

WARNING: If the information in this manual is not followed exactly, a fire or explosion may result causing property damage, personal injury or loss of life.

Do not store or use gasoline or other flammable vapors and liquids near 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.
- Immediately call your gas supplier from a neighbour'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: Improper installation, adjustment, alteration, service or maintenance can cause injury or property damage. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.

WARNING: For Outdoor Use Only.

AVERTISSEMENT: Si l'information de ce manuel n'est pas suivie exactement, un incendie ou une explosion peut résulter entraînant des dégâts matériels, des blessures ou la perte de vie.

Ne pas entreposer ou utiliser de l'essence, d'autres liquides ou vapeurs inflammables à proximité de cet appareil ou d'aucun autre appareil.

QUE FAIRE SI VOUS SENTEZ LE GAZ:

- N'allumez aucun appareil.
- Ne touchez aucun commutateur électrique; n'utilisez pas le téléphone de votre bâtiment.
- Appelez immédiatement votre fournisseur de gaz d'un téléphone dans un bâtiment voisin, si possible. Suivez les instructions du fournisseur de gaz.
- Si vous ne pouvez pas atteindre votre fournisseur de gaz, appelez le service d'incendie.

L'installation et le service doivent être effectués par un installateur qualifié, une agence de service ou le fournisseur de gaz.

AVERTISSEMENT: L'installation inexacte, l'ajustement, le changement, le service ou l'entretien peuvent causer des dommages ou des dégâts matériels. Lisez les instructions d'installation, d'opération et d'entretien complètement avant d'installer ou entretenir cet équipement.

AVERTISSEMENT: Pour l'Usage Extérieur Seulement.



GLOBAL
power technologies

5220 THERMOELECTRIC GENERATOR

Operating Manual



LR 55319

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NOTICE TO INSTALLER:

These instructions shall be left with the consumer to retain them for future reference.

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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, with the CSA-B149.1, Natural Gas and Propane Installation Code and CSA-B149.2, Propane Storage and Handling Code.



WARNING!

The Thermoelectric Generator, when installed, must be electrically grounded in accordance with local codes or, in the absence of local codes, with the Canadian Electrical Code, CSA C22.1.



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!**

Any guard or other protective device removed for servicing the Thermoelectric Generator must be replaced prior to operating the appliance.

**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!**

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!**

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.

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).

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.

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.

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 20°C (68°F). With the fuel flow held constant, TEGs operating in ambient temperatures higher than 24°C (75°F) will see power output decline by 0.8 W per °C (0.44 W per °F) of temperature change up to a maximum ambient temperature of 65.5°C (150°F). Conversely, for temperatures lower than 20°C (68°F) power output will increase by 0.8 W per °C (0.44 W per °F) 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. V_{SET} 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 (leg assembly or pole mount)
 - 1 Thread Sealing Compound
 - 17 Screws, #8 32 × 1/4 in. 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 10, and mount it on a firm and stable base, sufficiently high above ground level to prevent the TEG from being inundated with water. See Installation (Section 5), 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 5.6) 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:
 - a) Move the jumper clip on TB1 so that it connects terminals 2 and 3. See Figure 13 or Figure 14.
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 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. After a third unsuccessful trial, the ignition control system will go into lockout mode.
5. If the SI has gone into lockout mode (3 failed ignition attempts), reset it by removing one of the wires from the pressure switch, 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 spark 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 TB-1 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 TB-1 to connect terminals 1 and 2 with caution, as the terminals are now live (See Figure 13 or Figure 14) .
 - 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 only 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	195 Watts @ 12 Volts
20° C, 750 m above sea level	178 Watts @ 24 Volts
Electrical	
Voltage Adjustment	12 V 12–18 Volts 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 (698 ft ³ /day) of Std. 1000 BTU/ SCF (37.7 MJ/Sm ³) gas
Propane	28.0 L/day (7.4 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 in.)
Max Width	565 mm (22.26 in.)
Height	1274 mm (50.16 in.)
Net Weight	100 kg (221 lb.)
Shipping Weight	143 kg (315 lb.)
Mounting Holes	267 mm wide × 457 mm deep (10.53 in. × 18.00 in.)
Mounting Hole Diameter	8 mm (0.312 in.)

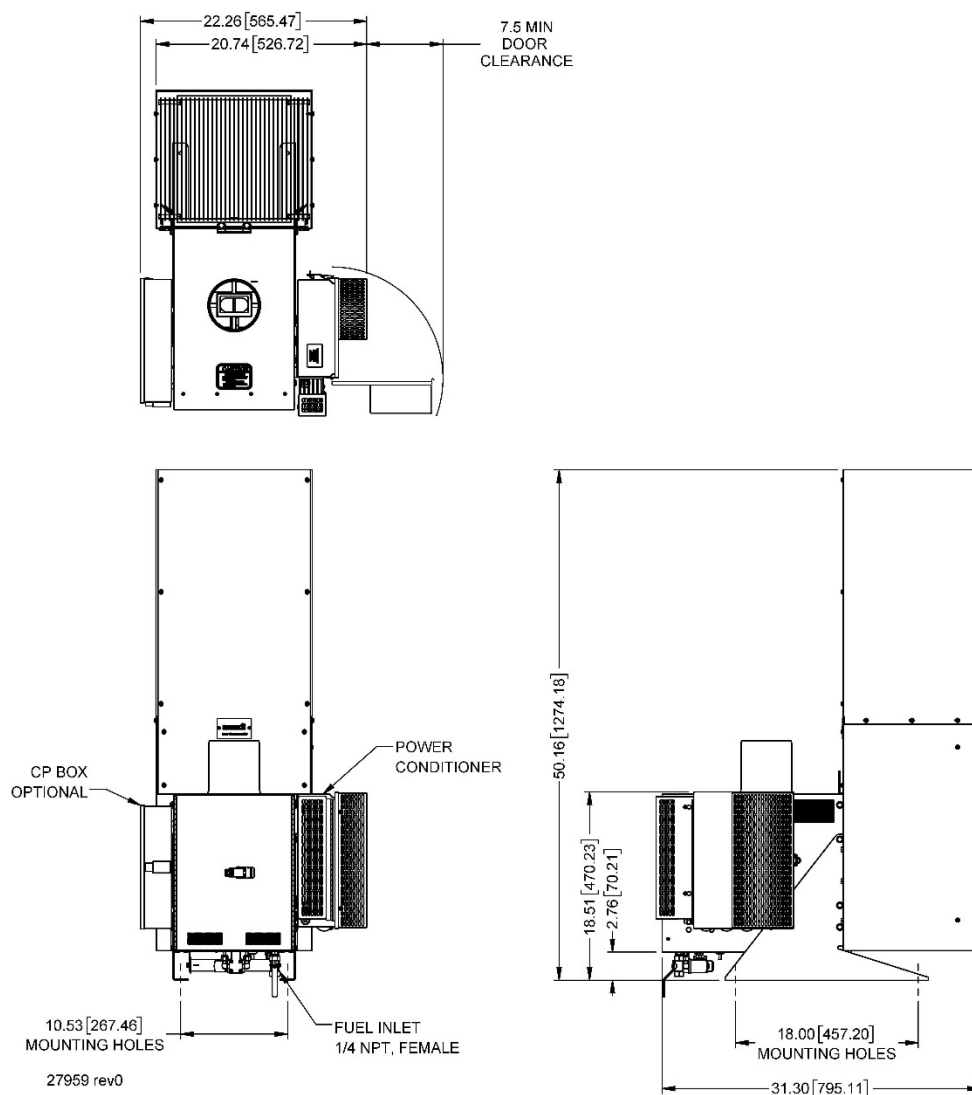


Figure 1 – Overall Dimensions of the 5220 TEG

3.4 IGNITION CONTROL SYSTEM

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

Electrical SI Power Supply	Input Voltage	Minimum 5.0 V DC
		Maximum 35.0 V DC
	Power Input	4.16 Watts
	Output Voltage	13.8 VDC
SI	Spark Rate	5/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 in.)
	Minimum	3.2 mm (0.125 in.)
	Maximum	6.3 mm (0.250 in.)
Continuous Operating Time Without Charge		120 minutes with full charged batteries @ 25°C (75°F)

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:

() 5220 () - () - SI - ()

CP = Cathodic Protection Interface

Fuel Type:

L = Propane

N = Natural Gas

Output Voltage:

12 or 24 Volts

Spark Ignition (SI)

Configuration Options:

SO = Safety Shut Off Valve

RS = Remote Start

RC = Rain Cap Included

SS = Stainless Steel

DF = Dual FET Electronics

CS = Current Split System

Contact your sales representative for all available 5220 configurations.

Serial Number: The serial number is a unique number assigned by GPT to provide traceability.

Fuel Type: 'NATURAL GAS' or 'PROPANE'.

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: The output rating is the output voltage range and power to customer load.

Design Altitude: The design altitude is the maximum design altitude of the TEG.

Fuel Input Rating: The fuel input rating is the maximum fuel energy input rate of the TEG.

Inlet Pressure: The inlet pressure is the maximum permitted fuel supply pressure range.

Burner Fuel Pressure: The burner fuel pressure as stated is the range of burner fuel pressure the TEG is designed to operate when using fuel gas meeting GPT's fuel specification requirements. Burner fuel pressure is set using the fuel system regulator.

Factory Settings: The power output at ambient temperature, voltage across the precision load, and burner 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 fuel pressure is adjusted to obtain the desired power at customer site.

3.6 FUEL CONSUMPTION

The 5220 is 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	-
ft ³ /hr**	11.10	29
m ³ /hr**	0.31	0.82

* At 15°C (60°F)

** At atmospheric pressure and 15°C (60°F), assuming an energy content of 37.3 MJ/m³ or 1,000 BTU/cu. ft for natural gas and 93.1 MJ/m³ or 2,500 BTU/cu ft for propane.

3.7 STANDARD SPECIFICATION FOR GASEOUS FUEL

Fuel supplied to GPT's Thermoelectric Generators:

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 more than 0°C (32°F) at 170 kPa (25 PSI).
3. Shall not contain more than 115 mg/Sm³ (2) (approx. 170 ppm) of H₂S.
4. Shall not contain more than 60 mg/Sm³ (approx. 88 ppm) of Mercaptan Sulphur.
5. Shall not contain more than 200 mg/Sm³ (approx. 294 ppm) of total Sulphur.
6. Shall not contain more than 10% [CO₂] and/or [N₂] by volume, nor vary more than +/- 1% [CO₂] and/or [N₂] during operation.
7. Shall not contain more than 120 mg/Sm³ of water vapour.
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/Sm³ (1,000 BTU/cu. ft)⁽¹⁾
 - b) Propane/LPG: 93 MJ/Sm³ (2,500 BTU/cu. ft)⁽¹⁾
 - c) Butane: 108 MJ/Sm³ (2900 BTU/cu. ft)⁽¹⁾
10. Shall not exceed 60°C (140°F) in temperature.

NOTE:

- For gaseous fuels outside of these specifications, please contact Global Power Technologies (GPT).
 - Sm³ = Standard cubic meter of gas at 101.325 kPa at 20°C (NIST).
-

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.

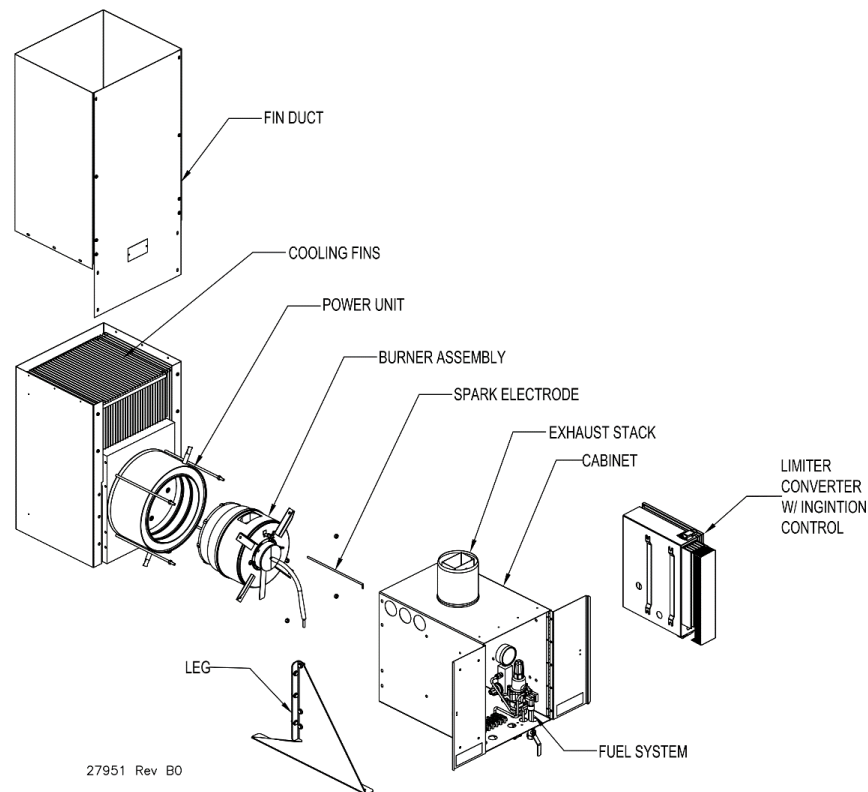


Figure 2 – 5220 TEG General Assembly, shown with L/C

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

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 has a resin-impregnated cellulose element which prevents solid particles from damaging the regulator and downstream parts.

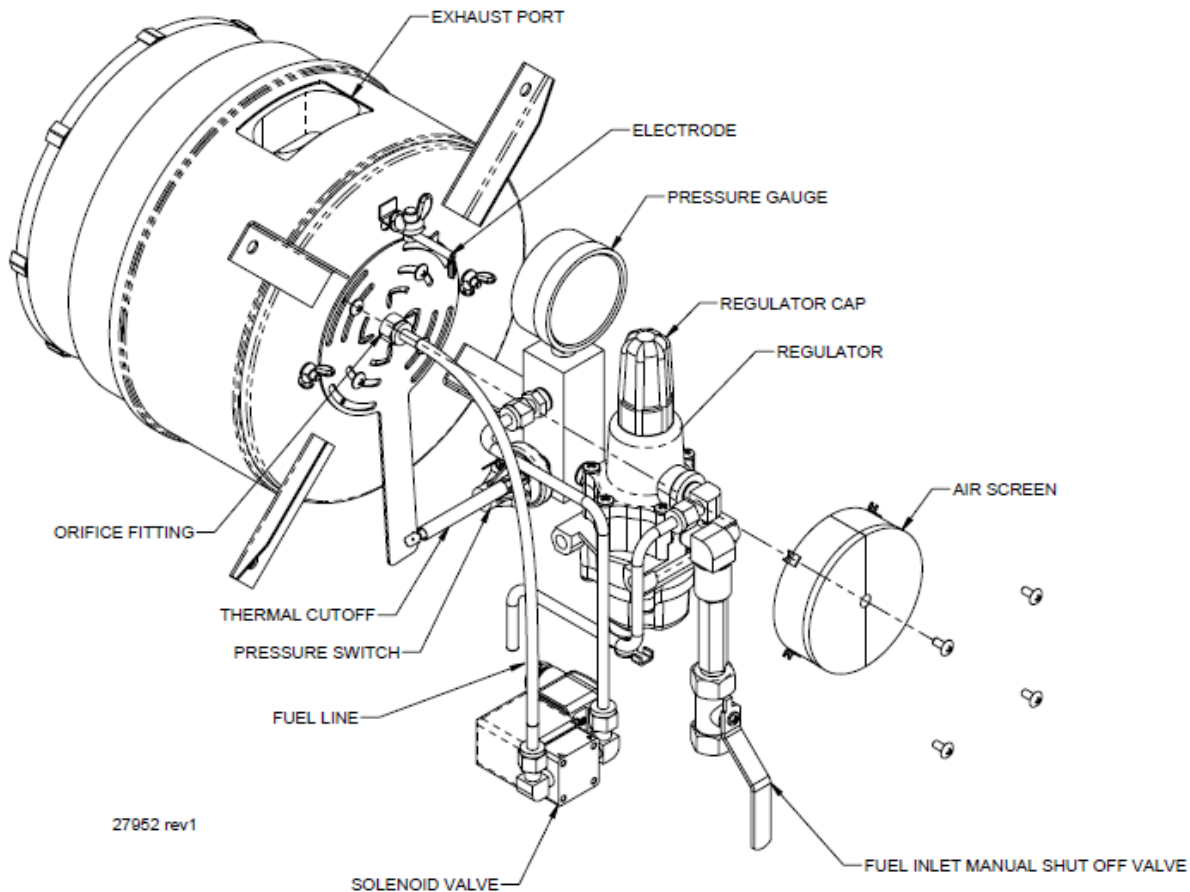


Figure 3 – 5220 Fuel System General Assembly

The outlet of the pressure regulator leads to a manifold. On the manifold there is a pressure gauge to monitor the fuel pressure and a pressure switch for the SI module. 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 jewel with a precisely sized hole to meter the fuel flow into the burner. A solenoid valve (SOV) is located beneath the cabinet and plumbed between the manifold and fuel line, allowing the SI module to control the burner.

The solenoid valve is controlled by the Spark Ignition (SI) module. The SI module opens the solenoid valve when the fuel pressure switch is closed (fuel pressure is present) and closes the solenoid valve when fuel pressure switch is open (no fuel pressure), or if the SI module does not sense a flame in the burner. The main parts of fuel system are shown in Figure 3.

4.1.2 Spark Ignition Control System

The SI system consists of the following parts:

- Spark electrode
- Pressure switch
- Spark Ignition module (SI)
- Solenoid Valve
- SI Power Supply Board (FPCi Board)
- Battery pack

When the manual ball valve is opened, fuel pressure causes the pressure switch (located in the fuel system) to close. This, combined with the absence of flame sensed with the spark electrode, signals the SI module to produce a spark in the burner. At this point, the SI module opens the solenoid valve, allowing gas to flow into the burner. Once a flame is detected, the SI will stop sparking and the SI will continue to monitor the presence of flame at the electrode. If the SI does not detect combustion after 7 seconds, it will stop sparking and close the solenoid valve. It will wait a 10 second purge period, and then make another attempt at ignition. The SI will attempt 3 ignition trials, and if combustion cannot be maintained, the SI will go into standby mode and the power supply board (FPCi) will go into sleep mode. The power supply will have to be reset for another attempt at ignition.

4.1.2.1 Resetting the Power Supply

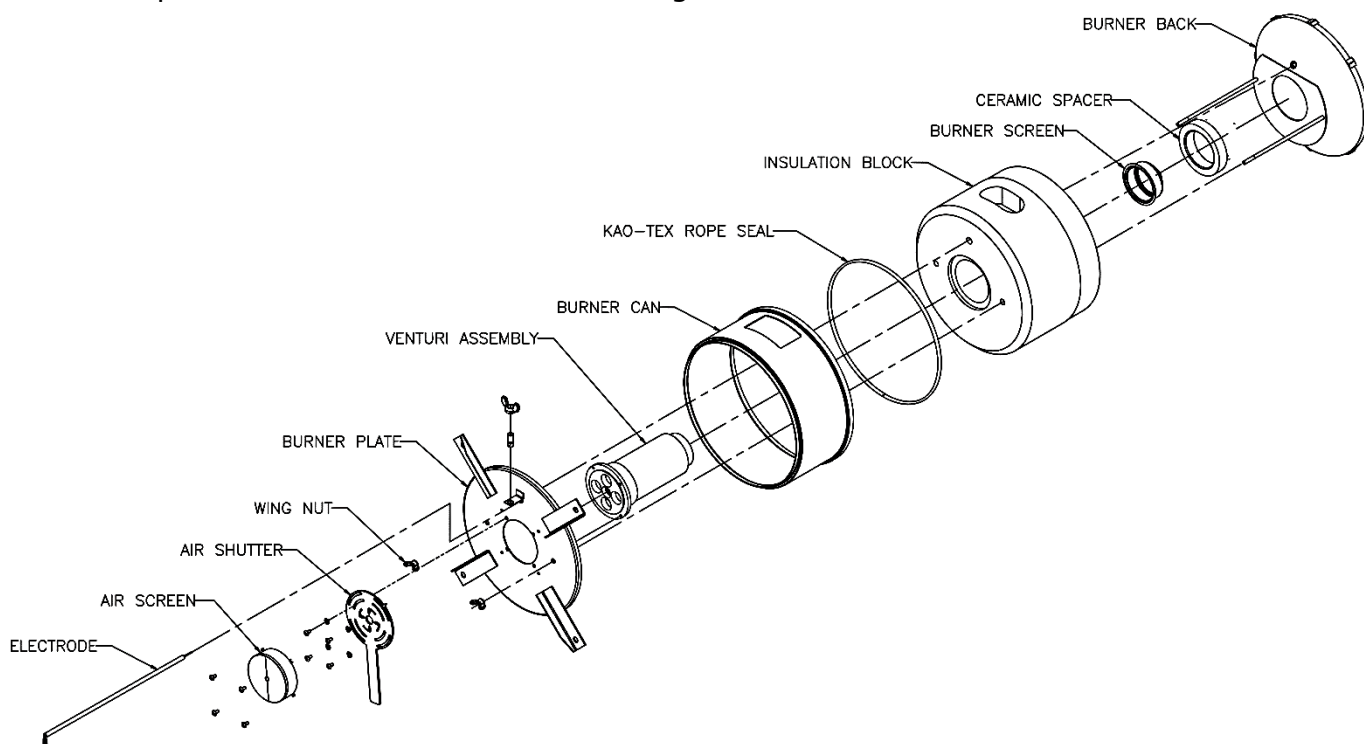
To reset the power supply, the closed signal from the pressure switch must be reset. The simplest method is to pull one of the orange wire spade connectors off the pressure sensor, wait 10 seconds and replace it. The power supply will energize the SI, and the SI will begin another three start trials.

NOTE:

The combustion control system contains 3 D-sized 2-volt, 2.5 amp-hour rechargeable batteries and a constant-potential battery charger. A new fully charged battery provides approximately 240 minutes of operating time at 25°C. The power supply switches from battery voltage to generator power unit voltage in less than 15 minutes after startup. Completely discharged batteries will take approximately 14 days' TEG operation to regain 100% charge.

4.1.3 Burner

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



27988 Rev B0

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.

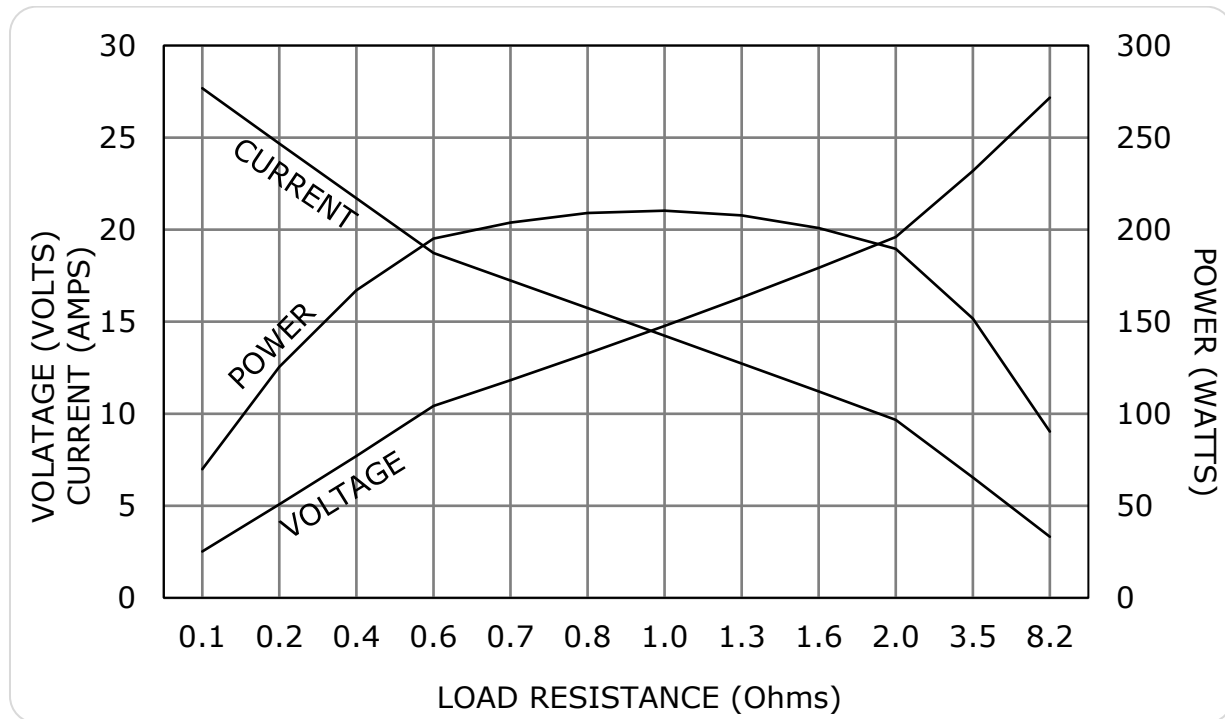


Figure 5 – Gross Power from Power Unit @ 20°C (Beginning of Service Life)

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-inch long piece of 3-inch diameter pipe with an "H" shaped bracket welded to one end. The Leg Assembly consists of 3 in. by 3 in. and 2 in. by 2 in. 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-inch 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.

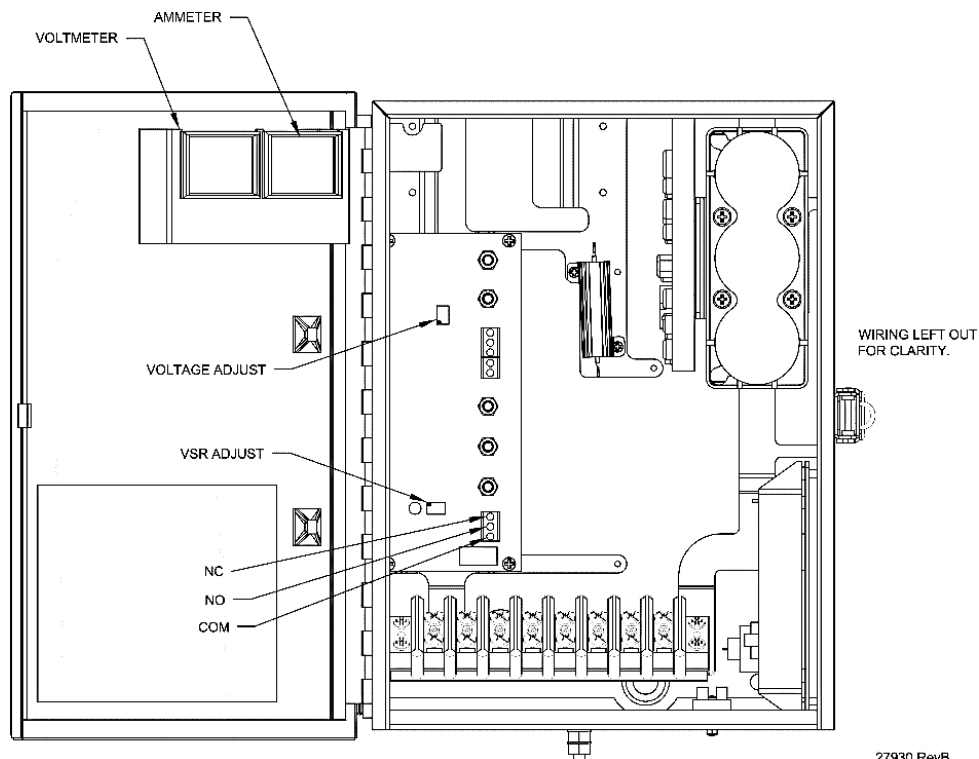


Figure 6 – 220-Watt Limiter Assembly

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 connections 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.

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.

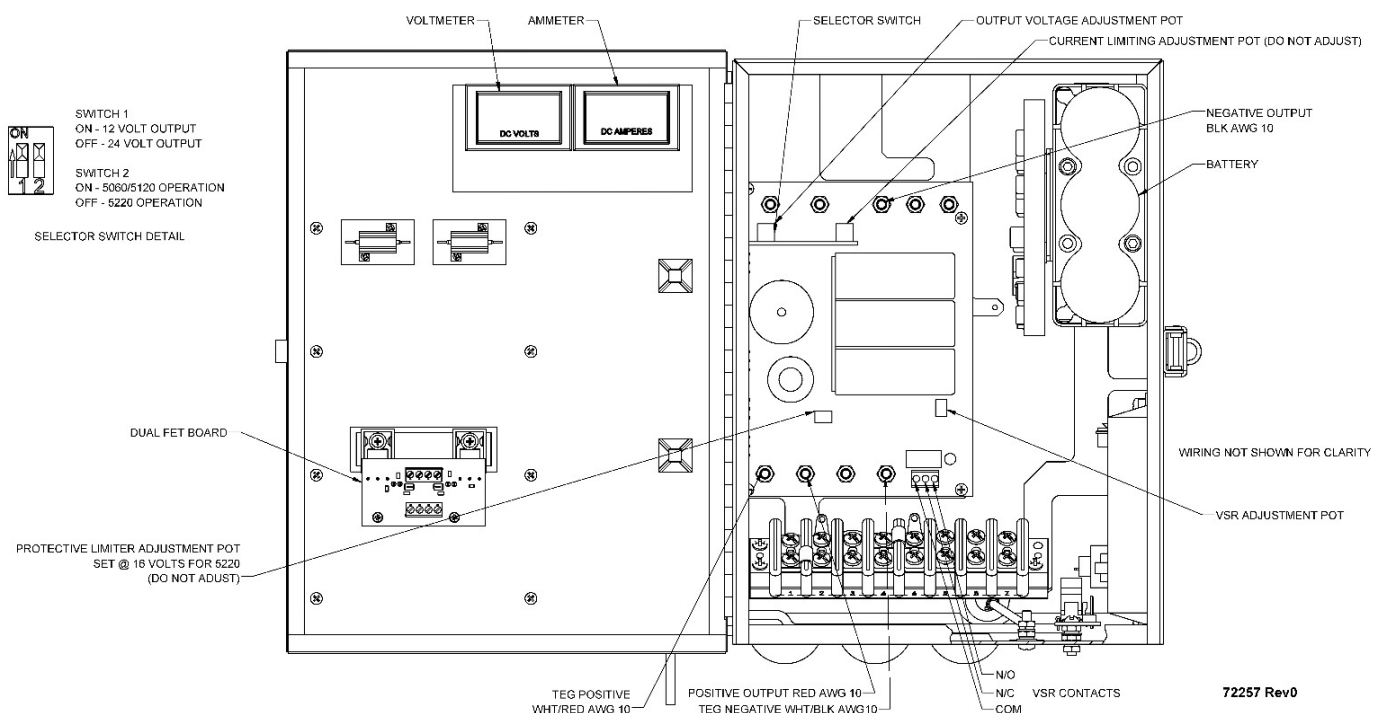


Figure 7 – 220-Watt L/C Assembly

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 8.

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.

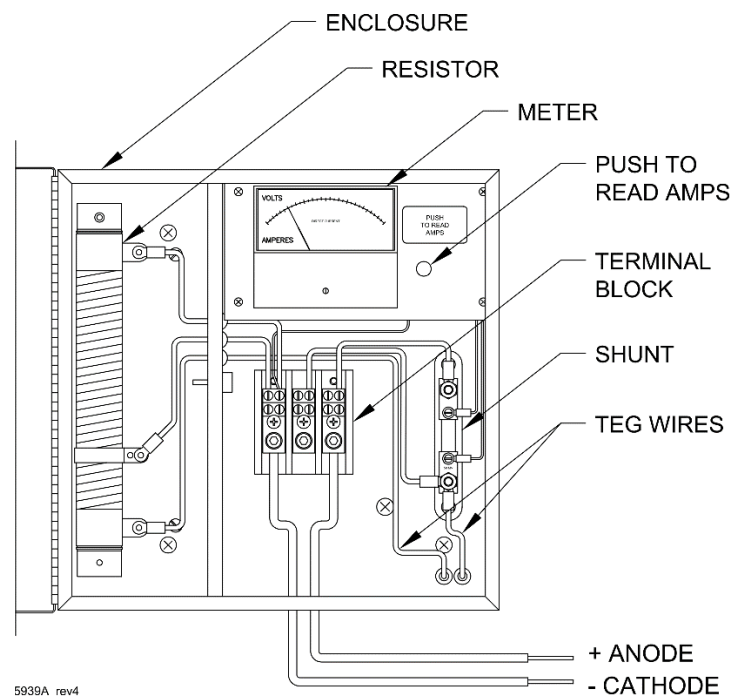


Figure 8 – CP Interface System Assembly

Enclosure: The CP interface system is enclosed within a weather resistant 304 SS enclosure. Enclosure features include a lockable cabinet door, 1 in. 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 $\pm 3\%$ 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, with the CSA-B149.1 Natural Gas and Propane Installation Code and CSA-B149.2: Propane Storage and Handling. The TEG must be kept clear and free from combustible materials, gasoline and other flammable vapours and liquids. Maintain 900 mm (36 in.) 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 the applicable provisions of the Canadian Electrical Code CSA C22.1. 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 in.)
- 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 (leg assembly or pole mount)
- 1 - Thread Sealing Compound
- 17 - Screws, #8 32 \times 1/4 in. 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.

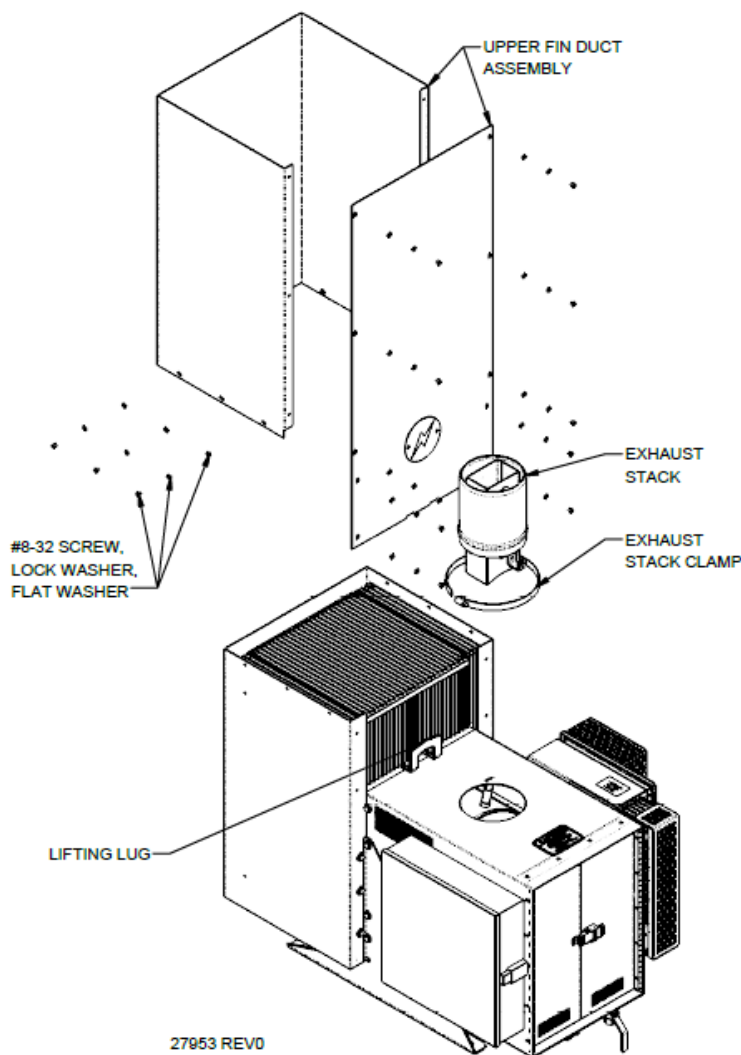


Figure 9 – Assembling the 5220 TEG

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 in.) clearance under the cooling fins and 900 mm (3 ft.) above the top of the fin duct. Locate the TEG to avoid flooding or snow accumulation interfering with the flow of cooling air.

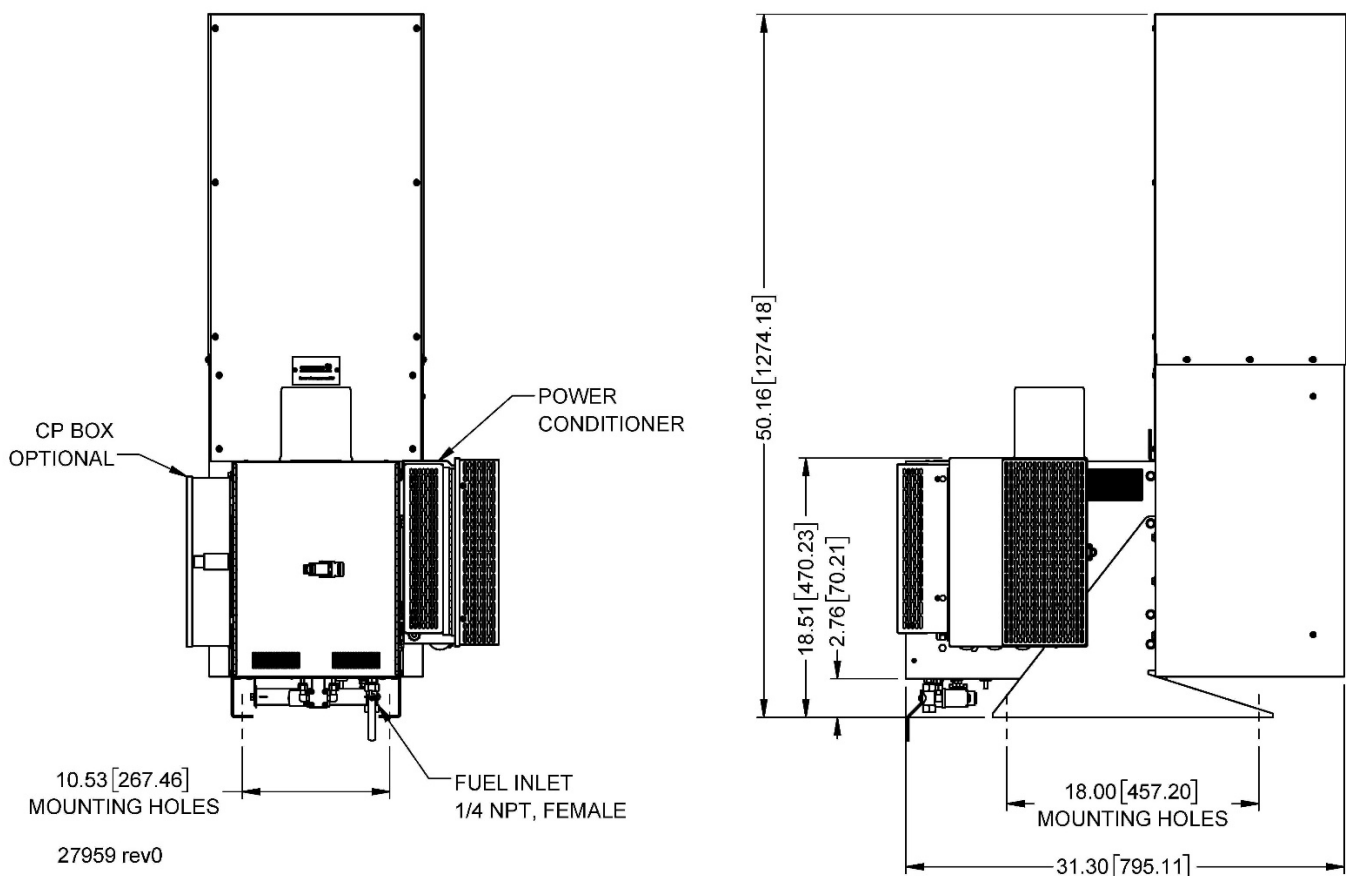


Figure 10 – Model 5220 Mounting Dimensions, shown with CP and L/C

5.6 SUPPLYING FUEL

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

5.6.1 Connecting the Fuel Supply

The TEG has a 1/4 in. female NPT fuel inlet - connection to the TEG's manual shutoff valve.

Follow these steps to connect the fuel supply:

1. Remove the any protective cap or plugs.
2. Apply thread sealant to the fuel line threads as per Figure 11 where the fuel line protrudes from the bottom of the cabinet.

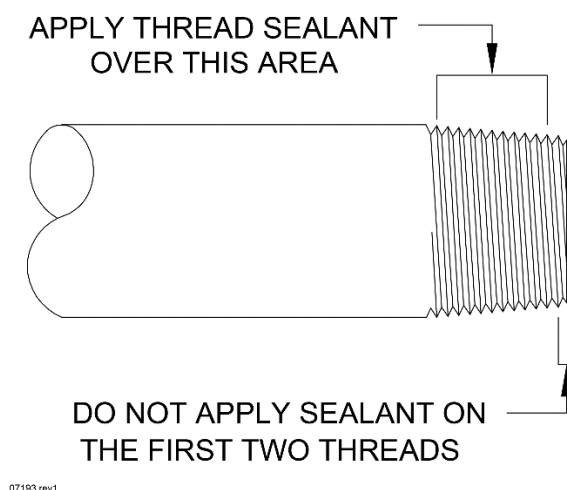


Figure 11 – Applying Thread Sealant

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.

5.6.2 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.

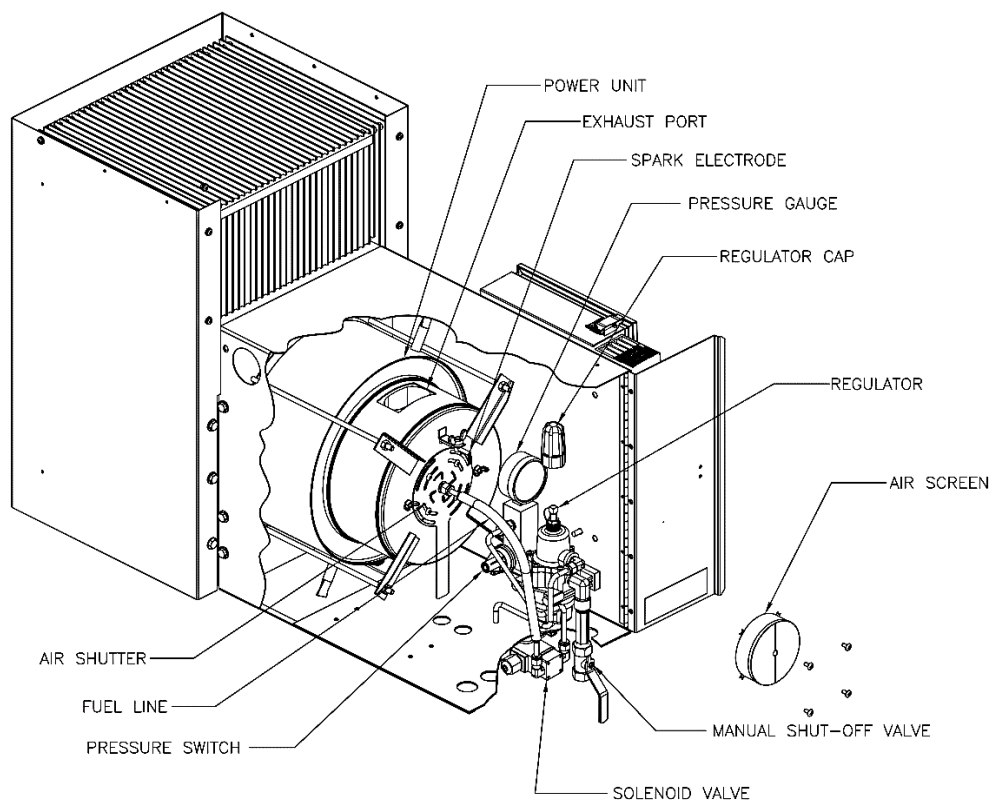


Figure 12 – Setting up the 5220 TEG, shown with Limiter assembly



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 -30°C (-22°F), special consideration must be given to the vaporization of the fuel.

5.6.2.1 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.

5.7 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. Bring the customer load wires through the strain relief bushing (located on the L/C or Limiter enclosure). Allow enough wire to connect to the terminal block TB-1.

NOTE:

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

2. Tighten the screws on the strain relief bushing.
3. Connect the customer load wires to TB-1:

12 V: Connect the load at terminals 5 (+) and 4 (-) (Figure 13).

24 V: Connect the load at terminals 7 (+) and 6 (-) (Figure 14).

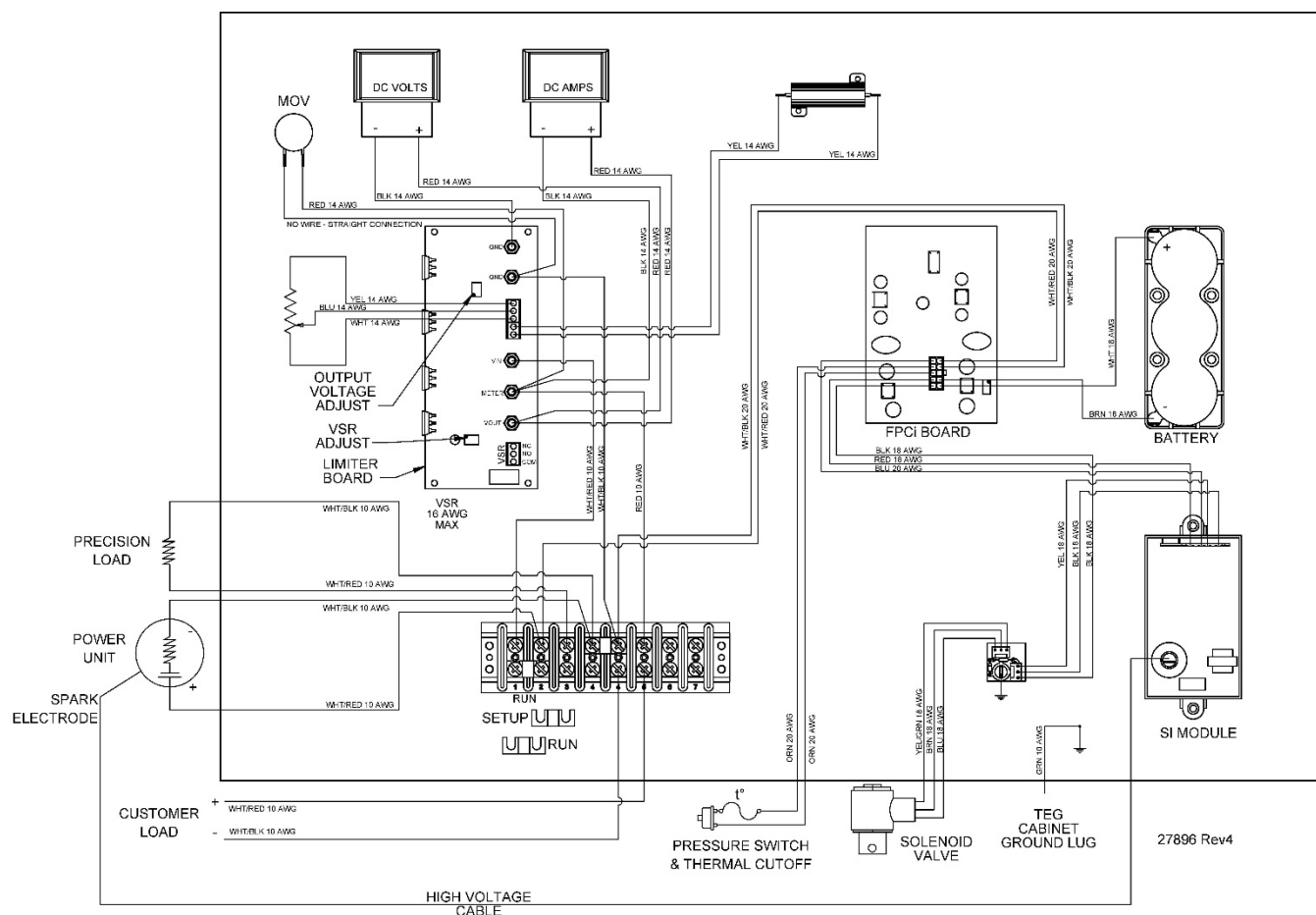


Figure 13 – Wiring Diagram 5220 TEG, with 12 V Limiter Assembly

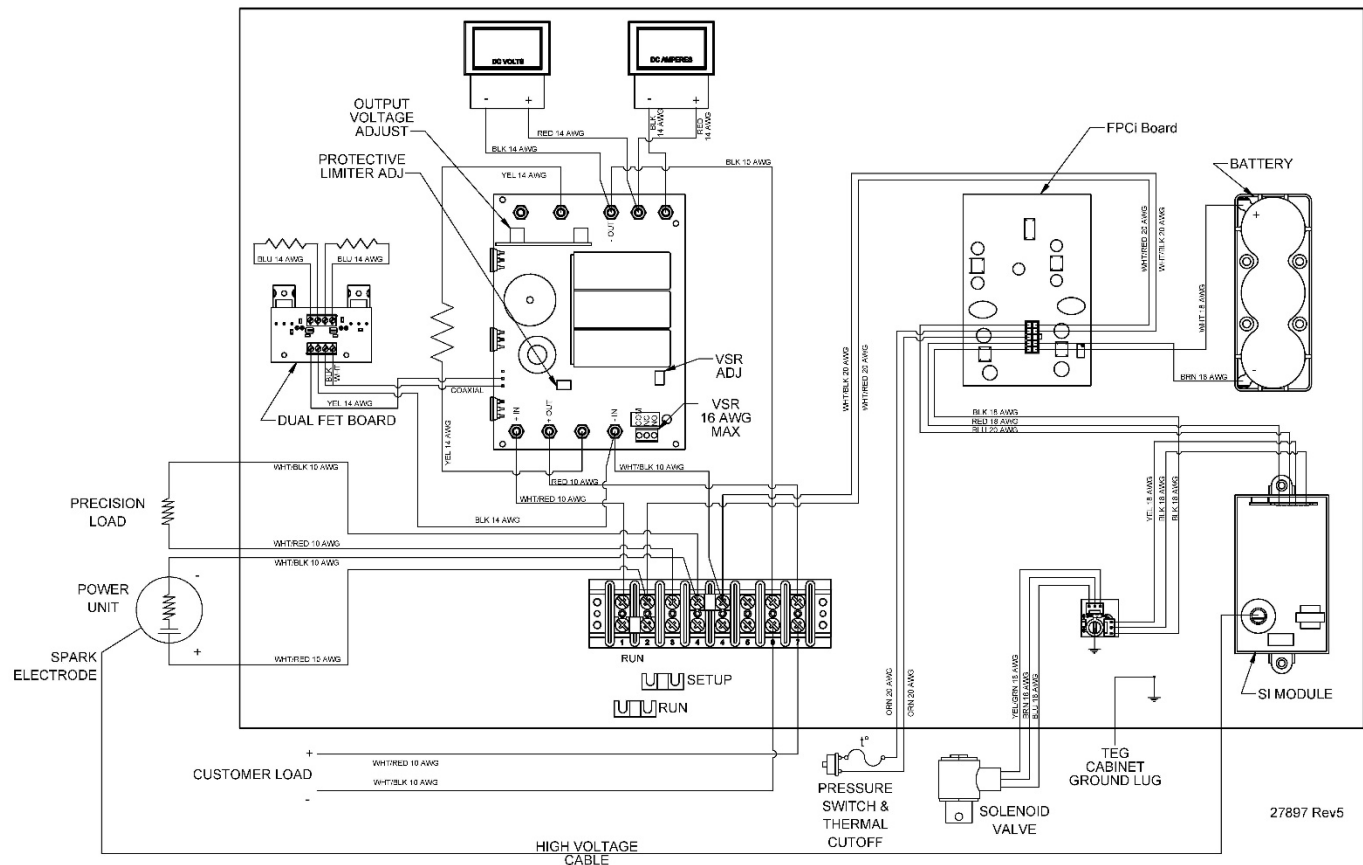


Figure 14 – Wiring Diagram 5220 TEG, with 24V L/C Assembly

5.8 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.

5.8.1 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 15).

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.

5.8.2 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 TB-1 as per Figure 14.

5.9 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.
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5.9.1 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 15.

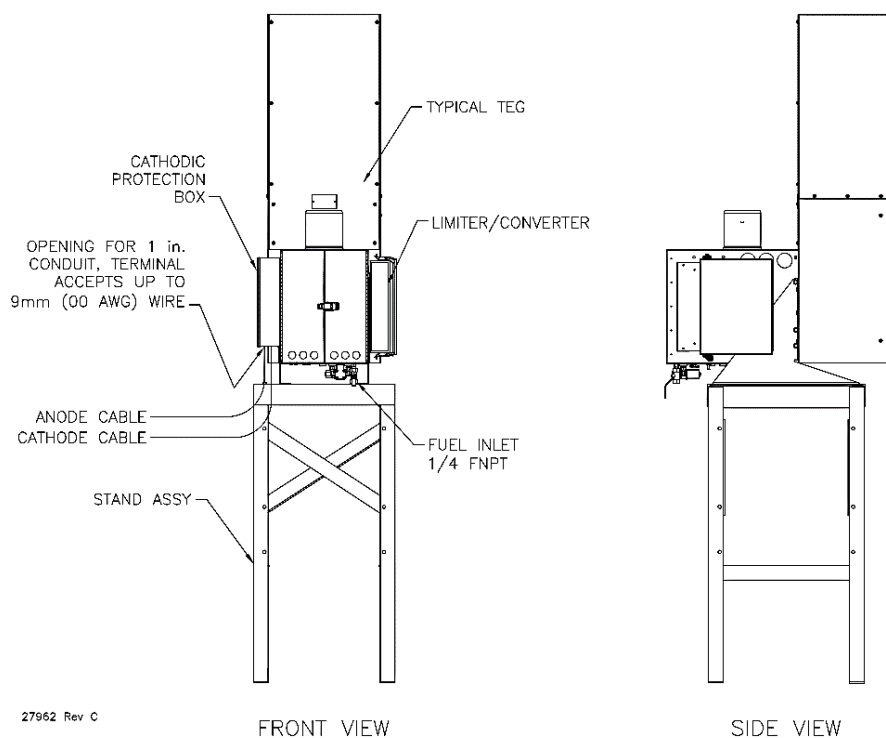


Figure 15 – CP Installation

NOTE:

Always mount the CP interface system in an upright position and allow the free flow of air through the unit.

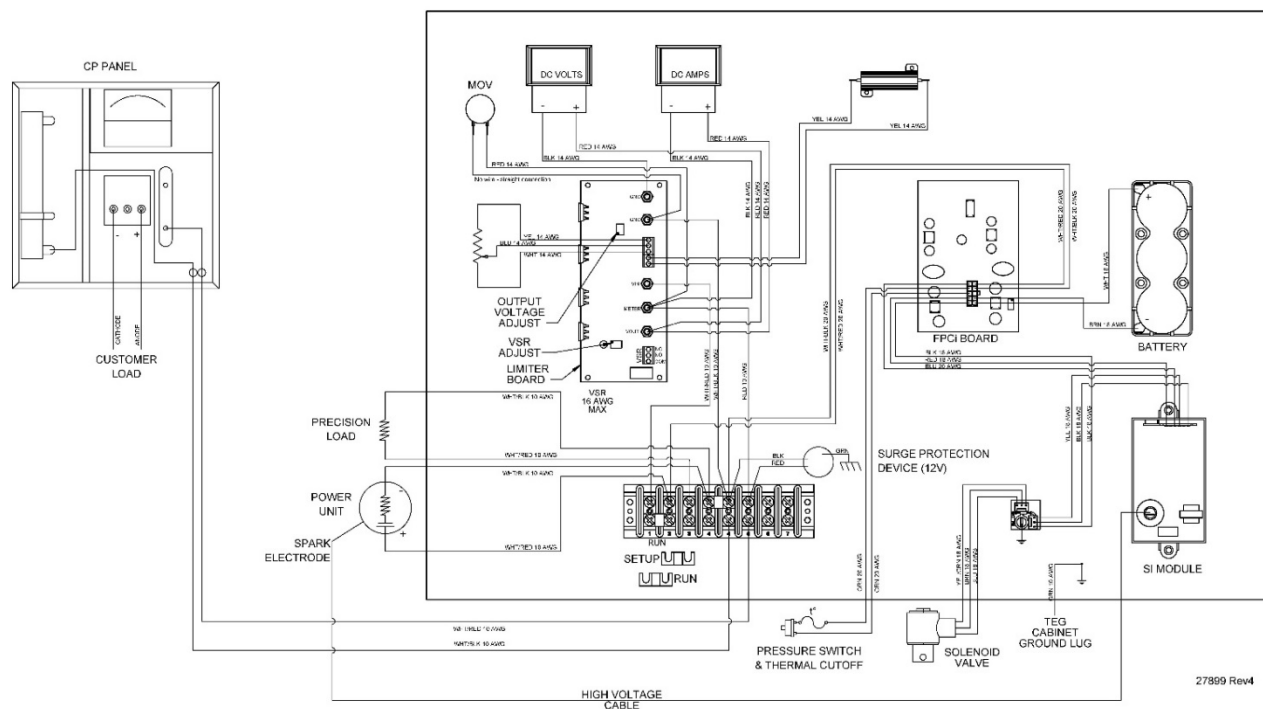


Figure 16 – CP Wiring for Model 5220-12 V, with Limiter Assembly

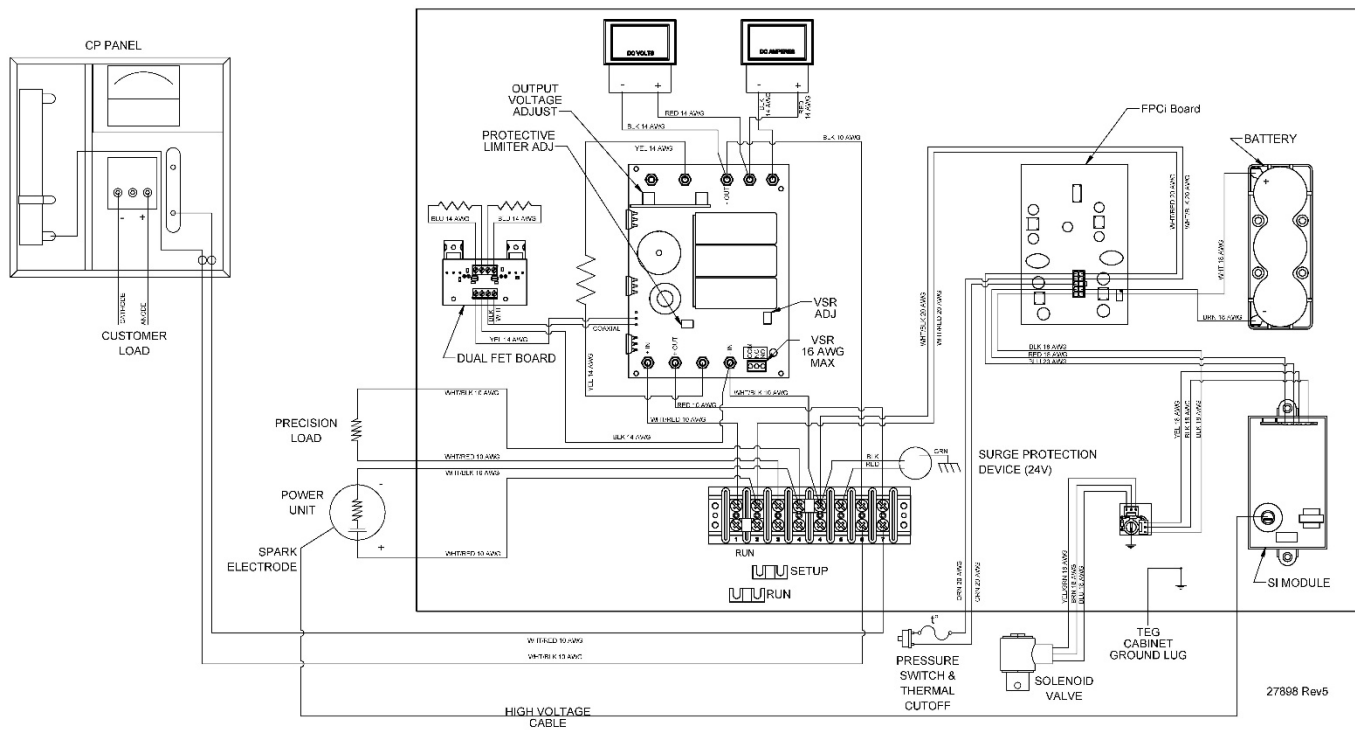


Figure 17 – CP Wiring for Model 5220-24 V, with L/C Assembly

5.9.2 TEG Wiring Interconnection

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

1. Consult the wiring diagram (Figure 16 or Figure 17, as applicable).
2. Run the CP interface system wires to the TEG as per the relevant diagram and terminate to TB-1.

5.9.3 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.

5.10 INSTALLATION OF WIND SCOOP

The Wind Scoop is normally shipped along with the TEG. See below for reference to the Installation Guides.

The wind scoop should be installed on the TEG in order to prevent the unit 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.

If your 5220 is not equipped with a wind scoop, please contact GPT to obtain a retrofit kit.

5.10.1 Wind Scoop – Leg Assembly

See Installation Guide Wind Scoop – Leg Assembly No. 70033

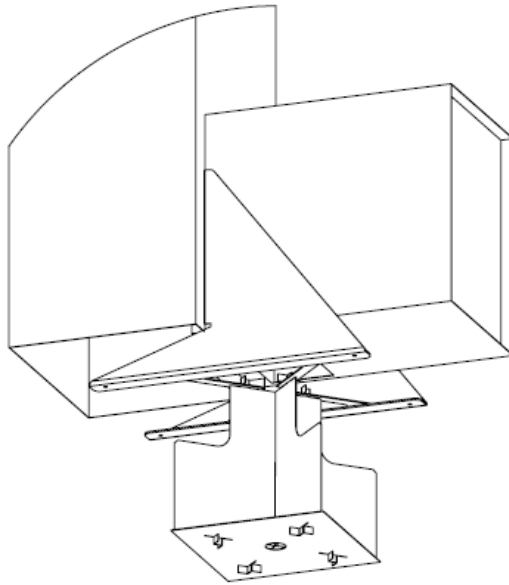


Figure 18 – Wind Scoop – Leg Assembly

5.10.2 Wind Scoop – Pole Stand

See Installation Guide Wind Scoop – Pole Stand No. 70094

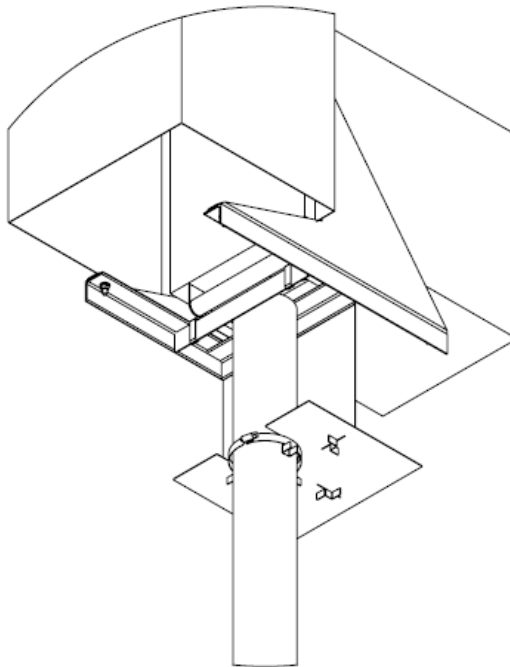


Figure 19 – Wind Scoop – Pole Stand

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 TB-1 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 13 or Figure 14.
2. Connect a DC voltmeter to terminals 2 (+) and 4 (-) of TB-1. 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 shut-off 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 Control System) of this manual.

NOTE: Once the TEG is started, closing the manual shut-off 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 100°C. 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 ball 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 20 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 20, 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 $\rightarrow V_{set} = V_{set\ ref} + [(T_{ref} - T) \times 0.026]$

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

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

Where: T = Ambient temperature, at site ($^{\circ}\text{C}$)
 T_{ref} = Reference ambient temperature, marked on Data Plate ($^{\circ}\text{C}$)
 $P_{set\ ref}$ = 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 65.5°C (150°F). If in doubt contact Global Power Technologies' (GPT) Customer Service Department for guidance.

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

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

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

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 20. 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.

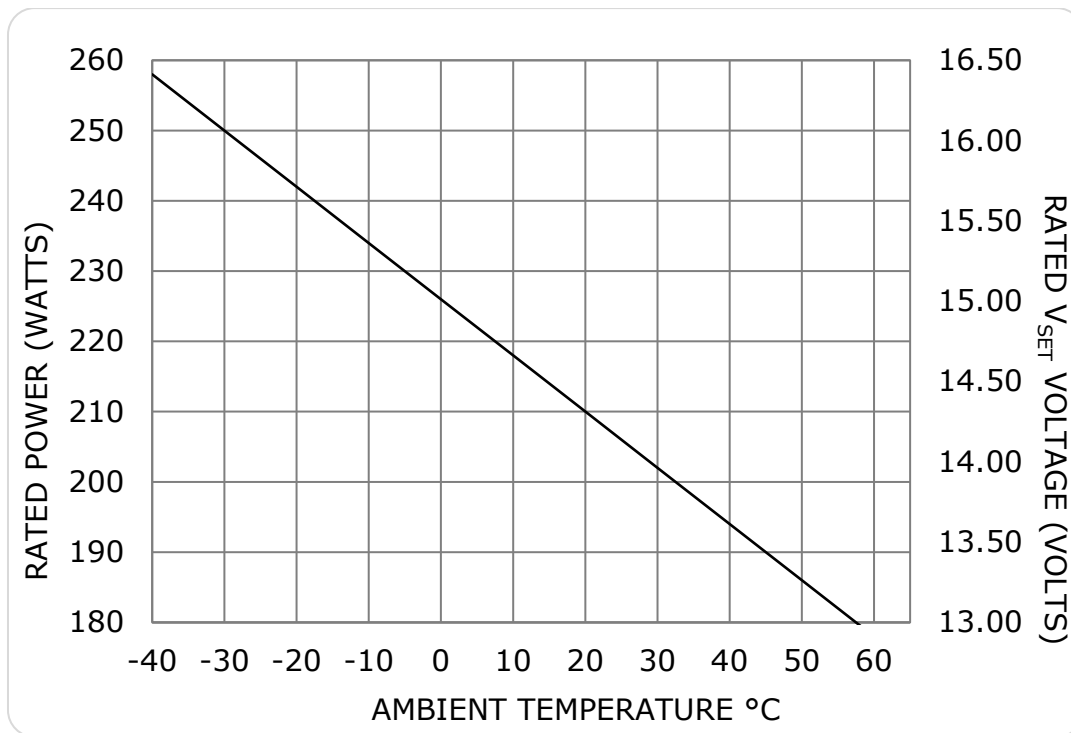


Figure 20 – V_{set} and Gross Power vs Ambient Temperature (Beginning of Service Life)

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 TB 1, as shown in Figure 13 and Figure 14).

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 TB-1 to the SETUP position, i.e. between terminals 2 and 3. See Figure 13 or Figure 14.
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 21.

**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.

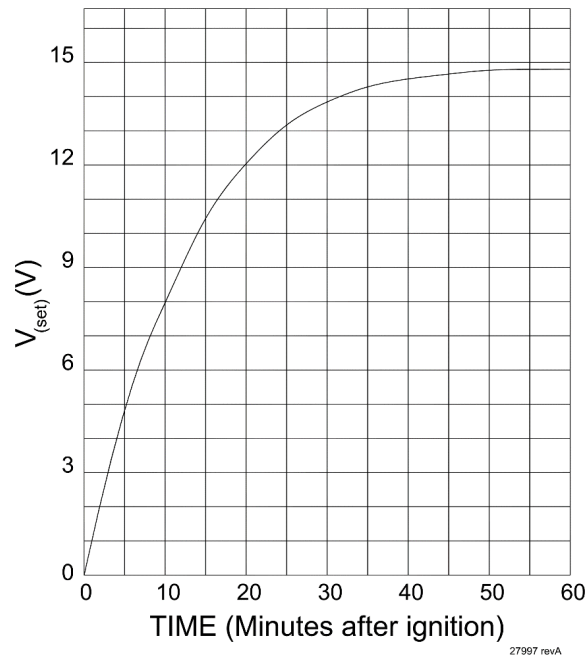


Figure 21 – V_{set} vs Time After Ignition, Example

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 TB-1 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 13 or Figure 14.
3. Connect a voltmeter between terminals 2 (+) and 4 (-). The measured V_{set} and 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} .

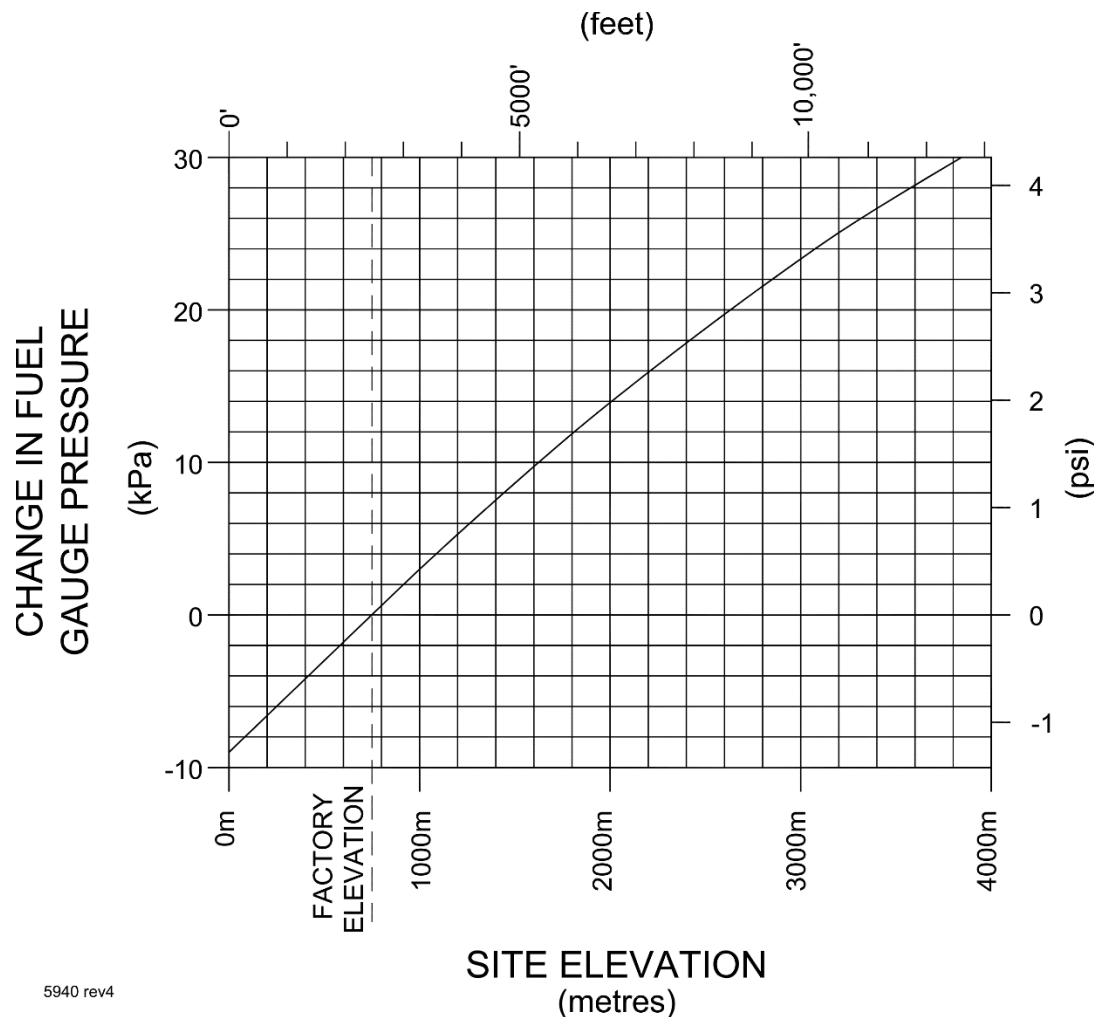
NOTE:

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.



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Figure 22 – 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.

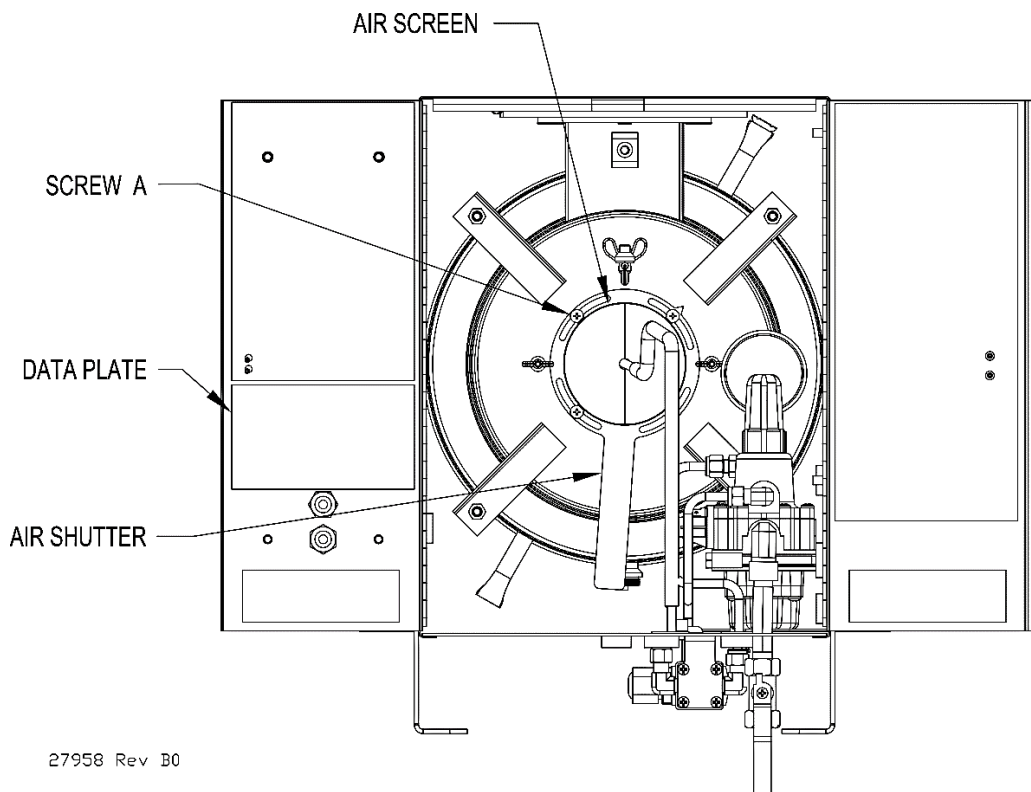
Keep in mind that if the TEG is located at a different altitude than the factory - 792 m (2,600 ft) - the fuel pressure may need to be compensated to achieve the correct power output. Use Figure 22 to determine how much to compensate the fuel pressure setting.

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.



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Figure 23 – 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 TB-1 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 $\pm 0.2V$ 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 23 for Data Plate location.

**WARNING!**

Do not exceed the fuel pressure stamped 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 23). 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 can be 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 $\pm 0.1V$.

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 TB-1 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 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.

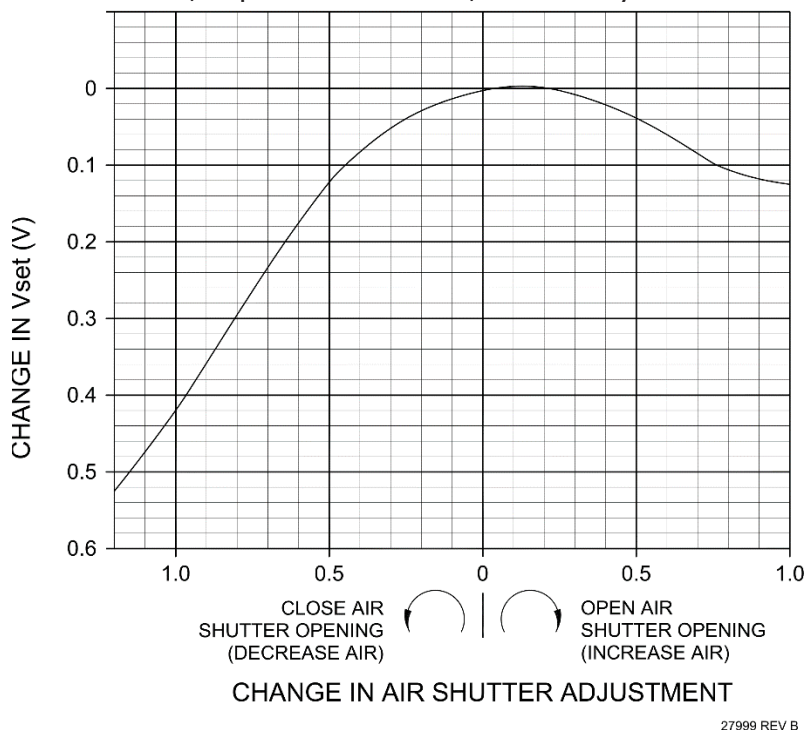
If V_{set} is greater than the required value ($\pm 0.2V$), repeat steps 3 and 4. Continue to open the shutter until V_{set} decreases, then rotate the shutter to the position that gave the highest V_{set} , and tighten screws A and B.

If V_{set} is less than the original value ($\pm 0.2V$), 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 screws A and B 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 A and B, replace air screen, and verify V_{set} before closing the cabinet.



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Figure 24 – 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 TB-1 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 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 TB-1 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.
Use the following table in
8. Figure 25 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
$> V_{SET\ REF}$	$< 800\text{ppm}$	TEG is over-fired	Air shutter unchanged. Turn fuel pressure down to decrease V_{SET} . Wait 15-20 minutes, then re-evaluate.
	$> 800\text{ppm}$	Not enough air	Open air shutter until CO falls below 800ppm. Leave fuel pressure unchanged. Wait 15-20 Minutes, then re-evaluate.
$< V_{SET\ REF}$	$< 800\text{ppm}$	TEG is under-fired	Turn fuel pressure up to increase V_{SET} . Air shutter unchanged. Wait 15-20 minutes, then re-evaluate.
	$> 800\text{ppm}$	Not enough air	Open air shutter until CO falls below 800ppm. Leave fuel pressure unchanged. Wait 15-20 Minutes, then re-evaluate.
$= V_{SET\ REF} \pm 0.2V$	$< 800\text{ppm}$	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.
	$> 800\text{ppm}$	Not enough air, TEG is under-fired	Open air shutter and increase fuel pressure slightly. Wait 15-20 Minutes, then re-evaluate

Figure 25 – 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 CO₂ percentage, or O₂ percentage, is needed.

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

- For Natural Gas when using as measured CO₂ percentage, and CO_{ppm}:

$$CO_{AFppm} = \left(\frac{11,8}{CO_2} \right) \times CO_{ppm}^{[1]}$$

- For Propane when using as measured CO₂ percentage, and CO_{ppm}:

$$CO_{AFppm} = \left(\frac{13,8}{CO_2} \right) \times CO_{ppm}^{[2]}$$

- When using as measured O₂ percentage, and CO_{ppm}:

$$CO_{AFppm} = \left(\frac{21}{21-O_2} \right) \times CO_{ppm}^{[3]}$$

[1], [2], [3] as per CSA TIL R-10

Where: CO_{AFppm} = Carbon monoxide, air-free ppm.
 CO_{ppm} = As-measured combustion gas carbon monoxide ppm.
 O₂ = Percentage of oxygen in combustion gas
 CO₂ = Percentage of carbon dioxide in combustion gas

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 26 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 26, the fuel pressure must then be increased by 3.6 kPa (0.52 PSI).

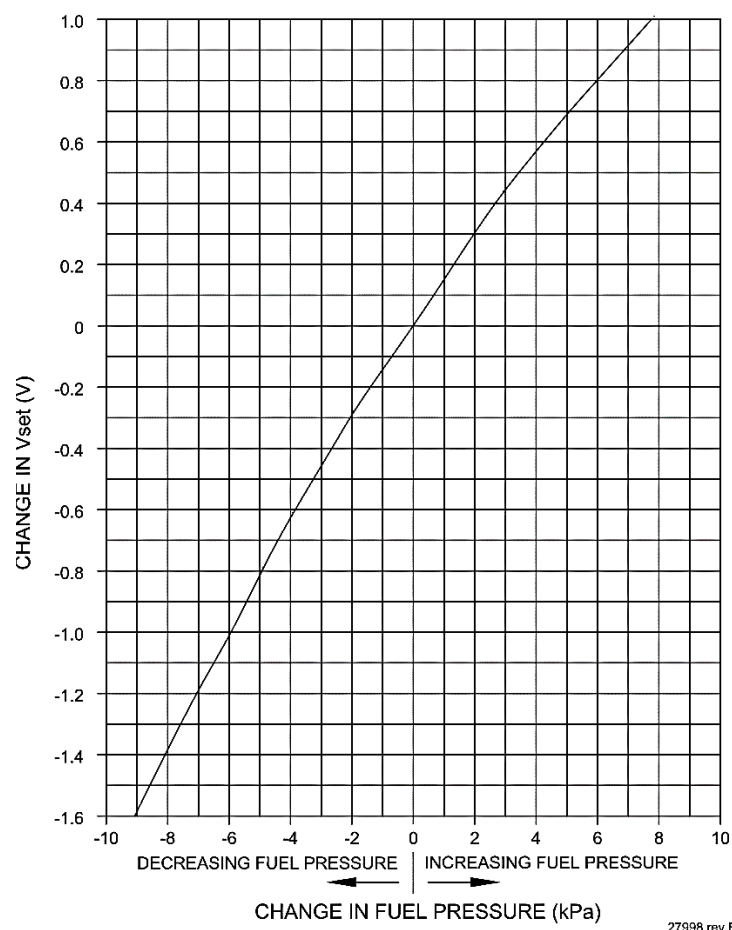


Figure 26 – Change in V_{set} vs Fuel Pressure Adjustment, Typical

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 TB-1 to the RUN position, i.e. between terminals 1 and 2.
3. Connect a voltmeter between terminals 6 (-) and 7 (+) of TB-1 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 TB-1 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 TB-1.
2. Move the jumper clip on the terminal block TB-1 to the RUN position, i.e. between terminals 1 and 2.
3. Connect a voltmeter between terminals 4 (-) and 5 (+) of TB-1 and measure the output voltage.
4. Adjust the output voltage by turning the output voltage adjustment potentiometer, shown in Figure 6 – 220-Watt Limiter Assembly, 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 TB-1 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 – 220-Watt Limiter Assembly.
4. Place an ohmmeter between the common and normally open contact of the VSR.
5. Turn the **VSR adjustment pot** shown in Figure 6 – 220-Watt Limiter Assembly 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 desired 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 0-1 Ω 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.

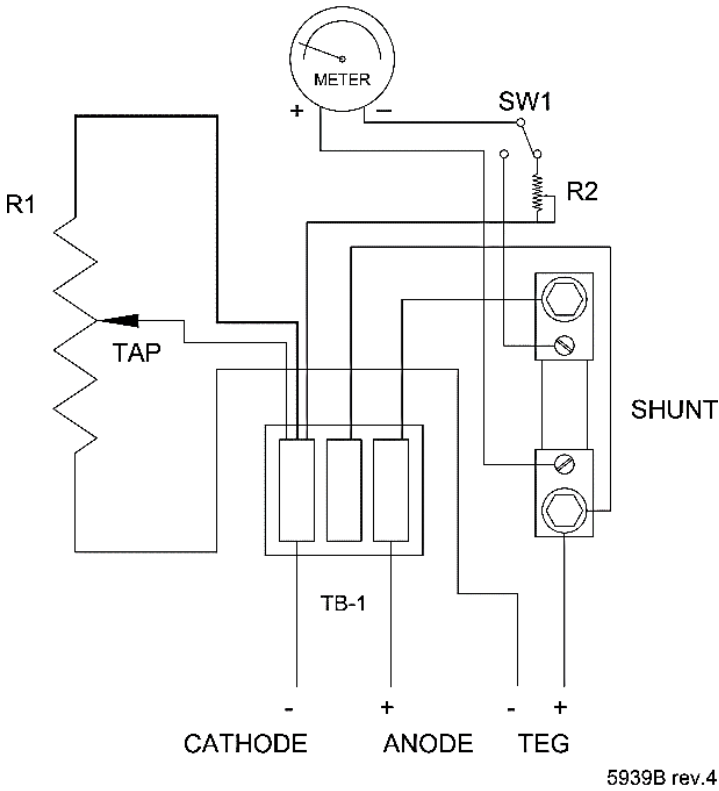


Figure 27 - CP Interface System, Series Wiring Diagram

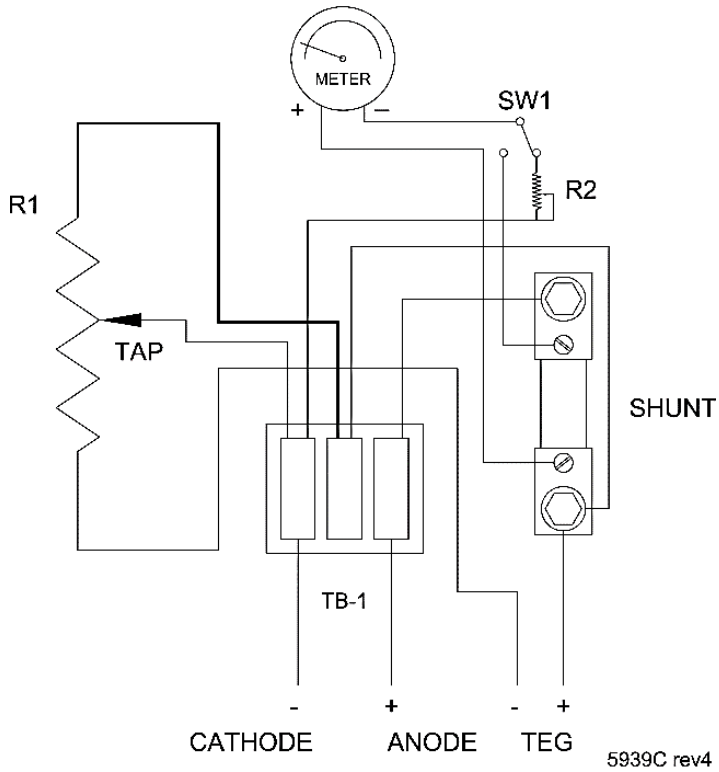


Figure 28 - CP Interface System, Parallel Wiring Diagram

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 in.
- 1 - Wrench, 1/2 in.
- 1 - Adjustable wrench, that will open to 16 mm (5/8 in.)
- 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 40069, 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 wellbeing 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# 22361) 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.

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 29 on the next page.

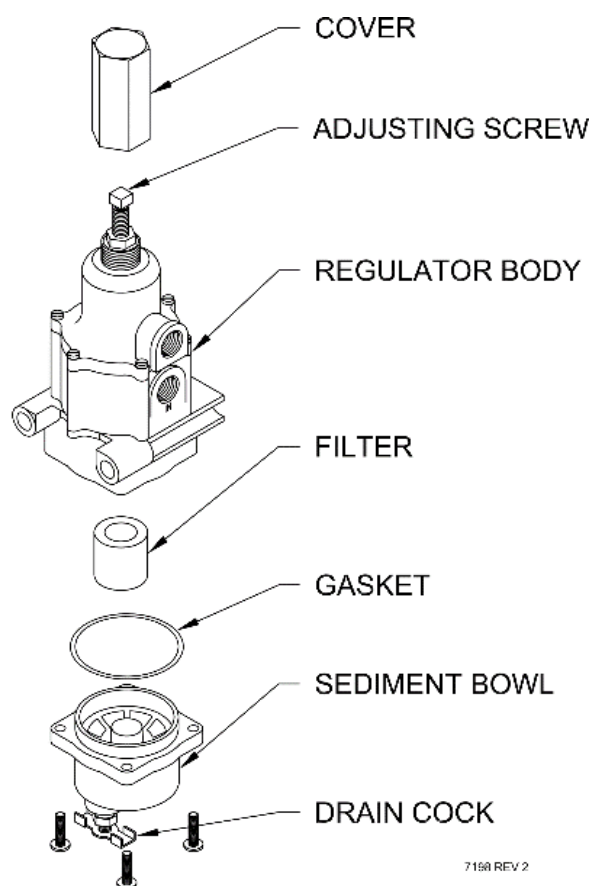


Figure 29 – Pressure Regulator

Follow these steps to install the fuel filter:

1. Install the filter and gasket onto the sediment bowl. See Figure 29.
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 flexible 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# 06251

Natural gas orifice (#8) - Part# 00690

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. 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 30 below:

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

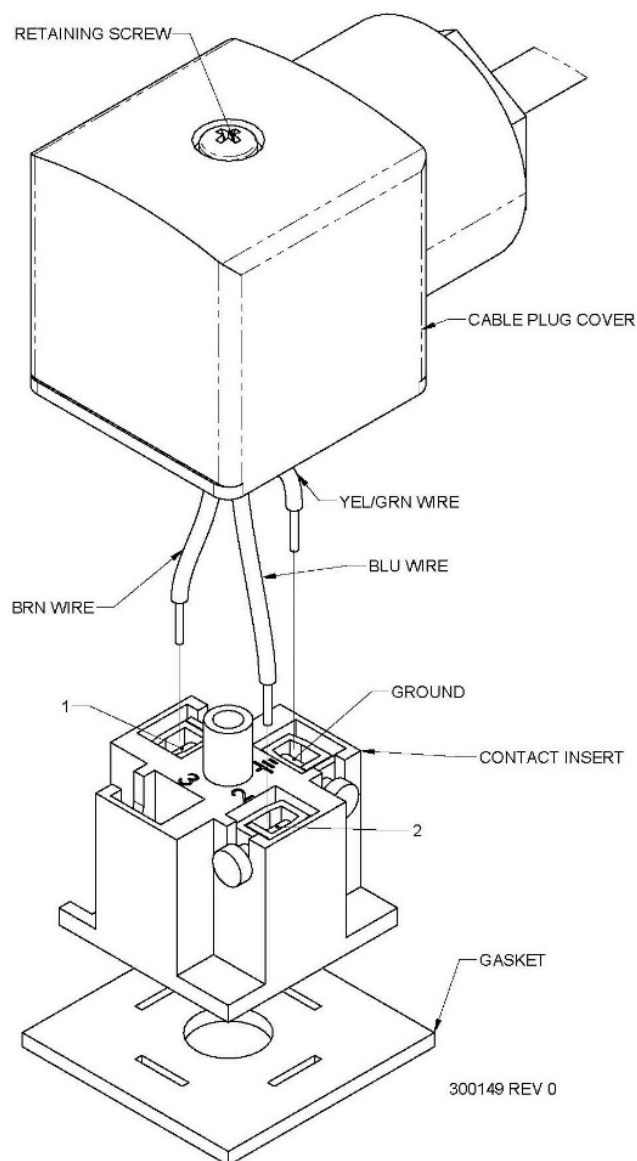


Figure 30 – Solenoid Valve Cable Plug Connections

9. Orient the contact insert as shown in Figure 30 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 31. 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.

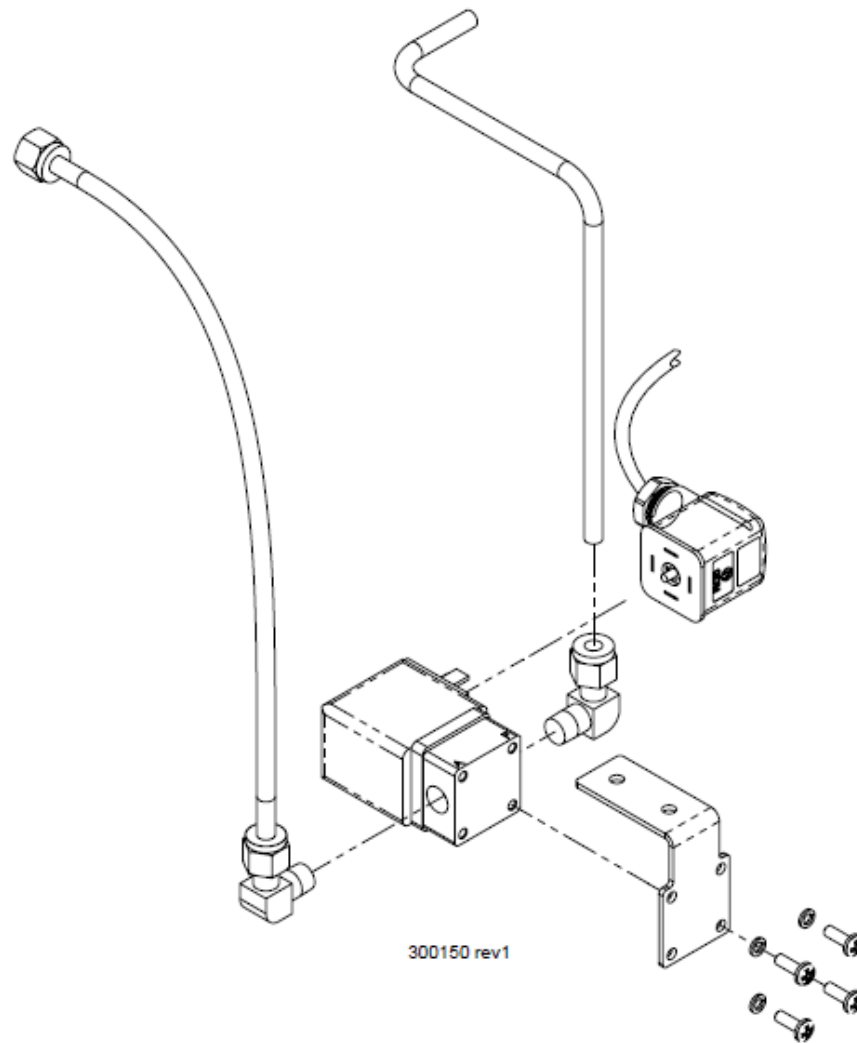


Figure 31 – Solenoid Valve Fuel System Connections

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	<i>Installation</i>
	Supply gas pressure too low	Increase gas supply pressure to the TEG	<i>Installation</i>
	Fuel filter dirty	Drain the regulator sediment	<i>Maintenance</i>
		Replace the fuel filter	<i>Maintenance</i>
	Fuel pressure adjustment incorrect	Adjust the TEG fuel manifold pressure	<i>Adjustment</i>
	Fuel orifice plugged	Replace the fuel orifice	<i>Maintenance</i>
	Fuel orifice size incorrect	Replace the fuel orifice	<i>Maintenance</i>
	TCO has opened	Check TCO continuity. Replace if open.	<i>Maintenance</i>
	Air filter dirty	Clean the air filter	<i>Maintenance</i>
	Air-shutter adjustment incorrect	Open the Air Shutter slightly	<i>Adjustment</i>
	SI system faulty	Maintain the SI system	<i>Maintenance</i>
Burner will ignite but will not continue to burn	Supply gas pressure too low	Increase gas supply pressure to the TEG	<i>Installation</i>
	Fuel filter dirty	Drain the regulator sediment bowl.	<i>Maintenance</i>
		Replace the fuel filter	<i>Maintenance</i>
	Fuel pressure adjustment incorrect	Adjust the TEG fuel manifold pressure	<i>Adjustment</i>
	Fuel orifice plugged	Replace the fuel orifice	<i>Maintenance</i>
	Fuel orifice size incorrect	Replace the orifice with one of the correct sizes	<i>Maintenance</i>
	Safety SOV valve malfunctioning	Check the safety SOV valve	<i>Troubleshooting</i>
	Air filter dirty	Clean the air filter	<i>Troubleshooting</i>
	Air shutter adjustment incorrect	Open the Air Shutter slightly	<i>Adjustment</i>

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	<i>Power Output Evaluation and Adjustment</i>
	Airflow past cooling fins insufficient	Clean the cooling fins of any debris	<i>Maintenance</i>
	Fuel filter dirty	Drain the regulator sediment bowl	<i>Maintenance</i>
	Fuel orifice plugged	Replace the fuel orifice	<i>Maintenance</i>
	Fuel orifice size incorrect	Replace the orifice	<i>Maintenance</i>
	Fuel pressure adjustment incorrect	Adjust TEG fuel manifold pressure	<i>Adjustment</i>
	Safety SOV valve malfunctioning	Check the safety SOV valve	<i>Troubleshooting</i>
	Air filter dirty	Clean the air filter	<i>Troubleshooting</i>
	Air-shutter adjustment incorrect	Adjust air-shutter	<i>Adjustment</i>
	L/C or Limiter damaged	Examine the L/C or Limiter	<i>Troubleshooting</i>
	L/C or Limiter adjustment incorrect	Adjust the L/C or Limiter	<i>Adjustment</i>
	Power unit damaged	Examine the power unit	<i>Troubleshooting</i>
Output power is too high	Fuel pressure adjustment incorrect	Lower the TEG fuel pressure	<i>Adjustment</i>
	Air-shutter adjustment incorrect	Open the air shutter slightly	<i>Adjustment</i>
Output voltage is too high	L/C or Limiter damaged	Adjust the L/C or Limiter	<i>Adjustment</i>
	L/C or Limiter adjustment incorrect	Adjust the L/C or Limiter	<i>Adjustment</i>

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.

Slide the spark electrode out of its receptacle. See

3. 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 flexible 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:

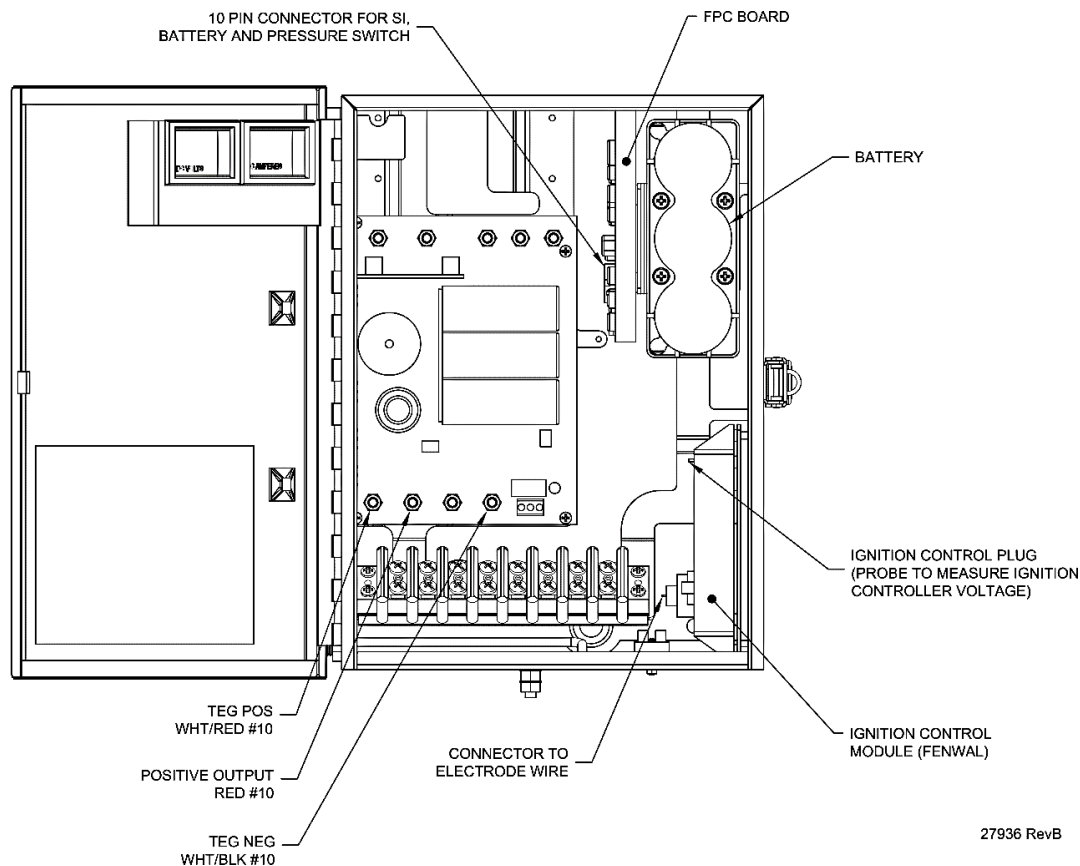
1. Reassembly is the reverse of disassembly.
2. Before re-starting the TEG, leak-check all fuel connections.

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®.



27936 RevB

Figure 32 – SI Module Wiring

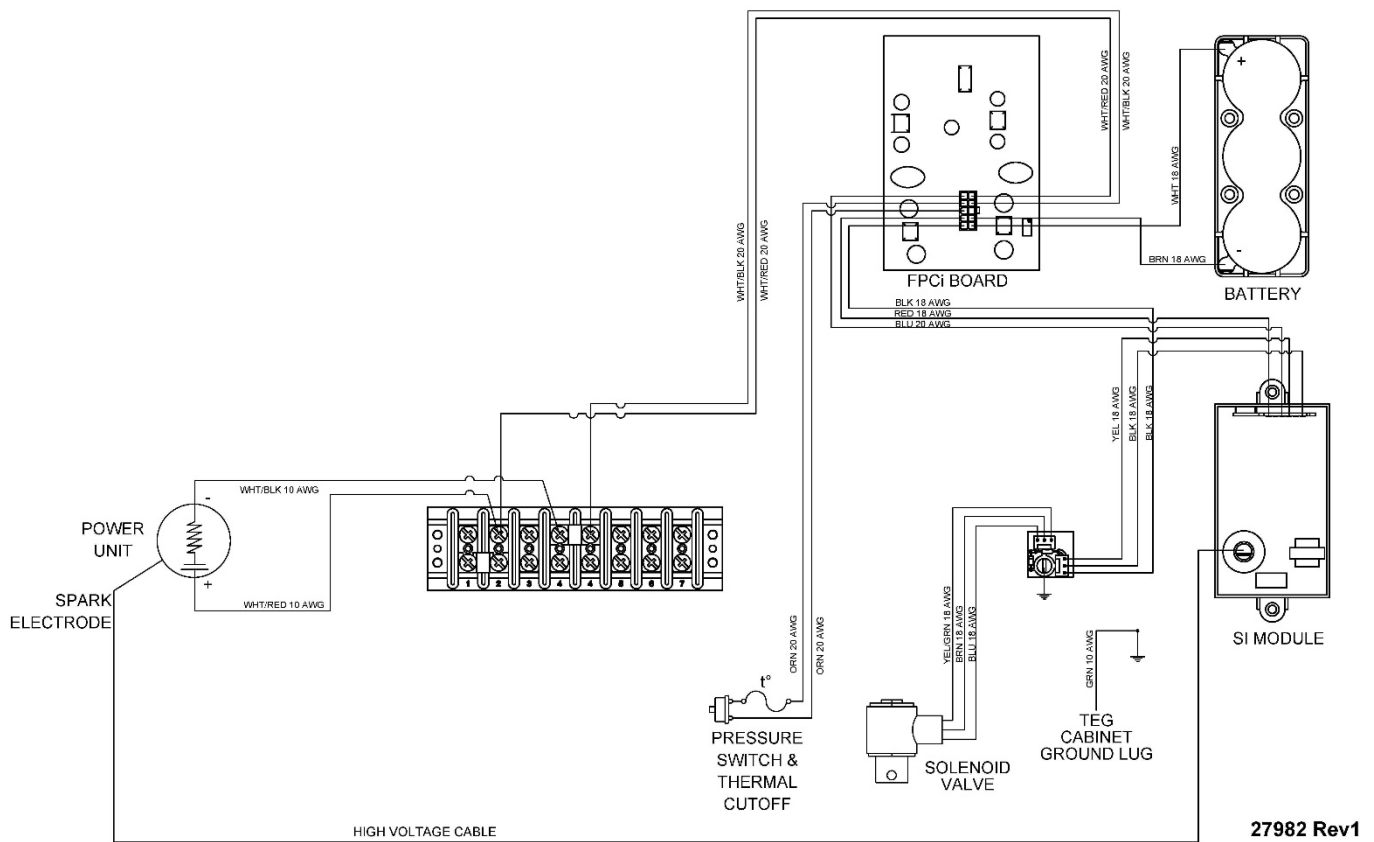


Figure 33 – Spark Ignition Control Module Wiring Diagram

10.2 SPARK IGNITION CONTROL SYSTEM TROUBLESHOOTING

The SI system may require occasional maintenance. If the Igniting Control system fails to ignite the burner, it must be checked and serviced as necessary. Use the procedures below to maintain the SI system.



WARNING!

Remove the orange wire connector from the pressure switch, and make sure it does not contact other surfaces to prevent high-voltage shocks during maintenance.

NOTE:

The Spark Ignition System is configured differently for 5220 models equipped with Remote Start systems. If troubleshooting a Remote Start 5220, consult your Remote Start Operating Manual for wiring diagrams and additional info.

10.2.1 Check the Spark Electrode

The spark electrode serves two roles; it ignites the incoming fuel-air mixture in order to start the TEG, and it also senses a 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:

1. Remove the electrode and inspect it for any cracks in the ceramic rod. If any cracks are found, the electrode must be replaced.
2. If it is not damaged, slide the electrode back into position through the burner-back until it stops (hits the far wall of the burner), then pull it back 3.2 to 6.4 mm (0.125 to 0.250 in.). 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.
3. Check that the fuel hand valve outside the TEG is closed.
4. Unplug the orange wire connectors from the terminals on the pressure switch and then short them together. Arcing should occur in the combustion chamber (making a clicking noise) at the rate of five sparks per second.
5. If consistent sparking occurs at a rate of 5 audible sparks per second, the SI system is functioning properly.

10.2.2 Check the Pressure Switch

The fuel pressure switch is used by the SI module to sense fuel pressure. A faulty pressure switch may manifest as a TEG that won't start. Follow these steps to check the pressure switch:

1. Remove the two wires from the pressure switch and connect a multi-meter across the pressure switch terminals, set to measure resistance (ohms). See Figure 32 and Figure 33.
2. With no fuel pressure reading on the gauge, check that the resistance measured across the switch is near infinity, which indicates the switch being open. Replace the pressure switch if necessary.
3. Disconnect the solenoid valve by removing the connector. This will prevent any fuel from flowing.

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

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

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

6. Remove fuel pressure from the switch by closing the manual gas valve.

10.2.3 Check the Internal Battery Voltage

Follow these steps to check the battery voltage:

1. Open the door of the L/C or Limiter electronics enclosure mounted on the right side of the generator cabinet.
2. Locate the battery wiring harness connector plugged into the FPCi board, see Figure 32 and Figure 33.
3. Carefully probe the back of connector, measuring the voltage between the red and black terminals of the battery wiring harness connector. The voltage should be greater than 6 V.
4. If the voltage is less than 6 V the battery assembly needs recharging or replacing. Follow the remaining steps only if the battery needs replacing.

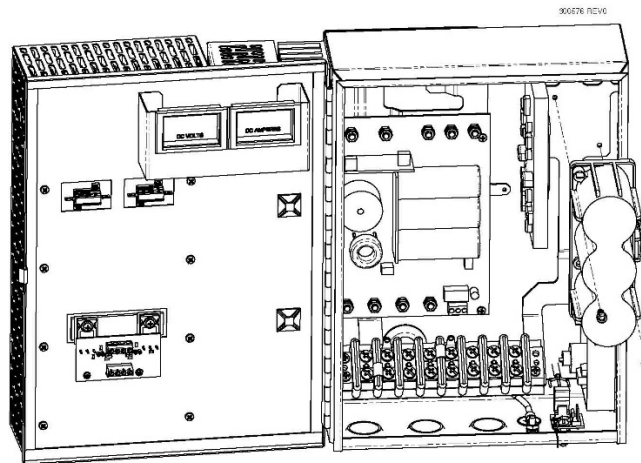


Figure 34 - Backup Battery Replacement

5. Unplug the negative brown wire from the lower battery terminal.
6. 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.
7. 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.
8. 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.
9. 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.

10.2.4 Check the Thermal Cutoff (TCO)

The model 5220 TEG is equipped with a thermal cutoff (TCO) attached to the pressure switch. 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 the TCO from the pressure switch
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.

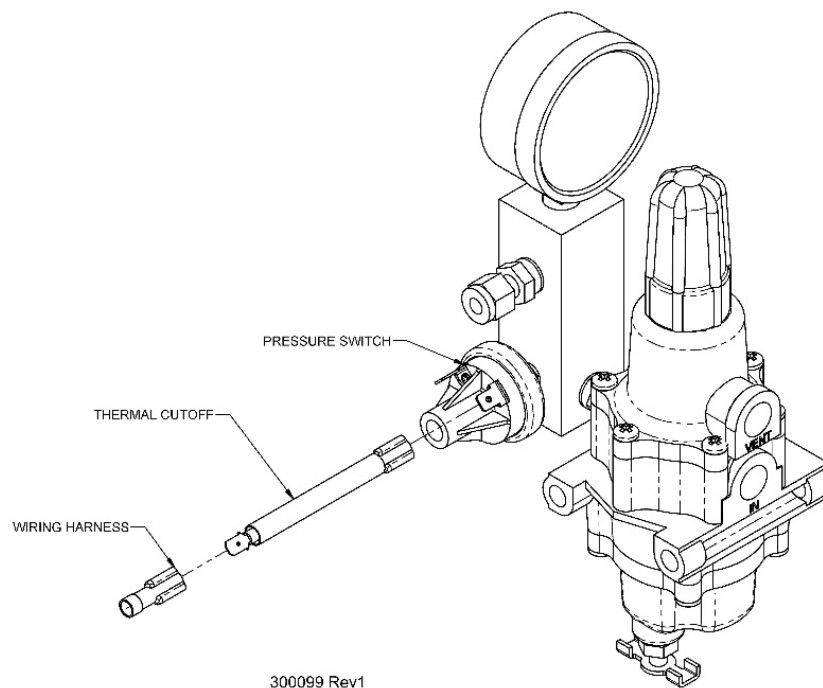


Figure 35 – Thermal Cutoff Installation Diagram

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

1. Disconnect one of the wires from the pressure switch. Polarity does not matter in the pressure-sensing circuit, so whichever wire is more easily reached will suffice.
 - a) For 5220 Remote-Start TEGs equipped with two pressure switches, use the switch connected with ORANGE wires.
2. Connect the TCO to the vacant terminal on the pressure switch.
3. Connect the free wire to the other end of the TCO.

NOTE:	On Remote-Start TEGs equipped with two pressure switches, the TCO should be attached to the pressure switch wired with ORANGE wires only.
--------------	---

If the TCO is discovered to be open, simply replacing the TCO may not be enough to solve the problem. The thermal fuse is set 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.

10.2.5 Check the SI Power Supply (FPCi Board)

The SI Module (also known as the FPCi Board) starts and monitors the TEG's burner. It also charges the internal startup battery. The board itself is potted, so troubleshooting is not possible in the field, but the board will not normally require service. Follow these steps to verify that the SI Module is getting power:

1. Start the TEG after it has been allowed to cool for 30-60 minutes.
2. Upon start up, probe and measure the voltage between the Red and Black wires of the SI Module's connector plug, see Figure 32 and Figure 33. Voltage should be between 13.7 V and 14.2 V.
3. Repeat the measurement after 20 minutes, voltage should again be between 13.7 V and 14.2 V.

Follow these steps to check the power supply battery charging circuit and ignition controller voltage Supply:

1. Start the TEG.
2. After twenty minutes of TEG operation, check the battery voltage.
3. Voltage should be 6.5 V or greater.

10.2.6 Check the Internal Battery Capacity

Follow these steps to check whether the internal startup battery holds a charge:

1. With the TEG allowed to cool and the manual shutoff valve turned off, remove the two orange wires from the terminals of the pressure switch and short them together.
2. Measure the battery voltage within 60 seconds of shorting the pressure switch wires together. If battery voltage drops below 6 V during this time, replace the battery.

10.2.7 Check the Solenoid Valve

The 5220 is equipped with a solenoid valve to control fuel flow to the burner and act as a safety shutoff. A faulty solenoid valve may prevent a TEG from starting or shutting down correctly. There are two ways to check the solenoid valve:

1. If you cannot hear the solenoid valve audibly “click” open when sparking begins, allowing fuel to flow, then unplug the solenoid valve connector from the back of the valve. Measure the resistance across pins 1 and 2 on the back of the solenoid valve. A 12V solenoid valve will have a nominal resistance of 72 Ohms, and a 24V solenoid will have a nominal resistance of 288 Ohms. Resistance values significantly above these indicate a damaged coil. Replace the solenoid valve if coil resistance is high.
2. Unplug the connector from the back of the solenoid valve and then apply fuel pressure to the TEG. While the SI is sparking, carefully measure the voltage across terminals 1 and 2 on the solenoid valve plug. If voltage is less than 11V, check power supply to the SI Module (Section 10.2.5). If the SI Module is getting correct power, replace the SI Module.

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 TB-1 terminals 6 (-) and 7 (+) for an L/C assembly (Model 5220-24V), or TB-1 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 TB-1.

3. Connect a voltmeter between terminals 2 (+) and 4 (-) of TB-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. 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 TB-1.
3. Connect a voltmeter between TB-1 terminals 6 (-) and 7 (+) for an L/C assembly (Model 5220-24V), or TB-1 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 TB-1.
3. Connect a voltmeter between terminals 2 (+) and 4 (-).

NOTE: Alternative resistor values are acceptable so long as the resistance is close to $1\ \Omega$ and accuracy class better than $\pm 1\%$.

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.

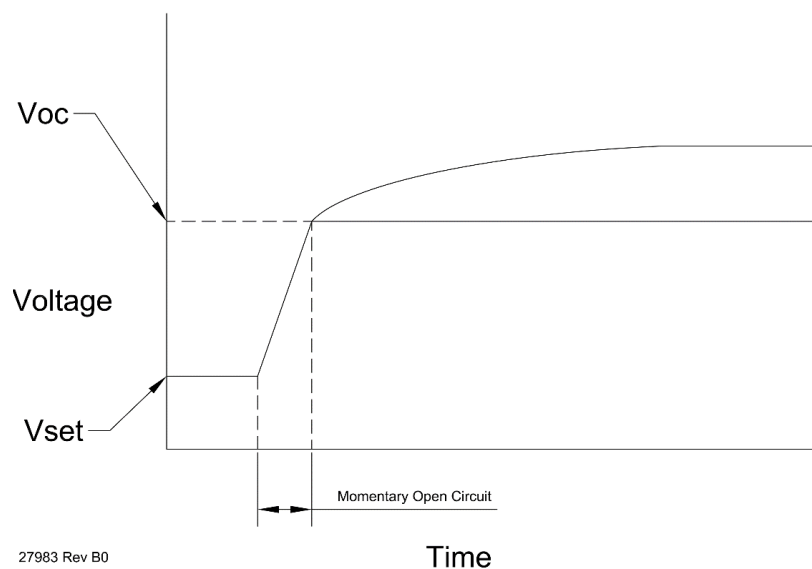


Figure 36 – Momentary Open Circuit Diagram

7. Calculate the internal resistance using the equations 6 and 7 below.

Equation 6 : $I_L = \frac{V_{set}}{R_L}$

Equation 7 : $R_i = \frac{V_{oc} - V_L}{I_L}$

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:

$$\begin{aligned} I_L &= V_{set} / R_L \\ &= 14.9 / 1.0 \\ &= \underline{14.9 \text{ A}} \end{aligned}$$

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

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 TB-1.
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 TB-1.

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 LIST

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 9.1.1 for further details on routine maintenance.

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

11.1 MODEL 5220 TEG

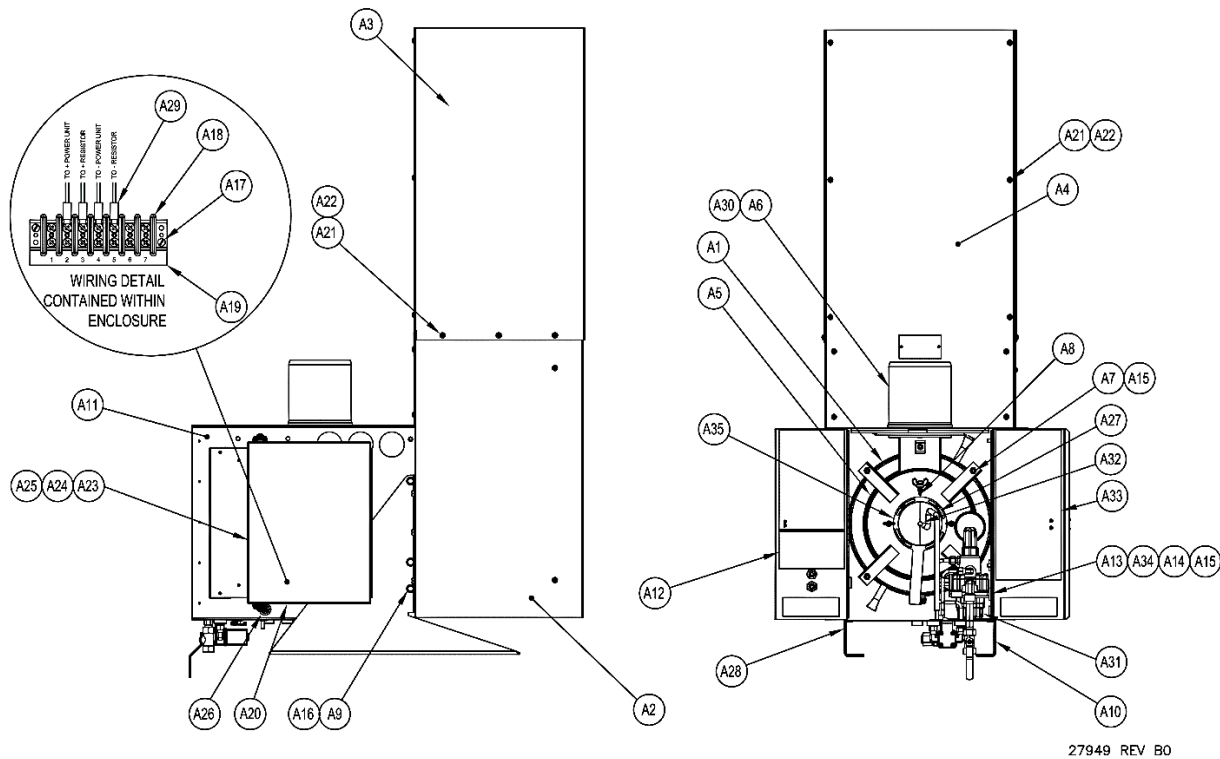
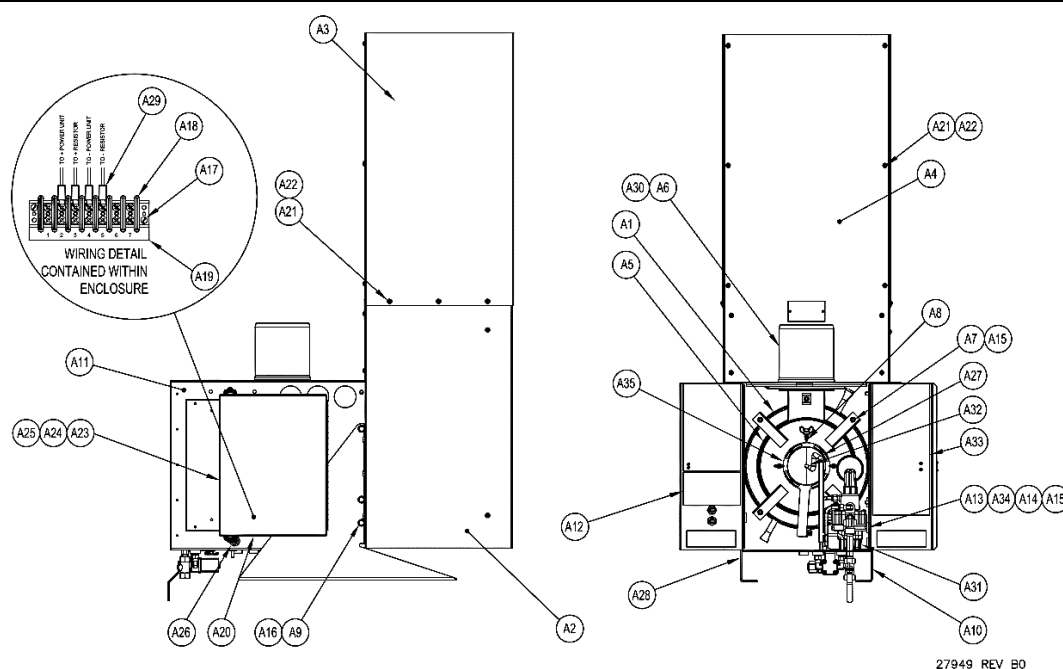


Figure 37 - Model 5220 TEG

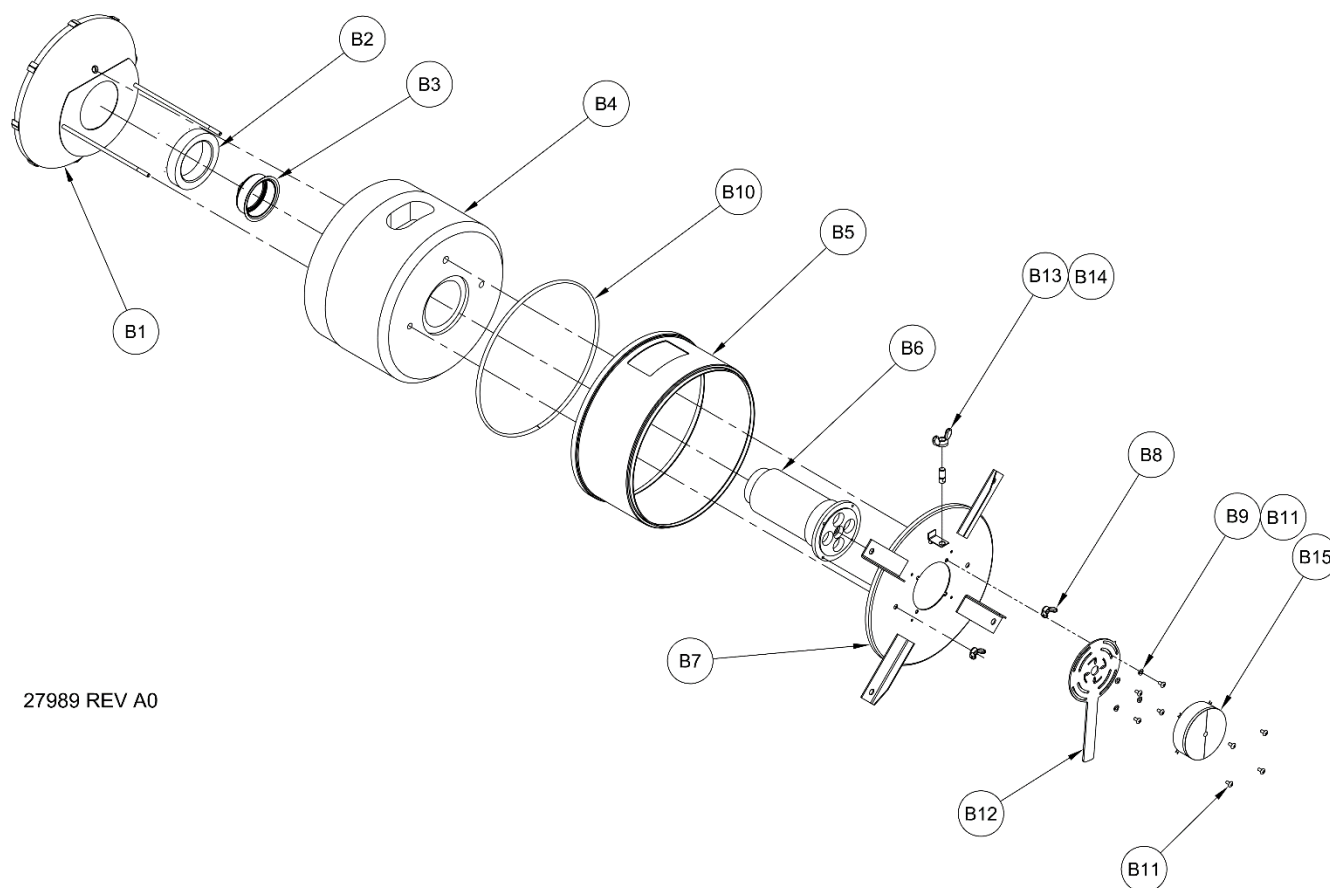
Item	Part No.	Description
A1	8908	POWER UNIT
A2	22947	FIN DUCT, LOWER
A3	22875	FIN DUCT, UPPER
A4	22906	COVER ASSY, UPPER FIN DUCT
A5	27902	BURNER ASSY
A6	6011	EXHAUST STACK ASSY
A7	6170	ROD, BURNER MOUNTING
A8	58496	ELECTRODE ASSY, FLAME SENSING SI
A9	20535	SCREW, CAP, HEX, HD, 1/4-20 X 5/8", SS
A10	22946	LEG, CABINET, RIGHT
A11	27917	CABINET ASSY
A12	27888	LABEL, DATA PLATE
A13	22520	SCREW, CAP, HEX HD, 1/4-20 X 3.75", SS
A14	473	WASHER, LOCK, EXT, 1/4, SS
A15	611	NUT, HEX, 1/4-20, SS
A16	557	WASHER, FLAT, 1/4, SS
A17	7412	SCREW, MACH, P-H-P, 10-32 X 3/4, SS
A18	2110	TERMINAL BLOCK, 8 POSITION

11.1 MODEL 5220 TEG (Cont'd)



Item	Part No.	Description
A19	2109	MARKER STRIP
A20	4552	CONNECTOR, STRAIGHT, 2 SCREW, 3/4"
A21	7410	SCREW, MACH, P-H-P, 8-32 X 1/4, SS
A22	472	WASHER, LOCK, EXT, #8, SS
A23	63096	SI BOARD ASSY CHANNEL PRODUCTS 2021-90, 50N-12-3-3-7-10-0-P23062
A24	27907	POWER CONVERTOR, 4VDC IN, 13.8VDC OUT, 6V BATT CHARGE
A25	24559	BATTERY 6V, 5.0 AHR, MONOBLOC
A26	283	BUSHING, UNIVERSAL, 1/8" HEYCO
A27	5586	AIR SCREEN ASSY
A28	22945	LEG, CABINET, LEFT
A29	208	TERMINAL, RING, #10 YELLOW
A30	523	CLAMP, 5 1/4" DIA., SS
A31	27905	FUEL SYSTEM, W/ BURKERT VALVE, 5220
or	66466	FUEL SYSTEM, SS, 5220
A32	6251	ORIFICE ASSY, PROPANE
	690	ORIFICE ASSY, NATURAL GAS
A33	27892	LABEL, INSTRUCTION
A34	22372	SPACER, FUEL SYSTEM W/67CFR REGULATOR
A35	27900	AIR SHUTTER, PROFILED 5220

11.2 MODEL 5220 BURNER



27989 REV A0

Figure 38 - Model 5220 Burner

Item	Part No.	Description
B1	5606	BURNER BACK ASSY
B2	5605	HOLDER, SCREEN INSULATOR
B3	5390	SCREEN ASSY
B4	6086	INSULATION BLOCK
B5	6186	BURNER CAN, EXHAUST
B6	5375	VENTURI TUBE INTAKE ASSY
B7	5378	BURNER TOP ASSY
B8	601	NUT, WING, 10-32, SS
B9	5047	SCREW, TRUSS-HD-P, 8-32 X 3/8, SS
B10	6631	ROPE, 1/4" KAOTEX 2000
B11	27901	WASHER, BOWED, 5MM, AZ SS, SPAENAU 681-821
B12	27900	AIR SHUTTER, PROFILED, 5220
B13	7004	PIN, MOUNTING, SI HOLDER
B14	7005	NUT, WING, 5/16-18, SS
B15	5586	AIR SCREEN ASSEMBLY

11.3 MODEL 5220 FUEL SYSTEM

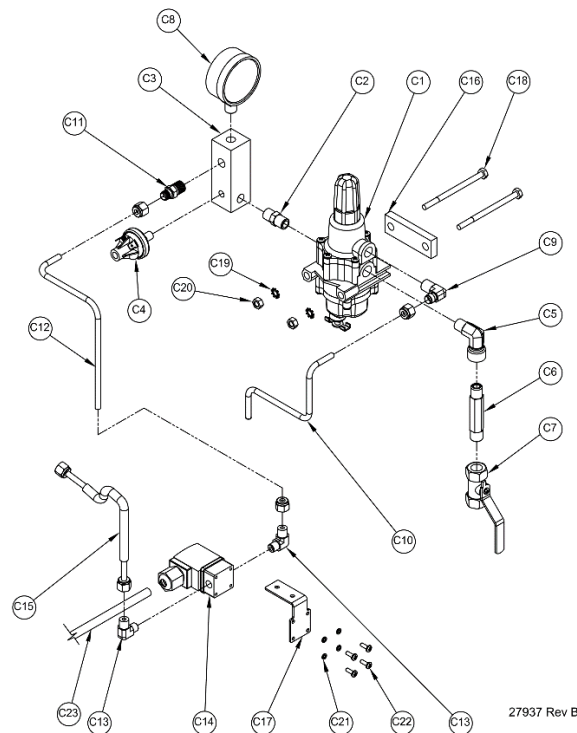
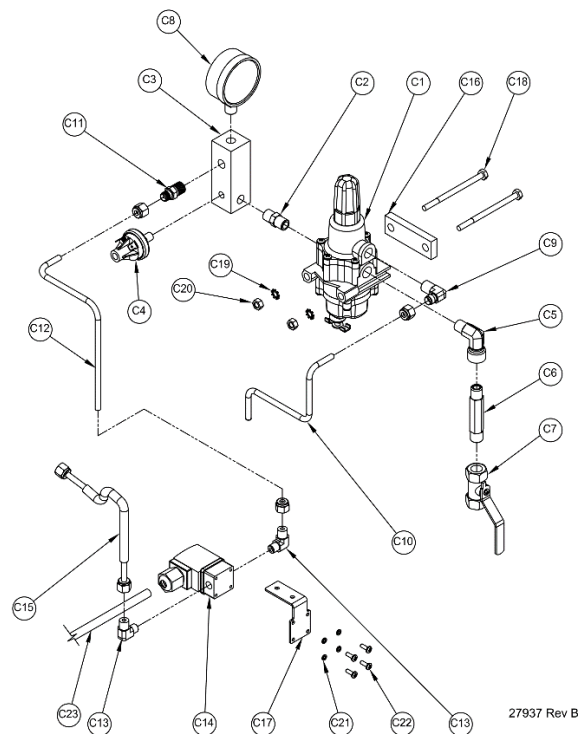


Figure 39 - Model 5220 Fuel System

Item	Part No.	Description
C1	64104	REGULATOR, FISHER 67CFR, 0-35 PSI, UL144, UL252, 5220
or	66475	REGULATOR, FISHER 67CFR, 0-35 PSI, UL144, UL 252, NACE, 5220
C2	501	NIPPLE, HEX, 1/4 NPT X 1 1/8, BRASS(FAIRVIEW)
or	2359	NIPPLE, HEX, 1/4 NPT X 1.5 LG, 316 SS
C3	2100	MANIFOLD BLOCK, FUEL SYSTEM
C4	6471	SWITCH, PRESSURE 1.6 PSI, 76056-DB 1.6-0.5
or	61849	SWITCH, PRESSURE 1.6 PSI, NO PLATED STEEL, HOBBS 76056-00000016-05
C5	21569	ELBOW, STREET 1/4 NPT, B-4-SE
or	2358	ELBOW, STREET, 1/4 NPT, SS
C6	2154	NIPPLE, HEX, 1/4" X 3", BRASS
or	2358	NIPPLE, HEX, 1/4 NPT X 3" LG, 316 SS
C7	24653	VALVE, 1/4 NPT, BRASS, 1/4 TURN, Q11F-600TB2.N
or	21689	VALVE, BALL, 1/4" 2000 LB, 316 SS, V-TEK V2
C8	406	GAUGE, PRESSURE, 0-30 PSI
or	7293	GAUGE, PRESSURE, 0-30 PSI, SS, 1/4 MNPT
C9	20071	ELBOW, 1/4 TB X 1/4 MNPT, SS, SS-400-2-4

11.3 MODEL 5220 FUEL SYSTEM Cont'd



Item	Part No.	Description
C10	7981	VENT TUBE ASSY, REGULATOR, SS, 5060/5120/5220
C11	380	CONNECTOR, 1/4 TB X 1/4 MNPT, 316 SS, SS-40-1-4
C12	27904	FUEL LINE, MANIFOLD, 5220
C13	26518	ELBOW, 1/4 TB X 1/4 MNPT, SS
C14	72158	VALVE, SOLENOID, BURKERT 6013A, 468015, 12VDC, 2WAY NC, 1/8 FNPT, BRASS, 2W, 2mm Orifice, FKM seals WITHOUT
or	72282	VALVE, SOLENOID, BURKERT 6013A, 468032, 12VDC, 2WAY NC, 1/8 FNPT, SS, 2W, 2mm Orifice, FKM seals, Burkert 468032
C15	5286	KIT, FUEL LINE, 10IN.
C16	22372	SPACER 3/8", FUEL SYSTEM W/CFR REGULATOR
C17	27844	BRACKET, SOLENOID VALVE, 5120/5220
C18	22520	SCREW, HEX HD, 1/4 - 20 X 3.75" SS
C19	473	WASHER, LOCK, EXT. 1/4, SS
C20	611	NUT, HEX, 1/4-20, SS
C21	538	WASHER, LOCK, SPRING, #8, SS
C22	23438	SCREW, MACH, P-H-P, M4 X 12MM, SS
C23	54282	WIRE HARNESS, SOLENOID VALVE, 5220
C24	22363	FILTER KIT, FISHER 67CFR, (NOT SHOWN)

12 TEG PERFORMANCE LOG

MODEL NO:
TEG SERIAL NO:
FUEL TYPE:
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)	FUEL PRESSURE	OPEN CIRCUIT VOLTAGE (V)		MAINTENANCE REMARK

CP INTERFACE SERIAL NO:

[illegible]