GLOBAL
power technologies

5060
THERMOELECTRIC GENERATOR

Operating Manual

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01571 REV 6

5060 Quick Start Procedure

5060-SI-SO

- Turn on gas supply to TEG. Hold down the button on Shut Off (SO) valve. The spark ignition system (SI) should begin clicking and the sound of combustion heard within 15 seconds. Continue holding the button for 90 seconds then release it. The SO valve should remain open and the TEG should continue to operate.

- Adjust the fuel pressure to 10-15% less than noted on Data Nameplate.

- Install the jumper clip between terminals 3 & 4 of TB-1

- After one hour measure the voltage, V_{set}, between terminals 2(+) and 4(-) of TB-1. The V_{set} should be approximately 13.8 volts.

- Return the jumper clip to between terminals 1 and 2 of TB-1

- Apply Customer load

Fuel Pressure

- Propane start up: 40-48 kPa 6-7 psi
- Natural Gas start up: 35-40 kPa 5-6 psi

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1 Introduction

This manual provides installation, operation and maintenance instructions for the Global Power Technologies Model 5060 Thermoelectric generators.

1.1 General Description and Specifications

The Model 5060 Thermoelectric Generator contains no moving parts. It is a reliable, low maintenance source of DC electrical power for any application where regular utilities are unavailable or unreliable.

Power Specifications	
Power Ratings 20ºC, 750 m above sea level	60 Watts @ 6.7 Volts 54 Watts @ 12 Volts 54 Watts @ 24 Volts 54 Watts @ 48 Volts
Electrical	
Adjustment	6.7 V Up to 11 Volts 12 V 12-18 Volts 24 V 24-30 Volts 48 V 48-60 Volts
Reverse Current Protection	Yes
Output	Terminal block which accepts up to 8 AWG wire. Opening for 3/4 in. conduit in the base of the cabinet
Fuel	
Natural Gas	4.4m^3/day (155 ft^3/day) of Std. 1000 BTU/SCF (37.7MJ/Sm^3) gas
Propane	5.7 l/day (1.5 US gal/day)
Maximum Supply Pressure	172 kPa (25 psi)
Minimum Supply Pressure	69 kPa (10 psi)
Fuel Connection	1/4 in. MNPT connection
Environmental	
Ambient Operating Temperature	Max. 45ºC (115ºF) Min. -40ºC (-40ºF)
Operating Conditions	Unsheltered Operation
Materials of Construction	
Cabinet	304 SS
Cooling Type	Natural Convection
Burner	Meeker type/Inconel 600
Fuel System	Brass, Aluminum & SS

1.1.1 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.

1.1.2 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 and/or property. Warnings will be printed in bold text in italics with the title WARNING in capital letters.

1.1.3 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. Cautions will be printed in bold text in italics with the title Caution.

1.1.4 Notes

Throughout this manual you will notice paragraphs preceded by the text Note. These paragraphs provide additional information or reference other sections of the manual, which may be useful. Notes will be printed in italics.

1.2 Standard Features and Options

1.2.1 Standard Features

The TEG comes standard with a fuel pressure regulator capable of accepting up to 172 kPa (25 psi) and a built in fuel filter, an Automatic Spark Ignition System (SI), and low voltage alarm contacts (Voltage Sensing Relay or VSR)

1.2.2 Options

Available options for the 5060 Thermoelectric Generator are as follows:

Automatic Shut-Off Option (SO): The Automatic Gas Shut-Off option (SO) is designed to turn off the gas supply to the burner if the flame in the TEG is extinguished and cannot be subsequently re-ignited by the automatic SI system within approximately three to five minutes.

Corrosive Environment Fuel System Option (SS): The Corrosive Environment Fuel System is specially constructed with increased corrosion resistant components. All of the standard brass fittings and gauge internals are replaced with stainless steel equivalents where possible and the fuel regulator is upgraded to comply with NACE standard MR-01-75 (Sulphide Stress Cracking Resistant Material For Oilfield Equipment). External components that can not be replaced are coated with Glyptal to reduce their risk of corrosion.

Flame Arrestor Option: Most of Global Power Technologies' (GPT) standard TEG's fall under the definition of "flame type equipment" as defined in the regulations of The Oil And Gas Conservation Act Alberta (Section 8.090). GPT has developed a flame arrestor system for use as an option on the Model 5060 TEG to meet the EUB requirements. It has been designed to allow its installation on both new or existing TEGs.

Please note that although GPT's engineers have designed the flame arrestor following CSA standards and have tried to satisfy regulatory requirements with the design, the flame arrestor is not CSA approved. It is the responsibility of the end user to determine the suitability of GPT's flame arrestor system to meet the requirements of their specific installations including, but not limited to: a) the suitability of EUB's definition of equipment location and b) the suitability of GPT's air intake flame arrestor design as an "adequate flame arrestor".

Cathodic Protection Interface System (CP): The Cathodic Protection Interface System 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 Ohm resistor, 300 watt variable resistor is provided for adjusting the output power applied to the CP system.

TEG Mounting Stands (Pole and Bench Type): The Pole Stand consists of a 76" long piece of 3" diameter pipe with an "H" shaped bracket welded to one end which the TEG can be firmly attached to using 1/4" fasteners (not included). The Bench Stand consists of 3" by 3" and 2" by 2" aluminum angle sections that are assembled together to provide a sturdy structure to support the TEG.

1.3 Definition of Terms

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

Power Unit: The hermetically sealed portion of the generator that contains the thermoelectric materials and the cooling fins.

TEG: A Thermoelectric Generator.

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

Generator System: The system consisting of the generator, including its factory options, the limiter-converter, including its factory options, and the special customer options.

Set-up Voltage, V_{set}: The set-up voltage of the generator. In the 5060 generator V_{set} equals open circuit voltage.

Rated Power: The amount of power a generator can be operated at when the ambient temperature of the site is expected to peak at 65ºC. As the ambient temperature increases the rated-power decreases.

Rated V_{set}: The amount of V_{set} a generator can be operated at when the ambient temperature of the site is expected to peak at 65ºC. As the ambient temperature increases the rated V_{set} decreases.

Open Circuit Voltage, V_{OC}: The voltage at the terminals of a power source when no appreciable current is flowing.

Matched Load is a condition where the power output of the generator is maximized. This occurs when the load resistance is equal to the internal resistance of the generator, and the load voltage is one half of the open circuit voltage on the generator.

Precision Load is the resistor used to create a matched load condition on the generator for analyzing electrical performance.

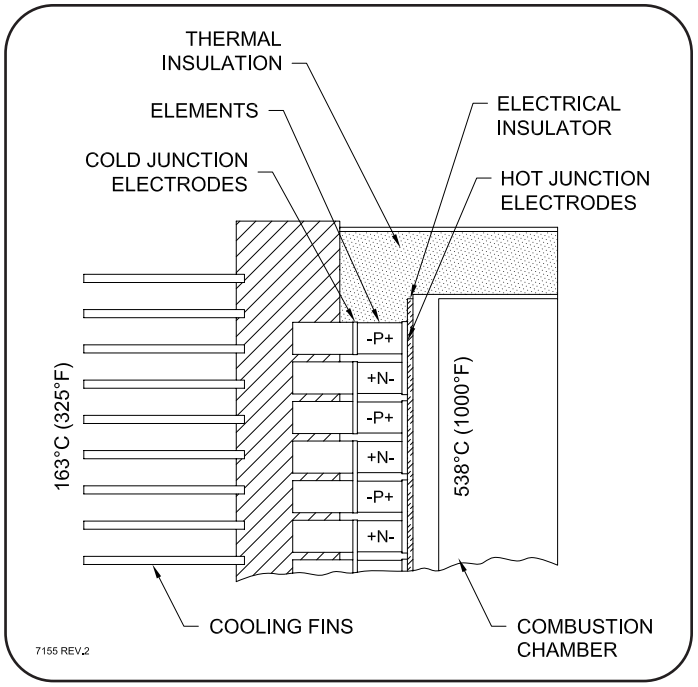

Figure 1 TEG Design

1.4 Theory of Operation

A thermoelectric generator (TEG) produces electrical power through the direct conversion of heat energy into electrical energy.

This is done by joining two dissimilar, thermoelectric materials at one end and then heating the junction end to a higher temperature than the other end. This creates a voltage across the cooler end. Since this voltage is relatively small, the junctions are joined in series to achieve a useful electrical output. If the temperature difference is maintained, electrical power can be delivered to a load placed in this circuit.

Figure 1 illustrates how this is done in the model 5060 TEG. A thermocouple is formed by P type and N type thermoelectric elements joined together at one end by a hot electrode. Adjacent thermocouples are joined at the other end by cold electrodes. Eighty thermocouples, each producing 84 mV are connected in series to total 6.7 Volts. This is the matched load voltage. At 9 Amps the generator then produces 60 Watts.

The TEG voltage varies according to the temperature difference at the thermocouple junction. The hot side of the thermocouples is maintained at a temperature around 538ºC (1000ºF) by a burner which operates on propane, or natural gas. The cold side of the thermocouples is maintained at a lower temperature, around 163ºC (325ºF), by the cooling fins which transfer the heat to the surrounding air. This temperature difference is controlled by adjusting the amount of fuel supplied to the burner.

In summary, the TEG produces electrical power when a temperature difference is maintained between the hot and cold junctions of the thermocouples. This temperature difference, and therefore the amount of power produced, depends on the rate at which fuel is supplied to the burner and the ambient temperature.

The electrical output of the 5060 TEG changes as the ambient temperatures changes; the power increases as the temperature decreases.
The term rated-power is used when the maximum ambient temperature is 65ºC.

- The 5060 TEG's power unit produces 60 Watts gross at 20ºC, at the beginning of its service life.

- Power decreases 0.18W per ºC rise in temperature (0.1W per ºF) see Figure 7.

- Maximum allowable ambient temperature for operation is 45ºC (115ºF).

2 Operation

2.1 Physical Description

5060 Dimension Chart	
Length	629 mm (24.8 in.)
Width	372 mm (14.64 in.)
Height	987 mm (38.9 in.)
Weight	41 kg (90 lb)
Shipping Weight	75 kg (165 lb)
Mounting Holes	267 mm X 457 mm (10.50 wide X 18.00 deep)

2.2 Unpacking, Assembly and Mounting

Tools Required:

- 1 DC Voltmeter accurate to 0.1V.
- 2 Small adjustable wrenches that will open to 16mm (5/8 inch).
- 1 Flat head screwdriver.
- 4 #1/4-20 bolts & nuts for mounting.
- 1 Phillips Screwdriver.

Unpack the 5060 TEG from its shipping crate. Keep the crate until the TEG is operational. Check the TEG for damage which may have occurred during shipping. Any damage must be reported as soon as possible. The damage may make the generator inoperable therefore, **Check with Global Power Technologies Customer Service before starting a damaged TEG.**

Locate and identify the following items that were shipped with the 5060 TEG.

- 1 1 Fin Duct.
- 1 Intake Stack with Clamp.
- 1 Exhaust Stack with Clamp.
- 1 Thread Sealing Compound.
- 7 #8 - 32 x ¼ inch long Screws (1 spare).
- 7 #8 Washers, external lock.

Assemble the TEG as follows (see Figure 2):

1) Attach the fin duct using the #8 screws and washers supplied.
2) Insert the intake and exhaust stacks into the top of the cabinet.
3) Slide the clamps over the bottoms of each stack and tighten the clamp screws.

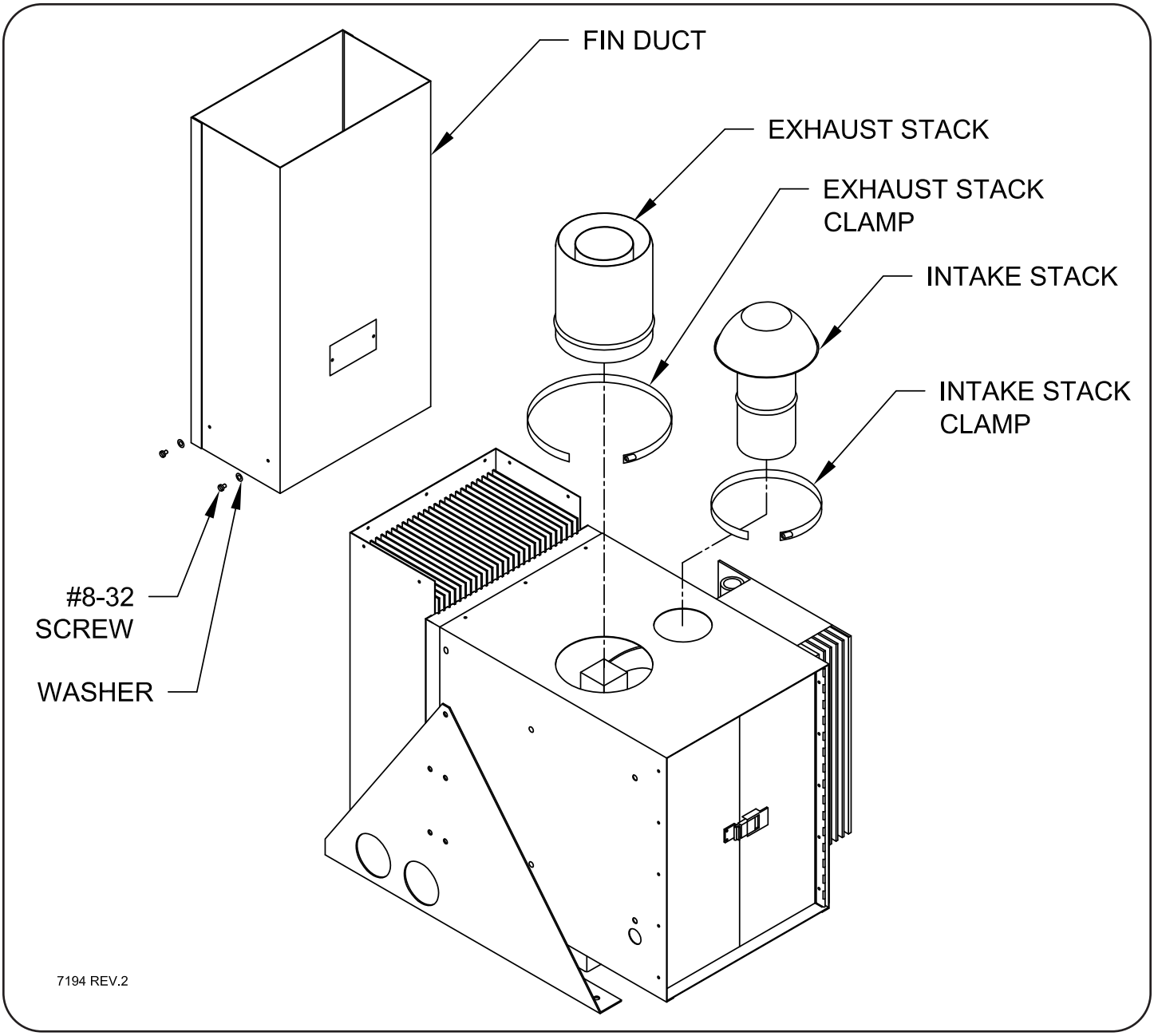

Figure 2 Assembling 5060 TEG

Mount the TEG to a firm and stable base, using 1/4-20 bolts, See Appendix Figure 40, page 7-2, for mounting hole locations. The base must be level and sturdy enough to support the 41 kg (90 lb) TEG. The TEG should be mounted high enough to avoid direct flooding or heavy snowfall interfering with the flow of cooling air. Allow a minimum of 150 mm (6 in.) clearance under the cooling fins.

WARNING: Operation of the TEG in locations where cooling air flow may be obstructed will cause overheating of the TEG.

2.3 Data Plate

The data plate is located on the inside of the TEG cabinet door and indicates the following:

Fuel Type: An X is stamped in the appropriate box for Natural gas or Propane. Each fuel type requires a different orifice, therefore the TEG must be used with the fuel indicated.

Model Number: The model number is interpreted as follows:
Serial Number: Unique to each TEG.

5060 - ( ) - ( ) - ( )

Fuel Type: L = Propane
N = Natural Gas

Output Voltage: 12 or 24 Volts

Fuel System:
SI = Spark Ignition Only
SI - SO = Spark Ignition & Auto Shut Off

Power, Fuel Pressure, Voltage: These were measured during the factory performance test and are for reference only. The operating power, fuel pressure and voltage are determined and adjusted as per Section 2.6.

2.4 Fuel Supply

Fuel Considerations

Clean Fuel: The fuel used to operate the 5060 TEG must be clean (see gas specifications in Appendix, page 4-3). If dirty fuel is anticipated then a customer supplied, in-line fuel filter is recommended.

Low Temperature: When using propane (C_3H_8) at temperatures below -30ºC (-22ºF) special consideration must be given to the low vapour pressure of the fuel.

Pressure: Make sure that fuel pressure is at least 69 kPa (10 psig) and will not exceed 172 kPa (25 psig). 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.
Check the TEG data plate for the fuel type. DO NOT use a different type of fuel than indicated.

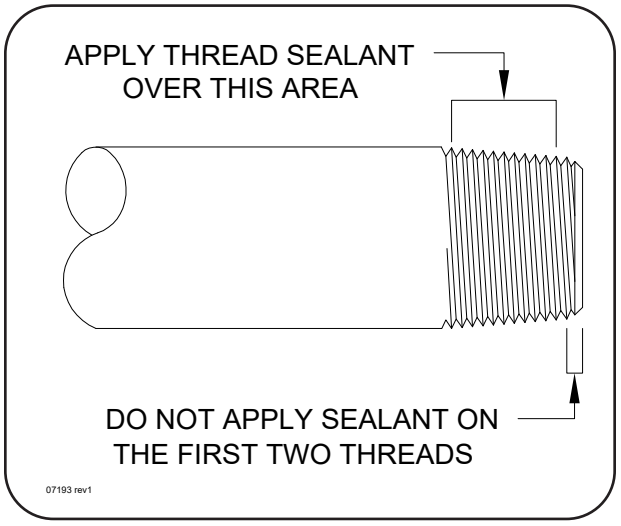

Figure 3 Applying Thread Sealant

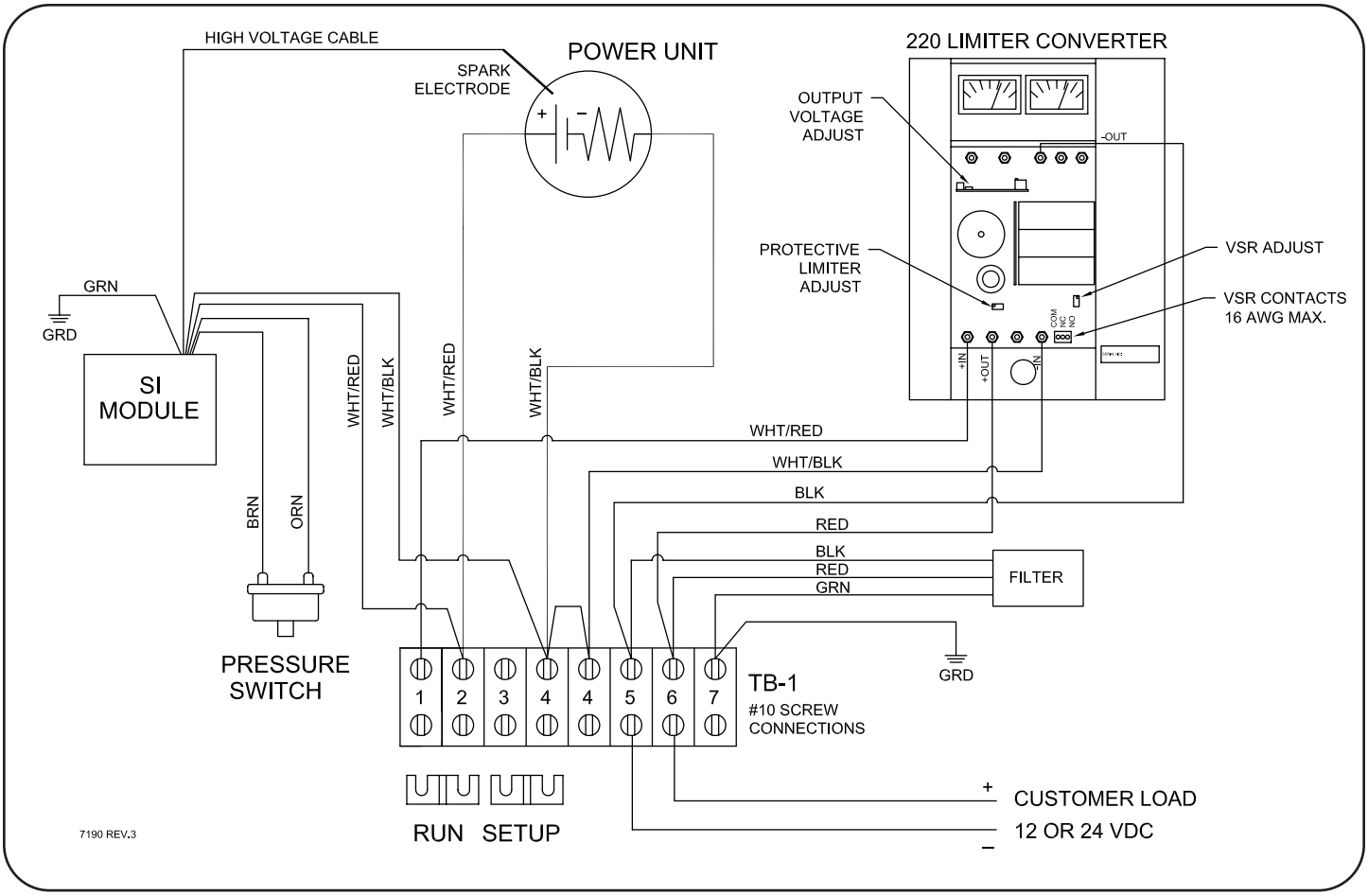

Figure 4 Wiring Diagram 5060 TEG

A fuel shut-off valve MUST be installed between the TEG and the fuel supply. All fuel piping must be in accordance with local regulations.

1) Inspect the fuel lines and fittings to be sure they are free of foreign material.
2) Purge fuel lines of all air.

The TEG has a 1/4 in. NPT, male fuel inlet. Remove the plastic protective cap and apply thread sealant, see Figure 3. Connect the fuel line and test all joints for leaks using a commercial leak detector.

2.5 Start Up

System Performance Logs are located at the back of this manual, Appendix 4.4. Use of these logs is recommended each time the site is visited. This information is valuable for future reference.

1) Move the jumper on TB-1 from between terminals 1 and 2 to between terminals 3 and 4, see Figure 4.
2) Connect a DC Voltmeter to terminals 2(+) and 4(-) of TB-1. This will be measuring V_{set}.
3) Make sure that all of the connections in the fuel system are tight and have been checked for leaks.

Check the ignition system, see Figure 5.

1) Loosen the ignitor rod wing-nut.
2) Push the ignitor rod in as far as it will go, (it should extend about 25mm (1 in.) past the holding screw), then pull it back 3 mm (1/8 in.).
3) Tighten the wing-nut, DO NOT over tighten as the ignitor rod will crack.

2.5.1 SI-SO Start

1) Turn on the fuel supply.
2) Push in the button on top of shut-off valve. The spark ignitor should begin clicking and the sound of combustion will begin. In some cases it may be necessary to bleed air from the fuel line before combustion will begin.
3) Continue to hold the button down for at least 90 seconds after combustion begins, then release the button.
4) If the sound of combustion stops, push the button again until combustion is sustained.

Note: It is necessary to fully depress the button before releasing it.

2.5.2 Manual Start

If the TEG's SI system is malfunctioning, one can manually start the generator. It should be noted that the malfunctioning SI be repaired as soon as possible as the TEG will not be able to reignite itself in the event that the TEG's burner goes out because of fuel interruptions.

1) Remove the SI electrode from the burner
2) If the TEG has a SI-SO fuel system push in the button on top of shut-off valve.
3) Place a lighted match or similar flame source to the electrode port. Ignition should occur quickly and the sound of combustion will begin. For SI-SO fuel system continue to hold the button on the shut-off valve for 90 seconds.
4) Repair and replace SI system as soon as possible.

2.6 Evaluation

2.6.1 Set-Up Power and V_{set}

The power in the 5060 TEG is produced by the difference in temperature between the burner and the cooling fins. This means that the power output of the 5060 TEG will be affected by the ambient temperature at the generator site.

The rated power is the power that the 5060 TEG should produce at a specific ambient temperature, up to a maximum temperature of 45ºC (115ºF). The 5060 TEG is rated at 60 Watts gross power (power from the power unit) when operating at an ambient temperature of 24ºC (75ºF). As the ambient temperature rises the gross power will decrease and as the ambient temperature decreases the gross power will increase. For every rise in temperature of 1ºC the 5060 TEG will drop 0.18 Watts in gross power output.

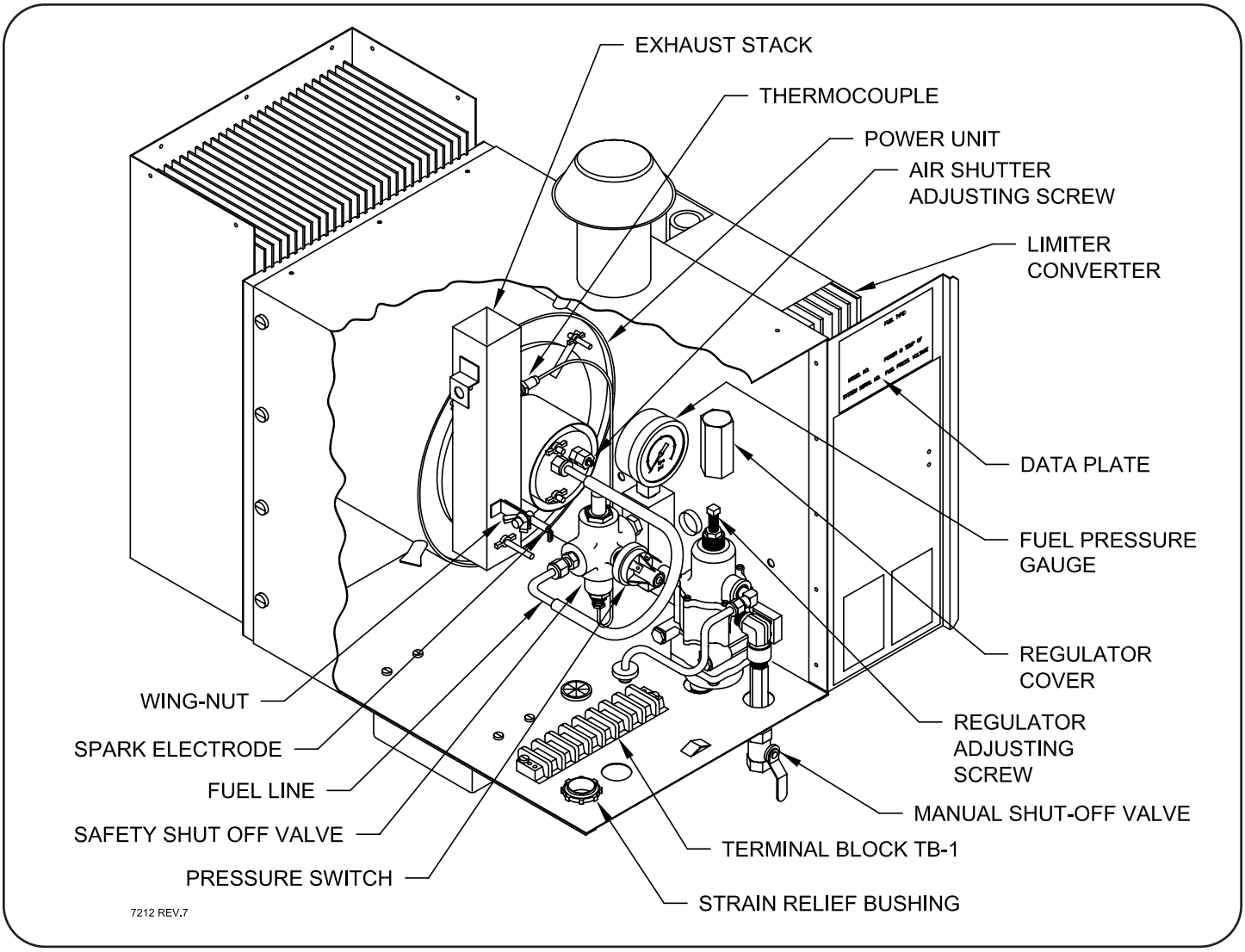

Figure 5 SI-SO Start Up

To determine the set-up voltage V_{set} and set-up power use the graph in Figure 6. For example if the ambient temperature is 10 C then V_{set} will be 13.6 Volts and set-up power will be 62 Watts. To calculate the set-up power use the formula:

$$P = 60 + [(24^{o} - T) \times 0.18]$$

where: T = Ambient temperature ºC
P = Set-Up Power (Watts)

EXAMPLE: The ambient temperature is 10ºC

$$P = 60 + [(24^{o} - 10^{o}) \times 0.18]$$
$$= 62.52 \text{ Watts}$$

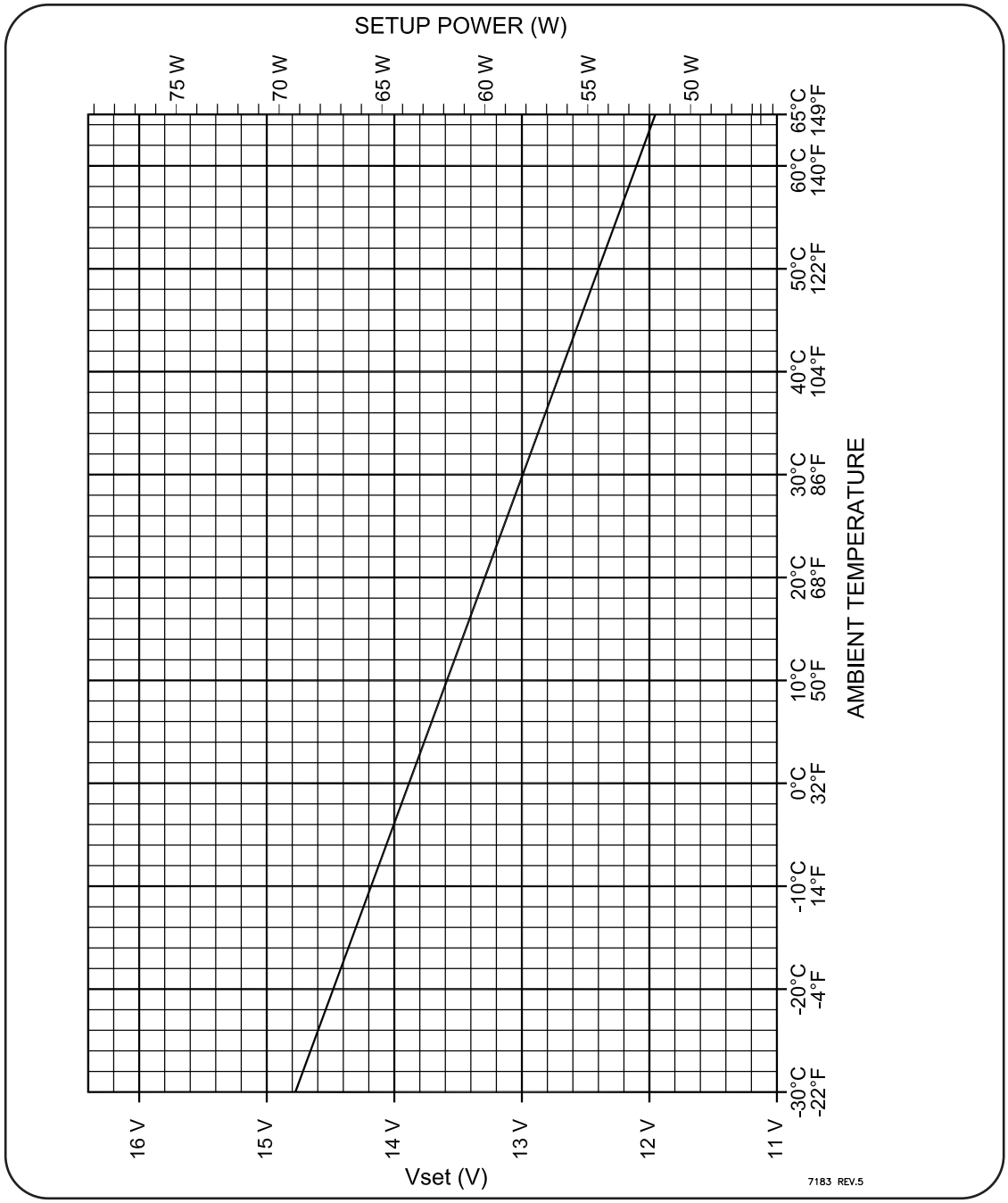

Figure 6 V_{set} & Gross Power Unit Rated Power vs. Ambient Temperature

2.6.2 V_{set} (Power) Check

After ignition has occurred the voltage between terminals 2(+) and terminals 4(-), that is, V_{set} will begin to climb as shown on the graph in Figure 7.

WARNING: DO NOT allow V_{set} to exceed the maximum as shown in Figure 7 or overheating may cause irreparable damage to the power unit.

The V_{set} will rise quickly at first then begin to level out. It will take at least one hour for the V_{set} to stabilize. When V_{set} no longer changes (±0.2 V in ten minutes) compare this value with rated V_{set} as determined in section 2.6.1, these should be within 0.2 Volts of each other.
If the measured V_{set} is greater than rated V_{set} then the fuel pressure needs to be reduced. If the measured V_{set} is less than rated V_{set} then proceed as follows.

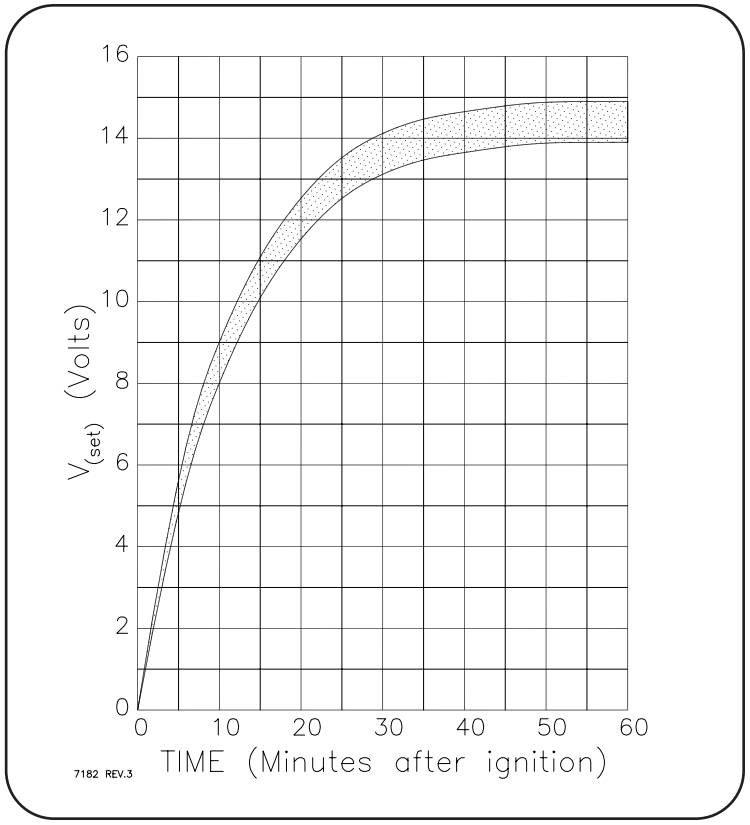

Figure 7 V_{set} vs Time After Ignition

2.6.3 Elevation Adjustment

Check the fuel gauge pressure. It should be near to the pressure indicated on the data plate. If the TEG is located at a different altitude than the factory, (750 m or 2460 ft.) the pressure will also be different. See Figure 8.

Example: If the site elevation is 2000m (6682 ft.) then 14 kPa (2 psi) must be added to the pressure on the data plate.

If it is necessary to adjust the pressure, remove the cover on the regulator and loosen the lock nut, see Figure 5. Turn the adjusting screw (clockwise to increase pressure) until the required pressure is obtained. Tighten the lock nut when finished adjusting.

2.6.4 Air-shutter Adjustment

1) Record the V_{set}.
2) Open the doors and loosen the adjustment screw lock-nut Figure 5.
3) Turn the adjusting screw one turn counterclockwise.
4) Close the doors, wait ten minutes then measure V_{set}.

If V_{set} is greater than the original value or did not change (air rich) turn

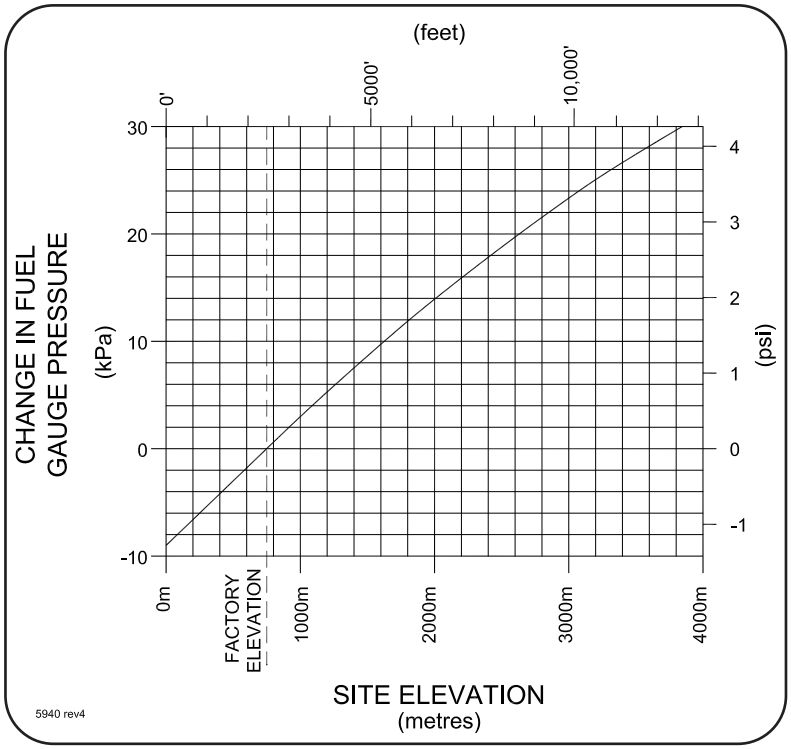

Figure 8 Fuel Gauge Pressure vs Elevation

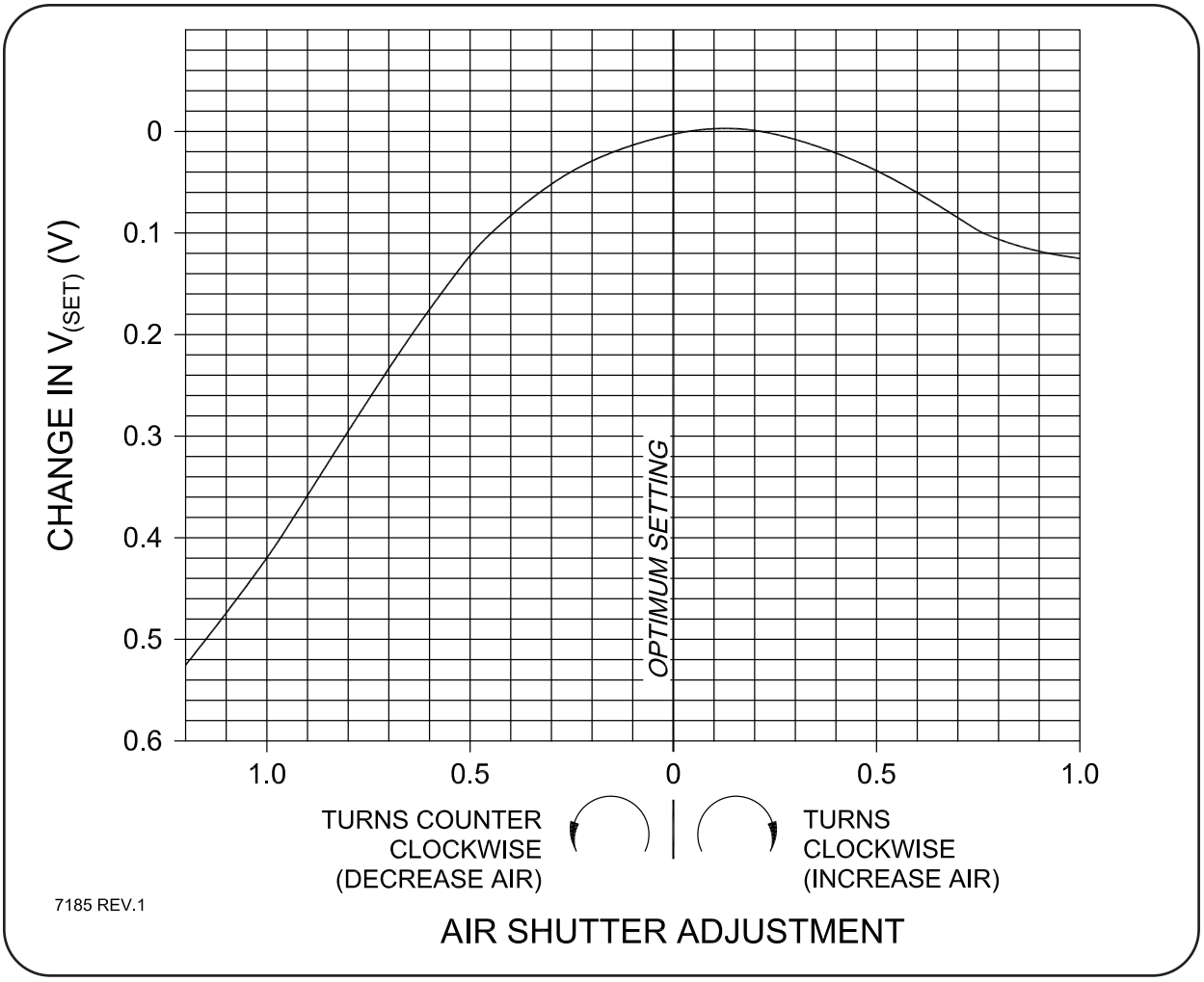

Figure 9 Change in V_{set} vs Air Shutter Setting

the adjusting screw another turn counter-clockwise and wait ten minutes. Continue until you observe a decrease in V_{set} then proceed to next paragraph.

If V_{set} is less than original value (fuel rich) refer to Figure 9. Notice that the peak of the graph is within one quarter of a turn (either direction) of the adjusting screw. Set the adjusting screw so that it is one half turn air rich.

Tighten the lock-nut.

2.6.5 Fuel Pressure Adjustment

If the fuel system and burner appear to be operating correctly, the fuel pressure may be slightly adjusted to match the TEG's voltage with the rated V_{set} value. Figure 10 can be used to determine how much to adjust the fuel pressure.

EXAMPLE:
Rated V_{set}	=	13.2V
Measured V_{set}	=	12.8V
Difference	=	+0.4V

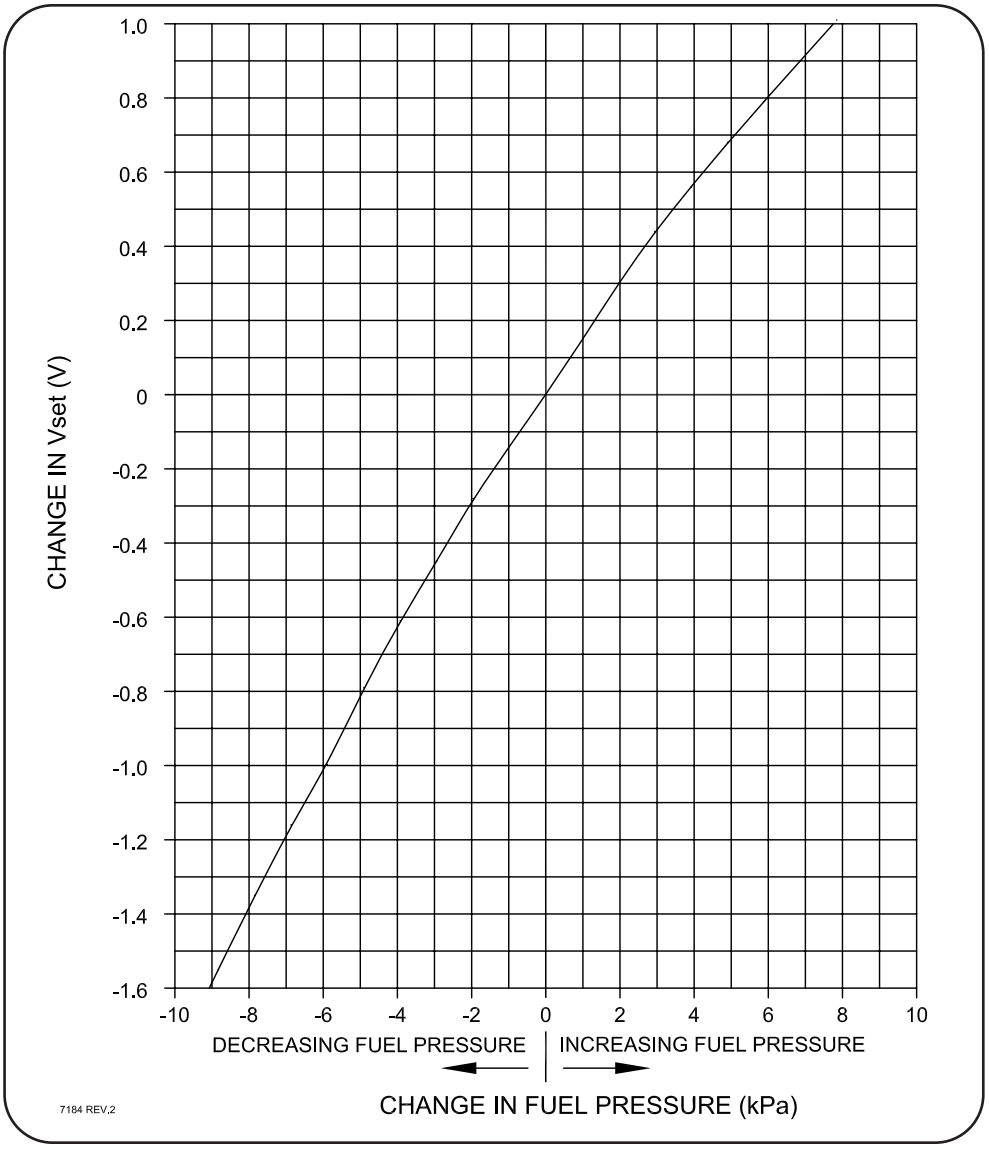

Figure 10 Change in V_{set} vs Fuel Pressure Adjustment

As seen on the graph, the fuel pressure must be increased 2.5 kPa (0.37 psi).

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

WARNING: Do not exceed the following values:

Natural Gas:	**52 kPa (7.5 psi)**
Propane:	**56 kPa (8.1 psi)**

3) Wait at least 10 minutes before measuring V_{set}. If the TEG still does not reach V_{set} value then a problem exists with one of the TEG's systems. See section 3.3, trouble shooting, for evaluation.

4) Replace the cover on the fuel regulator.

2.7 Customer Load Wiring

1) Use only copper wire, properly sized for the load current.
2) Bring the customer load wires through the strain relief bushing (located on the TEG cabinet floor). Allow enough wire to connect to the terminal block TB-1.
3) Tighten the screws on the strain relief bushing.
4) Connect the customer load wires to terminals 5(-) and 6(+).
5) Move the jumper clip to between terminals 1 and 2 of TB-1, see wiring diagram Figure 11.
6) Check the Voltmeter and ammeter readings on the limiter converter.

WARNING: Before leaving the site make sure that the button on the shut-off valve has been released.

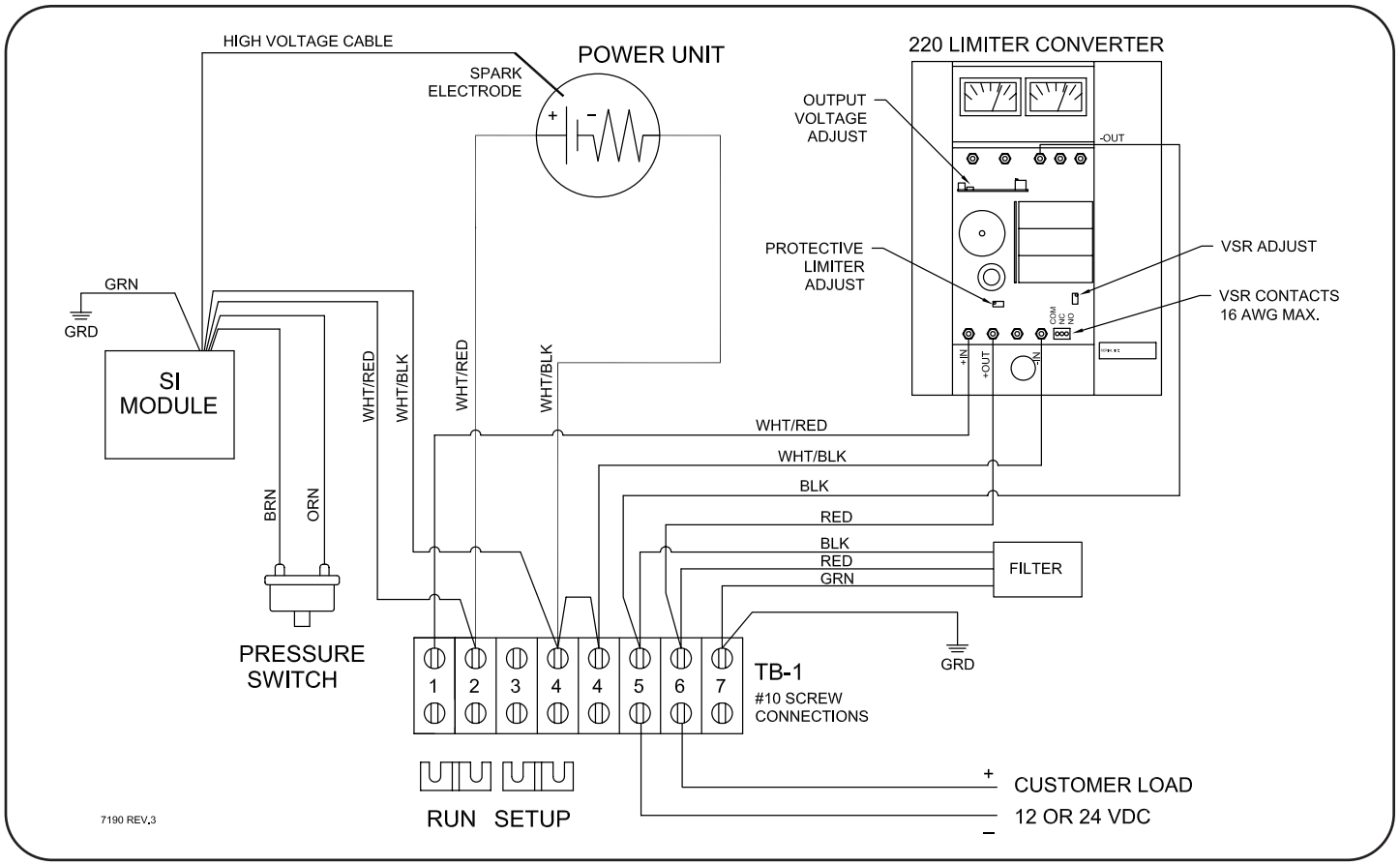

Figure 11 Wiring Diagram 5060 TEG

3 Service and Maintenance

Before attempting to service the Model 5060 TEG you should be thoroughly familiar with the operation of this generator. It is suggested that you review Sections 1 and 2 before attempting to service this TEG.

3.1 Suggested Periodic Maintenance

The TEG is a solid-state high-reliability device that requires very little maintenance. However, it does require periodic service checks in order to provide the years of trouble free service of which it is capable. The maintenance interval depends on the site conditions (fuel purity, weather, etc.) and must be established based on site experience. Field experience indicates that a properly installed TEG usually requires maintenance only once a year. For maximum reliability the following series of service checks are recommended.

Tools required for annual service :

- 1 voltmeter
- 1 flat head screwdriver
- 1 phillips screwdriver
- 1 9/16” wrenches or an adjustable wrench
- 1 Fuel Filter Kit (Part# 3400-22363)

At least once a year, perform a Power Check as outlined below. This should be the first procedure during any service visit and will determine what further service may be needed.

3.1.1 Power Check

The Power Check is completed to ensure the TEG is operating at the correct V_{set} for the current ambient temperature. This should be the first procedure completed during any service visit and will determine what further service may be required.

1) Determine the rated V_{set} for the current ambient temperature (see Section 2.6.1).
2) Move the jumper clip on the terminal block TB-1 to between terminals 3 and 4.
3) Connect a voltmeter between terminals 2 (+) and 4 ( ). This is the open circuit voltage or V_{set} and should match the V_{set} for the current temperature (see Figure 6).
4) When the V_{set} has stabilized (approximately 10 minutes), compare it to the following conditions:

If the measured V_{set} is more than 0.2 volts above rated V_{set}: The fuel pressure must be reduced. Proceed with the basic service as per Section 3.1.2, but remember to adjust the fuel pressure during restart or before leaving the site, see Section 2.6. DO NOT continue to operate above Set Power.

If the measured V_{set} is within 0.2 volts of rated V_{set}: The TEG is functioning well and requires only the basic service indicated in Section 3.1.2 below.

If the measured V_{set} is more than 0.2 volts below rated V_{set}: The cause must be evaluated.

Refer to the last entry in the System Performance Log. From the log, determine 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, the following possible causes should be considered.

a) Change in fuel pressure. Refer back to the last entry in the log and determine if the fuel pressure has changed. If the fuel pressure has changed, readjust the fuel pressure to the last entry. If this returns the V_{set} to within 0.2 volts of rated V_{set} you can proceed with the basic service as per Section 3.1.2.

b) Obstructed air flow. Check for obstructions at the cooling fins and the air filter stabilizer. Adjust the air shutter as per Section 2.6.4. If this returns the V_{set} to within 0.2 volts of rated V_{set} proceed with basic service as per Section 3.1.2.

c) Change in fuel quality. In order to maintain a constant output power it is essential that the TEG be supplied with a constant heating value fuel.

If the above causes have been ruled out the TEG may require more than just the basic service. Refer to Section 3.3 for further procedures to isolate the cause of the low V_{set} condition but keep the TEG operating for now.

Unless other service is indicated above, the following basic service is all that is required.

3.1.2 TEG Basic Service Schedule

1) Replace the fuel filter (Part# 3400-22363) in the pressure regulator once per year (see Section 3.2.2.2).
2) Drain the pressure regulator sediment bowl (see Section 3.2.2.1)
3) Check the fuel orifice for clogging and replace if necessary (see Section 3.2.2.3).

Propane Orifice (#4)	Part# 4200-00686
Natural Gas Orifice (#6)	Part# 4200-00688

4) Remove any debris, sand or dust from the cooling fins, air filter stabilizer and cabinet interior.
5) Check all bolts and wire connections for tightness.
6) Restart TEG as per Section 2.5.
7) Record service and current operation parameters in the System Performance Log.

3.2 System Components

The main parts of the 5060 TEG are as follows (see figure Figure 12):

Power Unit: The power unit includes the thermopile and the cooling fins. The thermopile consists of the N and P elements (thermocouples) placed in a sealed compartment to prevent oxidation and surrounded by insulation to prevent heat loss.

Cooling Fins: Cooling of the thermopile is done by the free movement of ambient air through the cooling fins. Check that the cooling fins are clear of leaves and other debris. There should be enough space around the fins for air movement.

Burner: Gas is expanded through an orifice and then flows through a venturi where it draws in air needed for combustion. This mixture passes through the burner screen and burns at the back of the combustion chamber (next to the thermopile).

Fuel System: The power output of the generator is controlled by adjusting the amount of fuel sent to the burner. The fuel system contains a pressure regulator which allows adjustment of fuel flow, a pressure gauge, and a pressure switch which signals the spark ignition system that fuel is present. An optional Shut-Off (SO) valve may also be present which closes when heat is no longer present in the exhaust stack, thereby stopping the flow of gas.

Spark Ignition (SI) Module: When the fuel is turned on, the gas pressure causes the pressure switch (located on fuel system) to close. This signals the SI module to generate 12 kV sparks, which arc from the SI electrode to the combustion chamber wall, causing ignition to occur. Once the fuel is burning the exhaust heat will signal the SI module to stop sparking.

Limiter Converter (L/C): The 220 Watt L/C consists of two separate circuits. The first is a shunt type voltage limiter that regulates the output of the generator. The second is a DC to DC converter that switches the input voltage to a different output voltage.

Cabinet: The power unit, burner and fuel system are enclosed in the stainless steel cabinet.

Fin Duct: The fin duct acts as a chimney, causing ambient air to rise through the cooling fins, thus cooling the thermopile.

3.2.1 Power Unit

The power unit contains the thermoelectric materials which produce the electrical power. Because these materials corrode in atmospheric conditions at high temperatures they are contained in a sealed unit.

If all other parts of the TEG have been checked out and it still does not produce rated power, then the power unit may be faulty. The power unit can not be repaired after leaving the factory.

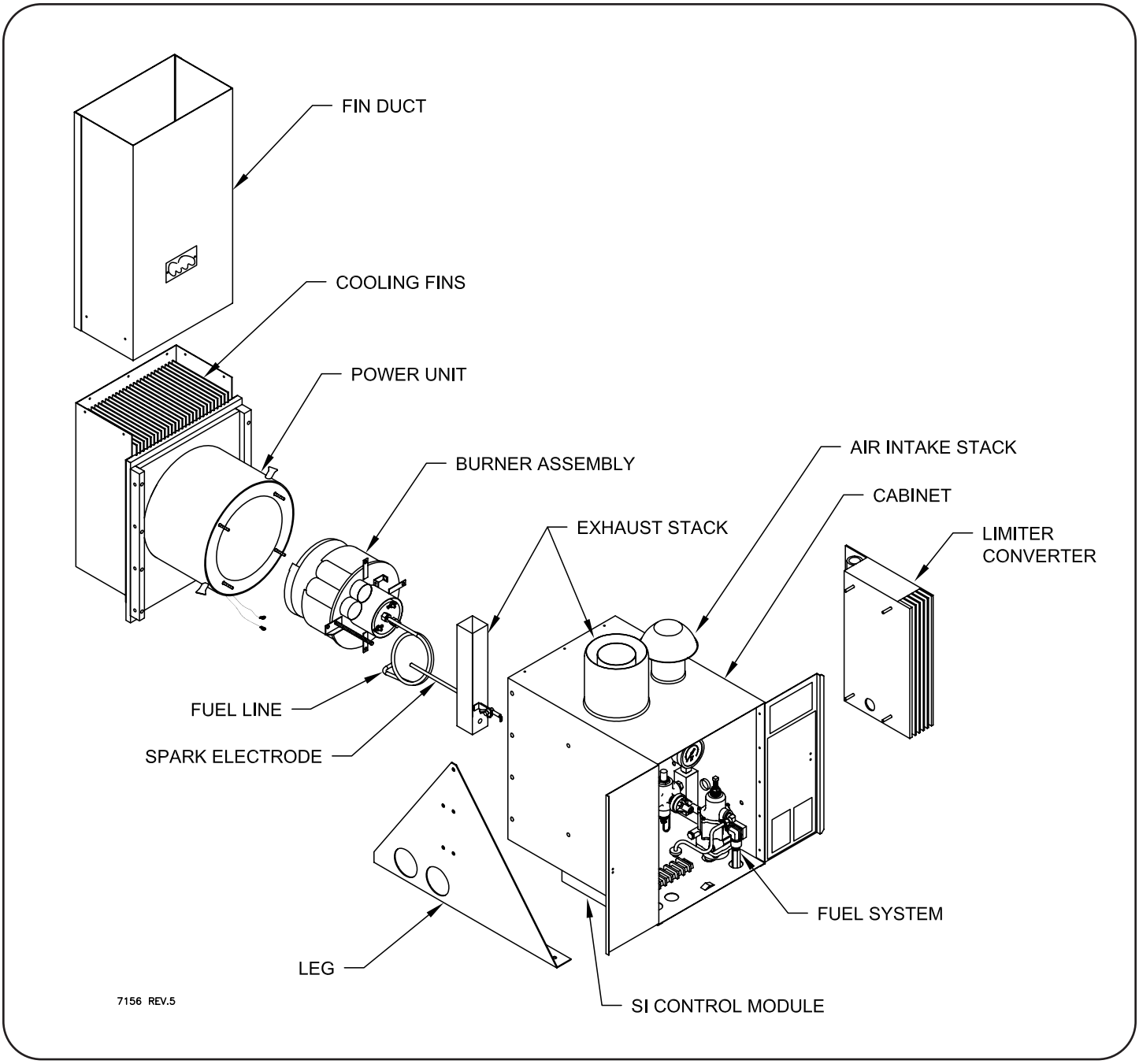

Figure 12 TEG Main Parts

3.2.2 Fuel System

The fuel system includes a FISHER 67CFR regulator which controls the fuel pressure to the orifice. The regulator contains both a sediment bowl with a manual drain cock and a fuel filter. The outlet of the pressure regulator leads to a manifold on which is mounted a pressure gauge to monitor the fuel pressure. The fuel flows through the manifold to the fuel line which connects to a orifice mounted on front of the burner. The orifice contains a jewel with a precisely drilled hole to control the fuel flow into the burner. For SI units a pressure switch is also mounted on the manifold and it connects to the spark ignition system. For SI-SO units a SO valve is located between the manifold and fuel line, and the SI pressure switch is mounted on the SO valve, see Figure 13.

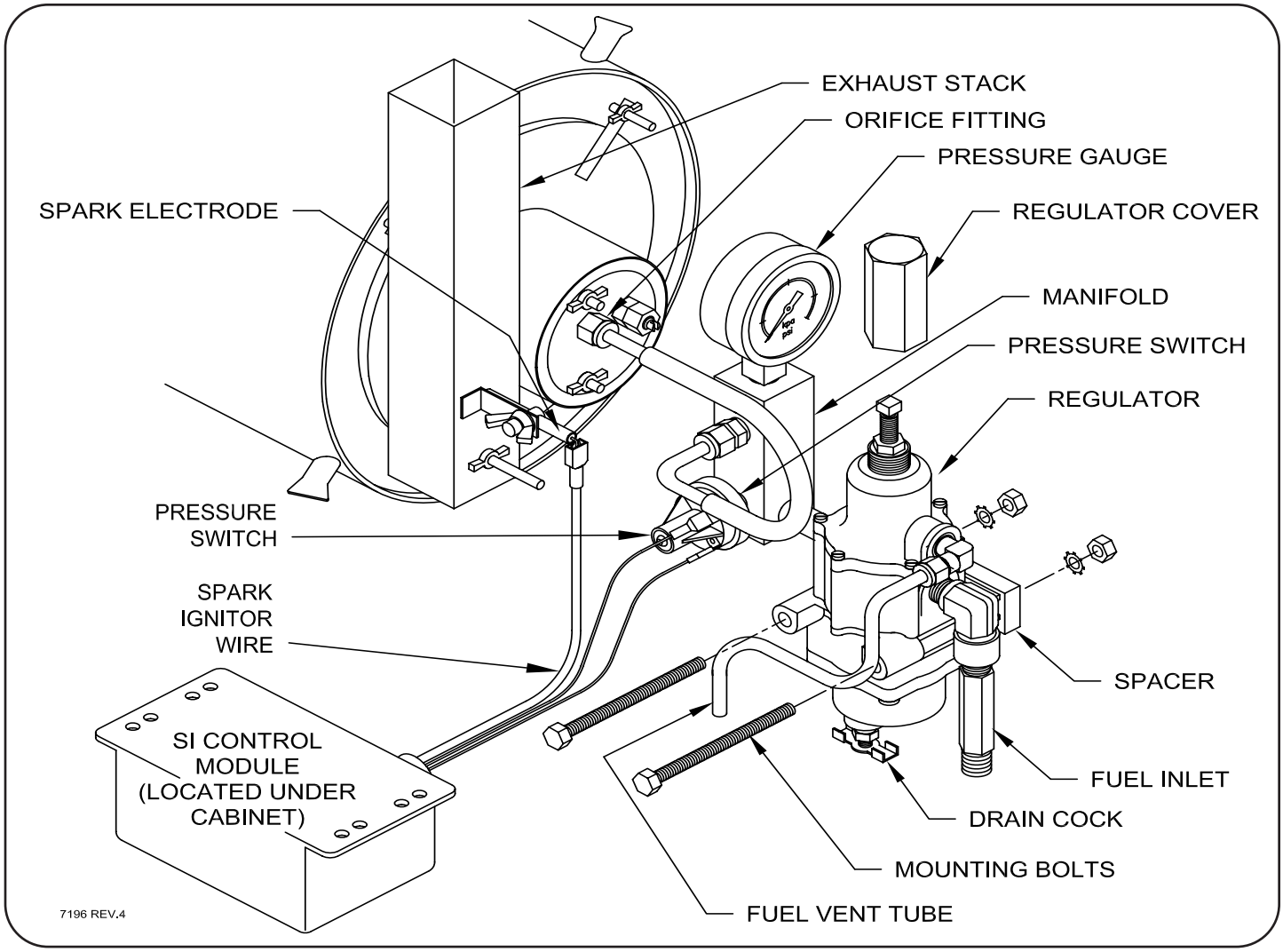

Figure 13 SI-SO Fuel System Service

3.2.2.1 Draining the Sediment Bowl

The sediment bowl will collect impurities in the fuel. Drain the regulator as follows:

1) Shut off the fuel supply to the TEG.
2) Open the drain cock located on the under side of the TEG cabinet. Any impurities will drain through the cock.
3) Close drain cock.

3.2.2.2 Fuel Filter

The fuel filter is a resin impregnated cellulose filter which prevents solid particles from damaging the regulator or downstream equipment. Change the fuel filter as follows:

1) Remove the wires from the pressure switch.
2) Shut off the fuel supply to the TEG. Drain the sediment bowl by opening the drain cock.
3) Disconnect the flexible fuel line from the manifold block.
4) Disconnect the vent hose from the cabinet base.
5) Remove the two bolts which hold the regulator to the cabinet.

6) Turn the regulator upside down and remove the four bolts from the bottom.
7) Change the filter, and viton gasket, See Figure14.
8) Carefully replace the bottom of the regulator making sure that the gasket is in its proper position.
9) Replace the four bolts and tighten.
10) Before re-installing the regulator check the orifice, Section 3.2.2.3 and air supply, Section 3.2.3.
11) Re-install the pressure regulator. With the fuel pressure on, leak check all joints.

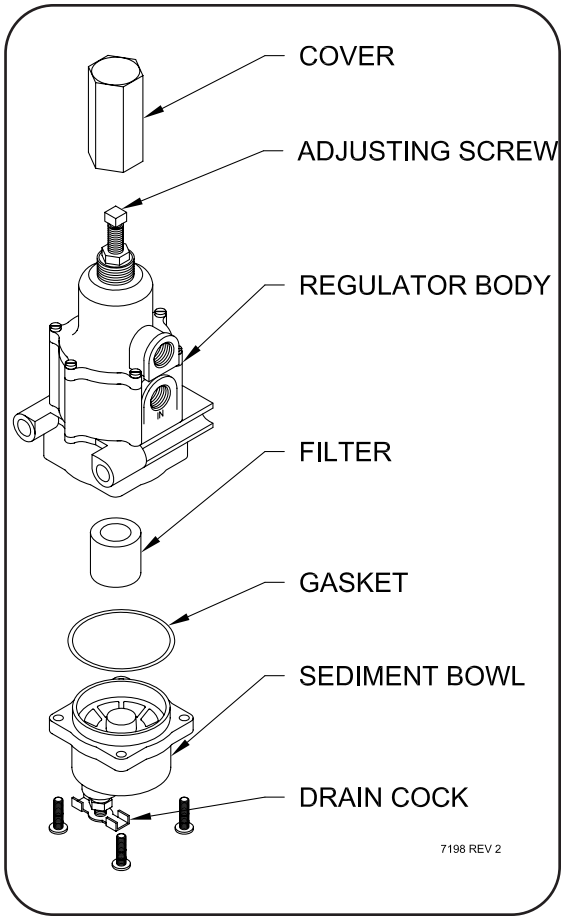

Figure 14 Pressure Regulator

3.2.2.3 Fuel Orifice

Check or replace the fuel orifice as follows:

1) Shut off the fuel supply to the TEG.
2) Disconnect the flexible fuel line from the front of the burner.
3) Remove the orifice fitting.
4) Visually check the orifice hole. It should be free from any obstructions.
   - Replace if necessary.
5) Re-assemble the fuel line, tightening all connections.
6) Leak check all connections using a commercial leak detector.

Note: Always use the same size orifice as was removed.
For propane service use orifice #4 part 4200-00686
For natural gas use orifice #6 part 4200-00688.

WARNING: After any fuel system service, check for fuel leaks.

3.2.3 Air Supply

The screen at the front of the burner may become clogged with dust and insects thereby preventing the proper flow of air to the burner. To clean it proceed as follows:

1) Shut-off the fuel supply to the TEG.
2) Disconnect the flexible fuel line from the front of the burner.
3) Remove the orifice fitting, the adjusting screw lock nut and the two wing-nuts.
4) Remove the screen.
5) Clean the screen by forcing air through it or washing in water.
6) Replace screen and fittings.

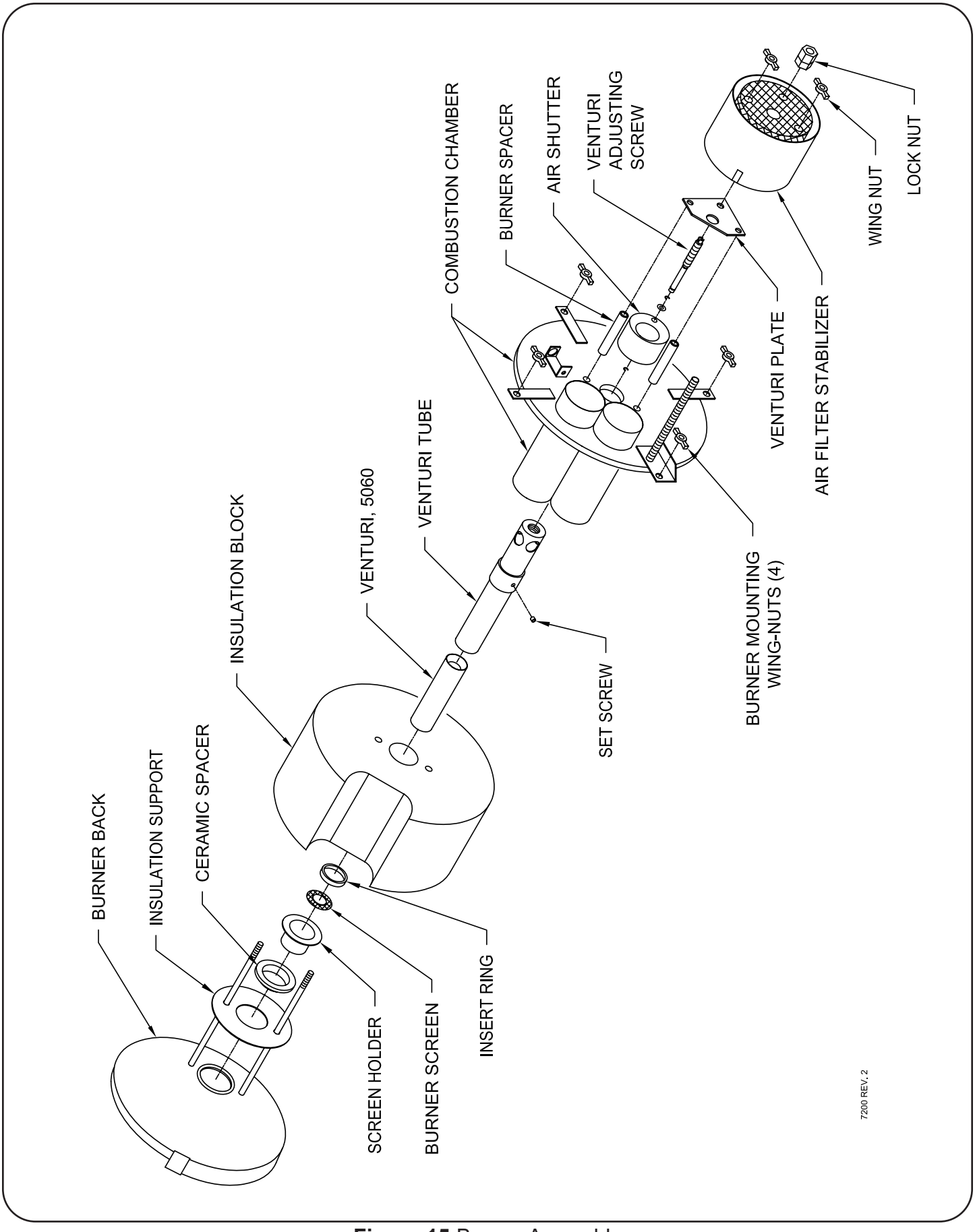

Figure 15 Burner Assembly

7) Turn the venturi adjusting screw counter-clockwise as far as it will go then turn it clockwise four turns. This will set the adjustment in the correct range to begin balancing the air-fuel mixture when re-starting.
8) Before re-starting the TEG, leak check all fuel connections.

3.2.4 Burner

The Burner system contains the venturi and air filter assemblies which allow for adjustment of the air/fuel mixture. This mixture passes through the venturi to the back of the burner where combustion takes place. A problem in the burner is suspected only if V_{set} cannot be brought up to rated power. Make sure the fuel system and air supply are okay before proceeding to service the burner.

3.2.4.1 Removing the Burner

Allow the generator to cool then proceed as follows:

1) Disconnect the high voltage wire from the spark electrode.
2) Loosen the wing-nut and slide the spark electrode out.
3) Remove the wing-nut near the bottom of the exhaust stack then slide the exhaust stack out.
4) Disconnect the flexible fuel line from the front of the air screen.
5) Remove the orifice fitting.
6) If necessary, disconnect and remove the fuel system (See Section 3.2.2).
7) Remove the four wing-nuts holding the burner in place and slide the burner out.

3.2.4.2 Inspecting the Burner (Figure 15)

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 (2.75” from end, Figure 16), and that the venturi is facing the proper direction.
2) Check the air filter screen for any tears or holes. If any are found it should be replaced.
3) Check the burner screen.
4) Check the ceramic spacer.

3.2.5 Spark Ignition (SI) System

The spark ignition system consists of 3 major components.

1) The high voltage spark electrode which ignites the gas.
2) The pressure switch which senses gas pressure.

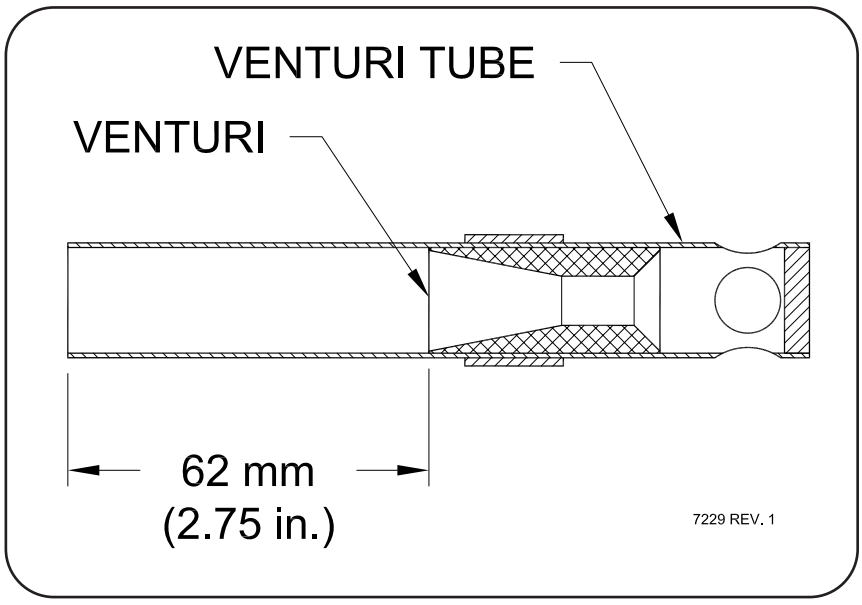

Figure 16 Venturi Location

3) The control module which generates the high voltage to the electrode and also has control functions.

3.2.5.1 SI Theory of Operation

When fuel is supplied to the TEG the presence of fuel pressure causes the pressure switch to close. This, combined with the absence of heat sensed by the spark electrode, causes the control module to generate 12 kVolt sparks. These sparks arc from the spark electrode to the combustion chamber wall and ignite the fuel present in the burner. Once ignition begins, the presence of heat signals the control module to stop sparking within five minutes.

The control module contains a D-size 2 volt, 2.5 amp-hour re-chargeable battery and a constant potential battery charger. A new fully charged battery provides about 16 hours of continuous starting capability without recharging. Twenty minutes of recharging is enough for one start cycle. If the battery is completely discharged it will require fifteen hours to fully recharge.

3.2.5.2 SI Maintenance

WARNING: To prevent high voltage shock remove the orange wire from the pressure switch and make sure it can not come into contact with other electrical connections.

1) Check the operation of the SI system as follows:
   a) Remove the Spark Electrode by loosening the wing-nut and sliding the electrode out.
   b) Inspect the electrode for any cracks in the ceramic rod. If any cracks are found

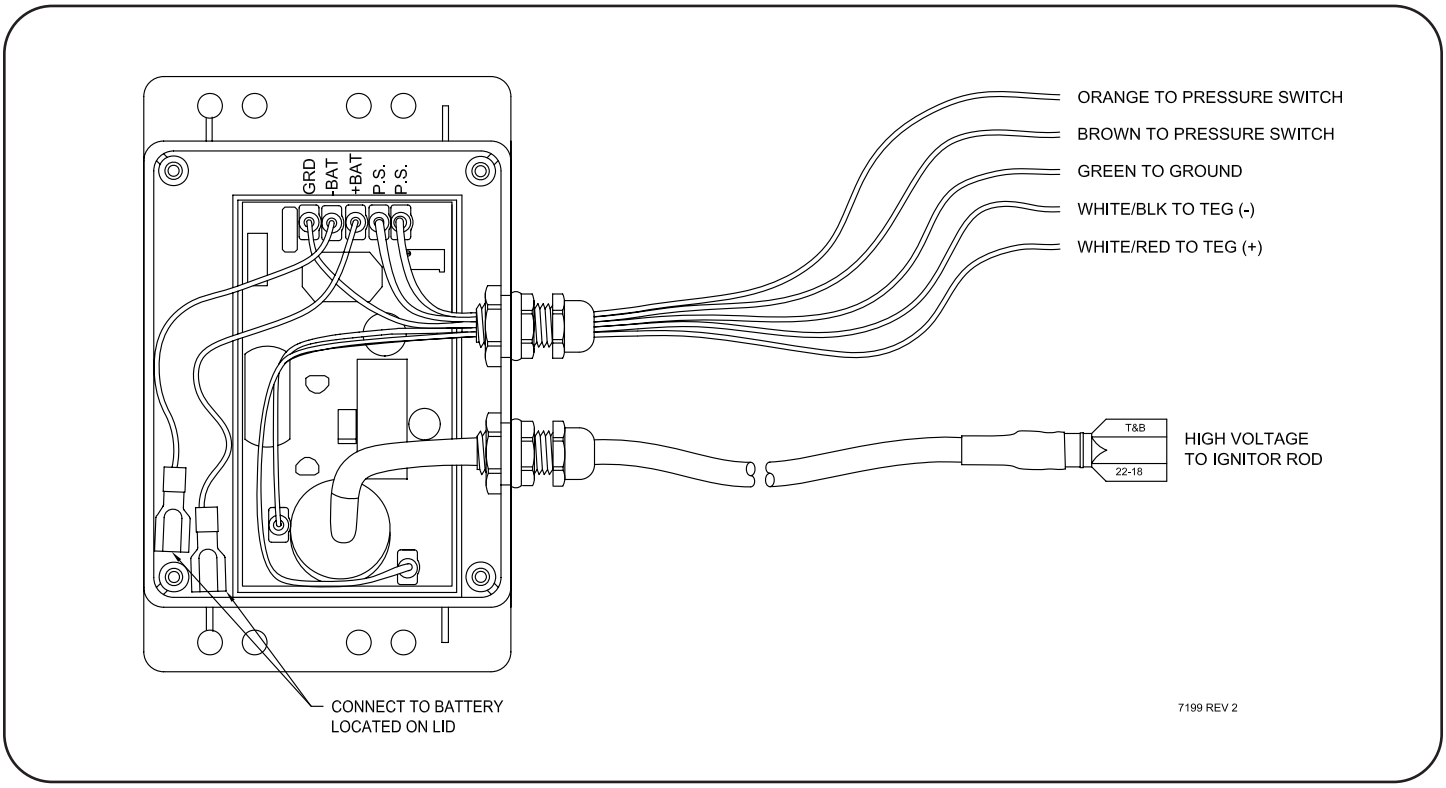

Figure 17 Spark Ignitor Wiring Diagram

the electrode must be replaced.

c) Slide the electrode back into position until it stops, then pull it back 3 to 6mm (1/8 to1/4”). The ceramic rod should extend about 25mm (1”) from the holding screw.

d) Tighten the wing-nut only until it is snug. DO NOT over tighten or the ceramic rod will crack.

e) Loosen the orange and brown wire connectors from the terminals on the pressure switch and then short the circuit between the two terminals. Arcing should occur in the combustion chamber (making a clicking noise) at the rate of one per second.

f) If arcing occurs the system is functioning well.

2) Check the pressure switch. It should close at a pressure of 13.8 kPa (2 psig) and open at 6.9 kPa (1 psig). Replace the pressure switch if necessary.

3) Check the battery voltage as follows:
   a) Measure the voltage between the brown lead and terminal 4 of TB-1. The voltage should be greater than 2 volts.
   b) If the voltage is less than 2 volts the battery needs recharging or replacing.
   c) Make sure all wire connections are secure.

4) Check the battery charger and spark generator as follows:
   a) Manually light the TEG by placing a lighted match at the port of the SI electrode.
   b) After twenty minutes of operation check the battery voltage as per step 3. The voltage should be 2.35 volts.
   c) Perform step 1 again. If sparking does not occur the control module needs to be replaced.

5) Check if the battery will hold charge as follows:
   a) Remove the thin white/red wire from terminal 2 of TB-1.
   b) Connect the orange wire to the brown wire.
   c) Measure battery voltage between the orange wire and terminal 4 of TB-1.
   d) If the voltage is less than 2.0 volts, replace the battery.
   e) To replace the battery open the control module.
   f) Disconnect the battery leads.
   g) Install a new battery, taking note of polarity.

3.2.6 Automatic Shut-Off (SO) System

The Automatic Shut-Off System is designed to turn off the fuel supply to the TEG if the burner goes out. The SO valve contains an electromagnet that is powered by a thermocouple mounted on the burner (see Figure 13). When the thermocouple is no longer heated by the flame, the current will drop to zero, causing the valve to close.

SI Control Module Specifications		
Electrical:	Input Voltage:	Minimum 4.0 V
		Maximum 12.0 V
	Input Current:	Maximum 150 MA (with TEG operating)
	Output Voltage:	12 kV Minimum
	Spark Rate:	1 per second (approximate)
	Noise Conducted:	40mV P-P
		28mV RMS
Flame Failure Re-ignition Time:		15 seconds
Spark Gap:	Nominal:	3.2mm (0.13”)
	Minimum:	2.5mm (0.10”)
	Maximum:	6.3mm (0.25”)
Continuous Operating Time Without Charge:		16 Hours with full charged battery at 23ºC.

If the SO valve fails to stay open after the generator has warmed up for five minutes then the SO system needs to be checked.

1) Make sure that the button on the SO valve is fully depressed before releasing it. This is necessary to activate the latching coil of the valve.

2) Check the Thermocouple
   a) Remove the thermocouple fitting from the bottom of the SO valve.
   b) Connect one lead of an ohm meter to the end of the thermocouple fitting. Connect the other lead of the ohm meter to the casing of the thermocouple cable. If an ohm reading registers on the meter then the thermocouple is okay. If the resistance is equal to infinity then the thermocouple is damaged and must be replaced.

3) Check the Shut-Off Valve.
   a) Remove the thermocouple fitting from the bottom of the SO valve.
   b) Connect one lead of an ohm meter to the SO valve at the point where the tip of the thermocouple was in contact with the valve. Connect the other lead of the ohm meter to the casing of the SO valve.
   c) If an ohm reading registers on the meter then the SO valve is okay. If the resistance is equal to infinity then the SO valve is damaged and must be replaced.

3.3 Troubleshooting Guide

Symptom	Probable Cause	Remedy and Procedure
Burner does not ignite.	Air in fuel line.	Purge fuel lines.
	Gas supply pressure too low.	Minimum gas supply pressure is 69 kPa (10 psig). Section 2.4.
	Incorrect pressure regulator setting.	Adjust pressure. Section 2.6 and 2.6.5.
	Dirty fuel filter.	Drain regulator sediment bowl. Section 3.2.2.1.
		Replace fuel filter. Section 3.2.2.2.
	Orifice plugged.	Replace orifice. Section 3.2.2.3.
	Air adjustment incorrect	Adjust air supply. Section 2.6.4.
	Clean air screen.	Section 3.2.3.
	SI system not working.	Check SI System. Section 3.2.5.
Burner will ignite but will not continue to burn.	Supply gas pressure to low.	Minimum supply gas pressure is 69 kPa (10 psig). Section 2.4.
	Incorrect pressure regulator setting.	Adjust pressure. Section 2.6.5
	Dirty fuel filter.	Drain regulator sediment bowl. Section 3.2.2.1.
		Replace fuel filter. Section 3.2.2.2.
	Orifice plugged.	Replace orifice. Section 3.2.2.3.
	SO Thermocouple not working.	Check thermocouple. Section 3.2.6.
	SO Valve not working.	Check SO Valve. Section 3.2.6.
	Air adjustment incorrect	Adjust air supply. Section 2.6.4.
		Clean air screen. Section 3.2.3

Symptom	Probable Cause	Remedy and Procedure
Low output power or low voltage.	Incorrect set-up voltage for site temperature.	Determine required V_{set} for present conditions. Section 2.6.1.
	Insufficient cooling around fins.	Clear fins of any debris.
	Dirty fuel filter.	Drain regulator sediment bowl. Section 3.2.2.1.
		Change filter. Section 3.2.2.2.
	Orifice plugged.	Change orifice. Section 3.2.2.3.
	SO valve malfunctioning.	Check SO valve. Section 3.2.6
	Incorrect air supply.	Adjust air supply. Section 2.6.4.
		Clean air screen. Section 3.2.3
	Incorrect fuel adjustment.	Adjust fuel regulator. Section 2.6.5
	Limiter Converter needs adjusting or repair.	Check switch settings.
		Check output voltage adjustment Pot.
	Power unit faulty.	Replace power unit
Output power or voltage is too high.	Incorrect fuel adjustment.	Lower fuel pressure. Section 2.6.5
	Incorrect Limiter Converter adjustment.	Re-adjust the output voltage adjustment Pot.

3.4 5060 TEG Parts List

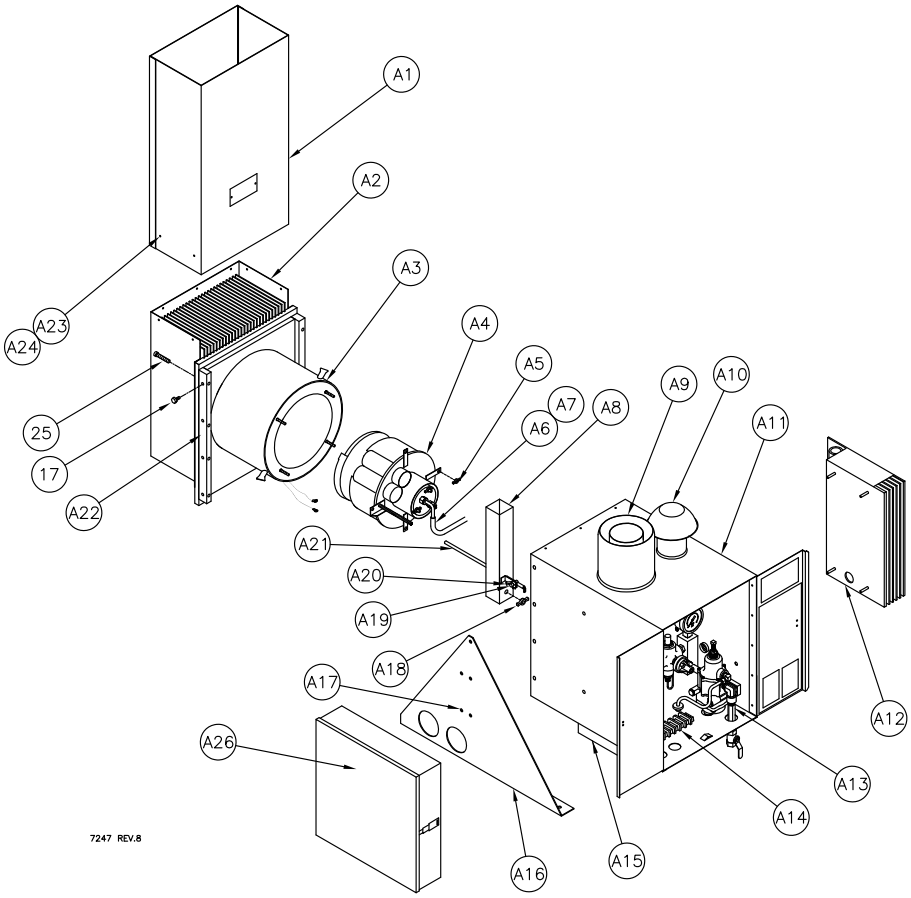

Figure 18 5060 TEG Parts

Item	Part No.	Description
A1	4100-00882	Fin Duct Assembly, Upper
A2	4100-00881	Fin Duct, Lower
A3	7900-08903	Power Unit
A4	6100-00899	Burner
A5	2708-00600	Nut, Wing, 8-32, SS
A6	4200-00686	Orifice, 4, Propane
	4200-00688	Orifice, 6, Natural Gas
A7	4200-05286	Fuel Line Kit, 10” f
	4200-23005	Fuel Line Kit with Elbow, 8” for TEG without Flame Arrestor
A8	4500-00979	Exhaust Stack, Inner
A9	4500-01025	Exhaust Stack Assembly, Outer
A10	4500-01026	Intake Stack Assembly
A11	6500-01016	Cabinet
A12	6300-06346	Limiter Converter, 220W, 12V
	6300-06347	Limiter Converter, 220W, 24V

3.4 5060 TEG Parts List

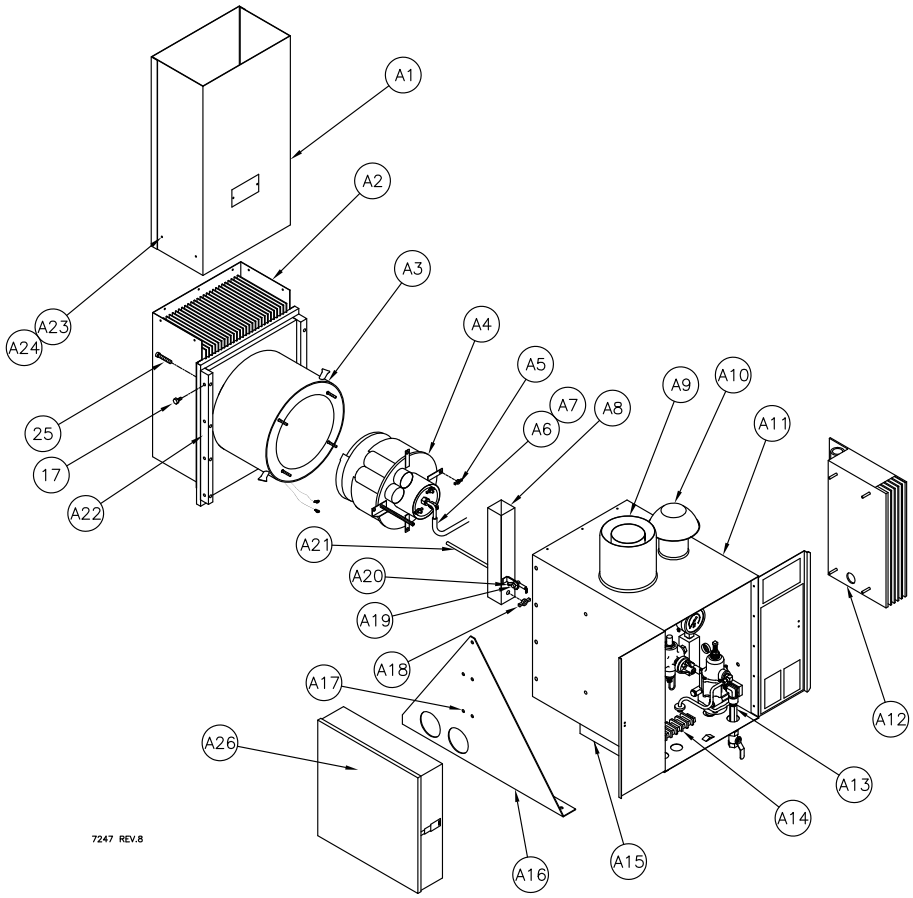

Figure 18 5060 TEG Parts

Item	Part No.	Description
A13	6400-22368	Fuel System, SI-SO
	6400-22369	Fuel System, SI-SO, SS Option
A14	2200-02110	Terminal Block, 8 Position
A15	6300-20144	Control Module, SI II
A16	4100-01019	Leg, Left
	4100-01020	Leg, Right
A17	2514-00258	Screw, Mach, P-H-P, 1/4 20 X 5/8, SS
A18	2710-00601	Nut, Wing, 10-32, SS
A19	4900-07004	Pin, Mounting, SI Electrode
A20	2756-07005	Nut, Wing, 5/16 - 18, SS
A21	4200-02032	Spark Electrode, SI
A22	4900-00900	Bar, Mounting
A23	2508-07410	Screw, Mach, P-H-P, 8-32 x 1/4, SS
A24	2808-00472	Washer, Lock, Ext., #8, SS
A25	2514-00267	Screw, Cap, SOC-HD 1/4-20 x 1, SS
A26	OPTIONAL	CP Panel, See Section 5

3.5 Burner Parts List

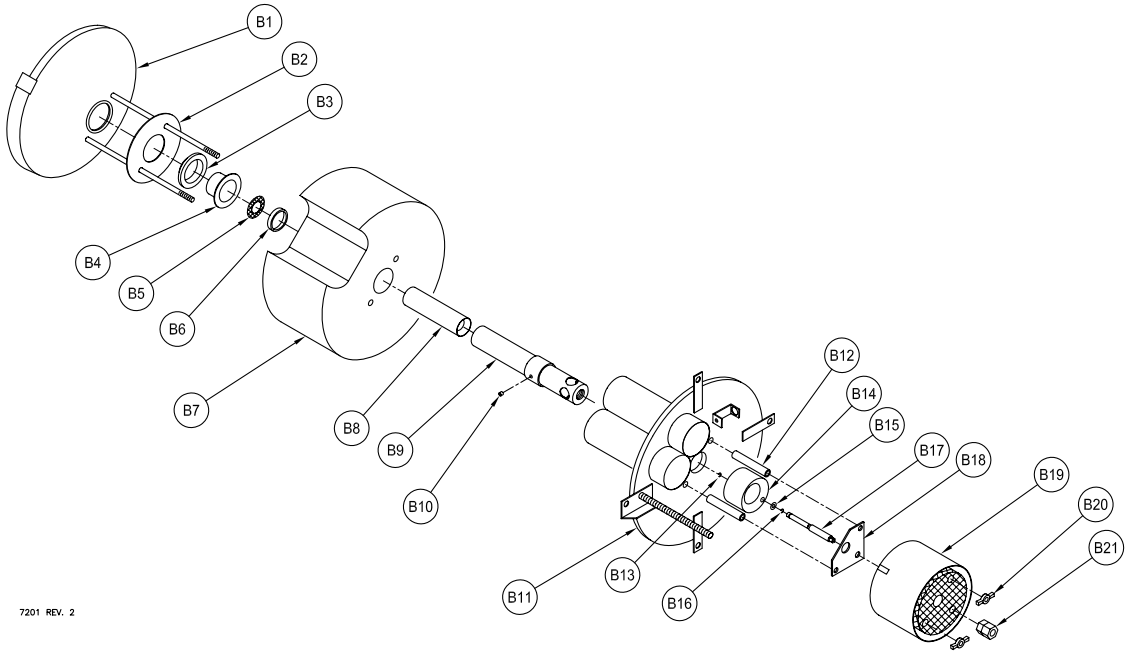

Figure 19 Burner Parts Illustration

Item	Part No.	Description
B1	4000-00983	Burner Back Assembly
B2	4000-01004	Insulation Block Support
B3	4000-00701	Spacer, Insulation
B4	4000-00693	Screen Holder
B5	4000-01008	Burner Screen Assembly
B6	4000-00694	Insert Ring
B7	4000-00998	Insulation Block
B8	4000-00698	Venturi
B9	4000-00999	Venturi Tube Assembly
B10	2506-00479	Screw, Set, Soc. HD, 6-32 x 1/8, SS
B11	4000-00985	Combustion Chamber Assembly
B12	4000-01005	Spacer, Burner
B13	2900-00549	Retaining ring, SS
B14	4000-00990	Air Shutter
B15	2810-00569	Washer, Flat, #10, SS
B16	2900-07267	E-ring, Bowed SS
B17	4000-00700	Venturi Adjustment Screw
B18	4000-00747	Venturi Plate Assembly
B19	4000-04648	Air filter Plate Assembly
B20	2710-00601	Nut, Wing, 10-32-SS
B21	4000-00758	Lock Nut, Venturi Adjustment Screw

3.6 Burner with Flame Arrestor Parts

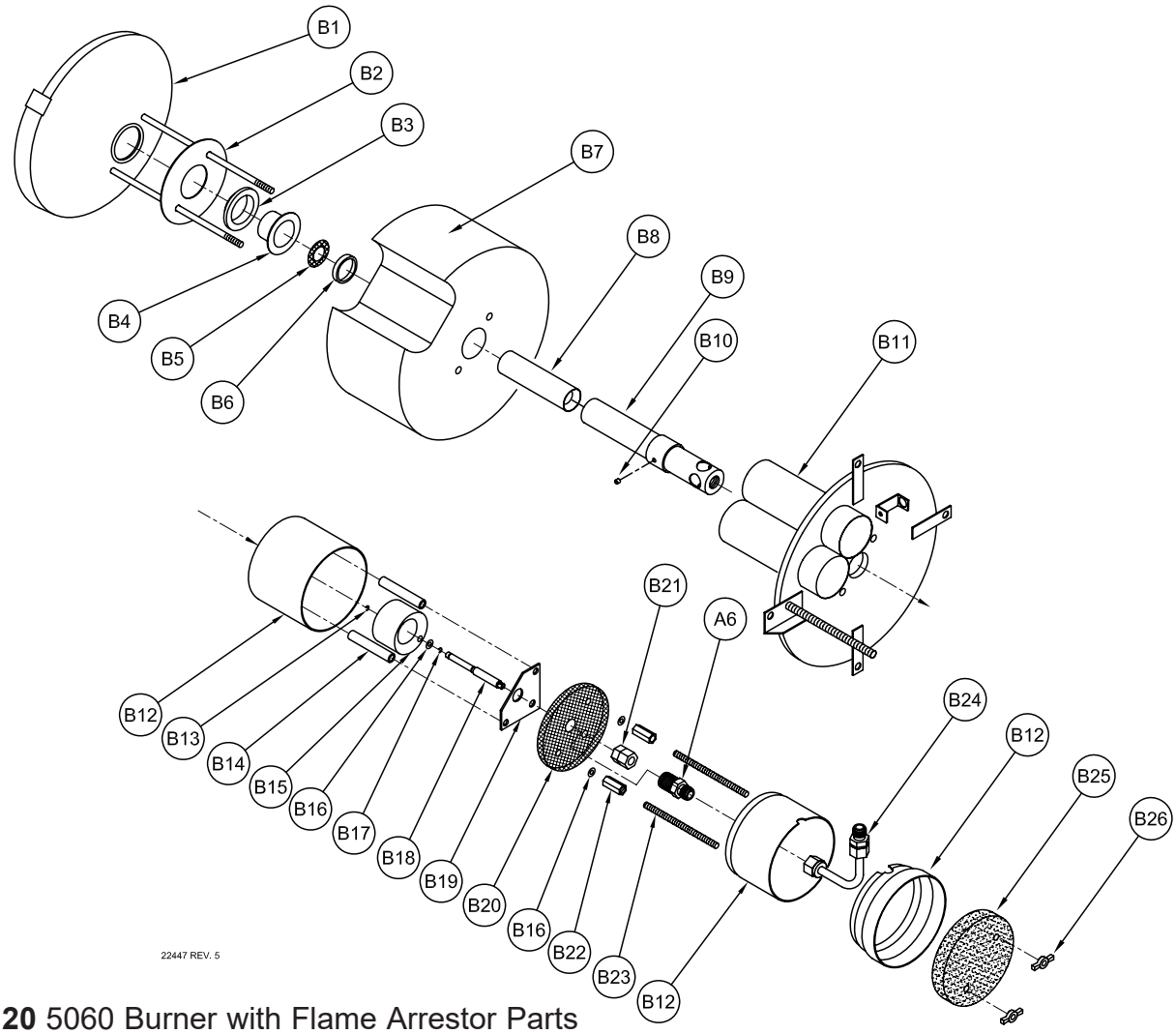

Figure 20 5060 Burner with Flame Arrestor Parts

Item	Part #	Description
B1	4000-00983	Burner Back Assembly
B2	4000-01004	Insulation Block Support
B3	4000-00701	Spacer, Insulation
B4	4000-00693	Screen Holder
B5	4000-01008	Burner Screen Assembly
B6	4000-00694	Insert Ring
B7	4000-00998	Insulation Block
B8	4000-00698	Venturi
B9	4000-00999	Venturi Tube Assembly
B10	2506-00479	Screw, Set, Soc. HD, 6-32 x 1/8, SS
B11	4000-00985	Combustion Chamber Assembly
B12	4900-27148	Flame Arrestor Can Assembly

3.6 Burner with Flame Arrestor Parts (Cont'd)

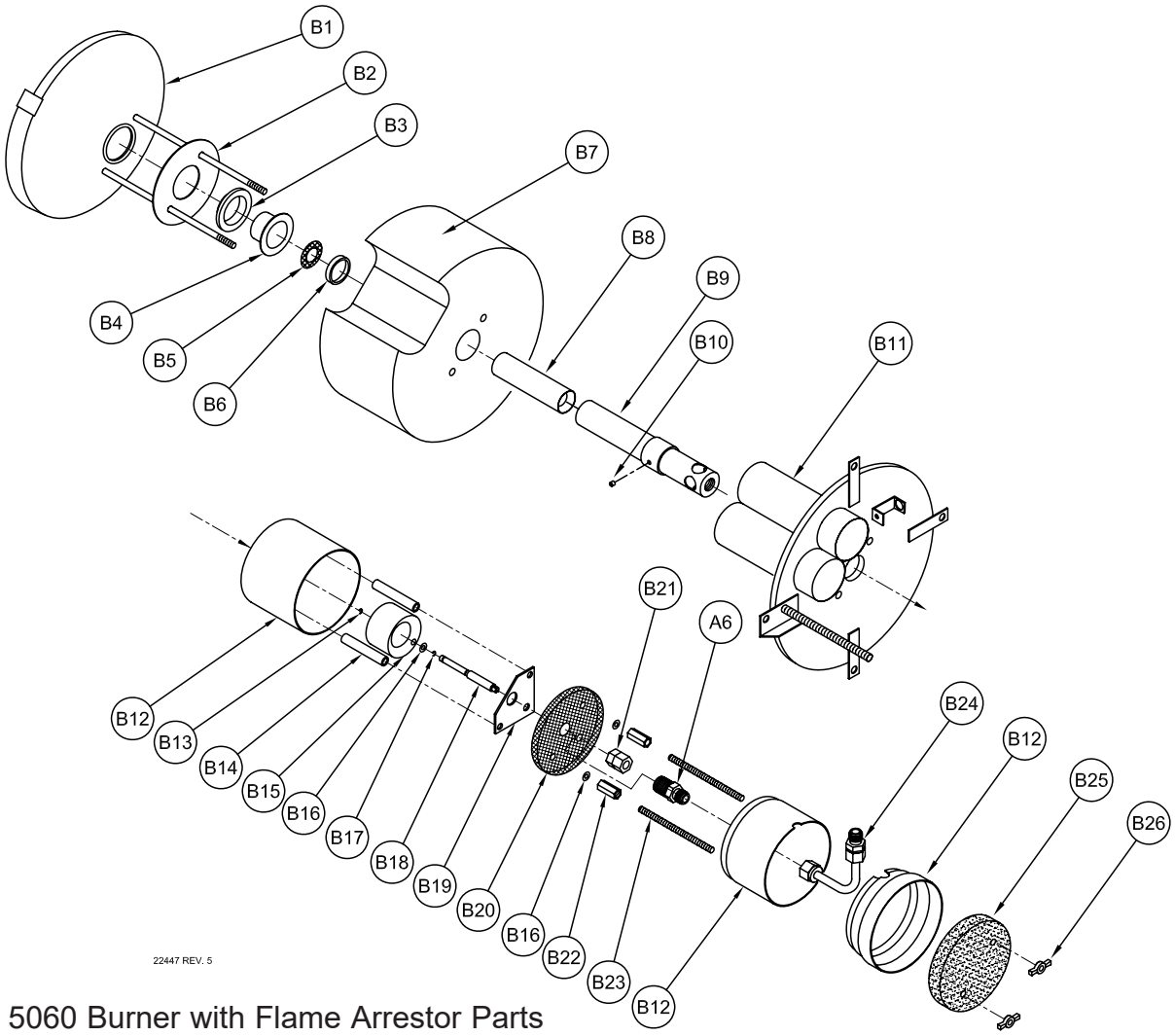

Figure 20 5060 Burner with Flame Arrestor Parts

Item	Part #	Description
B13	2900-00549	Retaining Ring, SS
B14	4000-01005	Burner Spacer
B15	4000-00990	Air Shutter
B16	2810-00569	Flat Washer, SS
B17	2900-07267	E-Ring, Bowed, SS
B18	400-00700	Venturi Adjustment Screw
B19	4000-00747	Venturi Plate Assembly
B20	4900-07683	Flame Arrestor Screen
B21	4000-00758	Nut, Lock, Venturi Adjustment Screw
B22	2710-07798	Nut, Coupling, 10-32, SS
B23	4900-07797	Extension Stud, Flame Arrestor
B24	4200-23004	Elbow, Fuel Line Skit
B25	4900-07684	Flame Arrestor
B26	2710-00601	Nut,Wing,10-32 SS

3.8 SI-SO Fuel System Parts List

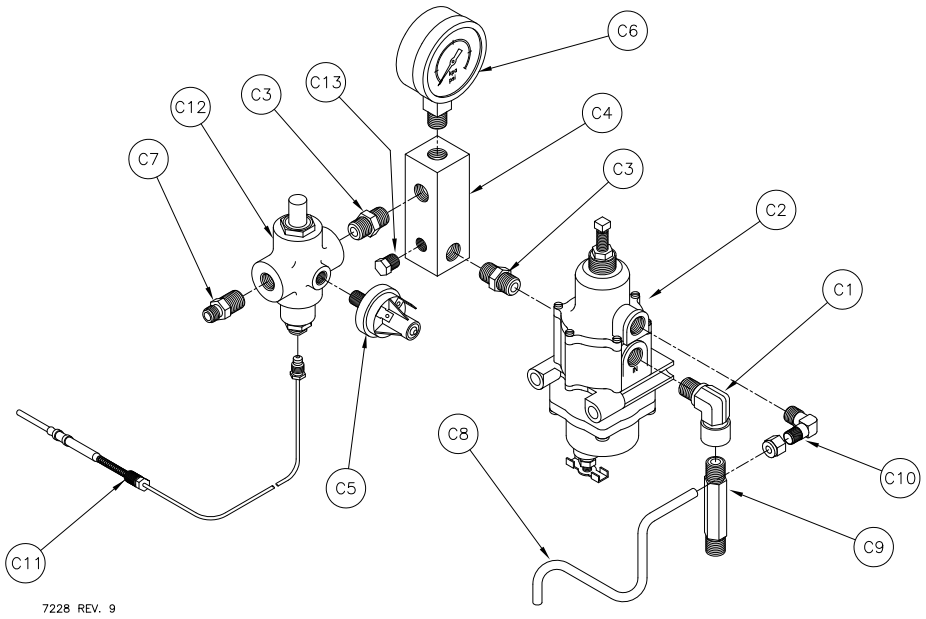

Figure 21 SI-SO Fuel System, Parts Illustration
*Alternate parts are for stainless fuel system

Item	Part No.	Description
C1	3034-00384	Elbow, Street, 1/4 NPT, Brass
	3034-02356	Elbow, Street, 1/4 NPT, SS-4-SE
C2	3100-02079	Regulator, 0-35 PSI
C3	3044-00376	Nipple, Close, 1/4 NPT X 2” LG. Brass
	3041-07291	Nipple, 1/4 NPT X 2.00, SS
C4	4900-02100	Manifold Block
C5	3400-06471	Pressure Switch, Hobbs 76056 16 NO
C6	3200-00691	Gauge, 0-15 PSI
	3200-07289	Gauge, Pressure, 0-15 PSI, SS
C7	3021-22790	Connector, Male, 1/4 TB X 1/4 NPT, SS
C8	4200-07981	Vent Tube Assy
C9	3044-02154	Nipple, Hex, 1/4 NPT X 3” LG, Brass
	3041-02358	Nipple, Hex, 1/4 NPT X 3 in. LG, SS
C10	3031-20071	Elbow, 1/4 Tube X 1/4 NPT, SS
C11	3400-00177	Thermocouple (order separately)
C12	3090-00176	Valve, Shut Off, Basco
C13	3054-00432	Plug, Brass 1/8 27 NPT
or	3051-07290	Plug, 1/8 - 27 NPT, SS
n/a	4200-22888	Fuel Filter Kit

4 220 Watt Limiter Converter

4.1 General Information

4.1.1 Product Application

This manual contains information pertaining to the 220 Watt L/C series limiter converter which is designed for use with a model 5060 requiring 12 or 24 Volt outputs.

4.1.2 Product Description

The 220 Watt L/C consists of two separate circuits operating together. The first is a shunt type voltage limiter that regulates the output of the generator. The second circuit is a DC to DC converter that switches the input voltage to a different output voltage. See Figure 22 for physical description.

4.1.3 Product Specifications

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 designed into the 220 Watt L/C. A 15 second short circuit will not damage the generator or the limiter converter. If extended short circuit durations are anticipated, an in-line fuse should be placed on the output of the limiter converter. Use 10 Amp slow blow for 5060-12, and use 5 Amp slow blow for 5060-24 configuration.

Reverse Current Protection is standard on all 220 Watt Limiter Converters. A diode in series with the output prevents current from flowing back through the converter when the generator is shut off.

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

4.2 Operation

4.2.1 Preparation for Use

The power conditioner is shipped ready for operation. If the limiter converter was shipped separately, it should be inspected for obvious dents or broken components. Notify the carrier if so.

4.2.2 Installation

The standard mounting location is on the right side of the generator cabinet. Remove the nuts and lock washers and mount to the outside of the cabinet. Feed the wires into the cabinet through the hole provided. Refer to Figure 23 to identify the input and output wires.

Check the selector switch setting (Figure 23) BEFORE connecting the input or output wires to the terminal block.

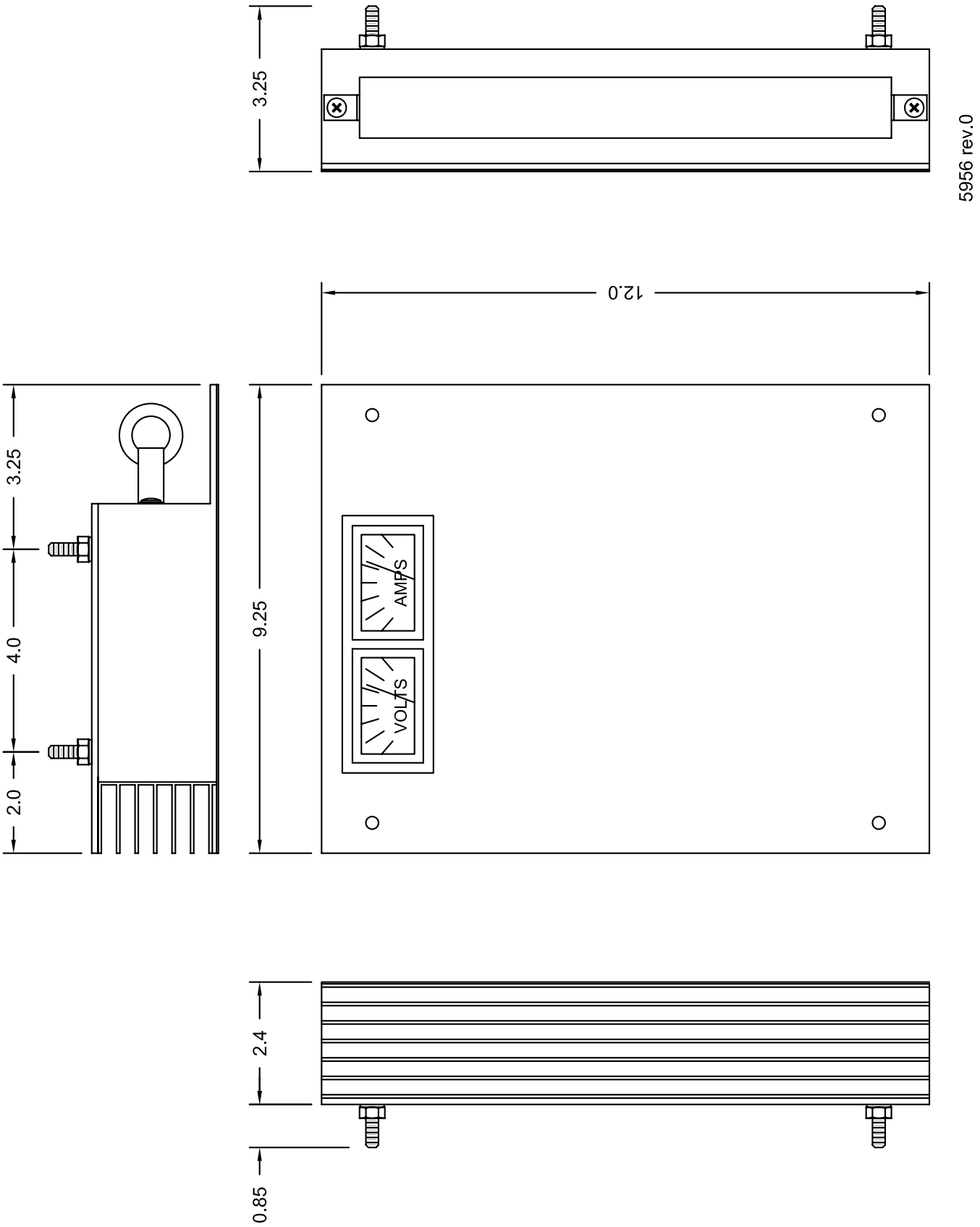

Figure 22 220 Limiter Converter Physical Description

Connect the 220 Watt L/C to the terminal block as per Figure 24.

Remote mounting of the limiter converter is acceptable, but allow for 17 Amps between the generator and the limiter converter when sizing wire.

The limiter converter must always be mounted in an upright position to allow air to pass freely over the heat sink section.

4.2.3 Output Voltage Adjustment

The 220 Watt limiter converter is factory set at 14.1 Volts or 27.0 Volts depending on the output ordered. To trim the output voltage use the output voltage adjustment pot shown in Figure 23. To change the output voltage range use the selector switch in Figure 23.

4.2.4 Protective Limiter

A protective limiter circuit is incorporated into the 220 Watt L/C to limit the input voltage. This setting can be measured across the TEG POS and TEG NEG terminals with no load connected. The 220 Watt L/C is factory set at 9 Volts for a 5060. When using a 220 Watt L/C on a generator other than what it was factory set for, the protective limiter must be readjusted at the factory.

4.2.5 Voltage Sensing Relay Adjustment

The VSR is factory set at 11.5 Volts for 14.1 Volt output and at 23.0 Volts for a 27.0 Volt output. Should this require adjustment, use the VSR adjustment pot in Figure 23.

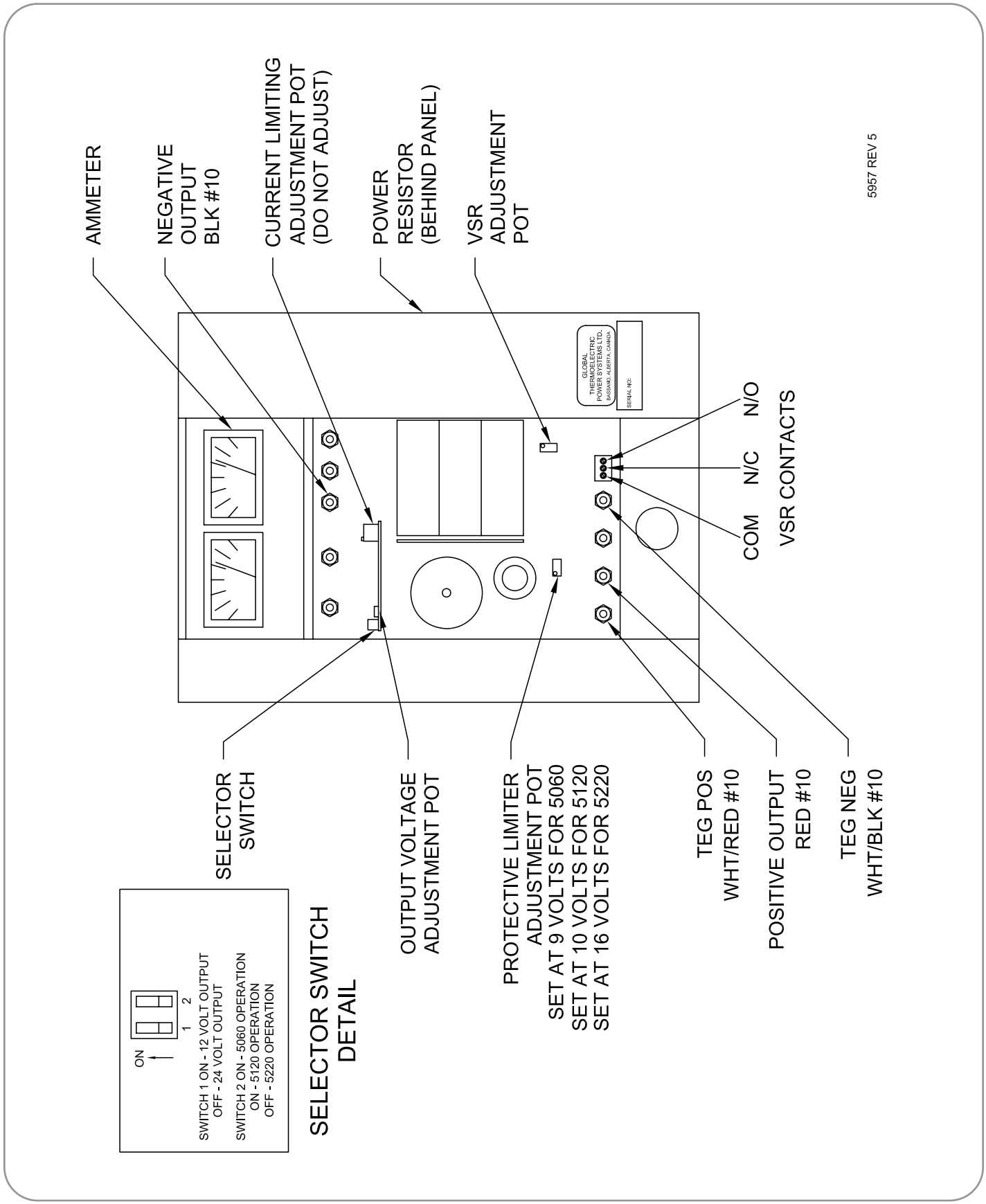

Figure 23 220 Watt L/C Connection and Adjustment Details

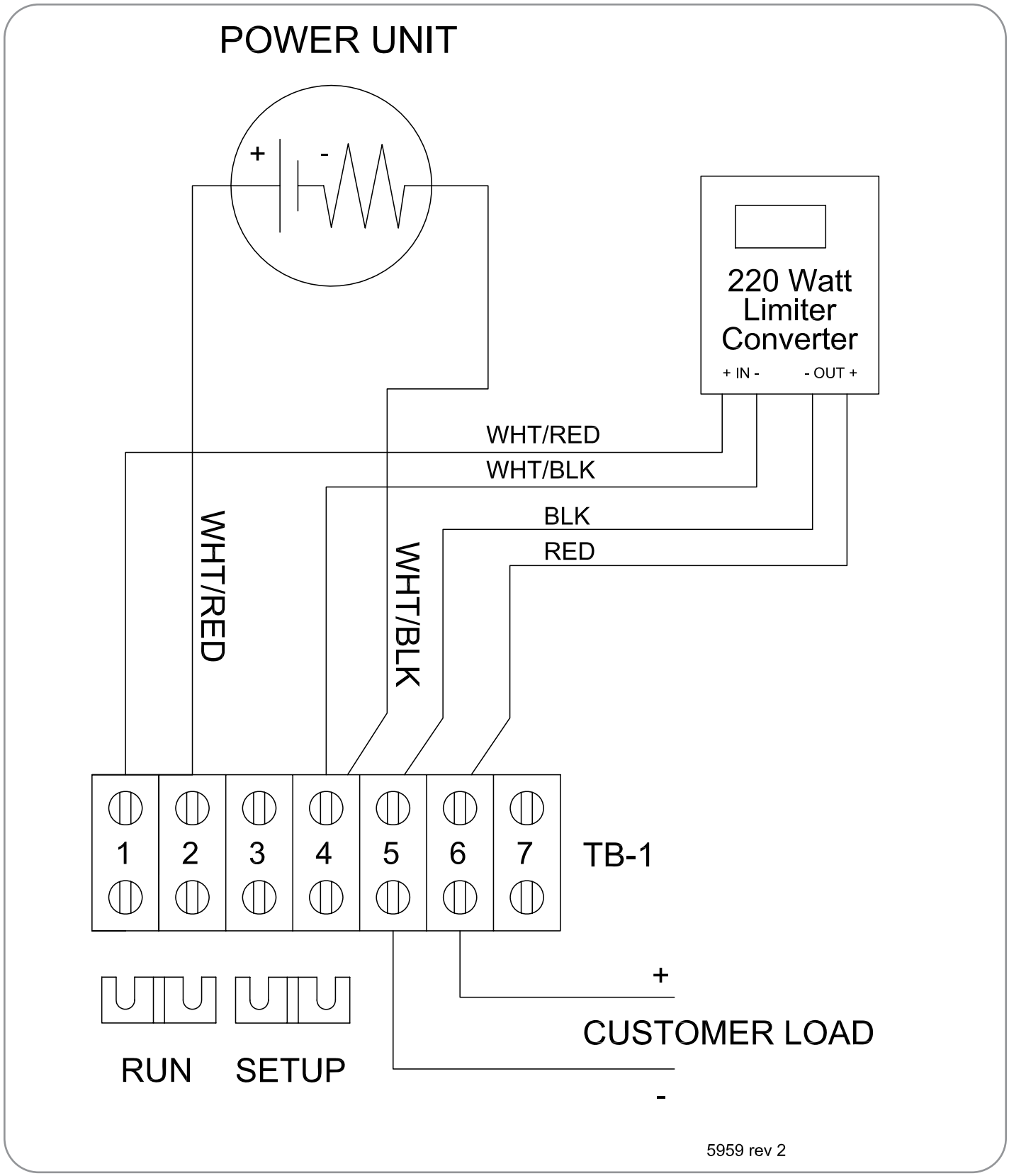

Figure 24 5060 Wiring diagram

5 Cathodic Protection Interface System

5.1 General Information

The Cathodic Protection Interface provides for adjustment and monitoring of power to the 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 25 for locations and description of the major components of the CP Interface Cabinet.

5.1.1 Meter

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

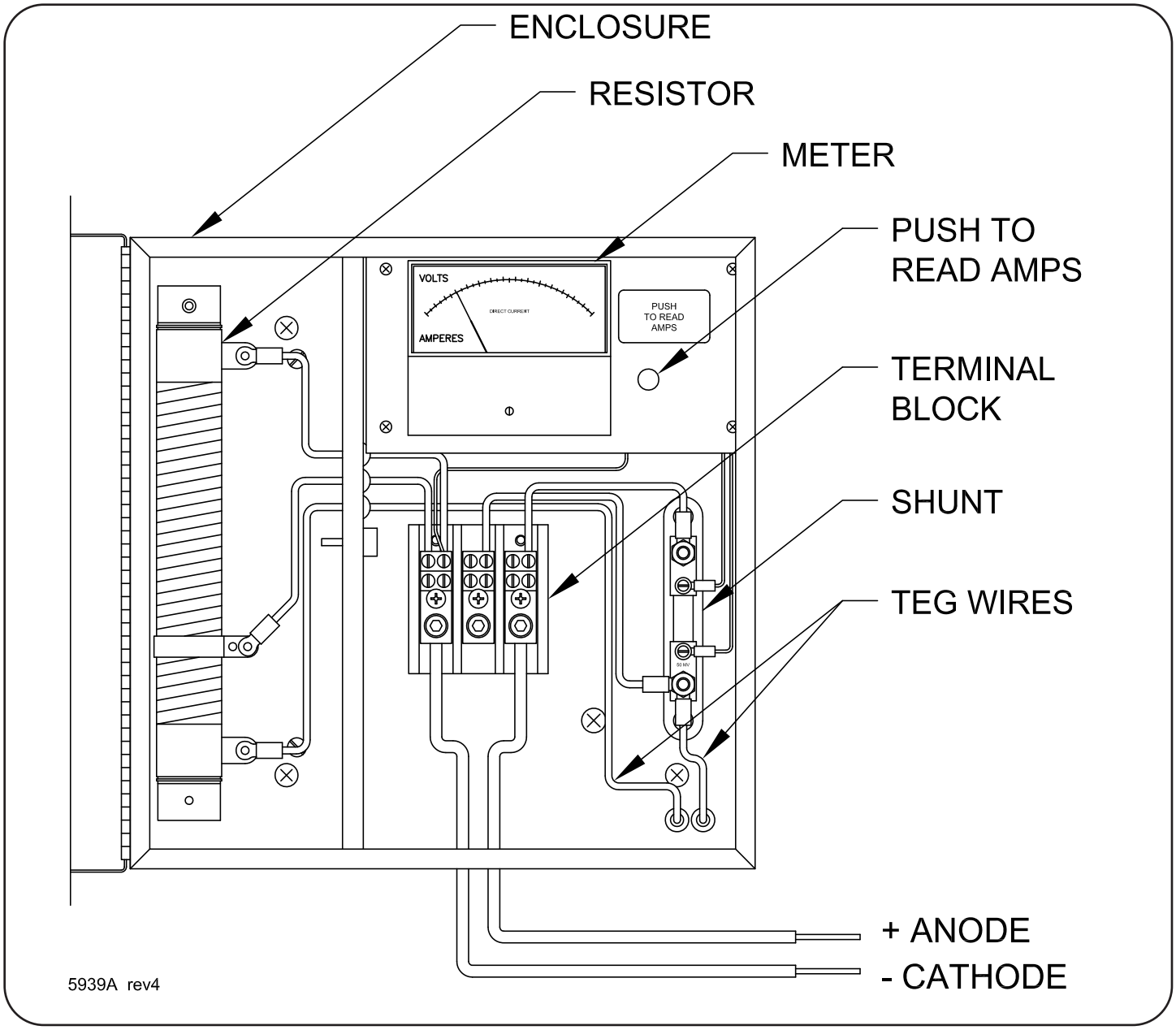

Figure 25 Cathodic Protection Interface Cabinet

5.1.2 Current Shunt

A shunt is used to measure the current to the terminal block. The voltage drop accross the shunt is proportional to the current flowing through it. The current shunt rating corresponds to the ampere scale on the meter.

5.1.3 Adjustments

A 0 to 1 ohm, 300 Watt variable resistor located inside the cabinet may be used to adjust the output power of the CP interface. This resistor may be connected in series or parallel with the TEG. See Figure 26 for series connection and Figure 27 for parallel Connections.

5.1.4 Series

By connecting the300 Watt resistor in series with the TEG the maximum allowable power may be delivered to the CP load. This is achieved by moving the tap to the bottom of the resistor.

5.1.5 Parallel

By connecting the 300 Watt resistor in parallel with the TEG smaller levels of power may be delivered to the CP load. This may be required when hot spots occur on the anode. With the tap located at the top of the resistor the output power will be zero. As the tap is moved down, the power to the CP load is increased.

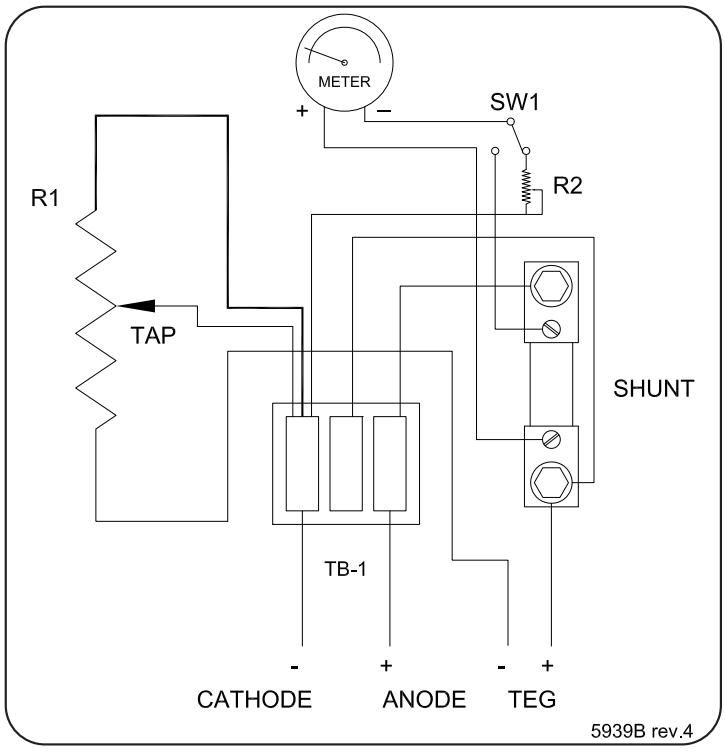

Figure 26 Wiring Diagram, CP Interface in Series Connection

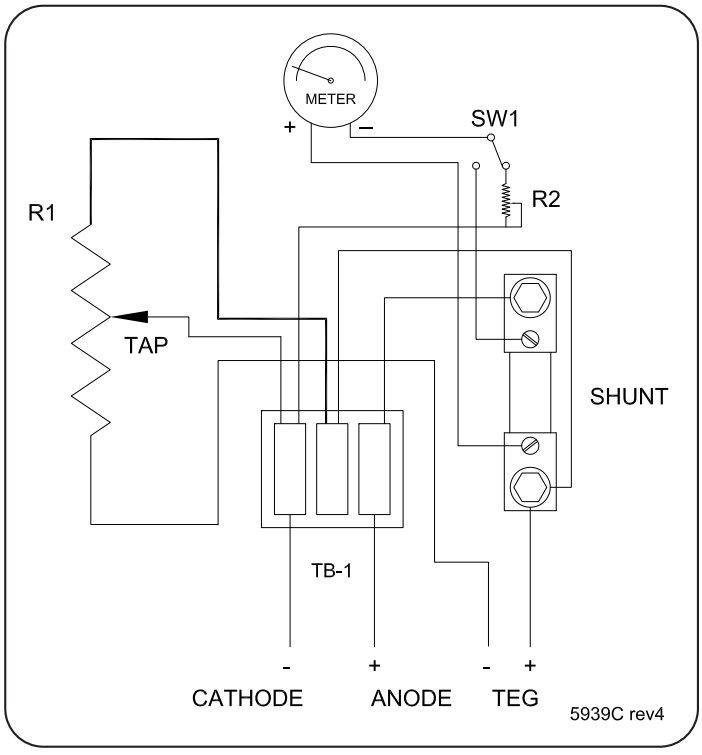

Figure 27 Wiring Diagram, CP Interface in Parallel Connection

Series and Parallel configurations are made by moving the wire at the top of the 300 Watt resistor from the left position to the center position of the heavy duty terminal block.

Comoplete parts listings are given in the next five pages for the various Cathodic Protection Interface System available. The suggested system for various TEGs are listed below.

TEG	Item	System Description
5060	6300-06222	CP Interface System Assy, 0-15V, 0-30A
5060-12	6300-06223	CP Interface System Assy, 0-20V, 0-10A
5060-24	6300-06224	CP Interface System Assy, 0-30V, 0-5A

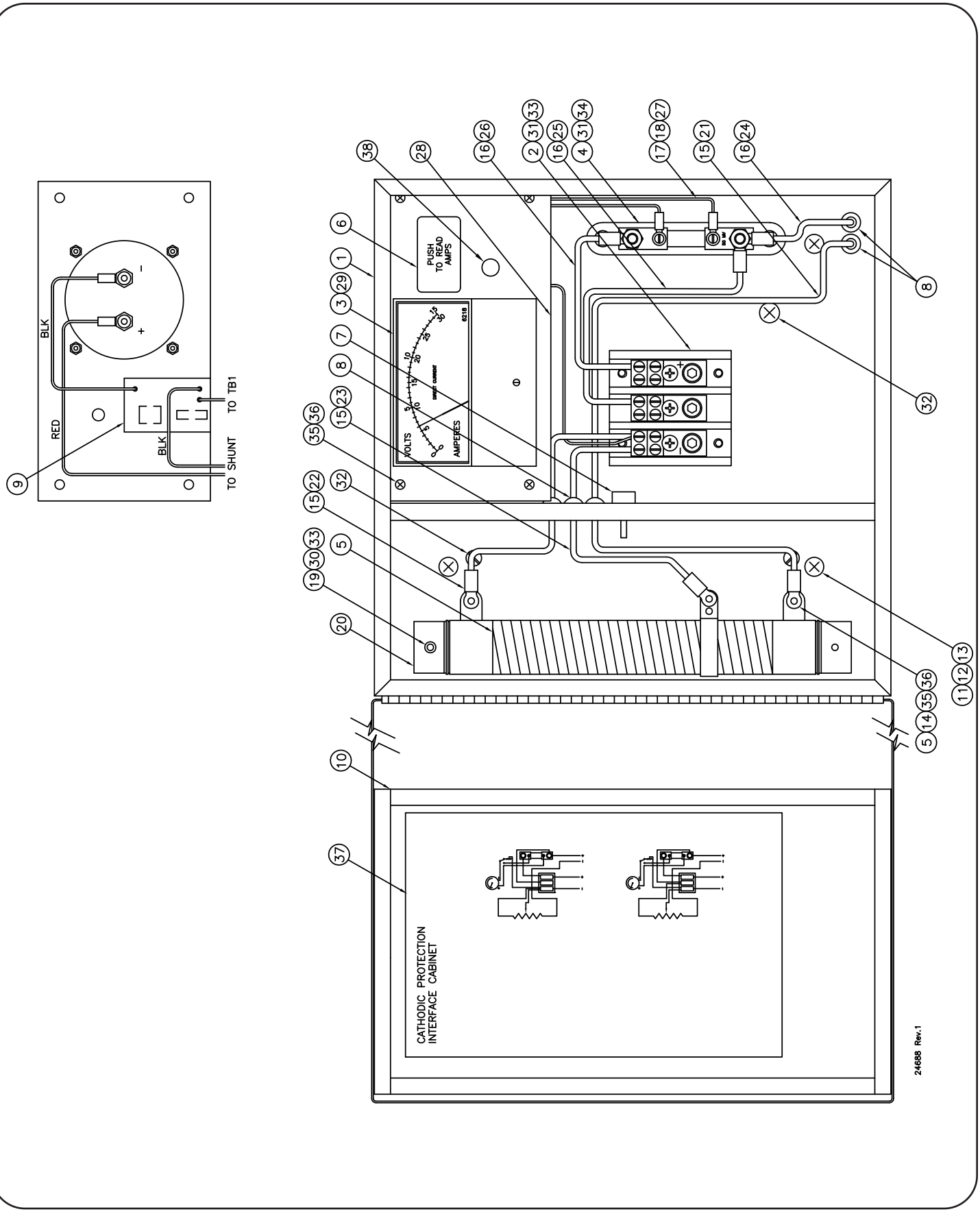

Figure 28 Cathodic Protection System Parts Identification

Item	Part No.	Description	QTY
1	4900-01839	Box, Cathodic Protection Shell	1
2	2200-06714	Terminal Block, Heavy Duty, 3 Pole	1
3	2420-06218	Meter Face, 0-15V, 0-30A (for panel #6300-06222)	
1			
	2420-06219	Meter Face, 0-20V, 0-10A (for panel #6300-06223)	1
3	2420-06220	Meter Face, 0-20V 0-5A (for panel #6300-06224)	1
	2420-06221	Meter Face, 0-30V, 0-30A (for panel #6300-06225)	1
4	2400-06217	Current Shunt, 30A, 50mV (for panel #6300-06222 & 06225)	1
	2400-06216	Current Shunt, 10A, 50mV (for panel #6300-06223)	1
	2400-06215	Current Shunt, 5A, 50mV (for panel #6300-06224)	1
5	2410-00087	Resistor, 1 ohm, 300 Watts	1
6	3600-01931	Label, Pust to Read AMPS	1
7	2900-03192	Plug, Bumper	1
8	2900-01947	Grommet, Rubber, 1/4 X 1/8”	5
9	4400-02284	CP Meter Adjust Assy	1
10	1600-01851	Weather Stripping, 3/8” X 1/8” THK	39
11	2514-00258	Screw, Mach, P-H-P, 1/4 - 20 X 5/8, SS	4
12	2814-00473	Washer, Lock, ext, 1/4, SS	8
13	2714-00611	Nut, Hex, 1/4-20, SS	8
14	2708-00606	Nut, Hex, 8-32, SS	3
15	2010-00208	Term, Ring, Yellow, #10	3
16	2010-00201	Term, Ring, Yellow, 1/4	3
17	2010-00202	Term, Ring, Red, 1/4	1
18	2010-00213	Term, Ring, Red, #6	1
19	2810-00569	Washer, Flat, 0.203 ID, 0.049 THK	2
20	2400-00086	Mounting Hardware, 300 W Resistor	1
21	2110-00156	Wire, #10, wht/blk, TIN-PLT-COP	35
22	2110-00156	Wire, #10, wht/blk, TIN-PLT-COP	8.5
23	2110-02041	Wire, #10, brn, TIN-PLT-COP11	
24	2110-00157	Wire, #10, wht/red, TIN-PLT-COP	24
25	2110-00157	Wire, #10, wht/red, TIN-PLT-COP	8
26	2110-00157	Wire, #10, wht/red, TIN-PLT-COP	4.25
27	2120-00133	Wire, #20, red, TIN-PLT-C	11
28	4900-02134	Meter Panel, CP, Brushed	1
29	2420-06226	Meter, GE/TCA, 251-324-ECXS	1
30	2510-00255	Screw, Mach, P-H-P, 10-32 x 3/8, SS	2
31	2510-00256	Screw, Mach, P-H-P, 10-32 x 1/2, SS	6
32	2510-00243	Screw, Mach, P-H-S, 10-32 x 1/4, SS	6
33	2808-00469	Washer, Lock Spring, #8, SS	6
34	2810-00539	Washer, Lock, Spring, #10, CAD	2
35	2508-00254	Screw, Mach, P-H-P, 8-32 x 3/8, SS	7
36	2808-00468	Washer, Lock, Int, #8, SS	10
37	3600-04795	Label, Cathodic Protection Interface	1
38	Part of Item 29	Button, Red, 61F-675, For ALCO Switch	11

6 Flame Arrestor Kit Installation and Operation

6.1 Important Warning

The Model 5060 TEG with Flame Arrestor Kit has 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.

The Flame Arrestor Kit includes a flame arrestor on the air intake, which has been tested in compliance with CSA standard Z343-98. Global Power Technologies (GPT) considers compliance with API 12N and CSA Z343-98 as evidence that the Flame Arrestor Kit is adequate for use in unclassified areas.

Ultimately, decisions concerning the installed location and operation of a TEG (with or without a flame arrestor) are the responsibility of the customer, and installations should comply with all applicable regulations. It must be noted that if a customer defines an area as hazardous (ie. may contain hazardous gases such as in a Class 1, Division 2 area) then TEG models 1120 & 1500 are the only TEGs suitable for installation in these hazardous areas. The addition of a flame arrestor kit does not make the Model 5060 TEG suitable for use in a hazardous area. For hazardous area use, TEGs require reduced surface temperatures (below hazardous gas ignition temperatures), addition of air intake and exhaust flame arrestors, and other modifications.

All TEG operators should be trained to follow the safe start-up procedure as outlined in the applicable TEG operating manual. GPT offers formal training programs on a regular basis. For further information contact GPT at (403)236-5556.

6.1.1 Product Bulletin

GENTHERM GLOBAL POWER TECHNOLOGIES

BULLETIN PB-5060-001

INFORMATION

PRODUCT: 5060 TEG

DATE: 25-FEB-2011

SERIAL NUMBER RANGE:

START: none
END: none

PRODUCT BULLETIN

5060 with Optional Flame Arrestor Kit

5060N-12-SI-SO-FA: PN 9560-08230
5060N-24-SI-SO-FA: PN 9560-08231

This document clarifies the design of the Flame Arrestor Kit used in Gentherm Global Power Technologies (GPT) general-purpose Model 5060N thermoelectric generator (TEG).

It must be noted that if a customer defines an area as hazardous (i.e. may contain hazardous gases such as in a Class 1, Division 2 area) then TEG models 1120 & 1500 are the only GPT TEGs suitable for installation in these hazardous areas. The addition of a flame arrestor kit does not make the Model 5060 suitable for use in a hazardous area. For hazardous area use, TEGs require reduced surface temperatures (below hazardous gas ignition temperatures), addition of air intake and exhaust flame arrestors, and other modifications.

The natural gas fueled Model 5060N TEG with Flame Arrestor Kit has 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.

The Flame Arrestor Kit includes a flame arrestor on the air intake, which has been tested in compliance with CSA standard Z343-98. GPT considers compliance with API 12N and CSA Z343-98 as evidence that the Flame Arrestor Kit is adequate for use in unclassified areas.

Ultimately, decisions concerning the installed location and operation of a TEG (with or without a flame arrestor) are the responsibility of the customer, and installations should comply with all applicable regulations.

All TEG operators should be trained to follow the safe start-up procedure as outlined in the applicable TEG operating manual. GPT offers formal training programs on a regular basis. For further information contact GPT at the number below.

For more information contact:

Local Representative:

Alternate Contact:
Customer Service
Gentherm Global Power Technologies, Canada
001-403-236-5556
Customer.Service@Globalte.com

PB-5060-001 BULLETIN CLASS: ■MANDATORY UPDATE □FIX ON FAILURE ■INFORMATION

6.2 Introduction

The flame arrestor kit for the model 5060 Thermoelectric Generators consists of three main sub-assemblies. These are:

1. An Air Intake Flame Arrestor Kit, GPT P/N 4900-23043.

2. A Flame Arrestor Stack Assembly, GPT P/N 4500-50178, plus Gasket, GPT P/N 4500-50198 and stack spacer, GPT P/N 4900-50196.

3. A Rain Cap Assembly, GPT P/N 4500-51516 & Flange, Exhaust Stack P/N 4500-28376

4. A Label to apply to the front door of the TEG, GPT P/N 3600-50222

Please refer to Figure 1 to identify these major sub-assemblies as installed on a Model 5060 Thermoelectric Generator.

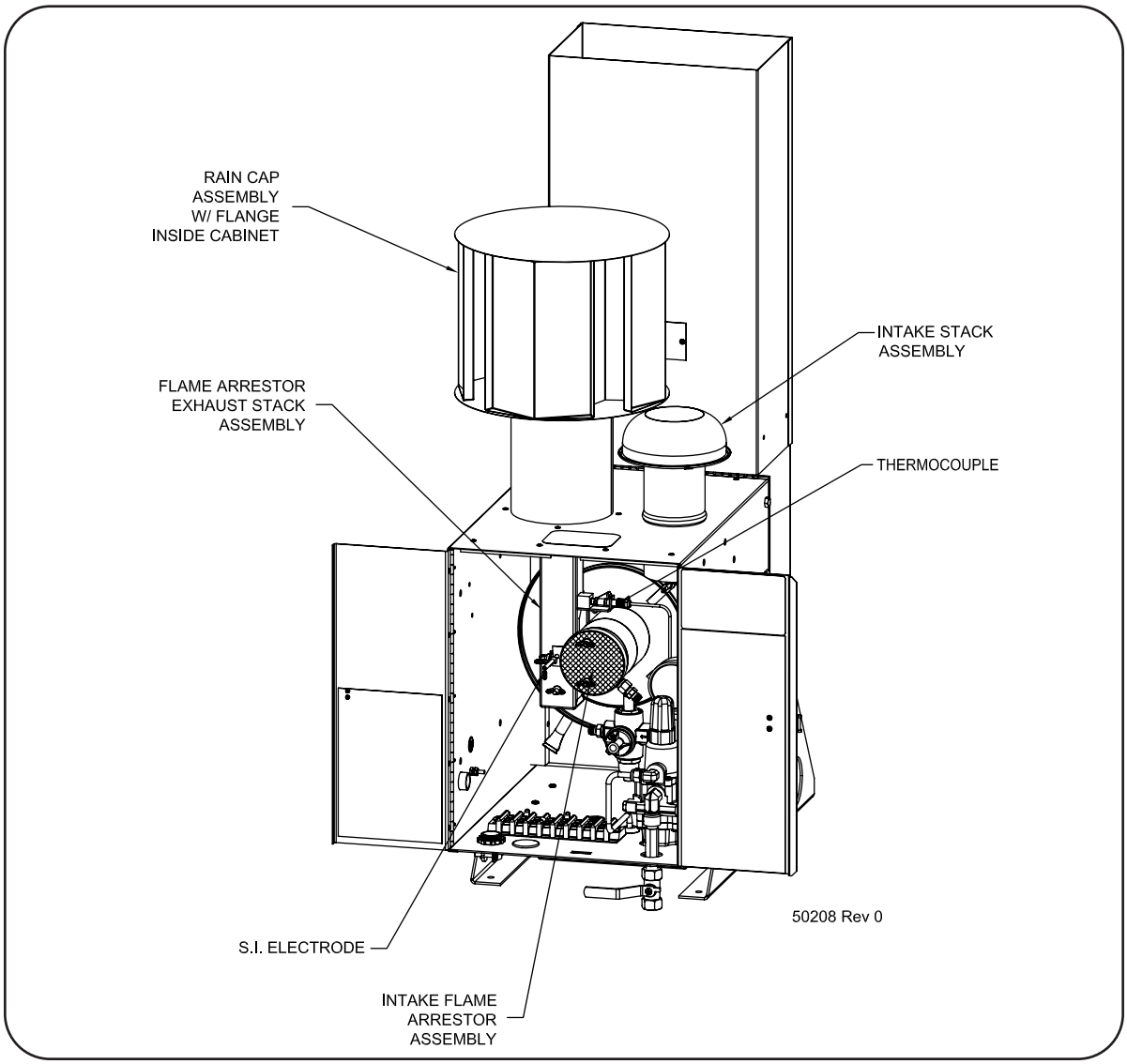

Figure 29 Flame Arrestor Kit - Installed

6.2.1 Trained Operators

Personnel performing installation, operation, service and maintenance work should be properly trained in such functions. Installation of this flame arrestor kit must be performed by a qualified service person who must inspect the generator before installation and again after the set-up is complete. Qualified service personnel must also perform an annual inspection of the generator and flame arrestor.

6.2.2 Surface Temperatures

When the TEG is operating, surface temperatures in the vicinity of the thermopile, burner, exhaust stack and around the cooling fins may be in excess of 100°C. Avoid contact of skin and clothing with these areas when operating in and around the TEG. Allow the TEG to cool sufficiently before performing any work. The burner area can remain very hot for some time after shutdown.

6.3 DISASSEMBLY

Before installing the Flame Arrestor kit, the existing Exhaust Stack, Inner Stack, Fuel Line, Thermocouple and Air Intake must be removed. Figure 30 shows the items that must be removed. See below for the disassembly procedure.

WARNING: Allow the TEG to cool sufficiently before performing any work. The burner area and exhaust can remain very hot for some time after shutdown.

6.3.1 Remove Stacks:

Figure 31 shows the removal of the inner and outer exhaust stacks.

Remove the outer exhaust stack assembly by loosening the band clamp inside the top of the TEG cabinet. Leave the intake stack assembly in place.

Remove the S.I. electrode by loosening the large wing nut on the front of the inner exhaust stack and pulling the electrode straight out. Inspect the electrode carefully. If it is damaged, or the ceramic insulator is cracked it MUST be replaced with Global Power Technologies (GPT) P/N 4200-02032.

Remove the inner exhaust stack assembly by removing the smaller 10-32 wing nut on the front of the exhaust stack, then gently pulling the inner stack assembly straight back. Save the wing nut for the installation of the new inner stack.

6.3.2 Remove Fuel Line and Thermocouple:

Figure 32 shows the removal of the fuel line, fuel orifice and thermocouple.

a) Disconnect the flexible fuel line from the fuel manifold using a 9/16 wrench.

b) Disconnect the other end of the flexible fuel line and attached orifice from the front of the air screen, using a 9/16 wrench if necessary.

c) Remove the orifice fitting from the the flexible fuel line using two 9/16 wrenches.

d) Visually check the orifice hole. It should be free from any obstructions. Replace if necessary.

e) Loosen the lock-nut on the thermocouple with a 7/16 wrench and remove the thermocouple from its bracket on the Combustion Chamber assembly. It is not necessary to remove the thermocouple connector from the base of the safety shutoff (SO) valve unless replacing the thermocouple.

f) Inspect the thermocouple carefully. If it is damaged, or threads on the lock nut are stripped, disconnect the thermocouple connector from the base of the SO valve with a 3/8 wrench, and replace the thermocouple with GPT P/N 3400-00177.

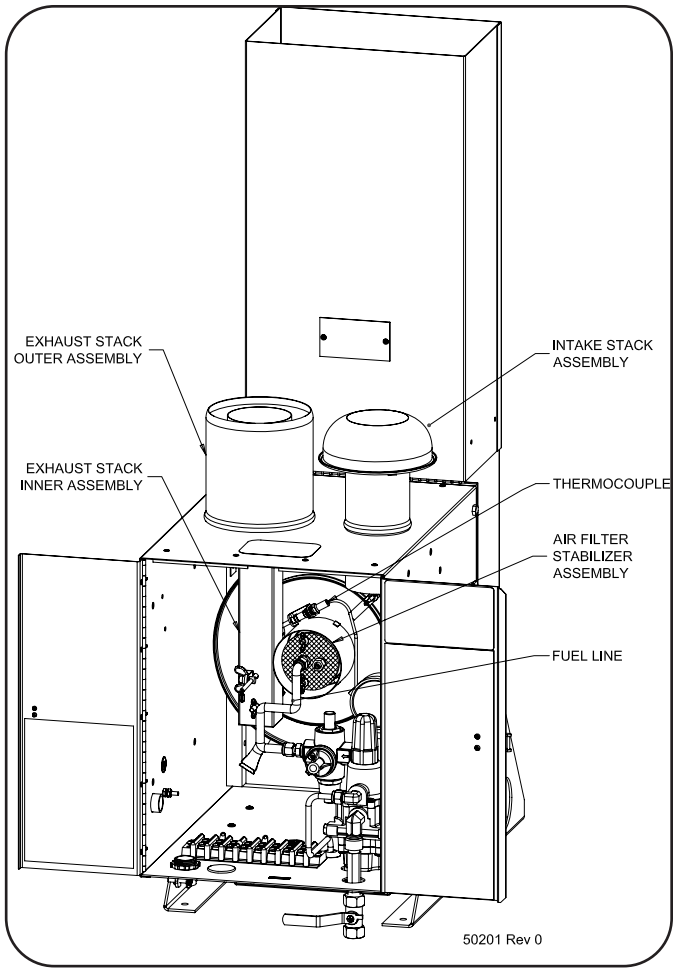

Figure 30 Items for Removal, Flame Arrestor Installation

6.3.3 Remove Air Intake Assembly:

Figure 33 shows the removal of the Air Intake and Air Shutter assemblies.

a) Attach the Flame Arrestor Kit label, GPT P/N 3600-50222 to either front door of the TEG.

b) Loosen the air shutter lock nut on the front of the air filter stabilizer assembly.

c) Using a flat blade screwdriver, close the air shutter by turning the air shutter adjustment screw counter-clockwise.

d) Count the number of turns required to close the air shutter.

e) Remove the 10-32 wing nuts and air shutter lock nut from the front of the air filter stabilizer assembly. Save these fasteners for installation of the flame arrestor intake.

f) Remove the air filter stabilizer assembly.

g) Remove the air shutter and burner spacers. Save these items for installation with the flame arrestor intake.

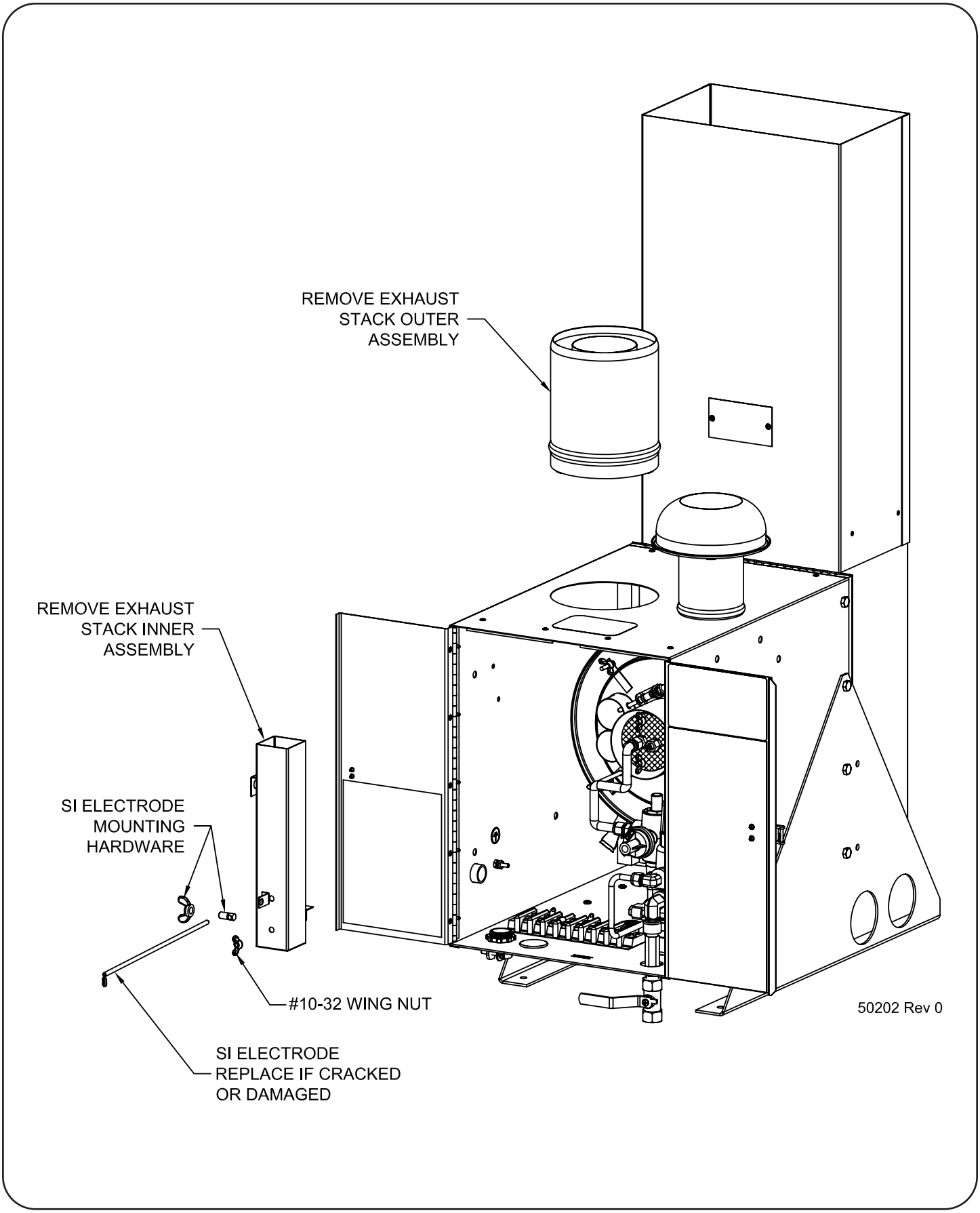

Figure 31 Exhaust Stack Removal

h) Inspect the air shutter bore and adjustment screw threads for evidence of galling or seizing.

j) Replace the appropriate parts if necessary.

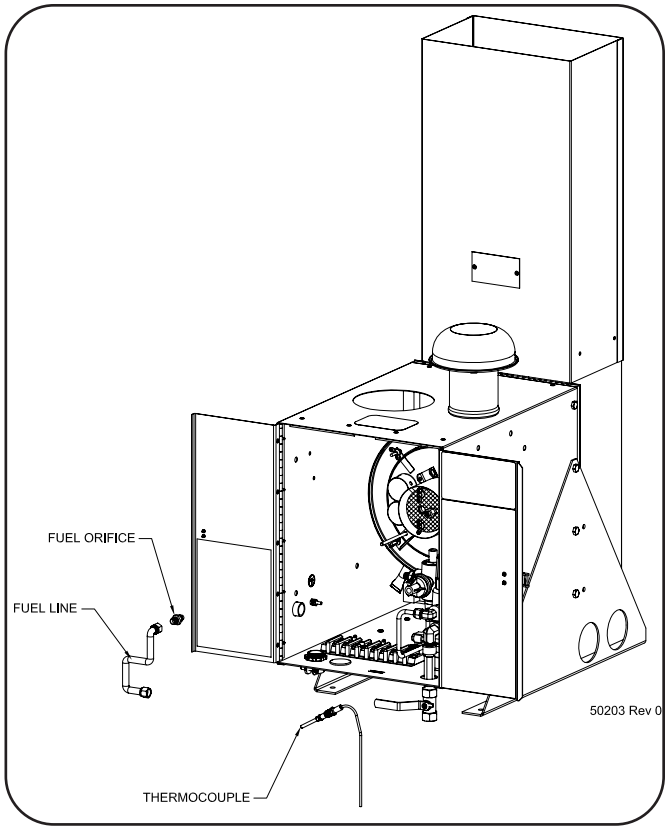

Figure 32 Fuel Line and Thermocouple Removal

6.3.4 Inspection

WARNING: Before proceeding any further, carefully inspect the following important items. Repair or replace as necessary.

a) Inspect the S.I. electrode carefully. If it is damaged, or the ceramic insulator is cracked it MUST be replaced with Global Power Technologies (GPT) P/N 4200-02032.

b) Visually check the orifice hole. It should be free from any obstructions. Replace if necessary.

c) Inspect the thermocouple carefully. If it is damaged, or threads on the lock nut are stripped, disconnect the thermocouple connector from the base of the SO valve with a 3/8 wrench, and replace the thermocouple with GPT P/N 3400-00177.

d) Inspect the air shutter bore and adjustment screw threads for evidence of galling or seizing. Replace the appropriate parts if necessary.

e) Inspect the Burner Cover assembly as it is installed in the TEG. See Figure 33. If there is any deformation of the exhaust tubes, or if the Burner Cover plate has warped and is no longer flat, the complete burner needs to be replaced or overhauled by qualified personnel.

6.4 INSTALLATION

WARNING: Follow the installation procedures carefully! The flame arrestor design and these instructions are intended to keep all joints or seams between parts tight. Failure to follow these instructions exactly, using worn or damaged parts, or installing items incorrectly may result in personal injury or death and possible damage to the equipment and/or property.

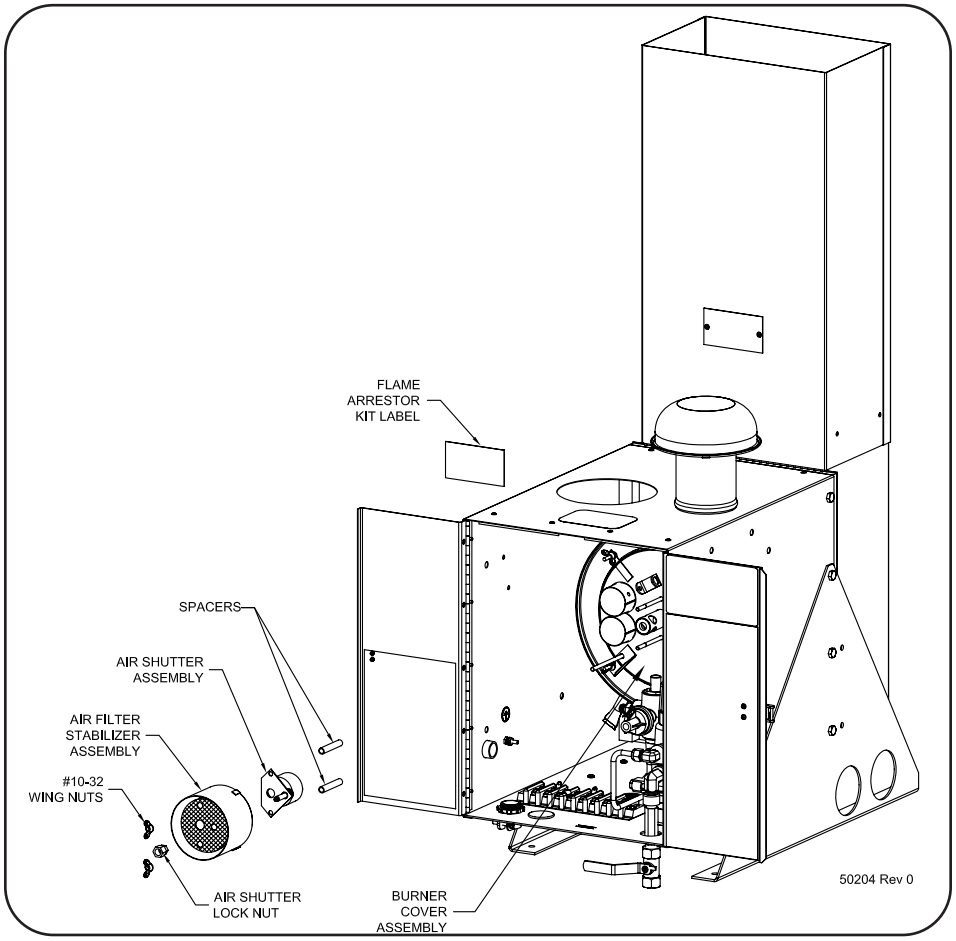

Figure 33 Air Intake and Air Shutter Removal

6.4.1 Install Flame Arrestor Air Intake:

Figure 34 shows the installation of the Flame Arrestor Air Intake.

a) Install the Flame Arrestor Can over the Venturi tube assembly and the two stud bolts protruding from the combustion chamber assembly. Make sure that the base of the can sits tight to the combustion chamber back plate.

b) Install the burner spacers over the combustion chamber stud bolts and slide the air shutter assembly over the bolts, up to the spacers.

c) Carefully place the flame arrestor screen over the combustion chamber stud bolts, venturi adjustment screw and inside the flame arrestor can. Install two (2) #10 flat washers to protect the screen, then install the two #10-32 x ¾ coupling nuts and the venturi adjustment locknut.

d) Close the air shutter completely by turning the air shutter adjustment screw counter clockwise. Then set the air shutter by turning the adjustment screw clockwise three (3) to four (4) full turns clockwise.

e) Install the burner orifice through the flame arrestor screen and tighten only hand tight into the venturi tube assembly inlet.

Caution: **Always use the correct size burner orifice, 5060 Natural Gas Orifice (#6), GPT P/N 4200-00688. The flame arrestor kit is not approved for use on a 5060 generator operating on propane fuel.**

f) Install the two (2) flame arrestor extension studs into the coupling nuts and place the flame arrestor can spacer over the studs.

g) Install, but do not tighten yet, the fuel line kit elbow into the fuel orifice fitting. Note that the short leg of the elbow, without the grommet, attaches to the orifice.

h) Rotate the fuel line elbow and flame arrestor can spacer so that the notch in the can aligns with the groove of the grommet on the fuel line elbow. Make sure that the fuel line fitting points away from the combustion chamber exhaust tubes, then tighten the fuel line fitting onto the fuel orifice with two 9/16 wrenches. See Figure 34.

i) Connect one end of the flexible fuel line to the fuel manifold. Connect and tighten the free end of the flexible fuel line to the fitting on the fuel line elbow kit using a 9/16 wrench.

WARNING: Check the system for fuel leaks at this point!

j) Rotate the flame arrestor element holder so that the notch in the can aligns with the groove of the grommet on the fuel line elbow. Slide the flame arrestor element holder inside the flame arrestor can spacer.

k) Rotate the flame arrestor element so that the two holes align with the flame arrestor extension studs. Install two (2), #10 flat washers and 10-32 wing nuts, then tighten.

6.4.2 Install Flame Arrestor Stack and Thermocouple:

Figure 35 shows the installation of the Flame Arrestor inner stack and thermocouple.

a) Carefully place the high temperature gasket over the combustion chamber exhaust tubes. The gasket is CRITICAL for proper operation. Do not use it if it is damaged. Obtain a new gasket, GPT P/N 3400-50198 if required.

b) Install the stack spacer sleeve over the 10-32 stud protruding from the burner cover plate, directly below the exhaust tubes. The spacer is CRITICAL for proper operation. Obtain a new spacer, GPT P/N 4900-50196 if required.

c) Carefully install the flame arrestor inner stack assembly over the burner cover exhaust tubes and the 10-32 stud protruding from the burner cover plate, until it contacts the high temperature gasket. Install the #10-32 wing nut on the combustion chamber stud and tighten. Check that the gasket is compressed evenly.

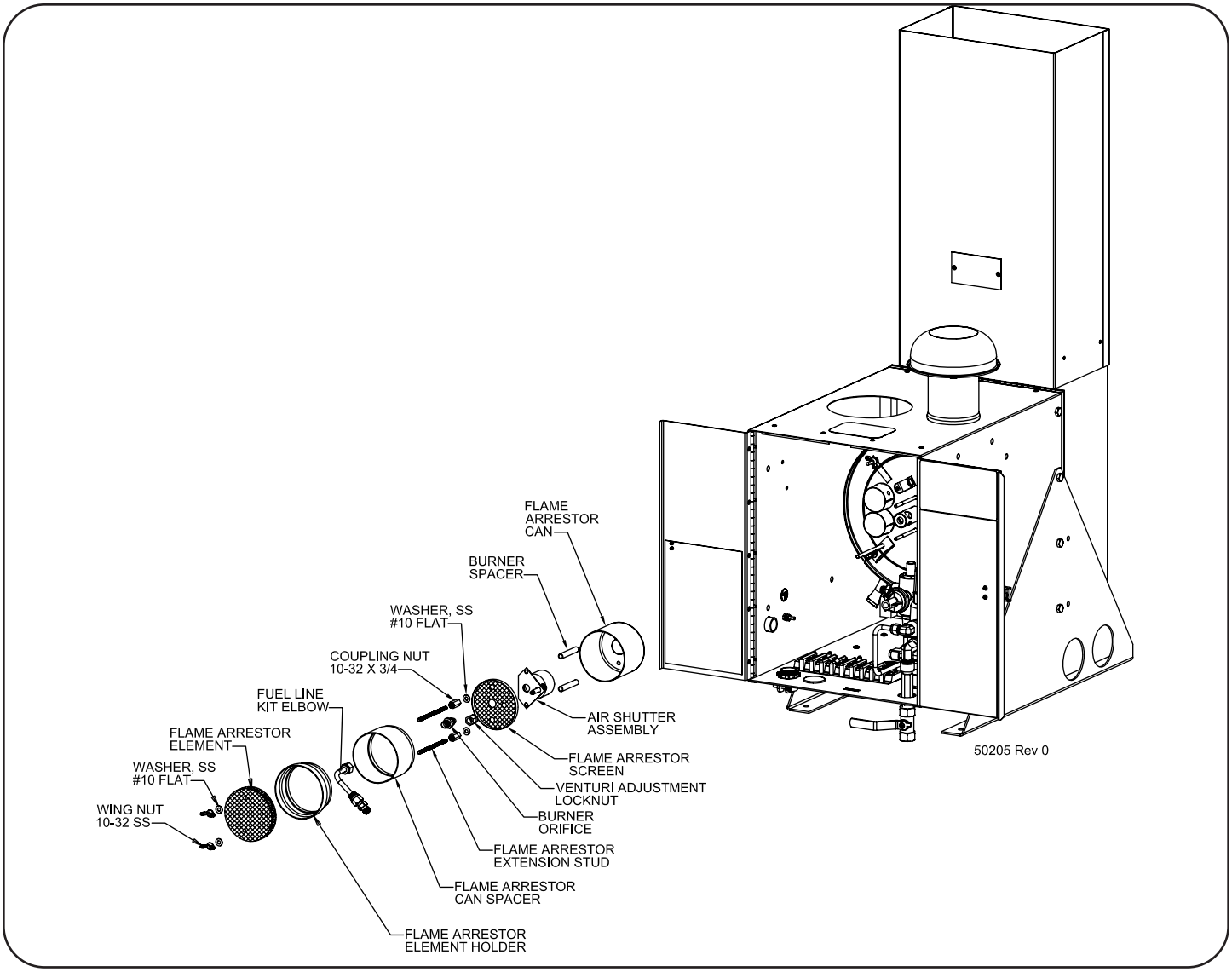

Figure 34 Intake Flame Arrestor Installation

d) Install the thermocouple into the mounting boss on the right side of the inner stack assembly. First, tighten the thermocouple lock nut finger tight only. Then, support the mounting boss with a 5/8 wrench and snug the thermocouple lock nut with a 7/16 wrench.

WARNING: Do not twist the inner stack assembly when installing the thermocouple, or the gasket may be damaged.

e) Loosely install the electrode mounting pin and large wing nut into the electrode bracket on the front of the inner stack assembly.

f) Feed the electrode through the hole in the mounting pin, then the hole in the mounting bracket and through the electrode hole in the burner back. Adjust the spark gap as directed in the appropriate section of the TEG operating manual.

g) Tighten the wing nut only until it is snug.

Caution: Do not over tighten the wing nut or the ceramic rod will crack.

h) Connect the high voltage spark wire to the electrode.

6.4.3 Install Rain Cap Assembly:

Figure 36 shows the installation of the Rain Cap Assembly.

a) Using the mounting flange as a template, drill 4 holes (9/16 diameter) in the top of the cabinet.

b) Install the rain cap assembly in the large hole in the cabinet top, centered over the flame arrestor inner stack.

c) Install the mounting flange from inside the cabinet. Use the 1/4-20 Hex head screws, washers and nuts to fasten in place.

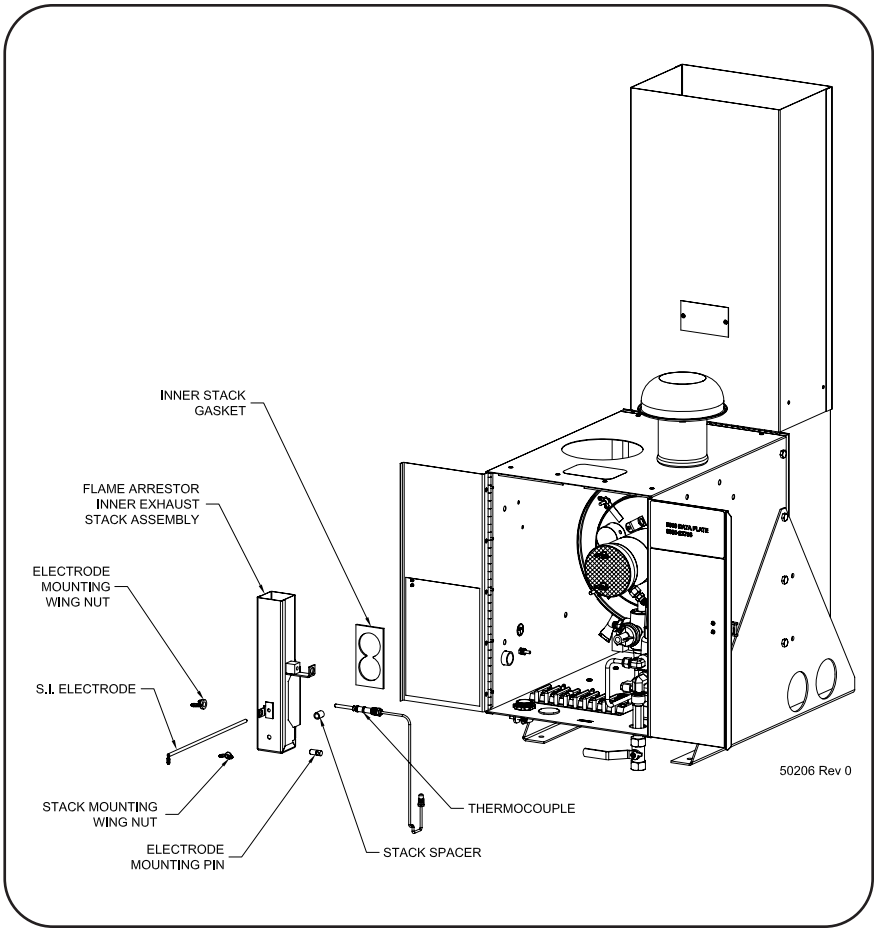

Figure 35 Flame Arrestor Stack and Thermocouple Installation

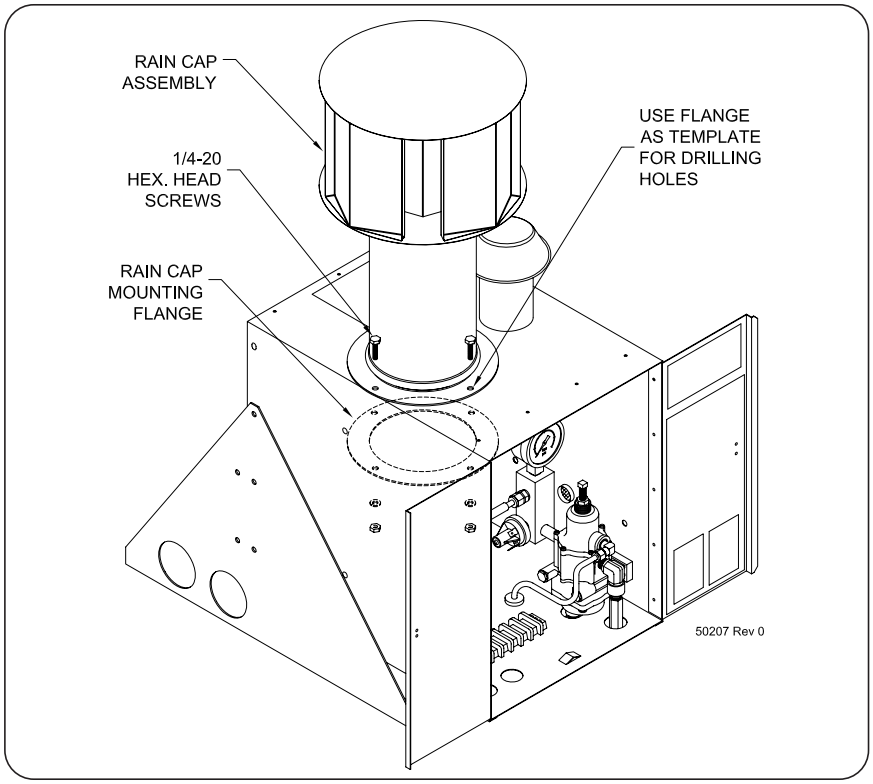

Figure 36 Rain Cap Installation

6.5 SET-UP

WARNING: Before starting the TEG, make sure that the area is free of all combustible gases.

Follow the start-up and adjustment procedures as indicated in the appropriate section of the TEG operating manual, noting the following items:

When setting fuel pressure on a 5060 TEG, use the fuel pressure stamped on the rating plate inside the front door of the unit, then adjust as directed in the appropriate section of the TEG operating manual.

When setting the air shutter, it will be necessary to remove the flame arrestor element from the holder, adjust the shutter screw, replace the element, then close the doors on the cabinet for each adjustment step. Allow the TEG to stabilize and record each air shutter adjustment step. Do not forget to reinstall the element and close the cabinet doors after each adjustment, when setting the fuel air mixture and evaluating the results.

WARNING: It is imperative that the fuel-air mixture be adjusted to peak V_{set} voltage plus ½ turn excess air, with the flame arrestor element in place and the cabinet doors closed. Proper operation of the flame arrestor kit on a TEG requires an excess air mixture. An excess air condition is indicated by a carbon monoxide concentration of less than 100 ppm inside the top of the flame arrestor inner stack. Failure to follow these instructions exactly, or adjusting the fuel-air mixture items incorrectly may result in personal injury or death and possible damage to the equipment and/or property.

Note: Proper combustion can be determined using a carbon monoxide (CO) meter. When properly adjusted, a model 5060 TEG produces less than 100 ppm as measured inside the top of the flame arrestor inner stack. Measuring carbon monoxide inside the rain cap assembly will give a false reading.

WARNING: Do not damage the flame arrestor element when it is being handled. If it is damaged, it must be replaced with GPT P/N 4900-07684. Using worn or damaged parts, or installing items incorrectly may result in personal injury or death and possible damage to the equipment and/or property.

WARNING: When the TEG is operating normally, and all required adjustments have been made, disconnect the orange wire from the pressure switch. Make sure the open end of the wire cannot contact metal, or the battery may discharge.

Make sure to keep track of each air shutter adjustment from the initial setting. When the air shutter has been adjusted to peak V_{set} voltage, add 1/2 turn, record the total air shutter opening and close the cabinet doors.

6.6 Maintenance

A 5060 TEG with the flame arrestor kit requires periodic maintenance.

The maintenance interval depends on the site conditions, fuel cleanliness, weather, dust, insects and other contaminant concentrations etc., and must be established based upon experience at each site.

Follow the service and maintenance instructions in the 5060 TEG Operating Manual. Since there are two “screens” in the intake flame arrestor assembly, both the screens (see Figure 37 item B20 and B26), must be cleaned when directed to clean the “air filter” in the 5060 Operating Manual.

6.7 Parts List

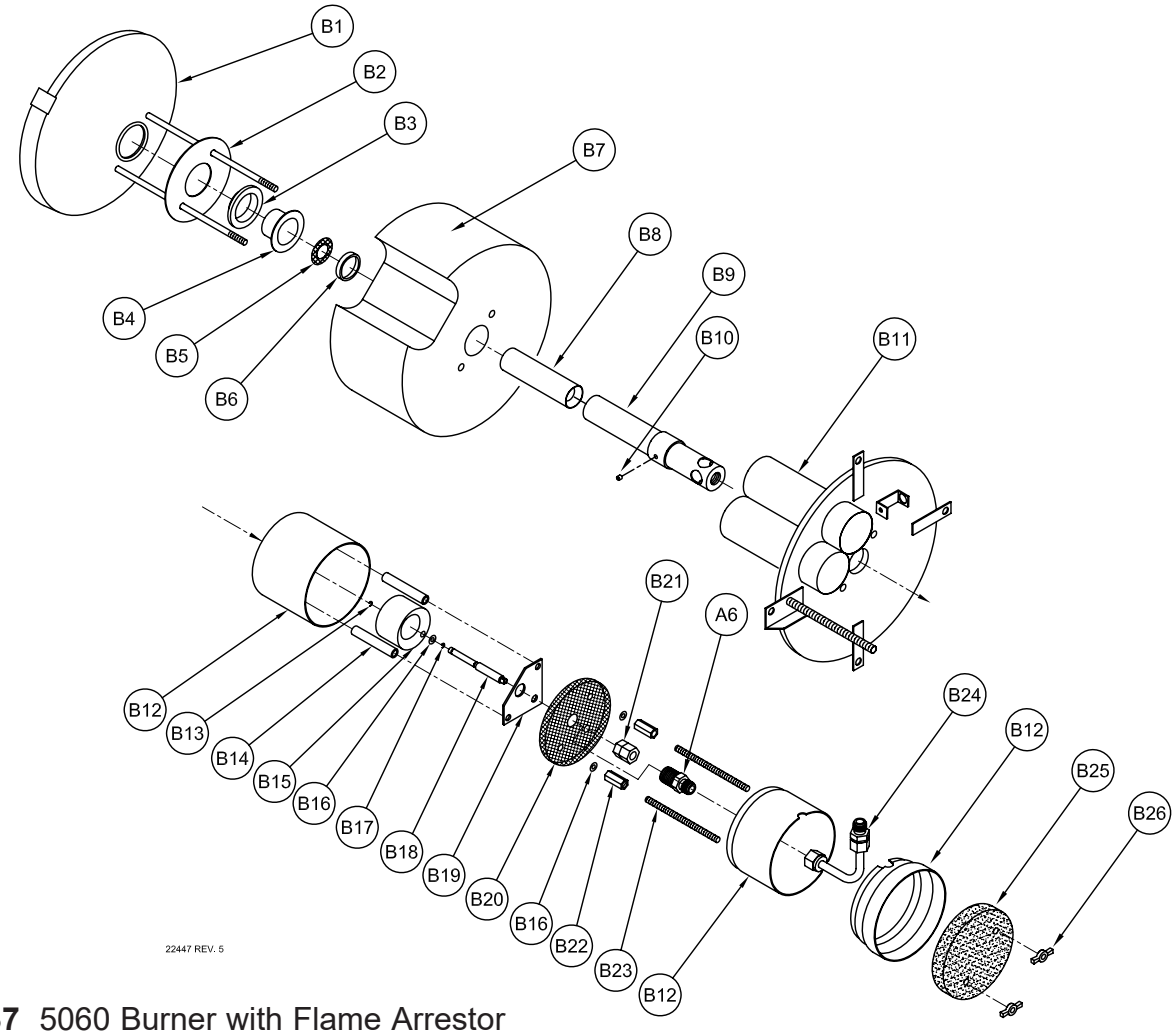

Figure 37 5060 Burner with Flame Arrestor

Item	Part No.	Description
A6	4200-00688	Orifice, 6, Natural Gas
B1	4000-00983	Burner Back Assembly
B2	4000-01004	Insulation Block Support
B3	4000-00701	Spacer, Insulation
B4	4000-00693	Screen Holder
B5	4000-01008	Burner Screen Assembly
B6	4000-00694	Insert Ring
B7	4000-00998	Insulation Block
B8	4000-00698	Venturi
B9	4000-00999	Venturi Tube Holder
B10	2506-00479	Screw, Set, Soc. HD, 6-32 x 1/8, SS
B11	4000-00985	Burner Cover Assembly
B12	4900-27148	Flame Arrestor Can Assembly
B13	2900-00549	Ring, Retaining, SS, 39-5122-18-H
B14	4000-01005	Spacer, Burner

6.7 Parts List

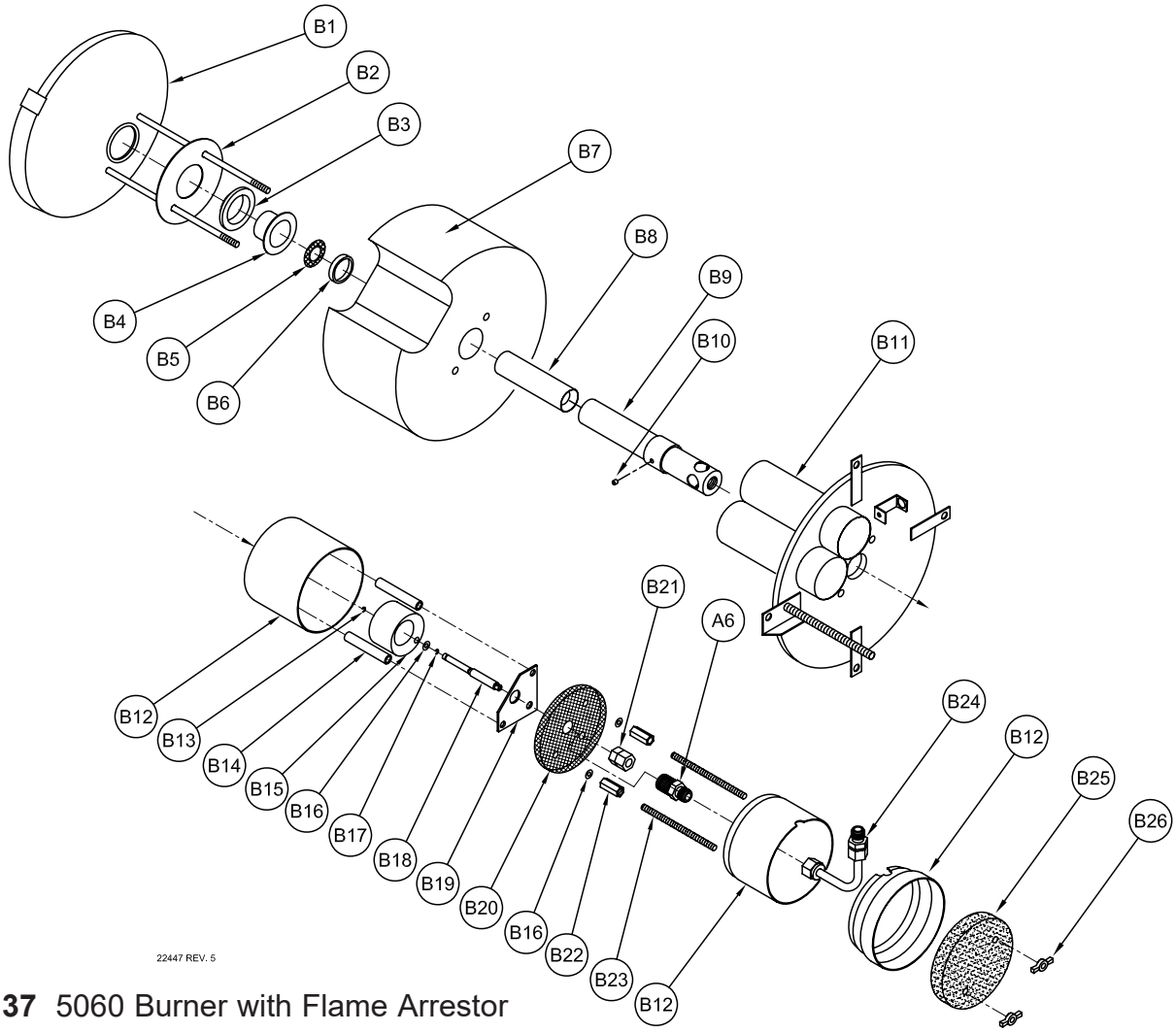

Figure 37 5060 Burner with Flame Arrestor

Item	Part No.	Description
B14	4000-01005	Spacer, Burner
B15	4000-00990	Air Shutter
B16	2810-00569	Washer, Flat, #10, SS
B17	2900-07267	E-Ring, Bowed, SS, Spae-Naur 251-802
B18	4000-00700	Venturi Adjustment Screw
B19	4000-00747	Venturi Plate Assembly
B20	4900-07683	Screen, Flame Arrestor
B21	4000-00758	Lock Nut, Venturi Adjustment Screw
B22	2710-07798	Nut, Coupling, 10-32 x 3/4”
B23	4900-07797	Stud, Extension, Flame Arrestor
B24	4200-23004	Elbow, Fuel Line Kit
B25	4900-07684	Flame Arrestor Element
B26	2710-00601	Nut, Wing, 10-32, SS

6.7 Parts List

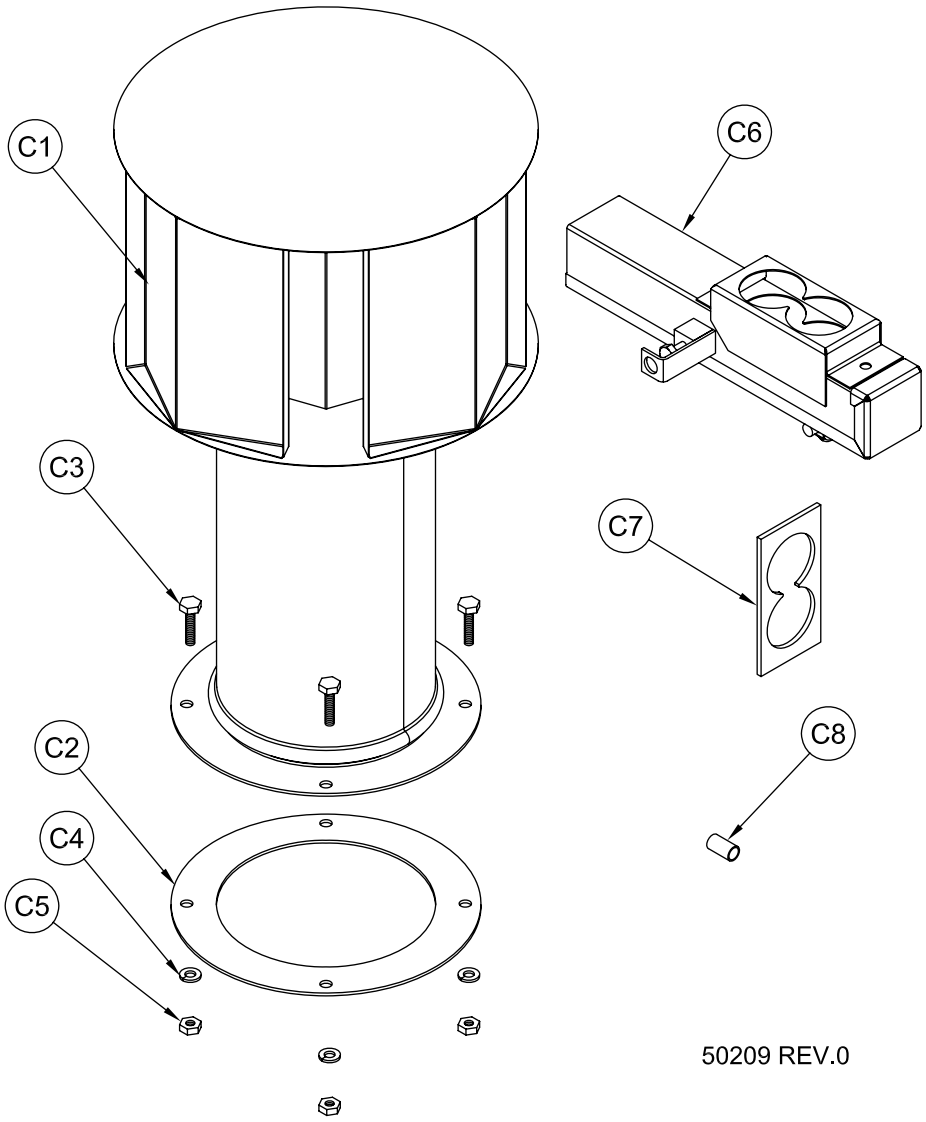

Figure 38 Rain Cap/Exhaust Stack Parts

Item	Part No.	Description
C1	4500-51516	Exhaust Stack Assembly, w/Rain Cap, 5060/5120
C2	4500-28376	Flange, Exhaust Stack
C3	2514--00258	Screw, Mach, P-H-P, 1/4-20 x 5/8, SS
C4	2814-00557	Washer, Flat, 1/4”, SS
C5	2714-00611	Nut, Hex, 1/4-20, SS
C6	4500-50175	Exhaust Stack Assembly, Inner, 5060 Flame Arrestor
C7	4500-50198	Gasket, Stack Seal, Flame Arrestor
C8	4500-50196	Spacer, Stack Assembly, Flame Arrestor

7 Appendix

7.1 Electrical Output Characteristics

The electrical output of a Model 5060 TEG is shown on the graph in Figure 39. Note that the power goes through a broad maximum between 0.5 and 0.75 ohms. The rated power of 60 Watts can be obtained only if the load resistance is within this range.

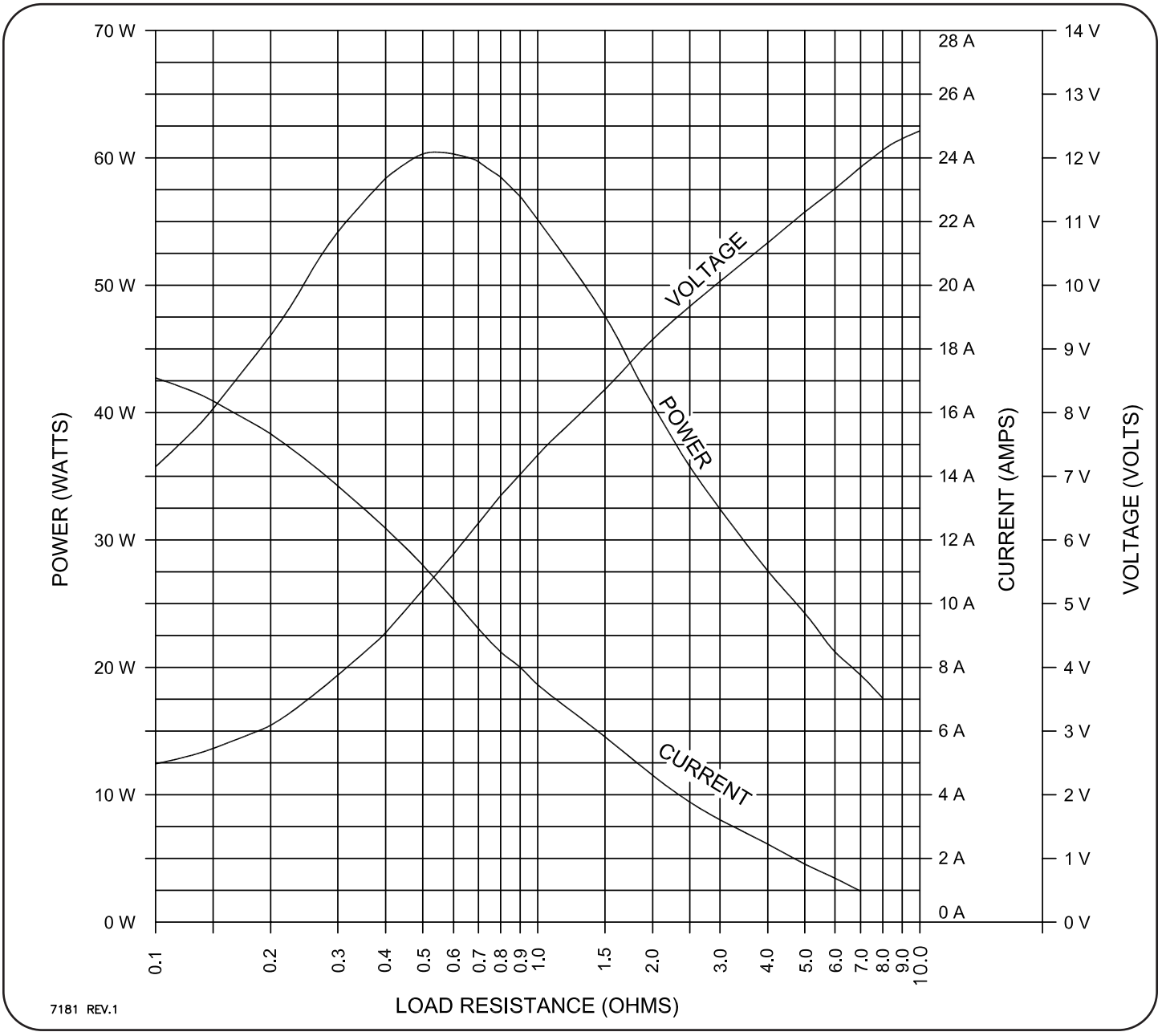

Figure 39 Gross Power Unit Electrical Output Characteristics @ 20°C, Beginning of Life

7.2 Physical Dimensions

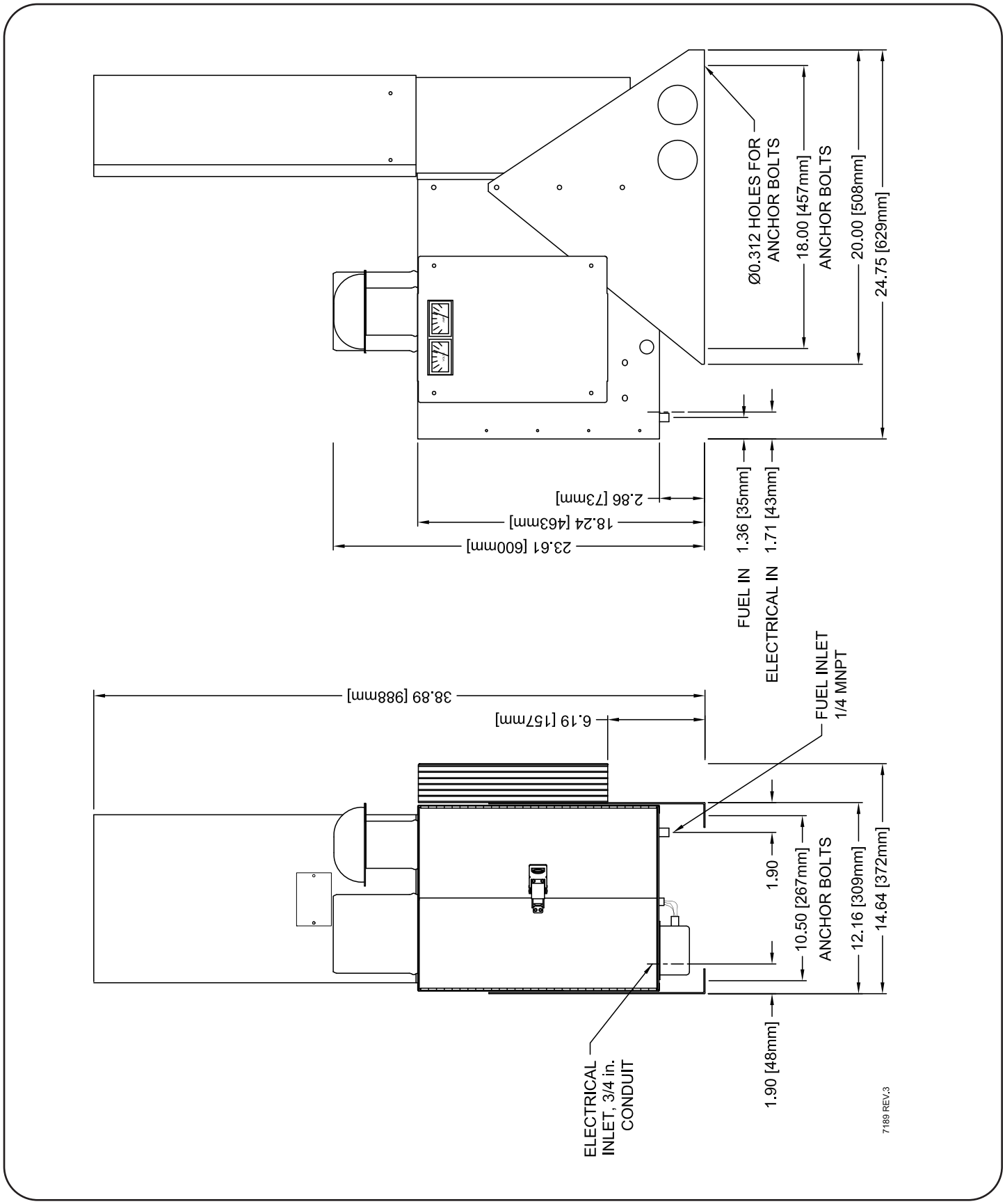

Figure 40 Physical Description, 5060 TEG

7.3 Gas Specifications

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.

4. Shall not contain more than 60 mg/Sm^3 (approx. 88 pmm) 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 vapour.

8. Shall not contain more than 1% by volume of free oxygen.

9. Shall have a nominal higher heating value (HHV) of:

Natural Gas: 37 MJ/m^3 (1000 BTU/cu.ft.)(1) (2)
Propane: 93 MJ/m^3 (2500 BTU/cu.ft.)(1) (2)
Butane: 122 MJ/m^3 (3300 BTU/cu.ft)1) (2)

10. Shall not exceed 60ºC (140ºF) in temperature.

Notes:

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

(2) - At 1 atm and 15ºC

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7.4 5060 Performance Log

MODEL NO:
TEG SERIAL NO:
FUEL TYPE:
LIMITER/CONVERTER SERIAL NO:

Date	Time	Ambient Temp °C	Rated Power (Watts)	Rated V_{set} (volts)	Measured V_{set} (volts)	Measured Power	Fuel Pressure	Open Circuit Voltage	Maintenance Repair Notes

7.4 5060 Performance Log

MODEL NO:
TEG SERIAL NO:
FUEL TYPE:
LIMITER/CONVERTER SERIAL NO:

Date	Time	Ambient Temp °C	Rated Power (Watts)	Rated V_{set} (volts)	Measured V_{set} (volts)	Measured Power	Fuel Pressure	Open Circuit Voltage	Maintenance Repair Notes