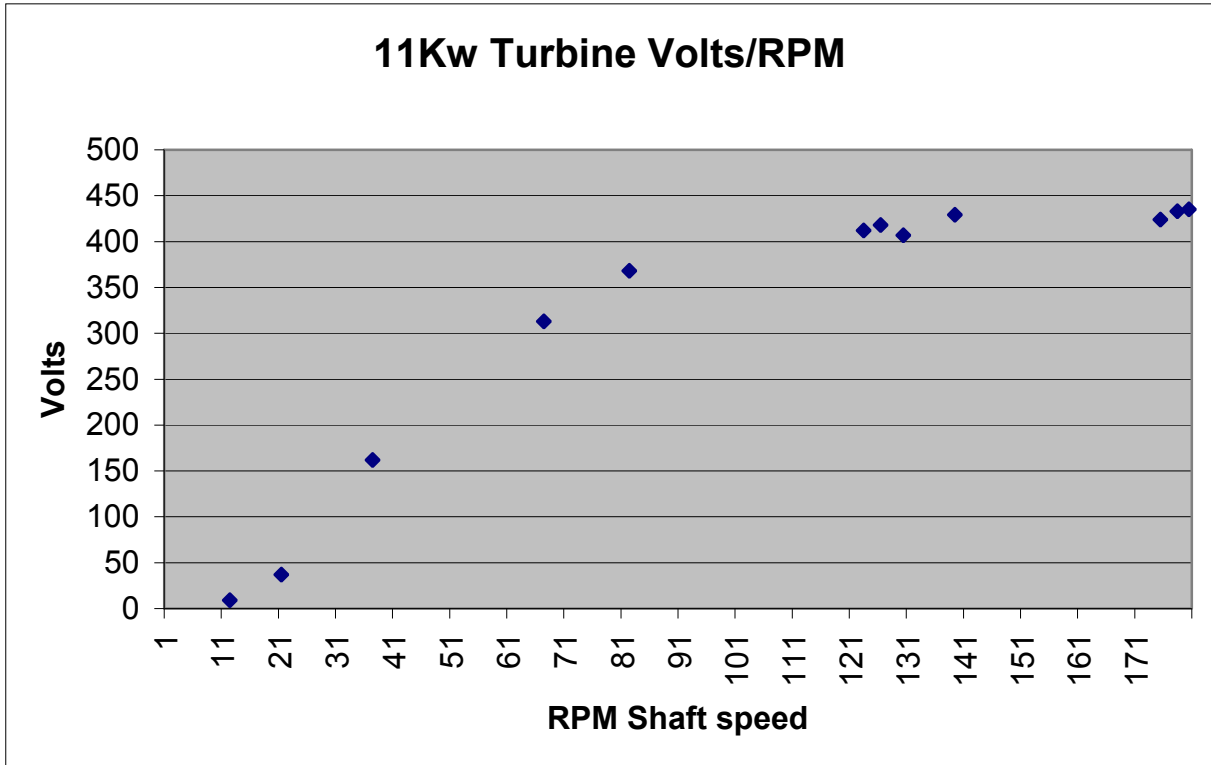


The blades were made of three cross ply matting. A carbon fibre tube of 2" was bonded to the wooden root block which run all the way up the blade cord. 8 layers of matting and resin was laid, 12 layers at the root. Then white gel coat over the top. The blades were left for 6 weeks to go off. TRS is about 7.5.



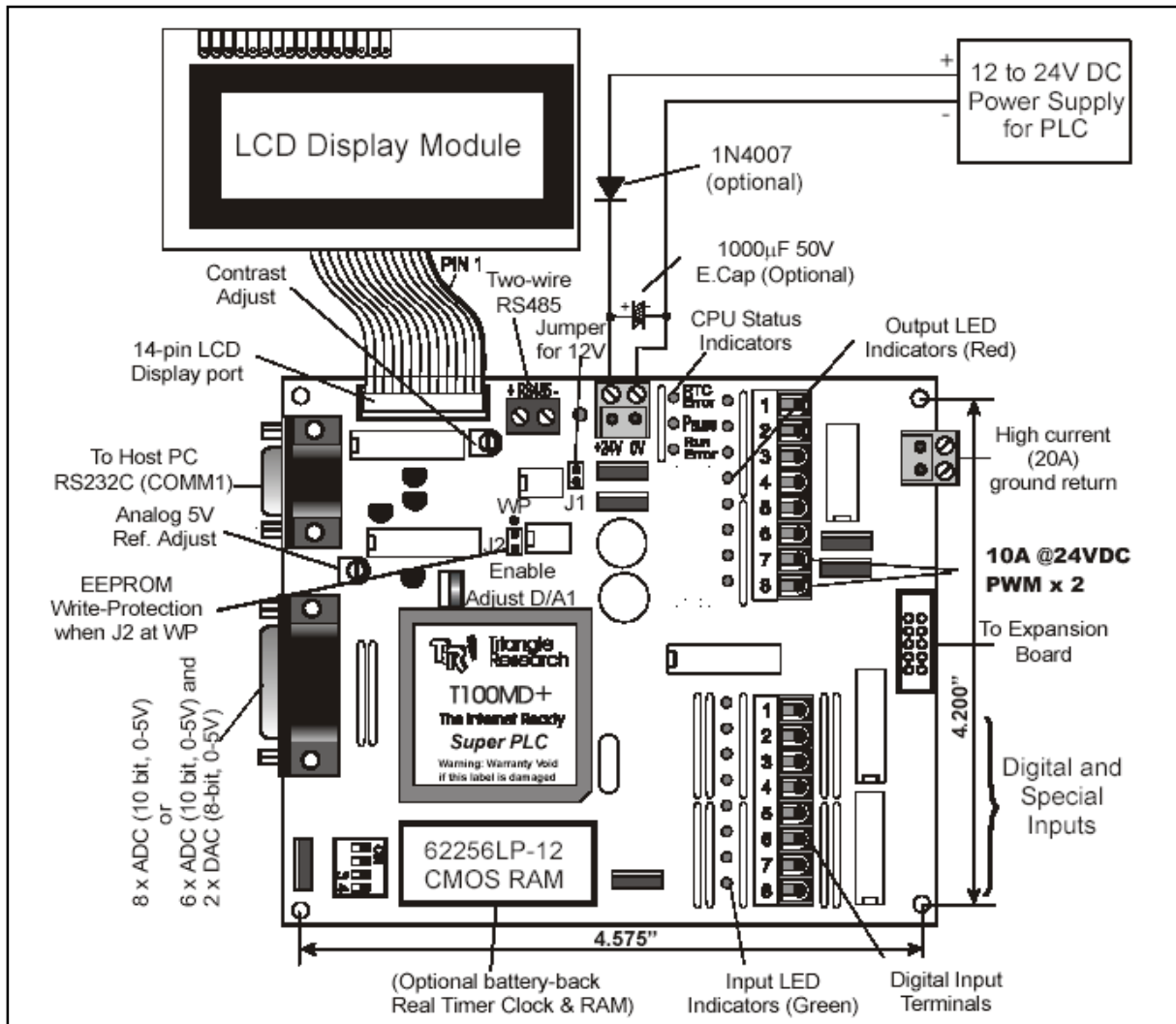
## Power

I linked the turbine up to a small PLC so as to be able to log the data for testing. The three phases come into the heating control panel through a trip and then into a PWM power controller.



## Control

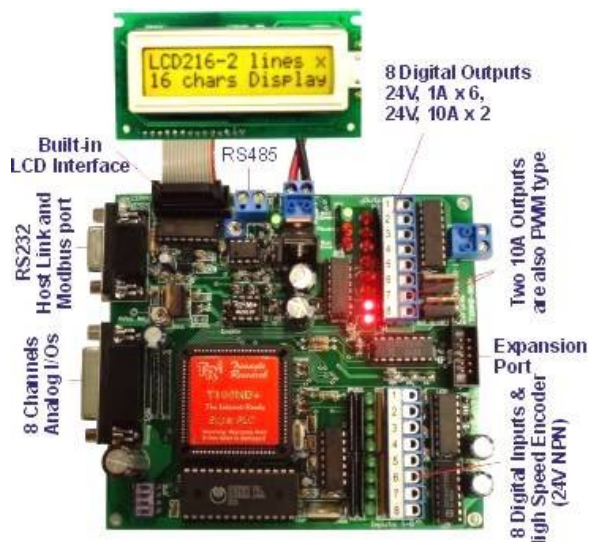
Control at the turbine head is done with a T100MD888+ PLC this has analog and digital inputs and a 10A PWM output.



The speed of the turbine is monitored with a sensor, which is feed into pin 3 the software converts it to Hz and feeds it into a PID control loop. I set the desired speed of 160, which is the max speed, and control the PWM output to the field windings. A range of .6 to 1.6A is 0 to 100% full load of the generator.

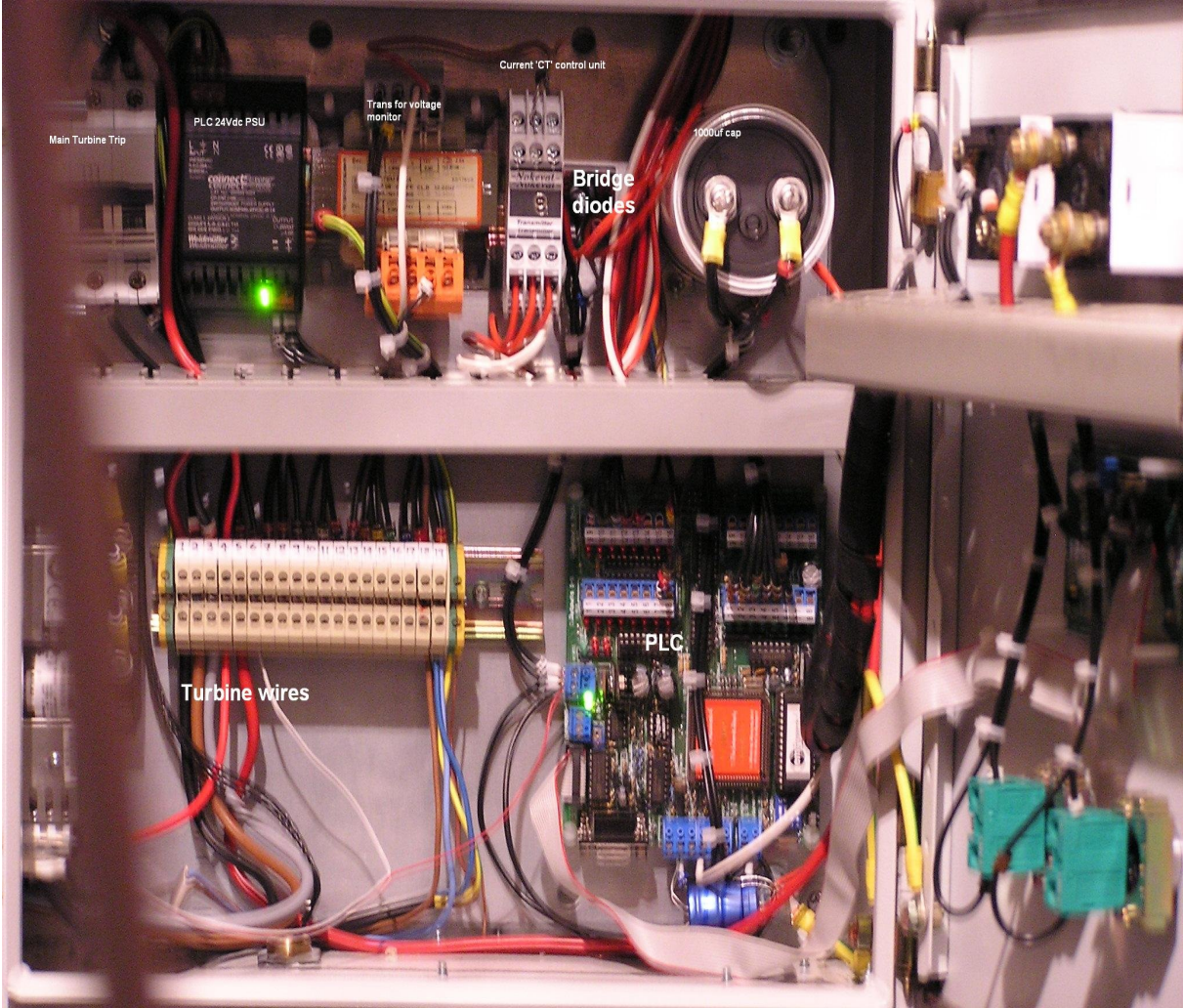
There is also a over speed setting that is used to put on the brake.

The brake is held on until it is manually reset. If a GSM modem is fitted to the rs232 output port then sms text can be sent to any mobile. Also control signals can be sent to the turbine.





The ac power comes down the tower and ½ a mile to the farmhouse. It is feed into the control panel, which with MPPT software controls a heat controller. The heaters are in the water system which runs around the house.



## Hub

The hub is a mechanical variable pitch design. Made from 20mm steel plate. There are phosphor bronze bushes instead of ball bearings in the blade sleeves.

