**⚠ WARNING**

**FIRE OR EXPLOSION HAZARD**

**Failure to follow safety warnings exactly could result in serious injury, death, or property damage.**

- **Do not store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.**
- **WHAT TO DO IF YOU SMELL GAS**
  - **Do not try to light any appliance.**
  - **Do not touch any electrical switch; do not use any phone in your building.**
  - **Leave the building immediately.**
  - **Immediately call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.**
  - **If you cannot reach your gas supplier, call the fire department.**
- **Installation and service must be performed by a qualified installer, service agency or the gas supplier.**

**⚠ WARNING**

**FIRE, EXPLOSION, AND ASPHYXIATION HAZARD**

**Improper adjustment, alteration, service, maintenance, or installation can cause serious injury or death.**

**Read and follow installations and precautions in User's Information Manual provided with this appliance. Installation and service must be performed by a qualified service agency or the gas supplier.**

**WARNING: For outdoor use only.**

**NOTICE TO INSTALLER**: These instructions shall be left with the consumer.
**NOTICE TO CONSUMER**: You must read all instructions in the manual and must keep all manuals for future reference.

**⚠ AVERTISSEMENT**

**RISQUE D'INCENDIE OU D'EXPLOSION**

**Si les consignes de sécurité ne sont pas suivies à la lettre, cela pourrait entraîner une utilisation dangereuse, la mort, de graves blessures ou des dommages matériels.**

- **Ne pas entreposer ni utiliser d'essence ou d'autres vapeurs et liquides inflammables à proximité de cet appareil ou n'importe quelle application.**
- **QUE FAIRE SI UNE ODEUR DE GAZ EST DÉTECTÉE**
  - **Ne mettre en marche aucun appareil.**
  - **Ne toucher aucun interrupteur électrique; ne pas utiliser de téléphone dans le bâtiment.**
  - **Quitter le bâtiment immédiatement.**
  - **Appeler immédiatement le fournisseur de gaz en utilisant le téléphone d'un voisin. Suivre les instructions du fournisseur de gaz.**
  - **Si le fournisseur de gaz n'est pas accessible, appeler le service d'incendie.**
- **Installation et l'entretien doivent être effectués par un installateur ou une entreprise d'entretien qualifié, ou le fournisseur de gaz.**

**⚠ AVERTISSEMENT**

**RISQUE D'INCENDIE, D'EXPLOSION ET D'ASPHYXIE**

**Si un réglage, une modification, une réparation, en entretien ou l'installation est effectué de façon inadéquate, cela pourrait causer de graves blessures ou la mort.**

**Lire et suivre les instructions et les précautions fournies dans le manuel de l'utilisateur accompagnant cet appareil. L'Installation et l'entretien doivent être effectués par un installateur ou une entreprise d'entretien qualifié, ou le fournisseur de gaz.**

**AVERTISSEMENT: Utiliser uniquement à l'extérieur.**

**AVIS À L'INSTALLATEUR**: Ces instructions doivent être remises au consommateur.

**AVIS AU CONSOMMATEUR**: Vous devez lire toutes les instructions du manuel et conserver tous les manuels pour référence future.

# 5220 THERMOELECTRIC GENERATOR

## Operating Manual

C US
LR 55319

**CSA/ANSI 13.1:22**

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# 1 ABOUT THIS MANUAL

This manual provides instructions for the operation and maintenance of the model 5220 Thermoelectric generator.

## 1.1 HEALTH AND SAFETY

Correct operation and maintenance according to this manual is critical for proper equipment function and safety. Keep the following in mind when using these instructions:

### 1.1.1 Warnings

Throughout this manual you will notice paragraphs preceded by the text "Warning". It is imperative that the advice in these paragraphs be adhered to, as failure to do so may result in personal injury or death and possible damage to the equipment. Here are some general warnings for the model 5220 Thermoelectric Generator.

| | | |
|---|---|---|
|  | **WARNING!** | The installation must conform with local codes or, in the absence of local codes, CSA B149.1 or ANSI Z223.1/NFPA 54, and CSA B149.2 or NFPA 58, as applicable. |
|  | **WARNING!** | The Thermoelectric Generator, when installed, must be electrically grounded in accordance with local codes or, in the absence of local codes, with CSA C22.1 or NFPA 70. |
|  | **WARNING!** | Keep the Thermoelectric Generator area clear and free from combustible materials, gasoline and other flammable vapors and liquids. Maintain minimum clearances specified in this manual. |
|  | **WARNING!** | The Thermoelectric Generator consists of sub-systems that combust gaseous fuel and others that consume excess power through resistors, all of which can pose high surface temperature hazards. Operators and service personnel should avoid indicated areas of the generator to avoid burns or clothing ignition when in operation or cooling down. |
|  | **WARNING!** | The Thermoelectric Generator is designed to combust gaseous fuels which will result in combustion products of heat, carbon dioxide and water vapor and may contain traces of Carbon Monoxide, unburnt Hydrocarbons and Nitrous Oxides. Emissions from combustion will depend on generator set-up and operation as well as the composition of the gas feed. It is imperative that these instructions be followed, and that gas supplied meets Global Power Technologies' gas specification. |

| | | |
|---|---|---|
|  | **WARNING!** | Installation and repair should be performed by a qualified service person. The Thermoelectric Generator should be inspected before use and at least annually by a qualified service person. More frequent cleaning may be required as necessary. It is imperative that control compartment, burners and circulating air passageways of the appliance be kept clean. |
|  | **WARNING!** | Any guard or other protective device removed for servicing the Thermoelectric Generator must be replaced prior to operating the appliance. |
|  | **WARNING!** | Do not use this Thermoelectric Generator if any part has been under water. Immediately call a qualified service technician to inspect the Thermoelectric Generator and to replace any part of the control system and any gas control which has been under water. |
|  | **WARNING!** | Inspect and check all gas connections for leaks using a commercially available liquid leak detection fluid after installation or service to any part of the fuel system. Remedy any fuel system leaks prior to starting the Thermoelectric Generator |
|  | **WARNING!** | This device contains electrical and gas related safety devices as identified throughout this manual. Tampering or rendering inoperative any of these safety devices may result in personal injury or death and possible damage to the equipment and is not permitted under any circumstances. |
|  | **WARNING!** | *CONDENSATE FROM REGULATOR IS VERY HIGH-RISK OF BEING FLAMMABLE.*<br>When draining condensate from regulator, ensure it is removed from cabinet and is a safe distance from ignition sources.<br>If there is a concern about liquids in the fuel line, it is suggested that the customer install a regulator drain line to remove condensate to a safe location away from ignition sources.<br>Condensate collecting/pooling/splashing/etc. inside the TEG cabinet creates a dangerous fire hazard. Contact GPT for assistance with fuel conditioning options to remove liquids from fuel line supply. |

| | |
|---|---|
| **WARNING!** | Install wind scoop prior to commissioning and startup. Failure to do so will void the 5220 TEG warranty and may result in catastrophic failure resulting from elevated cabinet temperatures. See wind scoop installation manual for details. |

### 1.1.2 Cautions

Throughout this manual you will notice paragraphs preceded by the text "Caution". It is imperative that the advice in these paragraphs be adhered to, as failure to do so may result in damage to the equipment. Here are some general cautions for the model 5220 Thermoelectric Generator.

| | |
|---|---|
| **CAUTION!** | The Thermoelectric Generator and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of 3.5 kPa (1/2 psi).<br>The Thermoelectric Generator must be isolated from the gas supply piping system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than 3.5 kPa (1/2 psi). |
| **CAUTION!** | The Thermoelectric Generator consists of some parts constructed from sheet metal. Every effort is made to ensure that edges have been deburred when manufactured, sharp edges may still exist. Caution must be exercised when handling and use of (gloves) is advised. |
| **CAUTION!** | If a hose assembly is used to connect the Thermoelectric Generator to the gas supply piping system, inspect the hose assembly before each use of the Thermoelectric Generator.<br>The hose assembly must be replaced prior to the appliance being put into operation if there is evidence of excessive abrasion or wear, or if the hose is damaged.<br>The replacement hose assembly shall be that specified by the manufacturer. |
| **CAUTION!** | Properly locating the hose out of pathways where people may trip over it or in areas where the hose may be subject to accidental damage. |

### 1.1.3 Trained Operators

Personnel performing installation, operation, and maintenance work should be properly trained in such functions.

## 1.2 TECHNICAL TERMS

An operator should be familiar with technical terminology. Terms of significance, defined for the model 5220, are as follows:

**Thermoelectric Generator (TEG):** A device that produces electrical power through the direct conversion of heat energy to electrical energy.

**Power Unit (PU):** The hermetically sealed portion of the TEG that contains the thermoelectric materials and cooling fins.

**Rated Power:** Model 5220 TEG power unit produces 210 Watts when operating in an ambient temperature of 20ºC (68ºF). With the fuel flow held constant, TEGs operating in ambient temperatures higher than 24ºC (75ºF) will see power output decline by 0.8 W per ºC (0.44 W per ºF) of temperature change up to a maximum ambient temperature of 65.5ºC (150ºF). Conversely, for temperatures lower than 20ºC (68ºF) power output will increase by 0.8 W per ºC (0.44 W per ºF) of temperature change.

**Set-up Power:** Power produced by the power unit at a specific ambient temperature. It is derived from voltage across a precision load, also known as $V_{set}$.

**Set-up Voltage ($V_{SET}$):** Voltage measured across the power unit at a specific ambient temperature while the power unit is connected to the precision resistor via SETUP mode. VSET is proportional to set-up power. Fuel flow to the burner is adjusted to maintain the correct voltage, and therefore maintain correct power output.

**Open Circuit Voltage:** Voltage at the terminals of the power unit when no current is flowing, (i.e. open circuit), which is related to the temperature applied to the thermoelectric materials inside the power unit.

When a power unit lead is suddenly disconnected, breaking the circuit with the load, the voltage measured across the power unit changes to a higher value. This is known as the momentary open circuit voltage ($V_{oc}$). The voltage will continue to climb from that level. Do not allow $V_{oc}$ to exceed 27.0 volts on the 5220 - otherwise, the TEG may be damaged.

**Measured $V_{set}$:** $V_{set}$ measured across the precision resistor using a voltmeter while the electronics are in SETUP mode.

**Required $V_{set}$:** $V_{set}$ needed to achieve rated power for the present ambient temperature.

**CP (Cathodic Protection):** Thermoelectric generators can be used in impressed current systems for cathodic corrosion protection of metallic structures, such as pipelines.

**CP Interface System:** An assembly of electrical components that acts as an interface between the TEG and the CP load, which also provides adjustment and monitoring of power to the CP load.

**Limiter/Converter (L/C):** The electronic system attached between the generator and the load. The L/C converts one level of DC voltage to another and limits the power unit voltage when the customer is not drawing peak load.

**Manual Shutoff Valve:** A manually operated valve in the gas line for turning on or shutting off the gas supply to the TEG.

**Solenoid Valve (SOV or SV):** An electrically actuated valve that controls the gas supply to the burner. This valve is operated by the Ignition Control System.

**Surge Protection Device (SPD):** A protective electronic device attached to the output terminals that improves resistance to electrical surges. Comes paired with a dielectric isolation adaptor for the fuel line. The SPD is included with all CP systems.

# 2 QUICK START PROCEDURE

This section describes the key steps for setting up the TEG. It is for the operator who is already familiar with operating TEGs - having successfully completed Global Power Technologies (GPT) TEG training course - and being a qualified service person with reasonable knowledge and experience working with industrial fuel and electrical equipment.

## 2.1 INSTALLATION

Follow these steps to install the TEG:

1. Unpack the TEG from its shipping crate. Keep the crate until the TEG is operational. Locate and identify the following items that were shipped with the 5220 TEG:
   - 1 Fin Duct
   - 1 Cover Plate
   - 1 Manual Shutoff Valve
   - 1 Wind Scoop
   - 1 Thread Sealing Compound
   - 17 Screws, #8 32 × 1/4" long, one spare
   - 17 Washers, #8 External Lock, one spare

| | |
|---|---|
| **NOTE:** | Inspect the TEG for damage that may have occurred during shipping. Please report any damage to GPT as soon as possible, as it may make the generator inoperable. Check with the factory before starting a damaged TEG. |

2. Assemble the TEG as shown in Figure 9. Refer to Figure 10, mount it on a firm and stable base, sufficiently high above ground level to prevent the TEG from being inundated with water. Install wind scoop. See Installation (Section 5), for details.

**WARNING!** Install wind scoop prior to commissioning and startup. Failure to do so will void the 5220 TEG warranty and may result in catastrophic failure resulting from elevated cabinet temperatures. See wind scoop installation manual for details.

3. Connect the fuel supply to the manual shutoff valve (TEG fitting is 1/4” Female NPT) using the thread sealant provided. See Supplying Fuel (Section 5.7) for details.
4. Connect the customer load:
   - In the case of a 24V L/C being fitted, connect the load to terminals 6 (+) and 7 (–).
   - In the case of a 12V Limiter being fitted, connect the load to terminals 4 (–) and 5 (+).
   - For CP applications, connect the cathode and anode wires to the external CP interface box and ensure the SPD fuel line isolation adaptor is installed.
   - Leave the TEG isolated from the load, batteries, or other voltage sources by way of a suitably sized circuit breaker or fuse. **The TEG must be wired in such a way that it can be disconnected from the load, batteries, and voltage sources including other TEGs, generators, and solar panels.**

## 2.2 START UP

Follow these steps to start the TEG:

1. Open the circuit breaker or fuse on the customer load that isolates the TEG.
2. Configure the TEG electronics to be in SETUP mode by moving the jumper clip on TB1 so that it connects terminals 2 and 3. See Figure 14 or Figure 15.
3. Open the manual shutoff valve.

---

**NOTE:** Once the TEG is started, closing the manual shutoff valve will shut it off.

---

4. The Spark Ignition (SI) system should begin clicking and the fuel will start flowing after one second, and the sound of combustion can be heard within 7 seconds. If the burner does not ignite, the SI will wait 10 seconds to attempt a second ignition trial. If the second trial is still unsuccessful, the system will wait a further 10 seconds to attempt a third ignition trial. After the third unsuccessful trial, the ignition control system will go into lockout mode.
5. If the SI has gone into lockout mode (3 unsuccessful ignition attempts), reset it by removing one of the orange wires from the pressure switch (see Figure 3), waiting 10 seconds, and reattaching it. The TEG should then restart the ignition sequence.
6. If the TEG fails to sustain ignition after 3 more ignition trials, see the Troubleshooting section of this manual.
7. Once the TEG is running, leak-check the entire fuel system from the fuel supply line to the burner inlet using a commercial leak detector fluid such as Snoop®.

---

**WARNING!** When the TEG is operating, surface temperatures near the thermopile, burner, exhaust stack and around the cooling fin duct may reach more than 100°C. Avoid contact with these areas when working in and around the TEG.

---

## 2.3 TUNING

Follow these steps to tune the TEG for the correct power output:

1. Check that the jumper clip on terminal block TB1 is in the SETUP position (between terminals 2 and 3).
2. Measure the voltage across terminals 2 (+) and 4 (-) with a multimeter. This voltage is $V_{set}$.
3. $V_{set}$ will rise after starting and will eventually stabilize about 60-90 minutes after ignition.
4. Check the measured $V_{set}$ value against the value calculated in the Power Output Evaluation section of this manual. If the measured value is not in its normal operating range, tune the TEG as described in the Adjustment section of this manual.
5. Once the TEG has been properly tuned and is producing the correct power for the present ambient temperature:

   a) Move the jumper clip on TB1 to connect terminals 1 and 2 with caution, as the terminals are now live (See Figure 14 or Figure 15) .

   b) Close the circuit breaker or fuse connecting the TEG to the customer load.

**CAUTION!** Do not allow measured $V_{set}$ to exceed the required $V_{set}$ determined in the Power Output Evaluation section of this manual. This will overheat the thermopile. Overheating may permanently damage the power unit.

**NOTE:** Details for adjusting the L/C, Limiter, and CP interface systems, if applicable, are in the Adjustment section of this manual.

## 2.4 PERFORMANCE LOG

The TEG is now running, providing continuous electrical power to the load. It is recommended that a record be kept of the TEG's performance and maintenance history. Each time adjustments are made, or service is carried out, the details should be recorded. This will ensure years of reliable, trouble-free operation. If you require assistance from GPT's Customer Service department, a detailed log will help us diagnose your problem quickly and accurately. A blank TEG Performance Log is provided at the end of this manual.

**NOTE:** Servicing requirements are given in the Maintenance section.

# 3 TECHNICAL SPECIFICATIONS

This section gives the technical specifications for the Model 5220 Thermoelectric generator.

## 3.1 OVERVIEW

The Model 5220 Thermoelectric Generator (TEG) converts heat directly into electricity with no moving parts. It is a reliable, low maintenance source of DC electrical power for any application where regular utilities are unavailable or unreliable.

The model 5220 Thermoelectric Generator provides 210 Watts of electrical power from the power unit at an ambient temperature of 20°C. This power is generated at a nominal 15 Volts, which can then be converted to other voltages using a voltage converter. The system provides 195 Watts of net electrical output power when equipped with a Limiter and provides 178 Watts with a 24 Volt Limiter/Converter.

If the generator is to be operated at load conditions that force the output voltage to vary significantly from 15 Volts, less than the rated power will be available to the load. Figure 6 identifies the electrical parameters of the 5220 as a function of the load resistance.

The 5220 generator uses Propane ($C_3H_8$), or Natural Gas ($CH_4$) fuel, and with an ignition control module (SI), it will automatically ignite whenever gas pressure is present. The output voltage from the generator is adjustable between 12 and 18 Volts in a 12V system, or between 24 and 30 Volts in a 24V system. The 5220 includes a voltage-sensing relay (VSR) that can be used to trigger alarms or other processes when an abnormally low voltage is detected.

## 3.2 OPTIONS

**Mounting Stand**: The 5220 can be conveniently mounted on any platform with four holes spaced as shown in Figure 10. It is important to mount the TEG at a height sufficient to prevent direct flooding or heavy snowfall from interfering with the flow of cooling air. A mounting stand is available from Global Power Technologies (GPT).

**Cathodic Protection Interface (CP)**: The Cathode Protection Interface option provides a termination point for cathode and anode cables up to 9 mm (00 AWG) in size, a meter to monitor the voltage and current of the CP circuit, and an adjustable resistor to control the output power.

**Current Split (CS)**: A Current Splitting variation of the CP Interface is also available. The CS version allows two CP circuits to be controlled individually from one CP Interface unit.

**Surge Protection Device (SPD)**: The SPD combines a protective electronic device with a dielectric isolation adaptor for the fuel line to provide increased resistance to lightning and surges. The SPD is included with all CP systems and is optional otherwise.

| | |
|---|---|
| **Power output** | |
| Power Ratings<br>20º C, 750 m above sea level | 195 Watts @ 12 Volts<br>178 Watts @ 24 Volts |
| **Electrical** | |
| Voltage Adjustment | 12 V 12–18 Volts<br>24 V 24–30 Volts |
| Reverse Current Protection | Yes |
| Output | Terminal block which accepts up to 8 AWG wire. Opening for 3/4” conduit in the base of the cabinet |
| **Fuel** | |
| Natural Gas | 19.7 $m^3$/day (696 $ft^3$/day) of Std. 1000 BTU/ $Sft^3$ (37.7 MJ/$Sm^3$) gas |
| Propane | 28.6 L/day (7.6 gal/day) |
| Maximum Supply Pressure | 345 kPa (50 PSI) |
| Minimum Supply Pressure | 165 kPa (24 PSI) |
| Fuel Connection | 1/4” Female NPT |
| **Environmental** | |
| Ambient Operating Temperature Continuously Running TEG | Max. 45°C (115°F) Min. -40°C (-40°F) |
| Operating Conditions | Unsheltered Operation |
| **Materials of Construction** | |
| Cabinet | 304 Stainless Steel |
| Cooling Type | Natural Convection |
| Fuel System | Brass, Aluminum & Stainless Steel |

## 3.3 WEIGHTS AND DIMENSIONS

The following table gives the overall dimensions and weights of the TEG.

| | |
|---|---|
| Depth | 795 mm (31.30”) |
| Max Width | 565 mm (22.26”) |
| Height | 1274 mm (50.16”) |
| Net Weight | 100 kg (221 lb.) |
| Shipping Weight | 143 kg (315 lb.) |
| Mounting Holes | 267 mm wide × 457 mm deep (10.53” × 18.00”) |
| Mounting Hole Diameter | 8 mm (5/16”) |

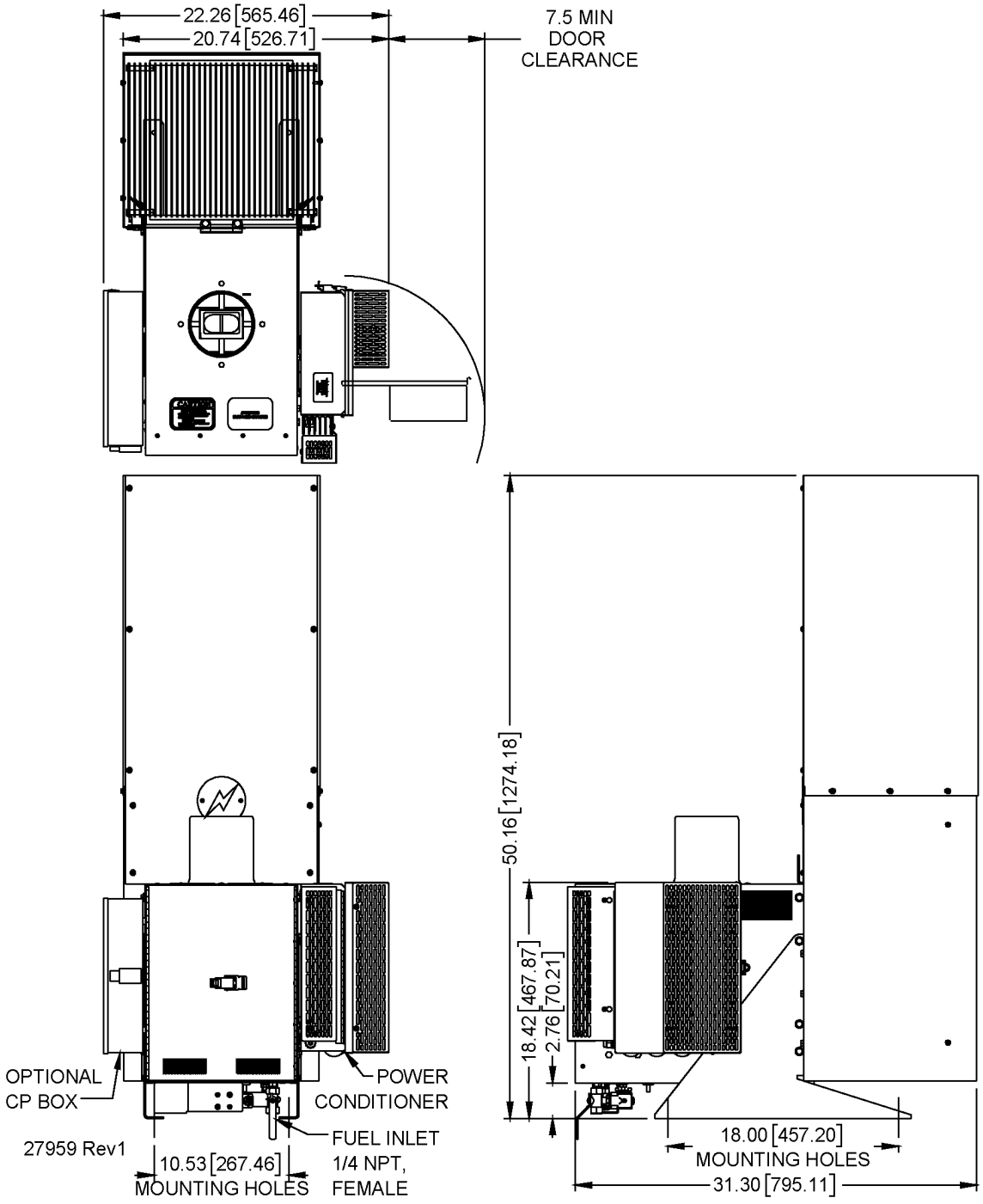



*Figure 1 – Overall Dimensions of the 5220 TEG*

## 3.4 IGNITION CONTROL SYSTEM

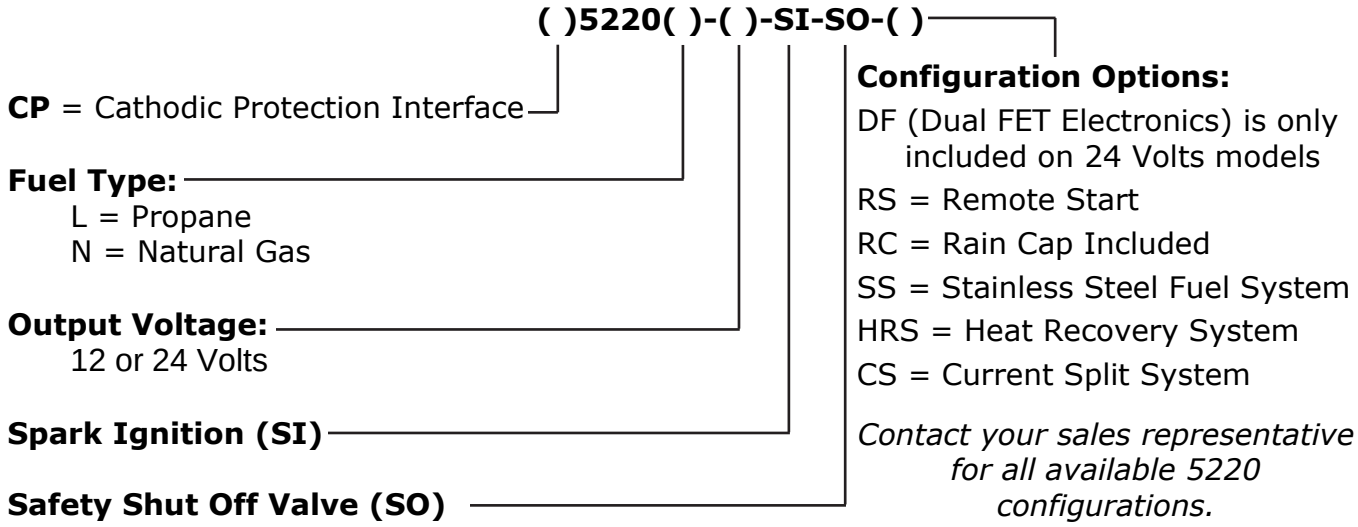
The following table gives the technical specifications for the Ignition Control System.

| | | |
|---|---|---|
| Electrical SI Power Supply | Input Voltage | Minimum 5.6 V DC |
| | | Maximum 35.0 V DC |
| | Power Input | 4.2 Watts |
| | Output Voltage | 13.8 VDC |
| SI | Spark Rate | 5 sparks per second |
| | Trial for Ignition | 7 seconds |
| | Number of tries for Ignition | 3 trials before lockout |
| | Inter-Purge Time | 10 seconds |
| Spark Gap | Nominal | 3.8 mm (0.150”) |
| | Minimum | 3.2 mm (1/8”) |
| | Maximum | 6.3 mm (1/4”) |

## 3.5 DATA PLATE

The Data Plate is on the inside of the cabinet door and includes vital information about the generator.

***Model Number:*** The model number on the Data Plate is interpreted as follows:




***Serial Number:*** This is a unique number assigned by GPT to provide traceability.

***Fuel Input Rating:*** This is the fuel energy input rate of the TEG.
***Inlet Pressure:*** This is the maximum permitted fuel supply pressure range.
***Fuel Type:*** ‘NATURAL GAS’ ($CH_4$) or ‘PROPANE’ ($C_3H_8$).

***Orifice Size:*** The size of orifice specific for the fuel type indicated.

**IMPORTANT:** Each type of fuel requires a specific orifice, therefore use only the fuel indicated.

**NOTE:** If butane is used, the fuel type will indicate propane. This is because the energy content of propane and butane are nearly equal; therefore, they require the same orifice.

***Output Rating:*** This is the output voltage range and power to customer load.

***Certified Altitude:*** This is the altitude the TEG certified to.

**CAUTION!** Installation of this appliance at altitudes above 2000 ft (610 m) shall be in accordance with local codes or, in the absence of local codes, CSA B149.1 or ANSI Z223.1/NFPA 54, and CSA B149.2 or NFPA 58, as applicable.

***Factory Settings:*** The power output at ambient temperature, voltage across the precision load, and manifold fuel pressure that were measured during factory performance test at elevation of the factory are recorded as factory settings. This information is provided for reference only because the manifold fuel pressure is adjusted to obtain the desired power at customer site.

## 3.6 FUEL CONSUMPTION

The 5220 operates on commercial propane, or commercial natural gas. The Fuel Consumption of the 5220 at rated power is listed in the table below for various Fuels.

| Fuel Consumption at Rated Power | Propane | Natural Gas |
|---|---|---|
| lb./hr* | 1.30 | - |
| gal/hr* | 0.31 | - |
| kg/hr* | 0.60 | - |
| L/hr* | 1.16 | - |
| $Sft^3$/hr** | 11.10 | 29 |
| $Sm^3$/hr** | 0.31 | 0.82 |

* At 15ºC (60ºF)

** At atmospheric pressure and 15ºC (60ºF), assuming an energy content of 37.3 MJ/$Sm^3$ or 1,000 BTU/$Sft^3$ for natural gas and 93.1 MJ/$Sm^3$ or 2,500 BTU/$Sft^3$ for propane.

## 3.7 STANDARD SPECIFICATION FOR GASEOUS FUEL

Gaseous fuels supplied to Global Power Technologies' Thermoelectric Generators: (1)

1. Shall not contain any particulates larger than 30 µm diameter, including but not limited to sand, dust, gums, crude oil, and impurities.
2. Shall not have a hydrocarbon dew point in excess of 0ºC (32ºF) at 170 $kPa_g$ (25 $psi_g$).
3. Shall not contain more than 115 mg/$Sm^3$ (2) (approx. 170 ppm) of $H_2S$ (3).
4. Shall not contain more than 60 mg/$Sm^3$ (approx. 88 ppm) of Mercaptan Sulphur.
5. Shall not contain more than 200 mg/$Sm^3$ (approx. 294 ppm) of total Sulphur.
6. Shall not contain more than 10% [$CO_2$] and/or [$N_2$] by volume, nor vary more than ±1% [$CO_2$] and/or [$N_2$] during operation.
7. Shall not contain more than 120 mg/$Sm^3$ of water vapor.
8. Shall not contain more than 1% by volume of free oxygen.
9. Shall have a nominal gross heating value of:
   a) Natural Gas: 37 MJ/$Sm^3$ (1,000 BTU/$Sft^3$ (2)) (1)
   b) Propane/LPG: 93 MJ/$Sm^3$ (2,500 BTU/$Sft^3$) (1)
   c) Butane: 123 MJ/$Sm^3$ (3,300 BTU/$Sft^3$) (1)
10. Shall not exceed 60ºC (140ºF) in temperature.

**NOTE:**

(1) For gaseous fuels outside of these specifications, please contact Global Power Technologies.

(2) $Sm^3$ = Standard cubic meter, $Sft^3$ = Standard cubic foot, of gas at 101.325 kPa (1 atm) and 15ºC (NIST).

(3) Contact local representative or Global Power Technologies if $H_2S$ concentration is greater than 170 ppm.

# 4 PROCESS DESCRIPTION

This section describes the function of the equipment, how the TEG generates power, and available options.

## 4.1 MODEL 5220 THERMOELECTRIC GENERATOR

The TEG generates electrical power directly from heat energy. The overall process is:

1. Provide fuel and air to the burner and ignite the mixture, generating heat.
2. Warm the hot end of a thermoelectric power unit using the available heat of combustion.
3. Cool the cold end of the thermoelectric power unit using natural convection over cooling fins.

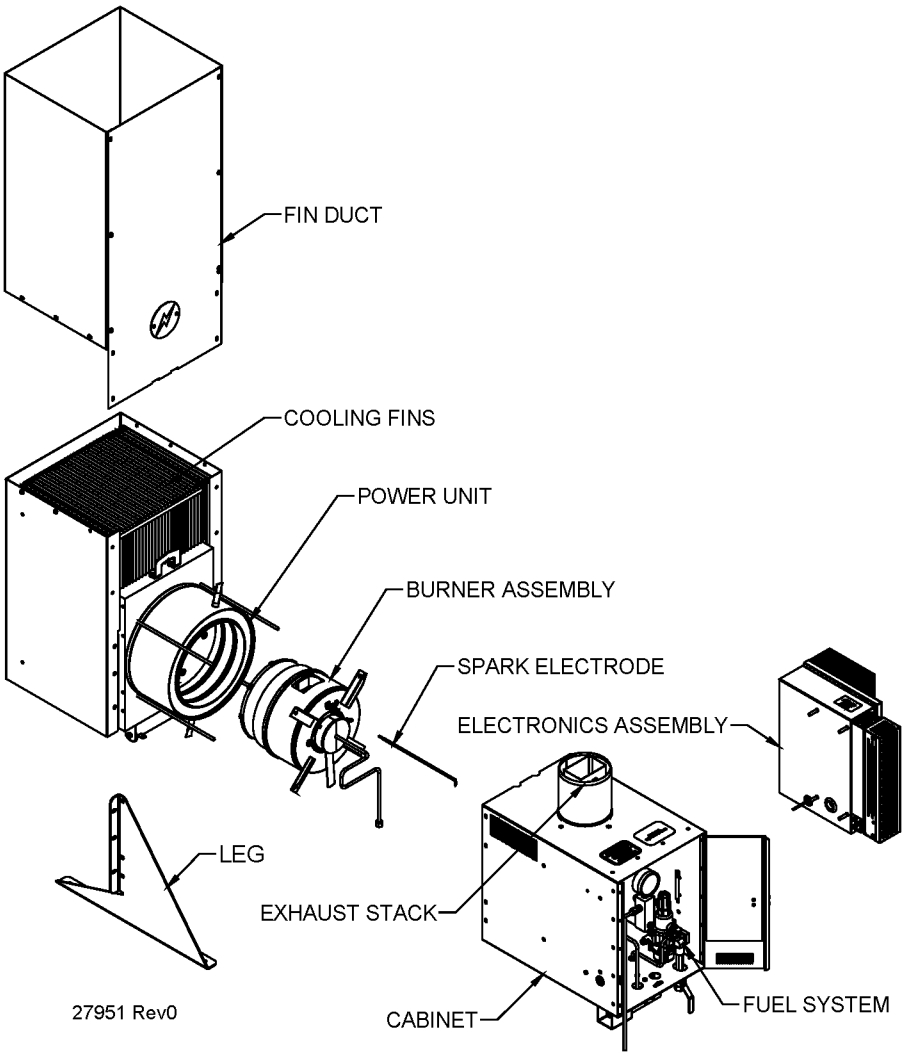



*Figure 2 – 5220 TEG General Assembly, shown with L/C*

4. Generate electrical power from the temperature difference created across thermoelectric materials housed within the power unit.
5. Condition the electrical power to be standard voltages; 12 or 24 volts.
6. Make the electrical power available to the load.

The main parts of the model 5220 TEG, with Limiter/Converter (L/C) attached, are shown in Figure 2.

### 4.1.1 Fuel System

**WARNING!**

*CONDENSATE FROM REGULATOR IS VERY HIGH-RISK OF BEING FLAMMABLE.*

When draining condensate from regulator, ensure it is removed from cabinet and is a safe distance from ignition sources.

If there is a concern about liquids in the fuel line, it is suggested that the customer install a regulator drain line to remove condensate to a safe location away from ignition sources.

Condensate collecting/pooling/splashing/etc. inside the TEG cabinet creates a dangerous fire hazard. Contact GPT for assistance with fuel conditioning options to remove liquids from fuel line supply.

Components making up the fuel system control the input of fuel to the burner. The primary control is a pressure regulator that controls the fuel pressure supplied to a metering orifice. The pressure regulator includes a sediment bowl with a manual drain cock and a fuel filter to remove fuel impurities. The fuel filter prevents solid particles from damaging the regulator and downstream parts.

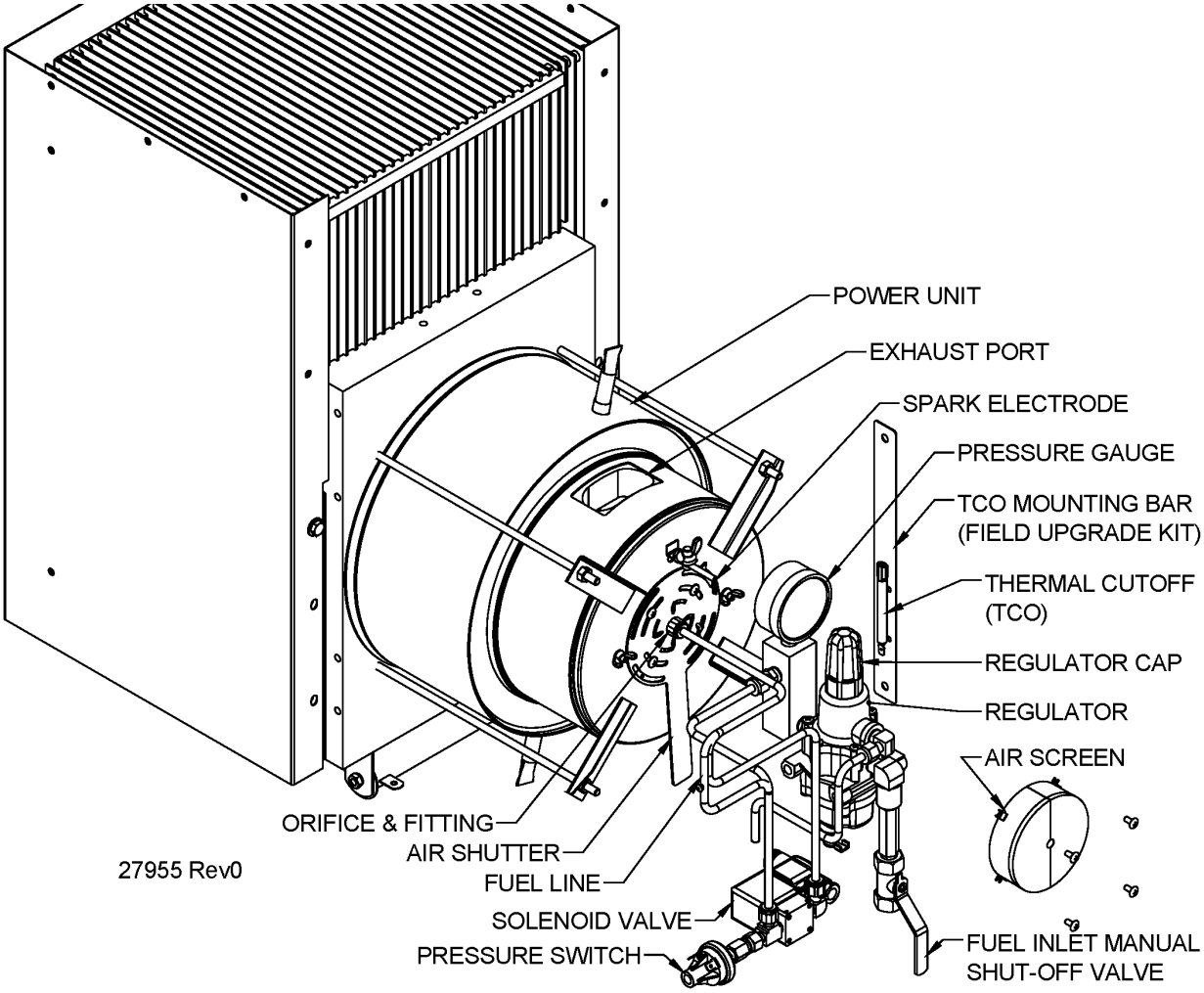



*Figure 3 – 5220 Fuel System General Assembly*

The outlet of the pressure regulator leads to a manifold. On the manifold there is a pressure gauge to display the fuel pressure. Fuel flows through the manifold to the fuel line which connects to an orifice mounted on the front of the burner. The orifice contains a precisely sized hole to meter the fuel flow into the burner. A solenoid valve (SOV) is located beneath the cabinet and plumbed before the orifice. A pressure switch is located upstream of the solenoid valve, allowing the SI system to sense the fuel gas pressure.

The main parts of fuel system are shown in Figure 3.

### 4.1.2 Spark Ignition (SI) Control System

The SI system consists of the following parts:

- Spark electrode
- Pressure switch
- Thermal Cutoff (TCO) assembly
- Spark Ignition (SI) module
- Solenoid Valve (SOV)
- SI Power Supply Board (FPCi Board)
- Battery pack

When the manual shutoff valve is opened, fuel pressure causes the pressure switch (located in the fuel system) to close. This, combined with the absence of flame, signals the SI module to produce sparks in the burner. At this point, the SI module opens the solenoid valve, allowing fuel gas to flow into the burner. Once flame is detected, the SI module will stop sparking and will continue to monitor the presence of flame at the electrode. If the SI module does not detect combustion within the 7 seconds trial for ignition period, it will close the solenoid valve and will stop sparking. It will make another ignition attempt at the end of the 10 seconds purging period. The SI module will attempt 3 ignition trials, and if combustion cannot be maintained, the SI system will enter lockout mode.

If the flame is lost when the TEG is running, the SI system will follow the same sequence as above to reignite the TEG.

If a flame is sensed when the solenoid valve is not opened by the SI Module, the SI system enters lockout mode. This can occur when attempting to restart a hot TEG. The TEG will need to cool sufficiently before attempting a restart.

Once entered lockout mode, the SI system will not allow any additional trials for ignition until reset by turning it off for 10 seconds before restarting the SI system.

To reset the SI system, pull one of the orange wire spade connectors off the pressure switch, wait for 10 seconds, and replace it.

| | |
|---|---|
| **NOTE:** | The SI system contains a 6V 5AH rechargeable battery pack and a battery charger. The SI system is initially powered up by the battery pack and will switch to the TEG once the TEG generates enough power to be able to power the SI system and to recharge the battery pack after startup.<br><br>FYI - A completely discharged battery pack will take approximately 20 days or longer TEG operation to regain 100% charge, as the priority is given to the customer load while recharging the battery pack. |

### 4.1.3 Burner

The main parts of the burner are shown in Figure 4.

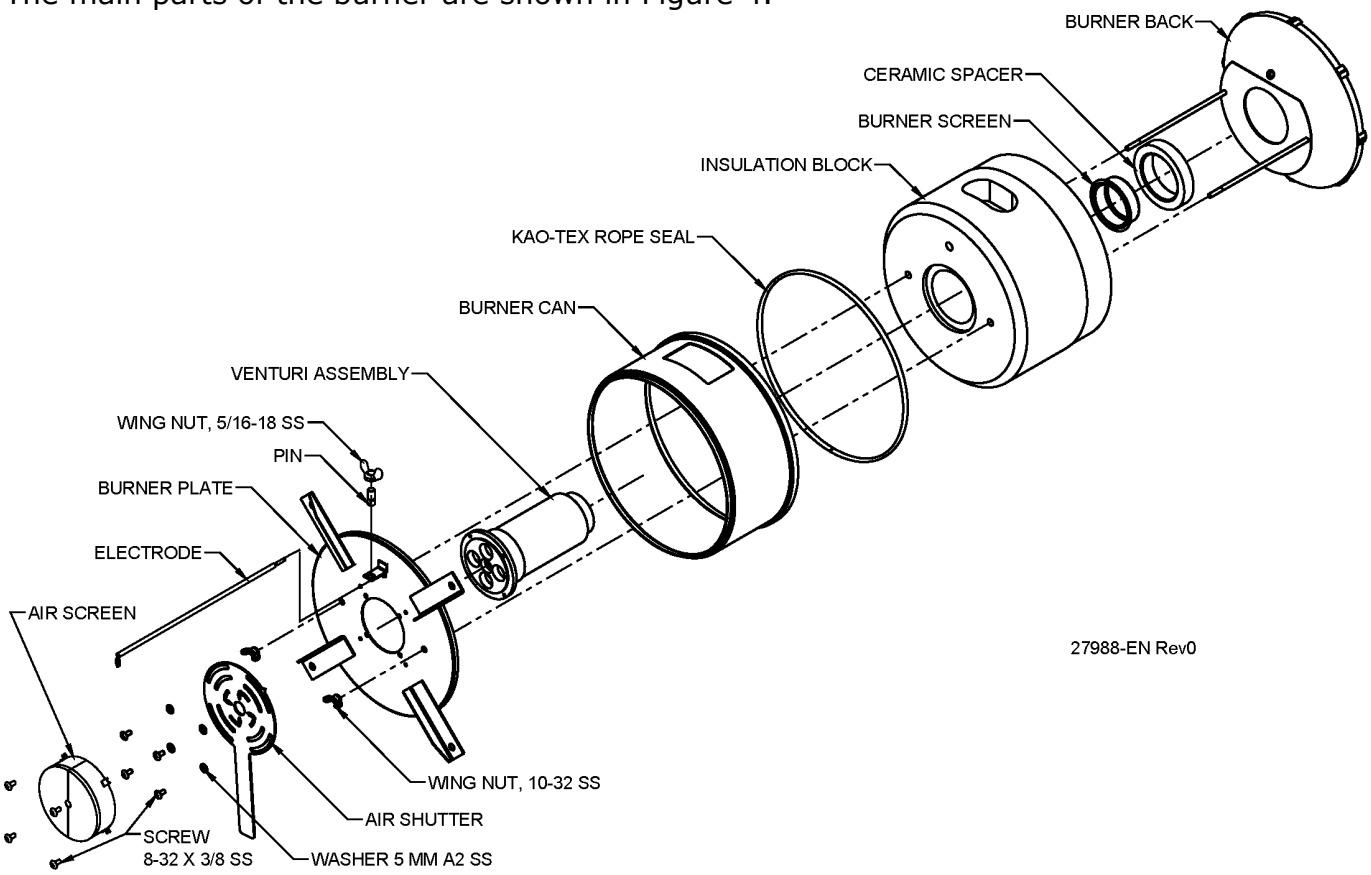



*Figure 4 – Burner General Assembly*

### 4.1.4 Power Unit

The power unit generates electric power from the direct conversion of heat into electrical energy.

Electrical output characteristics are shown below in Figure 5. Power peaks in a broad load resistance range of 0.8 - 1.5 Ω. Rated power of 210 Watts is obtained when the power unit load resistance is within this range.

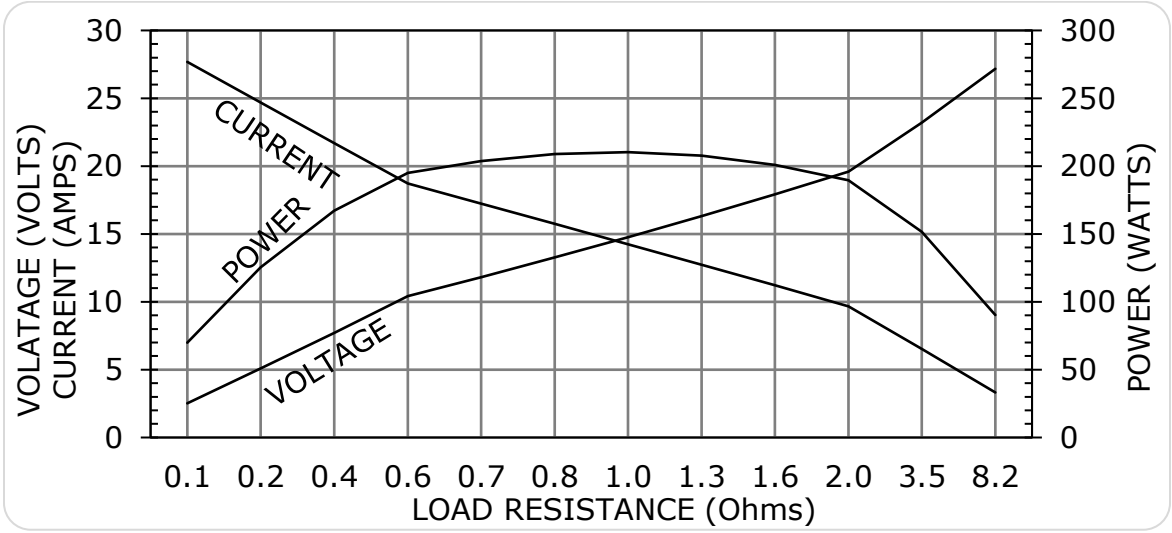



*Figure 5 – Gross Power from Power Unit @ 20°C (Beginning of Service Life)*

### 4.1.5 Cooling Fins and Fin Duct

Cooling of the thermopile is accomplished by the free movement of ambient air through the cooling fins. A fin duct acts as a chimney, causing ambient air to rise through the cooling fins as it warms, transferring heat away from the thermopile.

**WARNING!** Keep cooling fins clear and keep duct inlets and outlets free of obstructions. Restricting the free flow of cooling air may cause damage to the power unit.

### 4.1.6 Cabinet

The power unit, burner and fuel system are enclosed in a stainless-steel cabinet. The cabinet door has a latch that can be locked with a padlock.

### 4.1.7 Optional TEG Mounting Stands (Pole or Leg Type)

The Pole Stand consists of a 76” long piece of 3” diameter pipe with an “H” shaped bracket welded to one end.

The Leg Assembly consists of 3” x 3” and 2” x 2” aluminum angle sections that are assembled together to provide a sturdy structure to support the TEG.

The TEG can be securely mounted to either stand using 1/4" fasteners (not included).

## 4.2 220-WATT LIMITER

The minimum requirement for the 5220 is a limiter operating at a nominal voltage of 14 V. This limiter is a shunt-type voltage limiter that regulates the output voltage of the generator. The main components of the Limiter are shown in Figure 6, and explained below.

**Protective (Voltage) Limiter:** A voltage limiting circuit is incorporated into the 220 W Limiter, which limits input voltage helping achieve optimal performance from the TEG. It is factory set to activate at 14.1 V for the model 5220 TEG. Unless the generator is equipped with an optional CP System. In this case, the voltage is factory set at 17.5 V.

**Current Limiter:** Overload protection triggers when the load draws excess current. The result is a proportional drop in output voltage, fold-back current limiting.

Short circuit protection is also designed into the 220 W Limiter. A diode in series with the positive output prevents current from flowing back through the converter when the generator is shut off.

**CAUTION!** If extended short circuit durations are anticipated, an in-line fuse should be placed on the output of the limiter converter.

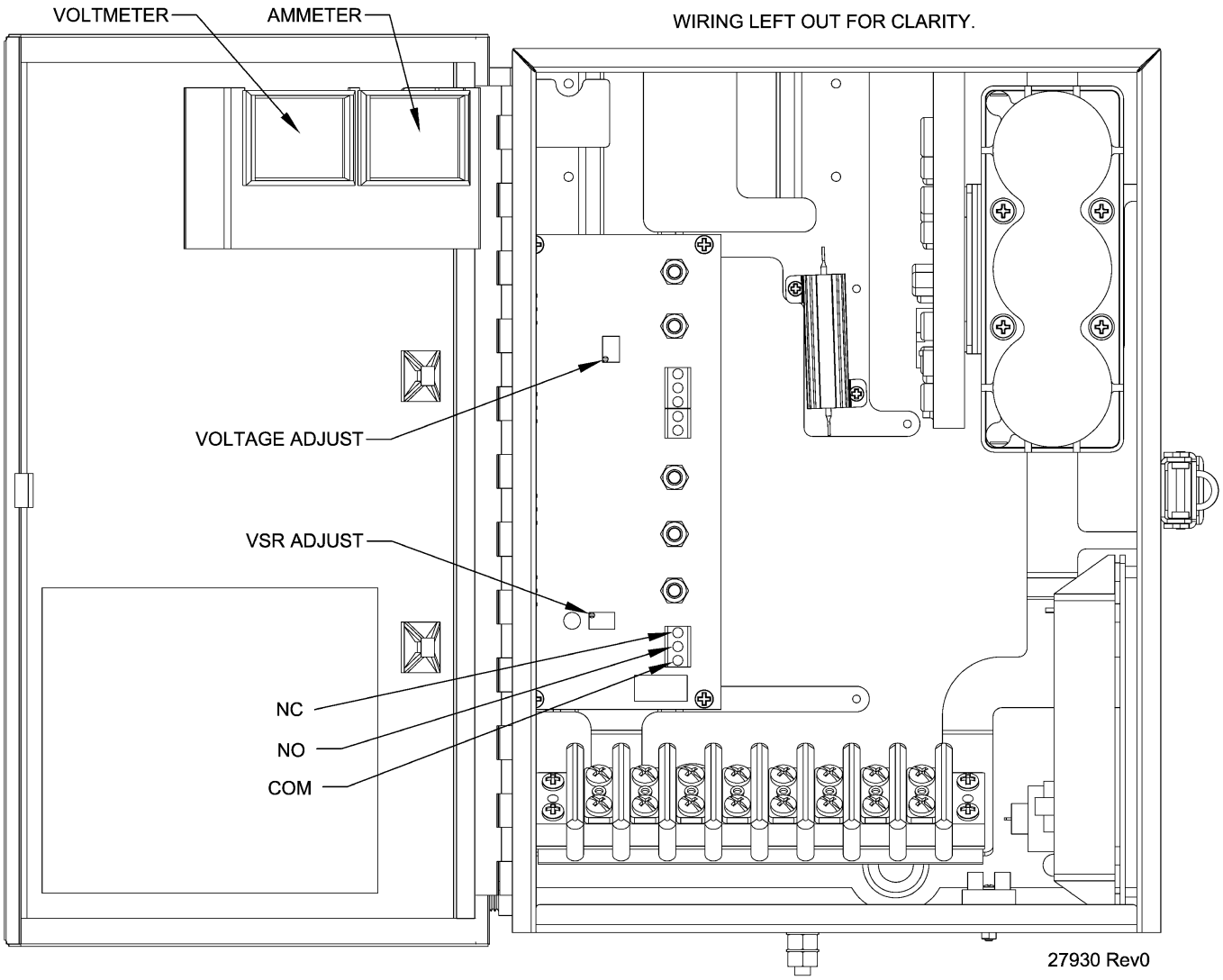



*Figure 6 – 220-Watt Limiter Assembly*

**Blocking Diode:** Reverse current protection is standard on the 220 W Limiter. A diode in series with the positive output prevents current from flowing back through the converter when the generator is shut off.

**Voltage Sensing Relay:** Voltage Sensing Relay (VSR) provides a set of contacts to indicate an alarm condition when the output voltage drops below a preset minimum. Low voltages, due to overloads, lack of fuel or a faulty generator, are detected by a voltage sensing circuit incorporated into the voltage limiter. When a low voltage condition is detected, the Voltage Sensing Relay (VSR) with connections NC (normally closed), NO (normally open) and COM (common) can be used to trigger an alarm or other processes. When the generator is above the trip voltage the connection between NO and COM is closed and the connection between NC and COM is open. If the generator is below the trip voltage, then the connection between NO and COM is open and the connection between NC and COM is closed. The trip voltage is adjusted by the pot labeled VSR adjust on the VSR board as shown if Figure 6.

**Volt and Amp Meters:** The volt and amp meters provide indication of voltage and current output from the Limiter board.

**Power Resistor:** When no load, or a very small load, is connected, the TEG has more power available than required by the load. This excess power is directed into a power resistor by the voltage limiter.

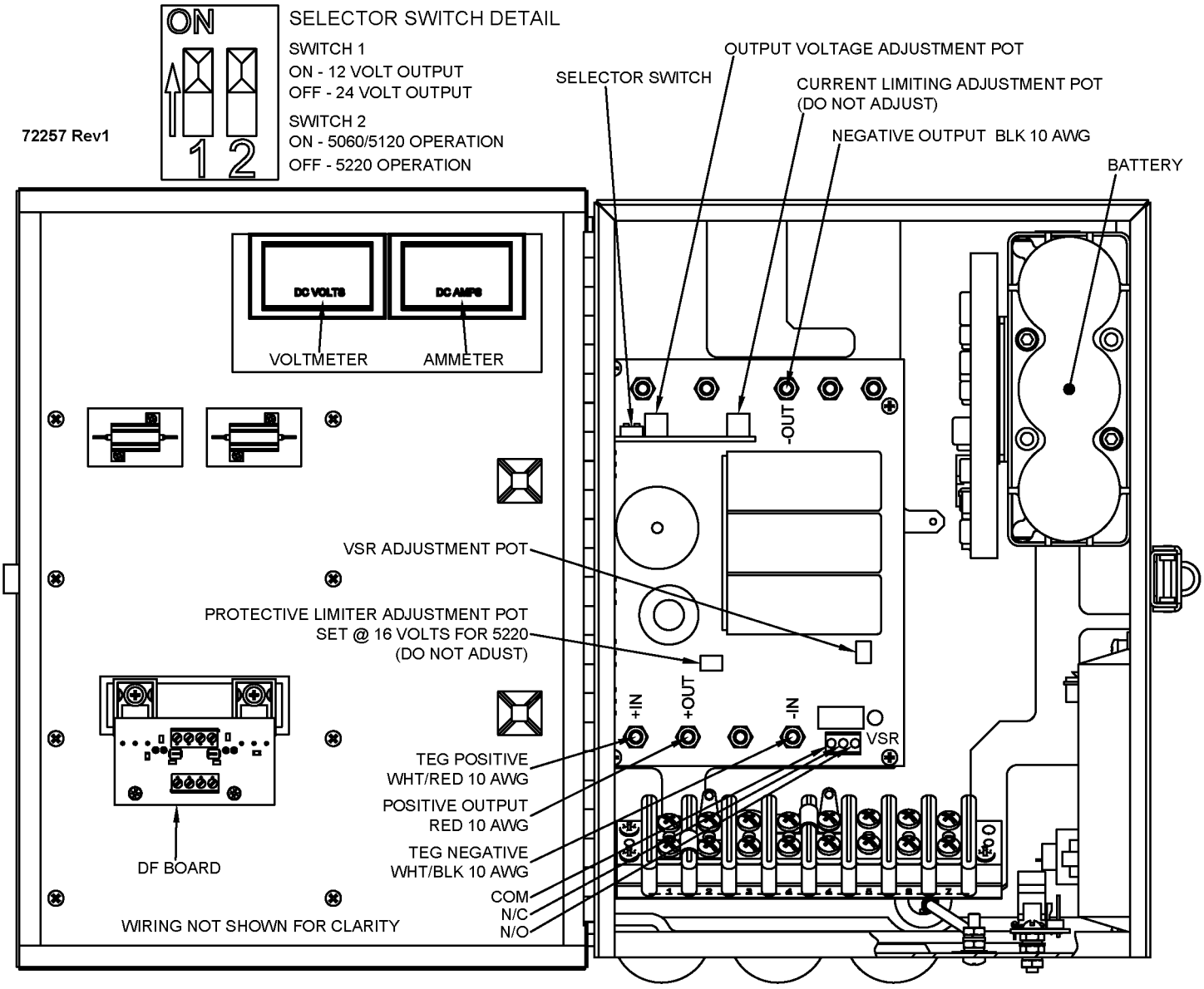



*Figure 7 – 220-Watt L/C Assembly*

## 4.3 220-WATT LIMITER/CONVERTER (L/C)

A 220 W Limiter/Converter (L/C) is available for use with the model 5220 TEG. It is intended for use with model 5220 applications requiring nominal 24 VDC output. It consists of two separate circuits operating together. The first is a shunt-type voltage limiter that regulates the output of the generator. The second circuit is a DC-DC converter that switches the input voltage to the customer's desired output voltage. It includes overload, short circuit and reverse current protection, as well as a set of low voltage alarm contacts. The main parts of the 220 W L/C are shown in Figure 7.

**Protective (Voltage) Limiter:** A voltage limiting circuit is incorporated into the 220 W L/C, which limits input voltage helping achieve optimal performance from the TEG. It is factory set at 16.0 V for the model 5220 TEG.

**Voltage Converter:** The voltage converter switches the Power Unit voltage to the customer's voltage setting.

**Current Limiter:** Overload protection triggers when the load draws excess current. The result is a proportional drop in output voltage, and fold-back current limiting.

Short circuit protection is also designed into the 220 W L/C. A 15-second short circuit will not damage the generator or the L/C.

**CAUTION!** If extended short circuit durations are anticipated, an in-line fuse should be placed on the output of the limiter converter. Use a 15 A slow blow for the model 5220-24 TEG.

**Blocking Diode:** Reverse current protection is standard on the 220 W L/C. A diode in series with the positive output prevents current from flowing back through the converter when the generator is shut off.

**Voltage Sensing Relay:** Voltage Sensing Relay (VSR) provides a set of contacts to indicate an alarm condition when the output voltage drops below a preset minimum.

Low voltages due to overloads, lack of fuel, or a faulty generator, are detected by a voltage sensing circuit incorporated into the voltage limiter. When a low voltage condition is detected, the Voltage Sensing Relay (VSR) with connections NC (normally closed), NO (normally open) and COM (common) can be used to trigger an alarm or other processes. When the generator is above the trip voltage, the connection between NO and COM is closed. If the generator is below the trip voltage, then the connection between NO and COM is open, and the connection between NC and COM is closed. The trip voltage is adjusted by the pot labeled "VSR Adjust" on the VSR board as shown in Figure 6 or Figure 7.

**Volt and Amp Meters:** The volt and amp meters provide indication of voltage and current output by the L/C.

**Power Resistor:** When no load or a very small load is connected, the TEG has more power available than required by the load. This excess power is directed into a power resistor by the voltage limiter.

## 4.4 OPTIONAL CATHODIC PROTECTION INTERFACE SYSTEM

An optional cathodic protection interface system is available for use with the model 5220 TEG. It provides for adjustment and monitoring of power to a Cathodic Protection (CP) load. The anode and cathode cables enter the cabinet at the bottom and connect directly to a heavy-duty terminal block. A 0 to 1 Ω 300-watt variable resistor is provided for adjusting the output power applied to the CP system. The main parts of the CP interface system are shown in Figure 8.

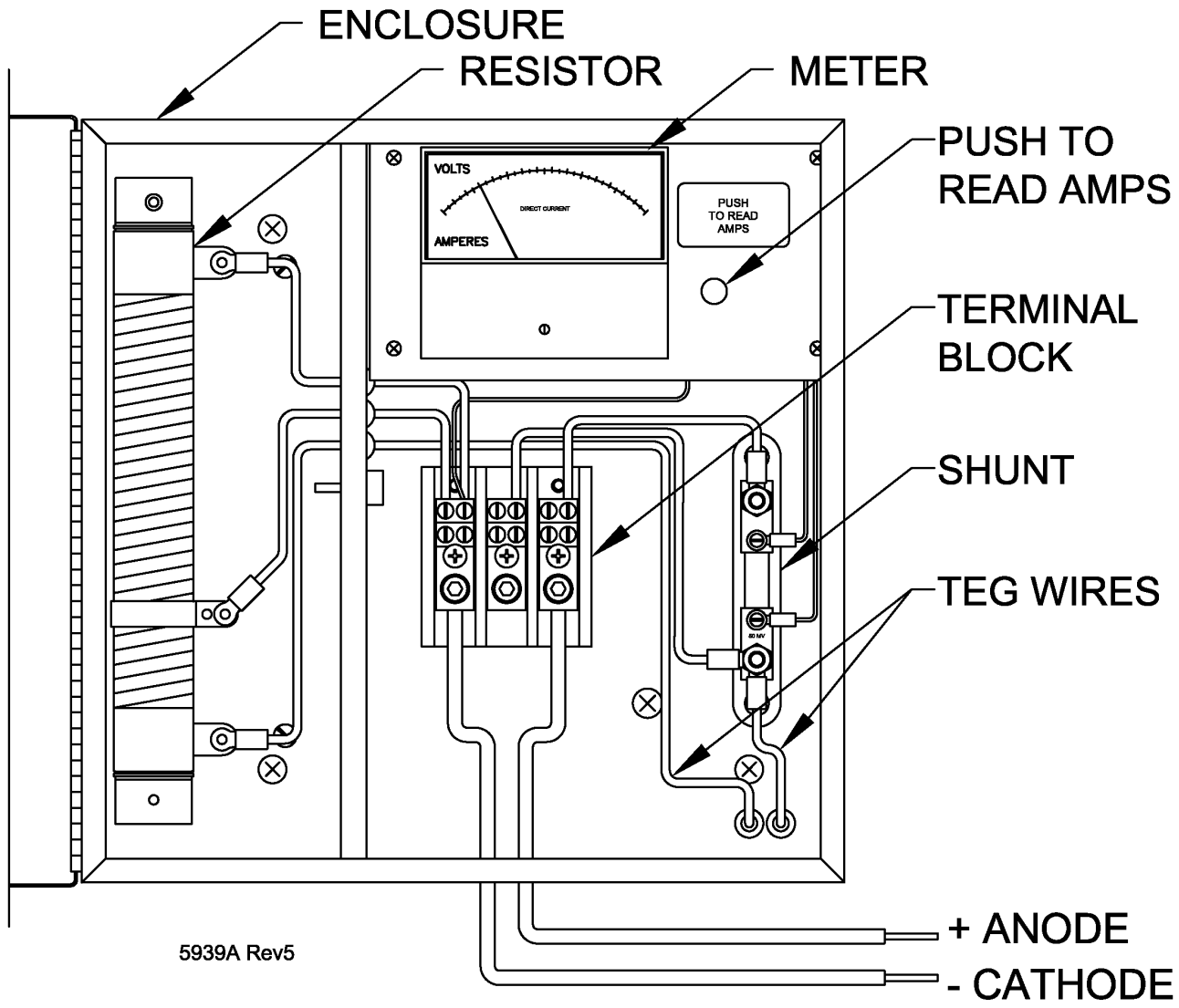



*Figure 8 – CP Interface System Assembly*

**Enclosure:** The CP interface system is enclosed within a weather resistant 304 SS enclosure. Enclosure features include a lockable cabinet door, 1" conduit opening on the bottom for customer CP wires, and separate area within the enclosure for the variable power resistor.

**Meter:** The dual scale meter displays voltage at the terminal block, and current when the PUSH TO READ AMPS button is depressed. The meter is accurate to ± 3% of full scale. Available standard meter face for the 5220 TEG is 0-30 V, 0-30 A.

**Current Shunt:** A shunt located in the CP Interface enclosure is used to measure the current to the terminal block. The voltage drop across the shunt is proportional to the current flowing through it. The current shunt rating corresponds to the ampere scale on the meter.

**Terminal Block:** Customer terminal block, is a heavy-duty terminal block that will accept customer anode & cathode wire up to 9 mm dia. (00 AWG).

**Variable Resistor:** A 300 W variable 0 to 1 ohms resistor located inside the enclosure may be used to adjust the output power of the CP interface. This resistor may be wired in series or parallel with the customers CP load depending on the application but comes factory-configured with the resistor in series.

# 5 INSTALLATION

This section provides installation instructions for the Model 5220 Thermoelectric Generator.

## 5.1 PRECAUTIONS

The installation must conform with local codes or, in the absence of local codes, CSA B149.1 or ANSI Z223.1/NFPA 54, and CSA B149.2 or NFPA 58, as applicable. Installation of this appliance at altitudes above 2000 ft (610 m) shall be in accordance with local codes or, in the absence of local codes, CSA B149.1 or ANSI Z223.1/NFPA 54, and CSA B149.2 or NFPA 58, as applicable. The TEG must be kept clear and free from combustible materials, gasoline and other flammable vapours and liquids. Maintain 900 mm (36”) minimum clearances from combustible construction to the top, sides and back, and install over a non-combustible floor.

Do not use this appliance if any part has been under water. Immediately call a qualified service technician to inspect the appliance and to replace any part of the control system and any gas control which has been underwater.

The TEG when installed must be electrically grounded in accordance with local codes, or in the absence of local codes, with CSA C22.1 or NFPA 70. A grounding lug is provided on the interior of the cabinet for this purpose.

**CAUTION!** Do not wire TEG through a stand-alone solar charge controller. This may cause internal damage to the TEG.

## 5.2 TOOLS REQUIRED

The following tools are required for installing the TEG:

- 1 - DC Voltmeter, accurate to ±0.1 V.
- 2 - Adjustable Wrenches, that will open to 16 mm (5/8”)
- 1 - Screwdriver, flat-head
- 1 - Screwdriver, Phillips
- 4 - Bolts & nuts, 1/4-inch diameter, for mounting

## 5.3 UNPACKING

Unpack the TEG from its shipping crate. Keep the crate until the TEG is operational. Locate and identify the following items that were shipped with the 5220 TEG:

- 1 - Fin Duct
- 1 - Cover Plate
- 1 – Manual Shutoff Valve
- 1 – Wind Scoop
- 1 - Thread Sealing Compound
- 17 - Screws, #8 32 × ¼” long, one spare
- 17 - Washers, #8 External Lock, one spare

| | |
|---|---|
| **NOTE:** | Inspect the TEG for damage which may have occurred during shipping. Please report any damage as soon as possible, as it may make the generator inoperable. Check with the factory before starting a damaged TEG. |

## 5.4 ASSEMBLING

Follow these steps to assemble the TEG, see Figure 9:

1. Attach the fin duct and cover using the #8 screws and lock washers supplied.
2. If not already installed, insert the exhaust stack into the top of the cabinet. Slide the clamp over the bottom of the stack and tighten the clamp screw.

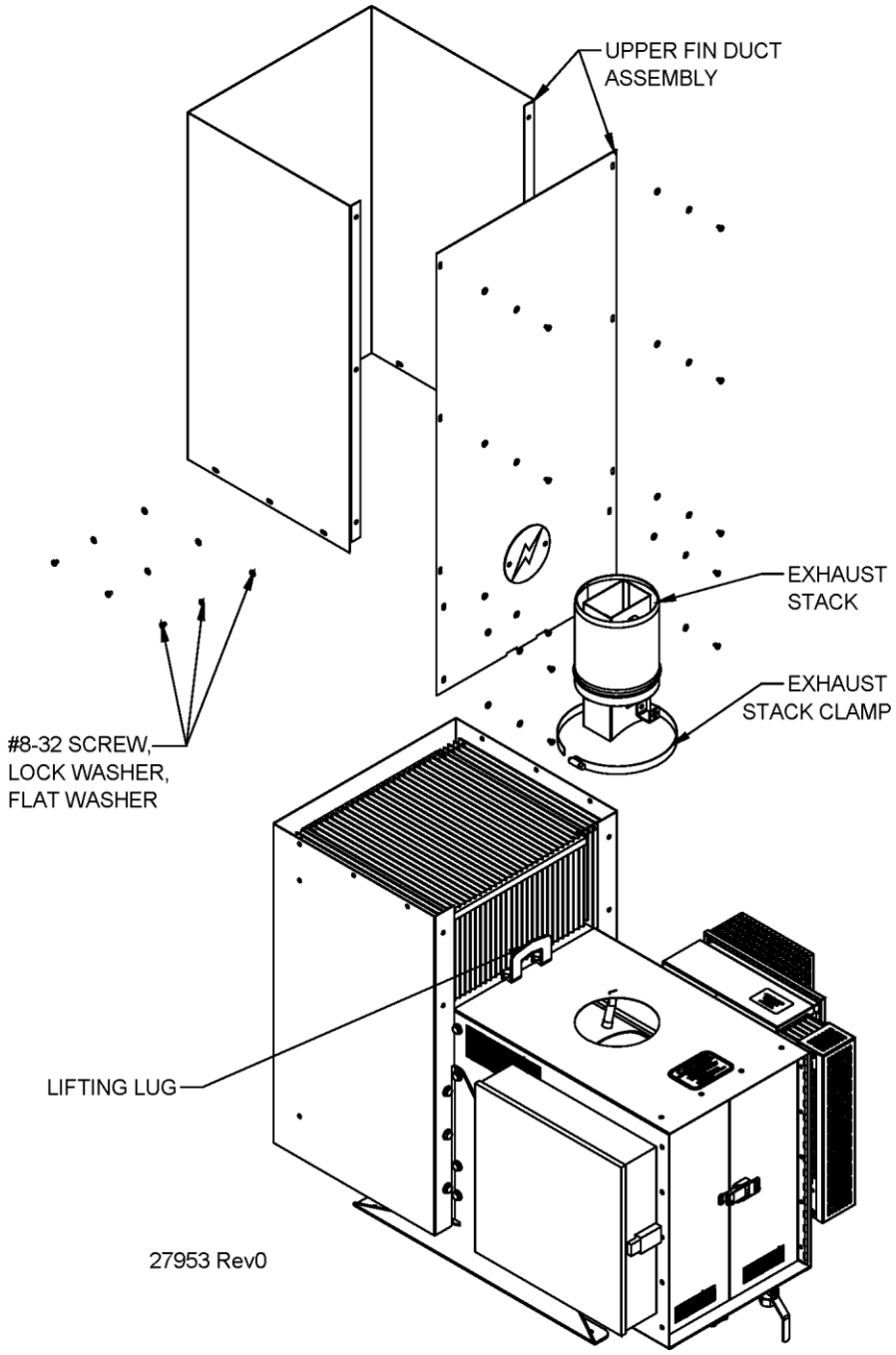



*Figure 9 – Assembling the 5220 TEG*

## 5.5 MOUNTING

Mount the TEG to a firm and stable base – or to a stand provided by GPT – using ¼ inch (6mm) diameter bolts of material suitable for the environment. See Figure 10 for mounting hole locations and spacing. The base must be level and sturdy enough to support the 100 kg (221 lb.) mass of the TEG. Various stands are available from the factory. Contact your sales rep for more information.

**CAUTION!**

Operation of the TEG in locations where cooling air flow may be obstructed will cause overheating of the TEG. Allow a minimum of 150 mm (6”) clearance under the cooling fins and 900 mm (36”) above the top of the fin duct. Locate the TEG to avoid flooding or snow accumulation interfering with the flow of cooling air.

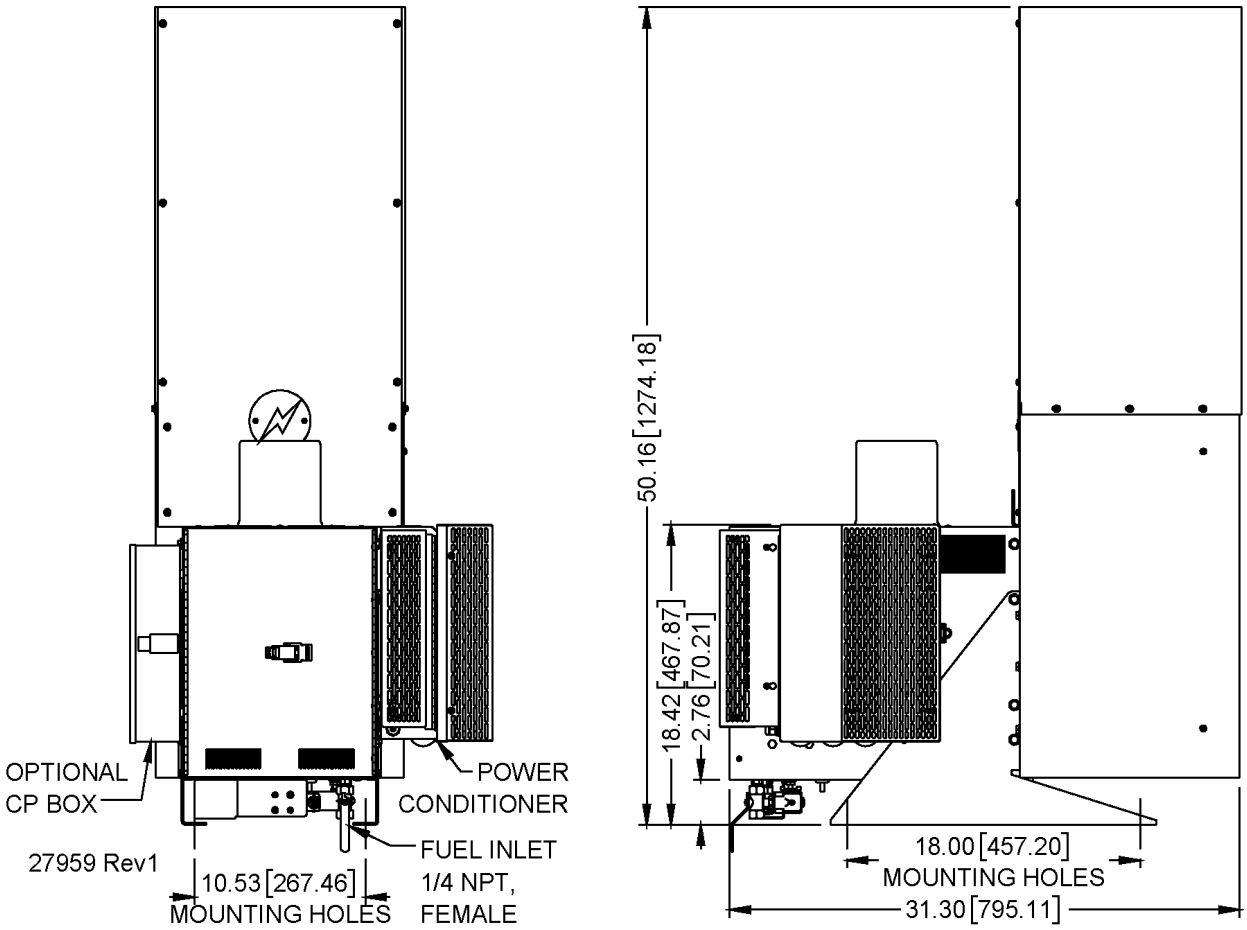



*Figure 10 – Model 5220 Mounting Dimensions, shown with CP and L/C*

## 5.6 INSTALLATION OF WIND SCOOP

**WARNING!**

Install wind scoop prior to commissioning and startup. Failure to do so will void the 5220 TEG warranty and may result in catastrophic failure resulting from elevated cabinet temperatures. See wind scoop installation manual for details.

The wind scoop is a very important addition to a 5220 TEG as it improves operating efficiency and performance in wind. The wind scoop must be installed to prevent the TEG from blowing out or running poorly in windy conditions. Failure to install the wind scoop may result in low power output, intermittent outages, or even damage to the TEG itself.

A wind scoop kit is shipped along with the 5220 TEG. Refer to the Installation Guide, included in the Wind Scoop package, to install the wind scoop onto your TEG. If your 5220 TEG is not equipped with a wind scoop, please contact GPT to obtain a retrofit kit.

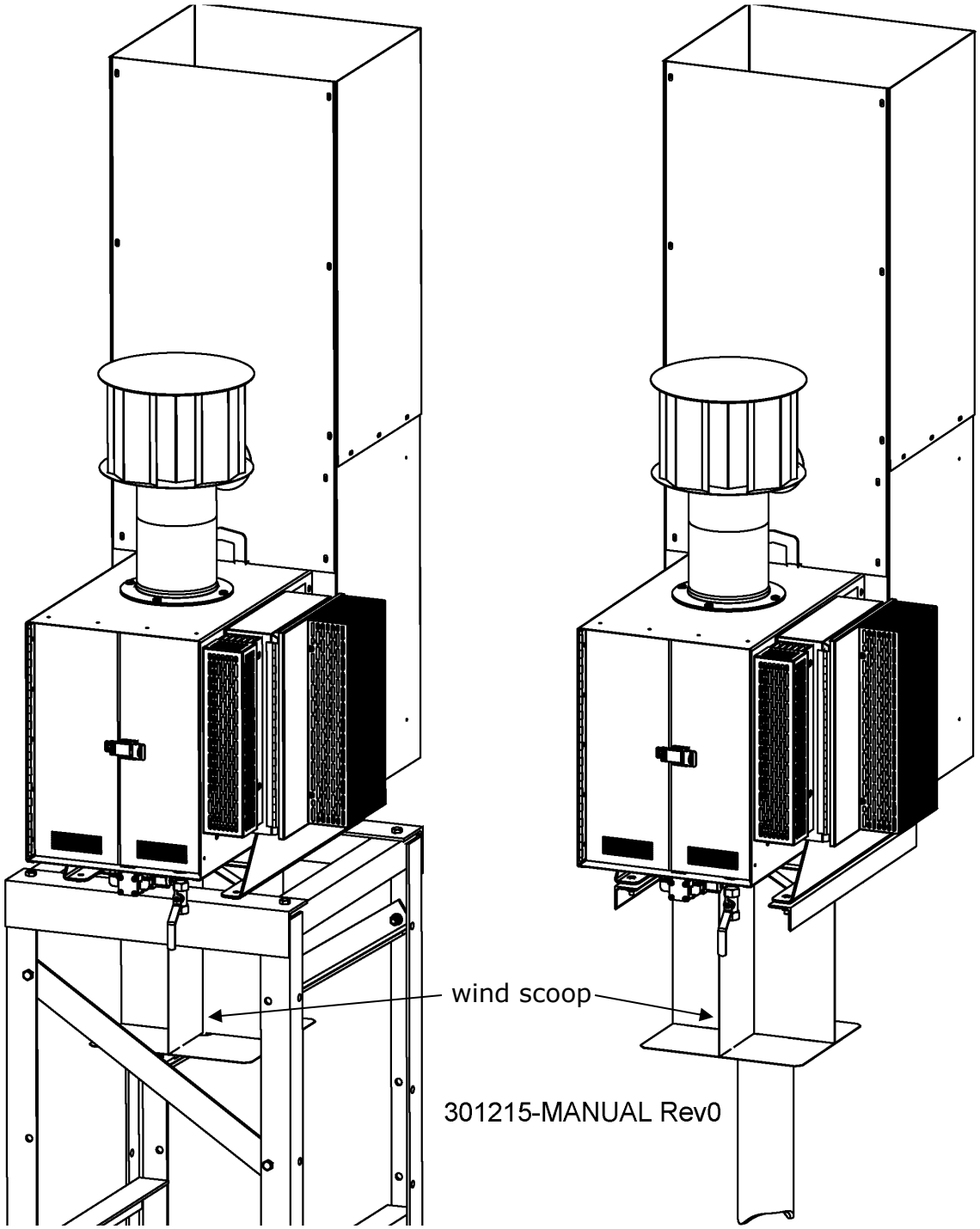



*Figure 11 – Wind Scoop Installed on Angle Mount (Left) and Pole Mount (Right)*

## 5.7 SUPPLYING FUEL

This topic describes how to connect the fuel supply and gives considerations for providing fuel to the 5220 TEG.

**WARNING!**

*CONDENSATE FROM REGULATOR IS VERY HIGH-RISK OF BEING FLAMMABLE.*

When draining condensate from regulator, ensure it is removed from cabinet and is a safe distance from ignition sources.

If there is a concern about liquids in the fuel line, it is suggested that the customer install a regulator drain line to remove condensate to a safe location away from ignition sources.

Condensate collecting/pooling/splashing/etc. inside the TEG cabinet creates a dangerous fire hazard. Contact GPT for assistance with fuel conditioning options to remove liquids from fuel line supply.

### 5.7.1 Connecting the Fuel Supply

The fuel inlet of the TEG is a ¼" FNPT on the manual shutoff valve.

Follow these steps to connect the fuel supply:

1. Remove any protective cap or plugs from inlet connections.
2. Apply thread sealant to the fuel line threads as per Figure 12 where the fuel line protrudes from the bottom of the cabinet.

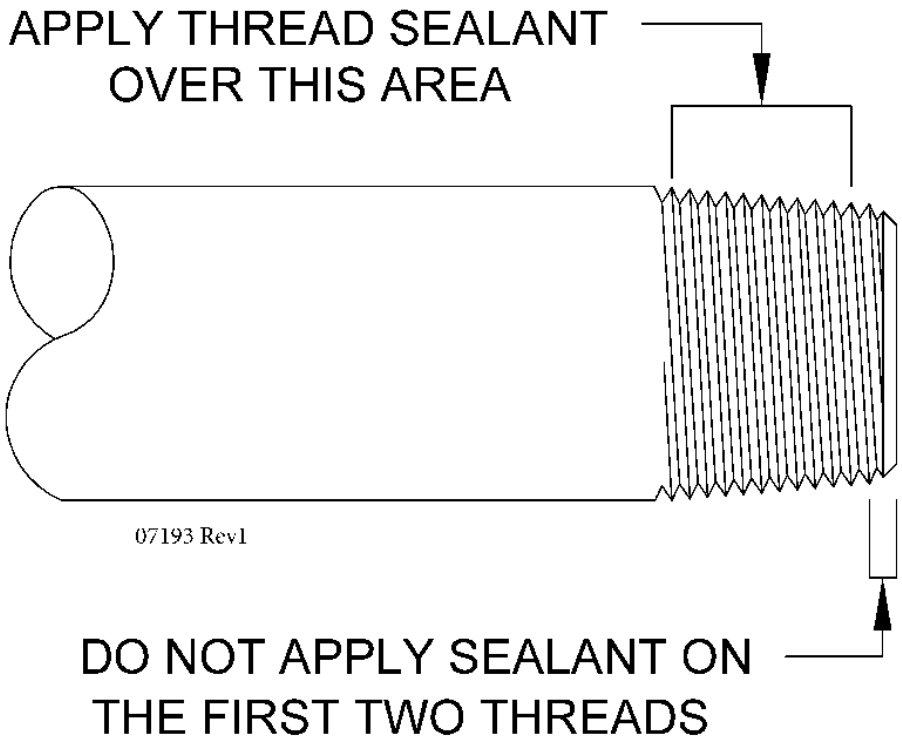



*Figure 12 – Applying Thread Sealant*

| | |
|---|---|
| **NOTE:** | Thread sealant is recommended. Sealant must be approved for use with gaseous fuels. Do not use tape on any fuel system fittings. |

3. Connect the manual shutoff valve supplied with the TEG, ensuring the connection is tight and the valve handle is accessible.
4. Connect the fuel line to the manual shutoff valve and test all joints for leaks using a commercial leak detector fluid such as Snoop®.

| | |
|---|---|
| **NOTE:** | The TEG and its manual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of the site gas supply piping system at test pressures more than 3.5 kPa (0.5 PSI). |

| | |
|---|---|
| **NOTE:** | All fuel plumbing must be in accordance with local regulations. |

### 5.7.2 Fuel Considerations

**Fuel Types:** Fuel must be either natural gas or propane gas. Check the TEG Data Plate for the fuel type. Do not use a different type of fuel than indicated. If you would like to convert your 5220 to run on a fuel other than the one indicated on the data plate, please contact GPT.

| | | |
|---|---|---|
|  | **WARNING!** | Fuel supplied to the TEG must not contain liquids. Liquid hydrocarbons in the fuel supply pose a risk of fire and may result in serious damage to the TEG and danger for the operator. |

| | | |
|---|---|---|
|  | **CAUTION!** | Do not exceed the data plate for Inlet Pressure rating under any circumstances. If fuel Inlet Pressure exceeds this limit, damage to the fuel system may occur. If the fuel supply Inlet Pressure will vary greatly, the use of an additional primary regulator is recommended to hold the inlet pressure relatively constant. |

**Clean Fuel:** The fuel used to operate the 5220 TEG must be clean and dry. See Technical Specifications section for the full gas specification for fuel supplied to GPT's TEGs. If dirty fuel is anticipated, then a customer-supplied in-line fuel filter is recommended. For further information regarding the condition of fuel supplied to the TEG, please contact GPT.

**Low Temperature:** Regulator freeze-off can be minimized by regulating the incoming supply pressure to 25 PSI (172 kPa). When using propane at temperatures below -30ºC (-22ºF), special consideration must be given to the vaporization of the fuel.

#### 5.7.2.1 Propane/LPG Gas Supply Considerations

If remote Propane/LPG gas supply system is used, consider the following:

**Location:** Propane/LPG tanks and cylinders must be located outdoors in a well-ventilated area, at least 3 meters (10 ft) from the TEG unless directed otherwise by the local authority having jurisdiction.

**Mounting:** Each tank or cylinder must be set on a firm, level, waterproof base, located on firm ground at grade level. The base must extend at least 300 mm (1 ft) from all sides of the tank or cylinder, must be designed to support the weight of the tank or cylinder and is subject to approval by the local authority having jurisdiction. To prevent remote cylinders from tipping over, they shall be secured by brackets, straps, or carriers designed and manufactured to withstand calculated loading in any direction equal to at least four times the weight of the filled cylinder.

**Connection:** Tanks and cylinders are to be equipped with flexible connections to offset any movement affecting the piping or tubing.

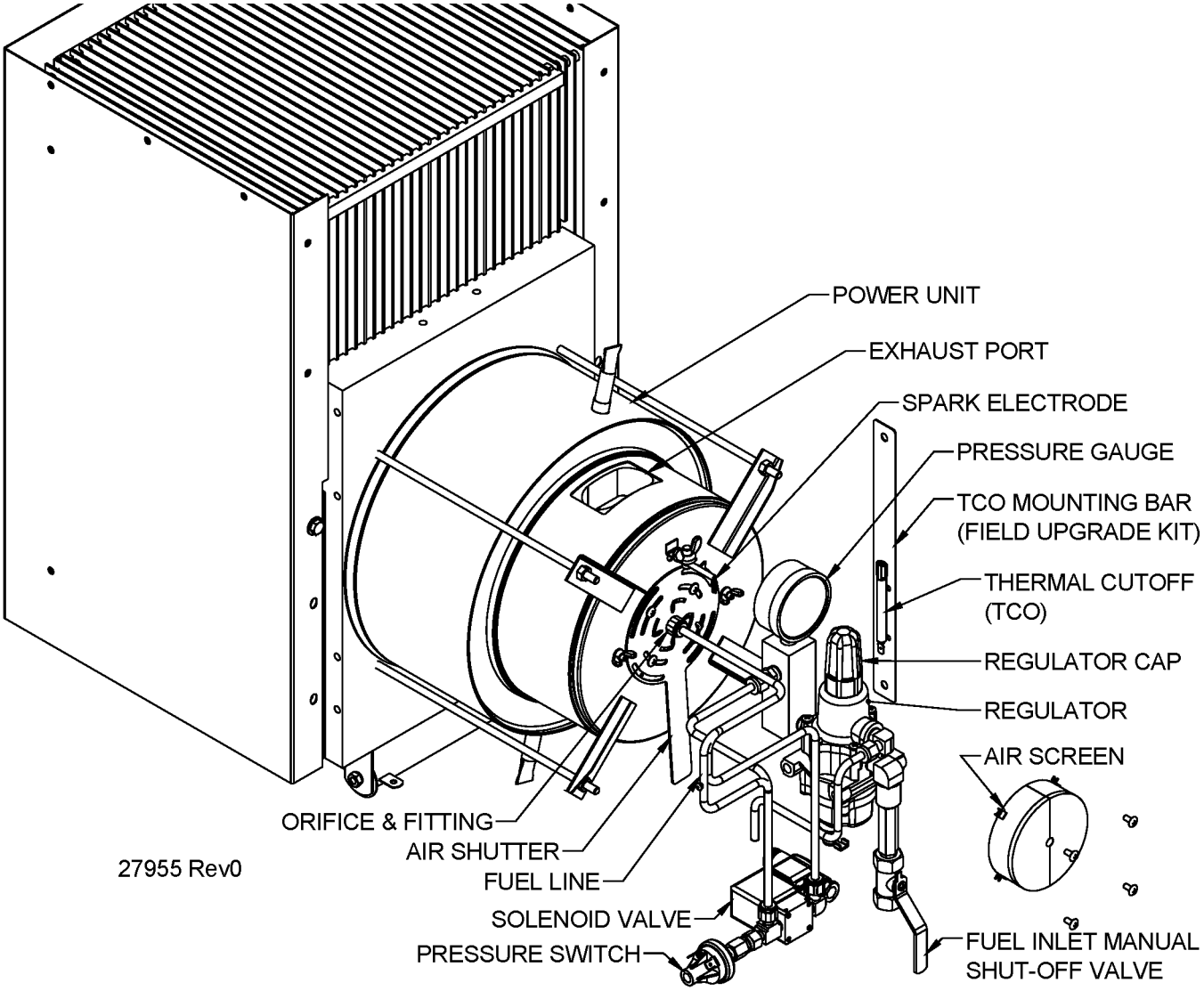



*Figure 13 – Setting up the 5220 TEG*

## 5.8 CONNECTING CUSTOMER LOAD

**CAUTION!**

The customer output from the 5220 must be wired through a suitably sized circuit-breaker or fuse that allows the TEG output to be electrically isolated from the station battery, load, and other voltage sources in the system. Failure to do so may result in damage to customer equipment or to the TEG's own electronics.

Connect the customer load directly to the TEG using the following procedure. If the TEG is equipped with the optional CP interface system, then see the INSTALLATION OF OPTIONAL CP INTERFACE SYSTEM topic below. Follow these steps to connect the customer load:

1. Remove a plug from openings, designed to fit 3/4" customer conduit, on the bottom of 5220 electronics enclosure.
2. Bring the customer load wires through the opening. Allow enough wire to connect to the terminal block TB1. Strain relief is required to protect customer load wires.

**NOTE:** Use only copper wire, properly sized for the load current. Electrical connections must be made in accordance with local electrical codes.

3. Tighten the connector of customer 3/4” conduit to the enclosure.
4. Connect the customer load wires to TB1:

   **12 V**: Connect the load at terminals 5 (+) and 4 (-) (Figure 14).

   **24 V**: Connect the load at terminals 7 (+) and 6 (-) (Figure 15).

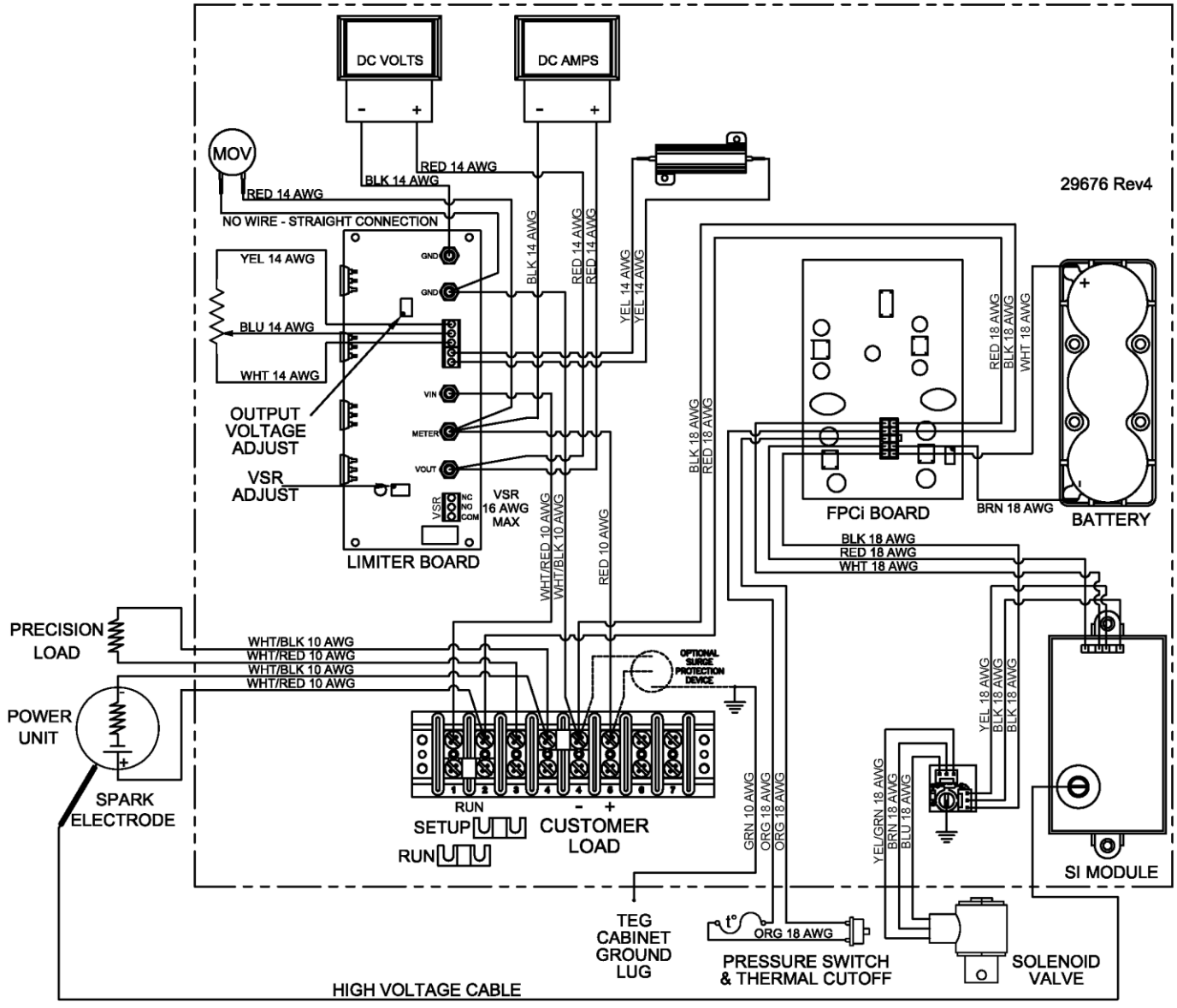



*Figure 14 – Wiring Diagram 5220 TEG, with 12 V Limiter Assembly*

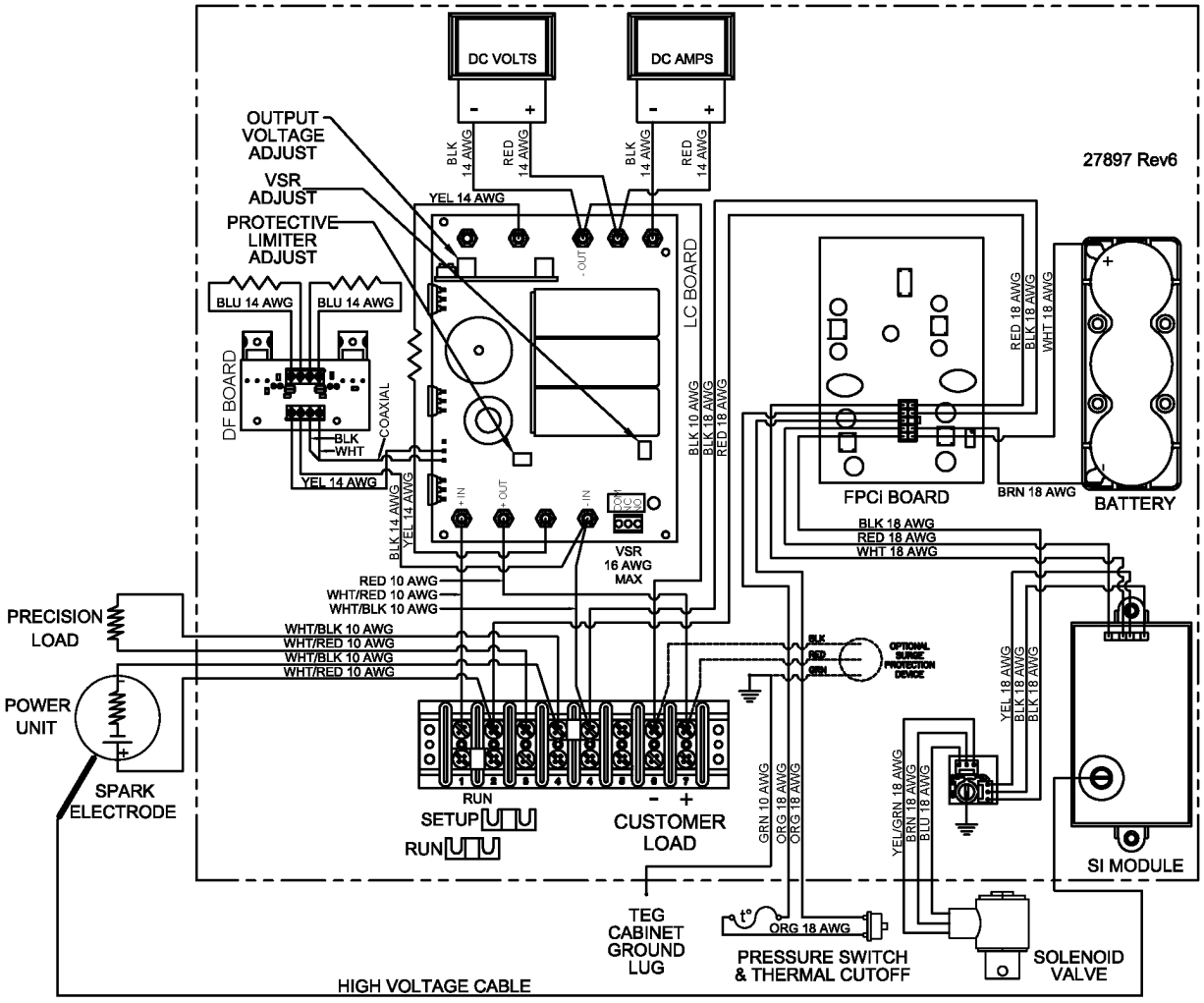



*Figure 15 – Wiring Diagram 5220 TEG, with 24V L/C Assembly*

## 5.9 INSTALLATION OF LIMITER/CONVERTER (L/C)

The L/C is normally shipped ready for operation, attached to the TEG. If it was shipped separately, install it as follows.

| | |
|---|---|
| **NOTE:** | Before installing, inspect the electronics for obvious damage and broken components and advise Global Power Technologies (GPT) if damage is found. |

### 5.9.1 Attaching the L/C to the TEG

The standard mounting location is on the right side (when looking at the front of the TEG) of the generator cabinet. To attach the L/C, remove the four nuts and lock washers provided and bolt it to the outside of the TEG cabinet (Figure 16).

| | |
|---|---|
| **NOTE:** | Always mount the L/C in an upright position and allow the free flow of air through the unit. Remote mounting of the L/C is acceptable. Contact GPT for more information on remote mounting. |

### 5.9.2 TEG Wiring Interconnection

Wire the L/C directly to the TEG using the following procedure:

1. Feed the wires from the L/C into the TEG cabinet through the hole provided.

| | |
|---|---|
| **NOTE:** | If remotely mounting the L/C, size the interconnecting wires between the generator and the L/C for 17 A, and use no less than AWG no. 10. |

2. Before connecting the input or output wires to the TEG terminal block, ensure that the selector switch setting (Figure 7) is correct for the required voltage and model of the TEG.
3. Connect the L/C wires to TB1 as per Figure 15.

## 5.10 INSTALLATION OF OPTIONAL CP INTERFACE SYSTEM

The CP interface is normally shipped ready for operation, attached to the TEG. If it was shipped separately, install it as follows:

| | |
|---|---|
| **NOTE:** | Before installing, inspect the electronics for obvious damage and broken components and advise Global Power Technologies (GPT) if damage is found. |

### 5.10.1 Attaching the CP Interface System to TEG

The standard mounting location is on the left side (looking at the front of the TEG) of the generator cabinet. To attach the CP interface system, remove the four nuts and lock washers provided and bolt it to the outside of the TEG, see Figure 16.

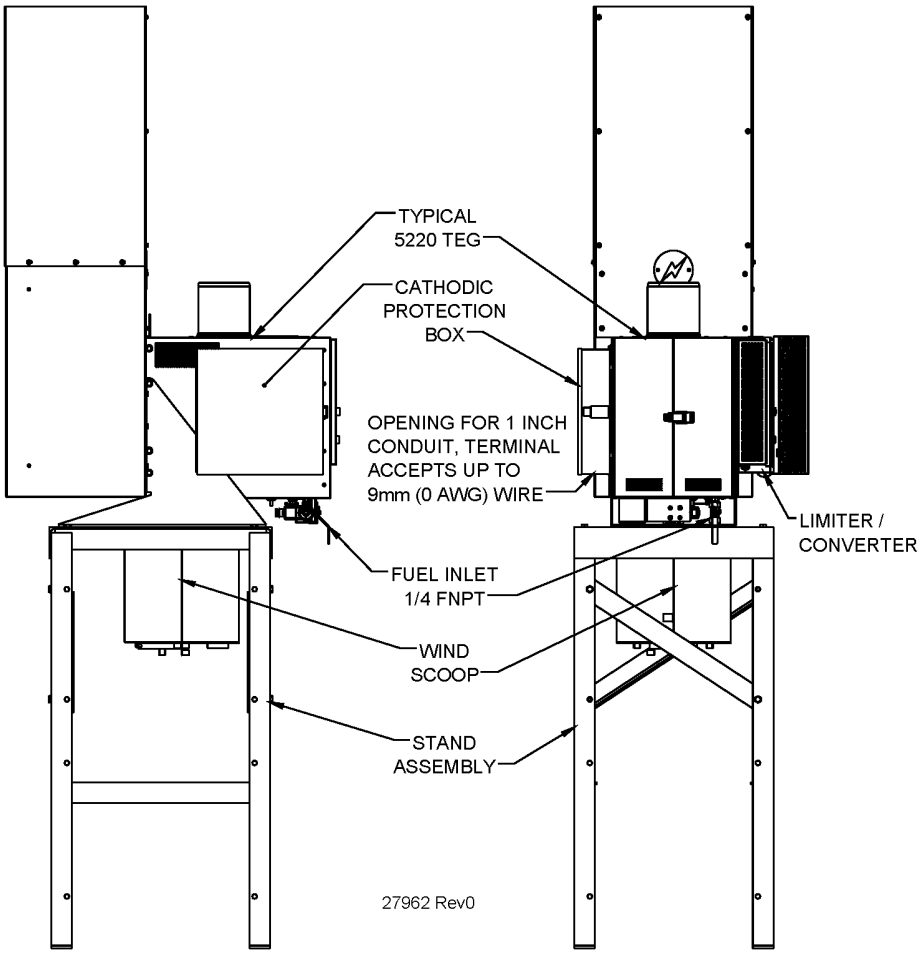



*Figure 16 – CP Installation*

| | |
|---|---|
| **NOTE:** | Always mount the CP interface system in an upright position and allow the free flow of air through the unit. |

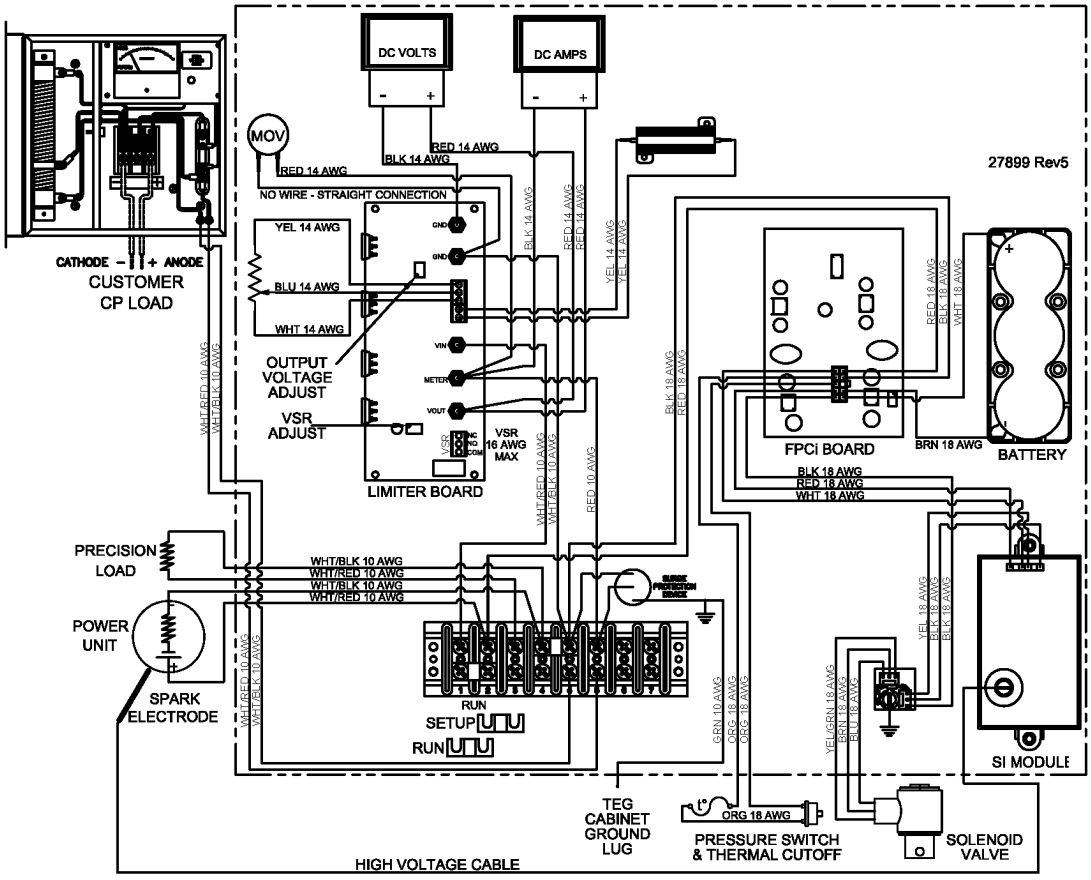



*Figure 17 – CP Wiring for Model 5220-12 V, with Limiter Assembly*

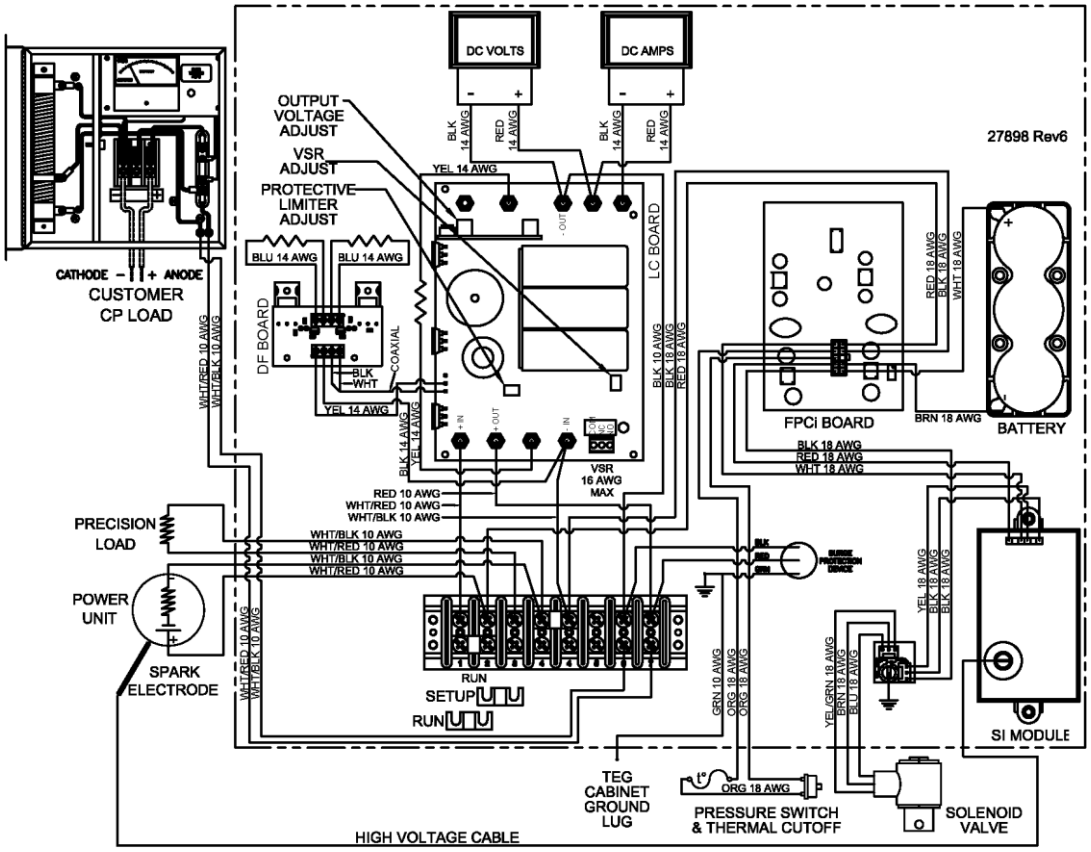



*Figure 18 – CP Wiring for Model 5220-24 V, with L/C Assembly*

### 5.10.2 TEG Wiring Interconnection

Wire the CP interface system directly to the TEG using the following procedure:

1. Consult the wiring diagram (Figure 17 or Figure 18, as applicable).
2. Run the CP interface system wires to the TEG as per the relevant diagram and terminate to TB1.

### 5.10.3 Connection of CP Load

Wire the CP load directly to the CP interface system. Feed the CP anode and cathode load cables into the CP box and terminate.

# 6 STARTUP AND SHUTDOWN

This section describes how to start and shut down the model 5220 TEG.

## 6.1 BEFORE STARTING

Before starting the TEG perform these steps:

1. Move the jumper on TB1 from the RUN position to the SETUP position, i.e. from between terminals 1 and 2 to between terminals 2 and 3 respectively. See Figure 14 or Figure 15.
2. Connect a DC voltmeter to terminals 2 (+) and 4 (-) of TB1. This will be measuring $V_{set}$.
3. Make sure that all the connections in the fuel system are tight and have been checked for leaks.

## 6.2 TEG START-UP

Follow these steps to start the TEG using the Ignition Control System:

1. Supply fuel and open the manual shutoff valve. The spark ignitor should begin clicking (sparking) and the sound of combustion will begin. In some cases, it may be necessary to bleed air from the system. If combustion is not sustained after three trials, see section 4.1.2 (Spark Ignition (SI) Control System) of this manual.

**NOTE:** Once the TEG is started, closing the manual shutoff valve will shut it off.

**WARNING!** When the TEG is operating, surface temperatures near the thermopile, burner, exhaust stack and around the cooling fin duct may be more than 100ºC. Avoid contact of skin and clothing with these areas when operating in and around the TEG.

## 6.3 SHUTDOWN

Thermoelectric generators are intended for continuous operation where reliable power is required without interruption. To shut the TEG down for servicing or in an emergency, simply cut off fuel to the TEG. This is easily accomplished by closing the manual shutoff valve provided for installation with the unit.

# 7 POWER OUTPUT EVALUATION

Output power is the primary indication of correct setup, adjustment, and operation of the TEG. This section describes how to determine if the TEG is providing rated power. Power output should be evaluated:

- during initial setup at site;
- when adjusting a TEG;
- before and after servicing a TEG, and
- whenever fuel composition or type has changed.

| | |
|---|---|
| **NOTE:** | Typical fuel pressure settings for the model 5220 are 130-144 kPa (18.5 – 21 PSI) for natural gas and 125-140 kPa (18.0 - 20.0 PSI) for propane. Consult the TEG data plate for the starting fuel pressure on your unit. |

| | |
|---|---|
| **NOTE:** | Good record keeping is necessary for long term follow-up. Use the TEG Performance Log - located at the end of this manual - for recording details each time adjustments are made, or servicing is carried out. |

## 7.1 AMBIENT TEMPERATURE EFFECTS ON $V_{set}$ AND RATED POWER

Power from the 5220 TEG is produced by the difference in temperature between the burner and the cooling fins. This means the power output of the TEG is affected by the ambient temperature surrounding the generator. Power output increases when temperature falls and decreases when temperature climbs.

Power drops by 0.8W for every 1°C increase in ambient temperature. Similarly, power increases by 0.8W for every 1°C decrease in ambient temperature. This effect needs to be considering when setting-up the TEG. Use Figure 19 to graphically determine the target power for a given ambient temperature.

### 7.1.1 Determining $V_{set}$ and Rated Power

$V_{set}$, proportional to rated power, must be adjusted for actual ambient temperature at site as described below. Use Figure 19, or use the following equations to determine the appropriate $V_{set}$ and expected rated power at various ambient temperatures.

Factory test data for rated power and voltage are marked on the Data Plate that is located inside the TEG cabinet door. These values are for a specific ambient temperature that is also indicated on the Data Plate. They require correction for ambient temperatures different from those indicated. The following equations apply:

**Equation 1** → $V_{set} = V_{set\ ref} + [(T_{ref} - T) \times 0.026]$

Where: T = Ambient temperature, at site (ºC)
$T_{ref}$ = Reference ambient temperature, marked on Data Plate (ºC)
$V_{set\ ref}$ = Reference set-up voltage, marked on Data Plate (V)
$V_{set}$ = Set-up voltage, at site (V)

**Equation 2** → $P_{set} = P_{set\ ref} + [(T_{ref} - T) \times 0.8]$

Where: T = Ambient temperature, at site (ºC)
$T_{ref}$ = Reference ambient temperature, marked on Data Plate (ºC)
$P_{set\ ref}$ = Reference power marked on TEG Data Plate (W)
$P_{set}$ = Rated power at new ambient (W)

| | |
|---|---|
| **NOTE:** | Avoid setting-up the TEG to run at higher $V_{set}$ or rated power values, as its life may be affected. This method is suitable for ambient temperatures of up to 65.5ºC (150ºF). If in doubt contact Global Power Technologies' (GPT) Customer Service Department for guidance. |

Example: Ambient temperature at site is 35ºC. Set-up power of 210 W and $V_{set}$ of 14.3 V, 22ºC is marked on the TEG Data Plate.

$$V_{set} = V_{set\ ref} + [(T_{ref} - T) \times 0.026]$$
$$= 14.9 + [(22 - \{35\}) \times 0.026]$$
$$= 14.9 + [(22 - 35) \times 0.026]$$
$$= 14.9 + [-13 \times 0.026]$$
$$= 14.9 + [-0.3338]$$
$$= 14.9 - 0.338$$
$$= 14.56\ V$$

$$P_{set} = P_{set\ ref} + [(T_{ref} - T) \times 0.8]$$
$$= 210 + [(22 - \{35\}) \times 0.8]$$
$$= 210 + [(22 - 35) \times 0.8]$$
$$= 210 + [-13 \times 0.8]$$
$$= 210 + [-10.4]$$
$$= 210 - 10.4$$
$$= 199.6\ W$$

## 7.2 DETERMINING $V_{set}$ AND RATED POWER GRAPHICALLY

A good approximation to $V_{set}$ and rated power can be obtained from the chart shown in Figure 19. Knowing the ambient temperature, move up vertically to the line. Read the $V_{set}$ from the right side of the graph and rated power from the left side.

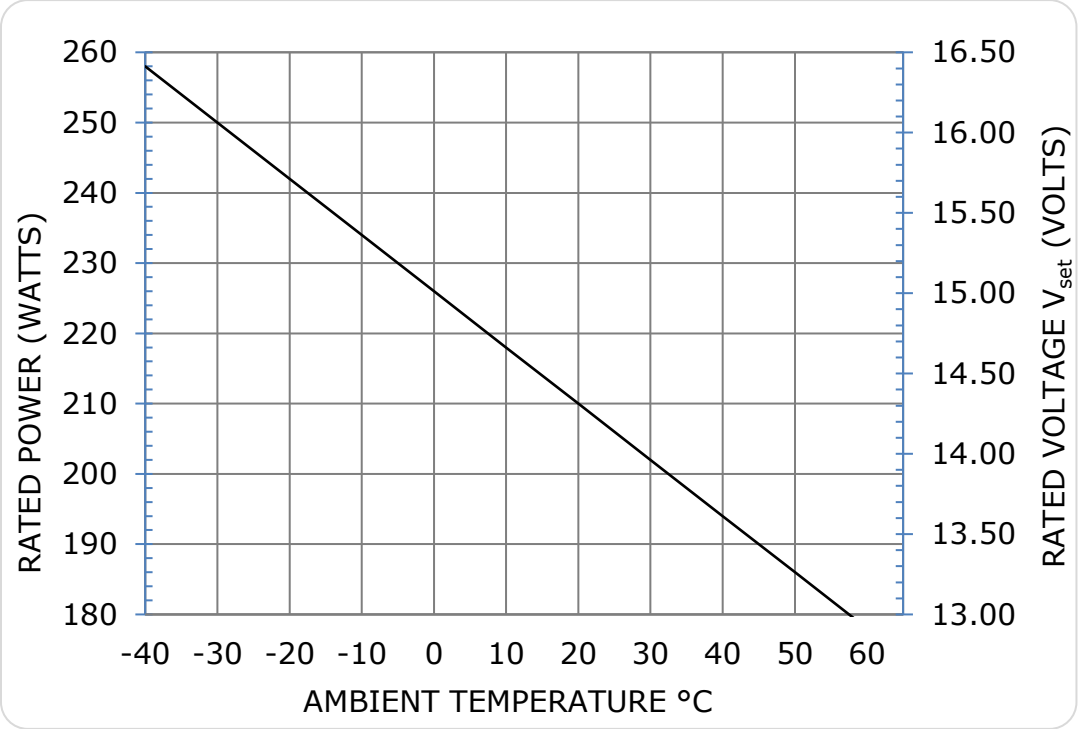



*Figure 19 – $V_{set}$ and Gross Power vs Ambient Temperature (Beginning of Service Life)*

## 7.3 $V_{set}$ AND RATED POWER

To determine the electrical power that the generator is producing, a precision resistor is provided within the generator. This resistor is called the $V_{set}$ resistor, or precision load. By connecting the generator to this resistor and measuring the voltage across it, the power produced by the generator can be calculated as follows:

**Equation 3 →**

$$P = V_{set}^2$$

*Where:* *P = Power (Watts)*
*$V_{set}$ = Setup Voltage (Volts)*

Power output is calculated from $V_{set}$ by squaring the measured voltage. Similarly, setup voltage can be calculated by taking the square root of the target power.

$V_{set}$ voltage is measured across terminals 2 and 4 on TB1, with the TEG in SETUP configuration (jumper clip in the setup position across terminals 2 and 3 on TB1, as shown in Figure 14 and Figure 15) .

### 7.3.1 $V_{set}$ Shortly after Ignition

Immediately after ignition, the power unit warms, and the resulting temperature rise produces power. Follow these steps to check $V_{set}$ after ignition:

1. Consult the Data Plate inside TEG door for the reference $V_{set}$ voltage and determine the required $V_{set}$ for the present ambient temperature.
2. Move the jumper clip on the terminal block TB1 to the SETUP position, i.e. between terminals 2 and 3. See Figure 14 or Figure 15.
3. Connect a voltmeter between terminals 2 (+) and 4 (-). This is the measured $V_{set}$ and should tend towards the required $V_{set}$ (determined in step 1). It will climb as shown in Figure 20.

**CAUTION!** Do not allow the measured $V_{set}$ to exceed the required $V_{set}$. Overheating will result and may cause irreparable damage to the power unit.

4. The measured $V_{set}$ will rise quickly at first, and then begin to level out. It will take at least 60-90 minutes for $V_{set}$ to stabilize. When the measured $V_{set}$ no longer changes (±0.2 V in ten minutes) compare this value with required $V_{set}$. The measured $V_{set}$ should be within 0.2 V of the required $V_{set}$.

**NOTE:** If the measured $V_{set}$ is greater than required $V_{set}$, the fuel pressure must be reduced. See the Adjustment section of this manual.

**CAUTION!** While the TEG is running, and for several minutes after it has shut down, Terminal 2 on TB1 will be live. Use caution when moving the jumper clip to configure the TEG for either SETUP or RUN. Always isolate the TEG from the load, station batteries, or other voltage sources in the system before working inside the electrical enclosure.

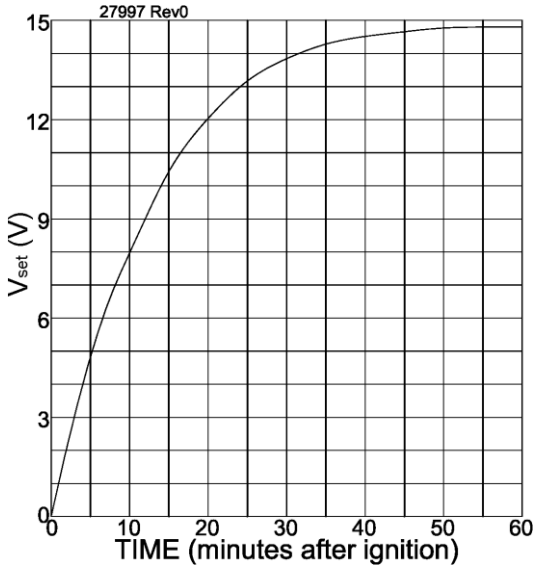



*Figure 20 – $V_{set}$ vs Time After Ignition, Example*

### 7.3.2 $V_{set}$ After TEG has Stabilized

Once the TEG has been running for 60-90 minutes, the power unit will be up to operating temperature. Follow these steps to check $V_{set}$:

1. Consult the Data Plate inside TEG door for the reference $V_{set}$ voltage and determine the required $V_{set}$ for the present ambient temperature.
2. Move the jumper clip on the terminal block TB1 to the SETUP position, i.e. between terminals 2 and 3. This connects the TEG to an internal load required for $V_{set}$. See Figure 14 or Figure 15.
3. Connect a voltmeter between terminals 2 (+) and 4 (-). The measured $V_{set}$ should match the required $V_{set}$ for the present temperature.

**CAUTION!** Do not allow the measured $V_{set}$ to exceed the required $V_{set}$. Overheating will result and may cause irreparable damage to the power unit.

4. Wait approximately 10-45 minutes, and when the measured voltage is stable, compare it to required $V_{set}$. Measured $V_{set}$ should be within 0.2 V of the required $V_{set}$.

**NOTE:** Waiting is necessary to allow the TEG voltage to stabilize to the new load conditions. (Changing from customer load to the on-board 1-ohm resistor).

# 8 ADJUSTMENT

This section describes how to adjust the Model 5220 Thermoelectric generator.

| | |
|---|---|
| **NOTE:** | Typical fuel pressure settings are 130 - 144 kPa (18.5 - 21 PSI) for natural gas and 125 - 140 kPa (18 - 20 PSI) for propane. |

| | |
|---|---|
| **NOTE:** | Good record keeping is necessary for long term follow-up. Use the TEG Performance Log, located at the end of this manual, for recording details each time adjustments are made, or service is carried out. |

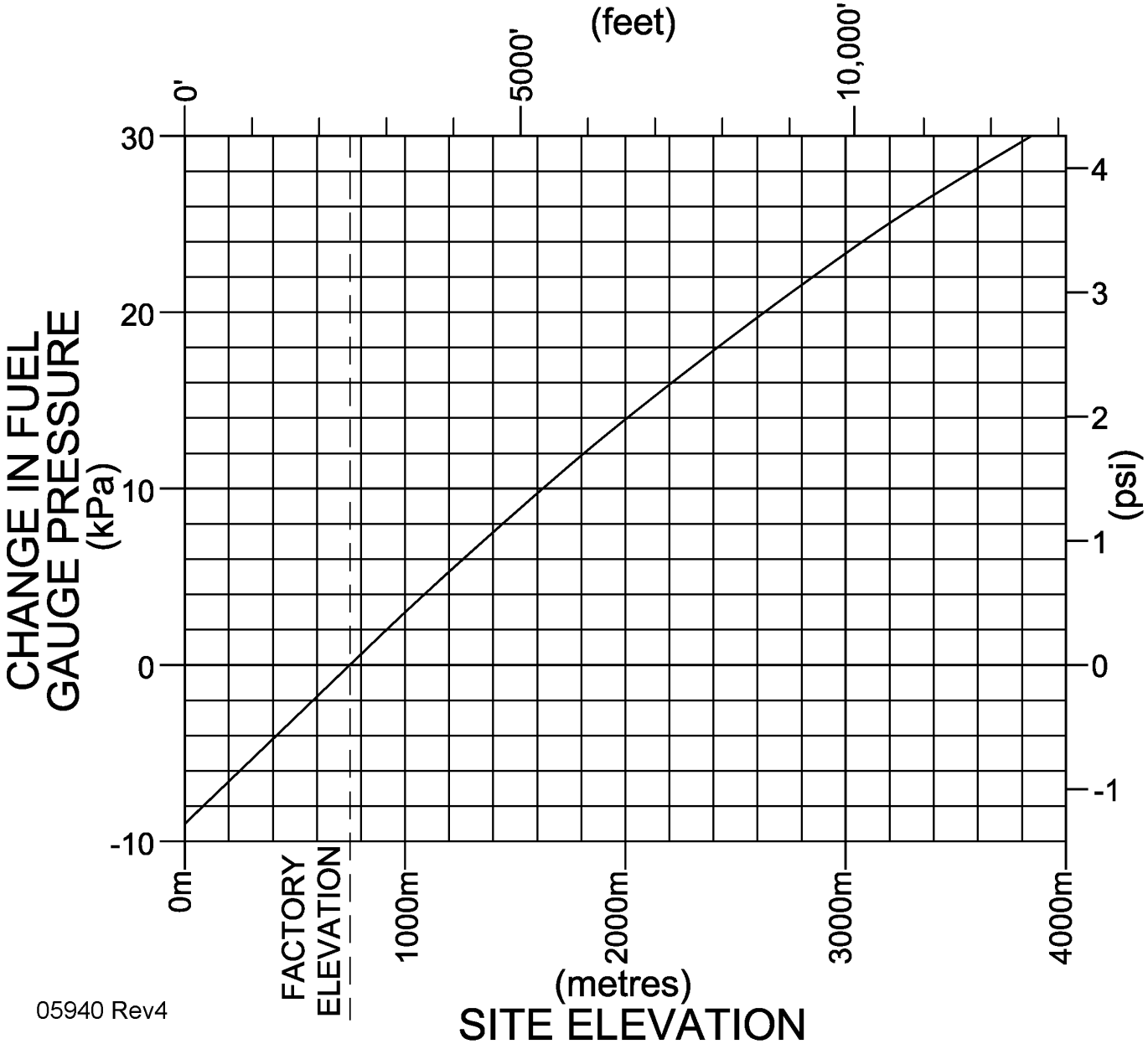



*Figure 21 – Change in Fuel Gauge Pressure vs Elevation Above Sea Level*

## 8.1 TUNING THE TEG

TEG power output is determined by the flow of air and fuel into the burner. Follow these procedures – in the order given – to adjust the TEG's power output.

GPT recommends the use of a combustion analyzer to tune the 5220 TEG. Tuning this way will result in a TEG that will run properly, cleanly, and reliably. See section 8.1.2.2 of this manual for tuning instructions using a combustion analyzer.

### 8.1.1 Fuel Pressure Adjustment

Confirm the fuel gauge pressure is near to the pressure indicated on the Data Plate located on the inside of the cabinet doors. This pressure is determined during the generator's final test at the factory.

Keep in mind that if the TEG is located at a different altitude than the factory - 792 m (2,600 ft) - the fuel pressure may need to be compensated to achieve the correct power output. Use Figure 21 to determine how much to compensate the fuel pressure setting.

Example: If the site elevation is 1,000m (3,281ft), consulting the altitude graph shows that 2.5 kPa (0.36 PSI) should be added to the pressure on the Data Plate.

**NOTE:** Typical fuel pressure settings are 130-144 kPa (18.5 - 21 PSI) for natural gas and 125 - 140 kPa (18.0 - 20.0 PSI) for propane. Refer to the TEG data plate for the starting fuel pressure.

While altitude will influence pressure readings, $V_{set}$ is the most important factor to consider when tuning a TEG. The TEG should be started at the factory-set pressure (stamped on the Data Plate) and adjusted once $V_{set}$ has stabilized.

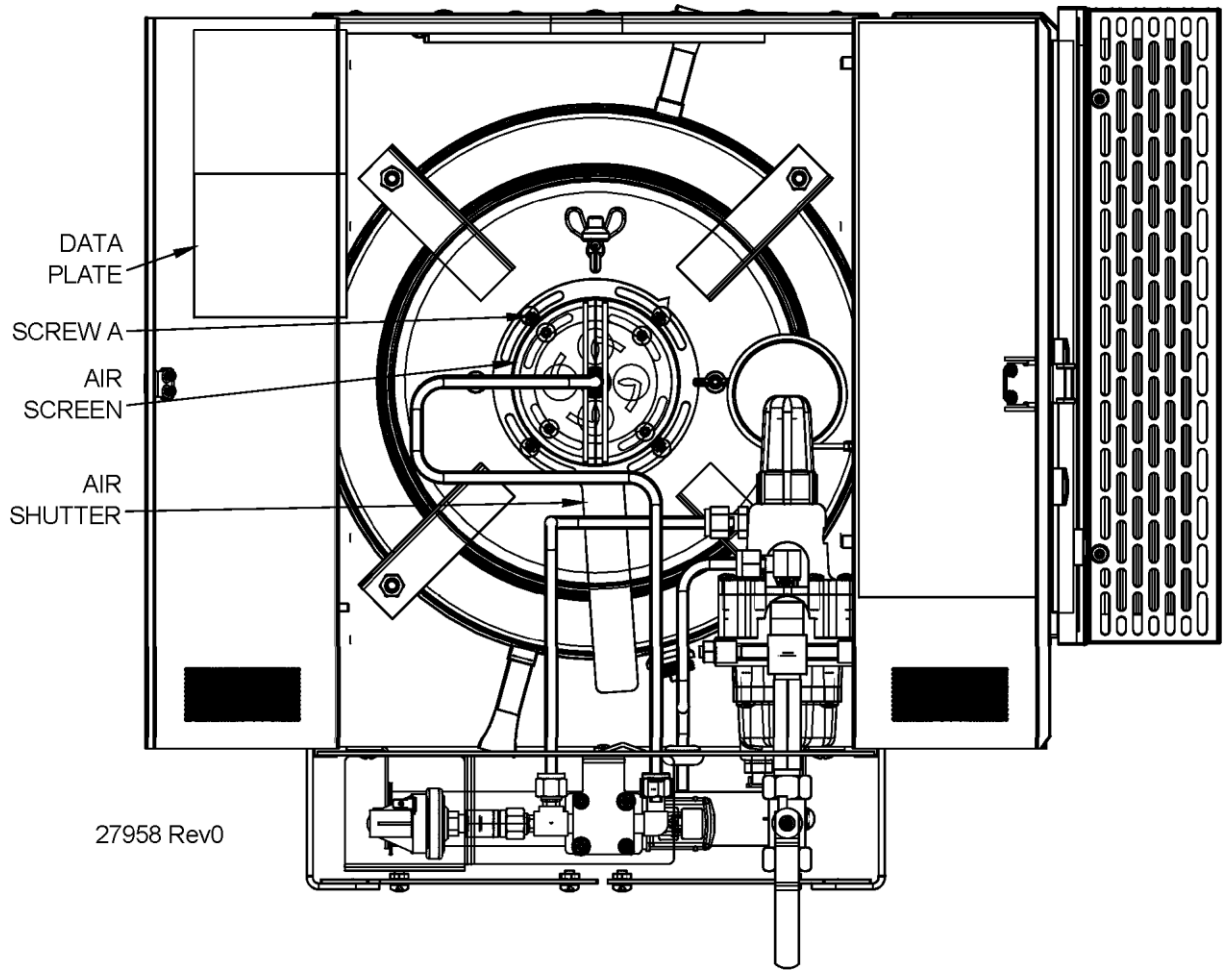



*Figure 22 – Air Shutter Diagram*

Follow these steps to adjust fuel pressure:

1. Isolate the TEG from the station battery, load, and other voltage sources by opening the circuit breaker or fuse connecting the customer load to the TEG.
2. Check that the jumper clip on terminal block TB1 is in the SETUP position (between terminals 2 and 3). Move the jumper clip if necessary.
3. Measure the voltage across terminals 2 (+) and 4 (-) with a multimeter. This voltage is $V_{set}$. If $V_{set}$ is below the required value for the present ambient temperature, the TEG is under-fired and requires more fuel. If $V_{set}$ is above the required value for the present ambient temperature, the TEG is over-fired and requires less fuel.
4. Remove the cover on the regulator and loosen the lock nut.
5. Turn the adjusting screw to increase (clockwise) or decrease (counterclockwise) fuel pressure.
6. Wait 20-30 minutes for the TEG to stabilize, then check $V_{set}$ again. If $V_{set}$ is within 0.2V of the required value, no further adjustment is required. If $V_{set}$ is further than ±0.2V from the required value, repeat steps 5 and 6 until the required voltage is attained.
7. Tighten the lock nut (1/2” Hex) and replace the cover on the fuel regulator.

| | |
|---|---|
| **NOTE:** | Consult the Data Plate Label (located on the inside of the cabinet door) for Reference Factory Fuel Pressure. See Figure 22 for Data Plate location. |

**WARNING!**

Do not exceed the fuel pressure listed on the TEG data plate without factory approval. If fuel pressure exceeds reasonable levels, the power unit may be seriously and permanently damaged.

The thermopile in a TEG is very sensitive to temperature. There is a very serious risk of permanent damage to the power unit and a drastic reduction in the TEG’s longevity if normal fuel pressures are exceeded. **When setting up a TEG, take extreme care not to turn the fuel pressure up too high. If you are unsure of the fuel pressure you should be using, contact GPT for assistance.**

It is also important to note that if your gas composition is different from the fuel specification at the beginning of this manual, fuel pressure must be adjusted accordingly.

| | |
|---|---|
| **NOTE:** | The TEG will require some time to stabilize after either air or fuel adjustments are made. Wait 20-30 minutes between readings while adjusting fuel pressure. |

### 8.1.2 Air-shutter Adjustment

At this point, adjusting the air shutter for optimum combustion may be necessary (see Figure 22). The generator should be stable, with the $V_{set}$ voltage constant.

**WARNING!** Air shutter components are very hot and will burn exposed skin. Make all air shutter adjustments using tools or wearing gloves only - not with bare hands.

There are two methods by which the air shutter can be adjusted: one using a combustion analyzer, and one using a meter.

**WARNING!** If the air shutter on the 5220 is closed too far, the flame will move up to the exhaust. A flame in the exhaust is visible in the gap between the exhaust stack and the burner. A flame in the exhaust stack is unsafe for several reasons and results in unstable combustion and low power output. Avoid closing the air shutter too far to prevent a flame in the exhaust.

#### 8.1.2.1 Air Shutter Adjustment Using a Meter

If a combustion analyzer is unavailable, the air shutter can be set using a voltmeter reading to an accuracy of ±0.1V.

To adjust the air shutter using a meter:

1. Disconnect the customer load by opening the customer-installed circuit breaker or fuse, isolating the TEG from any batteries, loads, or other voltage sources.
2. Check that the jumper clip on terminal block TB1 is in the SETUP position (between terminals 2 and 3). Move the jumper clip if necessary. Measure the original $V_{set}$.
3. Mark the original position of the air shutter with a felt pen against the burner cover.
4. Loosen the four screws mounting the air screen against the air shutter, leaving the air shutter still in place.
5. Open the air shutter slightly by rotating the shutter to enlarge the opening. Adjust the shutter only a small amount at a time. There will be a slight resistance to air shutter movement as the air shutter is still being held against the venturi by four screws.
6. Wait 15-20 minutes for the TEG to stabilize, then measure $V_{set}$ again.

**If $V_{set}$ is greater than the original value (±0.2V),** repeat steps 3 and 4. Continue to open the shutter until $V_{set}$ decreases, then rotate the shutter to the position that gave the highest $V_{set,}$ and tighten screws A and B.

**If $V_{set}$ is less than the original value (±0.2V),** return the air shutter to the original position and then close slightly. Let the unit stabilize for 15-20 minutes and then measure $V_{set}$. Repeat until $V_{set}$ decreases, then return to the position that gave the highest $V_{set}$, and tighten the 4 screws securing the air shutter & air screen and measure CO.

| | |
|---|---|
| **NOTE:** | The TEG will require some time to stabilize after either air or fuel adjustments are made. Wait 15-20 minutes between readings while adjusting the air shutter. |

7. Tighten screws and verify $V_{set}$ before closing the cabinet.

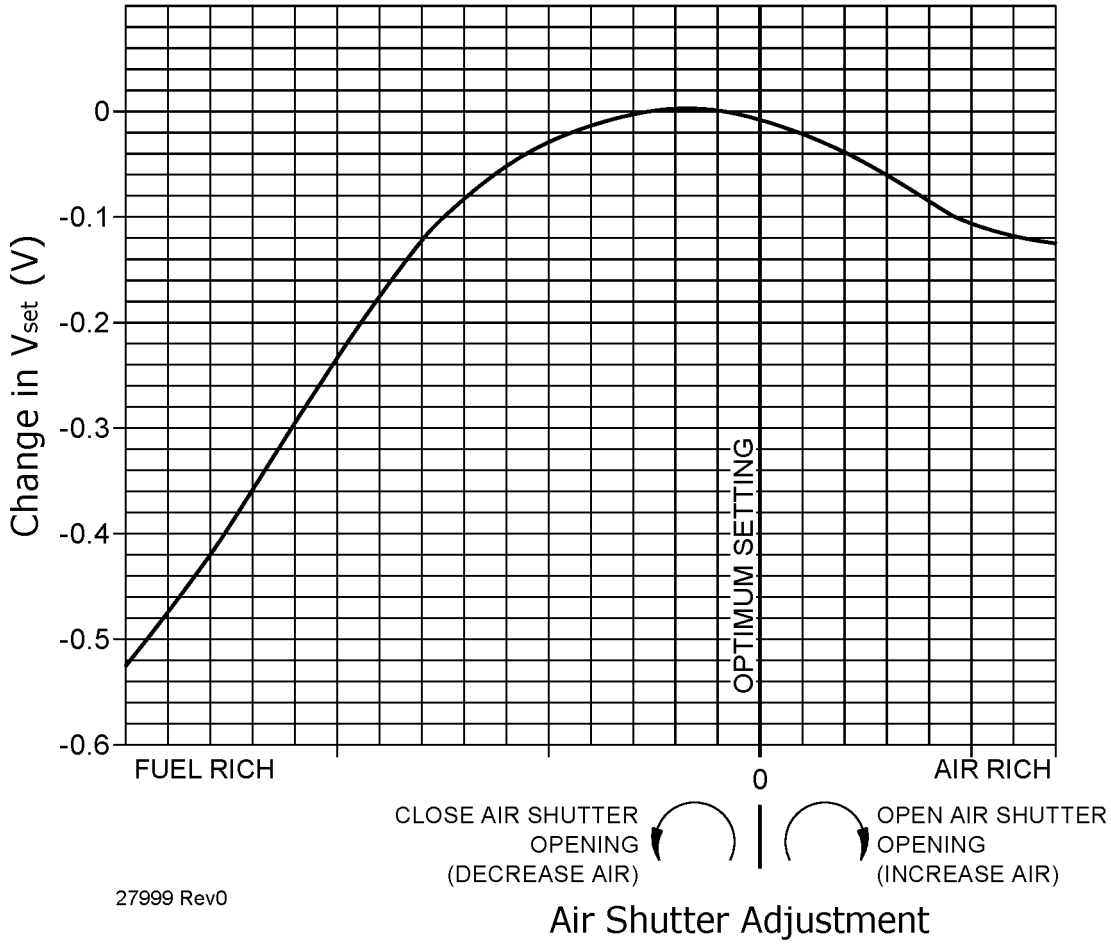



*Figure 23 – Change in $V_{set}$ vs Air-Shutter Adjustment, Typical*

### 8.1.2.2 Air Shutter Adjustment Using a Combustion Analyzer

GPT recommends the use of a combustion analyzer to tune the 5220 TEG. The air shutter can be set more quickly and accurately using a combustion analyzer. A voltmeter as described in the previous section is still necessary to verify power output. The combustion analyzer should be able to measure $O_2$ and CO.

| | |
|---|---|
| **WARNING!** | The TEG exhaust can reach temperatures of over 800°C. Do not touch any of the exhaust components or bring exposed skin near hot exhaust gases. Do not leave the combustion analyzer probe in the TEG exhaust – it may be damaged by extreme heat. |

| | |
|---|---|
| **WARNING!** | Exhaust gases are toxic and should not be inhaled. The 5220 TEG is strictly an outdoor device and should never be used indoors. Avoid inhaling exhaust gases while working around or above the TEG. |

If the 5220 TEG is adjusted correctly, it will not emit excessive CO. When properly tuned, the 5220 should emit exhaust with a CO concentration of less than 800ppm (air-free).

To tune the 5220 using a combustion analyzer, follow these steps:

1. Disconnect the customer load by opening the customer-installed circuit breaker or fuse, isolating the TEG from any batteries, loads, or other voltage sources.
2. Check that the jumper clip on terminal block TB1 is in the SETUP position (between terminals 2 and 3). Move the jumper clip if necessary.
3. Mark the original position of the air shutter with a felt pen against the burner cover.
4. Loosen the four screws mounting the air screen against the air shutter, leaving the air shutter and screen still in place.
5. Determine the required $V_{set}$ for the current ambient temperature, referring to Section 7.1 of this manual.
6. Measure $V_{set}$ across terminals 2 and 4 on TB1 inside the electrical enclosure.
7. Take an exhaust reading with the combustion analyzer. Remove the analyzer probe after taking the reading to avoid heat damage to the probe.
8. Use the following table in Figure 24 to determine the appropriate changes. Repeat steps 5 and 6 as necessary until the TEG is tuned.

| Measured $V_{SET}$ | Measured CO | State | Adjustment Required |
|---|---|---|---|
| > $V_{SET\ REF}$ | < 800ppm | TEG is over-fired | Air shutter unchanged. Turn fuel pressure down to decrease $V_{SET}$. Wait 15-20 minutes, then re-evaluate. |
| | > 800ppm | Not enough air | Open air shutter until CO falls below 800ppm. Leave fuel pressure unchanged. Wait 15-20 Minutes, then re-evaluate. |
| < $V_{SET\ REF}$ | < 800ppm | TEG is under-fired | Turn fuel pressure up to increase $V_{SET}$. Air shutter unchanged. Wait 15-20 minutes, then re-evaluate. |
| | > 800ppm | Not enough air | Open air shutter until CO falls below 800ppm. Leave fuel pressure unchanged. Wait 15-20 Minutes, then re-evaluate. |
| = $V_{SET\ REF}$ ± 0.2V | < 800ppm | TEG is properly tuned. | Tighten regulator adjustment screw locknut, replace cap. Tighten air shutter screws. Record final readings, return TEG to RUN mode, reconnect the load, and close the cabinet. |
| | > 800ppm | Not enough air, TEG is under-fired | Open air shutter and increase fuel pressure slightly. Wait 15-20 Minutes, then re-evaluate |

*Figure 24 – TEG Tuning Guide*

**Example:**

The TEG has been running for more than 90 minutes and is connected in SETUP mode. The breaker connecting the TEG to the load and station battery is switched off. The TEG is running on natural gas at 140 kPa. Ambient temperature is 10°C, so target power is 218W. This corresponds to a target $V_{SET}$ of 14.8V. A combustion analyzer is used to read CO levels of 7900ppm, and the measured $V_{SET}$ from the TEG is 15.3V. There is no flame in the exhaust.

Since the measured $V_{SET}$ of 15.3V is greater than our target of 14.8V, and the CO is higher than 800ppm, we know from the table above that the TEG is not getting enough air. The correct response is to open the air shutter in small increments until we see the CO drop below 800ppm. $V_{SET}$ will also drop, and we can re-evaluate both the voltage and emissions after waiting 15-20 minutes for readings to settle.

Suppose after waiting 20 minutes, we return and read $V_{SET}$ at 14.7V, with CO at 520ppm. Since our measured $V_{SET}$ is within 0.2V of our required 14.8V, and our CO is under 800ppm, the TEG is properly tuned and making rated power for the ambient temperature. We can tighten the regulator adjustment locknut, replace the regulator cap, tighten the air shutter screws, record our final readings, return the TEG to RUN mode, reconnect the load and station battery, close the cabinet, and perform final checks before leaving the site.

### 8.1.3 Measuring CO Emissions Levels

The model 5220 will not produce excessive amounts of CO if properly adjusted. Due to the open exhaust system of TEG, the CO measurement must be in the free air state. In a free air measurement, the allowable CO emission rate is 800 ppm. To be able to determine the levels of air-free CO ppm, a combustion analyzer capable of measuring CO ppm and either $CO_2$ percentage, or $O_2$ percentage, is needed.

The equations used to calculate the air-free stage of CO are:

- For Natural Gas when using as measured $CO_2$ percentage, and $CO_{ppm}$:

**Equation 4 →** $$CO_{AFppm} = \left(\frac{11.8}{CO_2}\right) x\ CO_{ppm}$$

- For Propane when using as measured $CO_2$ *percentage, and* $CO_{ppm}$*:*

**Equation 5 →** $$CO_{AFppm} = \left(\frac{13.8}{CO_2}\right) x\ CO_{ppm}$$

- When using as measured $O_2$ *percentage, and* $CO_{ppm}$*:*

**Equation 6 →** $$CO_{AFppm} = \left(\frac{20.9}{20.9 - O_2}\right) x\ CO_{ppm}$$

Where: $CO_{AFppm}$ = Carbon monoxide, air-free ppm
$CO_{ppm}$ = As-measured combustion gas carbon monoxide ppm
$O_2$ = Percentage of oxygen in combustion gas, as a percentage
$CO_2$ = Percentage of carbon dioxide in combustion gas, as a percentage

The model 5220 does not produce excessive concentrations of CO if adjusted properly.

### 8.1.4 Fuel Pressure Adjustment

Once the air is adjusted, and if the fuel system and burner appear to be operating correctly, the fuel pressure may be slightly adjusted to match the measured $V_{set}$ voltage with the required $V_{set}$ value. Use Figure 25 to determine how much to adjust the fuel pressure.

Example: Required $V_{set}$ = 14.1 V
Measured $V_{set}$ = 13.5 V
Difference = +0.6 V

Based on Figure 25, the fuel pressure must then be increased by 3.6 kPa (0.52 PSI).

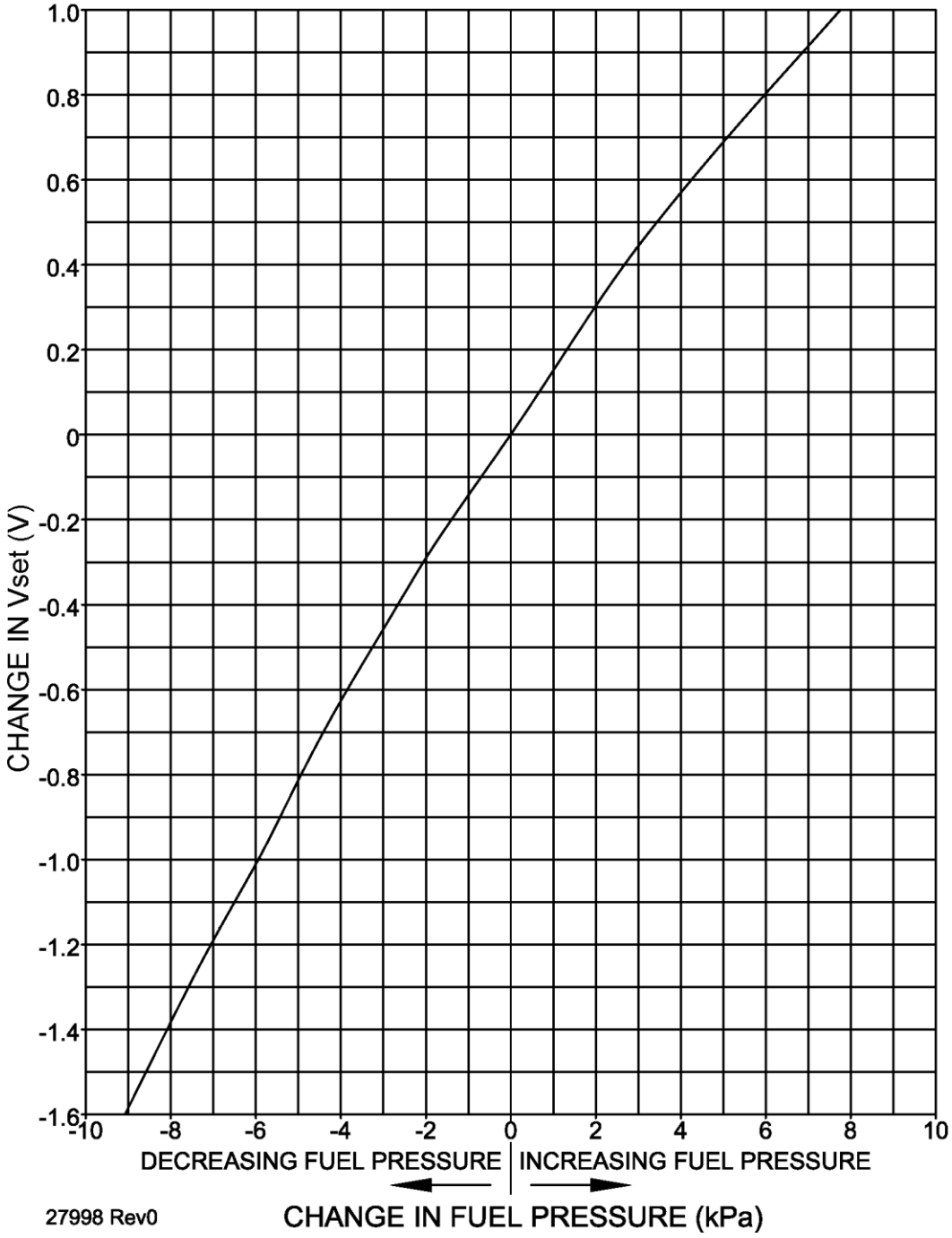



*Figure 25 – Change in $V_{set}$ vs Fuel Pressure Adjustment, Typical*

Follow these steps to adjust fuel pressure:

1. Remove the cover on the regulator and loosen the lock nut.
2. Turn the adjusting screw (clockwise to increase pressure) until the required change in pressure is obtained.

| | |
|---|---|
| **NOTE:** | Consult the Data Plate label located on the inner door for the reference Factory Fuel Pressure. |

3. Wait ten minutes then measure and record $V_{set}$. If the TEG cannot be adjusted to match the required $V_{set}$ value, then a problem exists with one of the TEG's systems. If necessary, see the Troubleshooting section for guidance.
4. Tighten the lock nut and replace the cover on the fuel regulator.

## 8.2 ADJUSTMENT OF L/C ASSEMBLY

An L/C is available for use with the model 5220 TEG, and it comes installed by default on all 24V 5220 TEGs. This text describes how to adjust the L/C parameters, if applicable.

### 8.2.1 Output Voltage Adjustment

The L/C is factory set at 27.0 V (Model 5220-24V). If the output voltage requires fine tuning to better match your application, follow the below steps:

1. Isolate the TEG from the load and batteries by opening the fuse or circuit breaker through which it is connected.
2. Move the jumper clip on the terminal block TB1 to the RUN position, i.e. between terminals 1 and 2.
3. Connect a voltmeter between terminals 6 (-) and 7 (+) of TB1 and measure the output voltage.
4. Adjust the output voltage by turning the output voltage adjustment potentiometer, shown in Figure 7, until the desired voltage is reached.
5. Re-connect the TEG to the load and batteries by closing the fuse or circuit breaker through which it is connected.

### 8.2.2 Voltage Sensing Relay (VSR) Adjustment

The VSR provides a set of contacts to indicate an alarm condition when the output voltage drops below a pre-set minimum. It is factory set at 23.0 V (Model 5220-24V). The VSR is rated for 2 A at 30 V DC and will take up to wire size no. 16 AWG.

| | |
|---|---|
| **NOTE:** | Because the sensing point for the relay trip is ahead of a blocking diode, set the no-load trip-point 0.5 V higher than the required trip-point. For example, consider an alarm is required when the output voltage drops to 23.0 V at the customer load terminals. When making the trip-point adjustment at no-load conditions, set it to trip at 23.5 V as measured at the customer load terminals. This way the VSR will trip when the customer load voltage approaches 23.0V. |

Follow these steps to adjust the VSR set point:

1. Isolate the TEG from the load and batteries by opening the fuse or circuit breaker through which it is connected.
2. Connect a voltmeter between terminals 6 (-) and 7 (+) of TB1 and measure the output voltage.
3. Set the output voltage to the desired VSR trip-point voltage value using the **output voltage potentiometer** shown in Figure 7.
4. Place an ohmmeter between the common and normally open contact of the VSR.
5. Turn the **VSR adjustment pot** shown in Figure 7 until the contacts open (the normally open contacts are closed when output voltage is above VSR trip-point).
6. Using the **output voltage potentiometer**, raise output voltage to a value where the VSR will reset.
7. To re-check the trip-point, lower the output voltage and monitor opening of the VSR contacts. Fine tune as required to achieve desire trip value.
8. Reset output voltage to the desired normal operating value. Consult the Data Plate label for the factory default voltage setpoint or adjust to your desired value.

## 8.3 ADJUSTMENT OF LIMITER ASSEMBLY

A Limiter-only Assembly is available for use with the model 5220 TEG, and it comes installed by default on all 12V 5220 TEGs. This text describes how to adjust the Limiter parameters, if applicable.

### 8.3.1 Output Voltage Adjustment

The Limiter is factory set at 14.1 V (Model 5220-12V). If the output voltage requires fine tuning to better match your application, follow the below steps:

1. Disconnect the customer load from the TEG, terminals 4 (-) and 5 (+) of TB1.
2. Move the jumper clip on the terminal block TB1 to the RUN position, i.e. between terminals 1 and 2.
3. Connect a voltmeter between terminals 4 (-) and 5 (+) of TB1 and measure the output voltage.
4. Adjust the output voltage by turning the output voltage adjustment potentiometer, shown in Figure 6, until the measured voltage is at a desirable level.

### 8.3.2 Voltage Sensing Relay (VSR) Adjustment

The VSR provides a set of contacts to indicate an alarm condition when the output voltage drops below a pre-set minimum. It is factory set at 11.5 V (Model 5220-12V). The VSR is rated for 2 A at 30 V DC and will take up to wire size no. 16 AWG.

| | |
|---|---|
| **NOTE:** | Because the sensing point for the relay trip is ahead of a blocking diode, set the no-load trip-point 0.5 V higher than the required trip-point. For example, consider an alarm is required when the output voltage drops to 11.5 V at the customer load terminals. When making the trip-point adjustment at no-load conditions, set it to trip at 12.0 V as measured at the customer load terminals. This way the VSR will trip when the customer load voltage approaches 11.5V. |

Follow these steps to adjust the VSR set point:

1. Isolate the TEG from the load and batteries by opening the fuse or circuit breaker through which it is connected.
2. Connect a voltmeter between terminals 4 (-) and 6 (+) of TB1 and measure the output voltage.
3. Set the output voltage to the desired VSR trip-point voltage value using the **output voltage potentiometer** shown in Figure 6.
4. Place an ohmmeter between the common and normally open contact of the VSR.
5. Turn the **VSR adjustment pot** shown in Figure 6 until the contacts open (the normally open contacts are closed when output voltage is above VSR trip-point).
6. Using the **output voltage potentiometer**, raise output voltage to a value where the VSR will reset.
7. To re-check the trip-point, lower output voltage and monitor opening of the VSR contacts. Fine tune as required to achieve desire trip value.
8. Reset output voltage to the desired normal operating value. Consult the Data Plate label for the factory default voltage setpoint or adjust to your desired value.

## 8.4 ADJUSTMENT OF OPTIONAL CP INTERFACE SYSTEM

An optional CP interface system is available for use with the model 5220 TEG. This section describes how to adjust the CP interface system, if applicable.

### 8.4.1 CP Power Output Adjustment

The 0-1Ω 300 W variable resistor, located inside the CP cabinet, may be used to adjust the output power from the CP interface. This resistor may be connected in series or parallel with the customer load.

Adjusting the variable resistor can be done simply while the system is running, by loosening the slide ring on the resistor and moving it up or down on the resistor. Check the power changes by using the meters provided in the enclosure or using a hand-held multi-meter to see the change in power when adjusting the variable resistor. Once the resistor has been adjusted to give the desired power output, re-tighten all loosened electrical connections. Lastly, recheck that the desired power output has not changed during tightening.

| | |
|---|---|
| **NOTE:** | TEG fuel pressure may be adjusted to fine tune the CP output. Fuel pressure within 10% of that marked on the Data Plate is recommended to prevent flame out. |

#### 8.4.1.1 Series Wiring

Series connection is achieved by connecting the 300 W resistor in series with the customer load as shown with the dark line. The maximum allowable power may be delivered to the CP load by moving the tap to the bottom of the resistor. To reduce power to the CP load, slide the tap upward.

### 8.4.1.2 Parallel Wiring

Parallel connection is achieved by connecting the 300 W resistor in parallel with the customer load as shown with the dark line. In this configuration, less power may be delivered to the CP load. This may be required when hot spots occur on the anode of the CP circuit. With the tap located at the top of the resistor, the output power will be zero. As the tap is moved down, the power to the CP load is increased.

Switch from a series to parallel configuration by moving the wire running from the top of the 300 W resistor from the center terminal of the heavy-duty terminal block to the left terminal.

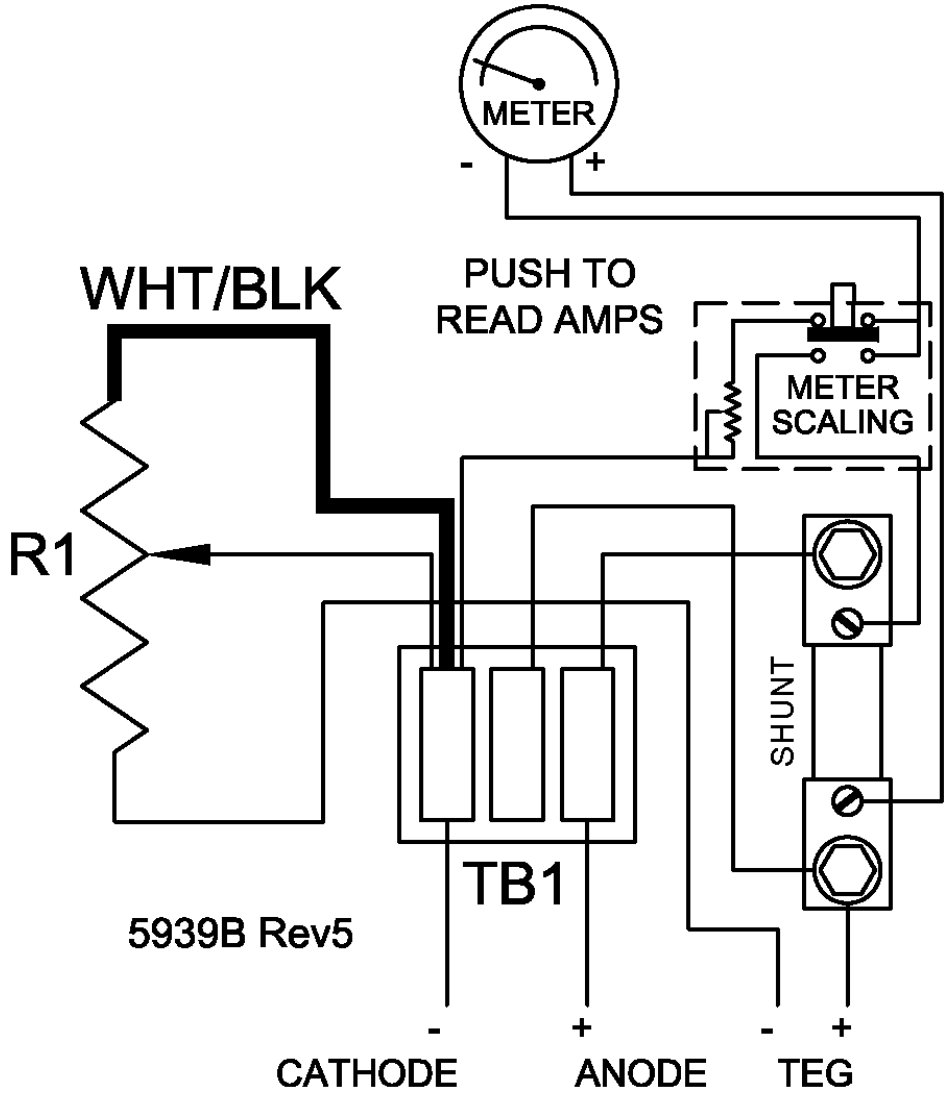



*Figure 26 – CP Interface System, Series Wiring Diagram*

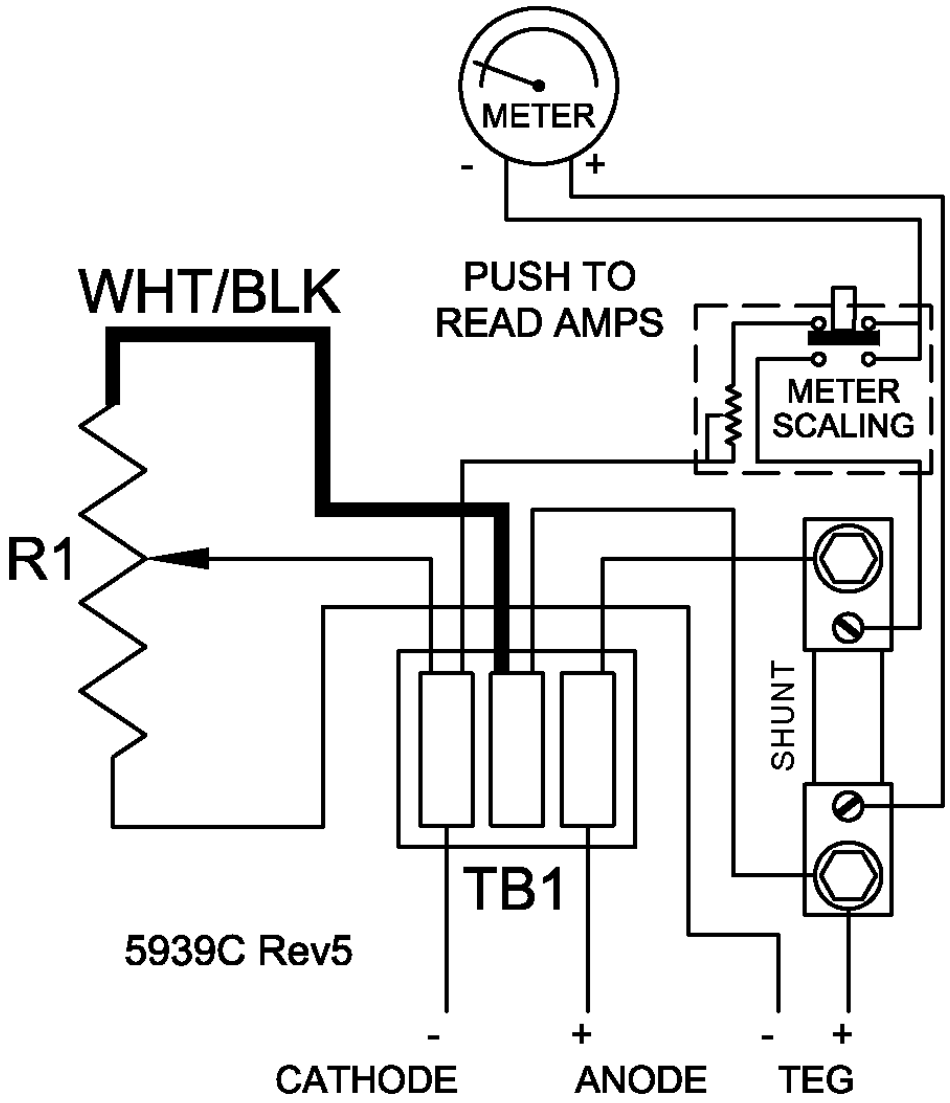



*Figure 27 – CP Interface System, Parallel Wiring Diagram*

# 9 MAINTENANCE

This section describes how to properly maintain the Model 5220 TEG. Before working on the TEG, the qualified service person should be thoroughly familiar with its:

- technical specifications;
- process description;
- installation;
- startup and shutdown;
- power output evaluation, and
- adjustment/tuning

| | |
|---|---|
| **NOTE:** | Good record-keeping is necessary for TEG maintenance and can aid in troubleshooting. Use the TEG Performance Log, located at the end of this manual, to record details each time adjustments are made or service is done. |

## 9.1 RECOMMENDED PERIODIC MAINTENANCE

The 5220 is a solid-state device that requires very little maintenance. However, it does require periodic service checks to provide the years of trouble-free service of which it is capable. The maintenance interval depends on site conditions (fuel purity, environment, etc.). A properly installed TEG usually requires maintenance only once a year.

Evaluate $V_{set}$ (as per the procedure below) at least once a year. This will keep your TEG running correctly and ensure the health and longevity of the Power Unit. A $V_{set}$ check should be the first procedure performed in any service visit and will determine any changes that may be required.

### 9.1.1 Tools and Parts Recommended for Routine Servicing

The following tools should be available for routine servicing:

- 1 - Multi-meter, including DC voltmeter accurate to ± 0.1 V (and Ohmmeter*)
- 1 – Combustion Analyzer with the ability to measure Carbon monoxide (CO)
- 1 - Flat-head screwdriver
- 1 - Phillips screwdriver
- 2 - Wrenches, 9/16”
- 1 - Wrench, 1/2"
- 1 - Adjustable wrench, that will open to 16 mm (5/8”)
- 1 – 9/64 allen key or hex driver (if backup battery needs replacement)

The following spare parts should be available for routine servicing:

- 1 - Fuel filter kit, P/N 22363
- 1 - Fuel orifice: for natural gas use orifice #8, P/N 690, for propane use orifice #10, P/N 6251.
- 1 - SI Ignition Control Battery pack, P/N 24559*
- 1 - Spark electrode, P/N 58496*
- 1 - Thermal Cutoff assembly, P/N 300074*

**items not usually required but could be convenient for troubleshooting.*

The above spare parts can be purchased as a bundle for simplicity:

- 1 - Spare parts kit: for natural gas 5220 TEGs, P/N 58755, for propane 5220 TEGs, P/N 67267

### 9.1.2 Evaluate $V_{set}$

This procedure describes how to interpret $V_{set}$ and determine what further service is required. Follow these steps:

1. Check $V_{set}$ as per Power Output Evaluation (Section 7) and record in the log.
2. Compare measured voltage with required $V_{set}$ for present ambient temperature and proceed as follows:

a) If measured voltage is more than 0.2 V above required $V_{set}$:

The fuel pressure must be reduced. Proceed with Routine Service, Section 9.1.3. Remember to adjust the fuel pressure during restart or before leaving the site. See Adjustment (Section 8).

**CAUTION!**

Do not continue operating the TEG with measured $V_{set}$ exceeding the required $V_{set}$ for present ambient temperature, otherwise overheating may cause irreparable damage to the power unit.

b) If measured voltage is within 0.2 V of required $V_{set}$:

The TEG is functioning well and requires only a routine check. Proceed with Routine Service.

c) If measured voltage is more than 0.2 V below required $V_{set}$:

The cause must be determined. Refer to the last entry in the TEG Performance Log. In the log, check if the TEG was left operating at the correct $V_{set}$ during the last service visit. Remember that $V_{set}$ changes with ambient temperature. If the TEG was not left operating at the correct $V_{set}$ during the last service, determine the reason for this. If the TEG was left operating at the correct $V_{set}$ during the last visit and the voltage has changed, consider the following probable causes:

**Change in Fuel Pressure**

Refer to the last entry in the log and determine if the fuel pressure has changed. If fuel pressure has changed, re-adjust the fuel pressure to match the last entry. If this returns the measured voltage to within 0.2 V of required $V_{set}$, proceed with Service.

| | |
|---|---|
| **NOTE:** | A dirty fuel filter may cause a drop-in fuel pressure. A plugged fuel orifice will change fuel flow without a change in fuel pressure. |

**Change in Air Flow**

Check for obstructions at the cooling fins and the air filter stabilizer. Adjust the air shutter, see Adjustment section. If this returns the measured voltage to within 0.2 V of required $V_{set}$ proceed with Routine Service.

**Change in Fuel Quality**

To maintain consistent power output, it is essential that the TEG be supplied with fuel of a constant heating value. If TEG power levels are fluctuating, a change in fuel composition may have occurred. For natural gas applications, consider the possibility of activity upstream of the TEG in the fuel supply such as a well, being stimulated. For tanked propane applications, consider when the propane tanks were last filled.

If all the above causes have been ruled out, the TEG may require more than just routine servicing. Keep the TEG operating for now and see Troubleshooting (Section 10) for guidance.

### 9.1.3 Routine Service

Basic annual servicing is all that is required unless other maintenance is indicated by the $V_{set}$ evaluation. Follow these steps to perform a routine annual service:

1. Shut the TEG down and allow it cool. See Startup and Shutdown (Section 6).
2. Drain the pressure regulator sediment bowl. See Draining the Sediment Bowl (Section 9.2.1).
3. Check the fuel filter (Part# 22363) in the pressure regulator and replace if necessary. See Fuel Filter Replacement (Section 9.2.2).
4. Check the fuel orifice and replace if necessary. See Fuel Orifice Replacement (Section 9.2.3).
5. Remove any debris, sand or dust from the cooling fins, air filter stabilizer and cabinet interior. See Air Filter Cleaning (Section 10.1.1).
6. Ensure all bolts and wire connections are tight.
7. Start the TEG. See Startup and Shutdown (Section 6).
8. Check $V_{set}$ and adjust the TEG if necessary. See Power Output Evaluation (Section 7) and Adjustment (Section 8), as applicable. Record the final setup in the TEG Performance Log before leaving site.

## 9.2 FUEL SYSTEM MAINTENANCE

This section gives procedures for servicing the fuel system.

**WARNING!**

*CONDENSATE FROM REGULATOR IS VERY HIGH-RISK OF BEING FLAMMABLE.*

When draining condensate from regulator, ensure it is removed from cabinet and is a safe distance from ignition sources.

If there is a concern about liquids in the fuel line, it is suggested that the customer install a regulator drain line to remove condensate to a safe location away from ignition sources.

Condensate collecting/pooling/splashing/etc. inside the TEG cabinet creates a dangerous fire hazard. Contact GPT for assistance with fuel conditioning options to remove liquids from fuel line supply.

### 9.2.1 Draining the Sediment Bowl

Follow these steps to drain the regulator sediment bowl:

1. Shut off the fuel supply to the TEG and allow it to cool.
2. Open the drain cock on the bottom of the regulator; any impurities will drain through the cock.
3. Close the drain cock.
4. Leak-check the drain cock.

**WARNING!**

Check for fuel leaks after any fuel system service using a commercial leak detector fluid such as Snoop®.

### 9.2.2 Fuel Filter Replacement (if necessary)

Follow these steps to remove the fuel filter:

1. Shut off the fuel supply to the TEG and allow it to cool.
2. Remove the two wires from the pressure switch.
3. Drain the sediment bowl by opening the drain cock.
4. Disconnect the fuel line from the solenoid valve.
5. Disconnect the vent hose from the cabinet base.
6. Remove the two bolts which hold the regulator to the cabinet.
7. Mark the regulator body and sediment bowl, to ensure proper orientation during reassembly.
8. Turn the regulator upside down and remove the four screws on the bottom.
9. Remove the filter and gasket. See Figure 28 on the next page.

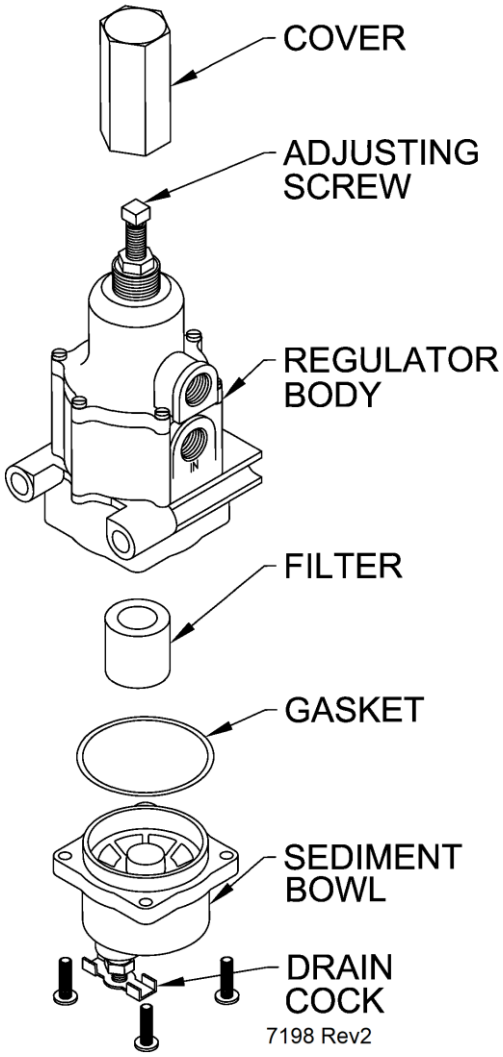



*Figure 28 – Pressure Regulator*

Follow these steps to install the fuel filter:

1. Install the filter and gasket onto the sediment bowl. See Figure 28.
2. Carefully replace the bottom of the regulator, making sure the filter and gasket are in the proper position.
3. Align the sediment bowl with the regulator body, replace the four screws, and tighten.

**NOTE:** It may be convenient to check the orifice and clean the air filter while the regulator is removed.

4. Installation of the pressure regulator into the TEG is the reverse of removal. With fuel pressure applied, leak-check all regulator joints and fuel connections.

**WARNING!** Check for fuel leaks after any fuel system service using a commercial leak detector fluid such as Snoop®.

### 9.2.3 Fuel Orifice Inspection

Follow these steps to inspect the fuel orifice:

1. Shut off the fuel supply to the TEG and allow to cool.
2. Remove the air screen by undoing the 4 mounting screws.
3. Disconnect the fuel line from the solenoid valve.
4. Disconnect the other end of the fuel line from the orifice fitting.
5. Unthread the orifice fitting from the venturi.
6. Visually check the orifice hole. It should be clean and free of obstructions. Replace it if necessary. A magnifying glass is recommended to aid in visual inspection.
7. Replace the orifice by threading it back into the venturi until it is finger tight.

**CAUTION!**

Always use the same size orifice as what was removed.

Propane orifice (#10) - Part# 6251

Natural gas orifice (#8) - Part# 690

8. Connect the fuel line to orifice fitting and to the solenoid valve.
9. Leak-check all connections using a commercial leak detector.

**WARNING!**

Check for fuel leaks after any fuel system service using a commercial leak detector fluid such as Snoop®.

### 9.2.4 Solenoid Valve Replacement

Should the solenoid valve fail (see troubleshooting procedure) and require replacement, follow these steps to replace the old valve with a new one:

1. Shut the TEG down.
2. Remove the connector from the valve coil by removing the retaining screw. Remove the wires from the insert by pulling them out the back. If your TEG is equipped with a valve having the same style DIN connector, do not replace the harness.
3. Disconnect the fuel lines from both sides of the valve using a 9/16” wrench.
4. Remove the 4 screws holding the valve body to the bracket.
5. Remove the elbow fittings from the old valve. Clean the threads and set aside.
6. Remove the connector at the other end of the valve wiring harness from the small interconnect board inside the electrical enclosure. Loosen the cord grip that the harness passes through and pull the cable back through it. You may need to cut off the interconnect board connector to fully remove the wire. Discard the old wiring harness.

7. Your replacement valve should come with a new wire harness. Plug the end with the white plastic connector into the connector on the board. Then, feed the other end through the cord grip.
8. The ends of the new harness are already stripped and tinned. Remove the contact insert from the new valve connector and feed the harness cable through the connector cover. Terminate the leads in the contact insert according to the table in Figure 29 below:

| Wire | Colour | Terminal |
|---|---|---|
| SOV (+) | BLU | 1 |
| SOV (–) | BRN | 2 |
| GND | YEL/GRN | GND |

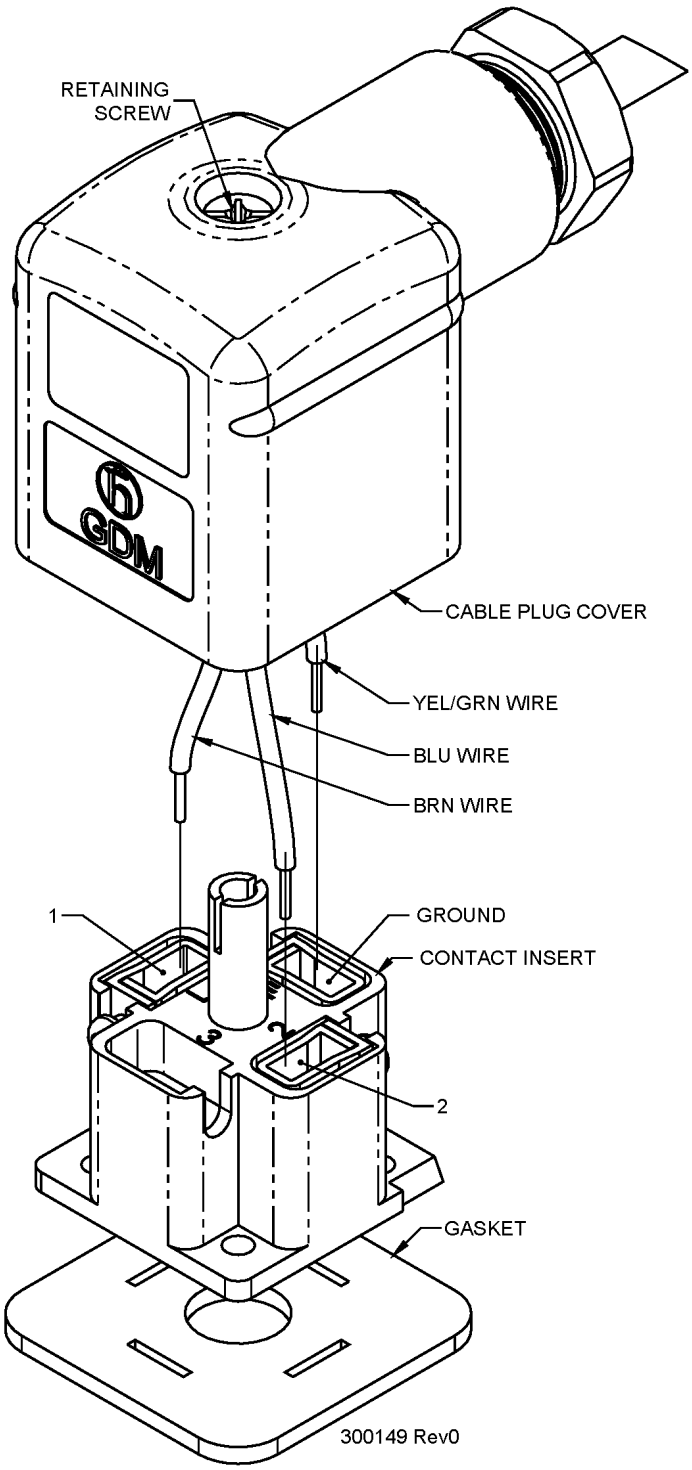



*Figure 29 – Solenoid Valve Cable Plug Connections*

9. Orient the contact insert as shown in Figure 29 above and re-insert it into the cover.
10. On the new solenoid valve, loosen the 5/8” retaining nut with a wrench and orient the head as shown in Figure 30. Take note of the P and A markings on the valve body. The P port must be on the fuel system side of the valve, and the A port must be on the burner side.

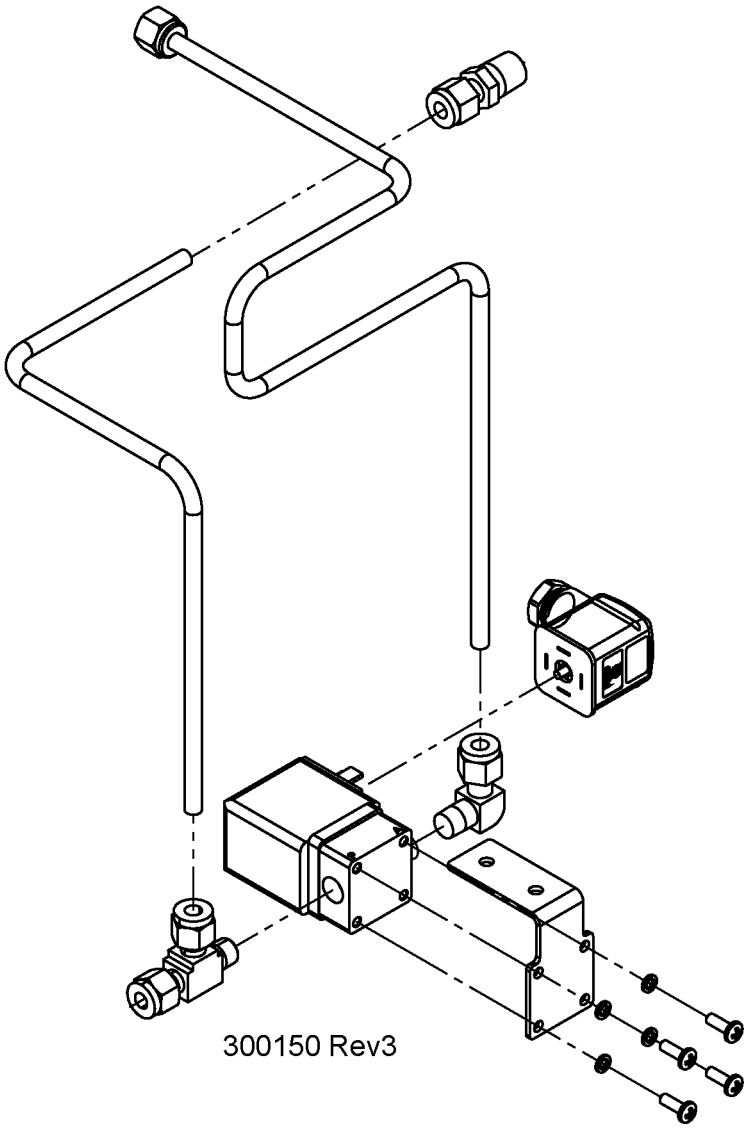



*Figure 30 – Solenoid Valve Fuel System Connections*

11. Install the elbow fittings on the new valve using a small amount of pipe thread sealant – DO NOT USE TAPE ON FUEL SYSTEM FITTINGS.
12. Attach the valve body to the bracket using the 4 screws removed previously.
13. Re-connect and tighten the fuel lines on both sides of the valve.
14. Attach the connector onto the back of the valve coil and tighten the retaining screw.
15. Apply fuel pressure and start the TEG. Immediately check all gas connections using leak-detector fluid. Shut the TEG off again before tightening, adjusting, or repairing any fuel system connections.

# 10 TROUBLESHOOTING

| Problem | Probable Cause | Possible Solution | Lookup Section |
|---|---|---|---|
| **Burner does not ignite** | Air in fuel line | Purge fuel lines of air | *Installation* |
| | Supply gas pressure too low | Increase gas supply pressure to the TEG | *Installation* |
| | Fuel filter dirty | Drain the regulator sediment | *Maintenance* |
| | | Replace the fuel filter | *Maintenance* |
| | Fuel pressure adjustment incorrect | Adjust the TEG fuel manifold pressure | *Adjustment* |
| | Fuel orifice plugged | Replace the fuel orifice | *Maintenance* |
| | Fuel orifice size incorrect | Replace the fuel orifice | *Maintenance* |
| | TCO has opened | Check TCO continuity. Replace if open. | *Maintenance* |
| | Air filter dirty | Clean the air filter | *Maintenance* |
| | Air-shutter adjustment incorrect | Open the Air Shutter slightly | *Adjustment* |
| | SI system faulty | Maintain the SI system | *Maintenance* |
| **Burner will ignite but will not continue to burn** | Supply gas pressure too low | Increase gas supply pressure to the TEG | *Installation* |
| | Fuel filter dirty | Drain the regulator sediment bowl. | *Maintenance* |
| | | Replace the fuel filter | *Maintenance* |
| | Fuel pressure adjustment incorrect | Adjust the TEG fuel manifold pressure | *Adjustment* |
| | Fuel orifice plugged | Replace the fuel orifice | *Maintenance* |
| | Fuel orifice size incorrect | Replace the orifice with one of the correct sizes | *Maintenance* |
| | Safety SOV valve malfunctioning | Check the safety SOV valve | *Troubleshooting* |
| | Air filter dirty | Clean the air filter | *Troubleshooting* |
| | Air shutter adjustment incorrect | Open the Air Shutter slightly | *Adjustment* |

| Problem | Probable Cause | Possible Solution | Lookup Section |
|---|---|---|---|
| **Low output power or low voltage** | $V_{set}$ adjustment incorrect | Determine required $V_{set}$ for present ambient temperature at site and adjust | *POWER OUTPUT EVALUATION and ADJUSTMENT* |
| | Airflow past cooling fins insufficient | Clean the cooling fins of any debris | *MAINTENANCE* |
| | Fuel filter dirty | Drain the regulator sediment bowl | *MAINTENANCE* |
| | Fuel orifice plugged | Replace the fuel orifice | *MAINTENANCE* |
| | Fuel orifice size incorrect | Replace the orifice | *MAINTENANCE* |
| | Fuel pressure adjustment incorrect | Adjust TEG fuel manifold pressure | *ADJUSTMENT* |
| | Safety SOV valve malfunctioning | Check the safety SOV valve | *TROUBLESHOOTING* |
| | Air filter dirty | Clean the air filter | *TROUBLESHOOTING* |
| | Air-shutter adjustment incorrect | Adjust air-shutter | *ADJUSTMENT* |
| | L/C or Limiter damaged | Examine the L/C or Limiter | *TROUBLESHOOTING* |
| | L/C or Limiter adjustment incorrect | Adjust the L/C or Limiter | *ADJUSTMENT* |
| | Power unit damaged | Examine the power unit | *TROUBLESHOOTING* |
| **Output power is too high** | Fuel pressure adjustment incorrect | Lower the TEG fuel pressure | *ADJUSTMENT* |
| | Air-shutter adjustment incorrect | Open the air shutter slightly | *ADJUSTMENT* |
| **Output voltage is too high** | L/C or Limiter damaged | Adjust the L/C or Limiter | *ADJUSTMENT* |
| | L/C or Limiter adjustment incorrect | Adjust the L/C or Limiter | *ADJUSTMENT* |

## 10.1 BURNER TROUBLESHOOTING

This text gives procedures for servicing the burner if required.

### 10.1.1 Air Filter Cleaning

The air-filter stabilizer screen at the front of the burner may become clogged with dust and insects thereby preventing the proper flow of air into the burner. Follow these steps to clean the air filter:

1. Shut-off the fuel supply to the TEG and allow to cool.
2. Remove the air screen by undoing the 4 mounting screws
3. Clean the air-filter screen by forcing air through it or washing in water.
4. Replace screen and mounting screws.

**NOTE:** If the air shutter setting was disturbed, reset the air shutter to the correct range as per Air Shutter Adjustment (Section 8.1.2) before starting the TEG.

### 10.1.2 Inspection of Burner Components

Burner internals are maintenance free for most applications. If the required $V_{set}$ still cannot be achieved after servicing the fuel system, air filter, and checking the cooling fins and air duct, then it may be necessary to check and service the burner internals. The procedures below give the steps for inspecting the burner components. Follow these steps to remove the burner:

1. Shut-off the fuel supply to the TEG and allow to cool.
2. Disconnect the ignition wire from the spark electrode.
3. Slide the spark electrode out of its receptacle. See Figure 2 and Figure 3.

**WARNING!** If TEG has not been given enough time to cool, the spark electrode can be dangerously hot.

4. Remove the air screen.
5. Disconnect the fuel line from the solenoid valve.
6. Disconnect the other end of the fuel line and attached orifice from the center of the air shutter.

**NOTE:** It may be convenient to disconnect and remove the fuel system.

7. Remove the four hex-nuts holding the burner in place and slide the burner out. See Figure 4.

Follow these steps to inspect the burner:

1. Check the air filter screen for any tears or holes. If any are found it should be replaced.
2. Check the burner screen.
3. Check the ceramic spacer.

Follow these steps to install the burner:

1. Reassembly is the reverse of disassembly.
2. Before re-starting the TEG, leak-check all fuel connections.

**NOTE:** The orifice fitting only needs to be finger tight when threaded back through the front of the air screen.

**WARNING!** Check for fuel leaks after any fuel system service using a commercial leak detector fluid such as Snoop®.

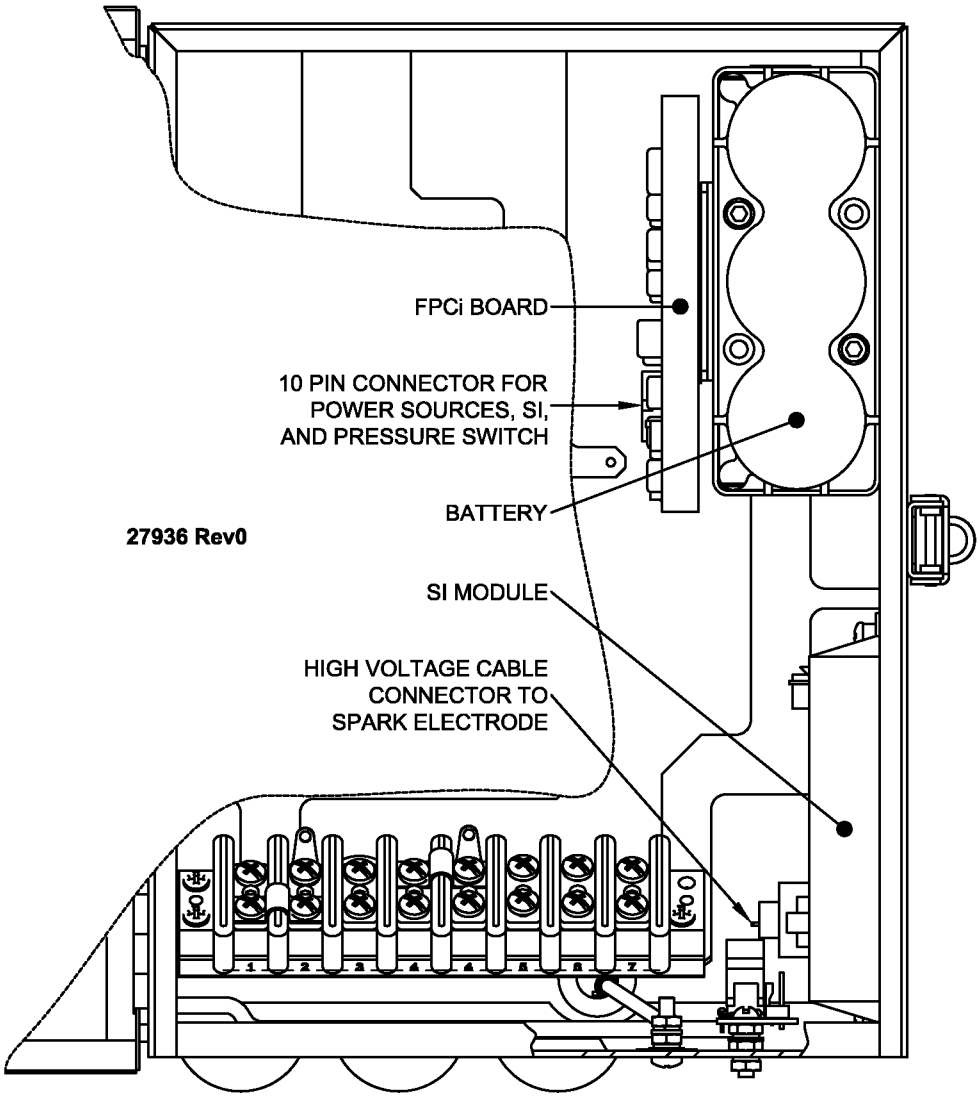



*Figure 31 – Spark Ignition Components in Electronics Box*

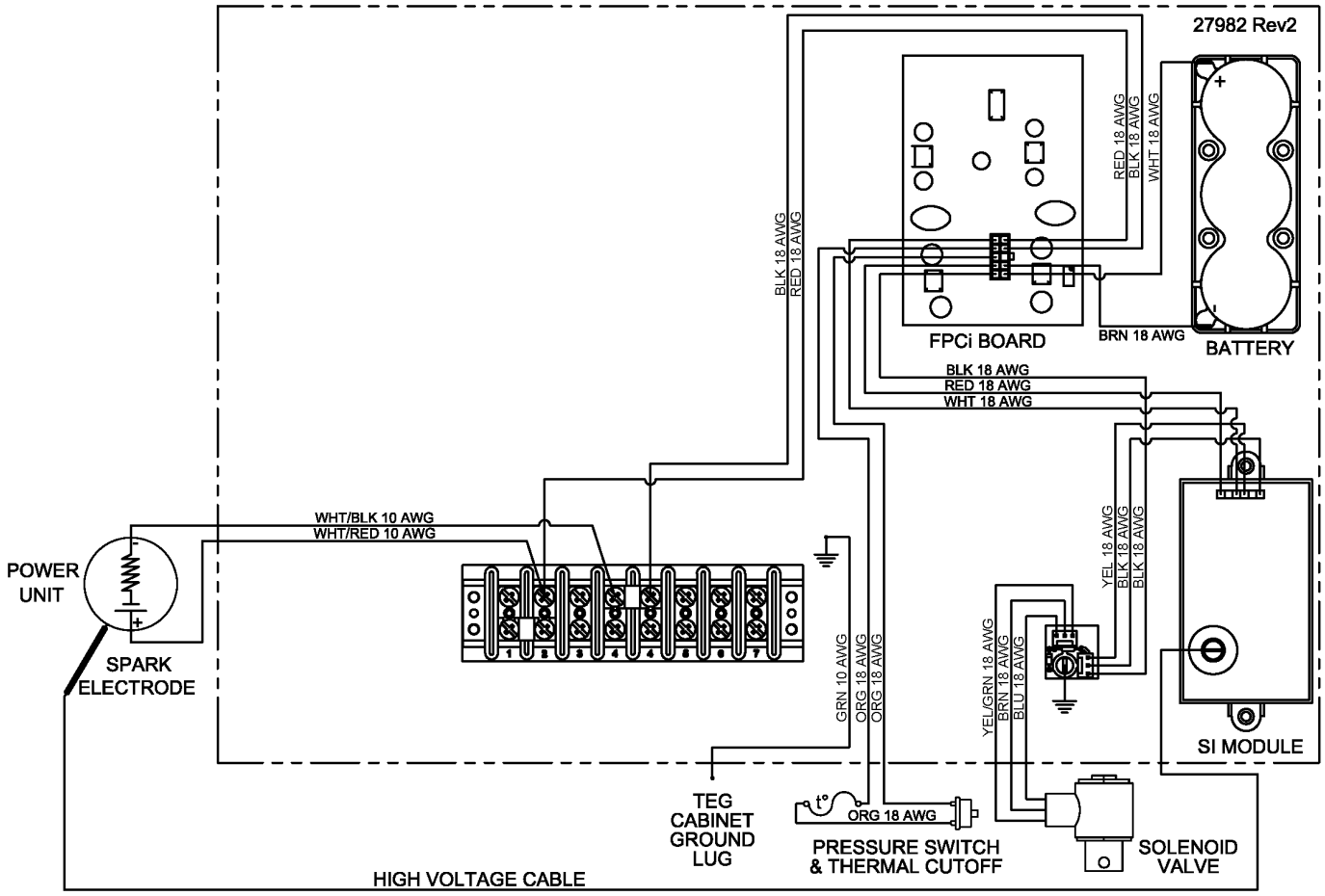



*Figure 32 – Spark Ignition Control Module Wiring Diagram*

## 10.2 SPARK IGNITION CONTROL SYSTEM TROUBLESHOOTING

If the SI system fails to start the TEG or shut the TEG off correctly, it must be investigated.

**NOTE:** The Spark Ignition System is configured differently for 5220 models equipped with Remote Start systems. If troubleshooting SI system for a Remote Start 5220, consult section 12.4, or see section 12 for other details.

If the SI system gets power, indicated by audible sounds of sparking and solenoid valve clicking, skip to section 10.2.4.

### 10.2.1 Check the Internal Battery Connection and Examine Fuse

Refer to Figure 31 and Figure 32, check the internal battery connection to make sure it is connected to the system.

Examine the fuse inserted to the fuse receptacle on the SI module. Replace if blown out.

### 10.2.2 Check the Thermal Cutoff (TCO)

The model 5220 TEG is equipped with a thermal cutoff (TCO) installed near the fuel pressure regulator. The TCO is a safety feature that prevents damage to the burner and fuel system. If cabinet temperatures exceed safe limits, a thermal fuse in the TCO assembly will open, closing the solenoid valve and shutting down the TEG. The thermal fuse in the TCO cannot be reset, and if it has been activated, the TCO must be replaced.

If the TCO has been activated, the TEG will neither spark nor flow fuel, even if fuel pressure

is supplied and the SI system has power. To check the TCO, follow these steps:

1. Disconnect wiring harness from one end of the TCO.
2. Using a digital multimeter, check the continuity of the TCO. If the fuse is open, and continuity cannot be established, replace the TCO.

A replacement Thermal Cutoff Assembly (part number 300074) can be ordered from GPT. Do not use any other thermal fuse.

**CAUTION!** Use only the thermal cutoff (TCO) supplied by GPT. Use of a different thermal fuse may result in fuel system component failures or unreliable operation.

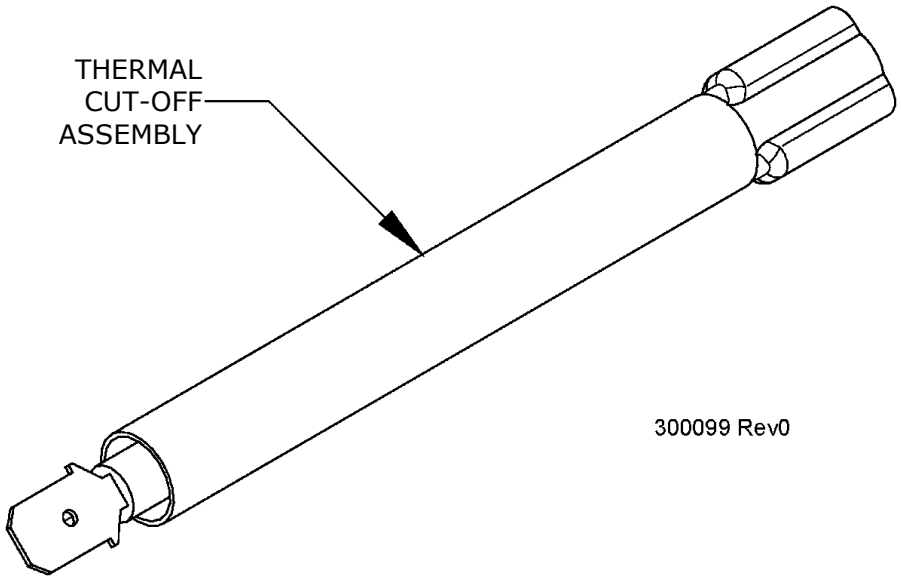



*Figure 33 – Thermal Cutoff Assembly*

To replace a TCO, proceed according to the following steps:

1. Disconnect one of the ORANGE wires from the pressure switch. Polarity does not matter in the pressure-sensing circuit, so whichever wire is more easily reached will suffice.
2. Remove the original TCO by cutting cable ties and disconnecting wiring harness.
3. Connect the wiring harness to the new TCO and secure it to place with cable ties.
4. Reconnect the ORANGE wire to the pressure switch.

If the TCO is discovered open, simply replacing the TCO may not be enough to solve the problem. The thermal fuse is configured to open if temperatures in the TEG cabinet exceed safe limits. If the fuse is open, it indicates that it has seen excessive temperature. If possible, the cause of this excessive temperature should be determined and remedied. After replacing the open TCO with a new one, check the following items:

- Check that the TEG is equipped with a wind scoop. If not, contact GPT to obtain one.
- Check the fuel system for leaks using a commercial leak detector fluid. Tighten any leaking connections or replace components as necessary.
- Ensure the fuel gas supplied to the TEG is dry and completely free of liquids.
- Ensure that the TEG is tuned correctly and is making proper power for the ambient conditions.

### 10.2.3 Check the Pressure Switch

The pressure switch is used by the SI system to sense fuel gas pressure. Follow these steps to check the pressure switch with a multimeter:

1. Remove the two orange wires from the pressure switch. See Figure 32 and Figure 38.
2. Remove fuel pressure from the fuel system by closing the manual shutoff valve, then shorting the two orange wires removed from the pressure switch.
3. With no fuel pressure reading on the gauge, verify that the resistance measured across the two terminals of the pressure switch is near infinity, which indicates the pressure switch is open. Replace the pressure switch if necessary.

**NOTE:** Switch should open at pressures below 6.9 kPa (1 PSI).

4. Separate the two orange wires removed from the pressure switch.
5. Provide fuel pressure to the switch by opening the manual shutoff valve.
6. Verify the resistance measured across the two terminals of the pressure switch is near zero, which indicates the pressure switch being closed. Replace the pressure switch if necessary.

**NOTE:** Switch should close at pressures above 13.8 kPa (2 PSI).

7. Remove fuel pressure from the fuel system as described in step 2 above.

### 10.2.4 Check the Spark Electrode and Sparking Gap

The spark electrode serves two roles; it sparks to ignite the incoming fuel-air mixture to start the TEG, and it also senses flame while the TEG is running. The ceramic rod insulating the metal electrode is very brittle and prone to breakage. A broken electrode may short to ground or spark in an unintended location. If the spark gap is set improperly, the TEG may fail to ignite, or the electrode may not sense flame properly. Follow these steps to verify that the spark electrode is functioning properly, and the sparking gap is set correctly:

1. Unplug the two orange wires from the terminals on the pressure switch. This removes power from the SI system to prevent possible high voltage shock.
2. Check the SI cable assembly for its connections on both ends and continuity with a multimeter before disconnecting from the spark electrode.
3. Remove the spark electrode by loosening the wingnut and sliding the electrode out.
4. Inspect the spark electrode for any cracks or pores in the ceramic rod. If any defects are found, the spark electrode must be replaced. Replace the electrode if suspect.
5. Sliding the spark electrode back into position through the burner back till it stops (hits the far wall of the burner), then pull it back 3.2 to 6.3 mm (1/8” to 1/4"). The ceramic rod should extend about 38mm (1.5”) from the holding fastener. If the spark electrode is too close to the burner back, the sparks may not deliver enough energy for successful ignition. If the spark electrode is too far from the burner back, the SI system may not provide enough total energy for arcing to reliably occur.
6. Tighten the wing nut only till it is snug. Do not over tighten or the ceramic rod will crack.
7. Reconnect SI cable assembly to the spark electrode.
8. Ensure the manual shutoff valve is closed.
9. Short the two orange wires removed from the pressure switch in step 1 above. Arcing

should occur in the combustion chamber (making a clicking noise) at the rate of 5 sparks per second.

10. If consistent audible sparking can be heard at a rate of 5 sparks per second, the spark electrode is functioning properly, and the sparking gap is set correctly. Procedure to next section to troubleshot SI system further.

### 10.2.5 Check the Internal Battery Pack Voltage and Capacity

Follow these steps to check the battery voltage and capacity:

1. Open the door of the L/C or Limiter electronics enclosure mounted on the right side of the generator cabinet.
2. See Figure 31 and Figure 32, locate the battery and make sure the battery is connected to the system. Then measure the battery voltage.
3. If the voltage is less than 6V, the battery pack needs to be recharged or replaced.
4. Recharge the battery pack to 6.2V and verify the battery open circuit voltage is 6.2V after recharge is completed. Otherwise replace the battery pack.
5. With the TEG allowed to cool and the manual shutoff valve closed, remove the two orange wires from the terminals of the pressure switch and short them together.
6. Measure the battery voltage within 60 seconds of shorting the pressure switch wires together. If battery voltage drops below 5.6 V during this time, replace the battery.

Follow the remaining steps only if the battery needs replacing.

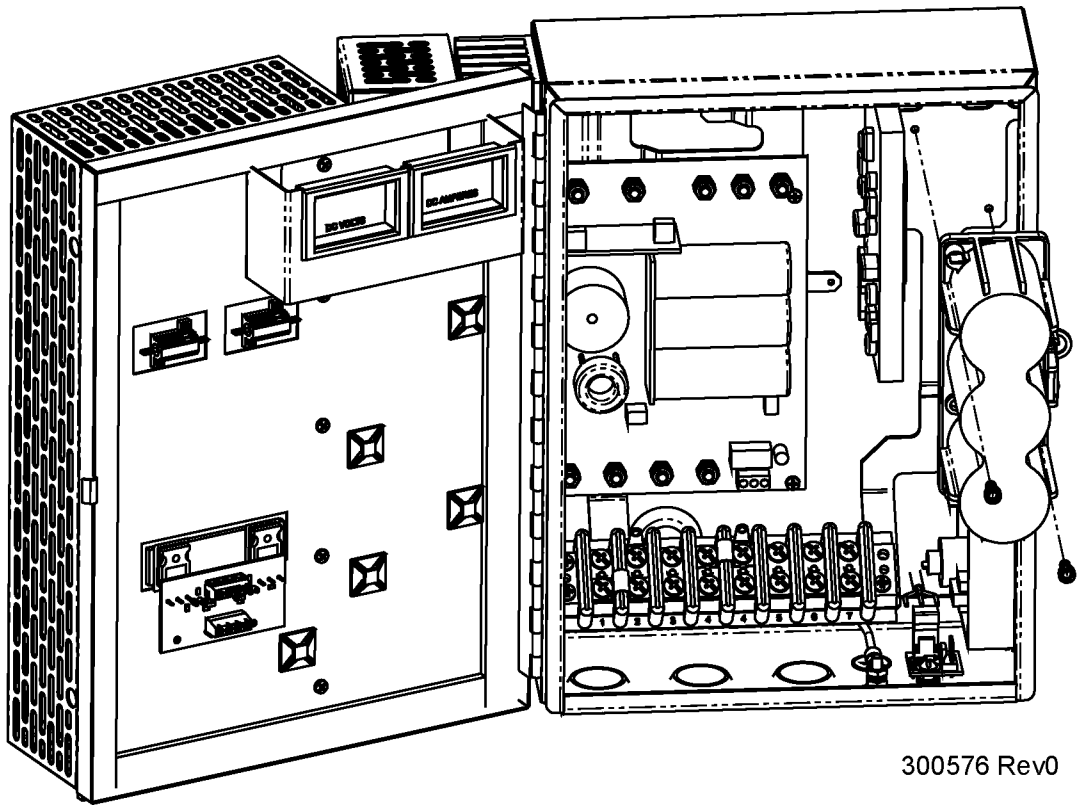



*Figure 34 - Backup Battery Replacement*

7. Unplug the negative brown wire from the lower battery terminal.
8. Using a 9/64 Allen key or hex driver, loosen the two hex socket screws from the battery and remove it from the panel. Remove the positive white wire from the battery terminal once you gain access to it.

9. Transfer the hex socket screws from the old battery to the new replacement one. The battery has four screw holes, but you must use the top-left and the bottom-right holes to connect to the panel.
10. Reconnect the white positive wire to the new battery and then carefully align the battery against the back panel. The positive end of the battery (noted by a + sign on the battery casing) must be pointed upwards.
11. Support the bottom of the battery with one hand while fastening the upper screw, and then fasten the lower screw. Finally, reconnect the negative brown wire to the lower battery terminal.

### 10.2.6 Check the Solenoid Valve

A solenoid valve is equipped in a 5220 TEG to control fuel gas flow to the burner and to act as a safety shutoff device. Follow these steps to examine the solenoid valve:

1. A 12V/2W solenoid valve must be installed beneath the TEG cabinet (refer to section 12.4.6 for a Remote Start 5220 TEG). Check the label on the solenoid valve body to confirm the solenoid valve voltage and power ratings are correct.
2. Remove the two orange wires from the terminals of the pressure switch and keep them separately. Open the manual shutoff valve to supply fuel gas to the TEG, perform a leak check to ensure there is no leak, and then close the manual shutoff valve. The pressure gauge reading shall remain unchanged for quite a long time. If the pressure drops, the solenoid valve must be replaced, and this step must be repeated after the solenoid valve has been replaced to ensure the solenoid valve acts as a safety shutoff device.
3. Reinstall the two orange wires back to the terminals of the pressure switch. Open the manual shutoff valve to supply fuel gas to the TEG to start it. If the TEG cannot start or combustion cannot be maintained, refer to Figure 34, unplug the solenoid valve cable connector from interconnection board located inside the bottom of the TEG electronics enclosure. Measure the resistance between the 3 contacts of the solenoid valve cable connector.
   - The resistance measured between brown and yellow/green wires shall be infinite.
   - The resistance measured between blue and yellow/green wires shall be infinite.
   - The resistance measured between brown and blue wires shall be 60Ω to 80Ω.

   If any measured resistance is out of the given range, refer to Figure 29, remove the retaining screw, unplug the solenoid valve cable connector, and identify the pins of the solenoid valve body connections to their corresponding wire colors. Measure the resistance again from the pins. Replace the solenoid valve body if any measured resistance between pins is still out of the given range, otherwise replace the solenoid valve cable harness.
4. Plug the solenoid valve cable connector back to the solenoid valve body and tighten the retaining screw. Check the continuity of yellow and black wires between the SI module and the interconnection board. Replace the wiring harness if suspect. Check the diode and the resistor on the interconnection board with a multimeter. The resistance of the resistor shall be 8Ω to 12Ω. Replace the interconnection board if necessary. Reconnect the solenoid valve cable connector back to the interconnection board.

### 10.2.7 Check the SI Power Supply Board and the SI Module

The SI Power Supply Board (also known as the FPCi Board) and the SI module are potted and do not require routine service/exam. Follow below procedures to troubleshoot the FPCi

board and the SI module if the SI system still needs further troubleshooting to resolve problem after completed sections 10.2.1 to 10.2.6:

1. Start the TEG after it has been allowed to cool for 30-60 minutes.
2. Upon start up, probe and measure following voltages (see Figure 31 and Figure 32):
   - The battery pack voltage. The battery pack voltage shall be less than 6.3V.
   - The SI module input voltage, between the red and black wires of the SI module's connector plug. Replace the FPCi board if the measured SI module input voltage is out of the range of 13.7V to 14.2V.
   - The valve voltage from the SI module to the solenoid valve, between the yellow and black wires of the SI module's connector plug. Replace the SI module if the measured valve voltage is out of the range of 13.7V to 14.2V.
3. Repeat the measurement after the TEG has been running for 20 minutes:
   - Replace the FPCi board if the measured battery pack voltage is less than 6.3V.
   - Replace the FPCi board if the measured SI module input voltage is out of the range of 13.7V to 14.2V.
   - Replace the SI module if the measured valve voltage is out of the range of 13.7V to 14.2V.

This completes the troubleshooting of the SI system. Contact GPT Customer Service if need further help.

## 10.3 ELECTRONICS ASSEMBLY EXAMINATION

The L/C and Limiter assemblies normally require no maintenance. If the TEG is producing required $V_{set}$ but it is not supplying expected power to the load, then the operation of the L/C or Limiter should be checked and serviced as necessary. Use the procedures below to help determine if the L/C or Limiter could be damaged.

### 10.3.1 Check the Dipswitch Settings (L/C only)

Check the selector dipswitches are set correctly for the model 5220-24V.

**NOTE:** Switch 1 and Switch 2 should both be OFF.

### 10.3.2 Check the Electronics Input Voltage

Follow these steps to check the input voltage to the L/C or Limiter assembly:

1. Disconnect the customer load from TB1 terminals 6 (-) and 7 (+) for an L/C assembly (Model 5220-24V), or TB1 terminals 4 (-) and 5 (+) for a Limiter assembly (Model 5220-12V).
2. Place the jumper clip in the RUN position between terminals 1 and 2 of TB1.
3. Connect a voltmeter between terminals 2 (+) and 4 (-) of TB1.
4. Wait for the TEG to reach nominal operating temperature, providing a stable voltage measurement on the voltmeter. Allow 1 hour if the TEG was just started from cold.
5. Evaluate the voltage measurement on the voltmeter. Unloaded input voltage should be about 16 V on an L/C assembly, or 14.1 V on a Limiter assembly. If values are atypical, likely suspects are an electrical short, damaged circuit board, or power unit.

### 10.3.3 Check the Electronics Output Voltage

Follow these steps to check the output voltage from the L/C or Limiter assembly:

1. Isolate the TEG from the customer load and batteries by opening the fuse or circuit breaker through which it is connected.
2. Place the jumper clip in the RUN position between terminals 1 and 2 of TB1.
3. Connect a voltmeter between TB1 terminals 6 (-) and 7 (+) for an L/C assembly (Model 5220-24V), or TB1 terminals 4 (-) and 5 (+) for a Limiter assembly (Model 5220-12V).
4. Adjust the output voltage by turning the output voltage adjustment pot (shown in Figure 6 or Figure 7). If the unloaded output voltage, seen on the voltmeter, does not change when the adjustment pot is turned, the electronics assembly needs to be replaced.

**NOTE:** If the TEG produces the required $V_{set}$ and the electronics appear to be operating properly, but still do not provide expected power to the load, then the power unit should be checked next.

## 10.4 POWER UNIT EXAMINATION

The power unit normally requires no maintenance. If after maintaining and adjusting all other systems the TEG does not produce expected power, consider examining the power unit. Use the procedures below to help determine if the power unit could be damaged.

### 10.4.1 Check the Internal Resistance

Follow these steps to check the power unit's internal resistance:

1. Start the TEG.
2. Move the jumper clip to the SETUP position, between terminals 2 and 3 of TB1.
3. Connect a voltmeter between terminals 2 (+) and 4 (-).

**NOTE:** Alternative resistor values are acceptable so long as the resistance is close to 1 Ω and accuracy class better than ± 1%.

4. Wait for the TEG to reach nominal operating temperature, providing a stable voltage measurement on the voltmeter. Allow 1 hour if the TEG was just started from cold.
5. Measure $V_{set}$ and record the voltage seen on the voltmeter.
6. While observing the voltmeter display, remove the jumper clip (creating an open circuit condition) and note the momentary voltage. On a digital multimeter this will be the first number displayed after removing the clip, usually within 2 seconds of removing the clip. Record the number as the momentary open circuit voltage ($V_{oc}$). If this was not recorded quickly enough replace the jumper clip and repeat above steps.

**NOTE:** When the jumper clip is suddenly removed the measured voltage leaps up to a value, known as the momentary open circuit voltage ($V_{oc}$). Measured voltage continues to climb gradually after this.

**WARNING!** Do not allow $V_{oc}$ to exceed 29 V, otherwise the TEG could be permanently damaged.

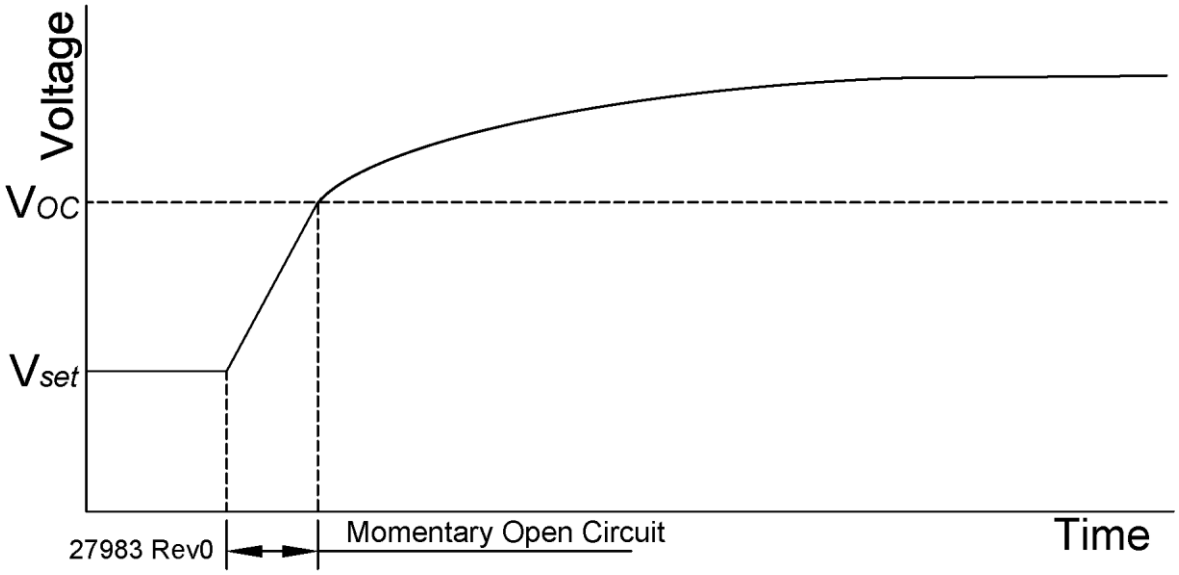



*Figure 35 – Momentary Open Circuit Diagram*

7. Calculate the internal resistance using the equations 7 and 8 below.

**Equation 7 →** $I_L = \frac{V_{set}}{R_L}$

**Equation 8 →** $R_i = \frac{V_{oc} - V_{set}}{I_L}$

Where: $R_i$ = internal resistance (Ω)

$V_{oc}$ = momentary open circuit voltage (V)

$V_{set}$ = setup voltage (V)

$I_L$ = load current (A)

$R_L$ = precision load resistance (Ω), nominal 1.0 Ω for 5220

8. Check the internal resistance ($R_i$) is less than 1.1 Ω. If not, the power unit may be damaged.

Example: If the $V_{set}$ voltage and momentary open circuit voltages were measured as 14.9 V and 28 V respectively and the precision load resistance was 1.0 Ω then:

$I_L = V_{set} / R_L$
$= 14.9 / 1.0$
$= 14.9\ A$

$R_{INT} = (V_{oc} - V_{set}) / I_L$
$= (28 - 14.9) / 14.9$
$= 13.1 / 14.9$
$= 0.88\ \Omega$

If the calculated internal resistance is too high, the power unit may not be able to provide rated power to the load and should be replaced. If the calculated internal resistance is within acceptable limits (under 1.1 Ω), an internal short may be present in the power unit.

### 10.4.2 Check for an Internal Short

Follow these steps to check for an internal short in the power unit:

1. Start the TEG.
2. Move the jumper clip to the SETUP position, between terminals 2 and 3 of TB1.
3. Free-up terminals 2 (+) and 4 (-) by removing all wires from these terminals except the white/red power unit lead connected to terminal 2, the white/black power unit lead connected to terminal 4, and the white/black precision load lead connected to terminal 4.
4. Connect a voltmeter to terminals 2 (+) and 4 (-).
5. Remove the jumper clip from the terminal block, and complete remaining steps within one minute.

**WARNING!** The following steps put the power unit in an open circuit condition. Do not allow the voltmeter reading to exceed 29 V, otherwise the power unit could be permanently damaged.

**CAUTION!** The following steps may cause sparking. If an internal short is present, the jumper wire in the following steps may arc to the chassis.

6. Connect a jumper wire from terminal 4 to the TEG chassis and watch the voltmeter reading. Then remove the jumper wire. Any fluctuation in voltage may indicate an internal short within the power unit.
7. Connect a jumper wire from terminal 2 to the TEG chassis and watch the voltmeter reading. Then remove the jumper wire. Any fluctuation in voltage may indicate an internal short within the power unit.
8. Reinstall the jumper clip to the SETUP position, between terminals 2 and 3 of TB1.

If an internal short is confirmed with no other equipment connected, the power unit is damaged and will need replacing. If no internal short is found and the TEG appears to be fully functional, check that the customer load is functioning correctly and is grounded properly.

For further information or assistance, please contact the Customer Service Department at Global Power Technologies (GPT).

# 11 PARTS LISTS

This section lists the parts that form the equipment.

For parts and service please contact Global Power Technologies' Customer Service Department at:

#16, 7875 - 57th Street SE
Calgary, Alberta T2C 5K7
Direct: (403) 720-1190
Fax: (403) 236-5575
Main: (403) 236-5556
E-mail: customer.service@globalte.com
Web: www.globalte.com

## Routine Maintenance Parts

The spare parts kits include the Fuel filter kit, Battery, Thermal cutoff assembly, Spark electrodes, and the respective Orifice. In case additional spares of a certain component are needed, they can also be ordered directly. See Section 9.1 for further details on routine maintenance.

| Part No. | Part Description | Replacement Notes |
|---|---|---|
| 58755<br>67267 | Spare Parts Kit for 5220 - Natural Gas<br>Spare Parts Kit for 5220 - Propane | Includes 22363, 24559, 58496, 300074, and one of 690 or 6251 |
| 690<br>6251 | Orifice #8 for Natural Gas<br>Orifice #10 for Propane | Required annually |
| 22363 | Fuel Filter Kit | Required annually |
| 24559 | Battery, 6V 5AH Monobloc | May be required annually |
| 58496 | Spark electrode assembly, flame sensing | May be required annually |
| 300074 | Thermal cutoff Assembly | May be required annually |

## 11.1 MODEL 5220 TEG

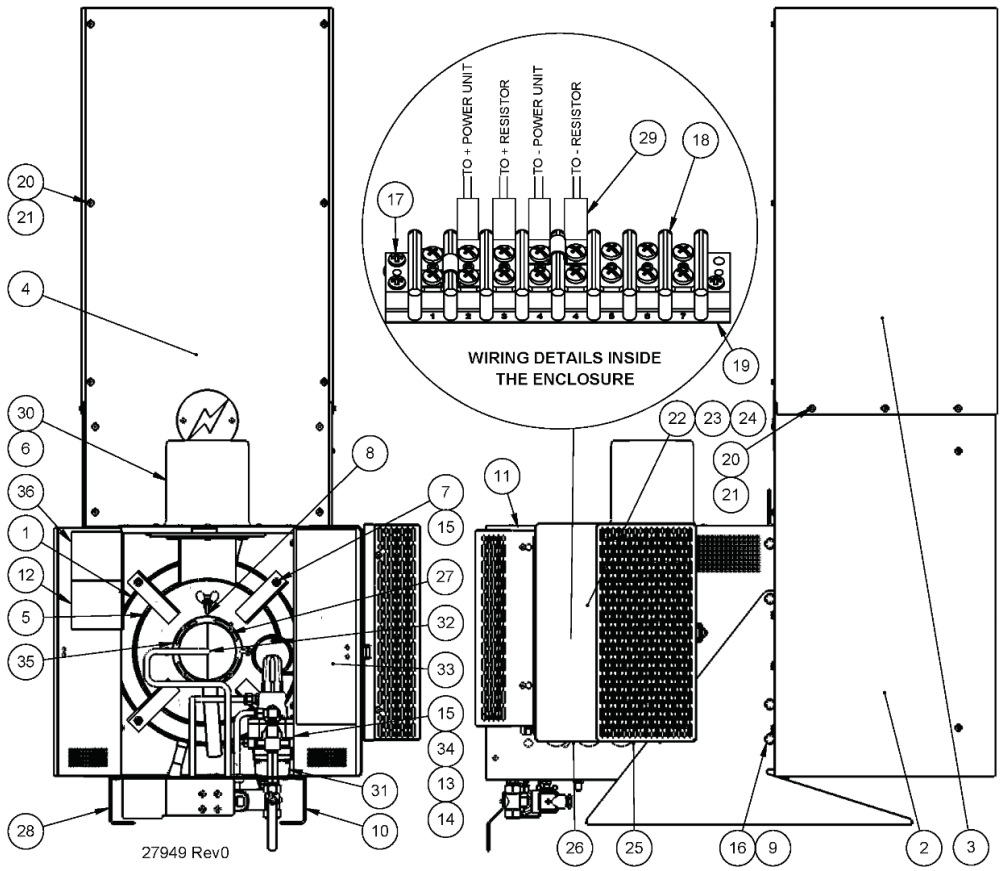



*Figure 36 - Model 5220 TEG*

| Item | Part No. | Description |
|---|---|---|
| 1 | 8908 | POWER UNIT |
| 2 | 22947 | FIN DUCT, LOWER |
| 3 | 22875 | FIN DUCT, UPPER |
| 4 | 22906 | COVER ASSY, UPPER FIN DUCT |
| 5 | 27902 | BURNER ASSY |
| 6 | 6011 | EXHAUST STACK ASSY |
| | or 58095 | RAIN CAP KIT, 5220 (*Not shown*) |
| 7 | 6170 | ROD, BURNER MOUNTING |
| 8 | 58496 | ELECTRODE ASSY, FLAME SENSING |
| 9 | 20535 | SCREW, CAP, HEX, HD, 1/4-20 X 5/8”, SS |
| 10 | 22946 | LEG, CABINET, RIGHT |
| 11 | 27917 | CABINET ASSY |
| | or 54590 | CABINET ASSEMBLY, 5220-RS |
| 12 | 27888 | LABEL, DATA PLATE |
| 13 | 22520 | SCREW, CAP, HEX HD, 1/4-20 X 3.75”, SS |
| 14 | 473 | WASHER, LOCK, EXT, 1/4, SS |
| 15 | 611 | NUT, HEX, 1/4-20, SS |
| 16 | 557 | WASHER, FLAT, 1/4, SS |
| 17 | 7503 | SCREW, MACH, P-H-P, 8-32 X ¾, SS |
| 18 | 2110 | TERMINAL BLOCK, 8 POSITION |
| 19 | 2109 | MARKER STRIP |
| 20 | 7410 | SCREW, MACH, P-H-P, 8-32 X 1/4, SS |

## 11.1 MODEL 5220 TEG (Cont'd)

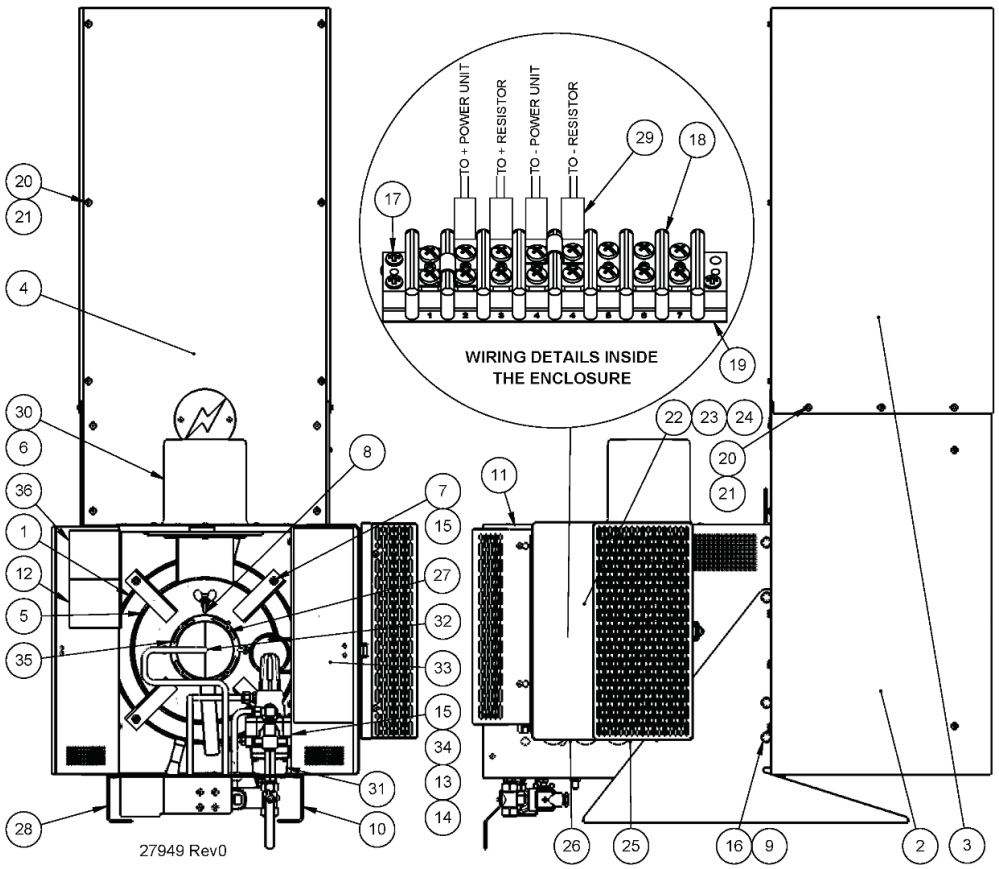



*Figure 36 - Model 5220 TEG*

| Item | Part No. | Description |
|---|---|---|
| 21 | 472 | WASHER, LOCK, EXT, #8, SS |
| 22 | 63096 | SI MODULE, CHANNEL PROD, MICRO 50N-12 |
| 23 | 27907 | POTTED FPCi BOARD ASSEMBLY |
| 24 | 24559 | BATTERY, 6V, 5AH, MONOBLOC |
| 25 | 5014 | BUSHING, UNIVERSAL, 1", NYLON, 0.125" PNL |
| 26 | 283 | BUSHING, 7/8", UNIVERSAL |
| 27 | 5586 | AIR SCREEN ASSY |
| 28 | 22945 | LEG, CABINET, LEFT |
| | or 51803 | LEG, LEFT, 5220-RS |
| 29 | 208 | TERM RING, 10-12 AWG, #10 STUD |
| 30 | 523 | CLAMP, 5 1/4" DIA. SS |
| 31 | 27905 | FUEL SYSTEM, 5220 |
| | or 66466 | FUEL SYSTEM, SS, 5220 |
| | or 54591 | FUEL SYSTEM, 5220-RS W/24V BURKERT VALVE |
| | or 54592 | FUEL SYSTEM, 5220-RS W/12V BURKERT VALVE |
| 32 | 6251 | ORIFICE ASSY, #10, FOR PROPANE |
| | or 690 | ORIFICE ASSY, #8, FOR NATURAL GAS |
| 33 | 27892 | LABEL, INSTRUCTION, 5220 |
| | or 53583 | LABEL, INSTRUCTION, 5220-RS |
| 34 | 22372 | SPACER, 3/8, FUEL SYSTEM W/CFR REGULATOR |
| 35 | 27900 | AIR SHUTTER, PROFILED, 5220 |
| 36 | 23794 | LABEL, INSTALLATION, 1500/5220 |

## 11.2 MODEL 5220 BURNER

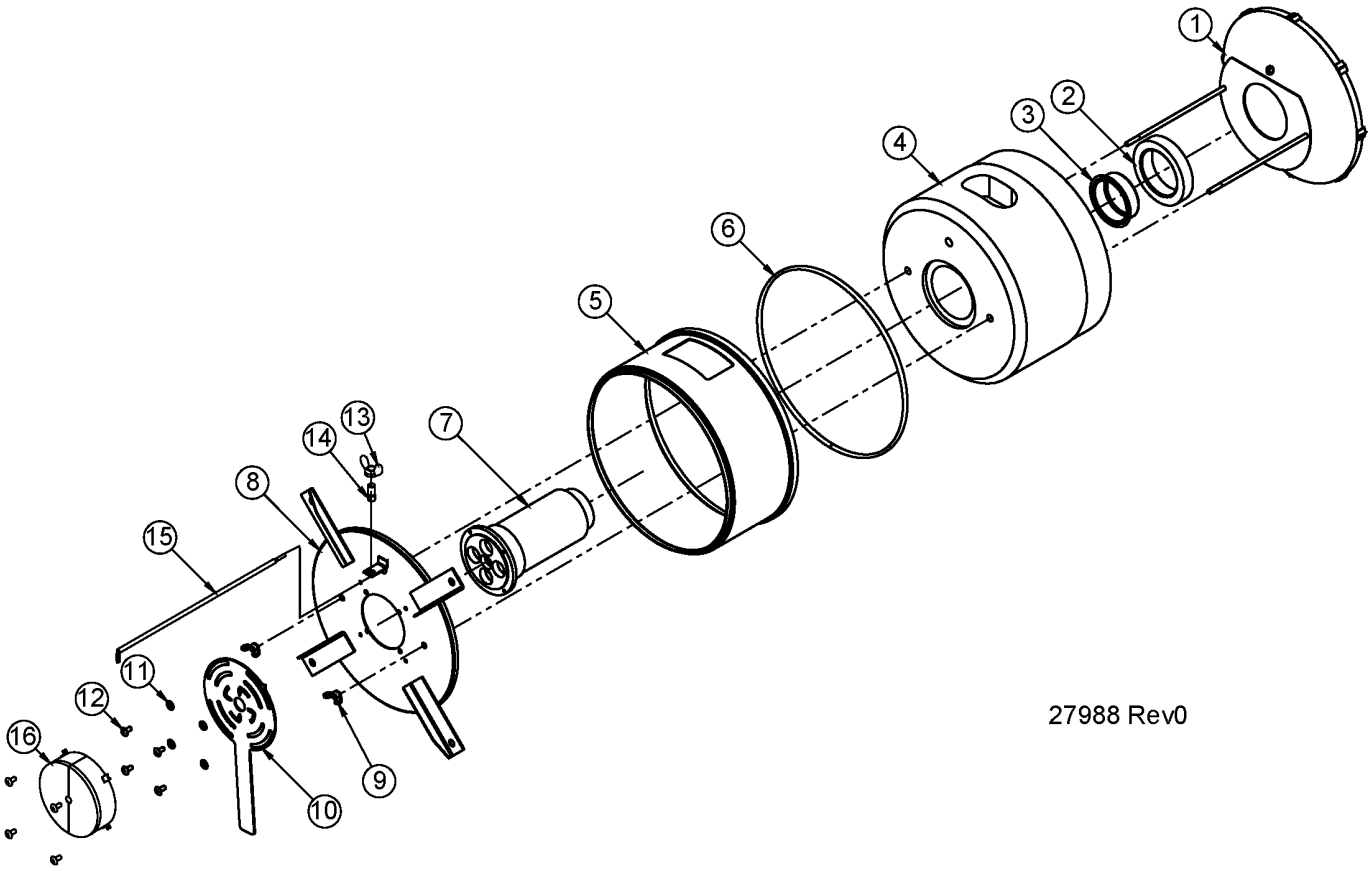



*Figure 37 - Model 5220 Burner*

| Item | Part No. | Description |
|---|---|---|
| 1 | 5606 | BURNER BACK ASSY, 5220 |
| 2 | 5605 | HOLDER, SCREEN INSULATOR, 5220 |
| 3 | 5390 | BURNER SCREEN ASSY, 5220 |
| 4 | 6086 | INSULATION BLOCK, 5220 |
| 5 | 6186 | BURNER CAN, EXHAUST |
| 6 | 6631 | ROPE, 1/4” KAOTEX 2000 |
| 7 | 5375 | VENTURI ASSY, 5220 |
| 8 | 5378 | BURNER TOP ASSY, 5220 |
| 9 | 601 | NUT, WING, 10-32, SS |
| 10 | 27900 | AIR SHUTTER, PROFILED, 5220 |
| 11 | 27901 | WASHER, BOWED, 5MM, A2 SS |
| 12 | 5047 | SCREW, TRUSS-HD-P, 8-32 X 3/8, SS |
| 13 | 7005 | NUT, WING, 5/16-18, SS |
| 14 | 7004 | PIN, MOUNTING, SI ELECTRODE |
| 15 | 58496 | ELECTRODE ASSY, FLAME SENSING |
| 16 | 5586 | AIR SCREEN ASSY, 5220, TCELL |

## 11.3 MODEL 5220 FUEL SYSTEM

NOTE:

If your fuel lines are different than illustrated, contact GPT Customer Service for correct part numbers. Retrofit kit is also available to upgrade your fuel system.

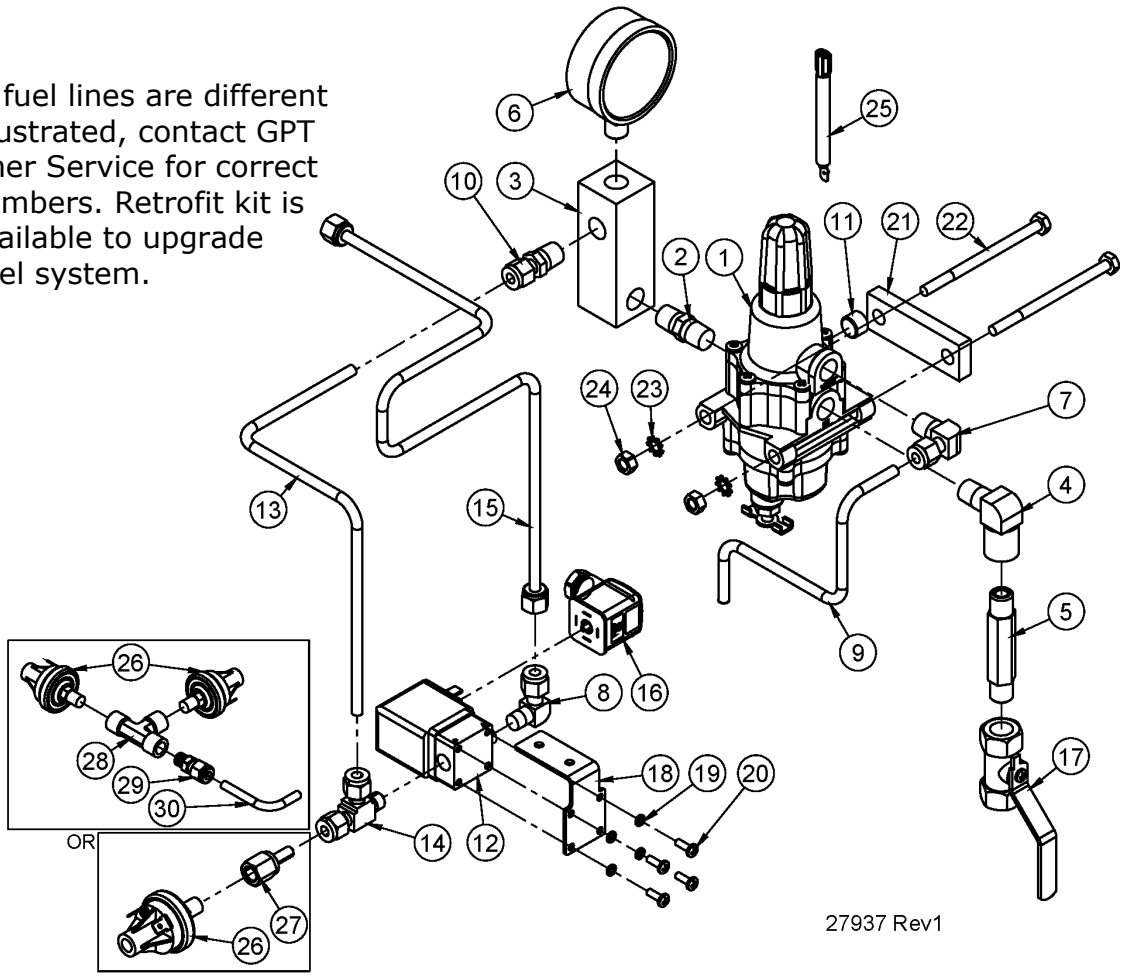



*Figure 38 - Model 5220 Fuel System*

| Item | Part No. | Description |
|---|---|---|
| 1 | 64104 | REGULATOR, FISHER 67CFR, 0-35 PSI |
| | or 66475 | REGULATOR, FISHER 67CFR, 0-35 PSI *(FOR 5220-SS)* |
| 2 | 501 | NIPPLE, HEX, 1/4 NPT X 1 1/8, BRASS |
| | or 2359 | NIPPLE, HEX, 1/4 NPT X 1 1/2, 316 SS *(FOR 5220-SS)* |
| 3 | 304187 | MANIFOLD BLOCK, FUEL SYSTEM, 5220 |
| 4 | 21569 | ELBOW, STREET, 1/4 NPT, BRASS |
| | or 2356 | ELBOW, STREET, 1/4 NPT, 316 SS *(FOR 5220-SS)* |
| 5 | 2154 | NIPPLE, HEX, 1/4 NPT X 3, BRASS |
| | or 2358 | NIPPLE, HEX, 1/4 NPT X 3, 316 SS *(FOR 5220-SS)* |
| 6 | 406 | GAUGE, PRESSURE, 0-30 PSI |
| | or 7293 | GAUGE, PRESSURE, 0-30 PSI, SS *(FOR 5220-SS)* |
| 7 | 20071 | ELBOW, 1/4 TB X 1/4 MNPT, 316 SS |
| 8 | 26518 | ELBOW, 1/4 TB X 1/8 MNPT, SS |
| 9 | 7981 | VENT TUBE ASSY, REGULATOR, SS, 5060/5120/5220 |
| 10 | 380 | CONNECTOR, 1/4 TB X 1/4 MNPT, 316 SS |
| 11 | 58949 | PLUG, 1/4" NPT X 7/8" STEEL |
| 13 | 304179 | FUEL LINE, MANIFOLD TO EXT SV, 5220 |
| 14 | 304182 | TEE, CONNECTOR, 1/8" MNPT, 1/4" TUBE, SS |
| 15 | 304188 | FUEL LINE ASSY, EXT SOL TO ORIFICE, 5220 |

## 11.3 MODEL 5220 FUEL SYSTEM Cont'd

NOTE:
If your fuel lines are different than illustrated, contact GPT Customer Service for correct part numbers. Retrofit kit is also available to upgrade your fuel system.

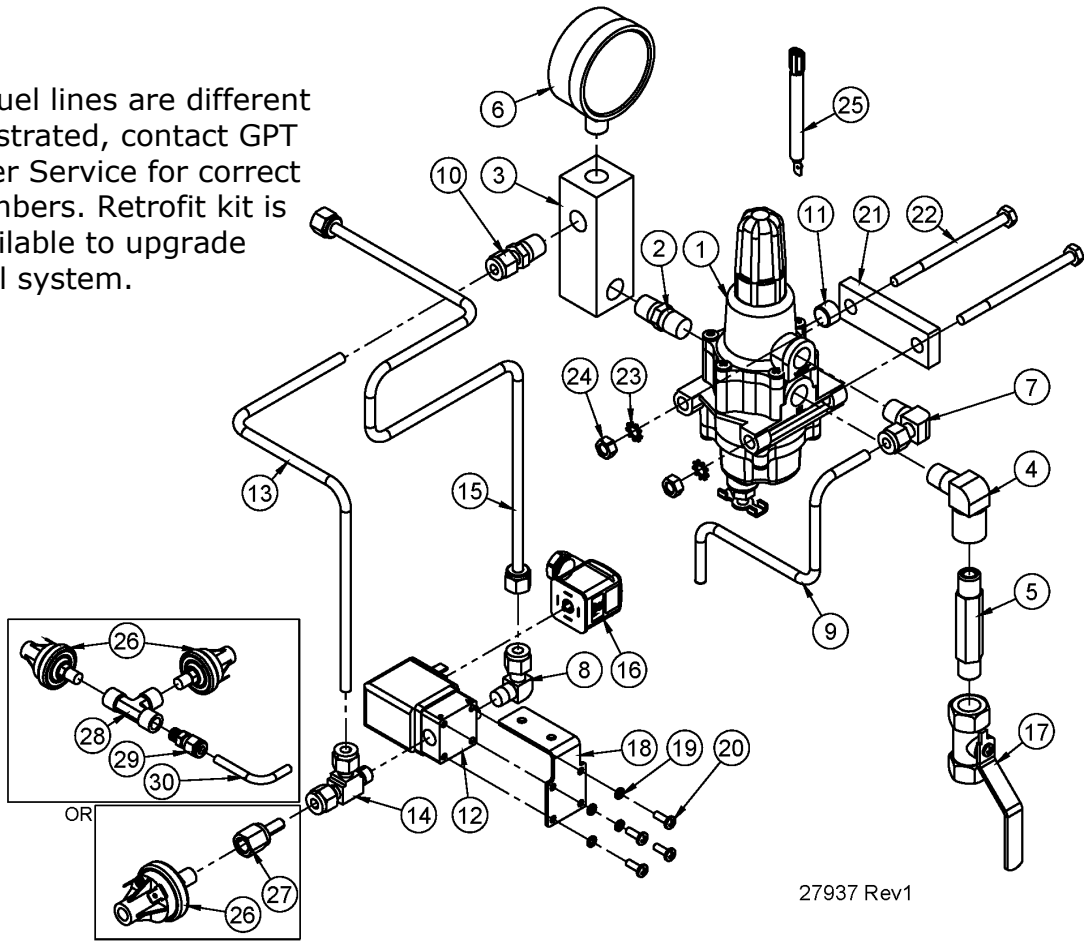



*Figure 38 - Model 5220 Fuel System*

| Item | Part No. | Description |
|---|---|---|
| 12&16 | 300023 | VALVE, 12V BR SOLENOID 5220, REPLACEMENT |
| | or 300022 | VALVE, 12V SS SOLENOID 5220, REPLACEMENT *(FOR 5220-SS)* |
| | or 300327 | VALVE, 12V BR SOL 5060/5120/5220 RS REPL *(FOR 5220-12-RS)* |
| | or 300455 | VALVE, 24V BR SOL 5060/5120/5220 RS REPL *(FOR 5220-24-RS)* |
| 17 | 24653 | VALVE, BALL, ¼" FNPT, BRASS |
| | or 21689 | VALVE, BALL, ¼" FNPT, 2000 LB, 316 SS *(FOR 5220-SS)* |
| 18 | 27844 | BRACKET, SOLENOID VALVE, 5120/5220 |
| 19 | 538 | WASHER, LOCK, SPRING, #8, SS |
| 20 | 23438 | SCREW, MACH, P-H-P, M4 X 12MM, SS |
| 21 | 22372 | SPACER, 3/8, FUEL SYSTEM W/CFR REGULATOR |
| 22 | 22520 | SCREW, CAP, HEX HD, 1/4-20 X 3.75", SS |
| 23 | 473 | WASHER, LOCK, EXT, 1/4, SS |
| 24 | 611 | NUT, HEX, 1/4-20, SS |
| 25 | 300074 | THERMAL CUTOFF ASSEMBLY |
| 26 | 6471 | SWITCH, PRESSURE 1.6 PSI, BRASS |
| | or 61849 | SWITCH, PRESSURE 1.6 PSI, NO PLTD STEEL *(FOR 5220-SS)* |
| 27 | 304186 | CONNECTOR, 0.25" TUBE X 0.125" FNPT, 316 SS |
| 28 | 304245 | TEE, BRASS, 1/8" NPTF *(FOR 5220-RS)* |
| 29 | 20977 | CONNECTOR, ¼" TB X 1/8" MNPT *(FOR 5220-RS)* |
| 30 | 304248 | FUEL LINE, SV TO FPSW ELBOW, 5220-RS |

# 12 OPTIONAL REMOTE START MODEL

## QUICK START PROCEDURE

Refer to INSTALLATION in section 2.1 for standard 5220 TEG, following additional INSTALLATION in section 12.1:

- Open the customer-installed circuit breaker or fuse on the customer load that isolates the TEG. Be sure a battery (12V battery for 12V systems or 24V battery for 24V systems) is connected to BAT +/- terminals on the TCC module.
- Configure the TEG electronics to be in SETUP mode by moving the jumper clip on TB1 so that it connects terminals 2 and 3. See Figure 41 or Figure 42.
- Open the manual shutoff valve to supply fuel gas to the TEG.

**NOTE:** Once the TEG is started, closing the manual shutoff valve will shut it off.

- Set the LOCAL/REMOTE switch to LOCAL position.
- Toggle the local START switch.
- The Spark Ignition (SI) system should begin clicking and fuel will start flowing after one second, and the sound of combustion can be heard within 7 seconds. If the burner does not ignite, the SI will wait 10 seconds to attempt a second ignition trial. If the second trial is unsuccessful, the system will wait a further 10 seconds to attempt a third ignition trial. After the third unsuccessful trial, the ignition control system will go into lockout mode.
- If the SI has gone into lockout mode (3 failed ignition attempts), reset it by waiting for the DC PWR and SI PWR lights on the TCC module to turn off, then toggling the START switch again. The TEG should then restart the ignition sequence.
- If the TEG fails to sustain ignition after 3 more spark trials, see TROUBLESHOOTING in section 12.4.
- Once the TEG is running, leak-check the entire fuel system from the fuel supply line to the burner inlet using a commercial leak detector fluid such as Snoop®.
- Refer to sections 7, 8, 2.3 and 2.4 to tune the TEG to required $V_{set}$ and put the TEG into operating mode: jumper clip on terminal block TB1 in RUN position so that it connects terminals 1 and 2 (see Figure 41 or Figure 42). Keep a record in the log.
- Refer to ADJUSTMENT in section 12.2 for instructions to configure the TEG ON value, TEG OFF value, and Output Voltage (either from Limiter or Limiter/Converter) value.

**NOTE:** The Output Voltage MUST be adjusted on-site for the specific application.

- Reconnect the customer load.
- Return the LOCAL/REMOTE switch to REMOTE position.

## INTRODUCTION

The purpose of this Remote Start option is to provide automatic start and stop control of the model 5220 TEG based of battery voltage sensing, as well as safe remote and local starting and stopping of the TEG, in nominal 12V systems or 24V systems. A spark ignition (SI) module constantly monitors the presence of the TEG's combustion flame and relays this information to the TEG Charge Controller (TCC) module. Control of the TEG can be either by a signal from the customer's Supervisory Control and Data Acquisition (SCADA) system, the battery voltage sensing, or by the manual switches located on the TCC module.

The remote start TEG has a few differences from the standard TEG, which are listed below:

- Addition of a remote start electronics enclosure, as shown in Figure 39.
- TEG cabinet and leg are different to accommodate the additional enclosure.
- Different Limiter/Converter or Limiter only electronics without SI related components.
- On applicable TEG models, the SOV is replaced with a system voltage dependent solenoid controlled by the spark ignition (SI) module within the remote start electronics enclosure.
- A second fuel pressure switch, see Figure 38, is added to the fuel system to provide a fuel pressure status signal to the optional customer SCADA system.
- A slightly different protective shield and a rain cap exhaust stack assembly are equipped.

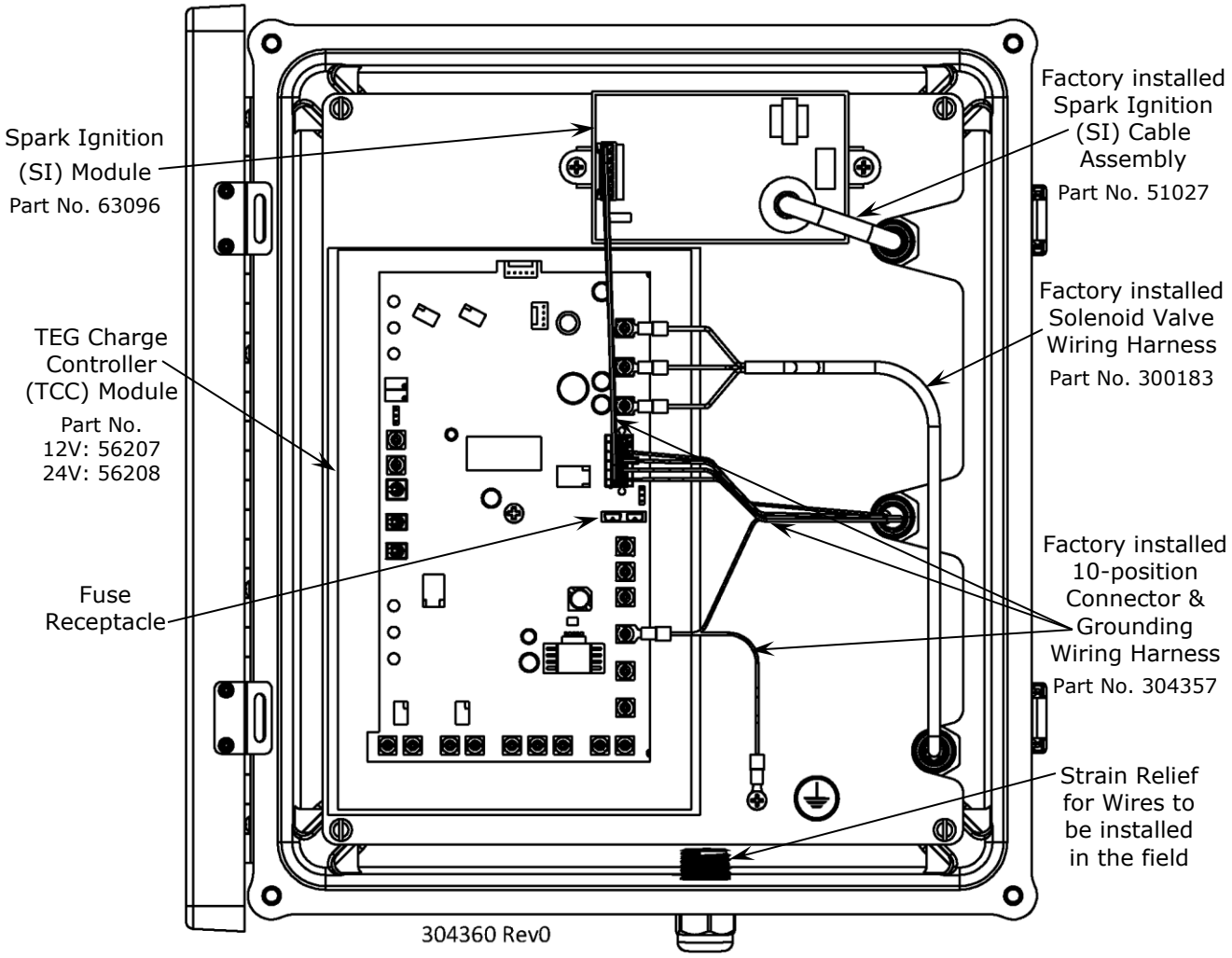



*Figure 39 - Remote Start Electronics Enclosure*

The Remote Start box and below listed wiring harnesses, shown in Figure 39, are all factory installed. Either a 12V or 24V Remote Start box is mounted on the left side of the cabinet (on the opposite side of the limiter or L/C electronics box).

- SI Cable Assembly

  The high voltage spark ignition cable assembly is factory installed from the SI module in the remote start box to the electrode assembly in the TEG cabinet.
- Solenoid Valve Wiring Harness

  The 3-conductor wiring harness is factory installed from the TCC module to the solenoid valve plug.

  The solenoid valve receives power through the battery voltage sensing wires, when the SI module is powered and requiring the solenoid valve to be operational.
- 10-position Connector & Grounding Wiring Harness

  Consists of a wiring harness that is factory installed from the TCC module to the SI module and to the fuel pressure switches.

  Green grounding wires are also factory installed to ground the Remote Start Box to the system's grounding lug. These green grounding wires are required to provide a spark return path, from generated spark connected to the electrode in the TEG burner assembly, to the high voltage generator inside the SI module.

Indicators are located on the TCC module and are described below (See Figure 40).

- Battery Voltage Status Indicators (MAX, MED, and MIN)

  Three green LED's, located in the top left-hand corner of the TCC module, are used to indicate the battery voltage. Only one light is on at a time.
  - MAX LED Indicator

    When the battery voltage is at or above the TEG OFF value set within the TCC module, only the MAX LED indicator is on. When the system is set to REMOTE mode, the MAX LED is also the voltage sensing stop signal, indicate stopping the TEG.
  - MED LED Indicator

    When the battery voltage is in between the TEG ON and the TEG OFF values, only the MED LED indicator is on. This indicates that the battery voltage is between the charging and discharging voltages.
  - MIN LED Indicator

    When the battery voltage is at or below the TEG ON value set within the TCC module, only the MIN LED indicator is on. When the system is set to REMOTE mode, the MIN LED is also the voltage sensing start signal, indicates starting the TEG.
- SI Power Indicator (SI PWR)

  One green LED, top indicator in the set of indicators located in the lower left-hand corner of the TCC module, is used to indicate when the SI module is being powered from the TCC module.
- DC/DC Power Indicator (DC PWR)

  One green LED, middle indicator in the set of indicators located in the lower left-hand corner of the TCC module, is used to indicate when the internal DC/DC converter is being powered by the TCC board.
- No Combustion Indicator (SI NC)

  One red LED, bottom indicator in the set of indicators located in the lower left-hand

corner of the TCC module, is used to display the no combustion signal received from the SI module.

Other controls and connections on the TCC module are described throughout the rest of this section in this manual.

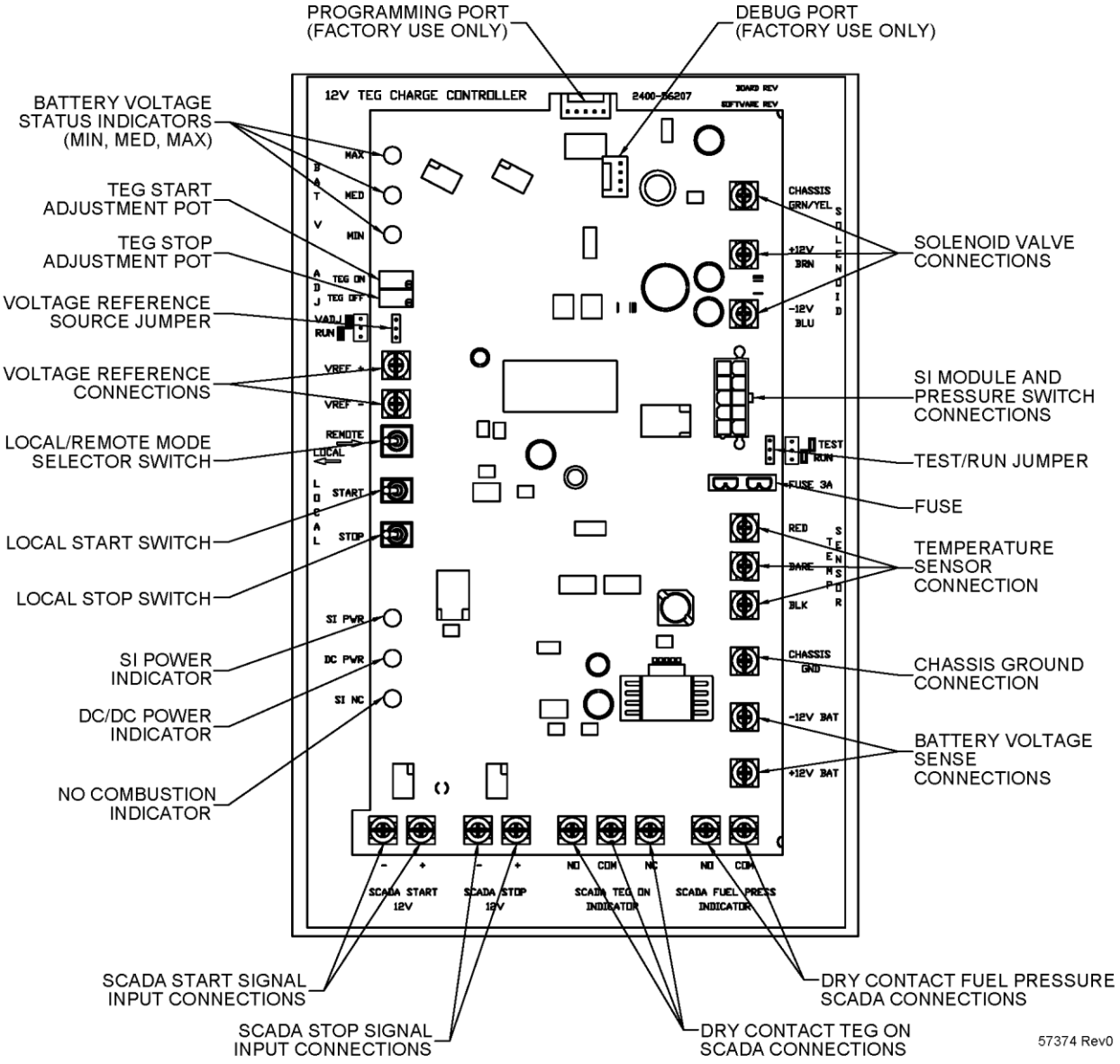



*Figure 40 - TEG Charge Controller (TCC) Module*

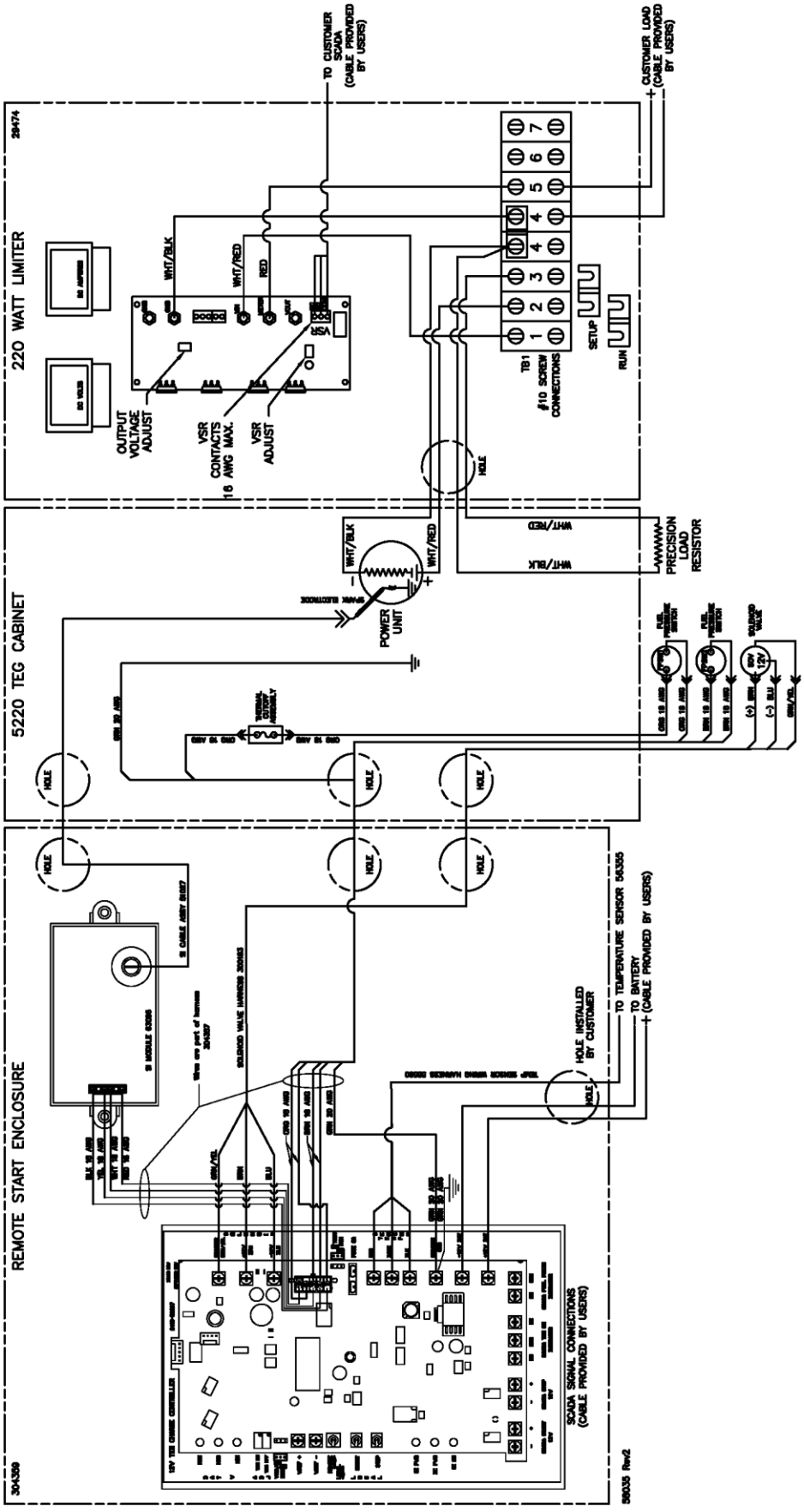



*Figure 41 - 12V Remote Start 5220 System Wiring Diagram*

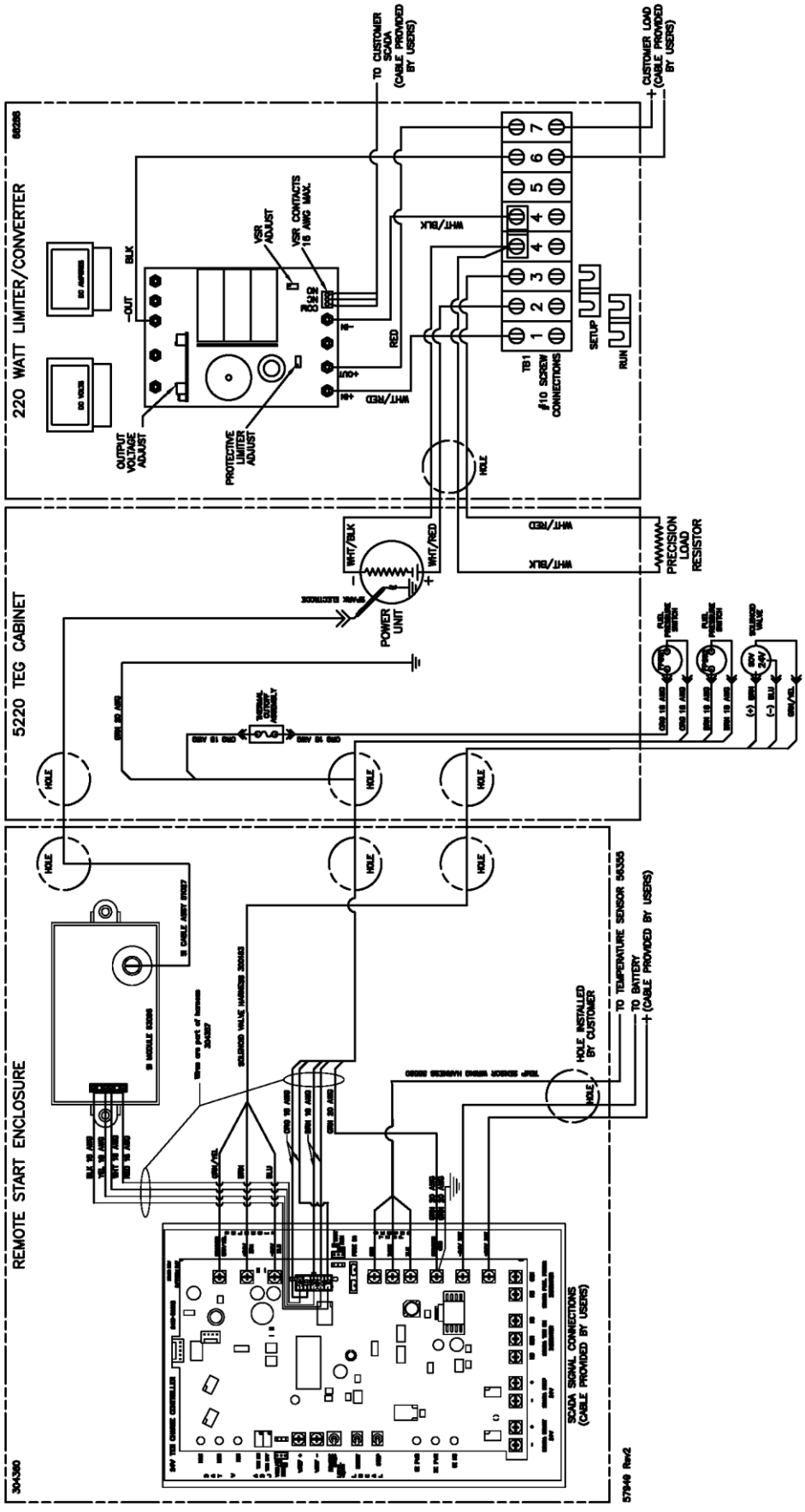



*Figure 42 - 24V Remote Start 5220 System Wiring Diagram*

## 12.1 INSTALLATION

In addition to INSTALLATION for standard 5220 TEG described in section 5, refer to wiring diagram Figure 41 or Figure 42, complete additional installations for model 5220-RS TEG.

### 12.1.1 Battery Voltage Sense Wiring Installation

Two wires are customer supplied and installed in the field to connect the TCC module to the customer batteries within the battery enclosure. These wires are used to power the TCC module and to accurately measure the battery voltage at the battery terminals.

The input voltage range is 11 – 16.5 Vdc, with an approximate 0.3A draw for a nominal 12V system. The input voltage range is 22 – 32 Vdc, with an approximate 0.6A draw for a nominal 24V system.

**CAUTION!** Route these two wires or cable all the way, starting from the battery enclosure, through the strain relief on the bottom of the remote start electronics enclosure. Cut to length, install suitable fork terminals, and connect to BAT +/- terminals on the TCC module. Install suitable ring terminals on the other ends, connect the battery negative terminal first, and then connect the battery positive terminal.

### 12.1.2 Temperature Sensor Installation

The included temperature sensor (Part No. 56355) measures the temperature of the battery when it is mounted to one of the battery posts on site, as shown in Figure 43, and the TCC module uses this temperature to compensate the automatic charging voltage by stopping the TEG at the compensated value.

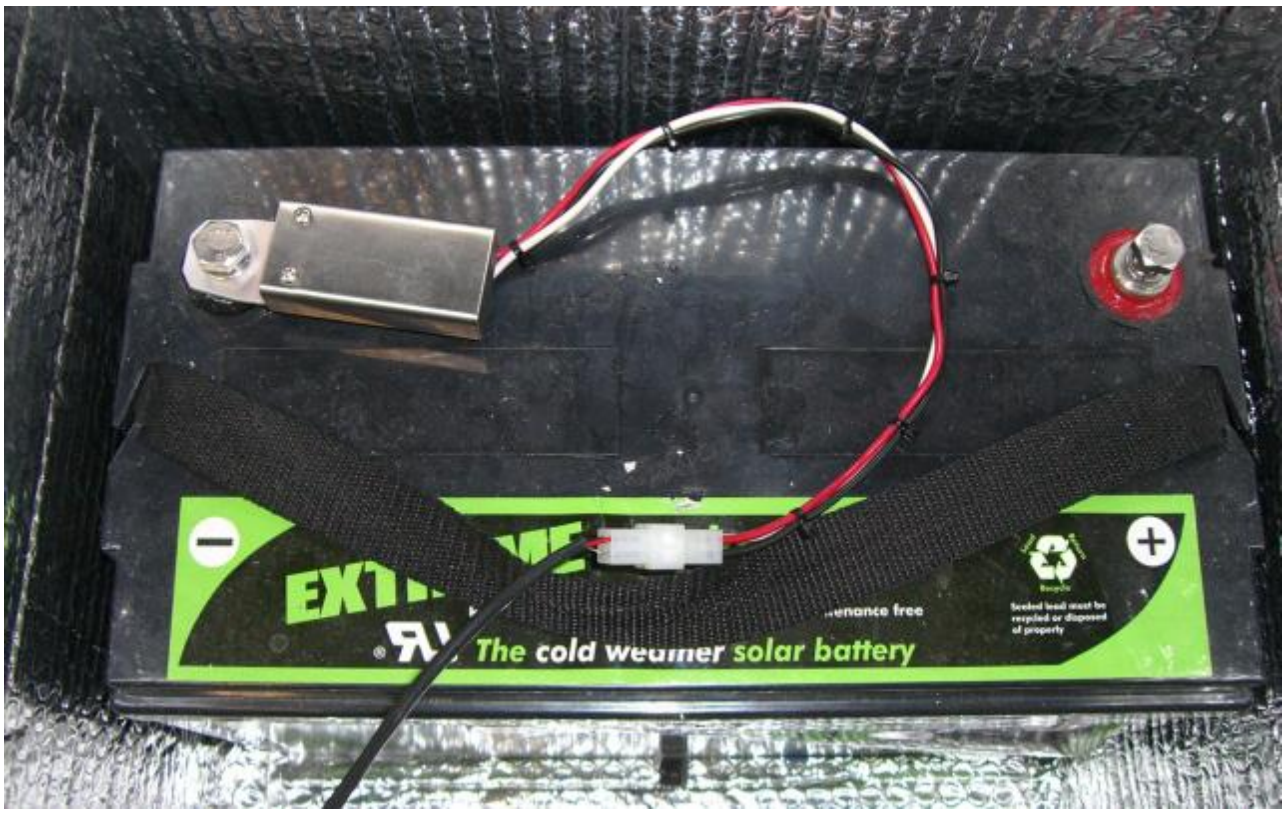



*Figure 43 - Example of the Temperature Sensor Mounted to a Single Battery*

Three-conductor temperature sensor wiring harness (Part No. 55580) provided is to be cut to length and installed in the field. Connect the mating connectors from the temperature sensor assembly to the connector on the harness. Route the harness all the way to the TCC module through the strain relief on the bottom of the remote start enclosure. Cut to length and trim back about one inch of the outer sheath of the wiring harness; be careful not to cut into any of the inner wire insulation. The bare drain wire does not have covering insulation. Install three provided fork terminals onto the ends of each wire. Eventually connect all three fork terminals to TEMP SENSOR connection terminals, RED/BARE/BLK, on the TCC module.

Temperature compensation is required because of the large range of temperatures the batteries are exposed to. Typically, battery charging voltages are given assuming the temperature is 25°C. Any deviation below this temperature will mean the batteries are not fully charged if the same upper charging limit is maintained resulting in reduced battery capacity. Any deviation above 25ºC can overcharge the battery resulting in permanent battery damage. To avoid this, the temperature of the battery is measured and the effective battery charge limits are adjusted. The TEG ON voltage will not change with temperature. The TEG OFF voltage will be temperature compensated from 25°C at a rate of 5.5 mV/°C per battery cell. On a 12V system, this equates to 0.033 V/°C. On a 24V system, this equates to 0.066 V/°C.

**WARNING!** The temperature sensor should always be installed on one of the battery terminals in the battery enclosure and connected to the TCC module. Improper installation or disconnecting the temperature sensor will cause the system to not operate as intended and can cause harm to the batteries.

### 12.1.3 Optional SCADA Wiring Installation

SCADA wiring is customer supplied and installed in the field between the TCC module and the customer's SCADA system.

SCADA Start Wiring

Supply a momentary nominal system voltage to the polarity sensitive SCADA START terminals to activate the on-board relay, which signals a SCADA start request when the LOCAL/REMOTE switch is in REMOTE position. Current draw is less than 20 mAdc.

SCADA Stop Wiring

Supply a momentary nominal system voltage to the polarity sensitive SCADA STOP terminals to activate the on-board relay, which signals a SCADA stop request when the LOCAL/REMOTE switch is in REMOTE position. Current draw is less than 20 mAdc.

SCADA TEG ON Wiring

Dry contact connection from the SCADA TEG ON INDICATOR terminals on the TCC module to SCADA system: NC (normally closed), NO (normally open), and COM (common) are provided, allowing the customer SCADA system to read the TEG's operating status (on or off).

Maximum switching current rating through dry contacts: 2 Adc resistive load.

SCADA Fuel Pressure Wiring

Dry contact connection from the SCADA FUEL PRESS(ure) INDICATOR terminals on the TCC module to the SCADA system, through a fuel pressure switch: NO (normally open) and COM (common) are provided, allowing the customer SCADA system to read the status of the pressure switch (open or closed).

Maximum switching current rating through dry contacts: 2 Adc resistive load.

## 12.2 ADJUSTMENT

In addition to adjustments listed in section 8 for a standard 5220 TEG, the remote start adjustments are all located on the TCC module (see Figure 40) and are described below.

### ➢ BENCH TESTING JUMPER

This jumper is located on the right-hand side, between the 10-position connector and the fuse in the middle of the TCC module.

There are two positions: **RUN** and **TEST**

- **RUN** position uses the pressure switch located in the fuel system to connect the power from the battery to the remainder of the TCC module. This is the position the jumper needs to be in for normal operation.
- **TEST** position is for bench testing purposes only. When the jumper is in the TEST position, it bypasses the pressure switch and makes the connection on the TCC module allowing the module to be configured on the bench.

### ➢ VOLTAGE REFERENCE SOURCE JUMPER

This jumper is located on the left-hand side, between the ADJ potentiometers (TEG ON and TEG OFF) and VREF terminals of the TCC module.

There are two positions: **RUN** and **VADJ**

- **RUN** position uses the battery voltage, connected at the lower right-hand corner of the TCC module to display the battery voltage status on the light and to start and stop the TEG when running in REMOTE mode. This is the position the jumper needs to be in for normal operation.
- **VADJ** position uses the reference voltage connected at the VREF terminals, located below the jumper, to display its voltage on the status indicators. The purpose of this jumper position is to use an alternate adjustable power source to adjust the TEG ON and TEG OFF voltages. The LOCAL/REMOTE switch should be in the LOCAL position when using the VADJ position, since the connected voltage affects the voltage sensing on and off signals controlling the starting and stopping of the TEG.

When this jumper is removed, the battery voltage status lights will turn off. When this jumper is re-installed, wait 10 seconds to allow the internal programming to finish initializing, before using the battery voltage status lights as indicators.

### ➢ VREF+ and VREF- TERMINALS– VOLTAGE REFERENCE CONNECTIONS

Connect positive/negative terminals of the reference voltage source to VREF+/VREF- terminals on the TCC module to adjust the TEG ON and TEG OFF values.

### ➢ TEG ON – TEG START ADJUSTMENT POTENTIOMETER

This potentiometer is used to adjust the TEG ON value.

The TEG ON value is the voltage that the TEG will start; and is selected to be the minimum voltage the battery should fall to before starting the TEG to begin the battery recharging cycle.

### ➢ TEG OFF – TEG STOP ADJUSTMENT POTENTIOMETER

This potentiometer is used to adjust the TEG OFF value.

The TEG OFF value is the voltage that the TEG will stop to end the current battery recharging cycle; and is selected to be the battery voltage to be charged to.

Set the TEG OFF value to the charging voltage at +25°C recommended by the battery manufacturer.

Factory default TEG ON value is set to 12.2V for a 12V system or 24.4V for a 24V system. Factory default TEG OFF value is set to 13.6V for a 12V system or 27.2V for a 24V system, at 25°C.

Factory default TEG ON and TEG OFF values were selected to maintain a valve regulated lead-acid gelled electrolyte solar battery system between approximately 50% and 80% state of charge in an application where the TEG is a backup power source to a solar system. If the application is different, these values can be adjusted to the required values based on the components in the system by following adjustment procedures described in section 12.2.1 or 12.2.2.

### 12.2.1 TEG ON/OFF Values Adjustment Using a Power Supply

Equipment and tools required:

- 30Vdc 1Adc adjustable power supply
- Voltmeter
- Small flat blade screwdriver
- Two jumper wires (minimum 20 AWG, long enough to connect power supply to TCC)

Following below steps to adjust TEG ON/OFF values by using an adjustable power supply:

1. Set the adjustable DC power supply output voltage to 12V for 12V system or 24V for 24V system. Turn off the power supply and connect its positive/negative terminals to VREF+/VREF- terminals on the TCC module.
2. Disconnect the temperature sensor from the TCC module.
3. Set the BENCH TESTING JUMPER to TEST position.
4. Set the VOLTAGE REFERENCE SOURCE JUMPER to VADJ position.
5. Set the LOCAL/REMOTE switch to LOCAL position.
6. Turn on the adjustable DC power supply to power up the system. Wait for minimum 10 seconds to let the TCC module complete initialization.
7. Set the DC power supply output voltage to the desired TEG ON value. Keep monitoring this voltage with the voltmeter till the TEG ON/OFF values adjustment is completed.

   Watch the MIN LED Indicator. If it is lit, turn the adjusting screw on the TEG ON potentiometer counterclockwise till it goes off. Then slowly turn the adjusting screw on the TEG ON potentiometer clockwise till the MIN LED Indicator lights.

   This procedure can be repeated several times to get comfortable with how fast (slow) to turn the pot to get the LED to light.

   Once set, the TEG ON value can now be verified by adjusting the output voltage of the DC power supply. Increase the output voltage of the DC power supply so the MIN LED Indicator is off. Then slowly decrease the output voltage of the DC power supply till the MIN LED Indicator lights up. Make sure the TEG ON value is set accurately.
8. Set the DC power supply output voltage to the desired TEG OFF value.

   Watch the MAX LED Indicator. If it is lit, turn the adjusting screw on the TEG OFF potentiometer clockwise till it goes off. Then slowly turn the adjusting screw on the TEG OFF potentiometer counterclockwise till the MAX LED Indicator lights.

   This procedure can be repeated several times to get comfortable with how fast (slow) to turn the pot to get the LED to light.

Once set, the TEG OFF value can now be verified by adjusting the output voltage of the DC power supply. Decrease the output voltage of the DC power supply so the MAX LED Indicator is off. Then slowly increase the output voltage of the DC power supply till the MAX LED Indicator lights up. Make sure the TEG OFF value is set accurately.

9. Once the TEG ON/OFF are set properly, return the system to operating mode by:
   - Shut off the DC power supply and remove jumper wires.
   - Reconnect the temperature sensor to the TCC module.
   - Set the BENCH TESTING JUMPER to RUN position.
   - Set the VOLTAGE REFERENCE SOURCE JUMPER to RUN position.
   - Set the LOCAL/REMOTE switch to REMOTE position.

### 12.2.2 TEG ON/OFF Values Adjustment Using the TEG

**WARNING!** The following procedure uses live circuits. Take extreme care when making or breaking the jumper connections, as touching other connections may damage multiple components.

Equipment and tools required:

- Voltmeter
- Small flat blade screwdriver
- Two jumper wires (minimum 20 AWG, 48 inches (122 cm) length each)

Following below steps to adjust TEG ON/OFF values by using the TEG in the field:

1. Disconnect the temperature sensor from the TCC module.
2. Check the BENCH TESTING JUMPER to make sure it is in RUN position.
3. Open the customer-installed circuit breaker or fuse on the customer load that isolates the TEG. Be sure the battery is connected to BAT +/- terminals on the TCC module.
4. Refer to Figure 44 or Figure 45, carefully connect VREF- terminal starting from the TCC module to the output negative terminal on the terminal block TB1 located inside the limiter or L/C electronics box, then carefully connect VREF+ terminal starting from the TCC module to the output positive terminal on TB1, with jumper wires.
5. Set the LOCAL/REMOTE switch to LOCAL position.

   If the TEG is still running and is hot enough, skip to step 6; if the TEG is not running, toggle the START switch to start the TEG.

   If the TEG was just started, allow the TEG to run for a minimum of 15 minutes to generate enough power to operate L/C or limiter electronics.
6. Set the VOLTAGE REFERENCE SOURCE JUMPER to VADJ position. Wait for minimum 10 seconds to let the TCC module complete initialization.
   - Keep monitoring the TEG's output voltage with the voltmeter till TEG ON/OFF values adjustment is completed.
   - Record the TEG's output voltage now. This value will be used to reset the output voltage after the TEG ON/OFF values adjustments are complete.
7. Refer to Figure 44 or Figure 45, use the Output Voltage Adjust Pot on the L/C board or limiter board to set the TEG's output voltage to the desired TEG ON value.

   Watch the MIN LED Indicator. If it is lit, turn the adjusting screw on the TEG ON

potentiometer counterclockwise till it goes off. Then slowly turn the adjusting screw on the TEG ON potentiometer clockwise till the MIN LED Indicator lights.

This procedure can be repeated several times to get comfortable with how fast (slow) to turn the pot to get the LED to light.

Once set, the TEG ON value can now be verified by adjusting the output voltage of the TEG. Increase the output voltage of the TEG so the MIN LED Indicator is off. Then slowly decrease the output voltage of the TEG till the MIN LED Indicator lights up. Verify this voltage with the voltmeter and determine if the TEG ON value is set accurately.

8. Set the TEG's output voltage to the desired TEG OFF value.

   Watch the MAX LED Indicator. If it is lit, turn the adjusting screw on the TEG OFF potentiometer clockwise till it goes off. Then slowly turn the adjusting screw on the TEG OFF potentiometer counterclockwise till the MAX LED Indicator lights.

   This procedure can be repeated several times to get comfortable with how fast (slow) to turn the pot to get the LED to light.

   Once set, the TEG OFF value can now be verified by adjusting the output voltage of the TEG. Decrease the output voltage of the TEG so the MAX LED Indicator is off. Then slowly increase the output voltage of the TEG till the MAX LED Indicator lights up. Make sure the TEG OFF value is set accurately.

9. Once the TEG ON/OFF are set properly, return the system to operating mode by:
   - Remove the jumper wires starting from output terminals on terminal block TB1.
   - Reconnect the temperature sensor back to the TCC module.
   - Reset the TEG's output voltage back to the original value recorded in step 6.
   - Reconnect the customer load to the TEG.
   - Set the VOLTAGE REFERENCE SOURCE JUMPER to RUN position.
   - Set the LOCAL/REMOTE switch to REMOTE position.

### 12.2.3 TEG Output Voltage Adjustment

The maximum output voltage of the TEG is the output voltage set to the L/C or limiter present on the customer load connections on terminal block TB1, without customer load connected. It must be adjusted properly depending on the application and the system operating mode (LOCAL or REMOTE). See section 12.3.1 and 12.3.2 for more information.

Refer to Figure 41 or Figure 42, use the Output Voltage Adjust Pot on the L/C board or limiter board to set the TEG's output voltage to the desired value for operation.

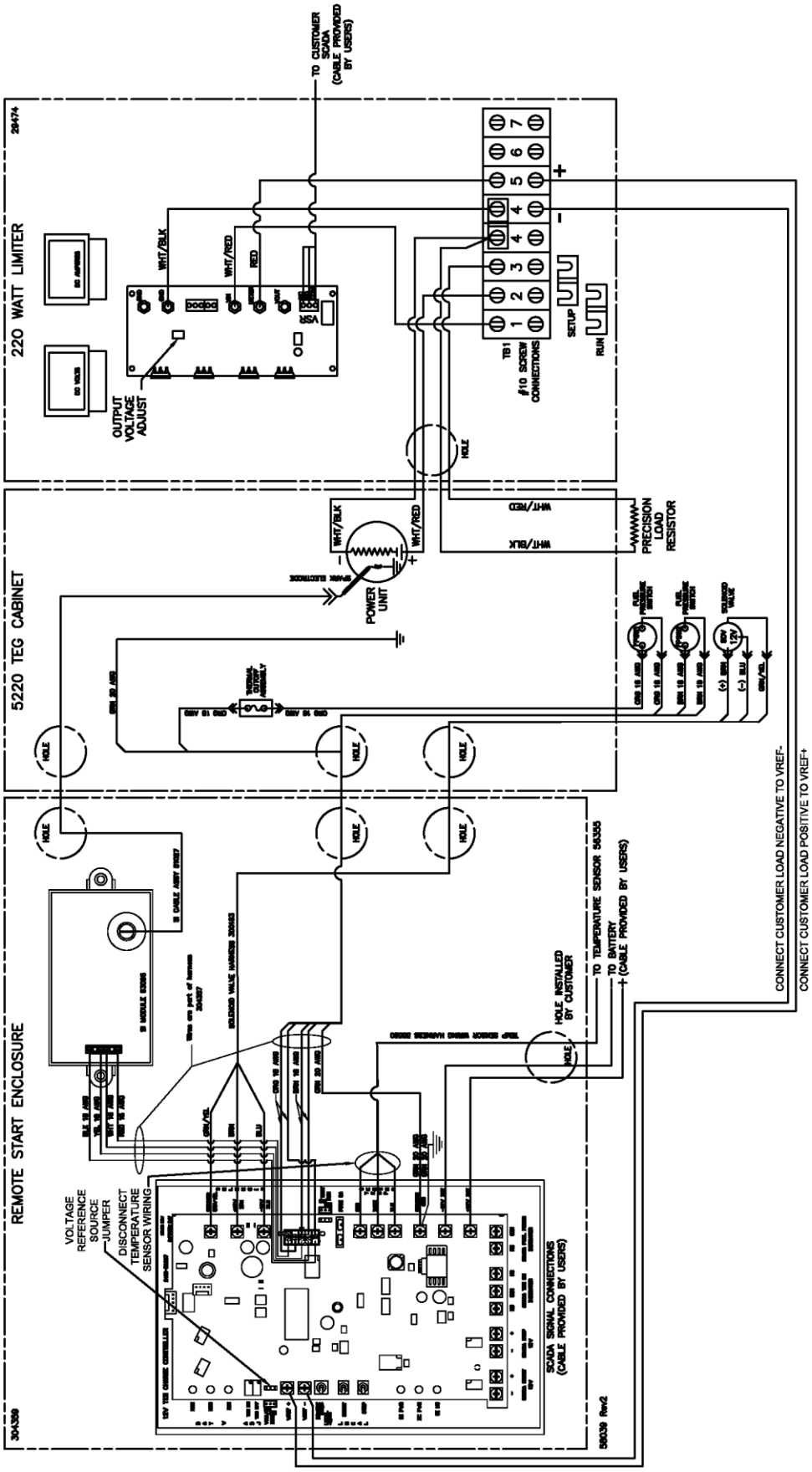



*Figure 44 - 12V Remote Start 5220 System In-Field Adjustment Using the TEG*

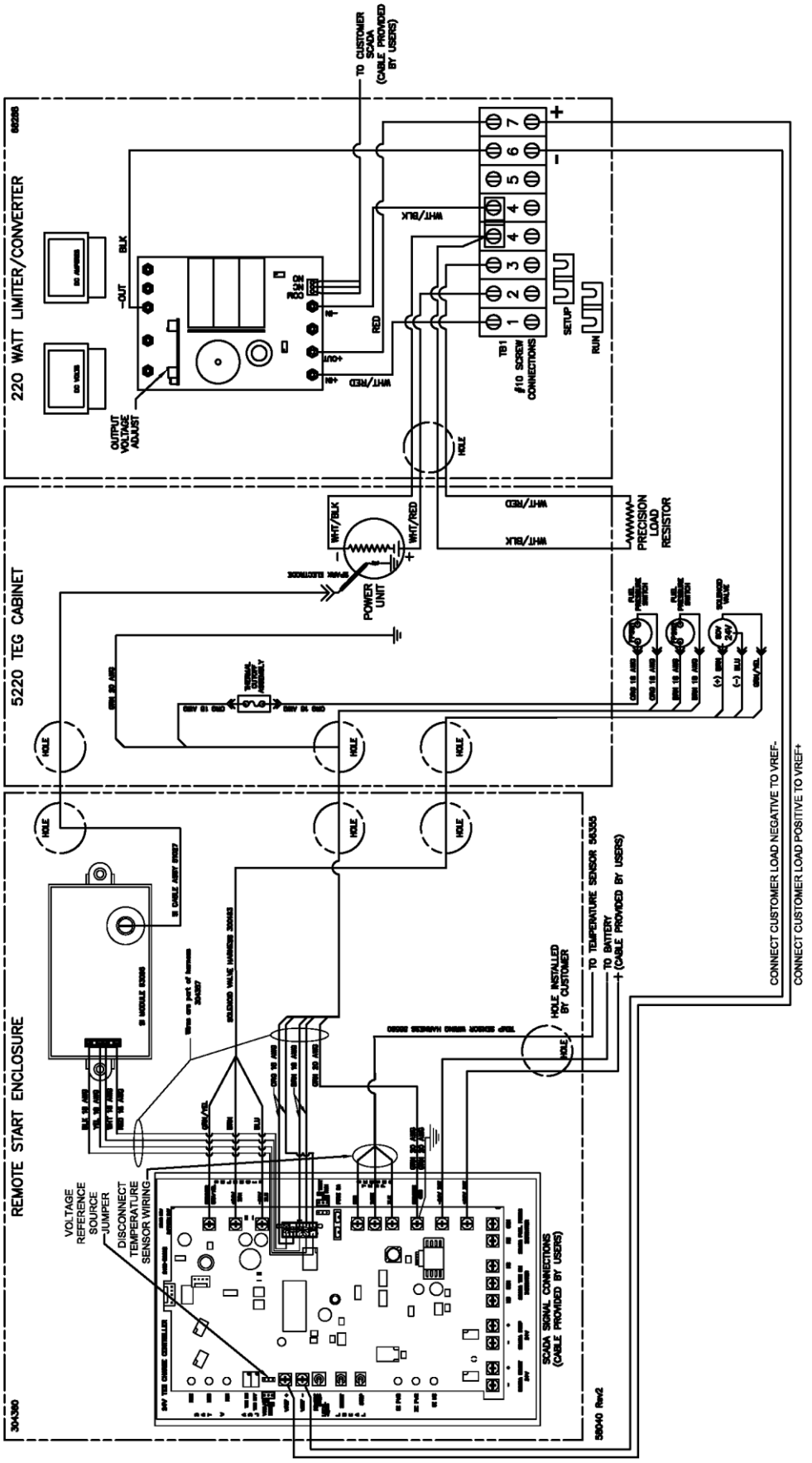



*Figure 45 - 24V Remote Start 5220 System In-Field Adjustment Using the TEG*

## 12.3 OPERATION

### 12.3.1 LOCAL Mode Operation

For LOCAL mode operation:

- The BENCH TESTING JUMPER needs to be in the RUN position.
- The VOLTAGE REFERENCE SOURCE JUMPER needs to be in the RUN position.
- The LOCAL/REMOTE switch needs to be in the LOCAL position.
- The TEG output voltage must be adjusted for the load and application.

In LOCAL operation mode, the TEG will run till manually stopped by using either the LOCAL STOP switch or the manual shutoff valve, and the output voltage will strive to reach the output voltage setting.

The L/C or limiter electronics output voltage must be set to the value required by the load and application to ensure the output voltage does not cause harm to the load being connected. If the load is a battery, consult the specification of the battery and assess the needs of the application to determine the required output charging setting.

**WARNING!** The TEG ON and TEG OFF values do not control the operation of the TEG when it is running in LOCAL mode. Temperature compensation is only applied to the TEG OFF value and has no effect in LOCAL mode. If the output voltage is set incorrectly, it may cause damage to what is connected.

Following below procedures to start the TEG:

- Open the manual shutoff valve to supply fuel gas to the TEG.

  **NOTE:** Once the TEG is started, closing the manual shutoff valve will shut it off.

- Toggle the START switch while the LOCAL/REMOTE switch is in LOCAL position.
- The SI PWR, DC PWR and SI NC indicators should turn on.
- Refer to section 12.3.4 to verify the SI operation.

  If the SI has gone into lockout mode (3 unsuccessful ignition attempts), reset it by waiting for the DC PWR and SI PWR lights on the TCC module to turn off, then toggling the START switch again. The TEG should then restart the ignition sequence.

  If the TEG fails to sustain ignition after 3 more ignition trials, see TROUBLESHOOTING in section 12.4.
- Once the TEG is running, leak-check the entire fuel system from the fuel supply line to the burner inlet using a commercial leak detector fluid such as Snoop®.

To turn off the TEG, toggle the STOP switch while the LOCAL/REMOTE switch is in LOCAL position, or close the manual shutoff valve. The TEG will continue to produce power while it is still hot.

### 12.3.2 Automatic REMOTE Mode Operation

For REMOTE mode operation:

- The BENCH TESTING JUMPER needs to be in the RUN position.
- The VOLTAGE REFERENCE SOURCE JUMPER needs to be in the RUN position.
- TEG ON and TEG OFF values need to be set.
- Temperature sensor needs to be installed to one of battery terminals and to be connected

to the TCC module.

- The LOCAL/REMOTE switch needs to be in the REMOTE position.
- The TEG output voltage must be adjusted for the load and application.

When the LOCAL/REMOTE switch is set to REMOTE position, operation of the Remote Start 5220 TEG system is automatic based on measured battery voltage, TEG ON value, TEG OFF value and temperature sensor readings.

The measured battery voltage is compared to the TEG ON and the temperature compensated TEG OFF values to determine when to start or stop the TEG.

When the measured battery voltage falls to or below the TEG ON value, the TEG is started.

When the measured battery voltage rises to or above the temperature compensated TEG OFF value, the TEG is stopped.

The temperature compensated TEG OFF value is calculated by the TCC module based on the set TEG OFF value and the readings of the temperature sensor.

**WARNING!** The temperature sensor should always be installed on one of the battery terminals in the battery enclosure and connected to the TCC module. Improper installation or disconnecting the temperature sensor will cause the system to not operate as intended and can cause harm to the batteries.

The TEG output voltage needs to be set higher than the temperature compensated TEG OFF value in automatic REMOTE mode operation. Otherwise, the TEG will not stop until temperature rises so the TEG is able to bring the measured battery voltage to the temperature compensated TEG OFF value.

To determine the output voltage setting value in a battery charging application while running in REMOTE Mode, use the following calculations:

Vout setting = (Losses) + (TEG OFF value) + (Temp Comp Value)

Temp Comp Value = Δ Temp * 0.033 V/ºC (for 12V systems)

Temp Comp Value = Δ Temp * 0.066 V/ºC (for 24V systems)

Δ Temp = 25ºC – Tmin

Where:

Vout setting = the value to set the output voltage with nothing connected to the customer load connections on the terminal block TB1

Losses = losses in the wires connecting the TEG output terminals to the battery, plus losses in the on-board reverse protection diode

TEG OFF value = the determined charging voltage (or float voltage) for the batteries being used. Based on the application and as referenced on the battery specification at room temperature with any temperature compensation – typically at 25ºC (volts dc)

Temp Comp Value = value used as part of the calculation to determine the Vout setting. Based on the minimum operating temperature and nominal system voltage (volts dc)

ΔTemp = temperature difference between 25ºC (fixed reference temperature) and minimum temperature (degrees Celsius)

Tmin = the minimum temperature the battery will be operating (degrees Celsius)

EXAMPLE: The following example is for reference only, to demonstrate the calculations. Recalculate the Vout setting using values for the specific application.

The minimum temperature, Tmin, is determined to be -25ºC.

The system is a nominal 24V system.

The charging voltage (from the battery specification) is determined to be 27.2V.

Losses approximated to be 1.0V (0.7V diode drop, plus very small losses in the cables).

Δ Temp = 25ºC – Tmin = 25ºC – (-25ºC) = 50ºC

Temp Comp Value = Δ Temp * 0.066 V/ºC = 50ºC * 0.066 V/ºC = 3.3 V

Vout setting = (Losses) + (TEG Off Value) + (Temp Comp Value)
= 1.0 V + 27.2 V + 3.3 V
= 31.5 V

Set the output voltage to 31.5 Vdc without any load connected (REMOTE mode only)

**WARNING!**

Do not leave the site with the system in LOCAL mode and the TEG running, otherwise the batteries will be over-charged, and the TEG will run continuously. The output voltage of TEG electronics should be set at a higher voltage to allow battery charging up to a higher voltage during colder temperatures.

When in REMOTE mode, the TCC module calculates when to stop the TEG based on the temperature compensated TEG OFF value and stops the TEG when that voltage has been reached. This functionality is not part of the LOCAL operating mode.

### 12.3.3 Optional SCADA Remote Operation

When the LOCAL/REMOTE switch is set to REMOTE position, SCADA START and SCADA STOP can also be used to control the TEG by the customer SCADA system.

In addition to VSR status, TEG ON and FUEL PRESS(ure) dry contacts are also provided to the customer SCADA system.

- When the measured battery voltage falls to or below the TEG ON set value, as indicated by the MIN battery voltage indicator, the TCC module automatically starts the TEG. SCADA START signal is not required and SCADA STOP signal is ignored till the measured battery voltage raises minimum 0.5V (in a nominal 12V system) or 1.0V (in a nominal 24V system) above the TEG ON set value.

  When the TEG is running and the measured battery voltage is minimum 0.5V (in a nominal 12V system) or 1.0V (in a nominal 24V system) above the TEG ON set value, a momentary SCADA STOP signal stops the TEG and a momentary SCADA START signal starts the TEG.

- When the measured battery voltage rises to or above the temperature compensated TEG OFF level, the TCC module automatically stops the TEG. SCADA STOP signal is not required, and SCADA START signal is ignored till the measured battery voltage falls minimum 0.5V (in a nominal 12V system) or 1.0V (in a nominal 24V system) below the temperature compensated TEG OFF level.

  When the TEG is not running and the measured battery voltage falls minimum 0.5V (in a nominal 12V system) or 1.0V (in a nominal 24V system) below the temperature compensated TEG OFF level, a momentary SCADA START signal starts the TEG and a

momentary SCADA STOP signal stops the TEG.

### 12.3.4 Spark Ignition (SI) System Operation

The SI system consists of the following parts:

- Spark electrode
- Spark Ignition (SI) module
- Solenoid Valve (SOV)
- TCC module
- Pressure switch (connected with orange wires)
- Thermal Cutoff (TCO) Assembly
- Customer battery (connected to BAT +/- terminals on the TCC module)

When the manual shutoff valve is opened, fuel pressure causes the pressure switch (located in the fuel system) to close. The SI system is now powered up by the customer battery through the closed contacts of the pressure switch. When a valid TEG start request signal (refer to section 12.3.1, 12.3.2, and 12.3.3 for details) received, combined with the absence of flame, the SI module produces sparks in the burner. At this point, the SI module opens the solenoid valve, allowing fuel gas to flow into the burner. Once flame is detected, the SI module will stop sparking and will continue to monitor the presence of flame at the electrode. If the SI module does not detect combustion within the 7 seconds trial for ignition period, it will close the solenoid valve and will stop sparking. It will turn on the No Combustion Indicator (SI NC), enter the 10 seconds purging period, and then make another ignition attempt. The SI module will attempt 3 ignition trials, and if combustion cannot be maintained, the SI system will enter lockout mode and the No Combustion Indicator (SI NC) will be on.

If the flame is lost when the TEG is running, the SI system will follow the same sequence as above to reignite the TEG.

If a flame is sensed when the solenoid valve is not opened by the SI Module, the SI system will enter lockout mode and the No Combustion Indicator (SI NC) will be on. This can occur when attempting to restart a hot TEG. The TEG will need to cool sufficiently before attempting a restart.

Once entered lockout mode, the SI system will not allow any additional trials for ignition until reset by turning it off for 10 seconds before restarting the SI system.

**CAUTION!**

The SI system has to be manually reset at site, if it entered lockout mode while the LOCAL/REMOTE switch was in REMOTE position.

To reset the SI system, set the LOCAL/REMOTE switch to LOCAL position, toggle the STOP switch to turn off the SI system, indicated by SI PWR and DC PWR indicator in the lower left corner of the TCC board turning off. Wait for 10 seconds and toggle the START switch to attempt a restart. When ignition has been achieved, return the LOCAL/REMOTE switch to REMOTE position.

## 12.4 TROUBLESHOOTING

Refer to section 10.1, 10.3, 10.4 as these are also applied to Remote Start 5220 TEG. This section focuses on troubleshooting SI system for a Remote Start 5220 TEG only.

| Problem | Probable Cause | Possible Solution | Lookup Section |
|---|---|---|---|
| **None of the Battery Voltage Status Indicators (MAX, MED, and MIN) on the TCC module is on<br><br>or<br><br>TEG does not start in LOCAL mode** | Out of fuel | Check all valves to make sure required fuel gas is supplied to the TEG | *INSTALLATION* |
| | Poor connection between the TCC module and the customer battery | Tighten fasteners or replace wires connect BAT +/- terminals from TCC module to customer battery | *INSTALLATION* |
| | VOLTAGE REFERENCE SOURCE JUMPER may be in VADJ position | Set VOLTAGE REFERENCE SOURCE JUMPER to RUN position | *ADJUSTMENT* |
| | Fuse is blown out | Replace fuse | *TROUBLESHOOTING* |
| | TCO is blown out | Replace the TCO | *TROUBLESHOOTING* |
| | Pressure switch malfunction | Replace the pressure switch | *TROUBLESHOOTING* |
| **TEG does not attempt to ignite in REMOTE mode** | LOCAL/REMOTE switch on the TCC module may be in LOCAL position | Set the LOCAL/REMOTE switch on the TCC module to REMOTE position | *OPERATION* |
| | VOLTAGE REFERENCE SOURCE JUMPER may be in VADJ position | Set VOLTAGE REFERENCE SOURCE JUMPER to RUN position | *ADJUSTMENT* |
| | SI system locked out | Reset SI system at site | *OPERATION* |
| | | Examine electrode and correct the ignition gap in the burner | *TROUBLESHOOTING* |
| | | Troubleshooting the SI system | *TROUBLESHOOTING* |
| | | Troubleshooting the TEG | *TROUBLESHOOTING* |
| **No response to SCADA commands** | Poor connections between TCC module and SCADA system | Tighten fasteners or replace wires connect TCC module and SCADA system | *INSTALLATION* |
| | Different TEG/SCADA system voltages | Use same system voltage between TEG and SCADA | *INSTALLATION* |
| | Invalid SCADA command | Operate TEG in allowed battery voltage ranges | *OPERATION* |

If the SI system fails to start the TEG or shut the TEG off correctly, it must be investigated.

If the SI system gets power, indicated by audible sounds of sparking and solenoid valve clicking, skip to section 12.4.5.

### 12.4.1 Check the Customer Battery Connection

Refer to Figure 41 or Figure 42, check the customer battery connection from the battery to the BAT +/- terminals on the TCC module. Verify the voltage across the BAT +/- terminals must be nominal 12Vdc for a 12V system, or 24Vdc for a 24V system, with a voltmeter.

### 12.4.2 Fuses Examination

Examine the fuse inserted to the fuse receptacle on the TCC module, and the fuse inserted to the fuse receptacle on the SI module. Replace if blown out.

### 12.4.3 Thermal Cutoff (TCO) Assembly Examination

Refer to section 10.2.2 to examine the TCO assembly.

### 12.4.4 Pressure Switches Examination

Follow these steps to examine the pressure switches with a multimeter:

1. Remove the wires from the pressure switches. See Figure 38.
2. Remove fuel pressure from the fuel system by closing the manual shutoff valve, placing the LOCAL/REMOTE switch to LOCAL position, setting the BENCH TESTING JUMPER to TEST position, and toggling the Local START switch on the TCC module.
3. With no fuel pressure in the fuel system, verify the resistance across the two terminals of the pressure switches is near infinity, which indicates the pressure switches being open. Replace the pressure switch if necessary.

**NOTE:** Switch should open at pressures below 6.9 kPa (1 PSI).

4. Provide fuel pressure to the fuel system by opening the manual shutoff valve.
5. Verify the resistance measured across the two terminals of the pressure switches is near zero, which indicates the switches being closed. Replace the pressure switch if necessary.

**NOTE:** Switch should close at pressures above 13.8 kPa (2 PSI).

### 12.4.5 Spark Electrode Examination and Sparking Gap Verification

The spark electrode serves two roles; it sparks to ignite the incoming fuel-air mixture to start the TEG, and it also senses the flame while the TEG is running. The ceramic rod insulating the metal electrode is very brittle and prone to breakage. A broken electrode may short to ground or spark in an unintended location. If the spark gap is set improperly, the TEG may fail to ignite, or the electrode may not sense flame properly. Follow these steps to verify that the spark electrode is functioning properly, and the sparking gap is set correctly:

1. Remove the fuse in the TCC module. This removes power from the SI system to prevent possible high voltage shock.
2. Check the SI cable assembly for its connections on both ends and continuity with a multimeter before disconnecting from the spark electrode.
3. Remove the spark electrode by loosening the wingnut and sliding the electrode out.
4. Inspect the spark electrode for any cracks or pores in the ceramic rod. If any defects

are found, the spark electrode must be replaced. Replace the electrode if suspect.

5. Sliding the spark electrode back into position through the burner back till it stops (hits the far wall of the burner), then pull it back 3.2 to 6.3 mm (1/8” to 1/4"). The ceramic rod should extend about 38mm (1.5”) from the holding fastener. If the spark electrode is too close to the burner back, the sparks may not deliver enough energy for successful ignition. If the spark electrode is too far from the burner back, the SI system may not provide enough total energy for arcing to reliably occur.
6. Tighten the wing nut only till it is snug. Do not over tighten or the ceramic rod will crack.
7. Reconnect SI cable assembly to the spark electrode.
8. Ensure the manual shutoff valve is closed.
9. Set the LOCAL/REMOTE switch on the TCC module to the LOCAL position.
10. Re-install the fuse removed in step 1 above into the TCC module.
11. Toggle the local START switch on the TCC module. Arcing should occur in the combustion chamber (making a clicking noise) at the rate of 5 sparks per second.
12. If consistent audible sparking can be heard at a rate of 5 sparks per second, the spark electrode is functioning properly, and the sparking gap is set correctly. Proceed to next section to troubleshot SI system further.

### 12.4.6 Solenoid Valve Examination

A solenoid valve is equipped in a 5220 TEG to control fuel gas flow to the burner and to act as a safety shutoff device. Follow these steps to examine the solenoid valve:

1. A 12V system must have a 12V/2W solenoid valve installed, and a 24V system must have a 24V/2W solenoid valve installed. Check the label on the solenoid valve body to confirm the solenoid valve voltage and power ratings are correct.
2. Set the LOCAL/REMOTE switch on the TCC module to LOCAL position. Open the manual shutoff valve to supply fuel gas to the TEG, perform a leak check to ensure there is no leak, and then close the manual shutoff valve. The pressure gauge reading shall remain unchanged for quite a long time. If the pressure drops, the solenoid valve must be replaced, and this step must be repeated after the solenoid valve has been replaced to ensure the solenoid valve acts as a safety shutoff device.
3. Open the manual shutoff valve to supply fuel gas to the TEG. Toggle the local START switch on the TCC module to start the TEG. If the TEG cannot start or combustion cannot be maintained, refer to Figure 39 and Figure 40, measure the resistance between the 3 terminals of SOLENOID on the TCC module while the Solenoid Valve Wiring Harness is connected.
   - The resistance measured between BRN and CHASSIS shall be infinite.
   - The resistance measured between BLU and CHASSIS shall be infinite.
   - For a 12V system equipped with a 12V/2W solenoid valve, the resistance measured between BRN and BLU shall be 60Ω to 80Ω.
   - For a 24V system equipped with a 24V/2W solenoid valve, the resistance measured between BRN and BLU shall be 250Ω to 320Ω.

   If any measured resistance is out of the given range, refer to Figure 29, remove the retaining screw, unplug the solenoid valve cable connector, and identify the pins of the solenoid valve body connections to their corresponding wire colors. Measure resistance again from the pins. Replace the solenoid valve body if any measured

resistance between pins is still out of the given range, otherwise replace the solenoid valve cable harness.

4. Plug the solenoid valve cable connector back to the solenoid valve body and tighten the retaining screw. Toggle the Local START switch on the TCC module to start the TEG. Measure the voltage across BAT +/- terminals on the TCC module with a voltmeter during TEG start up period. If voltage fluctuates significantly, recharge or replace customer battery.

### 12.4.7 TCC Module and SI Module Examination

The TCC module and the SI module are potted and do not require routine service/exam.

When all jumpers are in correct positions, one of the battery voltage status indicators will be on when the customer battery is connected to the TCC module, and fuel gas is supplied to the fuel system of the TEG.

Refer to section 12.3.1 to verify basic operation of the TCC module and SI module.

Follow below procedures to troubleshoot the TCC module and the SI module if the SI system still needs further troubleshooting to resolve problem after completed sections 12.4.1 to 12.4.6:

1. Refer to Figure 39, locate the wiring connector plugged into the SI module.
2. Refer to Figure 41 or Figure 42, use a voltmeter to probe and measure the voltage between the red and black wires from the top side of the connector.
3. Set the LOCAL/REMOTE switch to LOCAL position and toggle the START switch to start the TEG.
4. Check the voltage during the SI system ignites the TEG. If the measured voltage is out of the range of 10 to 15V, replace the TCC module; if the measured voltage is within the range of 10 to 15V, but no sparking sounds and no solenoid valve clicks, replace the SI module. Proceed to the next step if audible sparking sounds can be heard but no solenoid valve clicks.
5. Refer to Figure 41 or Figure 42, use a voltmeter to probe and measure the voltage between the yellow and black wires from the top side of the connector plugged into the SI module.
6. Set the LOCAL/REMOTE switch to LOCAL position and toggle the START switch to start the TEG.
7. Check the voltage during the SI system ignites the TEG. If the measured voltage is out of the range of 10 to 15V, replace the SI module; if the measured voltage is within the range of 10 to 15V, replace the TCC module.

This completes the troubleshooting of the SI system. Refer to section 12.3 to return the unit back to normal operation. Contact GPT Customer Service if need further help.

# 13 TEG PERFORMANCE LOG

MODEL NO: _____

TEG SERIAL NO: _____

FUEL TYPE: _____ SITE ALTITUDE: _____

LIMITER/CONVERTER SERIAL NO: _____

CP INTERFACE SERIAL NO: _____

| DATE | TIME | AMBIENT TEMP (°C) | REQUIRED POWER (W) | REQUIRED $v_{SET}$ (V) | MEASURED $v_{SET}$ (V) | MEASURED POWER (W) | MANIFOLD FUEL PRESSURE | MAINTENANCE NOTES |
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# 13 TEG PERFORMANCE LOG

MODEL NO: _____

TEG SERIAL NO: _____

FUEL TYPE: _____ SITE ALTITUDE: _____

LIMITER/CONVERTER SERIAL NO: _____

CP INTERFACE SERIAL NO: _____

| DATE | TIME | AMBIENT TEMP (°C) | REQUIRED POWER (W) | REQUIRED $v_{SET}$ (V) | MEASURED $v_{SET}$ (V) | MEASURED POWER (W) | MANIFOLD FUEL PRESSURE | MAINTENANCE NOTES |
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