BROTHER BRENNAN CENTRE

Renewable Energy System

User Manual

Introduction

The renewable energy system at the Brother Brennan Centre consists of four principal components;

1. two Whisper 500 wind turbine and controllers (3000 Watt peak power each), Figure 1 and Figure 2 and controllers, Figure 3
2. three battery packs of 24 cells each (Unigy II), Figure 4 and Figure 5
3. four Outback inverters/chargers (3600 watt each @ 48 volts, VFX3648), Figure 6
4. and a diesel backup generator

Figure 7 shows how the above components are interconnected.

Figure 1: Two Whisper 500 turbines on hill behind Brother Brennan Centre

Figure 2: Whisper 500 wind turbine

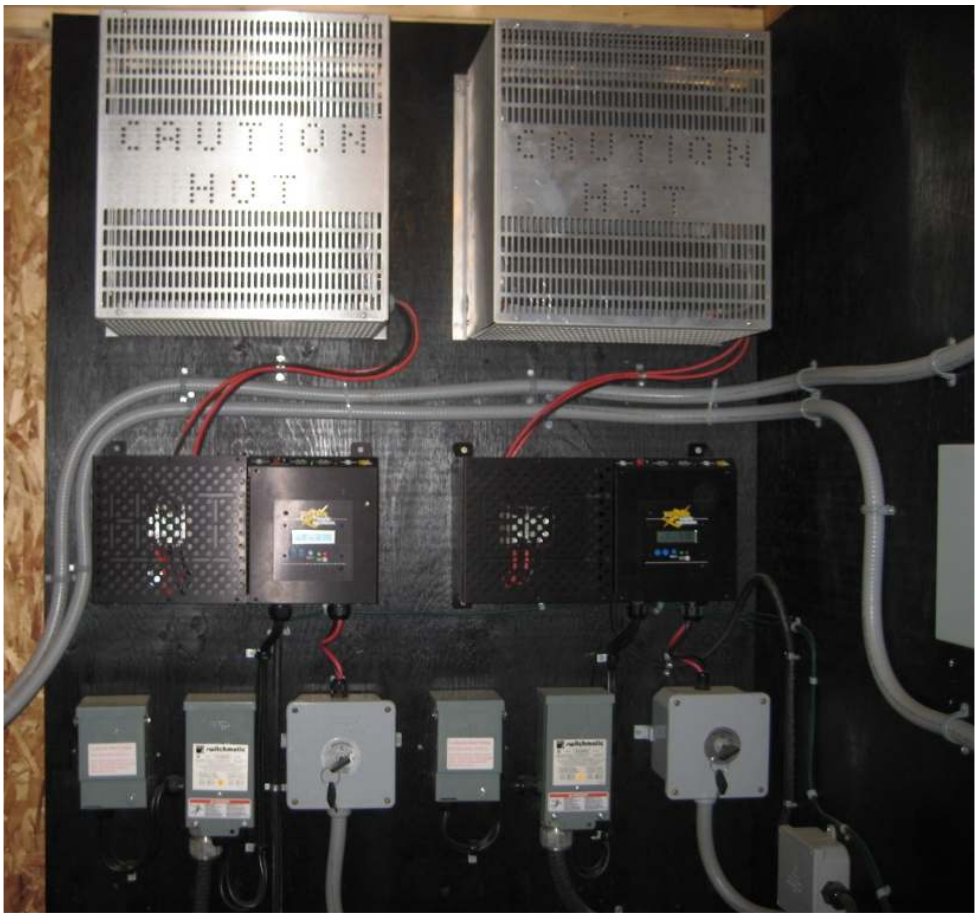

Figure 3: Charge controllers for wind turbines (diversion resistors on top, on bottom; brake, diversion switch, and battery key switch)

Figure 4: One of three 24 cell batteries – Battery A

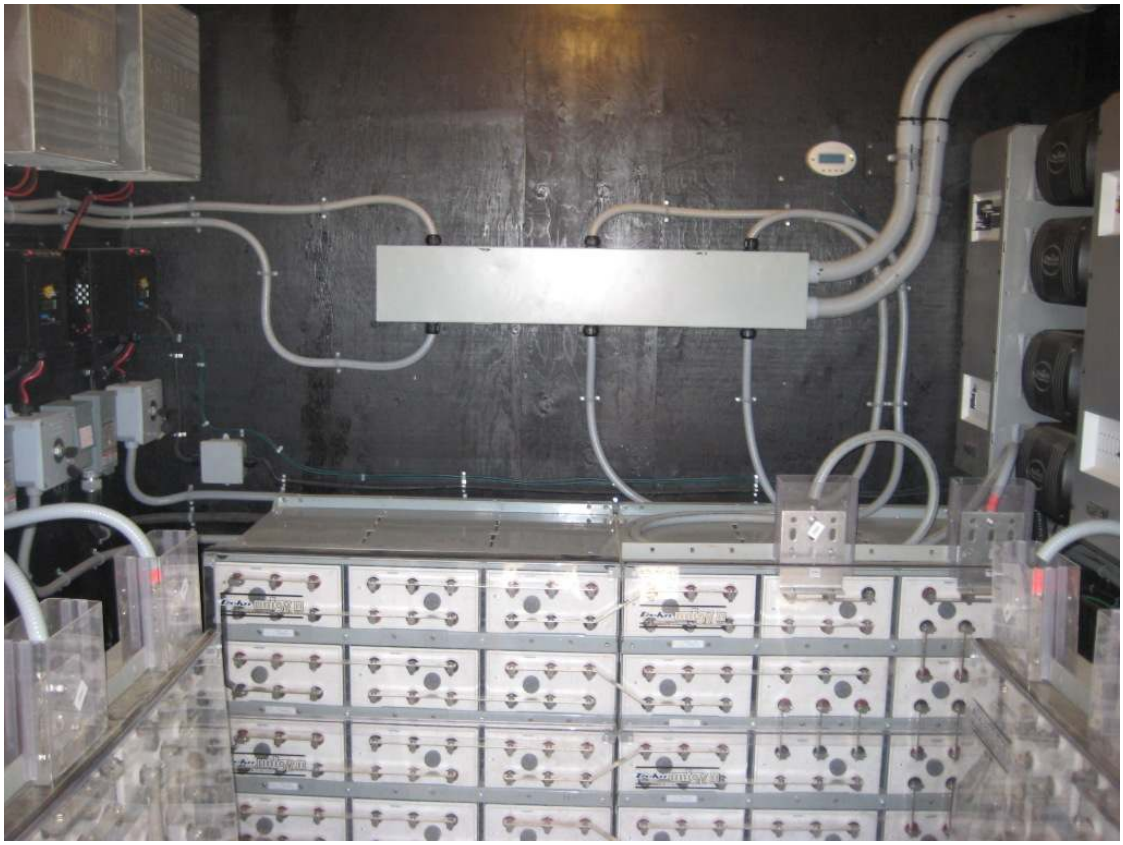

Figure 5: Battery B and 48 volt distribution panel behind, MATE in upper right corner

Figure 6: Outback Inverter/Charger system (AC panel on left, DC on right)

The Outback FX inverter/charger system and the Whisper wind turbines are relatively independent are only connected through the batteries. The wind turbine can only put energy into the batteries while the Outback system and put energy in (charging) or take it out (inverting). For charging it must be connected to the generator.

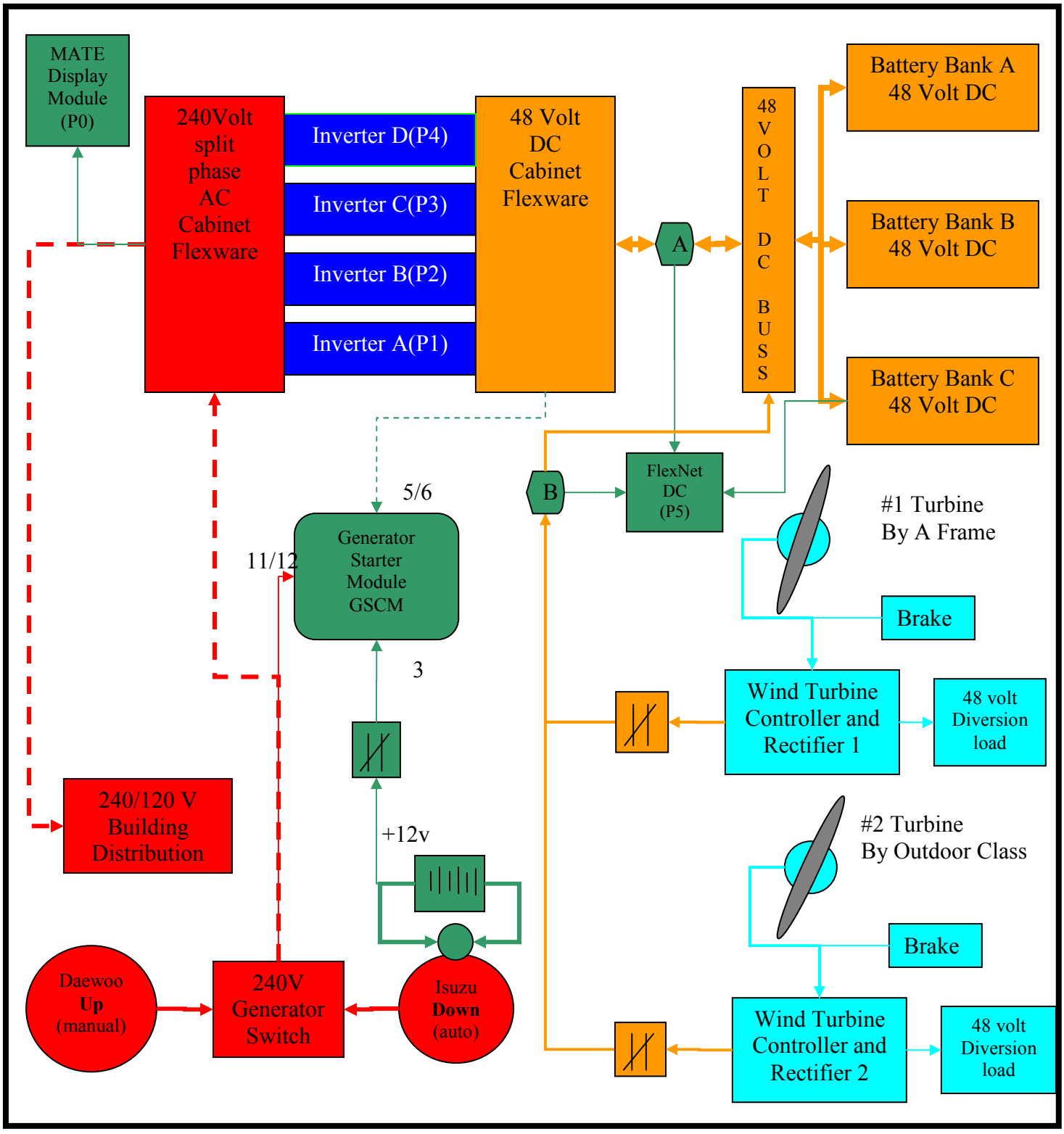

Figure 7: Red (high voltage AC), Orange (48 V DC), Green (Low voltage), Lt. Blue (48V AC)

General Operation

Figure 8: MATE displays status and controls generator/chargers/inverters

MATE serial number: *MA035149*

On the MATE there are two LED lights one above the AC IN key (yellow) and one above the INV key (green). The yellow LED above the AC IN provides status of the AC from the generator.

- ***Flashing*** means generator is running but not connected to Outback system
- ***Solid On*** mean generator running, connected and in use.
- ***Off*** no generator AC present (***normal***)

The green LED above the INV key provides status of the inverter and also has three modes:

- ***Flashing*** means the inverter is in search or power save mode (this mode not used at BBC)
- ***Solid On*** means the batteries are supplying power to the buildings (***normal***)
- ***Off*** means it is not converting battery power to AC

No Power in Buildings! – If there is no power in buildings it may mean that the inverters are switched off. The green light above the INV button on the MATE should be illuminated. To check the status of the inverters press the INV button once to get to the "INVERTER CONTROL" screen. It may read "Currently: OFF". If so, press the button below ON and the display should change to "Currently: ON", and then press OK. The light above the INV key should turn solid green.

Manual Generator Start/Stop – Press AC IN button on MATE twice (2) to get "GEN START CONTROL" and then press "ON", the diesel generator should start and yellow

light should illuminate. To manually stop the generator press AC IN button twice (2) and then press “OFF” and the yellow LED should go out.

Re-Setting AUTO Start - If for some reason the generator fails to start after 17 minutes while in AUTO mode it will set a fault flag to prevent any further attempts. To clear the fault the operator must manually start and then stop the generator (MAN ON then MAN OFF) and then switch the generator over to AUTO. If the generator needs to start it will display AUTO ON otherwise it will remain displaying AUTO OFF.

Forced Battery Charge (BULK) – To force a full battery charge cycle (known as BULK charge) press “AC IN” left hand side button on the Mate panel two (2) times. Then press “ON” to manually start the generator. You may hear a slight click coming from the DC power cabinet. After a few minutes the ACin light on the left side of the mate will be solid yellow. Press this button two more times until BULK or EQalize. Press BULK button. Then press START. The diesel generator will go through an entire BULK recharge cycle fully charging the batteries. Wait for “bulk charge stopped” to display – and the diesel generator should automatically stop. The BULK charge cycles has two steps, first the batteries are brought up to the ABSORB voltage for two hours and then the voltage is reduced to the FLOAT voltage for one hour.

Monthly Generator Exercise – At 9:30 AM on the first Tuesday of every month the Automatic Generator Start will run the generator for 15 minutes.

Monthly Battery Equalize (EQ) – Equalize applies a slightly higher charging voltage for a shorter time. Do BULK charging first if necessary. On MATE press AC IN four (4) times to get CHARGER MODE CONTROL. Press EQ to bring up the EQUALIZE screen. START will start charge and STOP will stop it. The AC IN status light must be solid yellow.

Inverter ByPass Mode - Before starting generators loosen the bypass mode switch mechanical lockout bar (need a 11/32” wrench) on the Flexware AC panel (left hand side cabinet) and switch the four switches under the right side of the plate (1) to ‘off’ (down) to disconnect the inverters from the buildings. Lights will go out. Then switch the four switches on the left side (2) of the plate to ‘on’ (also down) to connect the diesel generator directly. Start diesel generator and the inverters will now be by-passed and the power restored.

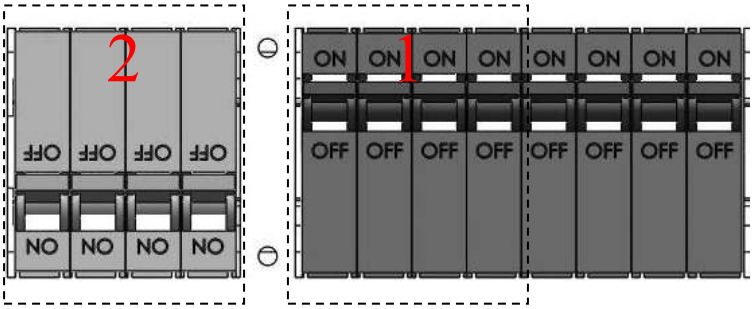

Figure 9: AC Bypass switches under plate do #1 switches first then #2 switches

To *leave by-pass mode* switch #2 to 'off' (up) then switch #1 'on' (also up)

Excessive Wind Speed – During periods of excessive wind speed approaching hurricanes etc. it will be better to put the brakes on to reduce the wear and tear on the turbines. Note when the wind speed is very high the Whisper controller dumps most of its energy so there is no big loss in having the brakes on.

Teaching in Meadow – If the battery is in a reasonable state of charge and the meadow or outdoor class is needed and it very windy the turbines can produce excessive noise preventing effective communication. To make a more pleasant environment the diversion rocker switch on the turbine controller could be temporally put on to slow down the turbines and dump the power (red light will be solid on). Inform the kitchen staff to avoid using the dryer/electric heaters to reduce load.

Light use during Summer or Weekends – If the Centre does not have clients over a period of time the diversion switch on the controller could be put on one turbine with the active one providing power to top up and maintain the batteries.

Winter Shutdown – Lay wind generator towers down remove tail pieces and nose cone and blades and wrap generator in waterproof tarp. Remove anemometers. Turn off Whisper Controller DC Key switch. If batteries are not charged run a BULK charge to charge the batteries completely then turn off DC breakers A-D providing power to inverters. These can run the batteries down over a long period of time.

Temporary Winter Usage – If necessary the system could be turned on (DC breakers A-D) for a few hours of light usage. Alternatively the system could be put in **Bypass** mode to bypass the inverters and run directly on generators.

Spring Startup – Touch up any paint. Check and replace return springs if showing cracks. Replace nose cone if cracked. Check turbine blades for cracks and replace any missing or torn leading edge tape, replace nose cone. Reattach tail stock. Check for cracks in wire. Install anemometers. Place brakes on and raise towers on calm day. Make sure DC key switch is turned on and Whisper controllers are energized. Turn off brakes.

Annual Battery Voltage Check – With system fully charged. Put turbine brakes on. Turn off breakers A-D on Inverter DC panel. Remove plastic protective battery covers and measure and record individual cell voltages. All cells should be about 2.15V and no cell should be more than 0.05V from the mean of all. Repeat for each battery bank.

Summer Rentals – Summer rentals may be under the mistaken impression that the power is free therefore there is no reason to conserve. This could not be further from reality. The batteries are most happy when fully charged. Education for all is necessary.

WattPlot

WattPlot (rev 4.6.10) is software that is installed on the Centre's laptop and connects to the MATE via a RS232 to USB adaptor. WattPlot provides a graphical interface to monitor the power and battery voltage. WattPlot communicates with the MATE via a pair of GC-ATC-981 wireless RS232 wireless serial port, Figure 10.

Figure 10: GridConnect ATC-871 Wireless Serial Module

The MATE must have it SETUP/MATE/COMM/PC set to ON. The MATE communication port does not have internal power so it is wired to battery bank B to provide ±9 volts at pins 4(+) and 7(-) at the MATE. The +12v DC power to the ATC-871 is also provided by the same batteries. When transmitting the yellow transmit led should

be flashing once per second indicating it is transmitting data.

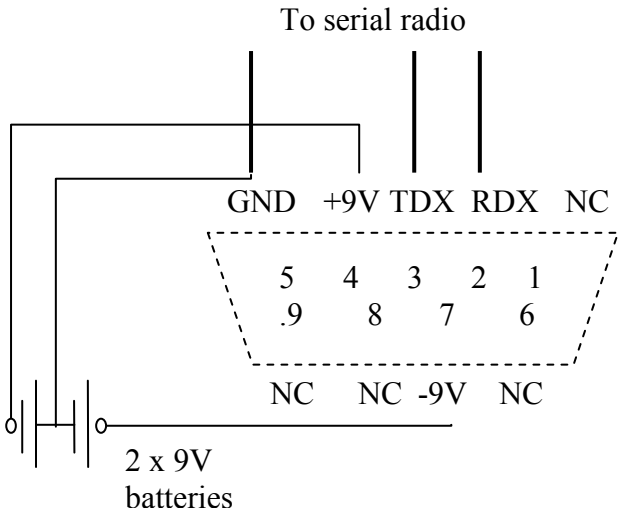

Figure 11: MATE Communication port connector

Note: WattPlot activation code is 58Z0H01q09 on centre's desktop PC (040e-f03f-0f43-921b-46a0-g) and the Mate S/N is MA035149. To move WattPlot to another computer you **MUST** follow the procedure listed in the WattPlot manual.

Communication Ports

The MATE, FX Inverters, and the FLEXnet DC monitor module all communicate through ports on the 10 port communication HUB. The mate is connected to port 00, the FX master L1 inverter on port 01, FX slave L1 is on ports 02, FX slaves L2 are on ports 03 and 04. The FLEXnet DC monitor is on port 05. The AGS start relay is assigned to port 1 that is the FX Inverter. A large yellow LED light will illuminate on the AC panel when the generator start relay is energized.

Whisper Wind Turbine System

The two wind turbines have their own controllers that consist of an electrical brake that shorts the 3 phase 48 volt windings on the turbines. When shorted the high current leads to high load torque so the turbine generator and the blades can only turn very slowly even in the strongest wind. There is also a load dump resistor bank (diversion load) that automatically takes excess power from the turbine and dumps it to prevent too high a voltage from reaching the batteries. There are two voltage settings in the Whisper controller that regulate the voltage delivered to the batteries. The "regulation on" voltage is the voltage above which 100% of the turbine output is dumped into the resistor to protect the batteries from over voltage. The "regulation off" voltage is that below which none of the power is dumped. The primary function of the controller is to convert the 48V 3Phase AC output from the turbine to 48 DC for battery storage. The controller is connected to the batteries via a key switch. **Note there must be an electrical load on the turbines either from the brake or the controller/batteries at all times or they**

could spin excessively fast. The 48V DC key switches should be turned off if the turbines are not in use as the controllers can drain the batteries. Note the brakes should be on if the controller is switched off.

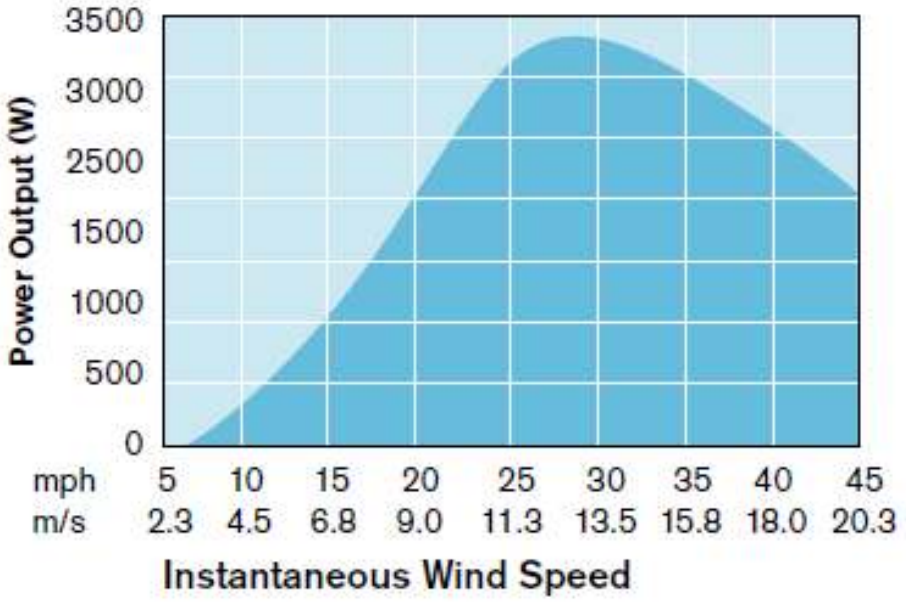

Figure 12: Whisper 500 Output as function of wind speed

Diversion Switch

The diversion rocker switch is located on the top of the controller, Figure 9, to the left of the green and red LEDs. Setting the switch to "OFF" causes all the power produced by the wind turbine to be diverted the Diversion Load and the wind turbines will slow down.

The Whisper 500 utilizes an external Diversion Load. (Note: The switch may not stop a rapidly spinning wind generator, however, once stopped setting the switch to "OFF" will keep the generator from spinning in most winds.)

Figure 13: Wind turbine diversion switch and LED

LED Indicators

- Steady illumination of the **Green LED** indicates that batteries are being charged by the wind generator.
- Steady illumination of the **Red LED** indicates that all available power produced by the wind generator is being diverted to the Diversion Load as a result of operator request. The operator may select this mode by setting the Diversion Switch to "OFF" or through the LCD Display. The turbines may turn slowly but will not produce power. *Thus the diversion switch provides a quick and easy way to shut down the turbines.*
- A **flashing Red LED** indicates power is being diverted to the diversion load in order to automatically regulate the battery voltage. This will happen if the battery voltage rises above 56 volts for more than 30 seconds. It will stay in this mode until the battery voltage drops below 52 volts for 30 seconds. When this happens the turbines turn at a much reduced speed.

In normal operation the rocker switch will be "ON" and the green LED will be lit. From time to time the red LED may be blinking, typically in high winds with batteries fully charged. The operator may place the rocker switch "OFF" and the green LED will go out and the red LED will be continuously illuminated.

Turbine Serial Numbers
17293010 (#1)
17292996 (#2)

Shock absorber
The shock absorber is manufactured by Competition Engineering as a 3-way adjustable front drag racing shock. The model number is C2620 and is set to the 90/10 ratio (XF). This puts maximum damping force into shock extension when the wind turbine is furling. The shock slows the rate at which the turbine furls in high winds. To set (1) hold shock vertical with rod upward, (2) extend/compress shock 10 times and then compress fully, rotate rod clockwise several times until "clicking" felt or heard, finally set index to XF, see http://www.competitionengineering.com/catalog/images/c2600_inst.pdf.

Figure 14: Competition Engineering's 3-way shock absorber (model C2620 set to 90/10)

Leading Edge Tape
The leading edges of the turbine blades should be covered with protective tape. The recommended tape is 3M 8607 Polyurethane Protective Tape. However this is difficult to obtain but 3M 8671 available from www.aviall.com seems to be a similar product.

Outback Inverter/Charger System

The Outback System consists of four 3600 w DC-AC inverter two for each phase of a 120V split phase system. In normal operation the inverters take the 48 Volt DC power form the batteries and convert it to 120V/240V split phase that is sent to the buildings. As it is a split phase system the load on the phases may become unbalanced so the Outback system has an autotransformer to transfer power form the lightly loaded phase to the more heavily loaded phase. There is a breaker on the Outback Flexware AC panel labeled Auto-Transformer – this should always be ON. The Flexware cabinet has two distribution panels; the one on the left handles the 120V AC side going to and from the generator and buildings while the right panel handles the 48V DC power coming from the batteries. The charger input current is limited to 18 amps which limits the overall

charging current to the batteries to about 39 amps per inverter or 156 amps for the four units (~7.8 kW).

In between there are four inverter/chargers (A-D) and these communicate with each other over "ports" 1-4, with port 1 (bottom) being the master and 2-4 being slaves. Control and configuration of the controllers is collected under the MATE and its programming interface.

On the DC side there are four breakers that disconnect the batteries from the controllers. If the system is going to be left dormant for a long period of time (longer and a weekend) without any wind power then these four breakers should be shut off as the inverters each require about 25 watts (100 watt total) of power when in idle mode and can over a period of time drain the battery. Also on this panel there is a battery indicator which is only accurate when the generator is not running. Also there is a small breaker at the bottom of the panel for 48V DC power (not used). On the top of the AC panel (left side) there are 12 breakers with the left most 8 of these are ganged to a mechanical lockout. These are the AC bypass breakers. If for instance the batteries failed (less than 42 volts) and the inverters could not be powered the generator power could not reach the buildings. **Before starting the generator loosen the lockout using a small wrench and switch all eight bypass breakers allowing the generator power to bypass the inverters and go directly to the buildings.** The generator power would now also be available in the control shed. The other four other breakers on the right providing AC power to the inverters could be left on. When switching back to normal mode it would be best to once again turn off the generator first, switch back the eight switches and then restart the generator.

FLEXnet DC Monitor

The FLEXnet DC monitor module, Figure 15, is located on the left hand side of the DC cabinet. It monitors the energy (current in amp-hr) entering and leaving the batteries. As the current from the wind turbines passes through Shunt A it causes a small voltage across it. Likewise the current coming from(+) or going to(-) the Outback inverter/charger passes through Shunt B and is also monitored. The total power going into the batteries is the sum of these two sources. The module also monitors the battery voltage. The state of charge (SOC), Figure 16 and Table 1, of the batteries is monitored by keeping track of the energy entering the batteries and that being drawn from the batteries. Energy withdrawn from the batteries by the inverters is removed at 100% factor while energy entering the batteries from the charger or the wind machines comes in at a lower efficiency, 94%. When the single green led is flashing SOC parameters have been met and battery recharging will cease and a discharge cycle will commence.

Figure 15: FlexNet DC Monitor Module (in DC cabinet)

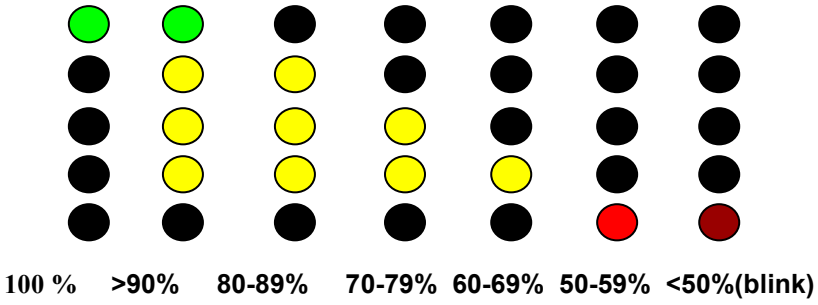

Figure 16: State of charge (SOC) indicator lights

Table 1: Approximate battery voltage and state of charge

State of Charge	Volts per Cell	48 Volt battery @ temperature (deg C)					Comment
		5	10	15	20	25	
Amp-hr		56	56	56	56	56	Regulation on
5421		52	52	52	52	52	Regulation off
100%	2.14	51.7	51.6	51.5	51.4	51.3	SOC Stop 93%
90%	2.11	50.9	50.8	50.7	50.6	50.5	
80%	2.09	50.5	50.4	50.3	50.2	50.1	
70%	2.07	50.0	49.9	49.8	49.7	49.6	SOC Start 79%
60%	2.05	49.5	49.4	49.3	**49.2**	49.1	24 hr start
50%	2.03	49.0	48.9	48.8	**48.7**	48.6	2 hr start
40%	2	48.3	48.2	48.1	**48.0**	47.9	2 minute start
30%	1.98	47.8	47.7	47.6	47.5	47.4	
20%	1.95	47.1	47.0	46.9	46.8	46.7	
10%	1.91	46.1	46.0	45.9	**45.8**	45.7	Shutdown
0%	1.77	42.8	42.7	42.6	42.5	42.4	

Manual Battery Re-Charging

If by accident the battery voltage becomes so low that the inverters cannot be powered up then they will have to be manually recharged with the centre's 24V charger. The general procedure is as follows *(take your time and be very careful)*

1. Place the AC panel in Bypass mode to provide 120V AC or bring in an external 120V generator. Turn off DC breakers (A-D) to disconnect the batteries from the inverters.
2. Remove plastic covers from batteries
3. Remove terminal wires from batteries **(remember the wires could be *still live and not fused* even when disconnected so wrap terminals in electrical tape!)**
4. For battery A place the red (+) terminal of the charger on the + side (red post) of cell#1 (has big "+" stamped on plate) and the negative (black) terminal of the charger on the negative terminal (black) of cell#12.
5. Turn the voltage selector knob fully clockwise to 24V full charge.
6. Check everything then turn timer to 1 hour. *Ventilate well, very explosive hydrogen gas may be vented during this recharging.*
7. Charging current should be 20-40 amps.
8. With the charger off remove both cables and put the negative (black) cable on the negative (black) post of cell#24 (has big "–" stamped on plate).
9. Connect the positive (red) cable of charger to negative (black) terminal of cell#13 (happens to be the same as the + of cell#12)
10. Again check and charge for 1 hour.
11. Repeat 4-10 for batteries B and C.
12. Measure voltages on all three batteries if not up to 43 volts repeat process.
13. Finally make fine adjustments of individual batteries to balance them to within 0.1 volts.
14. Re-Connect the battery with highest voltage to inverter.
15. Re-connect battery with second highest voltage
16. Re-connect battery with third highest voltage
17. Energize inverters by throwing four DC circuit breakers (A-D) on right hand panel.

Reference Voltages, Currents and Timers

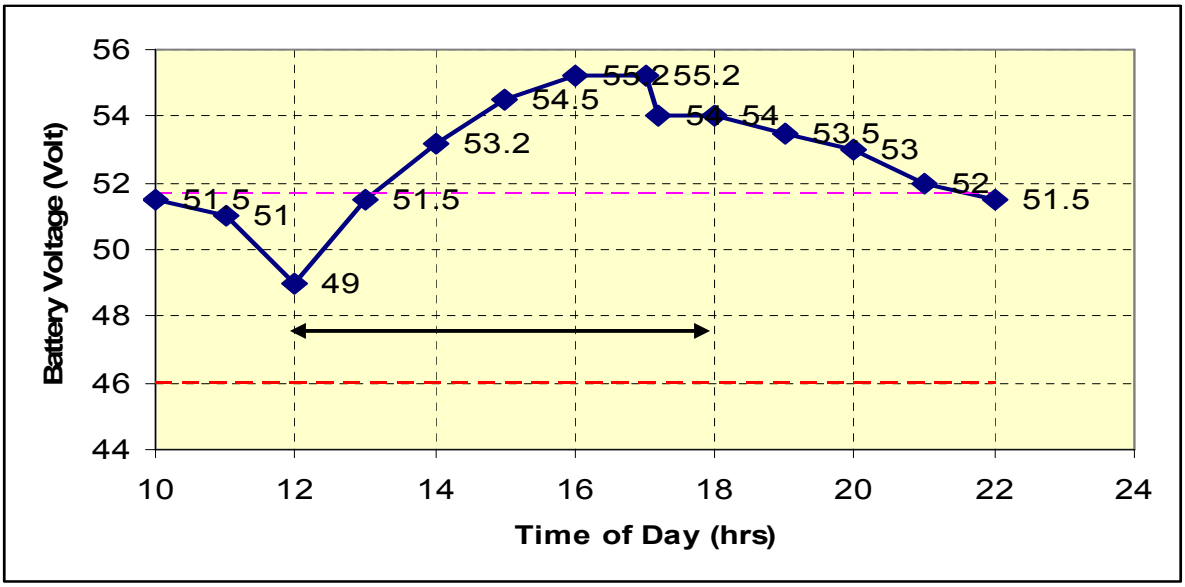

Figure 17: Typical charge cycle. Discharge from 10 to 12am, at 49V generator starts charging, when battery voltage reaches equalize voltage, 55.2 V @ 16:00), charger current is reduced so this voltage is held for 1 hr (17:00) then charge current is reduced further until voltage is at float voltage 54 V for one hour (17:00-18:00 hrs) . At 18:00 the generator is shut off.

1. Minimum allowable (but not recommended) battery voltage 42 Volt
2. Minimum voltage for Inverters (shutdown below this voltage) 46 Volt
3. Normal voltage of healthy battery (not charging, no load) ~51.4 Volt (wait 3 days after charging and no load)
4. Maximum voltage during adsorb recharge cycle (2.3 × 24) 55.2 Volt
5. End of charge voltage: 55.2 - 0.4 = 54.8 V
6. Float Voltage: 52.8 Volt
7. Duration of Adsorb Cycle before generator shutdown 3 hours. Note the FN-DC will stop the charge cycle if charge parameters are met for 10 minutes (green light flashing).
8. Maximum AC charge input current 18 amp per charger/inverter (145 amps DC)
9. Return amps (2% of 5400) ~110 amps
10. Equalize voltage 55.4 Volts (2.35V × 24)
11. Equalize period: 1 hrs
12. Enable FN-DC charge termination: YES
13. AGS Load start 10 kW
14. AGS Load start delay 10 minutes
15. AGS Load stop 7 kW
16. AGS Load stop delay 10 minutes
17. AGS Port: 1 (Inv A)
18. AGS Enabled: yes
19. AGS Control: AUTO
20. AGS 24 hr delay volt Start: 49.2 V
21. AGS 2 hr delay Start: 48.6 V

22. AGS 2 min delay Start: 48 Volt (minimum recommended battery voltage 2.04 v/cell)
23. AGS Exercise Day: First Tuesday of month
24. AGS Exercise Time: 9:15AM
25. AGS Exercise Period: 15 minutes
26. Output voltage: 120 V AC
27. Whisper controller "regulation on" voltage 56 Volt (100% power diverted)
28. Whisper controller "regulation off" voltage 52 Volt (0% power diverted)
29. Battery Capacity 5400 Amp-hr

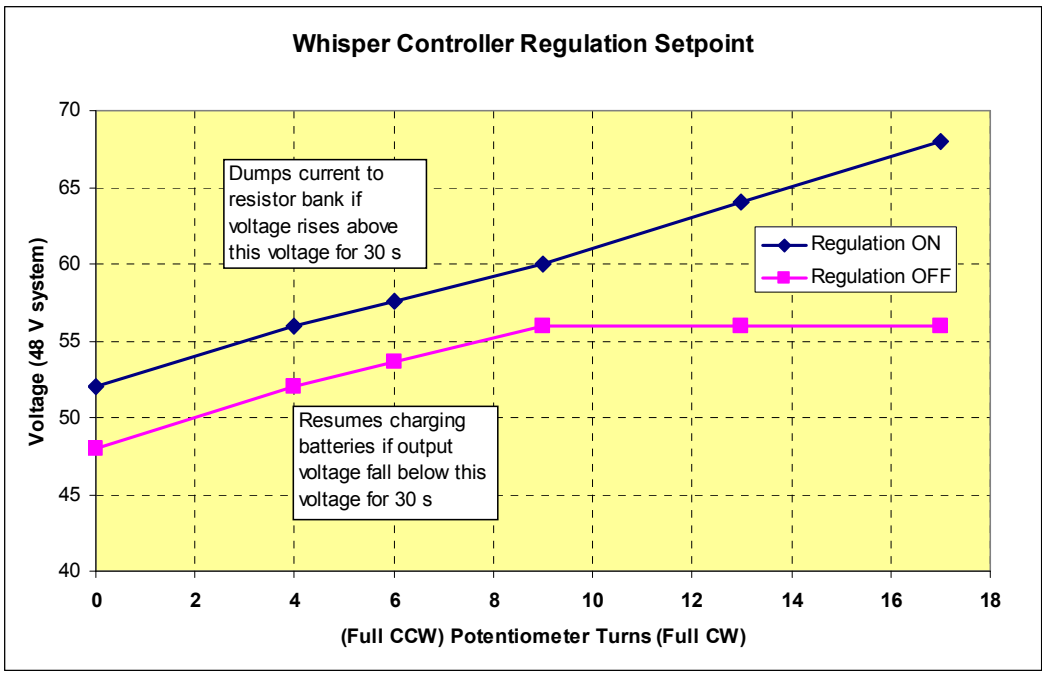

Figure 18: Whisper 500 regulator setpoint versus potentiometer (6 turns CW default, BBC setting is 52 and 56 volt, 4 turns CW)

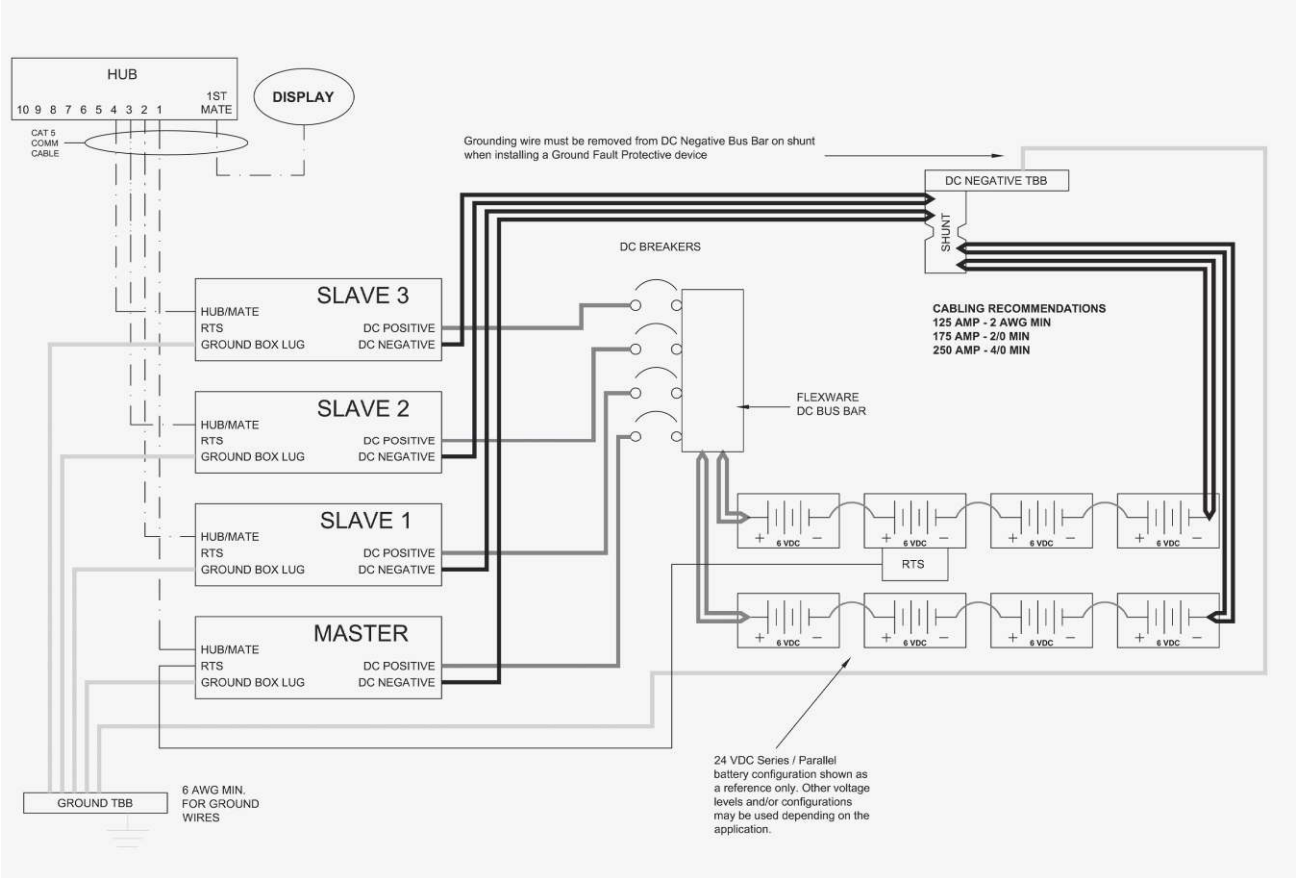

Figure 19: OutBack Flexware DC connections

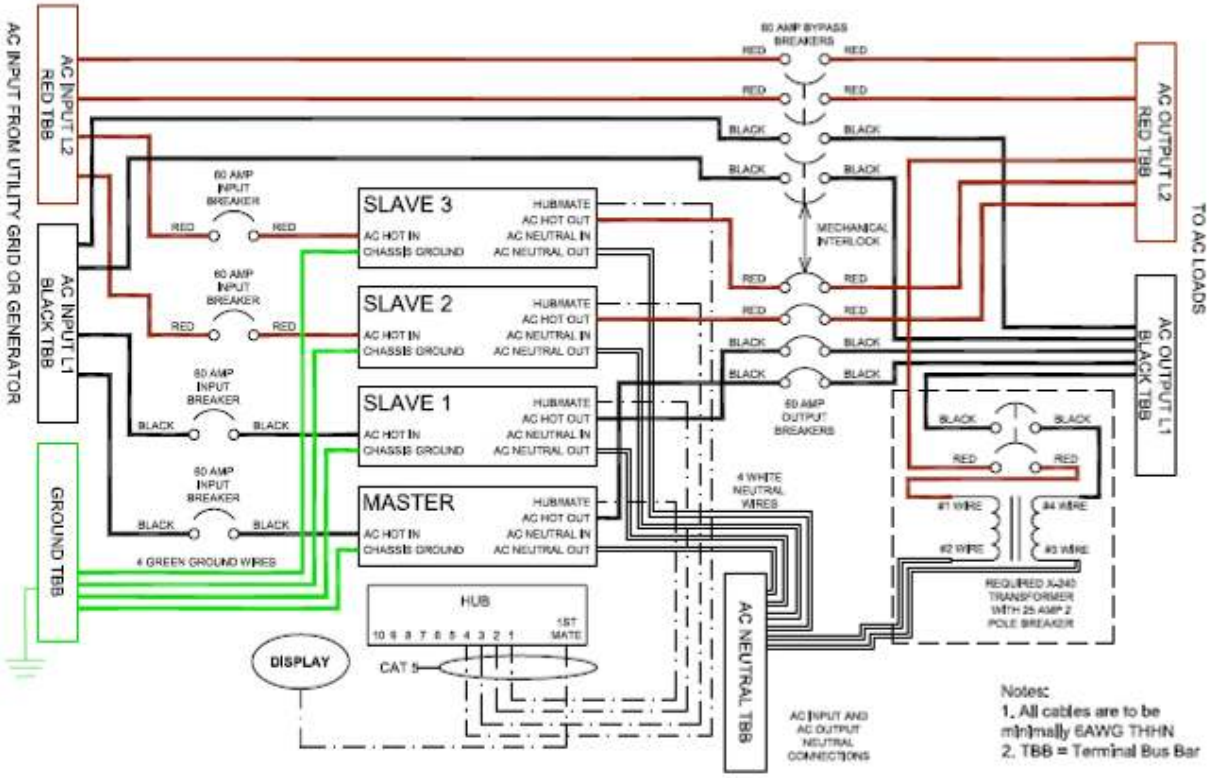

Figure 20: Outback Flexware AC Connections (120 v split phase with Autotransformer)

Generator Auto-Start (AGS Mode Auto Generator Start)

One controller is used to sense the battery voltage and if below a set minimum value it can send a start signal to an Atkinson Generator Start Control Module (GSCM), Figure 21, located adjacent the Isuzu generator. The GSCM will warm up the glow plug, turn the crank, and ignite the generator. If it fails it will try four times before locking out.

Part of its circuitry checks the frequency of the line voltage from the generator to ensure the motor speed is correct. However this feature can cause problems when the generator is used with an Outback inverter as higher harmonics can distort the wave form and instead of seeing the normal 60 Hz the sensor can mistakenly see the second harmonic (120 Hz) causing an "Generator Hz Shutdown" error (LED just under Start). The way around this is to disable this line frequency checking by the GSCM by setting the Under and Over Frequency Shutdown voltages to 0 volts (turning them both off) and allowing the Outback system to monitor line frequency itself. If the Outback system sees an error in line frequency it can shutdown the generator (see Atkinson Engineering Application Bulletin EAB#9, July 19, 2006).

Figure 21: Atkinson GSCM for staring the generator

When the generator starts it will begin supplying power to both the buildings and the batteries. If the buildings are requiring nearly all the generator power then the batteries will not charge. However even if the buildings are switched off the charger will only be allowed 20A of current or less if the batteries do not need it. Initially the batteries will usually take all the power they can have as they are weak. However as the charge progresses their voltage will increase until they reach a recommended preset "adsorption" voltage of about 55.2V (2.3 volt/cell × 24cells). At this time the current will begin to drop and the batteries will begin their adsorption cycle for some hours where additional charge is placed in them. At the end of the adsorption cycle the generator will automatically shutdown. Note the float / refloat cycles are not used in this remote off grid installation.

AGS will initiate a generator start under a number of conditions:

1. **Load Start**. If the building load is above 10 kW for 10 minutes then the generator will start to avoid a heavy battery drain. It will stop again when the load falls below 7 kW. Note a load start will not be commenced during Quiet Time.
2. **Monthly Exercise**: On the first Tuesday of each month at 9:15 AM the generator will run for 15 minutes. This is to burn of carbon or clean out condensation.
3. **SOC Start**. When the SOC as monitored by the FLEXnet DC falls below 79% the generator will start until the SOC reaches 93%. Note if in Quiet Time the 79% SOC limit will be bypassed until Quiet Time has passed. Once a week a full recharge will be called for and the 93% stop limit will be overridden.
4. **Voltage Start**. There are three set points for voltage start. Upon entering a voltage start sequence the generator will run through a full BULK charge cycle, that is the battery voltage will increase to the adsorb set point (54.2Volt) and then hold this for 1 hour.

Note: When AGS (Aux) has been initiated a yellow lamp will illuminate on the AC panel in the battery room to indicate that 12V DC start signal has been sent to the generator.

Storage Tank

The steel fuel tank is 4' in (1.22 m) diameter and 12' long. The capacity of the tank is approximately 4300 liters of diesel fuel. Table 2 and Figure 22 show the volume of fuel remaining in the tank versus the level on the dip stick (in inches or cm). The tank is double walled with a vacuum seal in the cavity between. If the seal fails the pressure will change indicating a problem with the tank. The seal pressure should be checked each year.

Table 2: Diesel Fuel Tank Capacity

Level (in)	Level (cm)	Volume (l)	Level (in)	Level (cm)	Volume (l)
1	3	22	25	64	2248
2	5	61	26	66	2361
3	8	111	27	69	2474
4	10	170	28	71	2586
5	13	236	29	74	2697
6	15	308	30	76	2807
7	18	386	31	79	2917
8	20	468	32	81	3024
9	23	554	33	84	3130
10	25	644	34	86	3234
11	28	738	35	89	3336
12	30	835	36	91	3435
13	33	934	37	94	3532
14	36	1036	38	97	3626
15	38	1140	39	99	3716
16	41	1246	40	102	3802
17	43	1354	41	104	3885
18	46	1463	42	107	3962
19	48	1573	43	109	4034
20	51	1684	44	112	4100
21	53	1796	45	114	4159
22	56	1909	46	117	4209
23	58	2022	47	119	4248
24	61	2135	48	122	4270

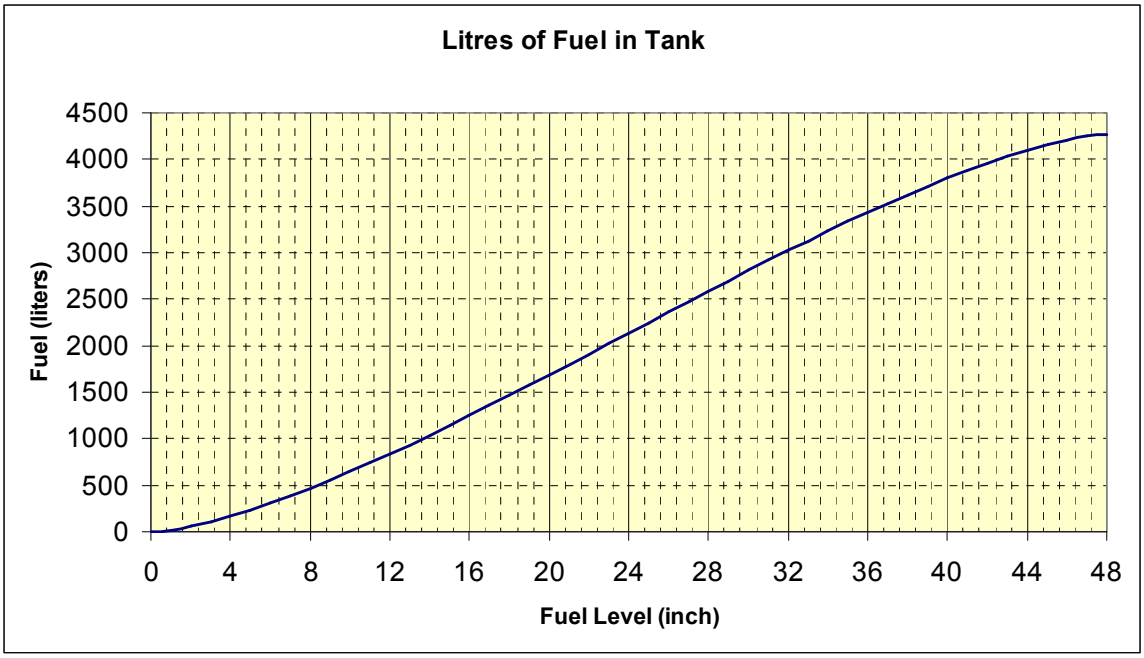

Figure 22: Storage Tank Capacity versus Fuel Level

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No AC Power	Turning on or off the Inverters. (Normally left ON)	• Press <INV> key once to get to ***INVERTER CONTROL*** menu, if display is "OFF" press key below ON. Green light on MATE above INV should come solid on and display should show "ON". **Note if generator is running the inverter is bypassed and the green light will be off.**
Start/Stop Generator	Manually START/ STOP Generator	• Press <ACIN> key twice for ***GEN START CONTROL***. • Press key below ON to start generator. Display will read "MAN ON". Yellow light on panel will illuminate to indicate control signal sent to generator. After a few minutes the yellow light on MATE will flash indicating generator running. Finally it should go solid yellow. **Note starting the generator alone will not charge the batteries – a BULK charge cycle is also required.** • Press key below OFF to stop generator. Display will read "MAN OFF". It will take 2-3 minutes for the generator to stop.
BULK Charge Battery	Applies AC power to charge batteries	• Press <ACIN> once and check ***AC INPUT CONTROL*** is "USE". If "DROP" press key below USE. • Next press <ACIN> key one more time to ***GEN START CONTROL*** – start generator. Wait until light above <ACIN> is solid yellow. • Next Press <ACIN> twice more to get to ***CHARGER CONTROL MODE.*** • Press key below BULK to enter ***BULK CONTROL***. • Press key below START to begin a bulk charge. As the charging proceeds the battery voltage will increase to 55.4 V. After 1 hour at this voltage the charging will cease. Wind turbines may stop at 55.2 V. STOP will stop the charging.
AUTO Start/Stop	Automatically starts and stops generator to maintain battery voltage, state of charge	• Press <ACIN> key twice for ***GEN START CONTROL***. • Press key below AUTO to place generator start control in automatic mode. • If either the battery SOC%, or voltage, are low the generator will automatically start and control will display "AUTO ON". • Make sure the enable/disable switch in generator house will allow the generator to start if required. If the generator fails to start automatically after 3 attempts it will set a fault flag which must be manually cleared.
Clearing Auto-Start Fault	Failure to start generator automatically will set a fault	• To clear an Auto-Start fault you **must** manually start generator, press <ACIN> twice to ***GEN START CONTROL***. • Press key below ON , display will read "MAN-ON" • After running 1-2 minutes press key below OFF. The control will be left in "MAN-OFF" (manual mode – off state). (Alternatively simply press key below AUTO and the display will read "AUTO ON". If the generator is not required it will switch to "AUTO OFF" and automatically shut down the generator.) • Press AUTO to restore AUTO mode. If either the battery SOC% or voltage are low the generator will automatically start.