

OPERATION & MAINTENANCE

VaxiCool[®] Mobile Refrigerator/Freezer

An Advanced Technology Vaccine Storage & Transport System

Model VXC-2



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Do not turn on the VaxiCool if you have not read the entire user's manual. Failure to understand the meaning of the light emitting diode (LED) indicators and the liquid crystal display (LCD) readouts could result in loss of your valuable vaccines and/or biologicals and, possibly, in damage to the unit.

This manual is for the current model and month of manufacture. If you need instructions for a different unit please consult the manufacturer for assistance. Contact info@acutemp.com or telephone 937-312-0114 and ask for technical support.

CAUTIONS

IF DAMAGE OCCURS TO THE UNIT, THE UNIT MUST BE REPAIRED AT THE FACTORY AT THE EXPENSE OF THE END USER. SEE WARRANTY SECTION.

- **USE THE -22°C TEMPERATURE SETTING ONLY FOR MATERIALS THAT MUST BE STORED FROZEN.**
- **DO NOT LOSE OR MISPLACE FREEZER KEYS SUPPLIED WITH THE UNIT. REPLACEMENT MAY NOT BE AVAILABLE AND FACTORY REPAIR WILL BE REQUIRED.**
- **DO NOT TILT THE UNIT OVER 30° WHILE OPERATING AND FOR MAXIMUM EFFICIENCY DO NOT TILT THE UNIT DURING OPERATION.**
- **DO NOT STORE THE UNIT IN TEMPERATURES BELOW -20°C (-4°F) OR OVER 60°C (140°F).**
- **DO NOT OPERATE THE UNIT IN AMBIENT TEMPERATURES BELOW 5°C (41°F) OR ABOVE 30°C (86°F).**
- **DO NOT SIT OR STAND ON THE UNIT.**
- **DO NOT PLACE ANY OBJECT WEIGHING OVER 10 LBS ON THE LID.**
- **DO NOT SUBMERGE THE UNIT IN WATER.**
- **DO NOT STACK THE UNIT UNLESS BOXED.**
- **USE THE $+4^{\circ}\text{C}$ TEMPERATURE SETTING ONLY WITH MATERIALS THAT MUST BE STORED ABOVE FREEZING.**

TABLE OF CONTENTS

Subject	Page
Introduction	5
General Description	5
Starting the VaxiCool	6
VaxiCool Display and Alarm Functions	11
Maintenance	16
Warranty	19
Appendix A – Solar Panel Application	20

INTRODUCTION

This manual is written to enable the VaxiCool user to readily start and operate the unit in the freezer mode, understand the light emitting diode (LED) and liquid crystal display (LCD) readouts, and perform rudimentary repairs and adjustments. Any questions about the unit should be directed to Energy Storage Technologies, Inc. by telephone, fax, or email. Please see the front cover for contact information.

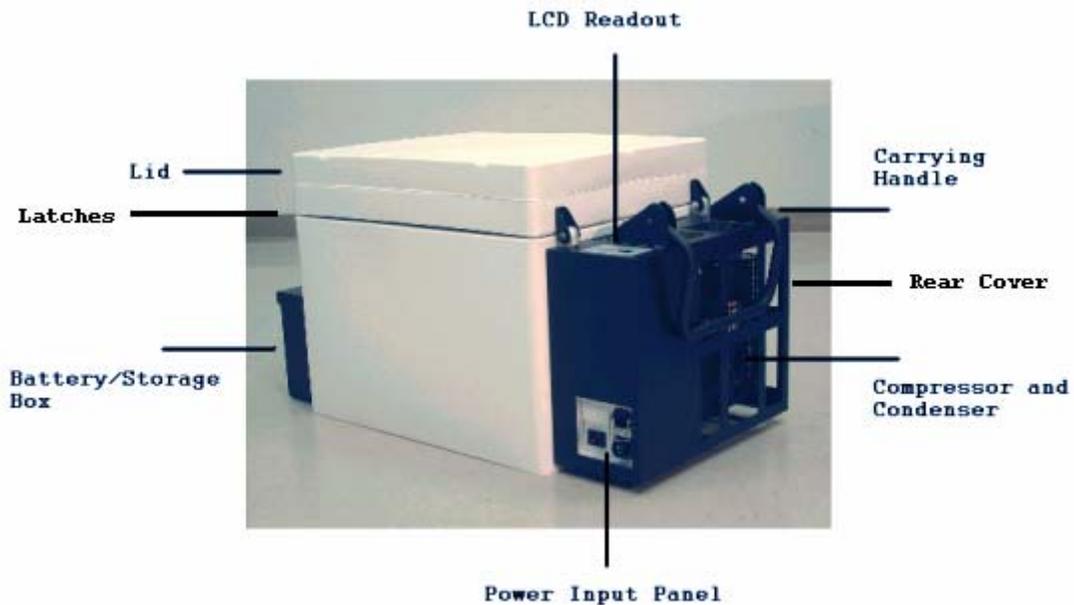


Figure 1. General View of the VaxiCool

GENERAL DESCRIPTION

The VaxiCool shown in Figure 1 has the following design and operational features:

- The lid is held closed with two front latches and must be held open by hand. This prevents the lid from being accidentally left open.
- The battery box is designed to house a pair of 20 amp-hour gel cell batteries (2 x 20 amp-hour equals 40 amp-hours) and the unit's battery charger. The lid to the

- box may be opened after removing the two screws keeping it closed. The battery charger for the unit is located under the lid of the battery box.
- The power input panel has three different connectors (See Figure 4.):
 - One for conventional AC power, either 120 VAC or 240 VAC (90 – 260 VAC),
 - One for a solar panel or PV/AUX power source, and
 - One for an external 12 Volt DC battery.
 - A key switch located on the power input panel allows the user to change from the -22°C freezer mode to the $+4^{\circ}\text{C}$ cooler mode.
 - The cover on the back of the unit protects:
 - The compressor and condenser of the refrigeration system.
 - The electronic components and their associated electrical leads. These components include: the power board, the AC to DC power supply, the compressor oscillator drive board, and the control board with LCD readout.
 - Ergonomically designed handles for easy transport of the unit are located on both the front and back of the unit. These handles can be used by either two or four people to maintain the unit on the level while moving it in the field.

The payload space/volume is approximately 27 liters. The unit weighs about 90 lbs without the gel cell batteries. It weighs approximately 125 lbs with the two 20 amp-hour gel cell batteries.

STARTING THE VAXICOOL

The VaxiCool may be started by connecting the unit to an appropriate power source with power ranges as defined by this manual. If a solar panel is used, proper sunlight is required. The unit requires battery backup if the sunlight is not sufficiently intense.

The temperature within the VaxiCool will reach satisfactory levels for storing payload in less than twenty-four hours of operation. Peak energy efficiency requires 24 hours of continuous operation for stabilization (ambient temperatures less than 30°C {86°F}). AC power is required for the first 24-hour period of operation to ensure the internal batteries are fully charged and the unit has reached full operating efficiency. Once the unit is stabilized and has fully charged batteries, it can be disconnected from external power and operate as a portable unit using its internal batteries. Using internal batteries only the unit can be operated as a freezer for up to 12 hours at ambient temperatures of 30°C (86°F). If power is totally lost the holdover time below -20°C is limited to less than three hours.

The VXC-2 unit is not equipped with an on/off switch. This is a safety feature designed to prevent accidental disruption of operation. The unit is “turned on” either by plugging it into an AC power source or, if they are sufficiently charged, by connecting its internal batteries. The batteries are connected to the unit through mating connectors incorporating fusible links. Fusible links are wires that act as fuses to protect the batteries in case of a short circuit. In the unlikely event that this fusible link is “blown” repair of the unit at the factory or by a factory trained technician is required.

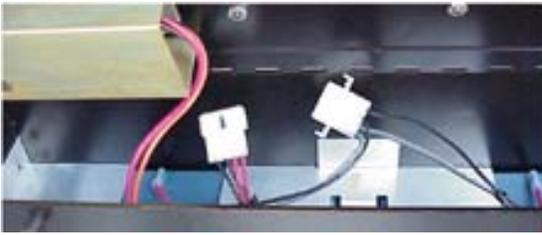
To start unit and ensure full battery charge, proceed as follows:

Step 1. Always start the unit using the AC power cord. Wait for 30 seconds and confirm that the LEDs are illuminated, the LCD is displaying information, and the audible alarm is on. Once these conditions are verified, disconnect the AC power cord so that you can connect the batteries as described in Step 2. **CAUTION: Using the batteries to condition the unit will deplete the batteries much more quickly than in stabilized operation. You must be prepared with a means of recharging the batteries before they are depleted.**

Step 2. Open the battery box cover on the front of the unit by removing the two cover screws. The battery leads are pre-wired to the battery terminals and are terminated through fusible links to a connector. To bring the batteries up to

charge, open the battery box cover and snap the fusible link connectors together (Figure 2). Be sure they are inserted fully.

Step 3. After the fusible link connector is engaged, operate the VaxiCool for at least 24 hours on AC, or 1 week on solar power to sufficiently charge the batteries. As indicated above, this operating period also ensures the temperature stabilization of the payload space and that the unit reaches maximum operating efficiency.



Disconnected



Connected

Figure 2. Fusible Link Mating Connectors

Setting Control Temperature

The control temperature is set using the keyswitch on the power input panel. The unit is shipped with the keyswitch in the -22°C position.

NOTE: The -22°C setpoint is ONLY used for materials which must be stored frozen. (If the ambient temperature is above 30°C , the VXC-2 may not have the cooling capacity to hold the payload temperature below -20°C). The temperature display indicates the temperature setpoint ten seconds after the LCD display turns on (see Display Functions). Because the unit was designed primarily to operate at ambient temperatures between 5°C (41°F) and 27°C (80°F), operating at temperatures outside this range will draw down its batteries much more quickly and it may not regulate at the selected temperature successfully. (See temperature range and operating limit label in Figure 3.)

The power input panel with the key switch is shown in Figure 4.

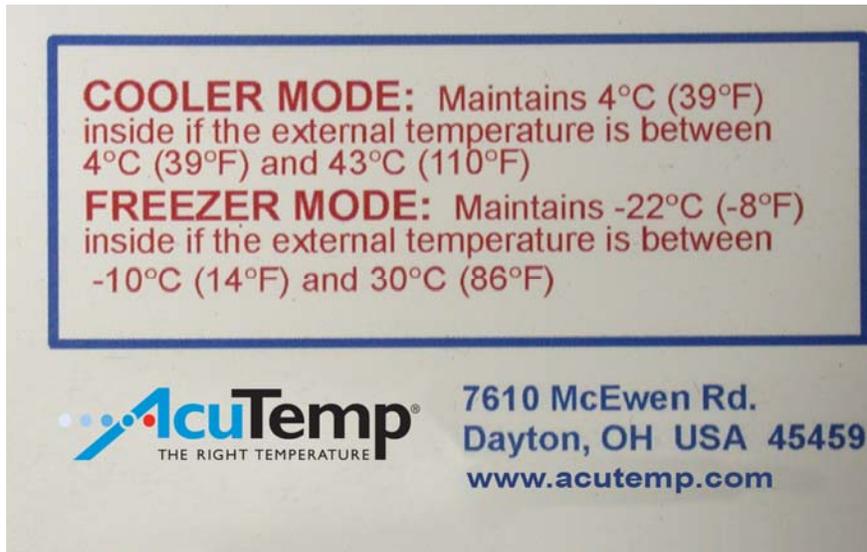


Figure 3. Temperature Range and Operating Limit Label

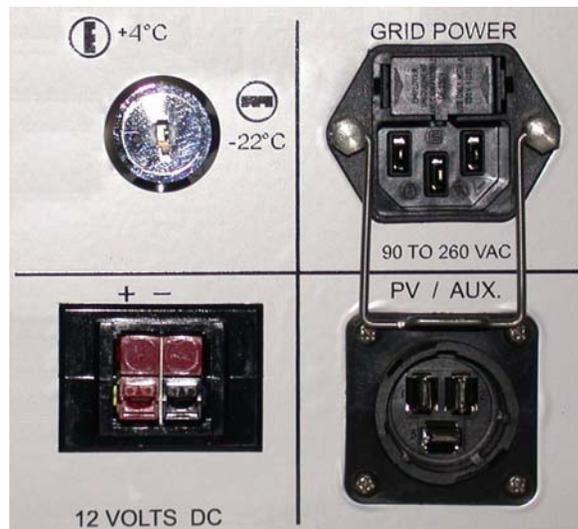


Figure 4. Power Input Panel with Key Switch

The connectors for the various power sources are clearly marked on the Power Input Panel. The receptacle for the “POWER GRID” (AC input power) has a fuse holder above the plug. The wire frame hanging from the connector is used to hold the electrical cord in place making it difficult to accidentally disconnect the unit.

The various power cords and cables for the unit are shown in Figure 5. The external battery cable has fittings for a typical lead acid battery, and the cigarette lighter cable has a plug that fits into a common automobile cigarette lighter or accessory power receptacle.

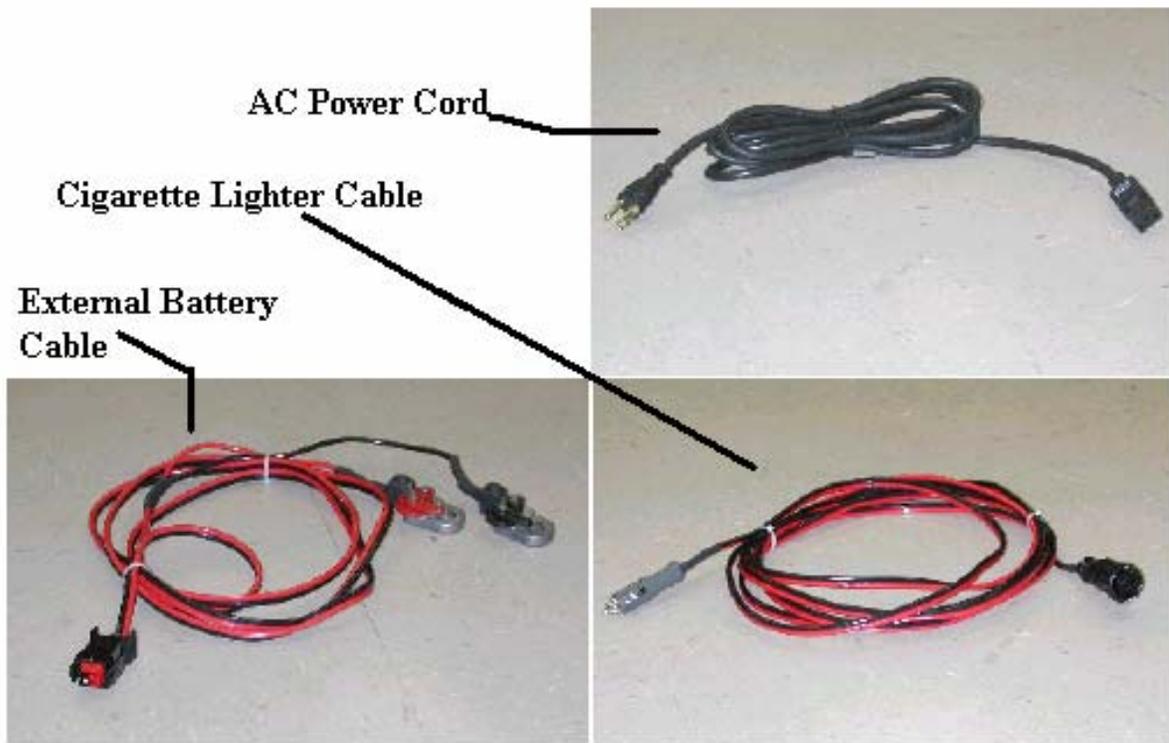


Figure 5. Power Cords for the VaxiCool

VAXICOOL DISPLAY AND ALARM FUNCTIONS

The LCD display will begin to function when the unit is turned on. The LCD readout and the two blinking LED alarm lamps (temperature and battery) located above the LCD display will illuminate. See Figure 6. If either the payload temperature or the battery voltage is out of acceptable operating range an intermittent audible alarm will sound.



Figure 6. The LCD and LED Panel

The VaxiCool display panel provides the following information:

The two LED alarm lamps indicate the payload temperature and battery operating voltage condition. The color of these two LEDs changes as the condition changes. The color indications are as follows:

- | | | |
|--------|---|--|
| GREEN | – | Good |
| YELLOW | – | Marginal |
| RED | – | The operating parameters are beyond acceptable limits. |

Note that an audible alarm sounds when any RED LED alarm condition occurs.

The LCD display consists of two rows of text. The top row, from left to right, shows the payload temperature from -20.0°C to 50.0°C , the operating voltage, and the temperature

mode selected by the user. The standard default temperature scale is Celsius ($^{\circ}\text{C}$), but the unit can be special ordered to display in the Fahrenheit ($^{\circ}\text{F}$) scale.

The temperature control mode selected by the keyswitch is indicated by a lower right corner symbol (\lrcorner) to indicate the -22°C mode and an upper left corner symbol (\llcorner) to indicate the $+4^{\circ}\text{C}$ mode.

The VXC-2 continuously records the temperature extremes in the payload space and remembers them for up to seven days. Assuming uninterrupted operation, at the end of each seven-day period the oldest day's temperature extremes are dropped and replaced by the current day's information.

The bottom row displays the highest temperature stored in the temperature history, separated by a slash (/) from the number of days since that temperature was last measured and the lowest temperature stored in the temperature history, separated by a slash (/) from the number of days since that temperature was last measured. Although not displayed, the temperature unit of measure ($^{\circ}\text{C}$ or $^{\circ}\text{F}$) for the temperature history line is the same as that for the current payload temperature on the first line of the display.

LEDs:

The two VaxiCool alarm LED indicators each have three status indicator colors as noted above: GREEN for "good", YELLOW for "marginal", and RED to indicate when the parameter is beyond acceptable limits. The left LED shows the status of the payload temperature and the right LED shows the status of the battery or operating voltage.

This LED on the left will illuminate GREEN when the payload space is within the temperature limit(s) associated with the operating mode (cooler or freezer) selected by the user. It turns YELLOW when the payload space temperature approaches the limit(s) set for the selected operating mode. It turns RED when the temperature exceeds the limit(s) for the selected operating mode.

The LED on the right shows the status of the battery or operating voltage. It warns when the operating voltage from any power source is low or has dropped below the safe operating limits. When the unit is operated on AC line power, this LED should always start out GREEN or turn GREEN within a few minutes (after the internal battery achieves adequate charge). When the unit is operating on a wet or gel cell lead-acid battery, the LED is GREEN as long as the battery voltage is above 11.8 volts (typically 10% or more of its charge capacity). The LED turns YELLOW when the battery has less than approximately 10% capacity remaining. When the LED is RED (11.5 V or below) the battery must be charged or the unit will soon shut down allowing the payload to exceed the temperature limits for that load. Draining the battery to 11.5 V or below greatly shortens battery life. **NOTE: Even if the battery status indicator is GREEN do not begin a battery powered portable mission if the battery voltage shown in the upper line is below 13.5 volts on AC power, or below 12.9 volts running on batteries.**

The tables below show the temperature alarm LED colors for the standard cooling and freezing set points and for operating voltages.

Temperature LED: Temperatures for +4°C

LED COLOR	PAYLOAD SPACE TEMPERATURE
RED	8.0°C and Above
YELLOW	Between 7.0°C and 8.0°C
GREEN	Between 2.0°C and 7.0°C
YELLOW	Between 1.0°C and 2.0°C
RED	1°C and Below

Temperature LED: Temperatures for -22°C

LED COLOR	PAYLOAD SPACE TEMPERATURE
RED	-20°C and Above
YELLOW	Between -22°C and -20°C
GREEN	Below -22°C

Battery Voltage LED Indicators

LED COLOR	BATTERY VOLTAGE
GREEN	11.8V and Above
YELLOW	Between 11.5V and 11.8V
RED	11.5V and Below

Audible Alarm:

The VaxiCool audible alarm sounds when either the temperature or battery voltages are outside their nominal operating range. The sound occurs three times, spaced one second apart, at eighteen-second intervals. The audible alarm is an indication that the payload is in danger and immediate attention is required. Typically this will mean using an available alternative applicable power source to keep the unit running. Either solar or AC line power is required to also recharge the unit's internal batteries.

LCD Display:

Typically, the temperature within the VaxiCool will reach satisfactory levels for storing payload in well under twenty-four hours of operation. Peak energy efficiency, however, requires twenty-four hours of continuous stabilizing operation to achieve. With AC line power operation, this 24-hour period is also recommended to ensure the internal batteries are fully charged. Once stabilized and with its internal batteries fully charged, the unit may be disconnected from external power and used for portable operation.

A schematic image of the display is shown in Figure 7. This shows the relative positions of the information in the display. In the schematic example, the operating voltage is too low, so the right alarm LED is yellow. This set of display conditions can occur when the unit is first turned on and the batteries are not adequately charged to handle the initial cool down task. Also in this schematic, the unit is set to -22°C (the freezer mode), which is indicated by the last character on the first line. The upper left hand corner symbol will appear in the $+4^{\circ}\text{C}$ (refrigerator) temperature mode.

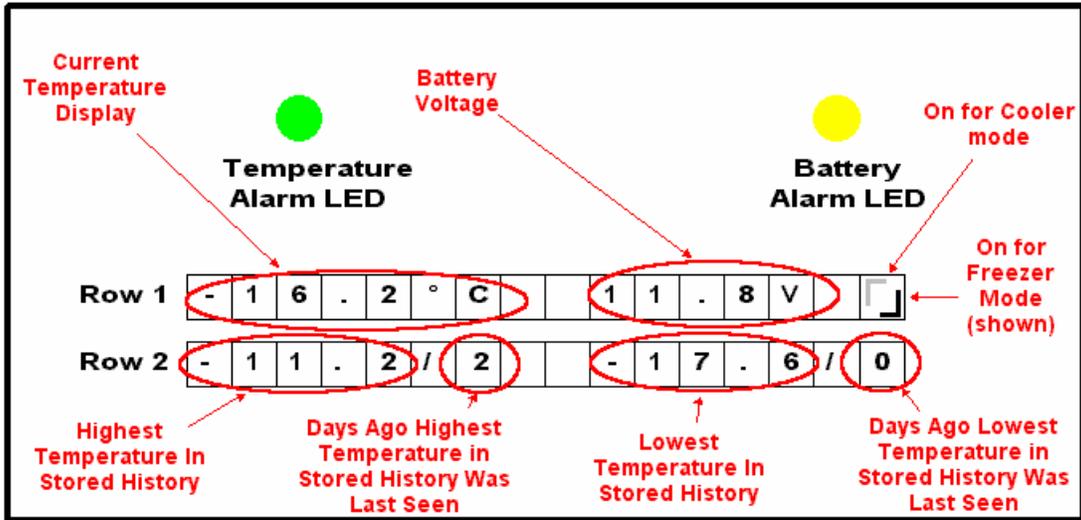


Figure 7. Schematic of the LED indicators and LCD display.

MAINTENANCE

WARNING: Disconnect all external power before connecting or disconnecting batteries. Also, disconnect all external power sources before performing maintenance or before removing the black cover over the electronic section of the unit. FAILURE TO COMPLY MAY RESULT IN INJURY OR DEATH.

The basic design of the VaxiCool relies on patented insulation technology, tight temperature control using solid-state electronic computer control, and patented PCM technology. The VaxiCool will perform with exceptional efficiency at -22°C and at $+4^{\circ}\text{C}$:

- At -22°C operation, the unit will operate for more than 8 hours with two properly charged 14 amp-hour batteries (at 25°C ambient temperature).
- At 4°C operation, the unit will operate for more than 60 hours with two properly charged 14 amp-hour batteries (at 25°C ambient temperature).

The VaxiCool is portable and self-powered when utilizing internal gel cell batteries. The system is designed with lightning protection and will accept electrical power from multiple sources, e.g. 12-volt batteries, solar panels, or a wide range of grid power (90 to 260 VAC with 47 to 63 Hz line frequencies, with no adjustment).

All operating power input to the system is distributed through the power board whose location is shown in Figure 8. The same figure also shows the locations of the oscillator board, power input panel, power supply and control board with LCD displays.

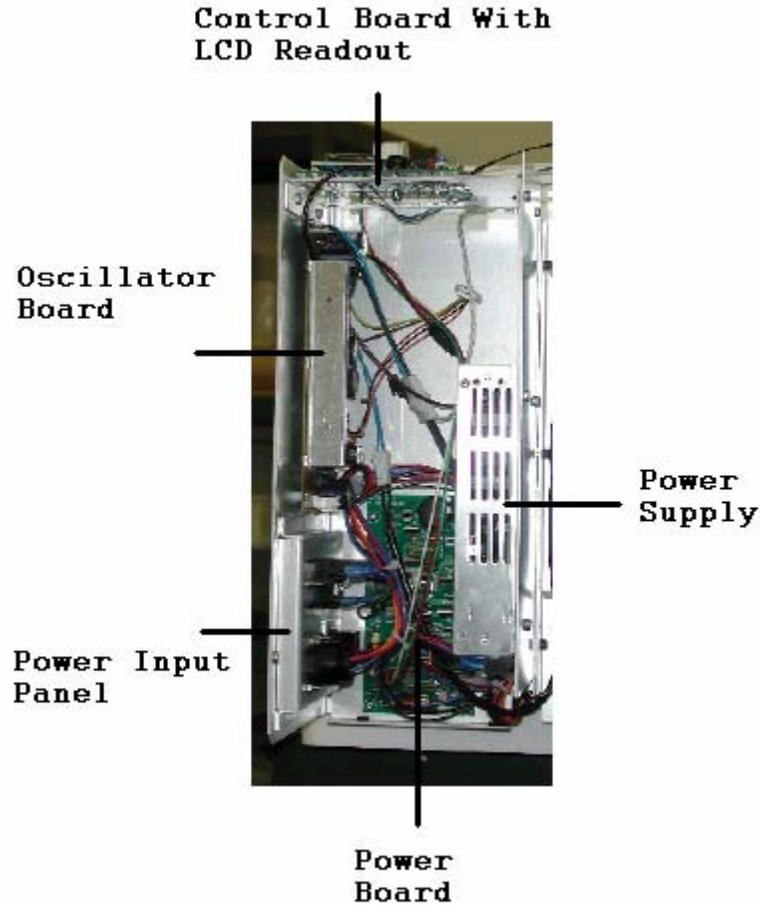


Figure 8. Location of Electronic Components

The internal batteries can only be charged if there is an external electrical input available to the system (AC power or a solar panel). The battery charger is mounted on the underside of the battery box lid behind a protective shield.

The VXC-2 operates on 12 VDC. Power from non-12 VDC sources (e.g. 120 VAC grid power) is converted internally to 12 VDC. Operating on this 12 VDC internal source, the oscillator board provides the correct power to the compressor. The compressor cools the interior of the VaxiCool through an evaporator that surrounds the interior sides of the unit. The temperature inside the unit is monitored via a thermistor, which is connected to the control board. The control board also monitors the battery voltage, creates the signals

for the LCD readout, and adjusts system functions to maintain the appropriate internal temperature.

To maintain good operation:

- The condenser must be kept cleaned of dust and dirt
- The external electrical connectors should be kept clean
- Lid gaskets should be kept clean and free of cuts and rips
- Batteries should be kept charged and terminals kept clean of corrosion

The system is protected from excessive currents by a series of fuses. The first set of fuses is located within the input receptacle for AC current shown in the upper right corner of Figure 4. **Depending on the model of the input receptacle, one or two fuses are required.** The fuse rating is 3 amps, 250 V (5x20 mm size). The remaining six fuses (10 amp, 250 V 5x20 mm size) are located on the power board as shown in Figure 9. These fuses are accessible by removing the compressor and electronics cover at the rear of the unit.

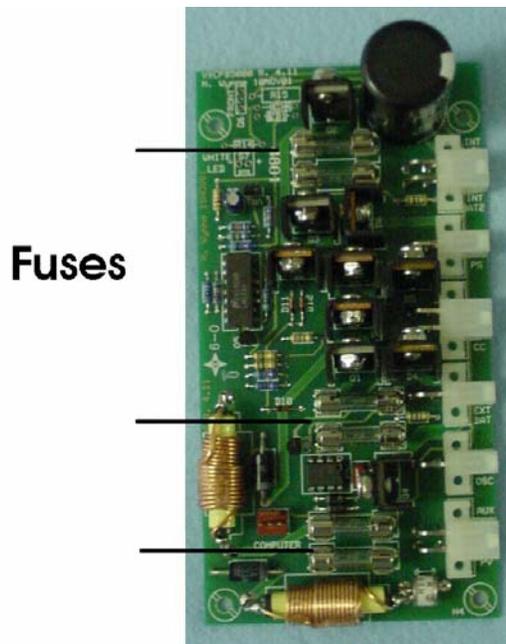


Figure 9. Location of Fuses

WARRANTY

The VaxiCool is warranted to be free from defects in manufacturing and workmanship for a period of one (1) year from the date of purchase F.O.B. Dayton, Ohio. This limited, warranty covers repair or replacement, at the Company's option, of components only. It does not cover any costs related to or damage resulting from the use of the VaxiCool. The owner of the VaxiCool must pay for insurance and shipping (and for overseas customers, import/export duties) to and from Dayton, Ohio or the factory-designated service center. The unit must be packaged such that it will not be damaged in transit; the Company will not be responsible for any such damage. Therefore, the unit must be insured for its full value.

AcuTemp reserves the right to change product specifications, materials used in construction, component parts, suppliers and product design elements at any time in order to provide the best product possible.

AcuTemp makes no representation or warranty, express or implied, with respect to the suitability of the VaxiCool and its phase change materials for holding or carrying any particular items or for any other purpose, including, without limitation, any implied warranty of merchantability or fitness for a particular purpose.

Appendix A

Solar Panel Application

If you have purchased or wish to purchase the optional solar panel for keeping the VaxiCool batteries charged via sunlight, selection of the solar panel is based on your location, solar conditions, and duration of daylight and nighttime hours. Using panels that are too small for your conditions will not adequately maintain a battery charge. If you change the geographical location of your VaxiCool system, please check with factory technical support to verify that your panel size does not need to change. Please contact info@acutemp.com for assistance.

The solar panel needs to be mounted in an appropriate manner per the instructions provided with the panel, to ensure maximum use of sunlight. The cable that comes with the solar panel will be the correct gauge and length, per factory specifications, and you should not attempt to extend it without consulting the factory or panel manufacturer for technical support.

The connector on the end of the solar panel cable will only fit into the PV/AUX connector on the power input panel of the VaxiCool (Figure 4, page 9). It cannot be mated accidentally to any other connector on the VaxiCool.

A properly selected solar panel will keep the internal batteries charged and the unit running continuously under conditions typical for your location. The panel will supply sufficient power to run the compressor during daylight hours and to charge the batteries to ensure operation through the night or longer. It is important that a unit running on solar panels not be disconnected from the panels during any daylight hours. Solar panels receive most of their energy from ultraviolet light, which can partially penetrate cloud cover. Do not assume that a cloudy day means you do not need to keep the panel connected. On days when cloud cover is heavy, the battery may not charge completely,

however, it should gain some charge. Fully charged, the battery stores enough energy to continue operating through a number of heavily clouded days.