⚠ WARNING

FIRE OR EXPLOSION HAZARD

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

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

⚠ WARNING

FIRE, EXPLOSION, AND ASPHYXIATION HAZARD

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

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

WARNING: For outdoor use only.

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

⚠ AVERTISSEMENT

RISQUE D'INCENDIE OU D'EXPLOSION

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

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

⚠ AVERTISSEMENT

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

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

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

AVERTISSEMENT: Utiliser uniquement à l'extérieur.

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

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

P-5100 THERMOELECTRIC GENERATOR

Operating Manual

Intertek
4008107

CSA/ANSI 13.1:22

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62128 Rev 13

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1 ABOUT THIS MANUAL

This manual provides instructions for the operation and maintenance of the model P-5100 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.

	**WARNING!**	Before any work begins on the Thermoelectric Generator, please read this Operating Manual thoroughly.
	**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!**	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.
	**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.
	**WARNING!**	Do not exceed the fuel pressure printed on the TEG data plate without factory approval. If fuel pressure exceeds reasonable levels, the power unit may be seriously and permanently damaged.
	**WARNING!**	The TEG exhaust can be very hot. 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 P-5100 TEG is strictly an outdoor device and should never be used indoors. Avoid inhaling exhaust gases while working around or above the TEG.
	**WARNING!**	If TEG has not been given enough time to cool, the spark electrode can be dangerously hot.

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.

	**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_g). 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_g).
	**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!**	*CONDENSATE FROM REGULATOR IS VERY HIGH-RISK OF BEING FLAMMABLE.* When draining condensate from regulator, ensure it is removed from cabinet and is a safe distance from ignition sources. If there is a concern about liquids in the fuel line, it is suggested that the customer install a regulator drain line to remove condensate to a safe location away from ignition sources. Condensate collecting/pooling/splashing/etc. inside the TEG cabinet creates a dangerous fire hazard. Contact GPT for assistance with fuel conditioning options to remove liquids from fuel line supply.

	**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.

	**CAUTION!**	When the TEG is operating, surface temperatures of the unit can approach temperatures close to 200°C. Avoid contact of skin and clothing with the surfaces of the TEG to avoid burns.

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 particular significance, defined for the model P-5100, 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 P-5100 TEG produces 100 W when operating in an ambient temperature of 20°C (68°F). With the fuel flow held constant TEGs operating in ambient temperatures higher than 20°C (68°F) will see power output efficiency reduce, 0.4 W per °C (0.2 W per °F) of temperature change up to a maximum ambient temperature of 55°C (130°F). Conversely for temperatures lower than 20°C (68°F) power output efficiency will increase by 0.4 W per °C (0.2 W per °F) of temperature change.

Set-up Power: Power from the power unit for a specific ambient temperature. It is derived from voltage across a precision load, also known as V_{SET}.

Set-up Voltage: V_{SET} Voltage from the power unit for a specific ambient temperature, which is proportional to set-up power. Fuel flow to the burner is adjusted so that proper voltage exists, necessary temperature difference within the power unit maintained, to deliver required power.

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 across the thermoelectric materials inside the power unit.

When a power unit lead is suddenly disconnected, breaking the circuit to the load, the voltage measured across the power unit leaps up to a new value. This is known as the momentary open circuit voltage (V_{OC}).

Measured V_{SET}: V_{SET} measured across the precision load on the output of the electronics without a customer load connected using a voltmeter.

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

CP (Cathodic Protection): Thermoelectric generators are used in impressed current systems for Cathodic corrosion protection of metallic structures such as pipelines.

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

Limiter Converter (L/C): A specific electronic device attached between the generator and the load that converts one level of DC voltage to another and limits the power unit voltage.

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

Solenoid Valve (SV): A electrically actuated valve that controls the fuel gas supply to the burner. This valve is operated by the Spark Ignition (SI) Module.

Spark Ignition (SI): The method and system used to ignite the TEG. Refer to section 4.1.2 for details.

2 QUICK START PROCEDURE

This section gives the key steps for setting-up the TEG. It is for the operator who is already familiar with operating the TEG, having successfully completed Global Power Technologies (GPT) TEG training course, and being a qualified service person with reasonable knowledge and experience 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 P-5100 TEG:
   - 1 Fin Duct (1 front piece and 1 rear piece).
   - 1 Manual Ball Valve.
   - 1 Thread Sealing Compound.
   - 12 Screws, #8-32 × 1/4 inch long, one spare.
   - 12 Washers, #8 External Lock, one spare.
   - 1 Thermal Cutoff Assembly, spare.

NOTE: Inspect the TEG for damage that 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.

---

2. Assemble the TEG as shown in Figure 2 and mount it on a firm and stable base, sufficiently high above ground level to prevent the TEG from being inundated with water.
3. Connect the fuel supply to the manual shutoff valve, 1/4” FNPT, using the thread sealant provided. Leak check the complete fuel supply system from the fuel supply line to the burner inlet using a commercial leak detector fluid such as Snoop®.
4. Connect the customer load:
   - Connect the load to terminals 7 (+) and 8 (-) of TB1 (see Figure 15).
   - For CP applications connect the cathode and anode wires to the external CP interface box

2.2 START UP

Follow these steps to start the TEG:

1. Ensure the battery is connected.
2. Open the manual shutoff valve.

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

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3. If the optional TEG Controller (Remote Start) board is installed, press the Start (S1) button or send a SCADA Start signal to the TEG Controller (Remote Start) board.

NOTE:	Once the TEG is started pressing the Stop (S2) button or sending a SCADA Stop signal to the TEG Controller (Remote Start) board will stop it.

4. The Spark Ignition (SI) system should begin clicking after one second and the sound of combustion heard within 7 seconds. If the burner does not ignite wait 10 seconds for a second or third ignition trial. After a third trial the ignition control system will go into lockout mode.

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.

2.3 ADJUSTMENT

Follow these steps to adjust the TEG:

1. Disconnect the customer load from the TEG, terminals 7 (+) and 8 (-) of TB1 (see Figure 15) and allow to stabilize for 15 minutes.
2. Measure the V_{SET} voltage between terminals 5 (+) and 6 (-).
3. Check the measured V_{SET} value rises to that required, as per POWER OUTPUT EVALUATION section. Measured V_{SET} will level off after 1-hour from ignition. If the measured value is not in its normal operating range, then adjust the power output as per the ADJUSTMENT section.

CAUTION! Do not allow measured V_{SET} to exceed required V_{SET}, determined in the POWER OUTPUT EVALUATION section, otherwise overheating may cause irreparable damage to the power unit.

NOTE:	Details for adjusting the L/C and optional CP interface systems, if applicable, are in the ADJUSTMENT section.

2.4 PERFORMANCE LOG

Your TEG is now operating successfully, making available 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 servicing is carried out the details should be recorded. 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 P-5100 Thermoelectric generator.

3.1 OVERVIEW

The Model P-5100 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 P-5100 Thermoelectric Generator provides 127 Watts of electrical power from the power unit at the beginning of life and at an ambient temperature of 20°C. This power is generated at a nominal 6 Volts, which can then be converted to other voltages using the voltage converter. The TEG system outputs at least 100 Watts of net electrical power from its 12 Volt or 24 Volt converter.

If the generator is to be operated at load conditions that force the output voltage of the power unit to vary significantly from 5.5 Volts, then less than the rated power will be available to the load. Figure 5 identifies the electrical parameters of the P-5100's power unit as a function of the load resistance.

3.2 OPTIONS

Mounting Stand: The P-5100 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 GPT.

Cathodic Protection Interface (CP): The Cathodic Protection Interface option provides a termination point of 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.

Remote Start System (TEG Controller Board): The Remote Start option provides a method of starting and stopping the TEG either locally or remotely, using on-board buttons, SCADA signal interface or system measurements.

VSR Terminal Block: The optional VSR terminal block is an additional wiring harness that provides the VSR and current measurement connection on a terminal block inside the TEG Cabinet as opposed to directly connecting to the electronic circuit board.

48 V_{DC} Converter: The 48 V_{DC} Converter Option allows your model P-5100 generator to supply a nominal 48V output voltage from the standard 24V TEG output. The Converter Assembly is installed on the left side of the TEG and connects to the main terminal block TB1 inside the TEG cabinet.

NOTE:	Specifications shown are for standard configurations. Global Power Technologies' Engineering Department is available to design installations meeting different specifications including custom voltages, fuel supply systems and nonstandard operating temperatures.

Power output	
Power Ratings at the beginning of life, 20°C ambient temperature, 750m above sea level, at TB1 terminal 7 (+) and terminal 8 (-)	100 Watts @ 14 Volts 100 Watts @ 27 Volts 80 Watts @ 54 Volts
Electrical	
Adjustment	12 V 12–18 Volts 24 V 24-30 Volts 48 V 53-57 Volts
Reverse Current Protection	Yes, blocking diode is standard.
Output	Terminal block which accepts up to 8 AWG wire. Opening for 3/4” conduit in the base of the cabinet.
Fuel	
Natural Gas	* 332 ft^3/day (9.4 m^3/day) of 1000 BTU/ft^3 (37.3 MJ/m^3) standard natural gas
High BTU Natural Gas	* 222 ft^3/day (6.3 m^3/day) of 1500 BTU/ft^3 (55.9 MJ/m^3) high BTU natural gas * 277 ft^3/day (7.8 m^3/day) of 1200 BTU/ft^3 (44.7 MJ/m^3) high BTU natural gas
Propane	* 13.8 L/day (3.6 US gal/day)
Maximum Supply Pressure	344 kPa (50 psi_g)
Minimum Supply Pressure	103 kPa (15 psi_g)
Fuel Connection	1/4” FNPT
Environmental	
Ambient Operating Temperature Continuously Running TEG	Max. 55°C (130°F) Min. -40°C (-40°F)
Operating Conditions	Unsheltered Operation
Materials of Construction	
Cabinet	304 Stainless Steel
Cooling Type	Natural Convection
Burner	Meeker type, Inconel 600
Fuel System	Brass, Aluminum & Stainless Steel

**** Gas volume at 1 atm and 15°C***

3.3 WEIGHTS AND MEASURES

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

Depth	790 mm (31.11 in.)
Width	306 mm (12.06 in.)
Height	994 mm (39.12 in.)
Net Weight	60 kg (132 lb.)
Shipping Weight	83 kg (183 lb.)
Mounting Holes	267 mm wide × 457 mm deep (10.53 in. × 18.00 in.)
Mounting Hole Diameter	ø7.9 mm (ø0.31 in.)

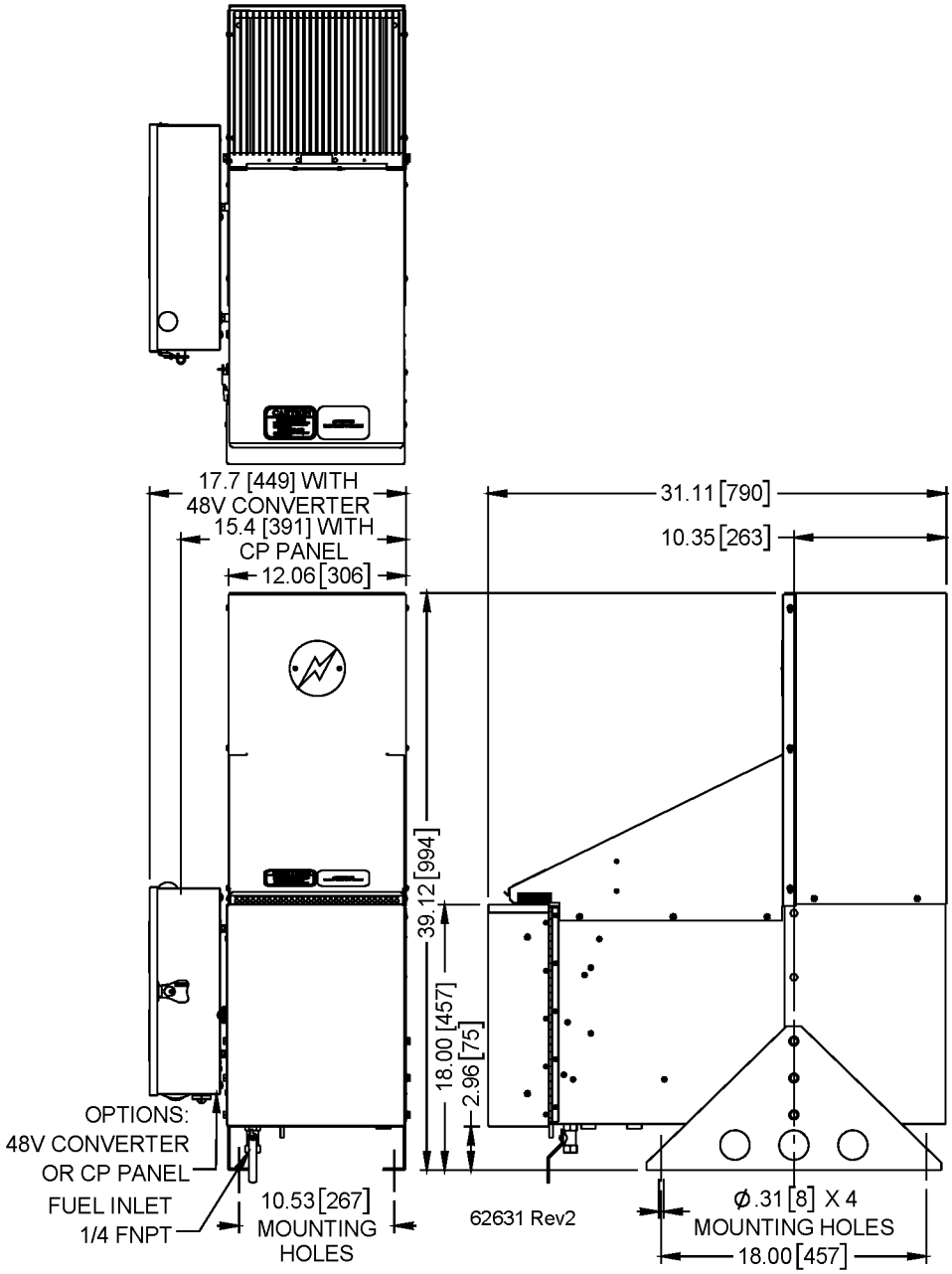

Figure 1 – Overall Dimensions of the P-5100 TEG

3.4 SPARK IGNITION SYSTEM

The following table gives the technical specifications for the SI system.

Electrical SI Power Supply	Input Voltage	Minimum 6 V DC
		Maximum 31 V DC
	Power Input	8 Watts
	Output Voltage	14 V DC
SI	Spark Rate	10/second
	Trial for Ignition	7 seconds
	Number of tries for Ignition	3 trials until lockout
	Inter-Purge Time	10 seconds
Spark Gap	Nominal	4.8 mm (0.19 in.)
	Minimum	3.3 mm (0.13 in.)
	Maximum	6.3 mm (0.25 in.)
Continuous Operating Time Without Charge		120 minutes with fully charged 6V, 5 Ah battery pack @ 25°C (75°F)

3.5 DATA PLATE

The data plate is on the inside of the cabinet door (see Figure 12) and includes vital information about the generator.

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

P-5100 ( ) - ( ) – ( ) – ( )

Fuel Type:
L = Propane
N = Natural Gas
H = High BTU Natural Gas

Output Voltage:
12, 24, or 48 Volts

SS = Stainless Steel Fuel System

CP = Cathodic Protection Interface
FA = Flame Arrestors
RS = Remote Start
HRS = Heat Recovery System

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

Fuel Input Rating: This is the fuel energy input rate of the TEG.

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

Fuel Type: 'NATURAL GAS' (CH_4) or 'PROPANE' (C_3H_8).

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

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

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

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

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

3.6 FUEL CONSUMPTION

The P-5100 is certified to operate on commercial propane, natural gas, or high BTU natural gas. The Fuel Consumption of the P-5100 at rated power is listed in the table below.

Fuel Consumption at Rated Power	Propane*	Natural Gas**	High BTU Natural Gas***
lb./hr	0.64	-	-
gal/hr	0.15	-	-
kg/hr	0.29	-	-
L/hr	0.57	-	-
ft^3/hr	5.45	13.8	9.2 – 11.5
m^3/hr	0.154	0.392	0.261 – 0.327

** At 20°C (68°F)*

*** At atmospheric pressure and 20°C (68°F), assuming an energy content of 37.3 MJ/m^3 or 1000 BTU/ft^3*

**** At atmospheric pressure and 20°C (68°F), assuming an energy content of 44.7 - 55.9 MJ/m^3 or 1200 - 1500 BTU/ft^3*

3.7 STANDARD SPECIFICATION FOR GASEOUS FUEL

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

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

NOTE:

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

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

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

4 PROCESS DESCRIPTION

This section describes the function of the equipment, the process of generating power and available options.

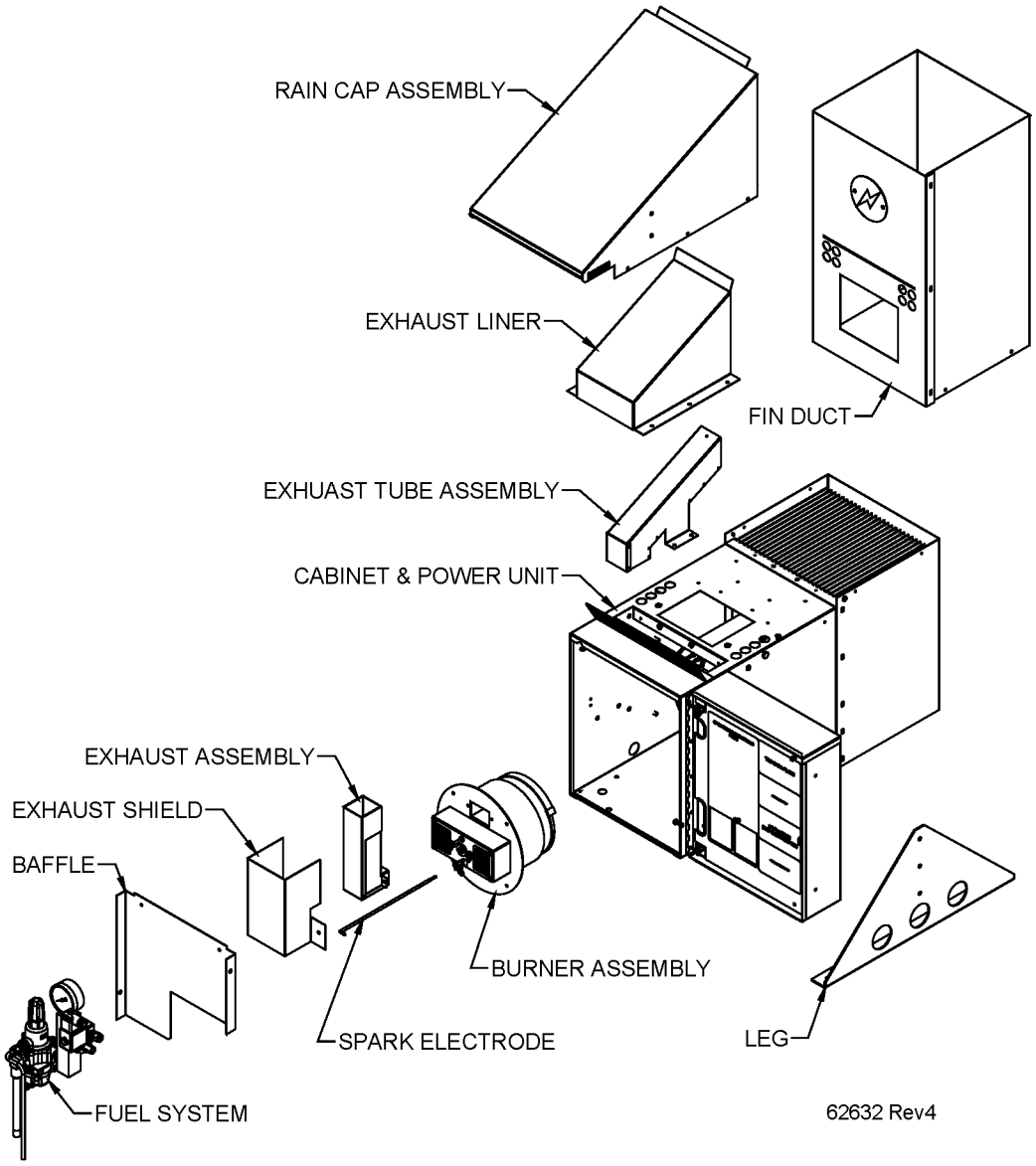

Figure 2 - P-5100 TEG General Assembly

4.1 MODEL P-5100 THERMOELECTRIC GENERATOR

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

1. Provide fuel, mix it with air and ignite making heat available.
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 cooling fins.
4. Generate electrical power from the temperature difference created across thermoelectric materials housed within the power unit.
5. Make the electrical power available to the load.

The main parts of the model P-5100 TEG, with CP attached, are shown in Figure 2.

4.1.1 Fuel System

WARNING!

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

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

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

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

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

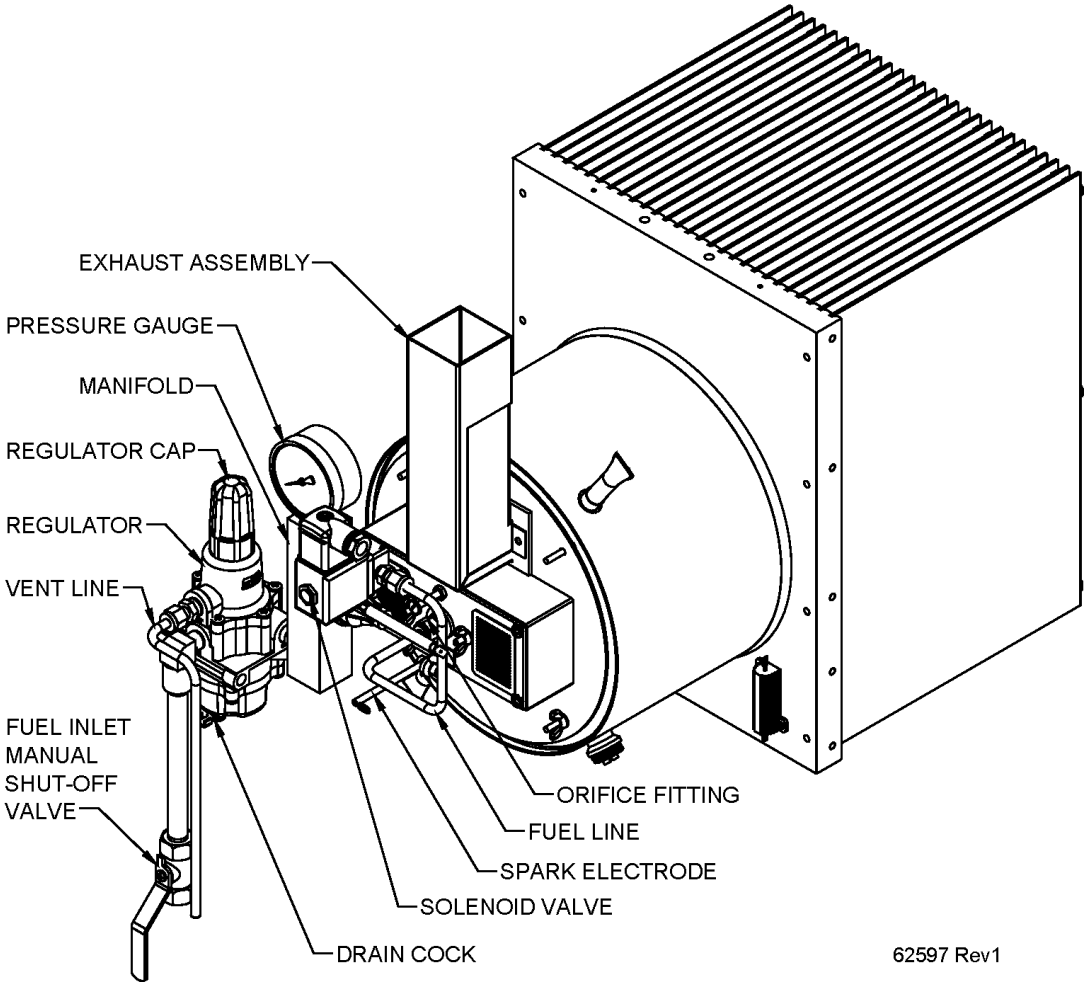

Figure 3 – P-5100 Fuel System General Assembly

The outlet of the pressure regulator leads to a manifold on which is mounted a pressure gauge to monitor the fuel pressure, and a pressure switch for the spark ignition control system. The 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 (SV) is plumbed between the manifold and fuel line.

The solenoid valve is controlled by the Ignition Control System. The Ignition Control System 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 the Ignition Control System does not detect combustion.

An optional NACE compliant stainless-steel fuel system is available as an option.

4.1.2 Spark Ignition Control System

The Ignition Control System consists of the following parts:

- Spark electrode
- Fuel pressure switch
- Thermal cutoff assembly
- Solenoid valve
- Spark Ignition (SI) module
- SI Controller board
- Battery pack

When the manual ball valve is opened, fuel pressure causes the pressure switch (located in the fuel system) to close. The pressure switch is connected to the ignition request inputs of the SI Controller board. If the optional TEG Controller (Remote Start) board is installed, the pressure switch is connected to it instead, and the TEG Controller (Remote Start) board forwards the ignition request to the SI Controller board when appropriate. An ignition request causes the SI Controller board to power up the SI module, indicated by the green SI power indicator being on.

When the SI module is powered up it will open the solenoid valve, allowing fuel gas to flow into the combustion chamber, and generate sparks between the spark electrode and combustion chamber plate. Once ignition occurs and flame is detected, sparking will cease, and the SI module will continuously monitor the presence of flame at the spark electrode. If the SI module could not verify combustion during the 7-second ignition window, it will stop sparking, close the solenoid valve, and then wait 10 seconds before making another attempt at ignition.

Up to 3 ignition trials will be attempted. If it fails to verify flame in all ignition trials, the SI Controller board will enter Lockout. The red Lockout LED on the SI Controller board will turn on and the SI module will be powered down. The SI Controller board must be reset before further ignition attempts can be made (see section 4.1.2.1 Resetting the SI Controller Board).

NOTE:	The certified Spark Ignition (SI) module is responsible for the ignition sequence, solenoid valve control, and spark generation.

NOTE: The spark ignition control system contains a single 6V, 5 amp-hour, sealed rechargeable battery and a constant potential battery charger. A new fully charged battery provides approximately 120 minutes of operating time at 25°C. The SI Controller switches from battery power to generator output power after the generator output voltage exceeds 8 V_{DC}. A completely discharged battery will take approximately 20 hours of TEG operation to regain 100% charge, as long as the TEG is not overloaded.

NOTE: If running the TEG lower than battery voltage, the battery will dead.

4.1.2.1 Resetting the SI Controller Board

To reset the SI Controller board, wait 10 seconds after the red Lockout LED turns on, then press the on-board reset switch. If the pressure switch is still closed, the SI Controller board will energize the SI module and the SI module will begin another three ignition trials.

If the optional TEG Controller (Remote Start) board is installed, press the Reset (S3) button or send a SCADA Reset signal to the TEG Controller (Remote Start) board.

4.1.2.2 Thermal Cutoff Assembly

The thermal cutoff assembly is a safety device installed on the fuel pressure switch that protects the TEG cabinet from over-temperature events. In the rare event that cabinet temperatures get too high, the thermal cutoff fuse will open, causing the TEG to shut down. The thermal cutoff is non-resettable, and must be replaced after any cabinet over-temperature events.

4.1.3 Burner

The burner conveys gas from the fuel system, mixes it with air and transports the mixture to the combustion zone. Air passes through a flame arrestor, screening out insects and dust, and then through a venturi and air-shutter assembly allowing for adjustment of the air/fuel mixture. This mixture leaves the venturi and passes through a burner screen that anchors the flame. Combustion chamber format enables the uniform heating of the power unit hot-end. The main parts of the burner are shown in Figure 4.

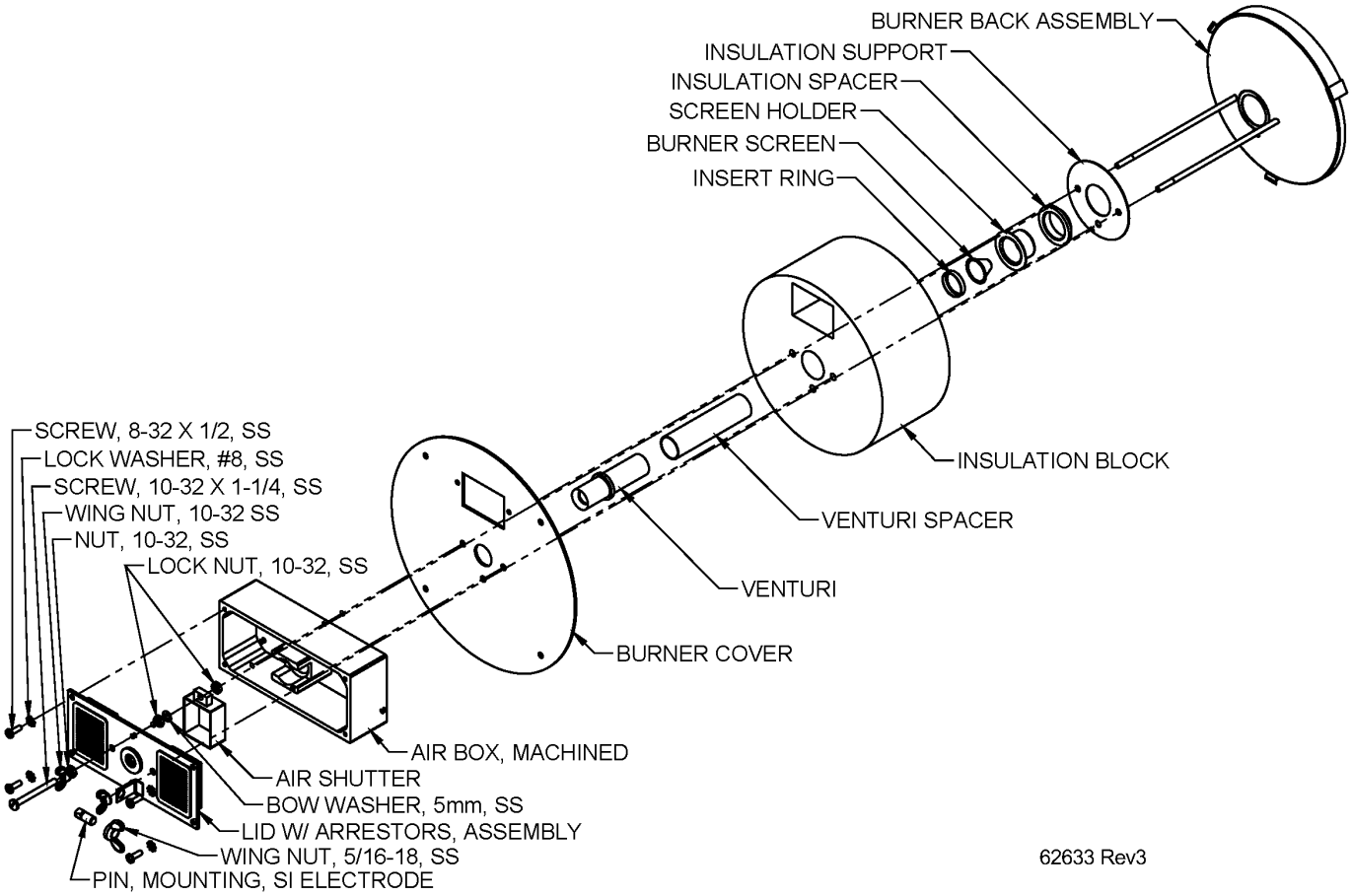

Figure 4 – Burner General Assembly

4.1.4 Power Unit

The power unit generates electric power from the direct conversion of heat energy into electrical energy. A temperature difference maintained across the power unit effects voltage, and power output. A burner maintains the hot side at a temperature of around 538°C (1000°F). Cooling fins, which transfer the heat to the surrounding air, maintain the cold side at a lower temperature of around 163°C (325°F). Adjusting the amount of fuel supplied to the burner varies the temperature difference and controls the power output.

Electrical output characteristics are shown in Figure 5. Power peaks in a broad load resistance range of 0.3 to 0.6 Ω. Rated power of 127 W gross is obtained when the power unit load resistance is within this range, at the beginning of the service life of the TEG.

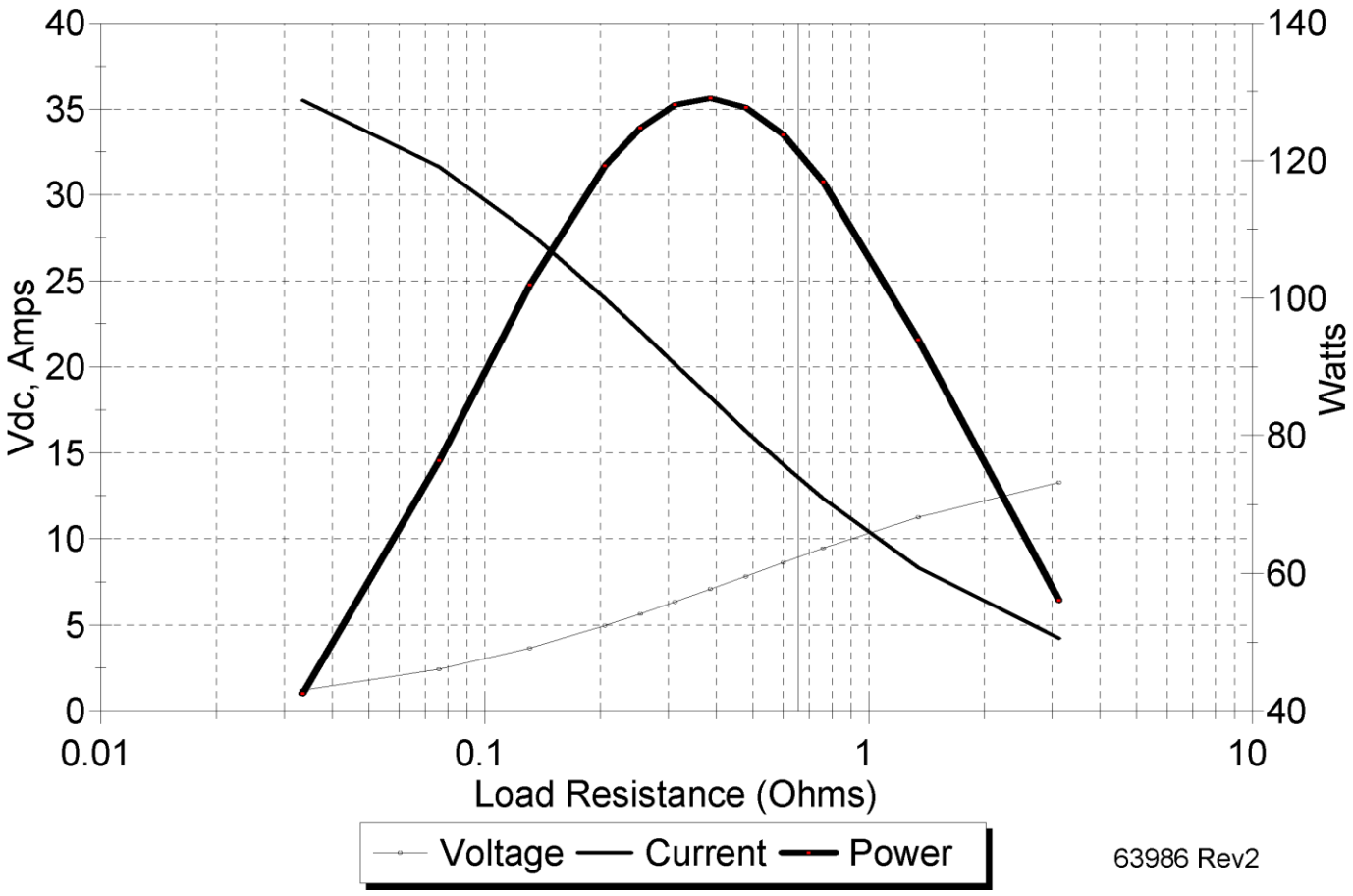

Figure 5 – Model P-5100 Power Unit Electrical Output Characteristics

4.1.5 Cooling Fins and Fin Duct

Cooling of the thermopile is done 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, thus helping transfer heat away from the thermopile.

⚠	**CAUTION!**	Keep cooling fins clean and ductwork inlets and outlets clear 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.

⚠	**WARNING!**	Surface temperatures of the burner components may be greater than 100°C.

4.1.7 Intake and Exhaust Flame Arrestors

The Model P-5100 is provided with flame arrestors (FA). P-5100 TEGs with Flame Arrestors have been tested in compliance with API Recommended Practice 12N, for the Operation, Maintenance and Testing of Firebox Flame Arrestors as it applies to continuously run, gas fired, natural draft burners. Global Power Technologies (GPT) considers compliance with API 12N as evidence that the Flame Arrestors are adequate for use in unclassified areas.

It must be noted that if an area is defined as hazardous (i.e., may contain hazardous gases such as in a Class I, Division 2 area) then TEG models 1500, 1120, and S-1100 are the only GPT TEGs suitable for installation in these hazardous areas. The addition of flame arrestors does not make the Model P-5100 TEGs suitable for use in a hazardous area. For hazardous area use, TEGs require reduced surface temperatures (below hazardous gas ignition temperatures) and other modifications.

It is the customers responsibility concerning the installed location and operation of a TEG (with or without a flame arrestor), and installations should comply with all applicable regulations.

The flame arrestors do not require maintenance other than cleaning the intake screen as seen in section 9.3.1.

4.1.8 Optional TEG Mounting Stands (Pole or Bench 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 which the TEG can be firmly attached to using 1/4 in. fasteners (not included). The Bench Stand 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.

4.2 LIMITER CONVERTER

A Limiter Converter (L/C) is available for use with the model P-5100 TEG. It is intended for use with a model P-5100 TEG requiring either 12 or 24 V DC nominal output. It consists of two separate circuits operating together. The first circuit is a DC/DC Converter that converts the input to 12 or 24V. The second circuit is a Regulating Voltage Limiter that regulates the voltage to a user selectable voltage. It includes overload and short circuit protective circuits, blocking diode, two voltage sensing alarm relays, and temperature compensation.

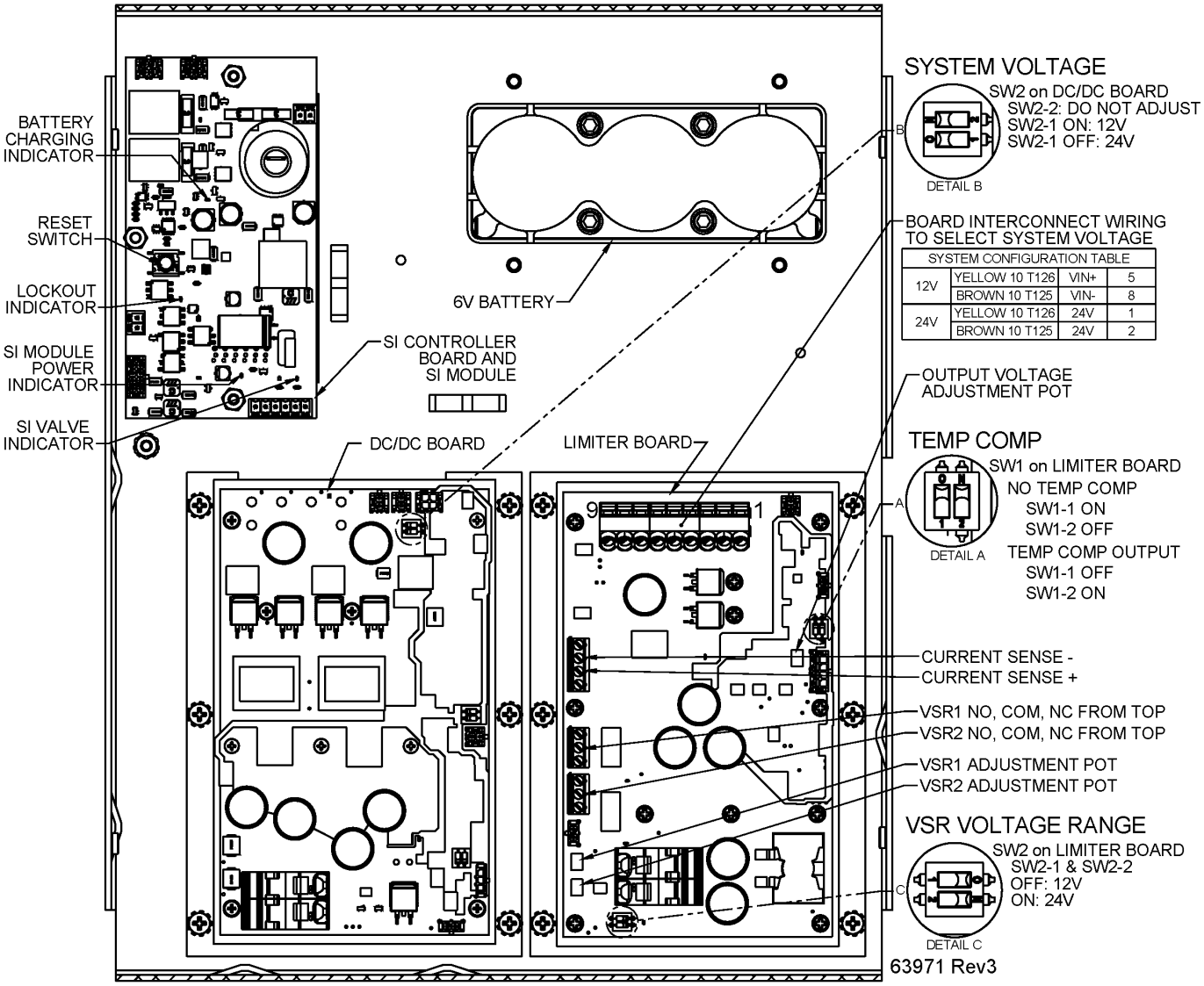

Figure 6 – L/C General Assembly

Regulating Voltage Limiter: A voltage limiting circuit is incorporated into the L/C, which regulates the Output voltage and provides a protective load for the power unit.

Voltage Converter: The voltage converter switches the input voltage to another level suitable for the load. Nominal 12 or 24 V settings can be selected, and the exact output voltage can be fine-tuned.

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 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 10 A slow blow fuse for the model P-5100-12 TEG or a 5 A slow blow fuse for the model P-5100-24 TEG.

Voltage Sensing Relay: Two independent Voltage Sensing Relays (VSRs) provide a set of contacts to indicate an alarm condition when the output voltage is lower or higher than preset limits. Low voltages, due to overloads, lack of fuel or a faulty generator, are detected by a voltage sensing circuit incorporated into the 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 1 and VSR 2 adjust on the Limiter board. See Figure 13, Figure 14, or Figure 15, depending on your TEG configuration.

On Board Current Sense: The L/C includes an onboard current sense that measures the customer load current. The output is across pin 3 (+) and pin 2 (-) of the J-Vsg1 connector on the Limiter board (see Figure 6) and is scaled at 100mV/A. The current sense has an accuracy of 10%. See Figure 13, Figure 14, or Figure 15, depending on your TEG configuration.

Power Resistor: Excess output power unused by the customer load is directed into a shunt Power Resistor by the Limiter circuit.

Temperature Compensation: When required for charging lead acid batteries, temperature compensation can be enabled to allow the output voltage to vary with temperature. The output will be adjusted by approximately 5.5mV per Cell per °C (33mV/°C for the 12V Setting, 66mV/°C for the 24V setting). Set DIP switches SW1 on the Limiter board to desired positions per the chart below as necessary.

SW1 on the Limiter Board	**SW1 – switch 1**	**SW1 - switch 2**
Enable Temperature Compensation	OFF	ON
Disable Temperature Compensation	ON	OFF

NOTE: The Limiter board has an on-board temperature sensor which is either switched into or out of the circuit.

Blocking Diode: A Blocking Diode is integrated into the L/C to allow multiple generators to be connected in parallel, or to allow one or more generators to be combined with alternative energy sources. It is connected in series with the output to prevent current from flowing back into the electronics from another power source.

4.3 OPTIONAL CATHODIC PROTECTION INTERFACE SYSTEM

An optional cathodic protection interface system is available for use with the model P-5100 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 tuning the output power applied to the CP load.

The main parts of the CP interface system are shown in Figure 7.

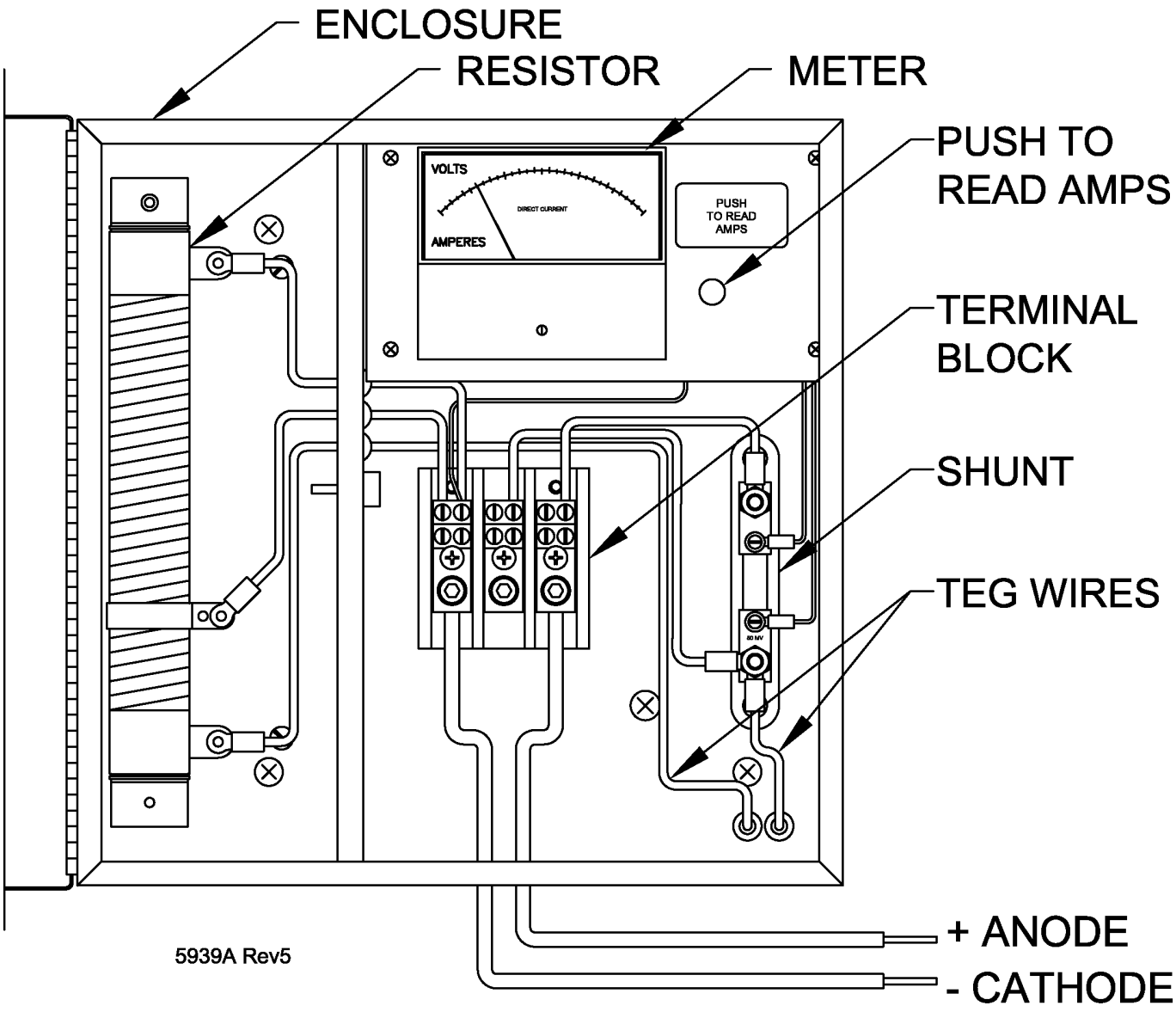

Figure 7 - CP Interface System General Assembly

Enclosure: The CP interface system is enclosed within a weather resistant 304 SS enclosure. Enclosure features include a lock-able cabinet door, 1 in. conduit opening on the bottom for customer CP wires, and a partition for the variable power resistor.

Meter: The dual scale meter displays CP voltage at the terminal block, and switches to CP current when the PUSH TO READ AMPS button is pressed. The meter is accurate to ± 3% of full scale.

4.4 OPTIONAL REMOTE START (TEG CONTROLLER)

An Optional Remote Start (also known as TEG Controller) board provides a method of starting, stopping, and monitoring the TEG either locally or remotely, using on-board buttons, SCADA signal interfacing, or system measurements.

Operation of the Remote Start board is fully covered in the Remote Start Operating Manual (PN 302254). This manual is included with every Remote Start P-5100 TEG, and is also available on GPT's website.

The Remote Start board is easily field-retrofittable for existing TEG systems with our upgrade kit (PN 64058).

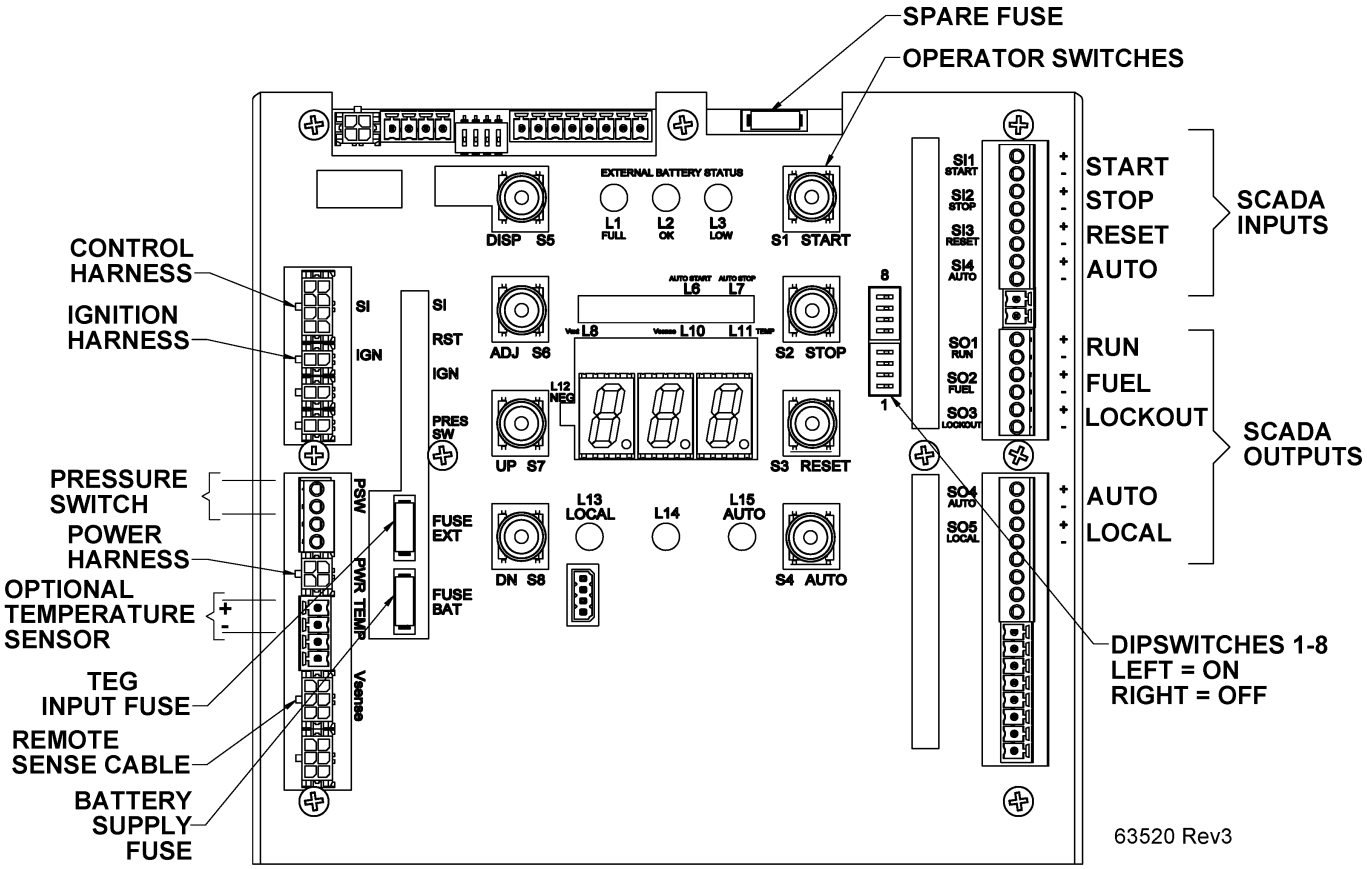

Figure 8 - TEG Controller Assembly

4.5 OPTIONAL 48 V_{DC} CONVERTER

The $48V_{DC}$ Converter Option allows your model P-5100 generator to supply a nominal 48V output voltage from the standard 24V TEG output. The Converter Assembly is installed on the left side of the TEG and connects to the main terminal block TB1 inside the TEG cabinet.

For more details, refer to 48 Volt Converter Operating Manual Addendum (PN 302228) that is shipped with each 48V Converter Assembly.

4.6 OPTIONAL VSR TERMINAL BLOCK

An optional wiring harness with terminal block can be provided for easy access to the voltage sensing relay and current sense connections. It connects VSR1, VSR2, and current sense outputs from the Limiter board to the terminal block on the wall inside the TEG cabinet. This option provides #6 screw terminals and will take up to wire size 10 AWG with an appropriate ring or fork terminal. This comes installed by default on Remote Start P-5100 systems.

5 INSTALLATION

This section provides installation instructions for the Model P-5100 Thermoelectric Generator.

5.1 PRECAUTIONS

WARNING!

The installation must conform with local codes or, in the absence of local codes, CSA B149.1 or ANSI Z223.1/NFPA 54, and CSA B149.2 or NFPA 58, as applicable.

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

The TEG must be kept clear and free from combustible materials, gasoline and other flammable vapors and liquids. Maintain 50 mm (2 in.) minimum clearances from combustible walls, 610 mm (24 in.) minimum clearances from a combustible ceiling, and install over a noncombustible floor.

WARNING!

The Thermoelectric Generator, when installed, must be electrically grounded in accordance with local codes or, in the absence of local codes, with CSA C22.1 or NFPA 70.

WARNING!

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.

5.2 TOOLS REQUIRED

The following tools are required for installing the TEG:

- 1 - DC Voltmeter, accurate to ±0.1 V
- 1 - Screwdriver, flat-head
- 1 - Screwdriver, Phillips
- 2 - Adjustable Wrenches, that will open to 16 mm (5/8 in.)
- 4 - Bolts & nuts, #1/4-20 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 P-5100 TEG:

- 1 Fin Duct (1 front piece and 1 rear piece).
- 1 Manual Ball Valve.
- 1 Thread Sealing Compound.
- 12 Screws, #8-32 × 1/4 inch long, one spare.

- 12 Washers, #8 External Lock, one spare.
- 1 Thermal Cutoff Assembly, 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 using the #8 screws and washer supplied inserting the exhaust shield tab into the duct.
2. Attach the rain cap to the top of the cabinet, inserting the rain cap tab into the duct.

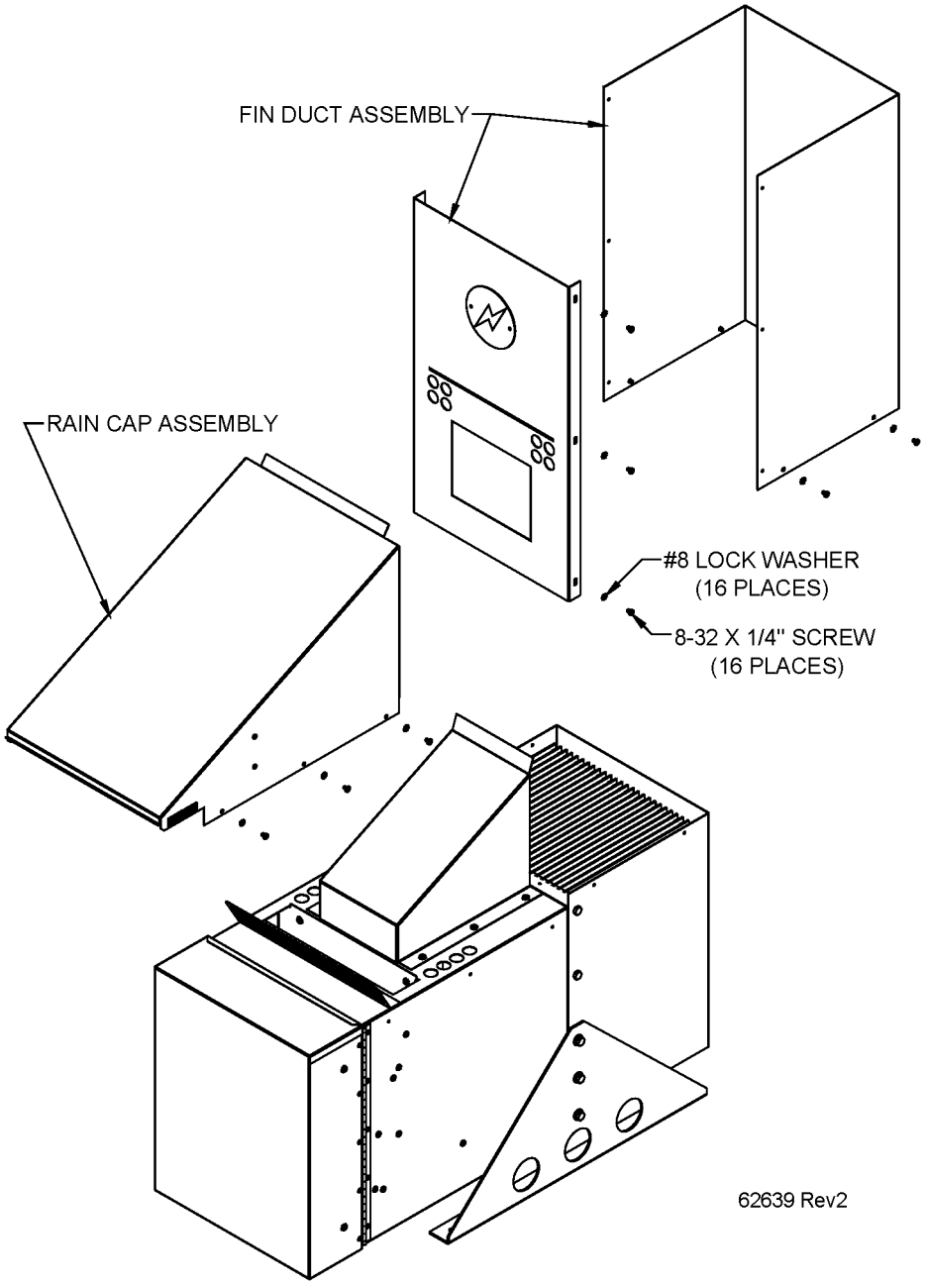

Figure 9 – Assembling the P-5100 TEG

5.5 MOUNTING

Mount the TEG to a firm and stable base, using 1/4-20 bolts of material suitable for the environment. See Figure 10 for mounting hole locations. The base must be level and sturdy enough to support the 60 kg (132 lb.) mass of the TEG.

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 610 mm (24 in.) above the top of the fin duct. Locate the TEG to avoid flooding interfering with the flow of cooling air.

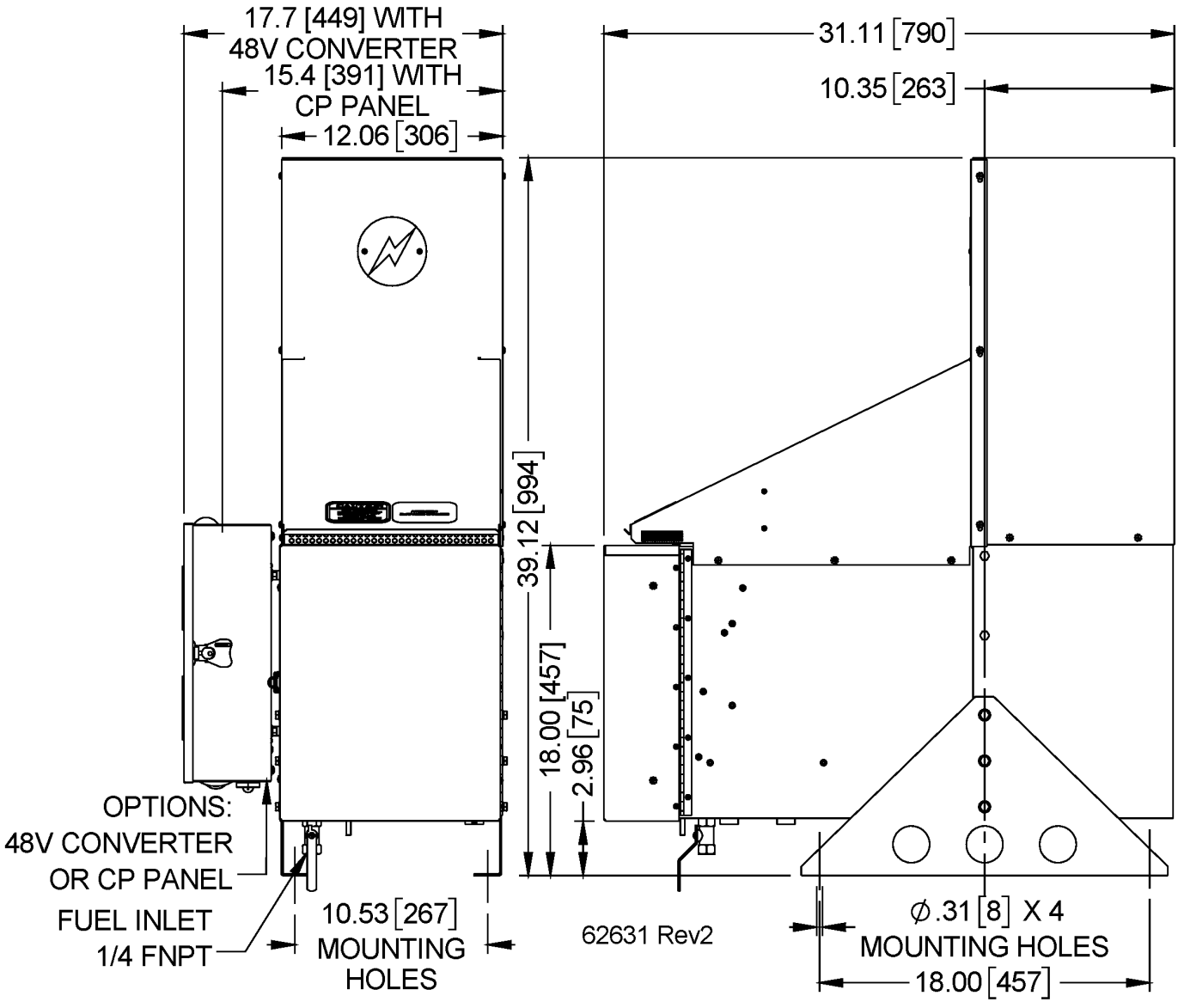

Figure 10 – Model P-5100 Mounting Dimensions

5.6 SUPPLYING FUEL

This topic describes how to connect the fuel supply and gives background information for consideration when providing fuel to the P-5100 TEG.

WARNING!

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

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

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

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

5.6.1 Connecting the Fuel Supply

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

Follow these steps to connect the fuel supply:

1. Remove the protective cap or plugs.
2. Apply thread sealant to the fuel line threads as per Figure 11.

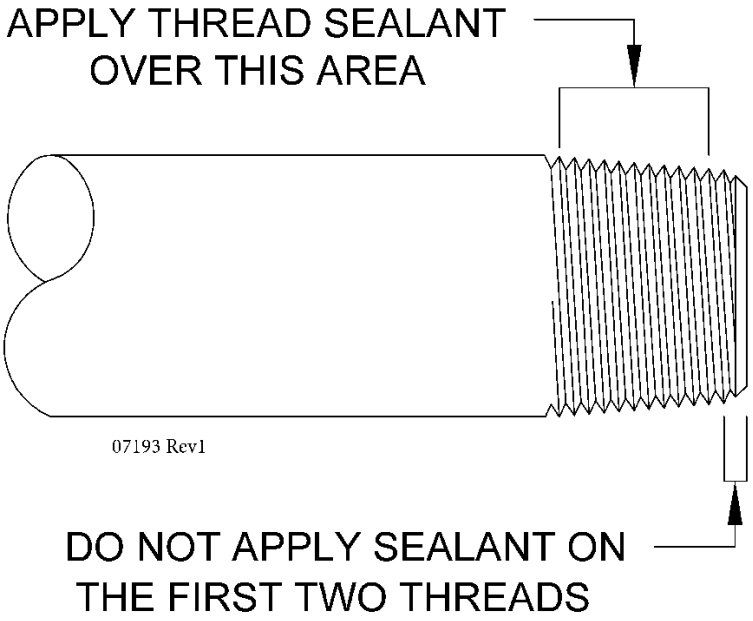

Figure 11 – Applying Thread Sealant

NOTE: Thread sealant is recommended. Sealant must be approved for use with gaseous fuels. Tape is not recommended.

3. Connect the fuel line 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 gas supply piping system at test pressures more than 3.5 kPa (0.5 psi_g).

The TEG 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 less than 3.5 kPa (0.5 psi_g).

4. Inspect the fuel lines and fittings to be sure they are free of foreign material.
5. Purge fuel lines of all air.

NOTE: All fuel piping must be in accordance with local regulations.

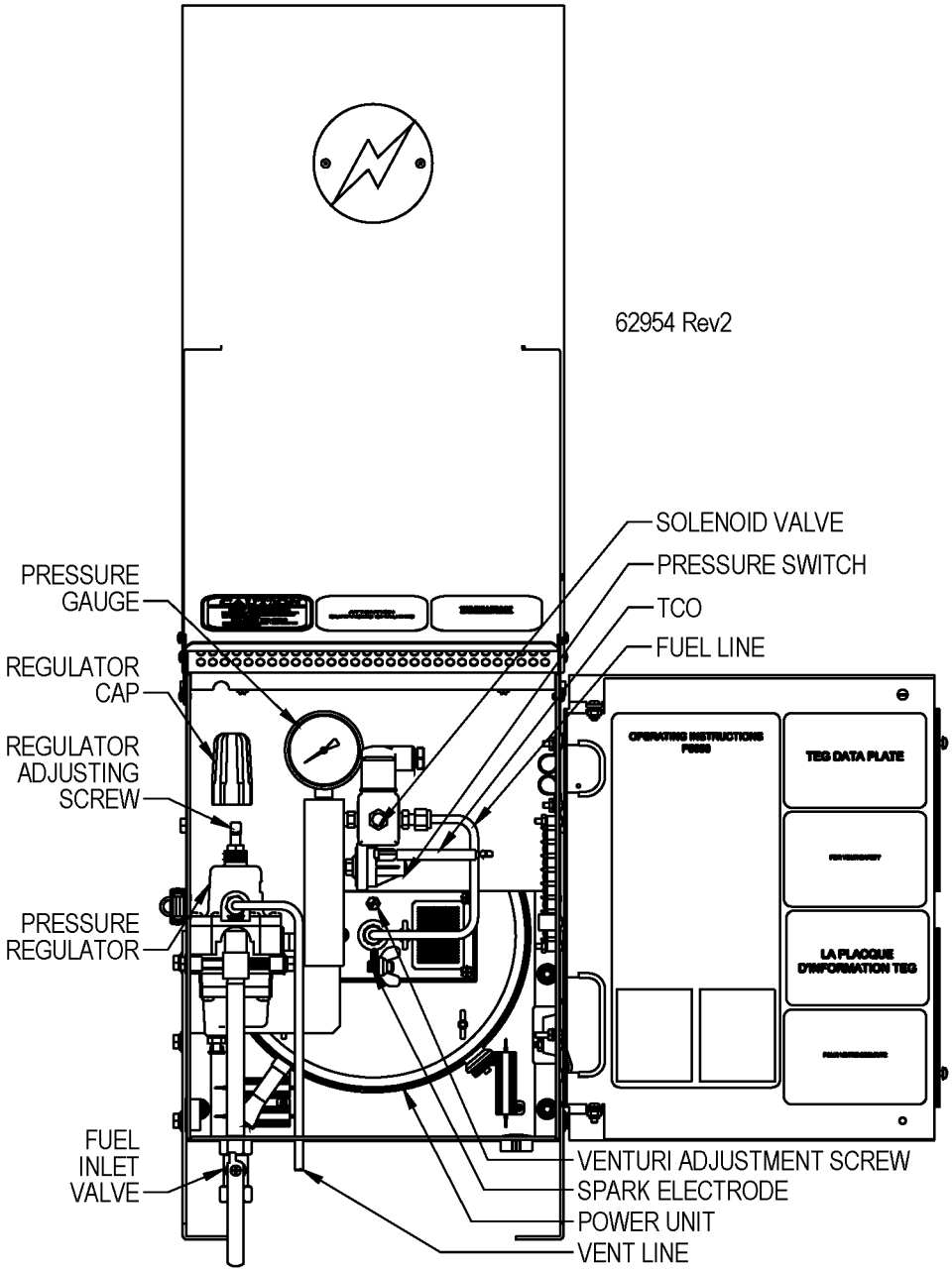

Figure 12 – Setting-up the P-5100 TEG

5.6.2 Fuel Considerations

Fuel Type: Fuel must be either natural gas or propane vapour. Check the TEG data plate for the fuel type. Do not use a different type of fuel than indicated.

Supply Pressure: Make sure that fuel pressure is at least 103 kPa (15 psi_g) and will not exceed 344 kPa (50 psi_g). If it is expected that the fuel supply pressure will vary greatly, the use of an additional primary regulator is recommended. This will hold the input pressure relatively constant.

Clean Fuel: The fuel used to operate the P-5100 TEG must be clean and dry. See TECHNICAL SPECIFICATIONS in section 3 for full gas specifications. If dirty fuel is anticipated, then a customer supplied in-line fuel filter is recommended.

Low Temperature: Regulator freeze-off can be minimized by limiting the incoming supply pressure to 138 kPa (20 psi_g). When using propane (C_3H_8) at temperatures below -30°C (-22°F) special consideration must be given to the low vapour pressure of the fuel.

5.6.3 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 consolidated ground at grade level. The base must extend at least 300mm (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.

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

WARNING!

Customer load installation wiring must conform with local codes or, in the absence of local codes, with CSA C22.1 or NFPA 70.

Use supply wires with a minimum wire gauge of 10 AWG copper wire, and a minimum temperature rating of 90°C (194°F).

Connect the customer load directly to the TEG using the following procedure. If an optional CP interface system is applicable, then see INSTALLATION OF OPTIONAL CP INTERFACE SYSTEM topic in section 5.8.

Follow these steps to connect the customer load:

1. Bring the customer load wires through the provided hole in the bottom of the TEG cabinet using appropriate cable connectors for the wire or cable being used. Allow enough wire to connect to the terminal block TB1. See Figure 15.
2. Connect the customer load wires to TB1 terminals 7 (+) and 8 (-). See Figure 13, or Figure 14 for Remote Start systems.

CAUTION!

Connecting to some types of solar charge controllers may damage the TEG. Please contact Global Power Technologies for advice on selecting and connecting a solar charge controller.

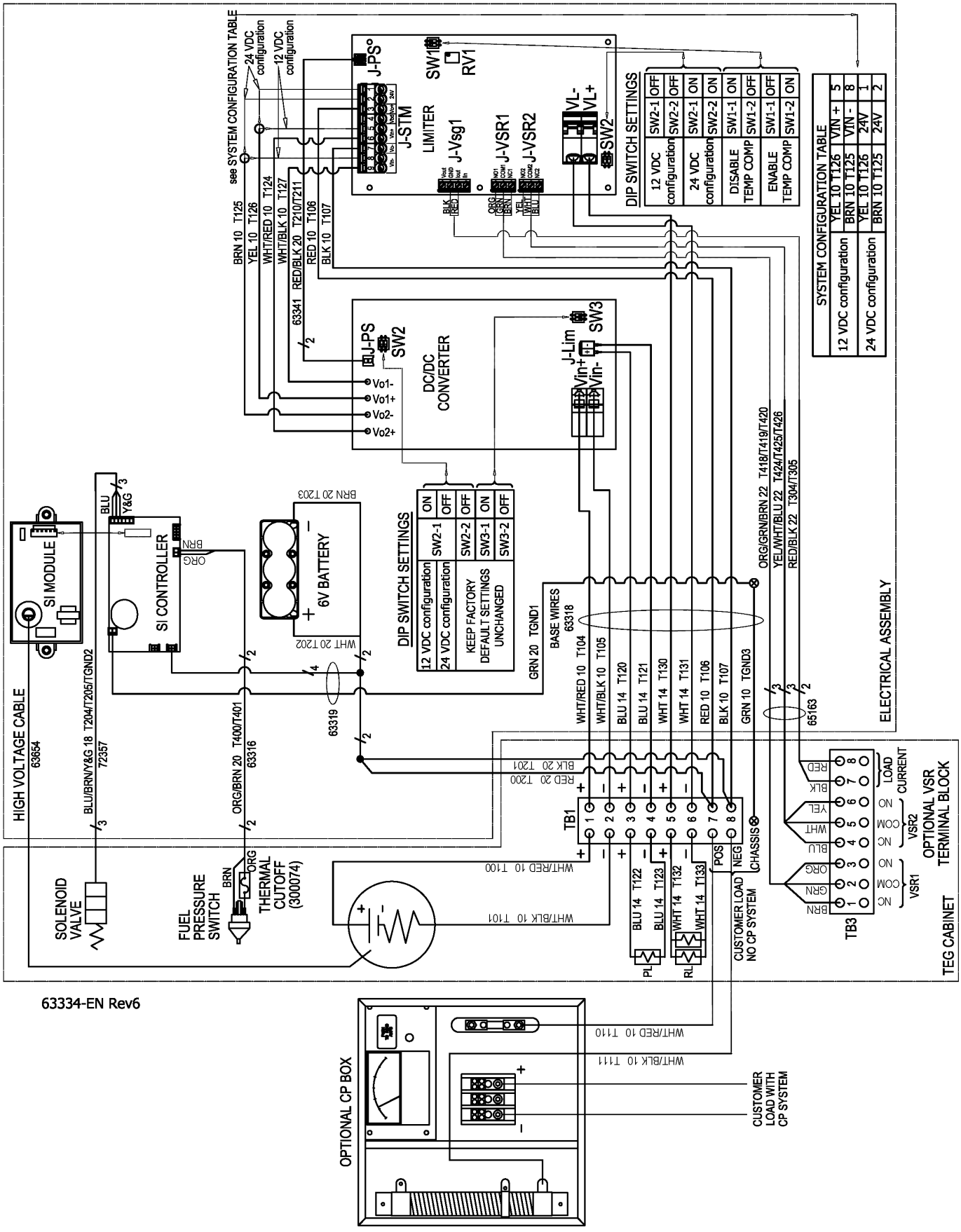

Figure 13 - Wiring Diagram P-5100 for 12 or 24 V

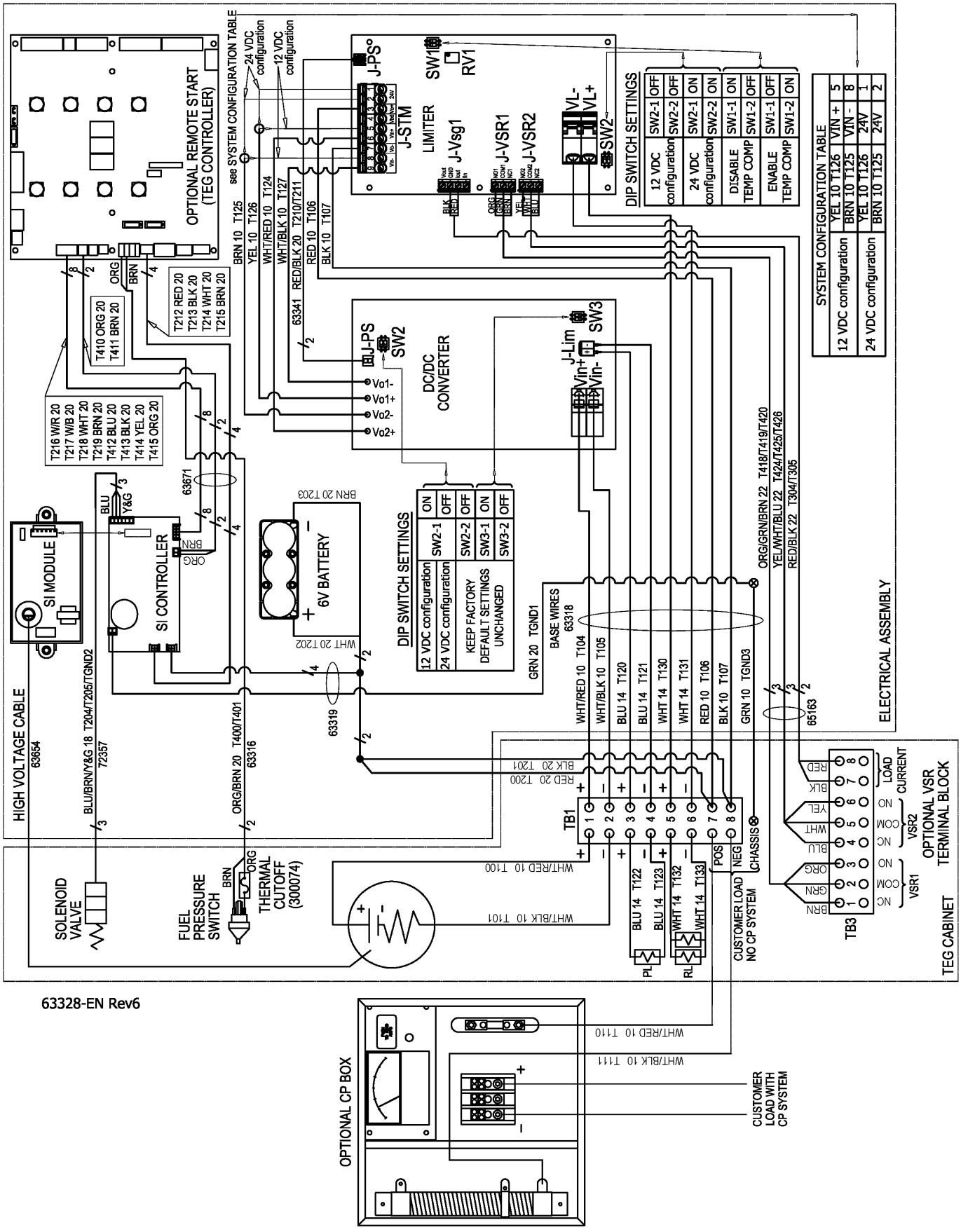

Figure 14 - Wiring Diagram P-5100 TEG for 12 or 24V with optional TEG Controller

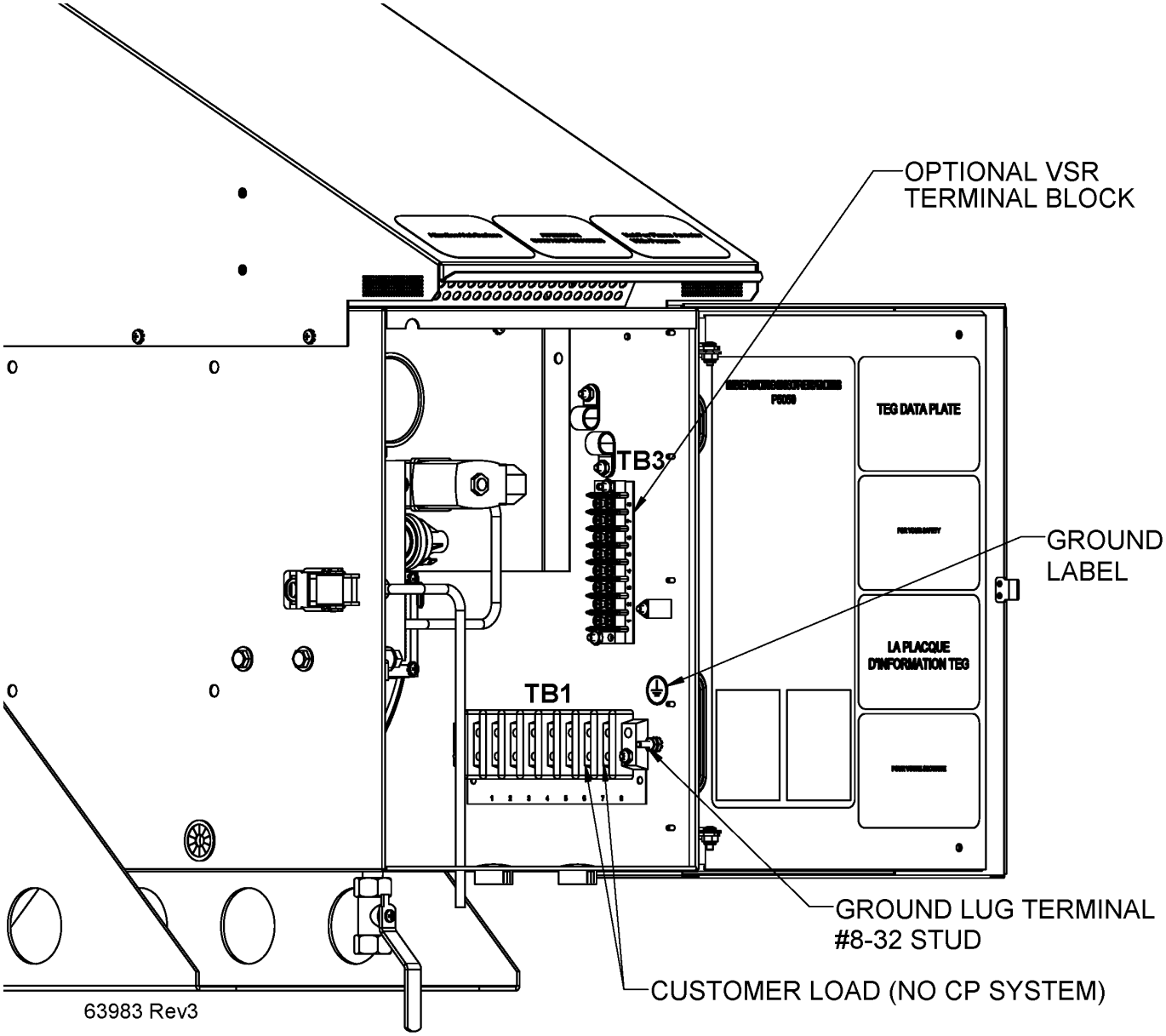

Figure 15 - Customer Load Connections

5.8 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 as follows.

NOTE:	Before installing inspect for obvious dents and broken components and advise the carrier, as applicable.

5.8.1 Attaching the CP Interface System To TEG

The standard mounting location is on the left side of the generator cabinet. To attach the CP interface system, remove the four nuts and lock washers from the CP enclosure mounting posts and bolt it to the outside of the TEG, see Figure 16. You must remove the fuel system and remove the baffle plate to gain access to the holes in the TEG cabinet for mounting the CP Interface System.

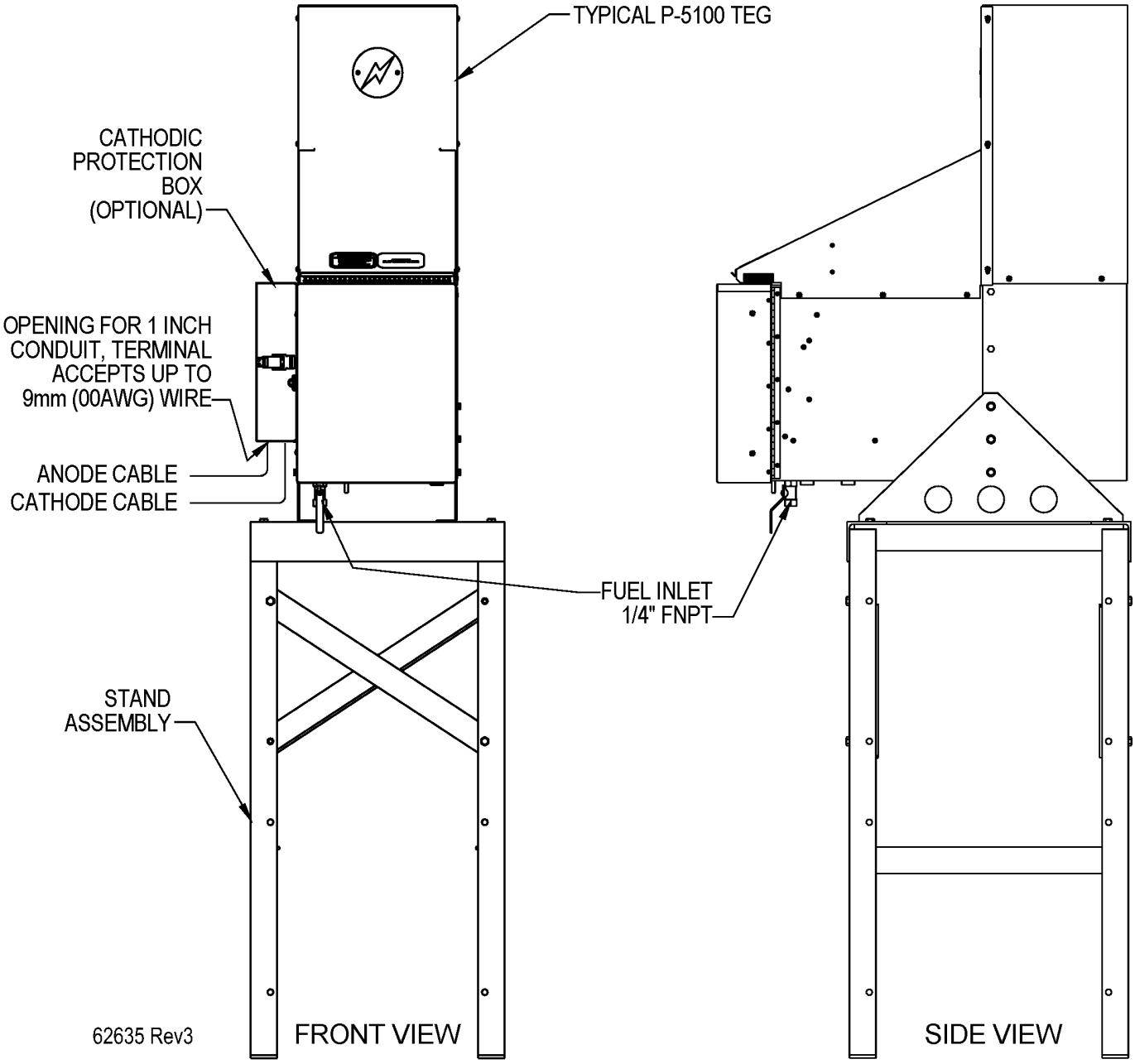

Figure 16 – CP Installation

5.8.2 TEG Wiring Interconnection

Run the CP interface system wires to the TEG as per Figure 13 or Figure 14, as appropriate, and terminate to TB1 (see Figure 15).

5.8.3 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. The tap on the power resistor may then be adjusted to fine-tune the voltage and current delivered to the CP load.

6 STARTUP AND SHUTDOWN

This section describes how to startup and shutdown the model P-5100 TEG.

6.1 BEFORE STARTING

Before starting the TEG perform these steps:

1. Make sure that all the connections in the fuel system are tight and have been checked for leaks.
2. Ensure the battery is connected.
3. To set-up the TEG for power output evaluation, disconnect customer load from terminals 7 (+) and 8 (-) of TB1 (see Figure 15). Connect a DC voltmeter to terminals 5 (+) and 6 (-) of TB1. This will be measuring V_{SET}.
4. If power output evaluation is not required, a DC voltmeter may be connected to terminals 7 (+) and 8 (-) of TB1 to measure the output voltage.

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.

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

2. If the optional TEG Controller board is installed, the Start (S1) button will need to be pressed. Alternatively, a SCADA Start signal can be sent to the TEG Controller.

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. In case the TEG must be shut down temporarily for servicing or an emergency close the TEG manual shutoff valve.

For Remote Start systems, the TEG may be stopped by pressing the Stop (S2) button, sending a SCADA Stop signal, or closing the manual shut-off valve.

7 POWER OUTPUT EVALUATION

Output power is the primary indication of correct set-up, 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 set-up at site;
- after any adjustments are made to a TEG;
- before and after servicing a TEG, and
- whenever altering the fuel's heat of combustion.

NOTE: Typical regulated fuel pressure settings are:
- 28 to 34 kPa (4.0 to 5.0 psi_g) for natural gas (P-5100N)
- 48 to 55 kPa (7.0 to 8.0 psi_g) for high BTU natural gas (P-5100H ONLY)
- 41 to 48 kPa (6.0 to 7.0 psi_g) for propane (P-5100L)

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 REQUIRED V_{SET} OR SET-UP POWER AT SITE

Power from the P-5100 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 at site. Power output increases when temperature falls and decreases when temperature climbs.

A decrease of 1°C from the ambient temperature indicated on the data plate causes a power increase of 0.4 W, and a temperature climb of 1°C from the ambient temperature indicated on the data plate causes a power decrease of 0.4 W. This behavior must be considered when setting-up the TEG.

7.1.1 Calculating Required V_{SET} or Setup Power

Factory test data for set-up power and voltage is 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. A correction factor must be applied when operating in different ambient conditions. The following formulas apply:

$$V_{SET} = V_{SETREF} + [(T_{REF} - T) \times 0.00925] \qquad \textbf{equation 1}$$

Where: T = Ambient temperature, at site (°C)
T_{REF} = Reference ambient temperature, marked on Data Plate (°C)
V_{SETREF} = Reference set-up voltage, marked on Data Plate (V)
V_{SET} = Target set-up voltage, with site ambient conditions (V)

$$P_{SET} = P_{SETREF} + [(T_{REF} - T) \times 0.4] \quad \textbf{equation 2}$$

Where: T = Ambient temperature, at site (°C)

T_{REF} = Reference ambient temperature, marked on Data Plate (°C)

P_{SETREF} = Reference power marked on TEG Data Plate (W)

P_{SET} = Target rated power, with site ambient conditions (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 126W and V_{SET} of 6.03V, 22°C is marked on the TEG Data Plate.

$$V_{SET} = V_{SETREF} + [(T_{REF} - T) \times 0.00925]$$
$$= 6.03 + [(22 - 35) \times 0.00925]$$
$$= 6.03 + [-13 \times 0.00925]$$
$$= 6.03 + [-0.1203]$$
$$= 6.03 - 0.1203$$
$$= 5.91 \text{ V}$$
$$P_{SET} = P_{SETREF} + [(T_{REF} - T) \times 0.4]$$
$$= 126 + [(22 - 35) \times 0.4]$$
$$= 126 + [-13 \times 0.4]$$
$$= 126 + [-5.2]$$
$$= 126 - 5.2$$
$$= 120.8 \text{ W}$$

7.1.2 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 17. Knowing the ambient temperature, move up vertical to the line. Read the V_{SET} from the left side of the graph and rated power from the right side.

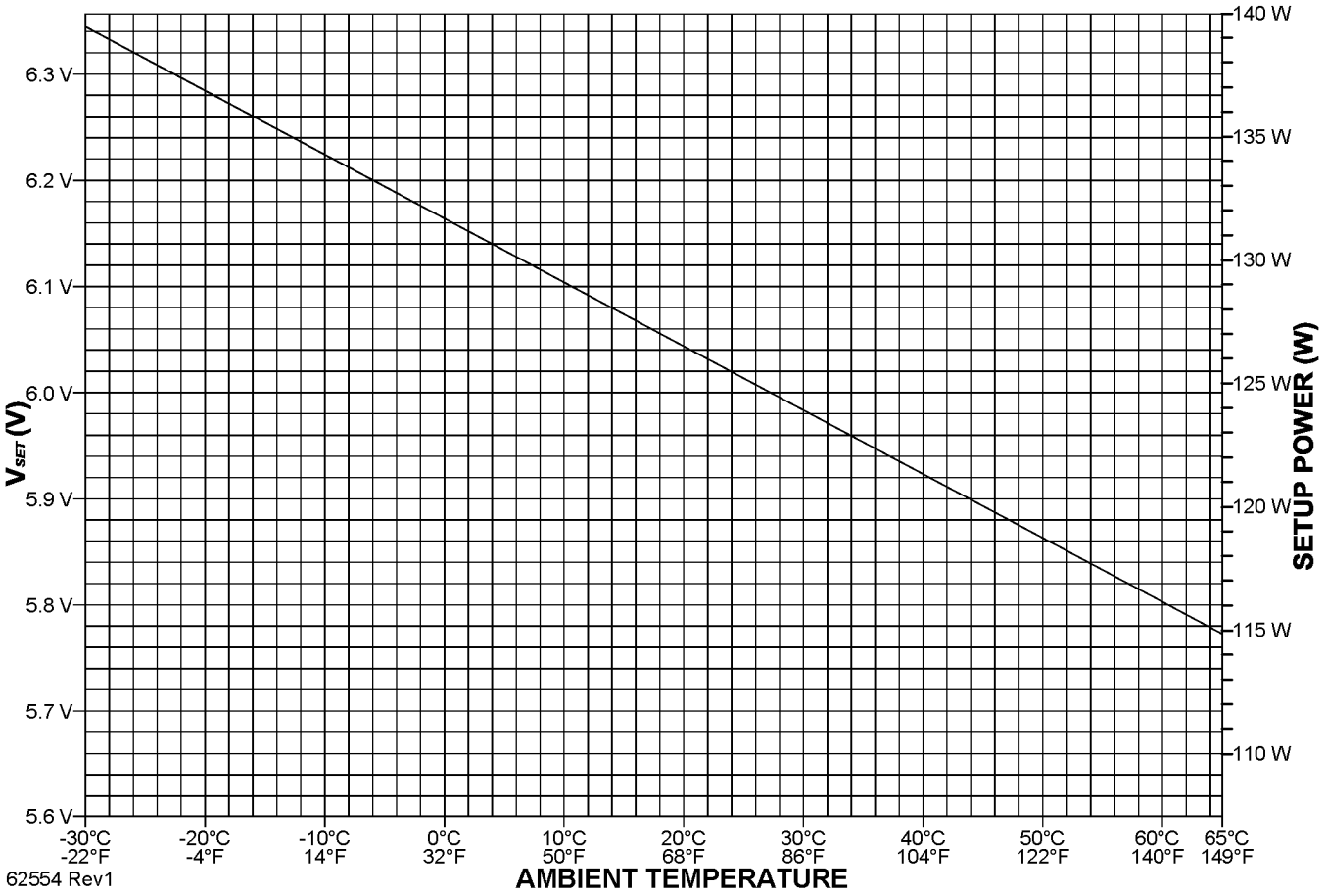

Figure 17 - V_{SET} and Setup Power Versus Ambient Temperature

7.2 CHECKING V_{SET} OR SET-UP POWER

V_{SET}, or set-up power, can readily be checked by using a voltmeter to measure the stable set-up voltage of the power unit. Use the following procedure, as appropriate, to check.

7.2.1 Examining V_{SET} Immediately 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. Disconnect the customer load from the TEG, terminals 7 (+) and 8 (-) of TB1 (see Figure 15) and allow to stabilize for 15 minutes.
2. Consult the data plate inside TEG door for the reference V_{SET} voltage and determine the required V_{SET} for the present ambient temperature. See section 7.1 for further details.
3. Connect a voltmeter between terminals 5 (+) and 6 (-). This will display the measured V_{SET}. It will climb as shown in Figure 18 as the TEG heats up.
4. V_{SET} will rise quickly at first then begin to stabilize. It will take at least one hour for the V_{SET} to level out. When V_{SET} no longer changes (<0.2 V change within the last ten minutes), compare this value with required V_{SET}. It should be within ±0.2 V of the required V_{SET}.

NOTE:	Typically, if the measured V_{SET} is greater than required V_{SET} then the fuel pressure needs to be reduced.

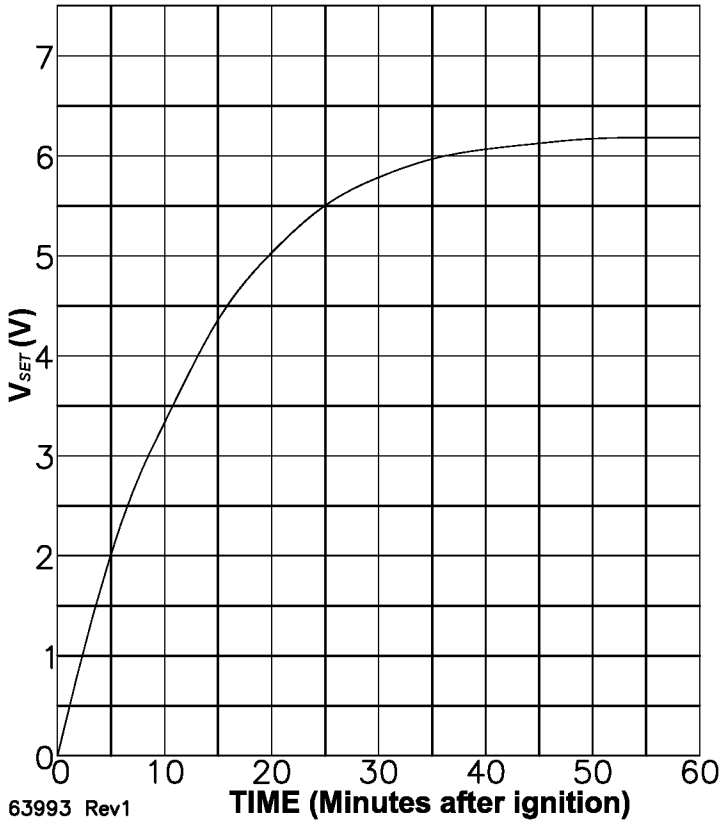

Figure 18 - V_{SET} Versus Time After Ignition, Typical Response

	**CAUTION!**	Do not allow measured V_{SET} to exceed that required V_{SET}, for present ambient temperature, otherwise overheating may cause irreparable damage to the power unit.

7.2.2 Examining V_{SET} after Running for Some Time

Once the TEG has been running for at least an hour, the power unit will have reached its operating temperature.

Follow these steps to check V_{SET} after running for some time:

1. Disconnect the customer load from the TEG, terminals 7 (+) and 8 (-) of TB1 (see Figure 15) and allow to stabilize for 15 minutes.
2. Consult the data plate inside TEG door for the reference V_{SET} voltage and determine the required V_{SET} for the present ambient temperature. See section 7.1 for further details.
3. Connect a voltmeter between terminals 5 (+) and 6 (-). This is the measured V_{SET} and should match the required V_{SET} for the present temperature.

	**CAUTION!**	Do not allow measured V_{SET} to exceed that required V_{SET}, for present ambient temperature, otherwise overheating may cause irreparable damage to the power unit.

4. When the V_{SET} measurement is completed, reattach the customer load to terminals 7 (+) and 8 (-) of TB1.

8 ADJUSTMENT AND TUNING

This section describes how to adjust and fine-tune the Model P-5100 Thermoelectric generator.

NOTE:

Typical regulated fuel pressure settings are:

- 28 to 34 kPa (4.0 to 5.0 psi_g) for natural gas (P-5100N)
- 48 to 55 kPa (7.0 to 8.0 psi_g) for high BTU natural gas (P-5100H ONLY)
- 41 to 48 kPa (6.0 to 7.0 psi_g) for propane (P-5100L)

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.

8.1 POWER OUTPUT TUNING

There are more factors to consider in order to achieve maximum power output for your site conditions. Air density, dependent on site altitude, will affect characteristics of the burner and air/fuel mixture. Use the following procedures to tune your P-5100 burner for optimal combustion and power.

8.1.1 Adjustment for Elevation

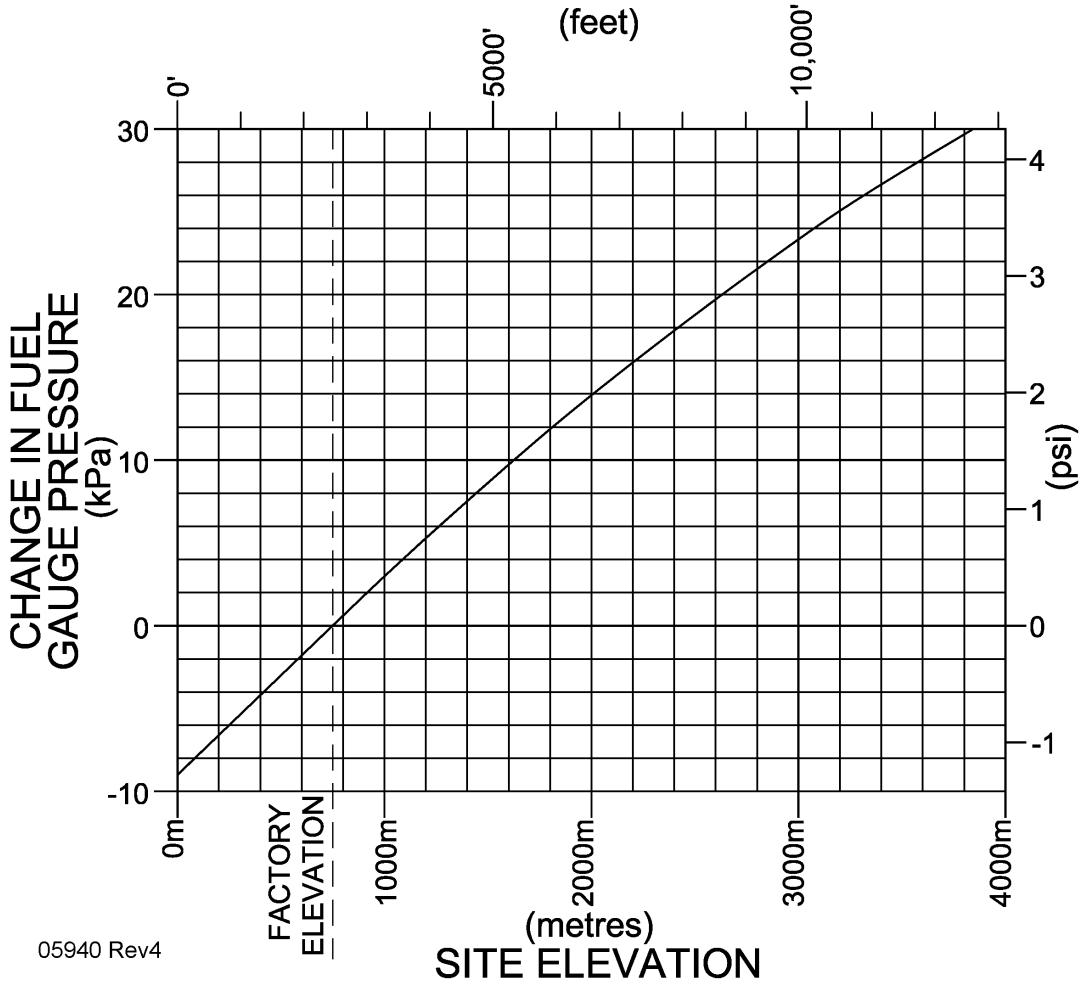

Figure 19 - Change in Fuel Gauge Pressure Versus Elevation Above Mean Sea Level

If your TEG is located at a different altitude than the factory, 795 m (2608 ft.) above sea level, its fuel pressure will need to be adjusted from factory settings in order to reach your required V_{SET}. Use Figure 19 to determine a starting point for your burner fuel pressure. This fuel pressure may be adjusted in later tuning steps as you correct for other conditions.

Example: If the site elevation is 1000 m (3281 ft.) then 2.5 kPa (0.36 psi_g) must be added to the value of BURNER FUEL PRESURE on the data plate.

Follow these steps to adjust fuel pressure:

5. Remove the cover on the regulator and loosen the locknut.
6. Turn the adjusting screw (clockwise to increase pressure) until the required change in pressure is obtained.
7. Tighten the locknut and replace the cover on the fuel regulator.

NOTE: Refer to Section 3.5 for the location of the Data Plate and factory BURNER FUEL PRESURE settings.

8.1.2 Air-shutter Tuning

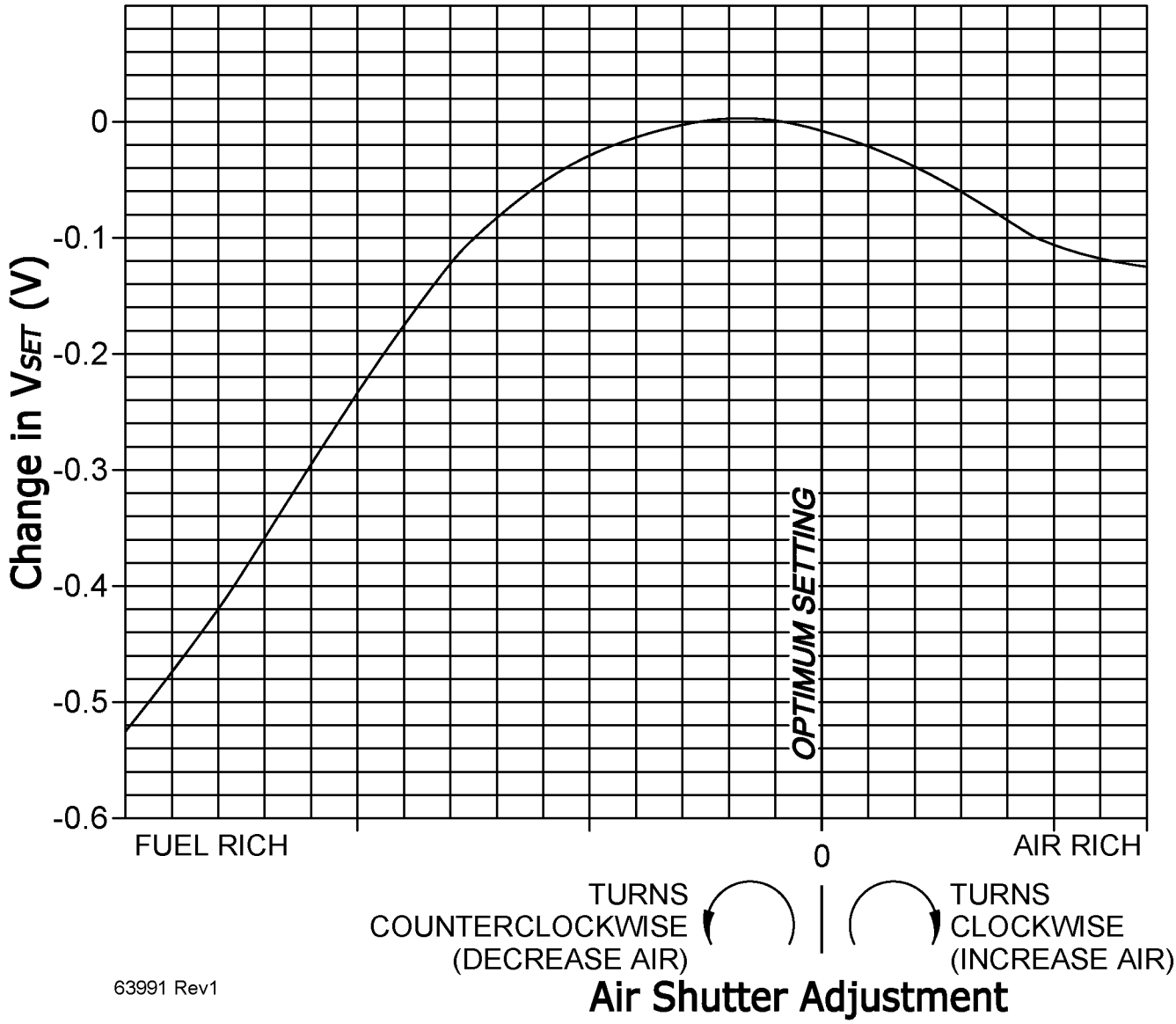

Figure 20 - Change in V_{SET} Versus Air-Shutter Adjustment

Tuning the P-5100 air shutter will help provide optimum burner performance for your site conditions. Follow these steps to adjust the air-shutter:

1. Start the TEG, and allow it to run until stabilized.
2. Check V_{SET}, see section 7, and record this initial value.
3. Open the doors and loosen the locknut on the air-shutter adjusting screw.
4. Turn the adjusting screw a quarter turn counterclockwise. Further adjustments can be made with 1/4-turn adjustments.

NOTE:

If the air-shutter adjustment is unknown and needs to be reset, the following procedure may be used for its initial positioning:

1. Turn air adjusting screw counterclockwise until it is free from the Air Lid. This will completely close off air intake.
2. Turn air adjustment screw clockwise:
   - 8.5 to 9 turns for natural gas (P-5100N).
   - 6 to 8 turns for high BTU natural gas (P-5100H)
   - 22 to 23 turns for propane (P-5100L).

5. Close the cabinet doors, wait ten minutes, then measure and record V_{SET}.
   - **If V_{SET} is greater than the previous value or did not change**, the burner adjustment is air-rich, see Figure 20. Turn the adjusting screw another quarter-turn counterclockwise, then return to the start of Step 5.
   - **If V_{SET} is less than previous value**, the burner adjustment is now fuel-rich, see Figure 20. Set the adjusting screw one half-turn clockwise from its current position; this will put it at the peak of the graph. Then proceed to the next step.
6. Measure the carbon monoxide (CO) levels as per section 8.1.2.1 to confirm it is below 400 ppm, if possible.
7. Tighten the locknut on the air-shutter adjusting screw.

8.1.2.1 Measuring CO Emissions Levels

The model P-5100 will not produce excessive amounts of carbon monoxide (CO) if properly adjusted. Due to the open exhaust system of TEG, the CO measurement must be in the air-free state. In an air-free measurement, the allowable CO rate is 400 ppm however a correctly adjusted P-5100 will produce less than 120 ppm CO air-free. In order to be able to determine the levels of air-free CO_{AFppm}, a combustion analyzer capable of measuring CO_{ppm} and either CO_2 percentage, or O_2 percentage, is needed.

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

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

$$CO_{AFppm} = \left(\frac{11.8}{CO_2}\right) x\ CO_{ppm} \qquad \textbf{equation 3}$$

- For Propane when using measured CO_2 percentage, and CO_{ppm}

$$CO_{AFppm} = \left(\frac{13.8}{CO_2}\right) x\ CO_{ppm} \qquad \textbf{equation 4}$$

- When using measured O_2 percentage, and CO_{ppm}

$$CO_{AFppm} = \left(\frac{20.9}{20.9 - O_2}\right) x\ CO_{ppm} \qquad \textbf{equation 5}$$

Where: CO_{AFppm} = Carbon monoxide, air-free ppm

CO_{ppm} = As-measured combustion gas carbon monoxide ppm

O_2 = Percentage of oxygen in combustion gas, as a percentage

CO_2 = Percentage of carbon dioxide in combustion gas, as a percentage

8.1.3 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 21 to determine how much to adjust the fuel pressure.

Example: Required V_{SET} = 5.91 V

Measured V_{SET} = 5.58 V

Difference = +0.33 V

Based on Figure 21 the fuel pressure must then be increased 2.4 kPa (0.35 psi_g).

Follow these steps to adjust fuel pressure:

1. Remove the cover on the regulator and loosen the locknut.
2. Turn the adjusting screw (clockwise to increase pressure) until the required change in pressure is obtained.
3. Wait ten minutes then measure V_{SET} and record. If the TEG cannot be adjusted to match required V_{SET} value, then a problem exists with one of the TEG's systems. If necessary, see TROUBLESHOOTING in section 10 for guidance.
4. Tighten the locknut and replace the cover on the fuel regulator.

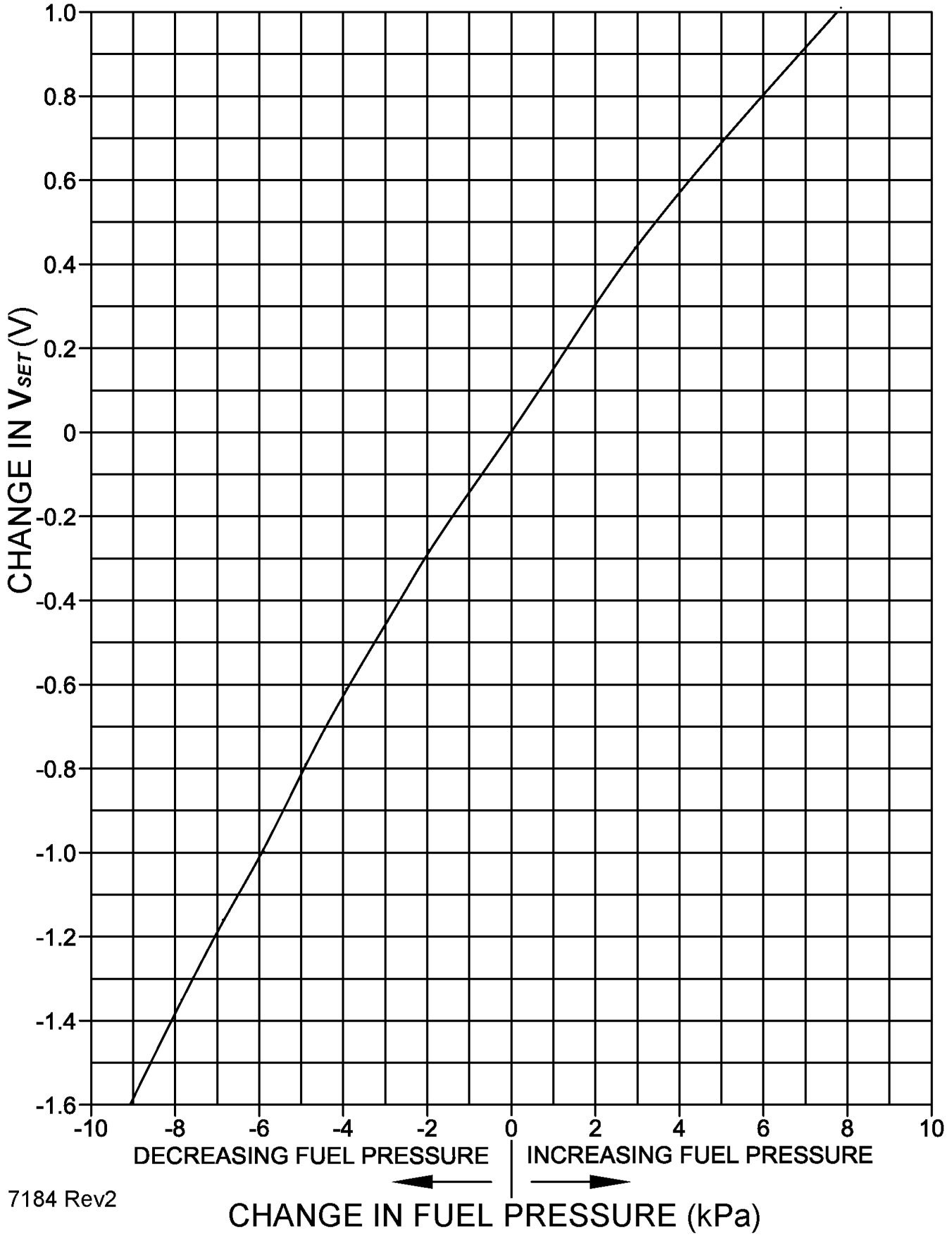

Figure 21 - Change in V_{SET} Versus Fuel Pressure Adjustment

8.2 LIMITER CONVERTER ADJUSTMENT

This section describes common adjustments to the Limiter Converter (L/C) of the model P-5100 TEG.

8.2.1 Output Voltage Adjustment

The L/C is factory set at either 14.1 V (Model P-5100-12) or 27.0 V (Model P-5100-24). If this requires changing for your application, use the following procedure:

1. Disconnect the customer load from terminals 7 (+) and 8 (-) of TB1 (see Figure 15).
2. Connect a voltmeter between terminals 7 (+) and 8 (-) of TB1 and measure the output voltage.
3. Adjust the output voltage by turning the output voltage adjustment pot shown in Figure 6.

8.2.2 Voltage Sensing Relay (VSR) Adjustment

The VSR's provide two sets of dual-pole contacts that can be used to indicate proper and/or improper operation, when the output voltage is above or below preset limits. VSR1 is factory set at 23.0V (Model P-5100-24) or 11.5V (Model P-5100-12), and is commonly used to indicate low voltage alarm. VSR2 is factory set at 28.5V (Model P-5100-24) or 14.3V (Model P-5100-12), and is commonly used to indicate high voltage alarm.

Each VSR is rated for 2A at $30V_{DC}$ and will accept stripped wire up to 14 AWG. The Optional VSR Terminal Block will allow for wire up to 10 AWG terminated with a ring or fork terminal.

To connect to the VSR outputs route the wire in through the hole provided in the bottom of the TEG cabinet and follow the main wiring harness around the loop and into the lower hole of the Electronics enclosure door. Continue to route the wires along the bottom of the electronics enclosure and then connect to the VSR terminals on the left side of the Limiter board. Refer to Figure 6 for the connector pinout.

Follow these steps to adjust the VSR set point:

1. Remove customer load from terminals 7(+) and 8(-) on terminal block TB1.
2. Connect a DC voltmeter to the customer load terminals 7(+) and 8(-) on TB1.
3. Set the output voltage to the desired trip point value.
4. Connect an ohmmeter between the COM and NO contacts of VSR1 or VSR2, whichever one you are adjusting. Continuity between these terminals indicates the relay is energized, while an open circuit indicates the relay is de-energized.
5. Turn the VSR1 or VSR2 Adjustment Pot until the continuity on the ohmmeter changes. Each VSR enforces a minimum of 0.5V between changes (prevents relay chatter). Calibrate the pot to your desired behavior; either energizing at the trip voltage, or de-energizing at the trip voltage.
6. Test the voltage trip point by slowly sweeping the output voltage above and below the trip point while observing the ohmmeter. Further tune the VSR trip point if necessary.
7. Reset output voltage to factory default or to your desired normal operating value. Factory setting is either 14.1 V (Model P-5100-12) or 27.0 V (Model P-5100-24).
8. Reconnect customer load to 7(+) and 8(-) on terminal block TB1 as necessary.

8.2.3 Output Voltage Conversion

The L/C can be configured for either a 12V or 24V output. If you need to change your TEG output voltage from one nominal output to the other, refer to Figure 6, Figure 13 or Figure 14, and the corresponding steps below.

WARNING! Incorrect conversions can cause damage or reduce the lifespan of your TEG. Follow the instructions carefully when performing any conversion procedure.

Converting From 12V to 24V Nominal Output

1. Ensure the TEG is turned off and allowed to cool. All customer loads should be disconnected from the customer output connections inside the TEG cabinet, terminal block TB1 positions 7 (+) and 8 (–). All of the LEDs on the DC/DC Converter Board and the Limiter Board must turn off before proceeding.
2. The ***10 AWG Yellow interconnect wire***, marked as ***T126***, going from the top of the DC/DC Converter Board to the Limiter Board should be relocated to terminal position ***1*** at the top of ***the Limiter Board***. Similarly, the ***10 AWG Brown interconnect wire***, marked as ***T125***, should be relocated to terminal position ***2*** at the top of ***the Limiter Board***.
3. DIP switch ***SW2*** on the ***DC/DC Converter Board*** should have switch position ***1*** changed to ***OFF***. Do not adjust switch position 2.
4. DIP switch ***SW2*** on the ***Limiter Board*** should have ***both*** switch positions changed to ***ON***.
5. Turn on the TEG again. Wait until the TEG turns on the electronics (evidenced by LEDs lighting on both the DC/DC Converter and Limiter Boards). Connect a voltmeter across the customer output connections, terminal block TB1 positions 7 (+) and 8 (–). Turn the Output Voltage Adjustment Pot on the Limiter Board until the voltage observed on the multimeter is at your desired setpoint (the factory default setpoint is 27.0V). The pot may take quite a few turns before any changes are observed.
6. If utilized, the VSR setpoints should also be recalibrated as per section 8.2.2. If the VSR's are unused, this step can be skipped.
7. Reconnect your customer loads to 7 (+) and 8 (–) on terminal block TB1 as necessary.

Converting From 24V to 12V Nominal Output

1. Ensure the TEG is turned off and allowed to cool. All customer loads should be disconnected from the customer output connections inside the TEG cabinet, terminal block TB1 positions 7 (+) and 8 (–). All of the LEDs on the DC/DC Converter Board and the Limiter Board must turn off before proceeding.
2. The ***10 AWG Yellow interconnect wire***, marked as ***T126***, going from the top of the DC/DC Converter Board to the Limiter Board should be relocated to terminal position ***5*** at the top of ***the Limiter Board***. Similarly, the ***10 AWG Brown interconnect wire***, marked as ***T125***, should be relocated to terminal position ***8*** at the top of the Limiter Board.
3. DIP switch ***SW2*** on the ***DC/DC Converter Board*** should have switch position ***1*** changed to ***ON***. Do not adjust switch position 2.

4. DIP switch ***SW2*** on the ***Limiter Board*** should have ***both*** switch positions changed to ***OFF***.
5. Turn on the TEG again. Wait until the TEG turns on the electronics (evidenced by LEDs lighting on both the DC/DC Converter and Limiter Boards). Connect a voltmeter across the customer output connections, terminal block TB1 positions 7 (+) and 8 (–). Turn the Output Voltage Adjustment Pot on the Limiter Board until the voltage observed on the multimeter is at your desired setpoint (the factory default setpoint is 14.1V). The pot may take quite a few turns before any changes are observed.
6. If utilized, the VSR setpoints should also be recalibrated as per section 8.2.2. If the VSR's are unused, this step can be skipped.
7. Reconnect your customer loads to 7 (+) and 8 (–) on terminal block TB1 as necessary.

8.2.4 Enabling Temperature Compensation

Enabling temperature compensation will vary the output voltage by approximately 33mV/°C for 12V (Model P-5100-12) or 66mv/°C for 24V (Model P-5100-24). To Enable Temperature compensation, use the following procedure:

1. Remove the customer load from terminals 7 (+) and 8 (-) of TB1 (see Figure 15).
2. Set/verify SW1 on the Limiter board to the following (default) configuration, to disable temperature compensation for adjustment of the output voltage:
   - Switch 1 ON
   - Switch 2 OFF
3. Connect a DC Voltmeter to the customer load Terminals 7 (+) and 8 (-) of TB1.
4. Turn the output voltage adjustment pot until the desired voltage is reached, per battery manufacturer's recommended charging voltage for 25°C, with no temperature compensation.
5. Set SW1 on the Limiter board to the following configuration, to enable temperature compensation:
   - Switch 1 OFF
   - Switch 2 ON
6. Reconnect the customer load to terminals 7 (+) and 8 (-) of TB1.

8.3 ADJUSTMENT OF OPTIONAL CP INTERFACE SYSTEM

An optional CP interface system is available for use with the model P-5100 TEG. This text describes how to adjust the CP interface system, if applicable.

8.3.1 CP Power Output Adjustment

The 300 W variable resistor (R1 in Figure 22 or Figure 23), located inside the CP cabinet, may be used to fine-tune the output power from the CP interface. This resistor may be connected in series or parallel with the CP Load, depending on the required power. By default, the CP Interface System is shipping in Series Configuration. See Figure 22 for series connection and Figure 23 for parallel connection.

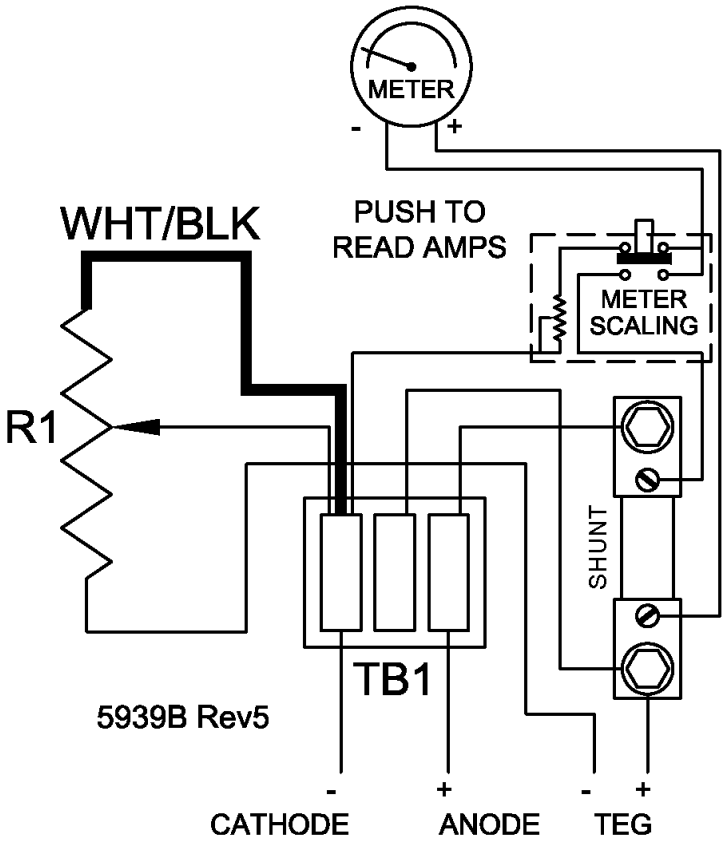

Figure 22 - CP Interface System, Series Wiring Diagram

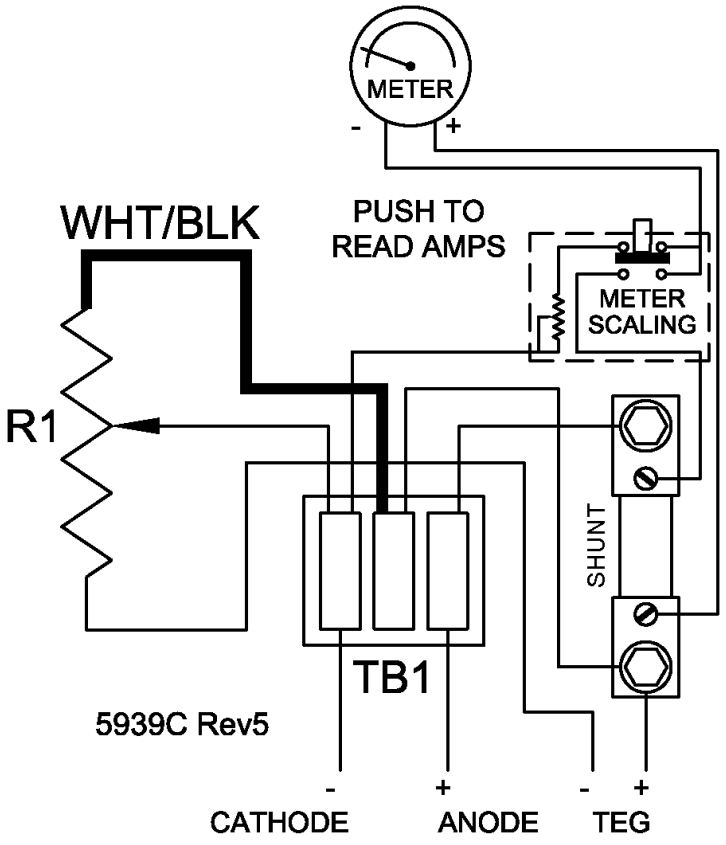

Figure 23 - CP Interface System, Parallel Wiring Diagram

Adjusting the variable resistor can be done while the system is running, by loosening the slide ring on the resistor and moving it up or down on the resistor. Use the meter inside the CP enclosure to measure the voltage and current being delivered to the CP Load. Once the resistor has been adjusted to give the desired output, check that all electrical connections are tight.

8.3.1.1 Series Wiring

Series Configuration is the default configuration from the factory, with the 300 W resistor in series with the CP Load. Maximum available 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.

8.3.1.2 Parallel Wiring

Parallel Configuration may be used when smaller amounts of CP Load power are needed than can be achieved in Series Configuration. This may also be required when hot spots occur on the anode of the CP circuit. With the tap located at the top of the resistor the CP Load power will be zero. As the tap is moved down, the power to the CP load is increased.

The CP Interface System can be freely changed between Series and Parallel Configuration by moving the wire from the top of the resistor between the leftmost and central positions on the heavy-duty terminal block in the CP enclosure. Refer to Figure 22 and Figure 23.

8.4 ADJUSTMENT OF OPTIONAL REMOTE START SYSTEM (TEG CONTROLLER)

Refer to the Remote Start Operating Manual (PN 302254) for details.

8.5 ADJUSTMENT OF OPTIONAL 48V_{DC} CONVERTER

Refer to the 48 Volt Converter Operating Manual Addendum (PN 302228) for details.

9 MAINTENANCE

This section describes how to maintain the model P-5100 TEG. Before attempting to maintain 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.

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.

9.1 RECOMMENDED PERIODIC MAINTENANCE

The TEG is a solid-state high-reliability 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 the site conditions (fuel purity, environment, etc.) and must be established based on-site records. Field experience indicates that a properly installed TEG usually requires maintenance only once a year.

At least once a year evaluate V_{SET} as per the procedure below. This should be the first procedure during any service visit and will determine what further service may be needed.

9.1.1 Tools and Parts Recommended for Routine Servicing

The following tools and parts should be available for routine servicing:

- 1 Multi-meter, including DC voltmeter accurate to ± 0.1 V (and Ohmmeter*).
- 1 Flat-head screwdriver.
- 1 Phillips screwdriver.
- 1 Wrench, 9/16 in.
- 1 Wrench, 1/2 in.
- 1 Wrench, 3/8 in.
- 1 Adjustable wrench, that will open to 16 mm (5/8 in.).
- 1 Fuel filter kit, part number 22363.
- 1 Fuel orifice: for natural gas use orifice #8 (part number 690), for high BTU natural gas use orifice #10 (part number 6251), for propane use orifice #7 (part number 689).
- 1 Battery 6V, 5Ahr, Monobloc, part number 24559*.
- A combustion analyzer capable of measuring *COppm* and either CO_2 percentage, or O_2 percentage*
- Magnifying Glass*

**not usually required but is convenient for troubleshooting.*

9.1.2 Evaluate V_{SET}

This procedure describes how to evaluate V_{SET} and determine what further servicing could be needed.

Follow these steps to evaluate V_{SET}:

1. Check V_{SET}, see POWER OUTPUT EVALUATION in section 7, and record.
2. Compare measured V_{SET} with required V_{SET} for present ambient temperature and act as follows:

a) If measured V_{SET} is more than 0.1 V above required V_{SET}:

The fuel pressure must be reduced, refer to section 8.1.3 as needed. Reduce the fuel pressure until measured V_{SET} is within 0.1 V of required V_{SET}, then proceed with Routine Service, section 9.1.3.

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

b) If measured V_{SET} is within 0.1 V of required V_{SET}:

The TEG is functioning well and requires only a routine service. Proceed with Routine Service, section 9.1.3.

c) If measured V_{SET} is more than 0.1 V below required V_{SET}:

The cause must be determined. Refer to the last entry in the TEG Performance Log. From 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 conditions. If the TEG was not left operating at the correct V_{SET} during the last visit, determine the reason for this. If the TEG was left operating at the correct V_{SET} during the last visit and is now not, consider the following possible causes:

- **Change in Fuel Pressure**

  Refer to the last entry in the log and determine if the fuel pressure has changed. If the fuel pressure has changed, re-adjust the fuel pressure to the last entry. If this returns the measured V_{SET} to within 0.1 V of required V_{SET} proceed with Routine Service, section 9.1.3.

NOTE: A dirty fuel filter may cause a drop-in fuel pressure. A clogged 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 lid screens. Adjust the air shutter as per ADJUSTMENT section 8. If this returns the measured V_{SET} to within 0.1 V of required V_{SET} proceed with Routine Service, section 9.1.3.

- **Change in Fuel Quality**

  To maintain a constant output power, it is essential that the TEG be supplied with a constant heating value fuel. If a change in fuel quality occurred, then proceed with Routine Service, section 9.1.3.

If the above causes have been ruled out then the TEG may require more than just routine servicing. Keep the TEG operating for now and see TROUBLESHOOTING in 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. Stop the TEG and pause to let cool. See STARTUP AND SHUTDOWN in section 6.
2. Drain the pressure regulator sediment bowl. See Draining the Sediment Bowl in section 9.2.1.
3. Replace the fuel filter in the pressure regulator. See Fuel Filter Replacement in section 9.2.2.
4. Check the fuel orifice for clogging and replace if necessary. See Fuel Orifice Inspection in section 9.2.3.
5. Remove any debris, sand or dust from the cooling fins, air lid screens and cabinet interior. See Air Lid Screens Cleaning in section 9.3.1.
6. Check all bolts and wire connections for tightness.
7. Start the TEG. See STARTUP AND SHUTDOWN in section 6.
8. Check V_{SET} once again, record and adjust if necessary. See POWER OUTPUT EVALUATION in section 7 and ADJUSTMENT in section 8, as applicable. Record final details in the TEG Performance Log before leaving site.

9.2 FUEL SYSTEM MAINTENANCE

WARNING!

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

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

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

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

9.2.1 Draining the Sediment Bowl

Follow these steps to drain the regulator sediment bowl:

1. Shut off the fuel supply to the TEG and allow to cool.
2. Open the drain cock located on the underside of the TEG cabinet, any impurities will drain through the cock. Place empty container beneath drain cock to prevent spillage inside the cabinet.
3. Close drain cock.
4. Leak check the drain cock.

WARNING! Check for fuel leaks after any fuel system service.

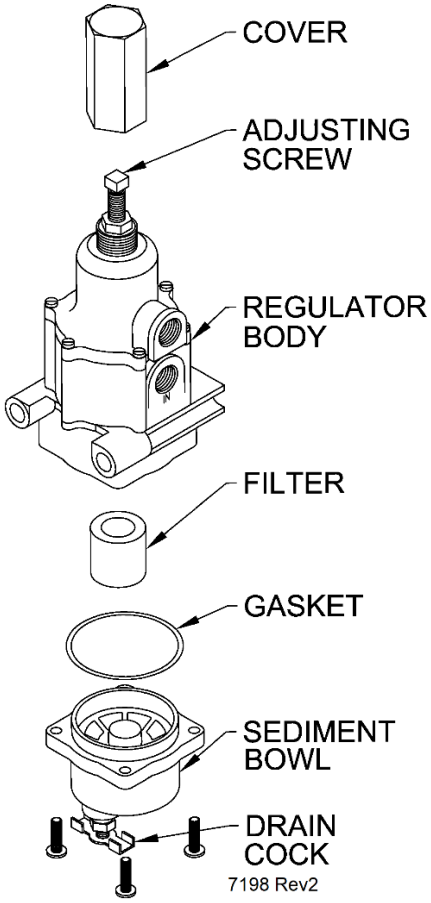

Figure 24 – Pressure Regulator

9.2.2 Fuel Filter Replacement

Follow these steps to remove the fuel filter:

1. Shut off the fuel supply to the TEG and allow to cool.
2. Drain the sediment bowl by opening the drain cock. Place empty container beneath drain cock to prevent spillage inside the cabinet.
3. Remove the four screws from the bottom of the regulator.
4. Remove the filter, and gasket. See Figure 24.

Follow these steps to install the fuel filter:

1. Install the filter, and gasket onto the sediment bowl. See Figure 24.

2. Carefully replace the bottom of the regulator making sure the filter and gasket are in their proper position.
3. Align the sediment bowl with the regulator body, replace the four screws and tighten.
4. With the fuel pressure on, leak check all regulator joints and fuel connections using a commercial leak detector.

NOTE: While the regulator is removed this can be a convenient time to check the orifice and clean the air lid screens. See Fuel Orifice Inspection and Air Lid Screens Cleaning sections below.

WARNING! Check for fuel leaks after any fuel system service.

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. Disconnect the fuel line from the solenoid valve.
3. Disconnect the other end of the fuel line from the orifice from the lid of the air box.
4. Remove the orifice fitting from the lid of the air box.
5. Visually check the orifice hole. It should be free from any obstructions. Replace it if necessary. A magnifying glass is recommended to aid with visual inspection.
6. Connect the orifice fitting to the fuel line then thread the orifice back through the center of the air shutter. This only needs to be finger tight.

CAUTION!

Always use the same size orifice as what was removed.
Propane orifice (#7) - Part# 689
Natural gas orifice (#8) - Part# 690
High BTU Natural gas orifice (#10) – Part# 6251

7. Connect the fuel line to solenoid valve and orifice, then tighten the fuel line fittings.
8. Leak check all connections using a commercial leak detector.

WARNING! Check for fuel leaks after any fuel system service.

9.3 BURNER MAINTENANCE

9.3.1 Air Lid Screens Cleaning

The air lid screens on the lid of the air-box may become clogged with dust and insects thereby preventing the proper flow of air into the burner.

WARNING! If TEG has not cooled sufficiently, these components will be very hot.

Follow these steps to clean the air lid screens:

1. Shut-off the fuel supply to the TEG and allow cooling.
2. Disconnect the supply fuel line and fuel inlet valve.
3. Disconnect the solenoid wire terminal connection and the orange wire connection of the pressure switch electrical connections.
4. Remove fuel line between the solenoid valve and orifice fitting.
5. Remove the 2 bolts mounting the fuel regulator to the cabinet wall and remove the fuel system.
6. Remove the 2 screws from each side of the cabinet baffle and remove baffle from cabinet.

NOTE: Try not to disturb the air shutter setting. If it becomes disturbed during maintenance, you should recalibrate the air shutter afterwards per section 8.1.2.

7. Remove the 2 wing nuts and 4 screws from air box lid.
8. Clean the screens by forcing air through them or washing in water.
9. Replace Air Box lid, cabinet baffle, fuel system and fittings.
10. Before restarting the TEG, leak check all fuel connections.

9.3.2 Inspection of Burner Components

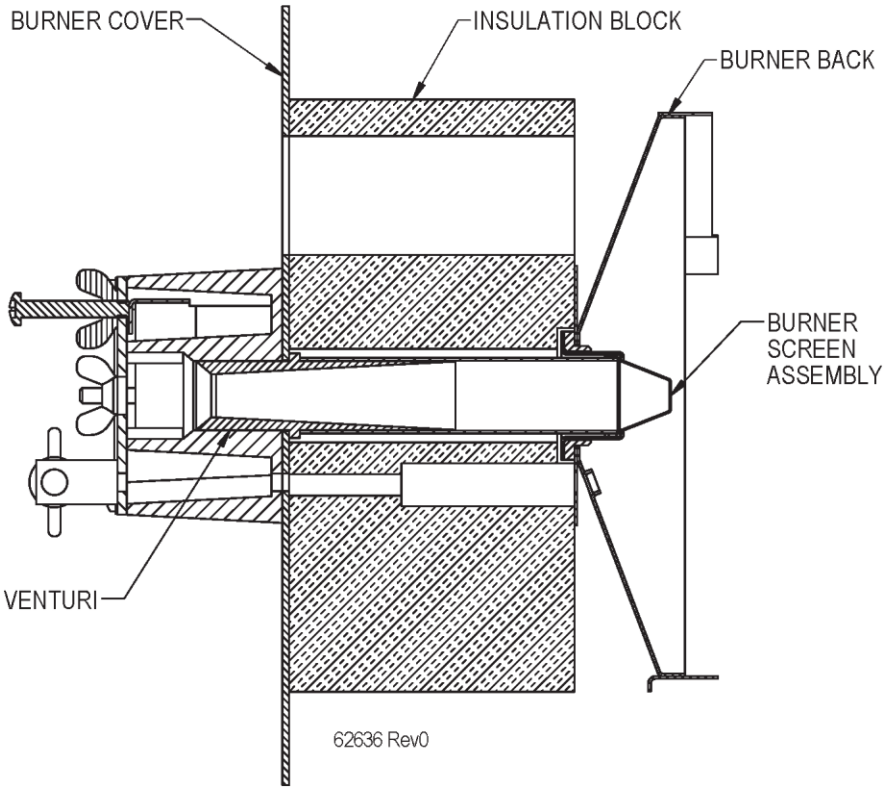

Figure 25 - Burner Assembly Cross Section

Burner internals are maintenance free for most applications. If the required V_{SET} still cannot be achieved after servicing the fuel system, air screens, and checking the cooling fins and air duct then it may be necessary to check and service the burner internals.

WARNING! If TEG has not cooled sufficiently, these components will be very hot.

Follow these steps to remove the burner:

1. Shut-off the fuel supply to the TEG and allow to cool.
2. Disconnect the supply fuel line and fuel inlet valve.
3. Disconnect the solenoid wire terminal connection and the orange wire connection of the pressure switch electrical connections.
4. Remove fuel line between the solenoid valve and orifice fitting.
5. Remove the 2 bolts mounting the fuel regulator to the cabinet wall and remove the fuel system.
6. Remove the 2 screws from each side of the cabinet baffle and remove baffle from cabinet.

NOTE: Try not to disturb the air shutter setting. If it becomes disturbed during maintenance, you should recalibrate the air shutter afterwards per section 8.1.2.

7. Disconnect the ignition wire from the spark electrode.
8. Loosen the wingnut and slide the spark electrode out. See Figure 12.
9. Remove screws from sides of rain cap and remove rain cap.
10. Remove screws from top exhaust shield and remove exhaust shield.
11. Remove screws from exhaust arrestor and remove exhaust arrestor.
12. Remove the 2 screws mounting the exhaust stack to the burner back cover.
13. Remove the four wingnuts holding the burner in place and remove the cabinet exhaust shield.
14. Slide the burner assembly out of the burner chamber.

Follow these steps to inspect the burner:

1. Check the venturi assembly. If it looks severely corroded it should be replaced. Make sure the venturi is properly located in the venturi tube (see Figure 4), and that the venturi is facing the proper direction.
2. Check the burner screen.
3. Check the ceramic spacer.

Follow these steps to install the burner:

1. Reassembly is the reverse of disassembly.

NOTE: The orifice fitting only needs to be finger tight when threaded to the front of the air box lid.

2. Before restarting the TEG, leak check all fuel connections.

WARNING! Check for fuel leaks after any fuel system service.

9.4 SPARK IGNITION SYSTEM MAINTENANCE

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

Refer to Figure 12 and wiring diagrams Figure 13 or Figure 14 as necessary. Be sure the manual ball valve is closed and allow time for the TEG to cool before beginning.

9.4.1 Check the Thermal Cutoff Assembly

Follow these steps to check the thermal cutoff assembly:

1. Disconnect the orange wire from the thermal cutoff assembly.
2. Check the continuity across the thermal cutoff assembly. If the thermal cutoff is not conductive, it means the thermal fuse has opened, preventing ignition. Investigate the cause of the cabinet over-temperature event before replacing the thermal cutoff.
3. For safety purposes, keep the orange wire disconnected until completion of section 9.4.8.

9.4.2 Check the Fuel Pressure Switch

The fuel pressure switch should be checked for correct functionality in both pressurized and unpressurized states:

1. Connect a multi-meter across the two fuel pressure switch terminals, set to measure continuity.
2. Open the manual ball valve.
3. Confirm the fuel pressure gauge reading is greater than 2 psi_g (13.8 kPa).
4. Check the multimeter. You should see continuity across the fuel pressure switch terminals. If there is no continuity, the fuel pressure switch has opened and should be replaced.

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

5. Close the manual ball valve.
6. Purge trapped fuel by briefly shorting together the disconnected orange wire and brown wire on the fuel pressure switch, causing the TEG to open the solenoid valve. If the optional TEG Controller is installed, the Start (S1) button must also be pressed. Observe the fuel pressure gauge. If doing this fails to clear the trapped fuel pressure, skip the next two steps and proceed with the next section 9.4.3. Return to this step if no other sections identify a problem.
7. With no fuel pressure present (below 1 psi_g / 6.9 kPa), check the multimeter. You should see no continuity across the fuel pressure switch terminals. If you see continuity, the fuel pressure switch has shorted and should be replaced.

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

8. Disconnect the multimeter.

9.4.3 Check the Battery Voltage

Follow these steps to check the battery voltage:

1. Open the front of the TEG, then open the cover door to the electronics, located inside the door assembly.
2. Locate the battery, see Figure 6.
3. Disconnect the brown wire from the battery to ensure it is electrically disconnected from the system. Measure the voltage of the battery, between the positive (white wire) and negative (previous location of the brown wire) terminals of the battery. The voltage should be greater than 6 V.
4. If the voltage is less than 6 V the battery pack needs recharging or replacing. The SI Controller board will not function properly if the battery voltage is below 5.8V.
5. Reconnect the brown wire to the battery to connect it back the system.

9.4.4 Check the spark return path

Follow these steps to check the spark return path for the SI system, using wiring diagrams Figure 13 and Figure 14 for reference:

1. Verify that the green wire is connected between the electronics assembly and the "SPARK RETURN" terminal on the SI Controller board (located at the top-right of the board, near the high-voltage coil).
2. Verify that the TEG bonding wire is connected between the electronics assembly and the TEG cabinet.

9.4.5 Check the SI Controller Board

Follow these steps to check the SI Controller board:

1. Make sure the battery pack is properly connected to the SI Controller board.
2. Verify fuse blown indicators located near the fuses are off. If any fuse blown indicator is lit or blinking red, replace the fuse with of the "Spare FUSE" located near the top of the board.
3. If any fuse repeatedly blows in subsequent ignition trials, replace the SI Controller board.

9.4.6 Check the Spark Electrode and SI Module

Follow these steps to check the spark electrode and SI module:

1. Remove the spark electrode by loosening the wingnut and sliding the electrode out, (see Figure 3 and Figure 12).
2. Inspect the electrode for any cracks in the ceramic rod. If any cracks are found the electrode must be replaced. Also inspect the electrode tip for corrosion, which can weaken flame sensing. Small amounts of corrosion can be buffed out, but replacement might be necessary for severe corrosion.
3. Slide the electrode back into position through the burner back until it stops, and then pull it back 3 to 6 mm (1/8 to 1/4 in.). Refer to Figure 26, make sure the ceramic electrode does not protrude more than 3.45".

4. Tighten the wingnut only until it is snug.

CAUTION! Do not over tighten the wingnut or the ceramic rod will crack.

5. Make sure the green 2-position screw connector is plugged into the header labeled "IGN" on the SI Controller board.
6. Temporarily short together the orange wire (disconnected from the thermal cutoff in section 9.4.1) and the brown wire (connected to the fuel pressure switch). Press the Start (S1) button if the optional TEG Controller is installed. Sparking should occur in the combustion chamber (making a clicking noise) at the rate of once per second. If sparking occurs, the SI module is functioning. If no sparking occurs, check the green SI power indicator on the SI Controller board; if it is lit, replace the SI module.

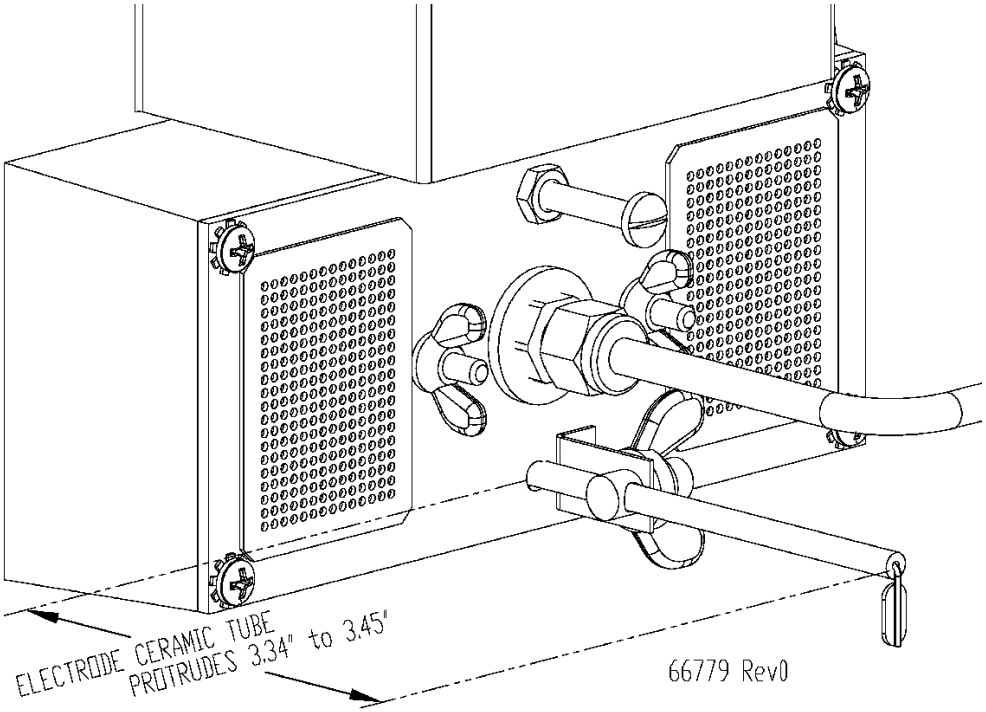

Figure 26 - Electrode Protrusion from Air Box Lid

9.4.7 Check Solenoid Valve

Follow these steps to check the solenoid valve:

1. If at the beginning of sparking, the solenoid valve does not audibly click open and no fuel flows, unplug the solenoid valve cable plug from the solenoid valve body (see Figure 12 for location and see Figure 27 for connection). Measure the voltage between the blue and brown wires of the plug; it should be between 12V and 14V when the SI module is sparking. If it is, replace the solenoid valve.
2. If not, measure the voltage on the solenoid connector on the SI Controller board, between the blue and brown wire terminals when the SI module is sparking, and the SI valve indicator is on. If it is between 12V and 14V, replace the solenoid valve wiring harness. If it is not 12V, return to section 9.4.5 to troubleshoot the SI Controller board and SI module.

NOTE:	Solenoid valve voltage measurements must be taken during a spark trial, otherwise the solenoid valve will be unpowered.

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

1. Close the manual ball valve to shut the TEG down.
2. Remove the retaining screw or nut on solenoid valve cable plug and then disconnect the plug from the valve body.
3. Unplug wires from the fuel pressure switch, then remove the fuel pressure switch from the manifold. Disconnect the burner fuel line from the valve body, then remove the valve body. Remove the fittings from the old valve. Clean the threads and set aside. Clean threads on the fuel pressure switch as well.
4. Use correct thread sealant while reinstall parts to fuel system.
   Take note of the P and A markings on the new valve body. The P port must be connected to the manifold, and the A port must be connected to the burner fuel line.

   Attach the new valve body P port to the manifold, then attach the fuel line to the A port. Reinstall the fuel pressure switch back to the manifold, and plug wires unplugged previously in step 3 back to their original terminals on the fuel pressure switch.

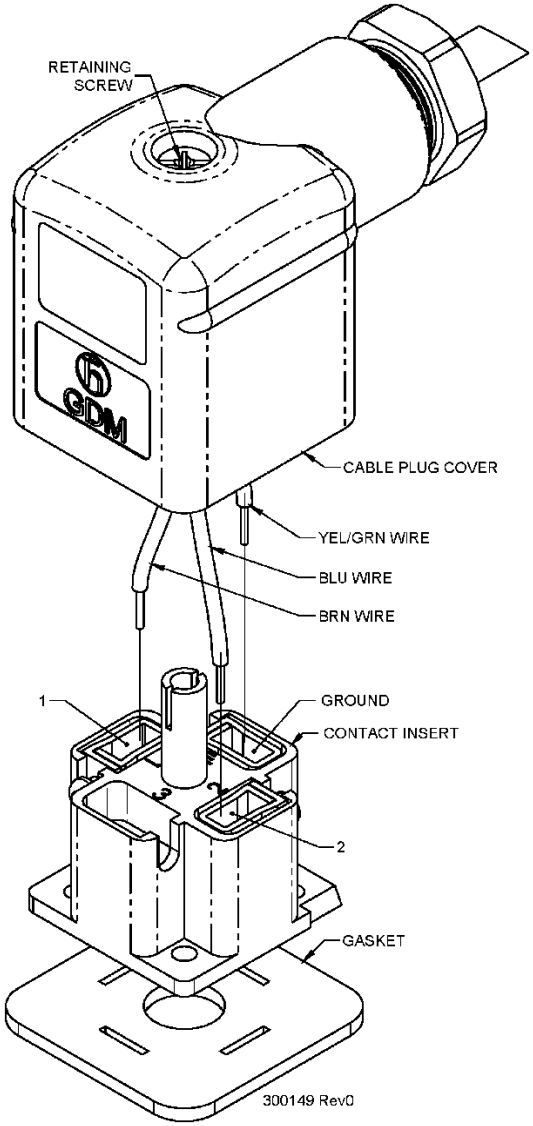

Figure 27 - Solenoid Valve Cable Plug Connections

5. If your TEG is equipped with a valve having the same style DIN plug, and it passed the test in section 9.4.7 step 1, do not replace the harness. Otherwise cut the old valve harness to remove it from your TEG. A new valve harness comes with your new field replacement valve kit. Route the new harness in place same as the old harness was originally installed and secure it with cable ties. Plug the valve cable plug to the valve body with the gasket in place, install and fasten the retaining screw. Plug the factory-installed green 6-position connector on the other end of the valve harness back to the SI Controller board. Make sure the connections are correct against the chart below:

Marks on the SI Controller Board, LO side of J201	Wire color
+	BLU
-	BRN
chassis	YEL/GRN

6. Apply fuel to start the TEG. Immediately leak check all gas connections. Shut the TEG off again before tightening, adjusting, or repairing any fuel system connections.

9.4.8 Check Connections of Spark Ignition System

Reconnect the orange wire that was disconnected in section 9.4.1. Make sure all other connectors are returned to their original positions.

9.5 LIMITER CONVERTER EXAMINATION

The L/C normally requires 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 should be checked and serviced as necessary. Use the procedures below to help determine if the L/C could be damaged.

9.5.1 Check L/C Configurations and Settings

Refer to section 8.2.3, confirm the L/C configuration and dipswitch settings are corresponding to 12V or 24V nominal output voltage.

Refer to section 8.2.4 to confirm if temperature compensation is correctly enabled/disabled for your application.

9.5.2 Check L/C Output Voltage

Refer to section 8.2.4 to disable temperature compensation (if enabled), then see section 8.2.1 to check the output voltage from the L/C. Replace the L/C if the unloaded output voltage cannot be adjusted by turning the output voltage adjustment pot.

9.6 POWER UNIT EXAMINATION

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

9.6.1 Check for Internal Short

Follow these steps to check for an internal short:

1. Disconnect the customer load from terminals 7 (+) and 8 (-) on TB1 (see Figure 15).

2. Connect a voltmeter across terminals 1 (+) and 2 (-) of TB1.
3. Start the TEG and allow it to run for at least one hour.

WARNING! The following steps may cause arcing if an internal short is preset. Use extreme caution when handling the jumper wire.

4. Using a jumper wire, momentarily connect Terminal 2 to the TEG chassis while observing the voltmeter. If the jumper wire arcs to the chassis, then the power unit has a severe short and should be replaced. If there is no arcing, but the voltage measurement shifts noticeably when the jumper wire is connected, then the insulation resistance has degraded and is negatively affecting output power. In both cases, contact GPT customer service for assistance.
5. Repeat Step 4, except making the momentarily connection between Terminal 1 and TEG chassis instead.

9.6.2 Check Internal Resistance

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

1. Disconnect the customer load from terminals 7 (+) and 8 (-) of TB1 (see Figure 15).
2. Connect a voltmeter between terminals 5 (+) and 6 (-) of TB1 to measure V_{SET}.
3. Start the TEG and allow it to run for at least one hour.
4. Pause for sufficient time to get a stable measurement of V_{SET} between terminals 5 (+) and 6 (-). 15 minutes is often sufficient if the TEG was already warm. 1 hour is required if the TEG was just started from cold.
5. Record V_{SET}.
6. Connect a voltmeter across the lower screws of terminals 1 (+) and 2 (-) of TB1 where 10 AWG WHT/RED wire T100 and WHT/BLK wire T101 are connected; this is in preparation to measure V_{OC}.

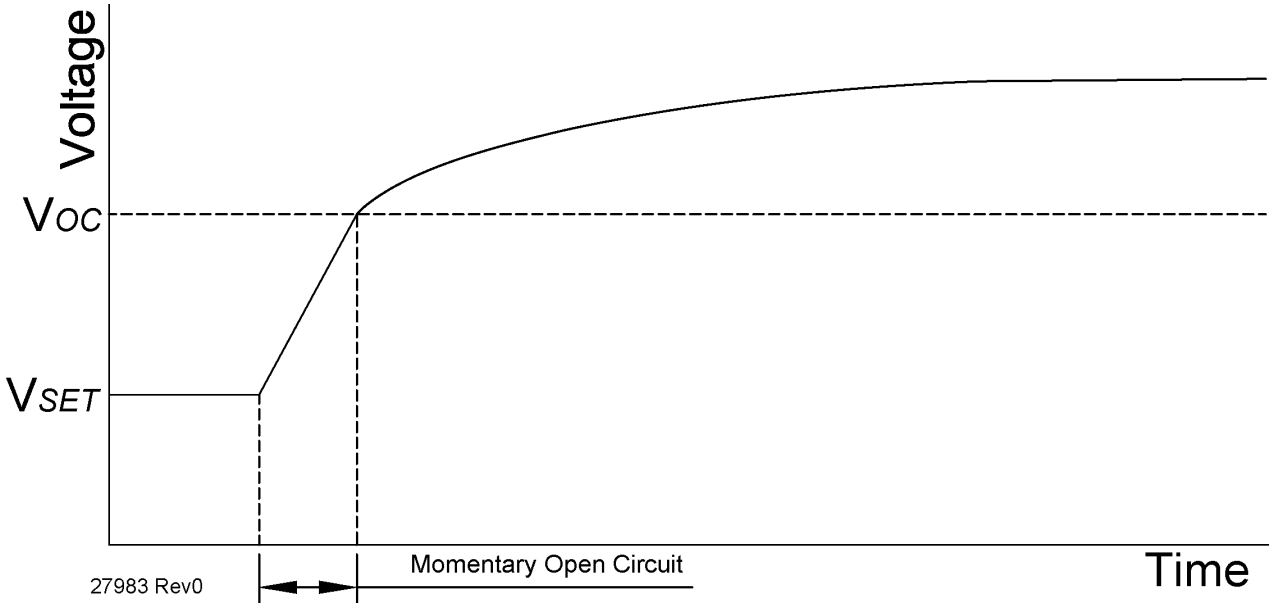

Figure 28 - Momentary Open Circuit Diagram

7. While observing the voltmeter, disconnect the 10 AWG WHT/RED wire T104 from upper screws of terminal 1 on TB1, creating an open circuit condition, and note the momentary voltage. On a digital multi-meter this will be the first number displayed after the disconnection, within 2 seconds of removing the wire.

WARNING! Do not leave the system in an open circuit state for longer than 10 seconds at a time.

8. Record this number as the momentary open circuit voltage, V_{OC}.

   If this was not observed quickly enough, allow the TEG 15 minutes to stabilize then repeat step 7.

9. Calculate the internal resistance using the equations 6 and 7 below.
10. Check the internal resistance, R_i, is less than 0.38 Ω. If not, the power unit may be damaged.

$$I_L = V_{SET} / R_L \qquad \text{equation 6}$$

$$R_i = (V_{OC} - V_{SET}) / (1.25 \times I_L) \qquad \text{equation 7}$$

Where:
- R_i = Internal resistance (Ω)
- V_{OC} = Momentary open circuit voltage (V)
- I_L = Precision load current (A)
- R_L = Precision load resistance (Ω)
  Use **0.375 Ω** for a model P-5100 TEG
- V_{SET} = Set-up Voltage measured across terminals 5 and 6 of TB1 (V)

Example: If the set-up voltage V_{SET} and momentary open circuit voltage V_{OC} were measured as 6.02 V and 12.2 V, then:

$I_L = V_{SET} / R_L$
$= 6.02 / 0.375$
$= 16.05A$

$R_i = (V_{OC} - V_{SET}) / (1.25 \times I_L)$
$= (12.2 - 6.02) / (1.25 \times 16.05)$
$= 6.18 / 20.07$
$= 0.31\ \Omega$

Internal resistance, < 0.38 Ω, is acceptable.

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

10 TROUBLESHOOTING

Problem	Potential Cause	Possible Solution	Lookup Section
Burner does not ignite	Air in fuel line	Purge fuel lines of air	*INSTALLATION Section 5.6.1*
	Supply gas pressure too low	Increase the gas supply pressure to the TEG	*INSTALLATION Section 5.6.2*
	Fuel filter dirty	Drain the regulator Sediment and replace the fuel filter	*MAINTENANCE Section 9.2.1 and 9.2.2*
	Fuel orifice clogged	Replace the fuel orifice	*MAINTENANCE Section 9.2.3*
	Fuel orifice size incorrect	Replace the orifice with correct size	*MAINTENANCE Section 9.2.3*
	Air screens dirty	Clean air screens	*MAINTENANCE Section 9.3.1*
	Air-shutter setting incorrect	Adjust the air-shutter	*ADJUSTMENT AND TUNING Section 8.1.2*
	Fuel pressure setting incorrect	Adjust the TEG fuel manifold pressure	*ADJUSTMENT AND TUNING Section 8.1.3*
	SI system fault	Check the SI system	*MAINTENANCE Section 9.4*
Burner will ignite but will not continue to burn	Supply gas pressure too low	Increase the gas supply pressure to the TEG	*INSTALLATION Section 5.6.2*
	Fuel filter dirty	Drain the regulator Sediment and replace the fuel filter	*MAINTENANCE Section 9.2.1 and 9.2.2*
	Fuel orifice clogged	Replace the fuel orifice	*MAINTENANCE Section 9.2.3*
	Fuel orifice size incorrect	Replace the orifice with correct size	*MAINTENANCE Section 9.2.3*
	Air screens dirty	Clean air screens	*MAINTENANCE Section 9.3.1*
	Air-shutter setting incorrect	Adjust the air-shutter	*ADJUSTMENT AND TUNING Section 8.1.2*
	Fuel pressure setting incorrect	Adjust the TEG fuel manifold pressure	*ADJUSTMENT AND TUNING Section 8.1.3*
	SI system fault	Check the SI system	*MAINTENANCE Section 9.4*

TROUBLESHOOTING, *continued*

Problem	Potential Cause	Possible Solution	Lookup Section
Low output power or low voltage	V_{SET} adjustment incorrect	Determine required V_{SET} for present ambient temperature at site and adjust	*POWER OUTPUT EVALUATION Section 7*
	Airflow past cooling fins insufficient	Clean the cooling fins of any debris	*MAINTENANCE Section 9.1.3*
	Fuel filter dirty	Drain the regulator Sediment and replace the fuel filter	*MAINTENANCE Section 9.2.1 and 9.2.2*
	Fuel orifice clogged	Replace the fuel orifice	*MAINTENANCE Section 9.2.3*
	Fuel orifice size incorrect	Replace the orifice with correct size	*MAINTENANCE Section 9.2.3*
	Air screens dirty	Clean air screens	*MAINTENANCE Section 9.3.1*
	Air-shutter setting incorrect	Adjust the air-shutter	*ADJUSTMENT AND TUNING Section 8.1.2*
	Fuel pressure setting incorrect	Adjust the TEG fuel manifold pressure	*ADJUSTMENT AND TUNING Section 8.1.3*
	L/C settings incorrect	Adjust the L/C	*ADJUSTMENT AND TUNING Section 8.2*
	L/C damaged	Examine the L/C, contact GPT	*MAINTENANCE Section 9.5*
	Power unit damaged	Examine the power unit, contact GPT	*MAINTENANCE Section 9.6*
Output power is too high	Fuel pressure setting incorrect	Adjust the TEG fuel manifold pressure	*ADJUSTMENT AND TUNING Section 8.1.3*
Output voltage is too high	L/C settings incorrect	Adjust the L/C	*ADJUSTMENT AND TUNING Section 8.2*
	L/C damaged	Examine the L/C, contact GPT	*MAINTENANCE Section 9.5*

11 PARTS LISTS

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

#16, 7875 - 57th Street SE
Calgary, Alberta T2C 5K7

Direct: +1 403 720 1190
Fax: +1 403 236 5575
Main: +1 403 236 5556

E-mail: customer.service@globalte.com
Web: www.globalte.com

11.1 MODEL P-5100 TEG

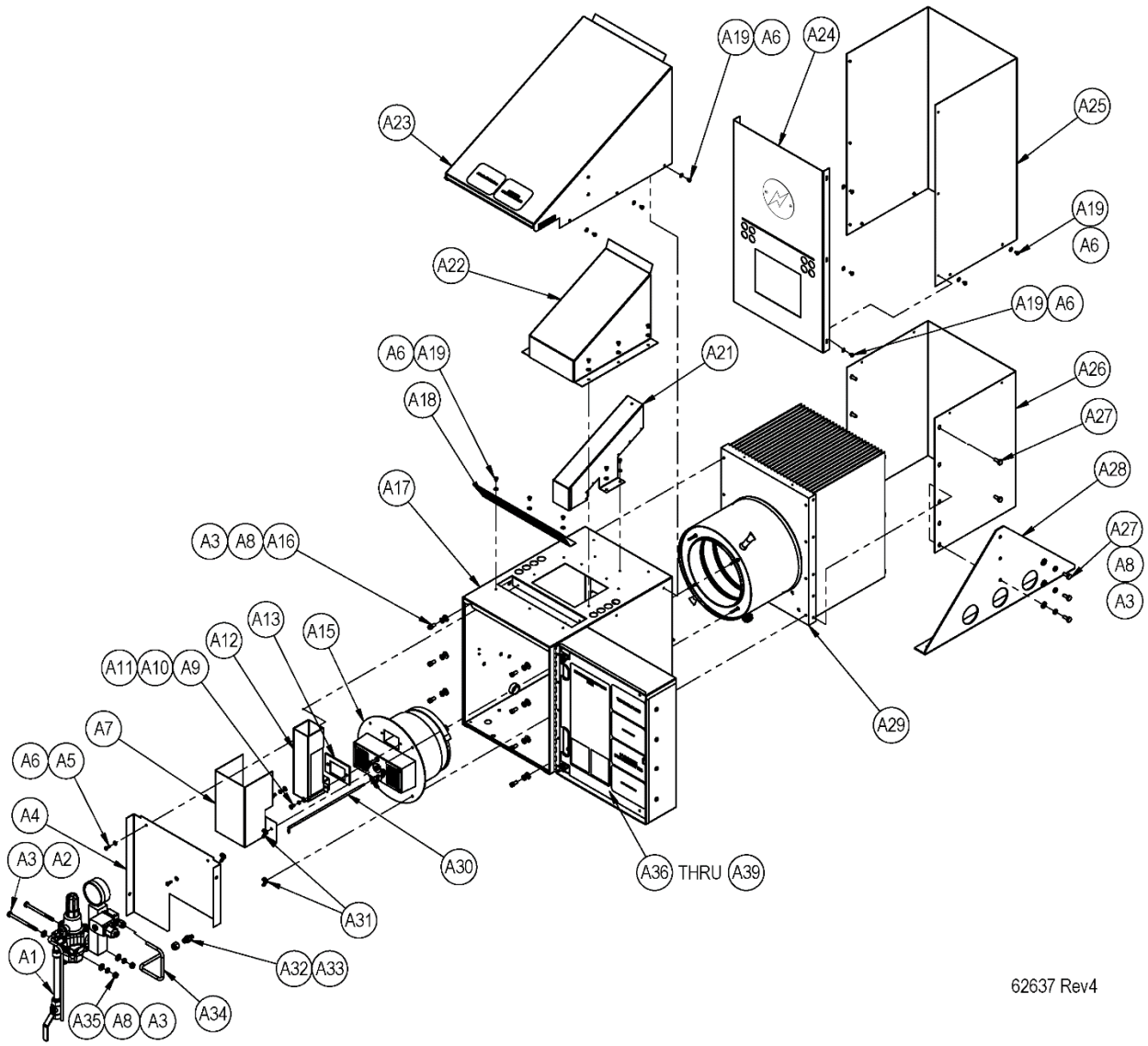

Figure 29 - Model P-5100 TEG

Item	Part No.	Description
A1	61864	FUEL SYSTEM, P-5050/P-5100
or	62557	FUEL SYSTEM, SS, P-5050/P-5100
A2	2105	SCREW, CAP, HEX-HD, 1/4-20 X 3-1/2, SS
A3	557	WASHER, FLAT, 1/4", SS
A4	62064	BAFFLE, INNER CABINET, P-5050/P-5100
A5	7324	SCREW, MACH, P-H-P, 8-32 X 1/2, SS
A6	472	WASHER, LOCK, EXT. #8, SS
A7	62124	EXHAUST SHIELD, OUTER, BACK, P-5100
A8	541	WASHER, LOCK, SPRING, 1/4, SS
A9	255	SCREW, MACH, P-H-P, 10-32 X 3/8 SS
A10	29696	WASHER, LOCK, SPRING, #10, 316 SS
A11	569	WASHER, FLAT, #10, SS
A12	61984	EXHAUST ASSY, P-5050/P-5100
A13	61569	GASKET, EXHAUST, P-5050/P-5100

11.1 MODEL P-5100 TEG (Cont'd)

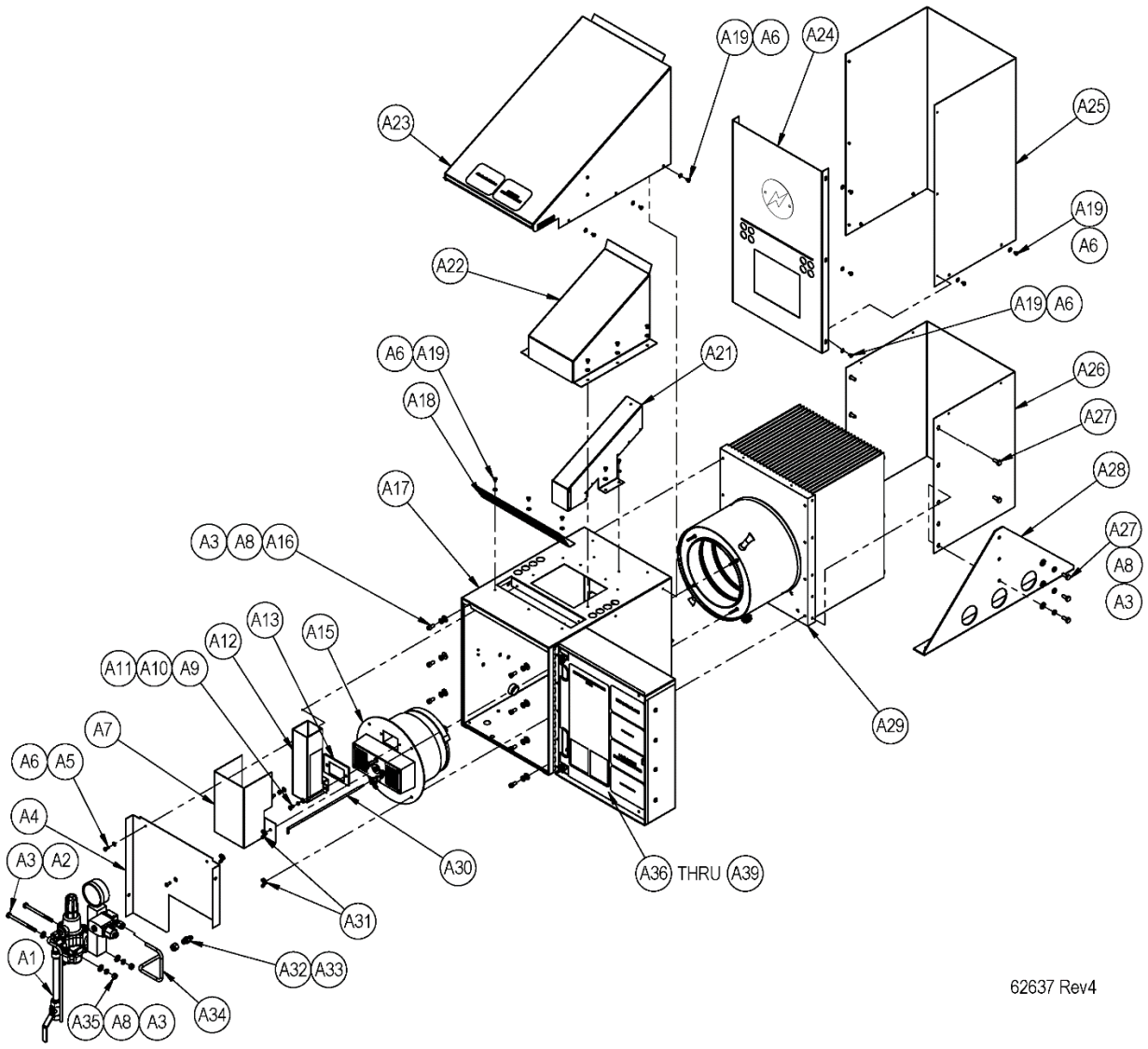

Figure 29 - Model P-5100 TEG

Item	Part No.	Description
A15	62121	BURNER ASSEMBLY, W/INTAKE ARRESTOR, P-5100
A16	266	SCREW, CAP, SOC, 1/4-20 X 1/2 SS
A17	61993	CABINET ASSEMBLY, P-5050/P-5100
A18	62122	RAIN GUARD, P-5050/P-5100
A19	7410	SCREW, MACH, P-H-P, 8-32 X 1/4, SS
A21	62126	EXHAUST TUBE ASSY, P-5050/P-5100
A22	62065	LINER, EXHAUST, P-5050/P-5100
A23	62067	RAIN CAP ASSEMBLY, P-5050/5100
A24	62113	COVER ASSY, UPPER, FIN DUCT, P-5050/P-5100
A25	61561	FIN DUCT, UPPER, P-5100
A26	61559	FIN DUCT, LOWER, P-5100
A27	20535	SCREW, HEX HD, 1/4-20 X 5/8, SS
A28	62114	LEG, P-5050/P-5100
A29	8911	POWER UNIT, P-5100, CUSTOMER SERVICE
A30	58496	ELECTRODE ASSY

11.1 MODEL P-5100 TEG (Cont'd)

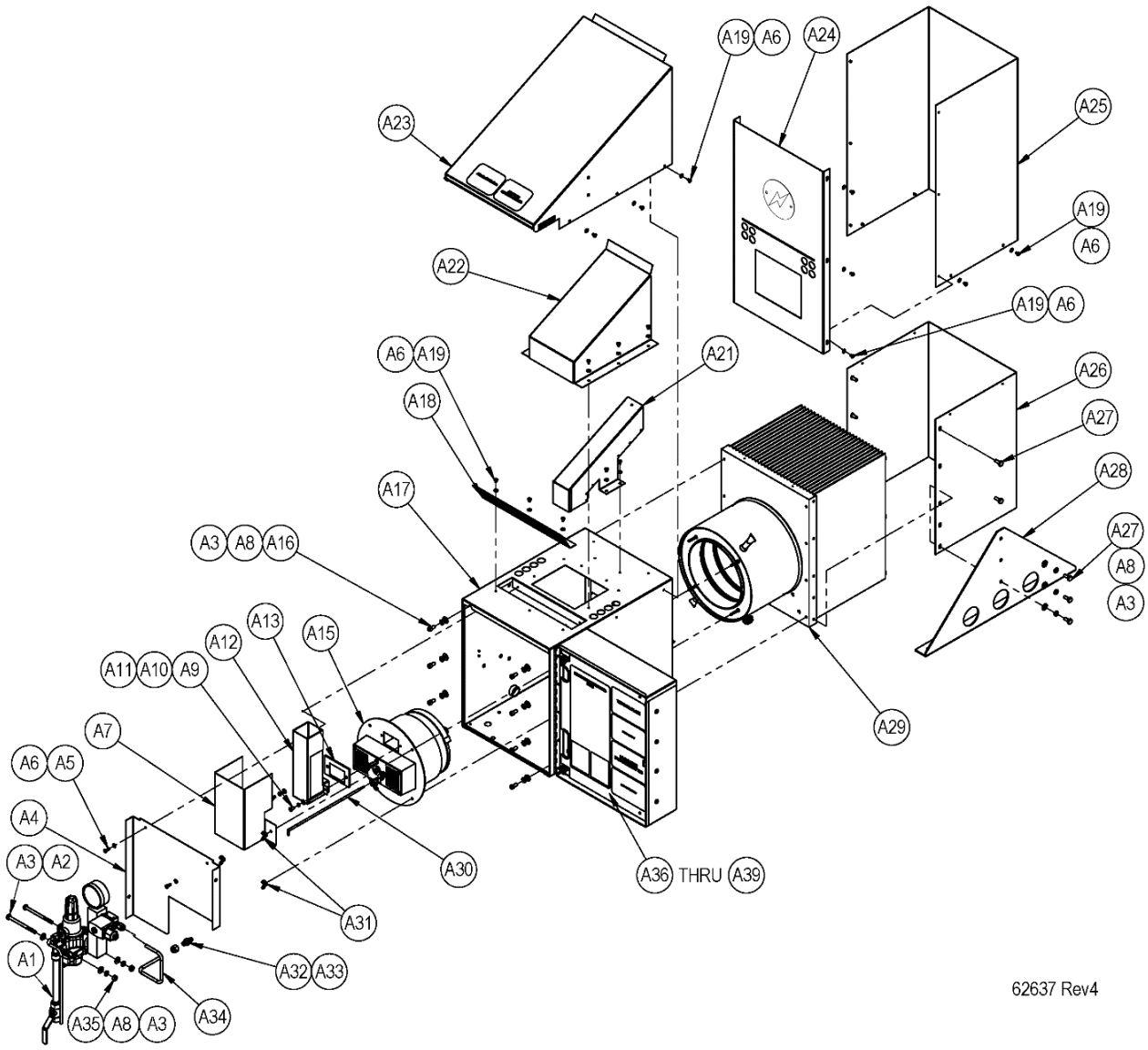

Figure 29 - Model P-5100 TEG

Item	Part No.	Description
A31	600	NUT, WING, 8-32, SS
A32/A33	689	ORIFICE, 7, 0.021 (*for Propane Model P-5100L*)
or	690	ORIFICE, 8, 0.029 (*for standard Natural gas Model P-5100N*)
or	6251	ORIFICE, 10, 0.024 (*for High BTU Natural gas Model P-5100H*)
A34	300393	FUEL LINE ASSY, P-5050/P-5100
A35	611	NUT, HEX, 1/4-20, SS
A36	65176	LIMITER CONVERTER ASSY, 12V, P-5050/P-5100
A37	65175	LIMITER CONVERTER ASSY, 24V, P-5050/P-5100
A38	63515	LIMITER CONVERTER ASSY, 12V, RS, P-5050/P-5100 (*OPTIONAL*)
A39	63516	LIMITER CONVERTER ASSY, 24V, RS, P-5050/P-5100 (*OPTIONAL*)
N/A	65209	CP INTERFACE ASSEMBLY P-5100 12 V (*NOT SHOWN*) (*OPTIONAL*)
N/A	65246	CP INTERFACE ASSEMBLY P-5100 24 V (*NOT SHOWN*) (*OPTIONAL*)
N/A	56980	SENSOR, TEMPERATURE, TRISTAR TS-RTS (*NOT SHOWN*) (*OPTIONAL*)
N/A	300076	THERMAL CUTOFF FIELD INSTALL (*NOT SHOWN*)

11.2 MODEL P-5100 BURNER

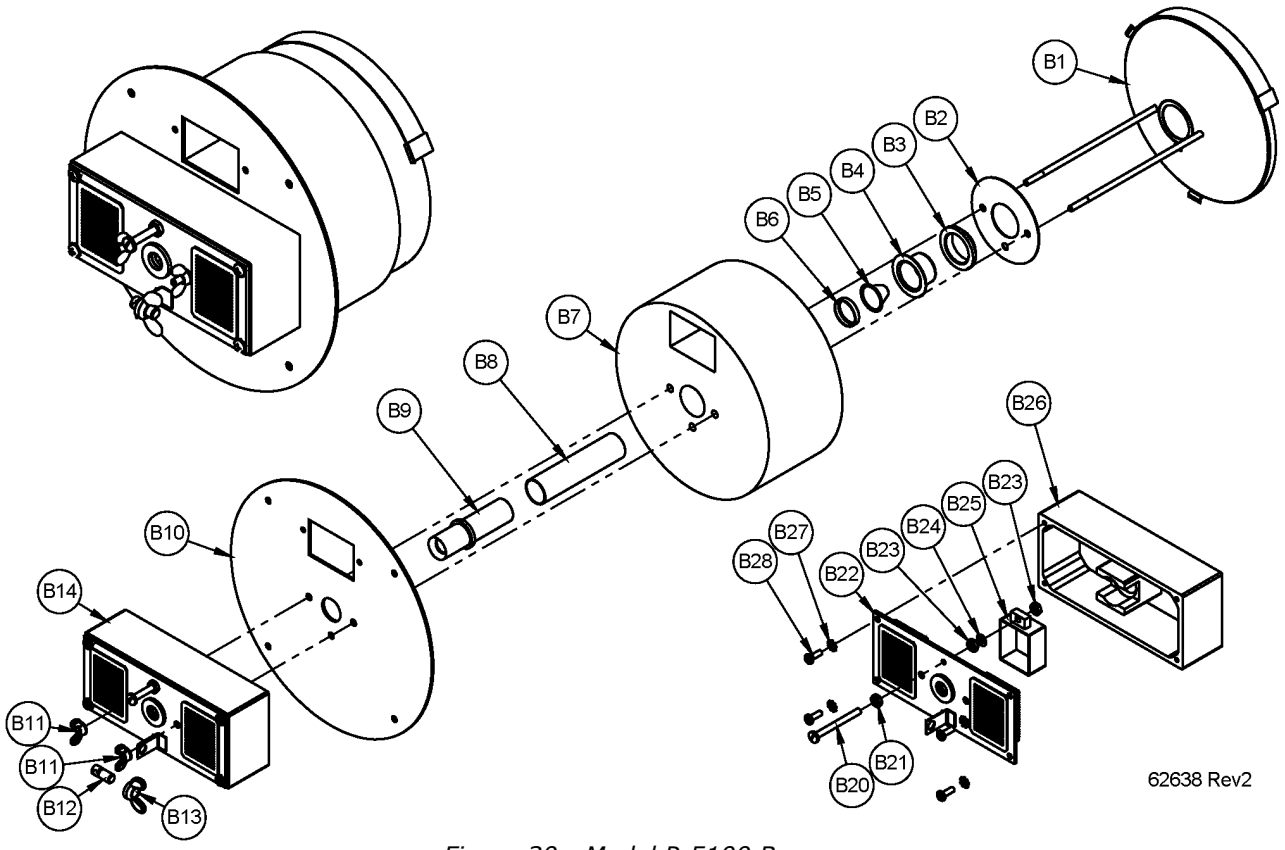

Figure 30 - Model P-5100 Burner

Item	Part No.	Description	
B1	62117	BURNER BACK ASSY, P-5050/P-5100	
B2	62115	INSULATION SUPPORT, P-5050/P-5100	
B3	701	SPACER, INSULATION, P-5050/P-5100	
B4	693	SCREEN HOLDER	
B5	873	SCREEN, BURNER, 5120/1120/P-5100	
B6	694	INSERT RING, BURNER	
B7	61869	INSULATION BLOCK, P-5050/P-5100	
B8	61871	SPACER, VENTURI, P-5050/P-5100	
B9	62056	VENTURI, P-5100	
B10	61870	BURNER COVER, P-5050/P-5100	
B11	601	NUT, WING, 10-32, SS	
B12	7004	PIN, MOUNTING, SI ELECTRODE	
B13	7005	NUT, WING, 5/16-18, SS	
B14	62118	AIR BOX ASSY, W/INTAKE ARRESTORS, P-5050/P-5100	
B20	63956	SCREW, MACH, P-H-S, 10-32 X 2”	Hardware in assembly (62118)
B21	609	NUT, HEX, 10-32, SS	
B22	61990	LID W/ ARRESTORS, ASSEMBLY, P-5050/P-5100	
B23	63957	NUT, LOCK, DISTORTED, HEX, 10-32, 316SS	
B24	27901	WASHER, BOWED, 5 MM, A2 SS	
B25	63954	AIR SHUTTER ASSY, P-5050/P-5100	
B26	61862	AIR BOX, MACHINED, P-5050/P-5100	
B27	472	WASHER, LOCK, EXT. #8, SS	
B28	7324	SCREW, MACH, P-H-P, 8-32 X 1/2, SS	

11.3 MODEL P-5100 FUEL SYSTEM

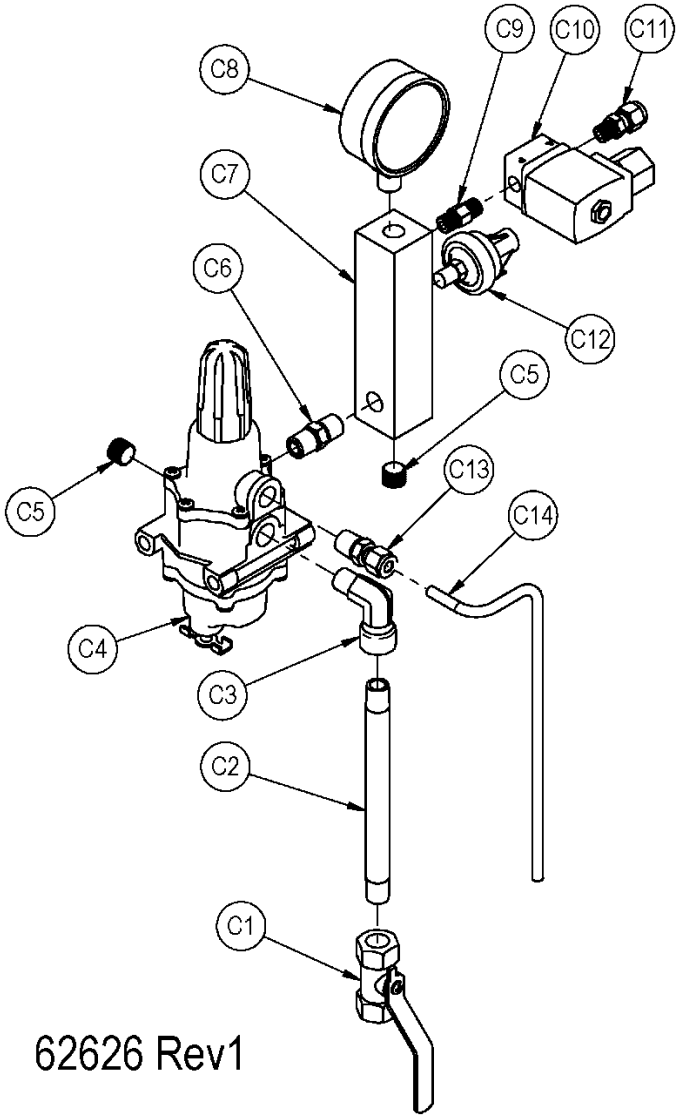

Figure 31 - Model P-5100 Fuel System

Item	Part No.	Description
C1	24653	VALVE, BALL, 1/4 NPT
C2	62069	NIPPLE, 1/4 NPT X 6” LG, BRASS
C3	21569	ELBOW, STREET, 1/4 NPT, BRASS
C4	63312	REGULATOR, FISHER 67CFR, 0-20 PSI
C5	58949	PLUG, 1/4” NPT X 7/8” STEEL
C6	304020	NIPPLE, HEX, 1/4 NPT X 1.5, BRASS
C7	61991	MANIFOLD BLOCK, FUEL SYSTEM, P-5050/P-5100
C8	691	GAUGE, PRESSURE, 0-15 PSI
C9	7996	NIPPLE, HEX, 1/8 NPT
C10	72239	VALVE, 12V BR SOLENOID PTEG REPLACEMENT
C11	20977	CONNECTOR, 1/4 TB X 1/8 MNPT
C12	6471	SWITCH, PRESSURE, 1.6 PSI, BRASS
C13	380	CONNECTOR, 1/4 TB X 1/4 MNPT, 316 SS
C14	61865	VENT TUBE ASSY, REGULATOR, SS P-5050/P-5100
N/A	22363	FILTER KIT, FISHER 67CFR (*NOT SHOWN*)

11.4 MODEL P-5100 OPTIONAL STAINLESS-STEEL FUEL SYSTEM

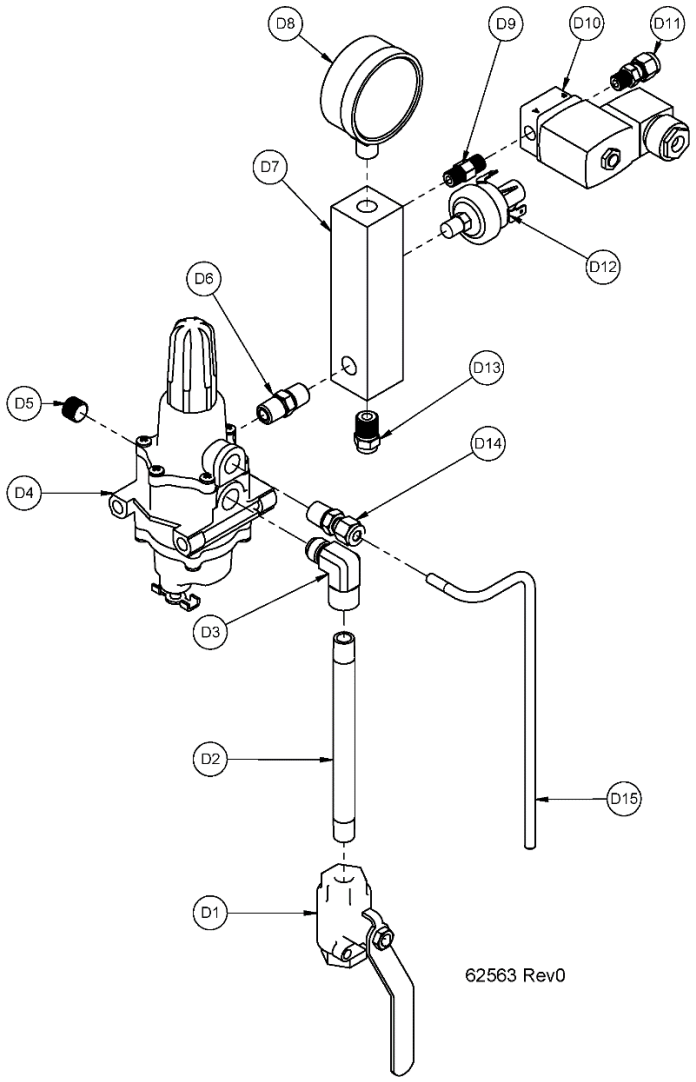

Figure 32 - Model P-5100 SS Fuel System

Item	Part No.	Description
D1	21689	VALVE, BALL, 1/4 NPT, 316 SS
D2	62559	NIPPLE, 1/4 NPT X 6” LG, SS
D3	2356	ELBOW, STREET, 1/4 NPT, SS
D4	22364	REGULATOR, FISHER 67CFR, 0-20 PSI, SOUR GAS
D5	58949	PLUG, 1/4" NPT X 7/8" STEEL
D6	2359	NIPPLE, HEX, 1/4 NPT X 1.5 LG, 316 SS
D7	61991	MANIFOLD BLOCK, FUEL SYSTEM, P-5050/P-5100
D8	691	GAUGE, PRESSURE, 0-15 PSI
D9	7996	NIPPLE, HEX, 1/8 NPT
D10	72238	VALVE, 12V SS SOLENOID PTEG REPLACEMENT
D11	20977	CONNECTOR, 1/4 TB X 1/8 MNPT
D12	61849	SWITCH, PRESSURE, 1.6 PSI, NORMALLY OPEN, PLATED STEEL
D13	20428	PLUG, 1/4 NPT, HEX, 316 SS
D14	380	CONCTR 1/4TBX1/4 MNPT 316 SS
D15	61865	VENT TUBE ASSY, REGULATOR, SS P-5050/P-5100
N/A	22363	FILTER KIT, FISHER 67 CFR (*NOT SHOWN*)

11.5 MODEL P-5100 ELECTRICAL

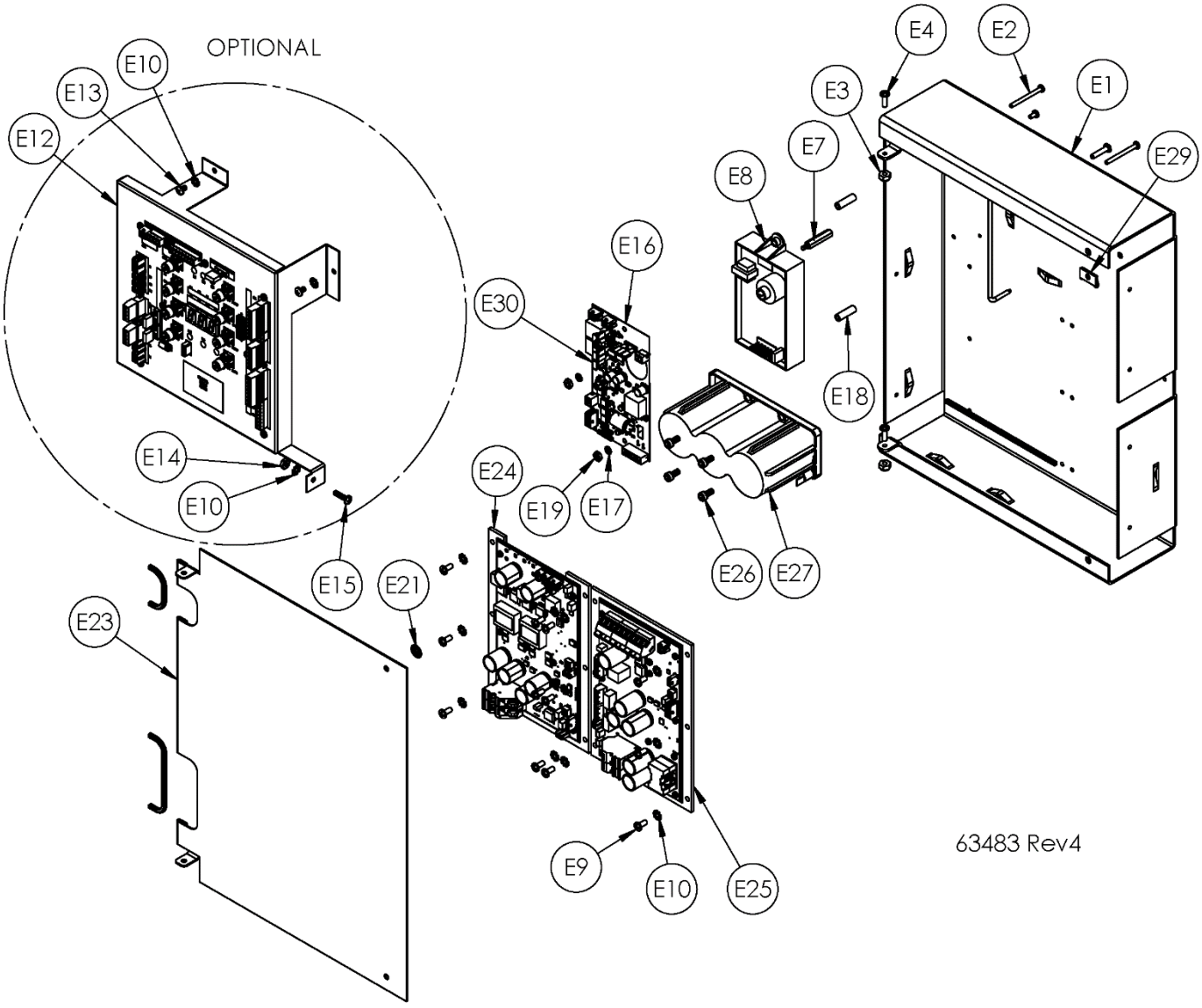

Figure 33 - Model P-5100 Electrical

Item	Part No.	Description
E1	63035	BACK PAN, ELECTRICAL ENCLOSURE, P-5050/P-5100
E2	56227	SCREW, MACH, P-H-P, 6-32 X 1.5” LG, SS
E3	56922	NUT, LOCK, HEX, 8-32, NYLON INSERT, SS
E4	7324	SCREW, MACH, P-H-P, 8-32 X 1/2”, SS
E7	63136	STANDOFF, 6-32 M/F, 1/4” HEX, ALUM, 1.12” LG
E8	63096	SI MODULE, CHANNEL PROD MICRO 50N-12
E9	254	SCREW, MACH, P-H-P, 8-32 X 3/8, SS
E10-15	64058	REMOTE START (TEG CONTROLLER) KIT, P-5050/P-5100
E10		WASHER, LOCK, #8 — Hardware supplied with board kit (64058)
E12		RS CONTROLLER
E13		SCREW, 8-32 X 1/4”
E14		NUT, HEX, 8-32
E15		SCREW, 8-32 X 5/8”
E16	64624	PCB ASSY, SI CONTROLLER W/VALVE SIGNAL

11.5 MODEL P-5100 ELECTRICAL (Cont'd)

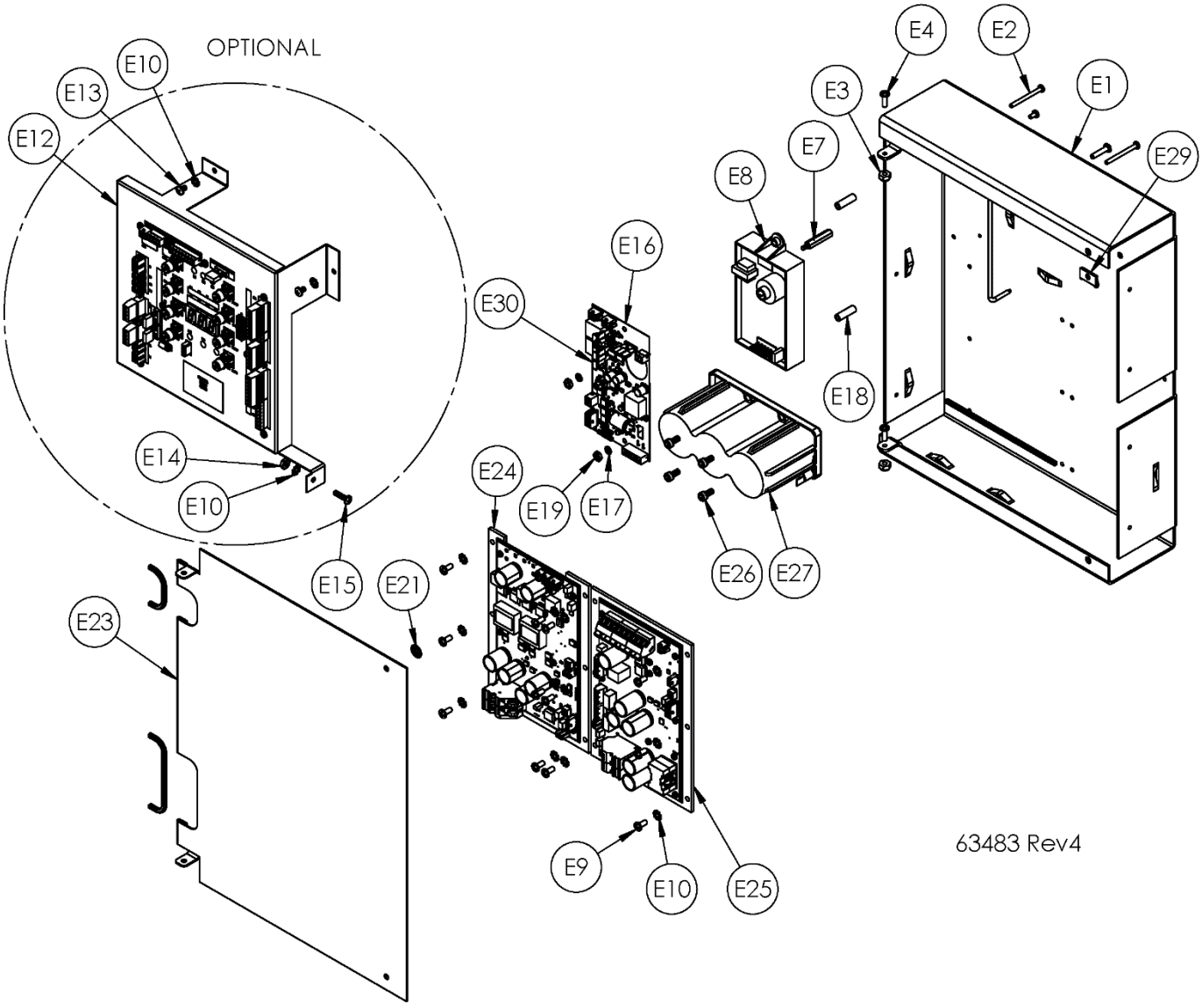

Figure 33 - Model P-5100 Electrical

Item	Part No.	Description
E17	25984	WASHER, LOCK, INTERNAL, #6, SS
E18	63137	SPACER, NYLON, 0.8125" LG, #6 HOLE
E19	604	NUT, HEX, 6-32, SS
E20	54087	SCREW, MACH, P-H-P, 6-32 X 1/4, SS
E21	63960	WASHER, RETAINING
E22	63959	SCREW, FAST LEAD, KNURLED, SS
E23	63039	DEAD FRONT, ELECTRICAL ASSY, P-5050/P-5100
E24	63126-1	PCBM, DC/DC, ENCAPSULATED, P-5050/P-5100
E25	64879-1	PCBM, LIMITER, ENCAPSULATED, P-5050/P-5100
E26	58437	SCREW, CAP, HEX SOCKET, 8-32 x 3/8", 18.8 SS
E27	24559	BATTERY, 6V, 5Ahr, MONOBLOC
E29	63961	NUT, CLIP-ON
E30	66222	FUSE, 3A, 32V VIOLET MINI ATM
N/A	65163	WIRING HARNESS, VSR, P-5050/P-5100 (*NOT SHOWN*) (*OPTIONAL*)

12 CATHODIC PROTECTION OPTION

12.1 INTRODUCTION

The Cathodic Protection Interface provides for adjustment and monitoring of power to a CP load. The anode and cathode cables enter the cabinet at the bottom and connect directly to the heavy-duty terminal block. Refer to Figure 34 for locations and description of the major components of the CP Interface Cabinet.

12.1.1 Meter

The dual Scale meter displays voltage at the terminal block, and current when the PUSH TO READ AMPS button is pressed. The meter is accurate to +/- 3% of full scale.

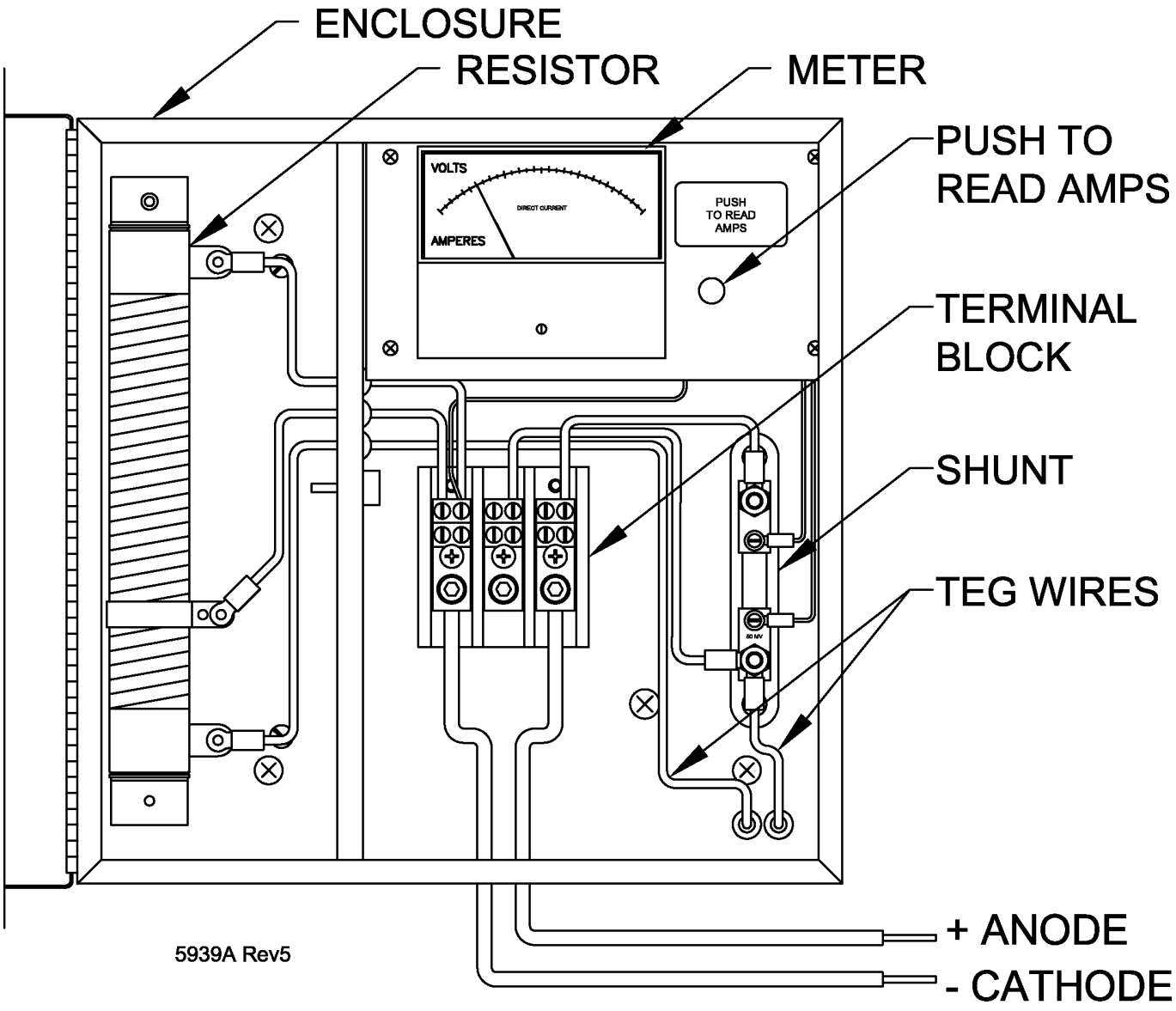

Figure 34 - Cathodic Protection Interface Cabinet

12.1.2 Current Shunt

A shunt 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.

12.1.3 Adjustments

The Adjustable Resistor can be easily adjusted to fine-tune the amount of power delivered to the CP Load. Refer to section 8.3 for details on adjusting your CP Interface.

12.2 CONFIGURATIONS

Complete parts listings are given in the following pages for the various Cathodic Protection Interface Systems available. The required systems for model P-5100 TEGs are listed below.

GPT TEG	Part No.	System Description
P-5100-12	65209	CP Interface Assembly, 12V, P-5100
P-5100-24	65246	CP Interface Assembly, 24V, P-5100

12.3 OPTIONAL CP SYSTEM PARTS LIST

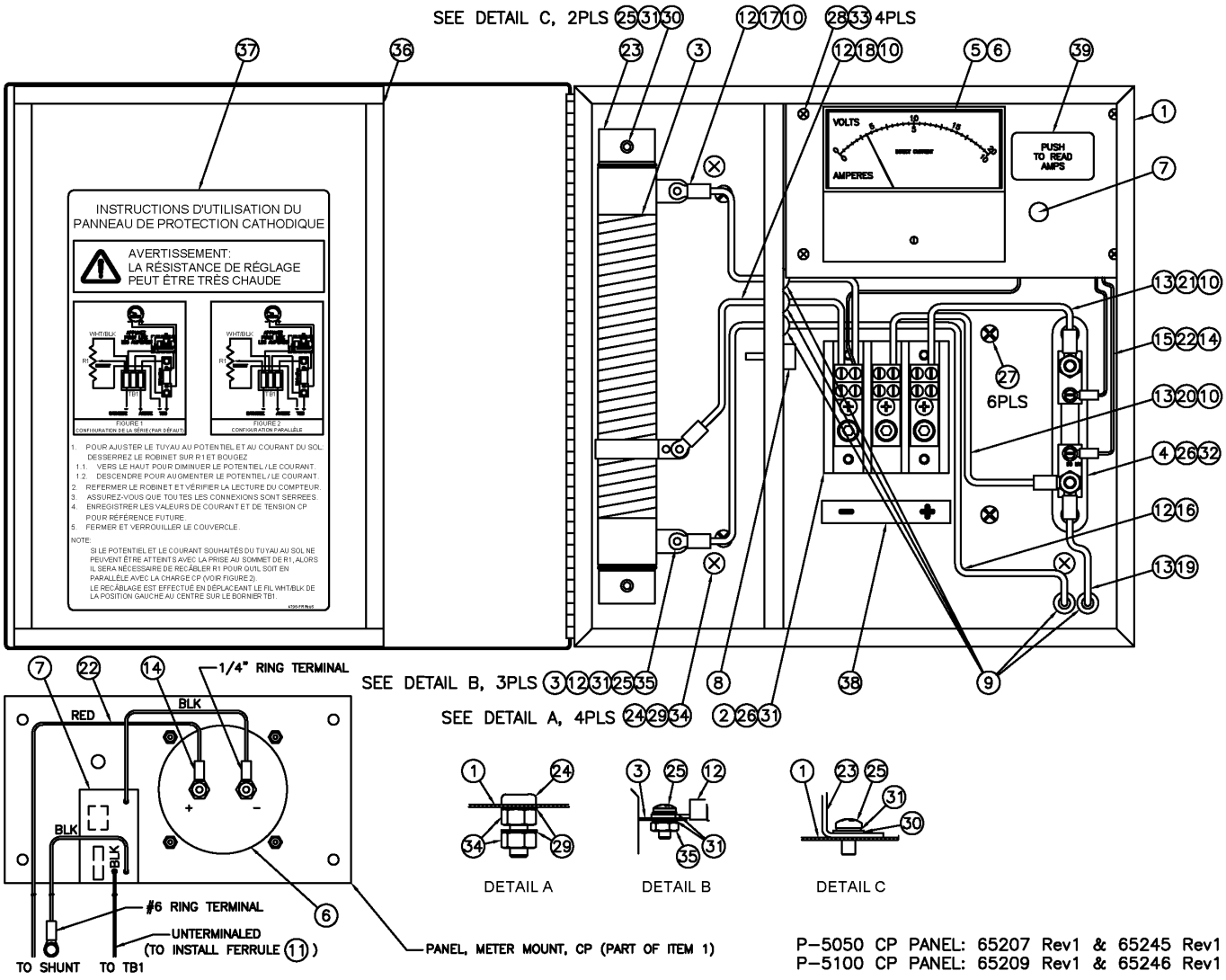

Figure 35 - Cathodic Protection System Parts Identification

Item	Part No.	Description	QTY
1	1839	CP BOX ASSY	1
2	6714	TERMINAL BLOCK, HEAVY DUTY, 3POLE	1
3	65212	RESISTOR, 2.5 Ω, 300 WATT, ADJUSTABLE (*FOR 65209*)	1
	65247	RESISTOR, 12 Ω, 300 WATT, ADJUSTABLE (*FOR 65246*)	
4	6527	CURRENT SHUNT, 10A, 50MV (*FOR 65209*)	1
	23843	CURRENT SHUNT, 5A, 50MV (*FOR 65246*)	
5	6219	METER FACE, 0-20V, 0-10A (*FOR 65209*)	1
	6220	METER FACE, 0-30V 0-5A (*FOR 65246*)	
6	6226	METER, 0-50 MV, 3.5"	1
7	2284	CP METER ADJUST ASSY	1
8	3192	PLUG, BUMPER	1
9	1947	GROMMET, RUBBER, 1/4” X 1/8”	5
10	23033	FERRULE, WIRE, 10 AWG, 12MM BLK	4
11	23034	FERRULE, WIRE, 20 AWG, 6MM OR	1
12	63920	TERM RING, 10-12 AWG, #10 STUD HI TEMP, YEL	3
13	203	TERM RING, 10-12 AWG, 1/4" STUD	3
14	202	TERM RING, 18-22 AWG, 1/4" STUD	1
15	21810	TERM RING, 18-22 AWG, #6 STUD	1
16	156	WIRE, 10 AWG WHT/BLK, TEFLON, AG PLT	51”
17	156	WIRE, 10 AWG WHT/BLK, TEFLON, AG PLT	8.5”
18	53041	WIRE, 10 AWG BRN, TEFLON	11”
19	157	WIRE, 10 AWG WHT/RED, TEFLON, AG PLT	36”
20	157	WIRE, 10 AWG WHT/RED, TEFLON, AG PLT	8”
21	157	WIRE, 10 AWG WHT/RED, TEFLON, AG PLT	5”
22	133	WIRE, 20 AWG RED, TEFLON	13”
23	86	MOUNTING HARDWARE, 300 W RESISTOR	1
24	26319	SCREW, MACH, P-H-P, 1/4-20 X 3/4, SS	4
25	255	SCREW, MACH, P-H-P, 10-32 X 3/8, SS	5
26	256	SCREW, MACH, P-H-P, 10-32 X 1/2, SS	6
27	25071	SCREW, MACH, P-H-P, 10-32 X 1/4, SS	6
28	254	SCREW, MACK, P-H-P, 8-32 X 3/8, SS	4
29	473	WASHER, LOCK, EXT, 1/4, SS	8
30	569	WASHER, FLAT, #10, SS	2
31	469	WASHER, LOCK, INT. #10, SS	12
32	539	WASHER, LOCK, SPRING, #10, CAD	2
33	468	WASHER, LOCK, INT, #8, SS	4
34	611	NUT, HEX, 1/4-20, SS	8
35	609	NUT, HEX, 10-32, SS	3
36	1852	WEATHER STRIPPING, 3/8” X 1/8” THK	39”
37	4795	LABEL, INSTRUCTION, CP INTERFACE	1
38	26162	LABEL, LAMACOID, CP PANEL	1
39	1931	LABEL, PUSH TO READ AMPS	1

13 HEAT RECOVERY SYSTEM (HRS) OPTION

13.1 INTRODUCTION

A Heat Recovery System (HRS) Option is available for P-5100. This option allows for waste heat recovery to warm building interiors where required.

The HRS Option must be paired with an HRS Configuration of P-5100 TEG. The HRS configured TEG has an HRS specific rain cap, exhaust tube assembly, and burner. Some of these can be observed in Figure 36 below. The fin ducts and legs are replaced with mounting bars for slotting into the HRS Assembly.

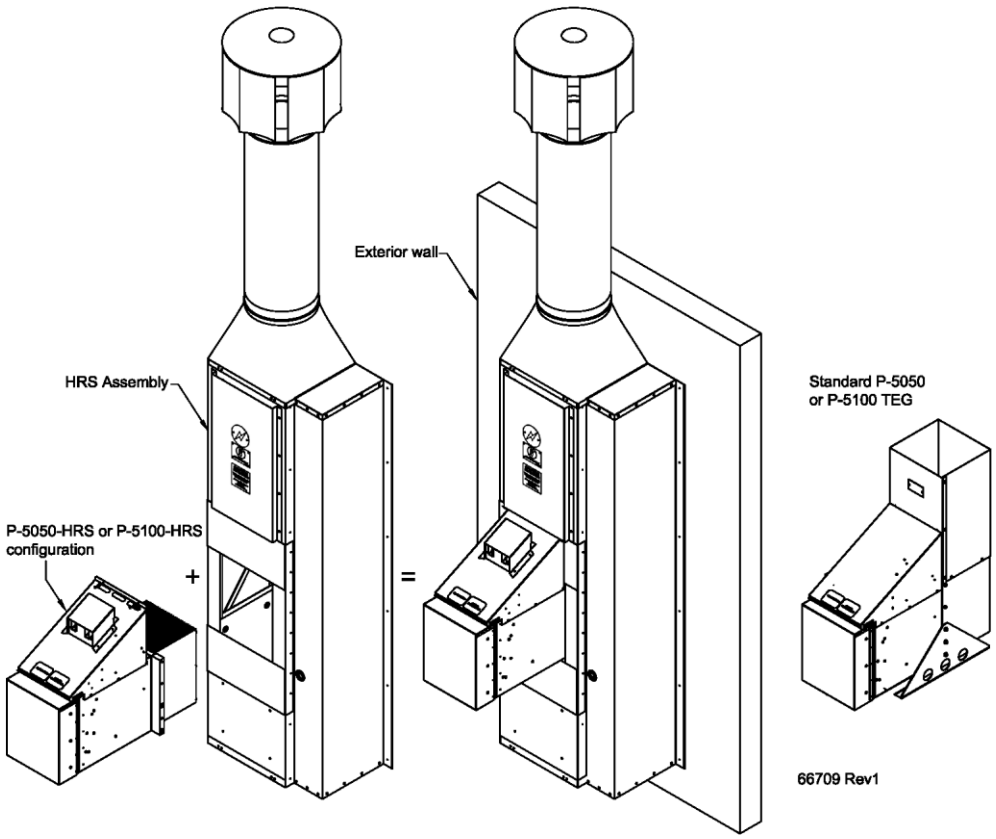

Figure 36 - HRS Option Overview

13.2 INSTALLATION

Each HRS System is shipped with a detailed installation manual (part number 66683). Refer to this manual for installing an HRS Assembly to the building exterior, and for installing an HRS model P-5100 into the HRS Assembly.

WARNING! Do not block air flow to duct openings. Doing so may cause over-temperature as well as damage to TEG.

13.3 TEG OPERATION

Operation of the HRS model TEG is identical to that of a standard TEG. Refer to the other sections in this manual for TEG operations.

13.4 MODEL P-5100 HRS CONFIGURATION PARTS

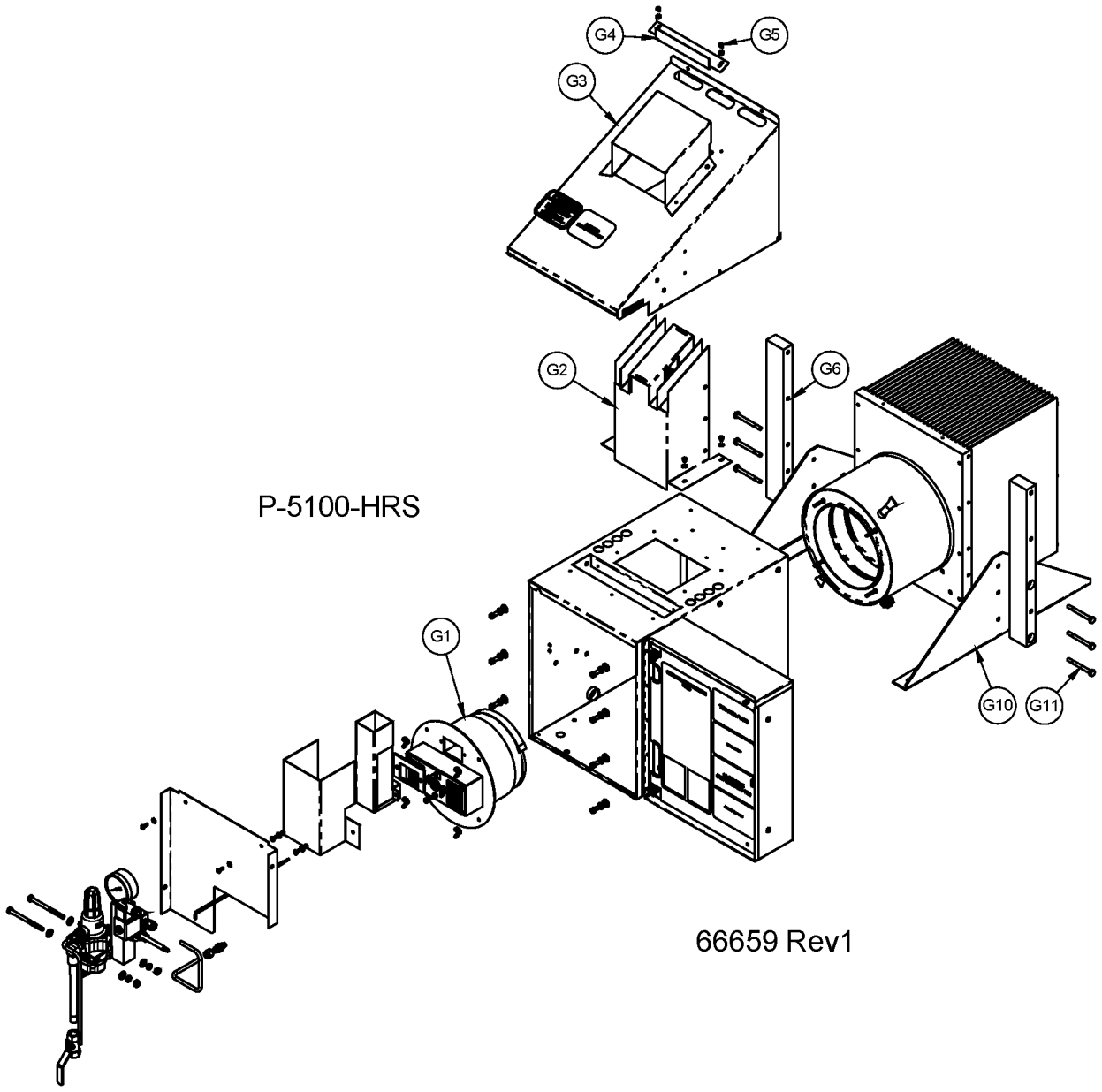

Figure 37 – P-5100 HRS Configuration

Item	Part No.	Description
G1	66634	BURNER ASSEMBLY, W/INTAKE ARRESTOR, HRS, P-5100
G2	65698	EXHAUST TUBE ASSY, HRS, P-5050/P-5100
G3	65697	RAIN CAP ASSEMBLY, HRS, P-5050/5100
G4	65709	RAIN DEFLECTOR, HRS, P-5050/P-5100
G5	7410	SCREW, MACH, P-H-P, 8-32X1/4, SS
G6	65733	MOUNTING BAR, HRS, P-5050/P-5100
G7	65724	SCREW, HEX HD, 1/4-20 X 2, SS (*NOT SHOWN, FOR INSTALLATION*)
G8	557	WASHER, FLAT, 1/4, SS (*NOT SHOWN, FOR INSTALLATION*)
G9	541	WASHER, LOCK, SPRING, 1/4, SS (*NOT SHOWN, FOR INSTALLATION*)
G10	64040	LEG, SHIPPING, P-5050/P-5100 POWER UNIT (*FOR SHIPPING*)
G11	65725	SCREW, HEX HD, 1/4-20 X 2-1/2, SS (*FOR SHIPPING*)

See Figure 29 for all other items.

13.5 MODEL P-5100 HRS BURNER PARTS

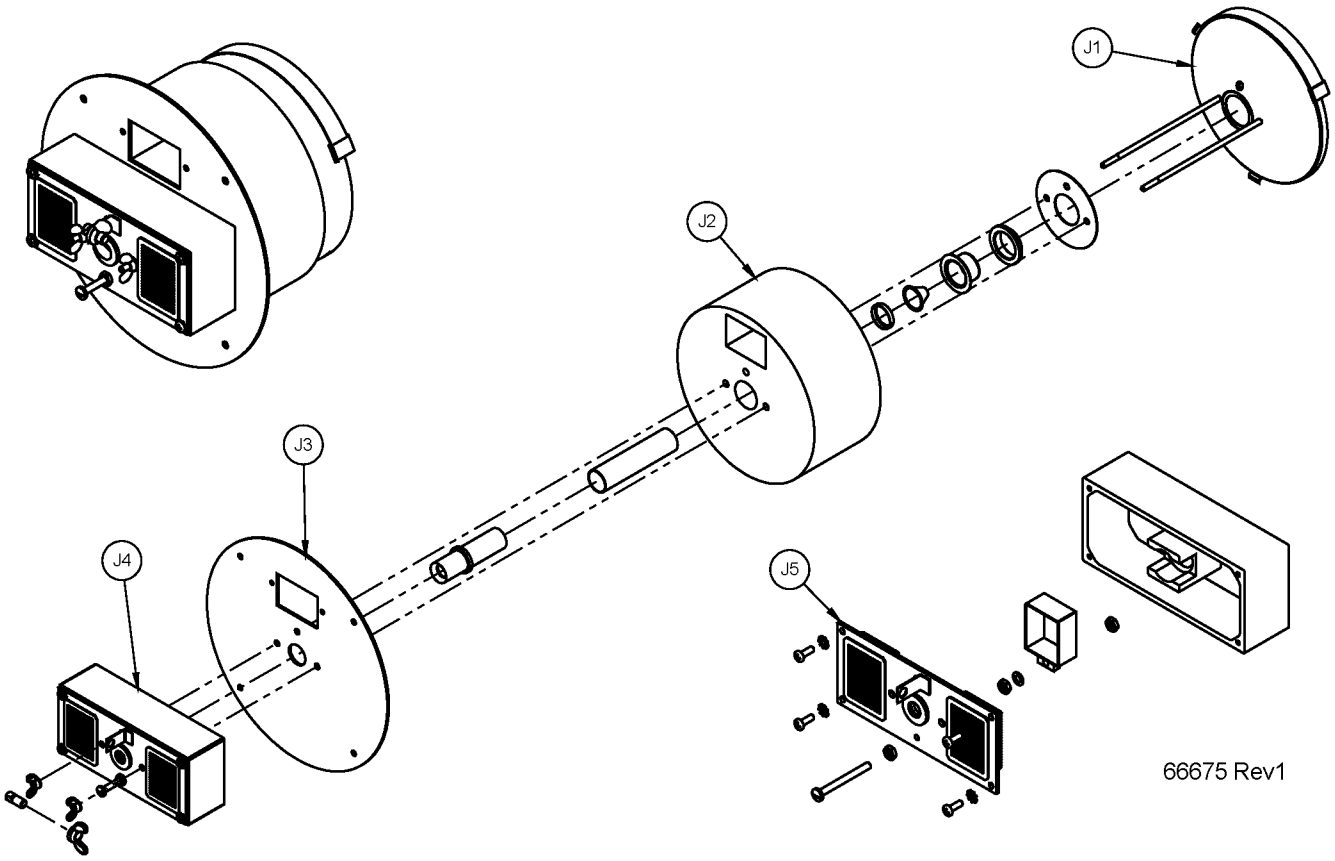

Figure 38 - Model P-5100 HRS, Burner

Item	Part No.	Description
J1	66633	BURNER BACK ASSY, TOP ELECTRODE, P-5050/P-5100
J2	66630	INSULATION BLOCK, TOP ELECTRODE, P-5050/P-5100
J3	66631	BURNER COVER, TOP ELECTRODE, P-5050/P-5100
J4	66635	AIR BOX ASSY, TOP ELECTRODE, P-5050/P-5100
J5	66632	LID W/ ARRESTORS, ASSEMBLY, TOP ELECTRODE, P-5050/P-5100

See Figure 30 for all other items.

14 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	MAINTENANCE NOTES

14 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	MAINTENANCE NOTES