MODEL 100
Gas Generator

INSTRUCTION MANUAL

Gas Type: _____

Flow Rate: _____

PPM Settings: ___ ___ ___
R1 R2 R3

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Revision - 020117

Figure #5
NOMINAL EQUILIBRIUM TIMES

Each calibration gas generated has a characteristic time to equilibrium. The Power LED flash timer is adjusted for the time it takes the instrument to come to ~95% equilibrium. The flash circuitry times listed below are nominal and may vary slightly, particularly for the longer equilibrium times.

Gas	95% Equilibrium Time (minutes)
Chlorine	5
Chlorine Dioxide	5
Bromine	5
Hydrogen	8
Hydrogen Sulfide	8
Hydrogen Cyanide	~60

Instruction Manual

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WARNING:

This instrument generates calibration gas for toxic gas detectors. The instruction manual should be read and understood prior to operation of the instrument. Failure to operate the instrument correctly can lead to improper calibrations.

This instrument conforms to the protection requirements of the **EC DIRECTIVE 89/336/EEC** on Electromagnetic Compatibility (EMC), in accordance with the provisions of Statutory Instrument 2372.

The following standards have been applied:

EN 50081-1
Emissions Standard (Residential Commercial and Light Industry)

EN 50082-1

Immunity Standard (Residential Commercial and Light Industry)

The flow rates listed above have been calculated for the standard low flow of 1/2 LPM but the correction factors can be calculated for other flow rates. Simply divide the desired flow rate in milliliters per minute by 500 and multiply by the correction factor above. An example of this would be:

(Sea Level Flow of 1 LPM, 2500 Altitude) = 1000/500 x 548 = 1096 mLPM correct flow

Note: The pump flow rate is dependent upon system pressures. Do not induce added pressure to the instrument when checking flow rates. A low pressure drop flow meter, for instance a soap bubble meter, should always be used at all times. **Do not** use mass flow meters with the above table. These flow meters automatically compensate for desnity changes due to altitude and temperature.

Figure #4
ALTITUDE CORRECTION TABLE

The output concentration of the instrument is directly dependent upon the mass of air that is mixed with the generated gas. The pumps used are constant volume pumps, not constant mass pumps. Therefore, the mass of the air will change as the density of the air changes. Because temperatures can fluctuate continuously, the circuit boards are designed to correct for changes in density due to temperature fluctuations. Altitude usually does not fluctuate from day to day, hence the boards are not designed to correct for changes in density due to altitude fluctuations. All instruments are set up at the factory to sea level altitude. If the instrument is to be used at a much different altitude, its flow should be readjusted to the correct flow for that altitude. The following table and formula may be used to derive the correct flow rate.

ALTITUDE CORRECTION TABLE

Altitude (in feet)	Correct Volumetric Flow (in milliliters per minute)
-500	491
0	500
500	509
1000	519
1500	528
2000	538
2500	548
3000	558
3500	568
4000	579
4500	590
5000	601
5500	612
6000	624

I. GENERAL DESCRIPTION

The Model 100 Gas Generator is a battery-powered, portable instrument that can generate up to three different concentrations of a calibration gas in air. Ambient air is drawn into the instrument through a small built-in pump and discharged through a charcoal filter. This ensures a fresh air supply for proper calibrations even in potentially contaminated areas. It is important that this filter be replaced often in high background gas areas. Gas is generated electrochemically and mixed with the cleaned air stream to provide accurate gas concentrations.

Power for the instrument is provided by a built-in, rechargeable, nickel-cadmium battery. An extension hose permits transport of the calibration gas to the desired location. Diagnostic lights inform the user of low battery charge level, improper electrolyte levels, generating range selected and stand-by during warm-up. The instrument is designed to withstand severe service including exposure to dust, bumps, moisture and rough handling.

The concentrations of the generated gases are controlled by two factors, the amount of current driven through the electrochemical generating cell and the amount of air mixed with the generated gas. The amount of current can be controlled and adjusted on the circuit board to extremely close tolerances. The overall accuracy of the instrument is, therefore, highly dependent upon the control and adjustment of the mixing air flow. The generation rate is electronically compensated to nullify the effects of changes in the air density at constant volume due to changes in temperature. It is **not** compensated for the changes in density due to changes in altitude. The flow rate must be compensated to correct for the altitude density changes for the instrument to generate correct concentrations. The altitude correction table is located in Figure #4.

II. DETAILED DESCRIPTION

A. Housing

The Model 100 is housed in a water and wear resistant polystyrene plastic case which is durable, light-weight and shock resistant. The lower half contains all of the electronic circuitry and mechanical components. The upper half may be removed completely from the lower half. The case is held together by four screws through the lower case.

B. Controls and Indicators

The following is a brief description of the controls and indicators found on the Model 100:

1. POWER, a push button switch with built-in green LED located on the front, left of the lower case. The green LED flashes until the equilibrium time required when switching between ranges is reached (see Figure #5 for nominal equilibrium times). Then it is on continuously during normal operation.

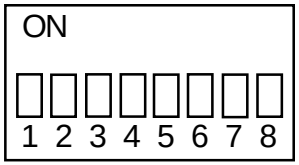
2. R1, R2, R3, push button range switches with built-in green LEDs located to the right of the power switch. These switches are used to select the range of calibration gas to be generated. Individual green range LEDs will light up to indicate which range is activated. With no range switches activated and no range LEDs lit, the instrument does not generate gas and may be used to pump "fresh" air (can be used as zero air setting).

3. FLOW ADJUST, a screw potentiometer located on the circuit board. This control is used to vary the rate of air flow which is

Always adjust the dip switch setting to give a slightly higher value than the current desired in the highest range output. For instance, if the desired ouput was 1, 3, 10 ppm chlorine at 1.2 LPM the desired current in range 3 for 10ppm is .718 mA. Dip switch #5 should be turned on and all three ranges may then be set correctly.

Figure #3
CURRENT DIP SWITCH ADJUSTMENTS

The current range dip switch is designed to provide a fine adjustment over a wide range of currents. Each switch shunts current through a selected resistor that controls the upper limit of currents available to the screw potentiometer and in effect moves a current envelope or window up or down the range of available currents. The dip switch itself is shown in more detail below with the ranges of available currents listed below that.



Dip Switch On	Resistance (OHM)	Maximum Current (mA)
1	100K	0.02
2	33.2K	0.05
3	10.0K	0.14
4	3.32K	0.35
5	1.00K	1.39
6	332	2.48
7	100	13.84
8	33.2	41.8

Multiple switches may be turned on at once to achieve different current ranges. For instance:

2+3	7.68K	0.19
5+6	249.25	3.87

indicated on a flowmeter. Recommended air flow for the low flow instrument is 1/2 LPM. Check the front cover of the instruction manual to determine the proper air flow rate.

4. CELL CHECK, a red LED, off during normal operation. The LED will be lit continuously in the event the electrolyte level falls below a safe operating level. The LED flashes when more than one Range Select button is activated as the instrument will not generate gas in this mode.

5. LOW BATTERY, a red LED. Off during normal operation, the LED will be lit continously to indicate low battery level. In charge mode, the LED will flash when charging the battery and will extinguish when the battery reaches approximately 95% of full charge.

6. FLOW METER (OPTIONAL), a variable area "float" flow meter, built-in to the rear of the lower case. The flow meter should be inspected periodically to ensure that it is unobstructed by foreign matter and that the float ride freely in the flow tube. The flow meter is mounted to the case by two screws through the rear of the case. If there is no flow meter present, an external flow meter should be used to verify and adjust air flow.

Warning: Only low differential pressure type flow meters, e.g., soap bubble types, should be used to reset the air flow on instruments with no flow meter built-in. These flow meters will not pressurize the system which could change the pump characteristics and introduce error to the flow rate of the instrument.

The following components are located inside the instrument. To open case, remove the four perimeter screws through the lower case and lift upwards on the handle.

C. Gas Generation Cell

The gas generation cell is an electrochemical cell mounted directly behind the rechargeable nickel-cadmium battery and to the left of the pump as viewed from the front and top of the instrument. The fresh air enters the cell from the filter/flow meter and flows out the top to the outlet fitting mounting directly behind the cell in the front of the instrument.

The U-shaped half of the cell body is an electrolyte reservoir which feeds the generating part of the cell. There is one screw plug in the top of the cell reservoir. The electrolyte may be added by removing the screw plug.

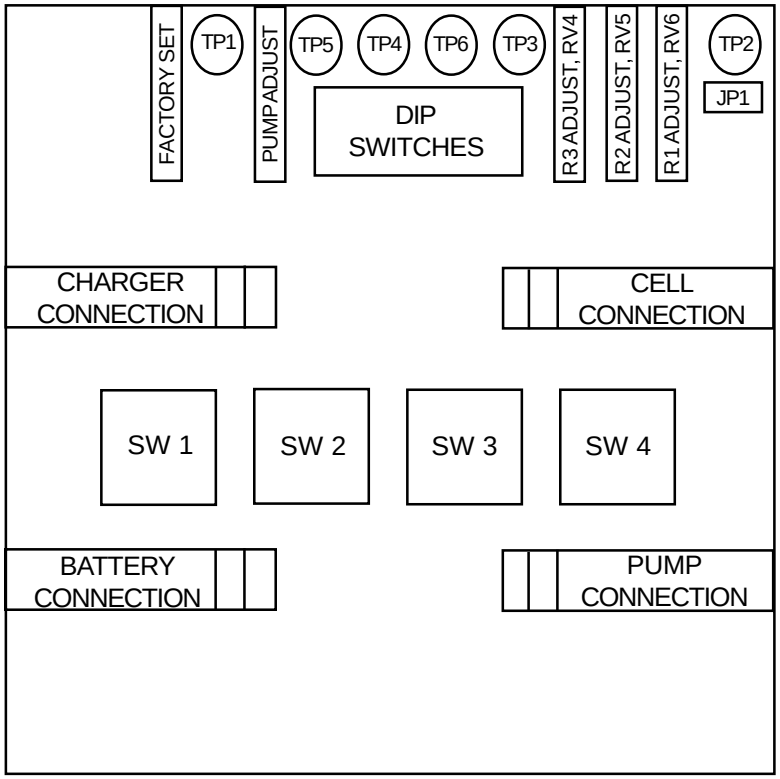
NOTE: The electrolyte is hygroscopic, i.e. it will come to a state of equilibrium with the environment through absorption or evaporation. In a dry climate where evaportation is likely, you may add deionized water on a regular basis to compensate. In a humid climate, the electrolyte level should be checked periodically, especially within a couple of weeks after shipment to ensure it is at a proper lever (no less than 1/4 inch from top of cell. If low, add electrolyte). See Section V for details.

WARNING: Do not over-fill reservoir. Fill liquid up to within 1/8 inch of the top of the reservoir.

The calibration gas is generated electrochemically in the lower half of the cell, passed through a gas permeable membrane into the air chamber and mixed with the incoming airstream before exiting through the outlet fitting. The gas concentrations are very dependent upon the flow rate of the instrument. The flow rate should be controlled at the rate stated on the front of this instruction manual.

The generating cell connects electronically to the circuit board by means of a two-pin plastic quick connect. The cell may be removed

Figure #2
MODEL 100 COMPONENT LAYOUT



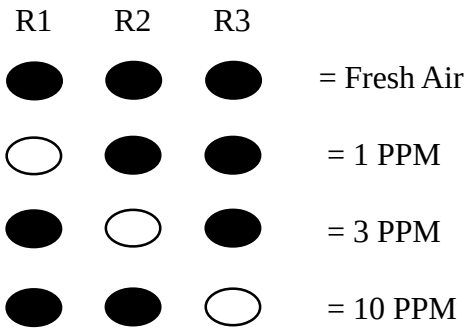
Example #2

A hydrogen cyanide gas generating cell set to 5 ppm and 2 LPM air flow.

(Current needed for 5 ppm HCN, 2 LPM) = 5 x 2 x .0718 x 1 = .718 mA

The following schematic indicates a ***typical*** ppm output of the R1, R2 and R3 switches as listed on the top side of the instrument case. The exact ppm values are listed on the cover page.

NOTE: These output levels may be changed as described in Section IV. It is highly recommended that this schematic be altered accordingly to reflect those changes.



= LED Off

= LED On

from the instrument by removing the screws on the back of the mounting bracket and removing the inlet and outlet fittings on the sides of the air chamber.

D. Batteries

The nickel-cadmium battery pack is located directly in the center of the case, directly behind the circuit board. The battery pack is secured by two screws through the bottom of the case. Power output leads extend from the side of the pack and terminate in a two-pin plastic connector, which in turn mates with a connector on the main circuit board. A fully charged battery pack will power a low flow instrument for approximately 4 to 6 hours; high flow instruments will have less operating time due to the increased demand from the larger pump.

E. Air System

The air system supplies fresh air at the controlled rate to the generating cell where it is mixed with the calibration gas and exhausted through the outlet fitting. These components are further described below:

1. Charcoal filter, for scrubbing air intake to remove potential background gas and provide clean air for the calibration samples. The filter is a removeable charcoal cartridge in a stationary housing. The filter cartridge is accessed from the rear of the instrument.

2. Screw potentiometer, a fine adjustment used to control air flow through the instrument. Access to this control is obtained by removing the rubber plug located next to the FLOW ADJUST label. **The airflow rate is critical for proper gas concentrations and should be maintained at the rate specified on the front of the manual.** This adjustment provides control of approximately 20% above and below the specified flow rate. Larger changes to the air flow may

be made by adjusting the internal restiction found in the flow path itself. This restriction is either an adjustable needle valve or an orifice restrictor. Contact the factory for more information on gross changes to the air flow rate.

3. Pump is a motor driven rotary vane type. It operates directly from the battery output or the AC adapter when the circuitry is turned on. The pump is firmly secured by a metal mounting bracket.

4. Tubing is flexible polyurethane and connects to the air chamber by 1/4" plastic tube elbows with 10-32 male threads. Outlet is a panel mounted quick connector for direct connection of the sample hose.

5. Hose is a 3' flexible polyurethane tube equipped with a male quick connect hose coupling to fit outlet fitting of the instrument.

F. Charger

The charging circuit of the instrument is designed to charge the battery, then automatically reduce to a trickle charge to maintain full capacity. The charger plugs directly into a socket in the rear of the case. The LOW BATTERY light flashes when the charger is in the trickle charge mode.

G. Continuous Operation

Instrument can be operated continuously from AC power through the use of the charger. It also may be operated continuously from a 12-volt vehicle battery, by use of a Continuous Operation Adapter. This is a power cord with a mating plug to fit the charger socket. When connected to the instrument and to a 12-15 volt supply, it will carry the load and recharge the battery. The polarity is automatically corrected on the circuit board.

Figure #1
CELL CURRENT CALCULATIONS

The amount of gas generated by the electrochemical generating cells is directly proportional to the current flowing through the cell and the air flow mixed with the generated gas. It is possible to change the generating rate by adjusting the current through the cells. **The current circuitry is temperature compensated and should be checked and adjusted at 20 C.** The following formula may be used to calculate the correct current for desired ppm levels and flow rate:

(Current needed in ma) = (ppm desired) x (flow rate in LPM)
x (.0718) x (gas factor)

The gas factors are as follows:

Bromine	2	Chlorine Dioxide	1
Chlorine	2	Hydrogen Cyanide	1
Hydrogen Sulfide	2		

The following examples illustrate how to calculate the correct cell currents:

Example #1

A chlorine gas generating cell set to 2 ppm and 1/2 LPM air flow.

(Current needed for 2 ppm Cl2, 1/2 LPM) = 2 x 1/2 x .0718 x 2 = .1436 mA

incidental or consequential loss or damage of any kind connected with the use of its products or failure of its products to function or operate properly.

WARRANTY SUPPLEMENT - ELECTROCHEMICAL GENERATING CELLS AND ELECTROLYTE

The following is a listing of the available electrochemical cells and their standard warranty when installed in equipment manufactured and supplied by Advanced Calibration Designs, Inc. The associated electrolyte has also been listed for reference purposes.

Chlorine Cell - One year, unlimited use.
Chlorine Electrolyte - 1000 hours at 1 ppm, 1/2 LPM air flow

Chlorine Dioxide Cell - One year, unlimited use.
Chlorine Dioxide Eelctrolyte - Six months or 100 hours at 1 ppm, 1/2 LPM air flow.

Bromine Cell - One year, unlimited use.
Bromine Electrolyte - 1000 hours at 1 ppm, 1/2 LPM air flow.

Hydrogen Sulfide Cell - One year or 1000 hours at 1 ppm, 1/2 LPM air flow.
Hydrogen Sulfide Electrolyte - One year or 1000 hours at 1 ppm, 1/2 LPM air flow.

Hydrogen Cyanide Cell - One year or 1000 hours at 1 ppm, 1/2 LPM air flow.
Hydrogen Cyanide Electrolyte - One year or 1000 hours at 1 ppm, 1/2 LPM air flow.

Hydrogen Cell - One year unlimited use.
Hydrogen Electrolyte - 1000 hours at 1 ppm, 1/2 LPM air flow.

III. OPERATION

A. Normal Operation

To use the instrument, carry out the following steps:

1. Attach hose by means of the quick connector fitting.

2. Push the POWER switch to activate instrument. The indicator should turn on and begin flashing.

3. Push a range select switch, R1, R2, or R3, to select the desired gas output. No more than ONE switch should be activated at one time. The selected range indicator should turn on.

4. Check LOW BATTERY indicator. If lit, recharge batteries. Alternately, instrument may be used with the AC CHARGER or CONTINUOUS OPERATION ADAPTER.

5. Observe CELL CHECK indicator. If lit continuously, check electrolyte level in cell and add as necessary (see maintenance section and note below). If flashing, more than one range select switch has been activated. Refer to #3 above.

6. Observe the green POWER indicator. The generating cell is reaching equilibrium while the indicator is flashing. Instrument is ready for use when the light stops flashing and remains on.

7. Prior to use of the instrument check the air flow of the instrument. Some instruments have built-in flow meters designed for this purpose. For instruments without flow meters, an external flow meter should be used. Standard air flow rate for the low flow versions is 1/2 LPM. The specific air flow rate for

this instument is listed on the title page. Use the FLOW CONTROL potentiometer to finely adjust the flow rate. (See Figure #4 regarding altitude adjustments.).

8. **Before turning the instrument off after use, change the select range switches to the fresh air position (all range indicators will be off). Allow the instrument to clear itself of gas for approximately five minutes.** This will purge the gases from the generating cell reducing the risk of corrosion or damage to the instrument.

9. Attach charger to maintain full battery capacity if desired.

IV. ADJUSTMENT

Note: Although the Model 100 is not particularly position-sensitive, occasionally a bubble in the electrolyte may be trapped between the working electrodes. If this happens, the cell check light will indicate cell failure. Invert the instrument momentarily several times. The cell check light should turn off immediately. If the cell check light persists, check and add electrolyte as necessary as indicated in Section V.

It may become necessary or desirable to change the current levels through the generating cell. These levels correspond to the amount of calibration gas that is being produced. Adjust them as follows:

1. Remove the upper half of the case.

2. Remove jumper JP1 from the circuit board. (Refer to Figure #2 for the component layout of the circuit board).

3. Plug a sensitive ammeter into test points TP2 and TP3 on the circuit board.

VII. STANDARD WARRANTY

We warrant gas calibration equipment manufactured and sold by us to be free from defects in materials, workmanship and performance for a period of one year from date of shipment. Any parts found defective within that period will be repaired or replaced, at our option, free of charge, F.O.B. factory. This warranty does not apply to those items which by their nature are subject to deterioration or consumption in normal service, and which must be cleaned, repaired, or replaced on a routine basis.

Such items may include: electrochemical type generating cells, batteries, fuses, and/or air filters.

Warranty is voided by abuse including rough handling, mechanical damage, alteration, or repair procedures not in accordance with the instruction manual. This warranty indicates the full extent of our liability, and we are not responsible for removal or replacement cost, local repair costs, transportation costs or contingent expenses incurred without our prior approval.

Advanced Calibration Designs, Inc.'s obligation under this warranty shall be limited to repairing or replacing, and returning any product which shall be returned to Advance Calibration Designs, Inc. at its manufacturing facilities, with transportation charges prepaid, and which Advance Calibration Designs, Inc.'s Material Review Board examination shall disclose to its satisfaction to have been defective.

This warranty is expressed in lieu of any and all other warranties and representations, expressed or implied, and all other obligations or liabilities on the part of Advanced Calibration Designs, Inc. including, but not limited to, the warranty of fitness for a particular purpose. In no event shall Advanced Calibration Designs, Inc. be liable for direct,

4. Turn instrument on. POWER indicator should be on and flashing, CELL CHECK indicator should be off.

5. Check the current between TP2 and TP3.

6. Adjust potentiometer RV6, RV5, and RV4 located on the upper right of the PC board as viewed from the front to change the calibration gas output levels of Range 1, Range 2, and Range 3, respectively. The corresponding current level versus calibration gas output may be found in Figure #1.

7. If the desired currents cannot be obtained in any particular range, the current range may be increased or decreased through the use of the current range dip switch box. (Refer to Figure #3 for more information on the current range dip switch and its adjustment).

8. Replace JP1 prior to normal operation.

Note: All three ranges generate calibration gas independent of each other. Adjusting R1 will not change R2 and R3. However, if a dip switch is changed to change the current envelope on one range, it will affect the other two ranges. Recheck all three current values after adjusting a current dip switch. Refer to Figure #1 to insure that proper concentrations are being produced.

WARNING: This procedure should only be carried out by trained personnel. The current levels are temperature compensated and should be adjusted at 20 C. It is highly recommended that the instrument be returned to the factory for adjustment and recalibration.

VI. PARTS LIST

The following items are available as accessories for the Model 100:

P/N	Description
112-0120-00	Needle Valve, 1/8" barb, brass
113-0100-00	Outlet Fitting, female (panel mount) quick connect
113-0102-00	Male Hose Barb Quick Connector, low flow 1/4" OD hose
113-0103-00	Male Hose Barb Quick Connector, high flow 3/8" OD hose
150-0121-00	Plug-in Charcoal Filter Element, one each
150-0131-00	Plug-in Charcoal Filter Element, package of 12
361-0115-00	Battery pack, Ni-Cad, Model 100/150
362-0100-00	Charger/Continuous Operation. 115 VAC
715-0110-0X	3 Foot Hose w/connector, low flow, 1/4" OD (specify gas)
715-0115-0X	5 Foot Hose w/connector, low flow, 1/4" OD (specify gas)
715-0300-00	3 Foot Hose w/connector, high flow, clear, 3/8" OD
730-0100-00	Nylon Carrying Case
730-0215-00	Hard Body Accessory Kit
910-0100-00	Instruction Manual, generic

V. MAINTENANCE

A. Batteries

1. Check battery voltage periodically by observing LOW BATTERY indicator. Recharge when red LED turns on. The LOW BATTERY indicator should light and flash as the charger is plugged in if it is supplying the proper voltage to the battery. If not, check the AC or DC source, then check the charger itself. Replace as necessary. The indicator will go off when the battery charge level reaches approximately 95% of full charge.

2. If the LOW BATTERY indicator goes off as expected but the instrument is inoperable from the battery, the battery is probably faulty. If the LOW BATTERY indicator does not turn on and there is incoming power to the charger, the charger is probably faulty. Contact factory for service.

B. Generating Cell and Electrolyte

1. The electrolyte in the generating cell is designed to last for several months of normal operation. If the CELL CHECK indicator is lit, the most likely explanation is that the electrolyte level has dropped below the amount required for proper operation. If this is due to normal evaporation of the water component, deionized water may be added to refill the reservoir. To add either water or electrolyte, follow the steps below:

    a. Open instrument case.

    b. Unscrew solid fill plug on reservoir and remove liquid if necessary.

    c. Use syringe to add liquid to within 1/8 inch from the bottom of fill hole.

WARNING: Do not over-fill the reservoir. Trapped air must be allowed to escape through vent plug as fill screw is replaced. Contact the factory for more information.

    d. Replace fill plug.

2. The generating cell will need to be replaced once the active components have been consumed. When this becomes necessary, the cell can be removed by unscrewing the two screws from the cell's mounting bracket. Remove the two-pin quick connector from the circuitry. Remove the inlet and outlet fittings from the air chamber.

C. Circuit Board

The main circuit board can be removed by unplugging the four quick connectors on either side as viewed from the top. Remove the two mounting screws that hold the circuit board to the front of the case. The board may be pulled up out of the case.

D. Pump

The pump is a rotary vane type, driven by a DC motor. It should have a life of several years in normal operation, but may lose efficiency if dirt is drawn in and collects under the valves. If the pump is unable to be adjusted to the required flow, it must be removed for repair.

The pump can be removed by lifting the pump out of the mounting bracket and unplugging the quick connector from the circuitry. It should be returned to the factory for exchange.