GLOBAL
power technologies

1120 THERMOELECTRIC GENERATOR
CLASS I, DIVISION 2, GROUP D, T3

Operating Manual

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MODEL 1120
HAZARDOUS AREA GENERATING SYSTEM
DESIGNED FOR
CLASS I, DIVISION 2, GROUP D
T3 OPERATION

SPECIFICATIONS

Output Voltage	
Nominal	12-18 VDC 24-30 VDC
Power Output	100 Watts Minimum
Special Features	Digital Panel Meter, LED, Voltage and Current Integral Blocking Diode Voltage Sensing Alarm with dry contacts Auto Shutoff Spark Ignition Auto Re-ignition
Fuel Consumption	Natural Gas: 8.8 m^3 per day, (311 Sft^3 per day) Propane: 11.4 L per day, (30 US gal per day)
Inlet Fuel Supply Pressure	Max 172 kPa (25 psi) Min 69 kPa (10 psi) Natural Gas Min 103 kPa (15 psi) Propane
Dimensions	
Width	61 cm (24.0 in.) with electronics box closed 92 cm (36.0 in.) with electronics box open
Depth	80 cm (31.6 in.)
Height	115 cm (45.3 in.) with drip cap 126 cm (49.4 in.) with rain shroud
Weight	123 kg. (270 lbs.)
Operating Temperature	-20ºC (-4ºF) to +40ºC (105ºF)
Storage Temperature	-65ºC (-85ºF) to +65ºC (149ºF)

1 GENERAL

1.1 General Information

This manual provides installation, operation and maintenance instructions for the Global Power Technologies (GPT) Model 1120 Thermoelectric Generator System.

Special Customer Option: If the Generator System was ordered with specially engineered options, they are completely described in the red Special Customer Option section of the manual.

1.2 Definition of Terms

To correctly use this manual the reader must interpret the meaning of the following words as herein defined:

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.

Matched Load: A condition of load where:
a) the load voltage of the generator is one-half of the open circuit voltage.
b) the load resistance is equal to the internal resistance of the generator.

Optimum Load: A condition of load where the power output of the generator is maximized.

Precision Load: The precision resistor contained on the generator that provides the optimum load condition. The voltage across the resistor is defined as V_{set} and is used to analyze generator electrical performance.

Power Conditioner: A broad term used to describe an electronic device attached to the generator output that converts, adjusts, limits or otherwise conditions power.

Auto Shutoff: The 1120 generator is equipped with a thermocouple controlled solenoid valve that can be manually reset. In the event of extended flame failure the thermocouple output will be reduced sufficiently to release the solenoid and stop fuel gas flow to the burner.

Converter: A specific electronic device attached between the generator and load that converts one level of DC voltage to another.

Limiter: A specific electronic device attached across the generator output that limits the voltage level.

Generator System: The system consisting of the generator including its factory options, the power conditioner including its factory options, and the special customer options.

Safe Operation, Operate Safely, Operating Safely: These are terms used to describe the operation of the 1120 Generating System, when its operating area or zone, should suddenly or gradually go hazardous towards or beyond the lower explosive limit (LEL). The generator will either operate at reduced power or extinguish completely due to lack of oxygen. The generator system will not, either while running or attempting to be ignited, ignite the surrounding hazardous atmosphere. If the operating area should clear within a short period of time the generator will attempt to reignite itself. See short term auto ignition.

Short Term Auto Ignition: The generators high voltage ignition system will automatically come on to reignite itself in the event of a flame failure due to either a blow out or short duration gas failure. Fuel gas must be present and the shut off valve must not have operated for the auto reignition to occur.

Hazardous Area: (definition per Canadian Electrical Code, Part 1, Section 18)

18-002 Classification: Hazardous locations shall be classified according to the nature of the hazard, as follows:

a) Class I locations are those in which flammable gases or vapours are or may be sufficient to produce explosive or ignitible mixtures;

b) Class II locations are those which are hazardous because of the presence of combustible or electrically conductive dusts;

c) Class III locations are those which are hazardous because of the presence of easily ignitible fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitible mixtures.

18-004 Division of Class I locations: Class I locations shall be further divided into two divisions as follows:

a) Division 1, comprising Class I locations in which:

   (i) Hazardous concentrations of flammable gases or vapours exist continuously, intermittently, or periodically under normal operating conditions; or

   (ii) Hazardous concentrations of flammable gases or vapours may exist frequently because of repair or maintenance operation or because of leakage; or

   (iii) Equipment is operated or processes carried on of such nature that breakdown or faulty operation thereof could result in the release of hazardous concentrations of flammable gases or vapours and simultaneous failure of electrical equipment;

b) Division 2, comprising Class I locations in which:

(i) Flammable volatile liquids, flammable gases or vapours are handled, processed, or used, but in which the liquids, gases, or vapours are normally confined within closed containers or closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or systems or the abnormal operation of the equipment by which the liquids or gases are handled, processed, or used or;

(ii) Hazardous concentration of gases or vapours are normally prevented by positive mechanical ventilation, but which may become hazardous as the result of failure or abnormal operation of the ventilation equipment or;

(iii) The location is adjacent to a Class I, Division 1 location, from which a hazardous concentration of gases or vapours could be communicated, unless such communication is prevented by adequate positive pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

c) Group D includes propane, methane, butane.

NOTE: Throughout this manual the words Generator, Thermoelectric Generator, TEG and Generator System will be used interchangeably.

1.3 Theory of Operation

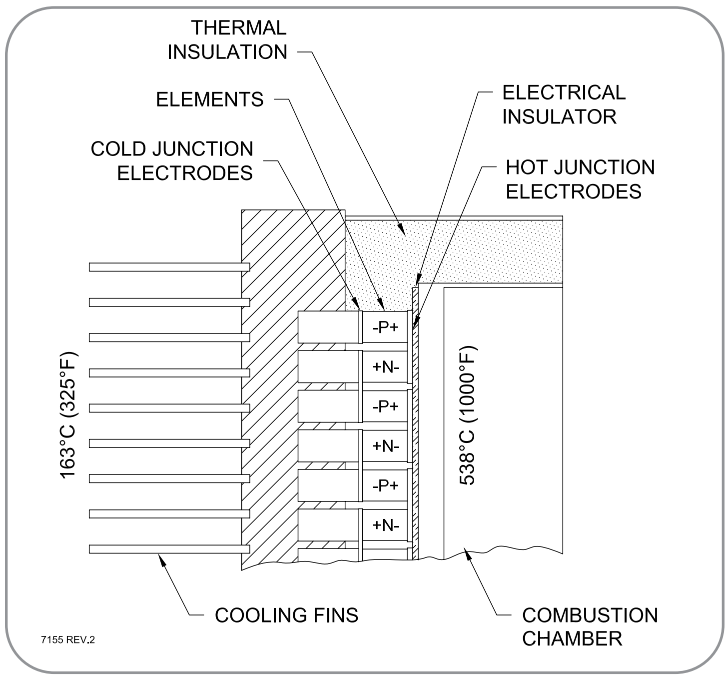


Figure1 TEG Design

A TEG produces electrical power through the direct conversion of heat energy into electrical energy. It operates on the same principle as the thermocouples that are used for measuring temperatures and in safety shutoff controls for gas water heaters, home furnaces, etc.. However, the TEG utilizes semiconducting thermoelectric materials that are much more efficient and thus permit practical thermoelectric power sources. A thermocouple consists of two dissimilar materials (usually in wire form) which are joined together at one end. If this junction is heated to a higher temperature than the other end of the wire, a voltage will exist across the cooler end. Further, electrical power will be delivered to a load placed in the circuit. This process will continue provided that the temperature difference is maintained. A TEG is a system which provides the means to maintain these required conditions.

Figure 1 illustrates how this is accomplished in the model 1120 TEG. A thermocouple is formed by a P type and an N type thermoelectric element joined together electrically by a hot junction electrode. Adjacent thermocouples are joined together electrically by cold junction electrodes. Eighty thermocouples, each producing 84mV are connected in series so the power unit produces 120 Watts at 6.7 Volts and 18 Amperes.

The hot junction of the thermocouples is maintained at a high temperature (538ºC or 1000ºF) by a burner which operates on gaseous fuels such as propane or natural gas. The cold junction of the thermocouples is maintained at a lower temperature (163ºC or 325ºF) by an array of cooling fins which transfer the heat to ambient air by natural convection. The thermocouples are contained in a hermetically sealed enclosure because they are adversely affected when exposed to air at operating temperatures. They are surrounded by thermal insulation to minimize heat loss.

Maximum power is delivered to the load when: (a) the load voltage is one-half of the open circuit voltage and (b) the load resistance is equal to the internal resistance. This condition is called the matched-load power (also maximum efficiency) when the load voltage is slightly higher than one-half (approx. 55%) of the open circuit voltage.

The TEG is supplied with a precision load resistor that provides a known load. This resistor is used both in adjusting the TEG for proper operation and in evaluating its performance. The fuel flow to the burner is adjusted so that the proper voltage exists across this precision resistor. At this condition the TEG is operating at the intended junction temperature and is delivering maximum power.

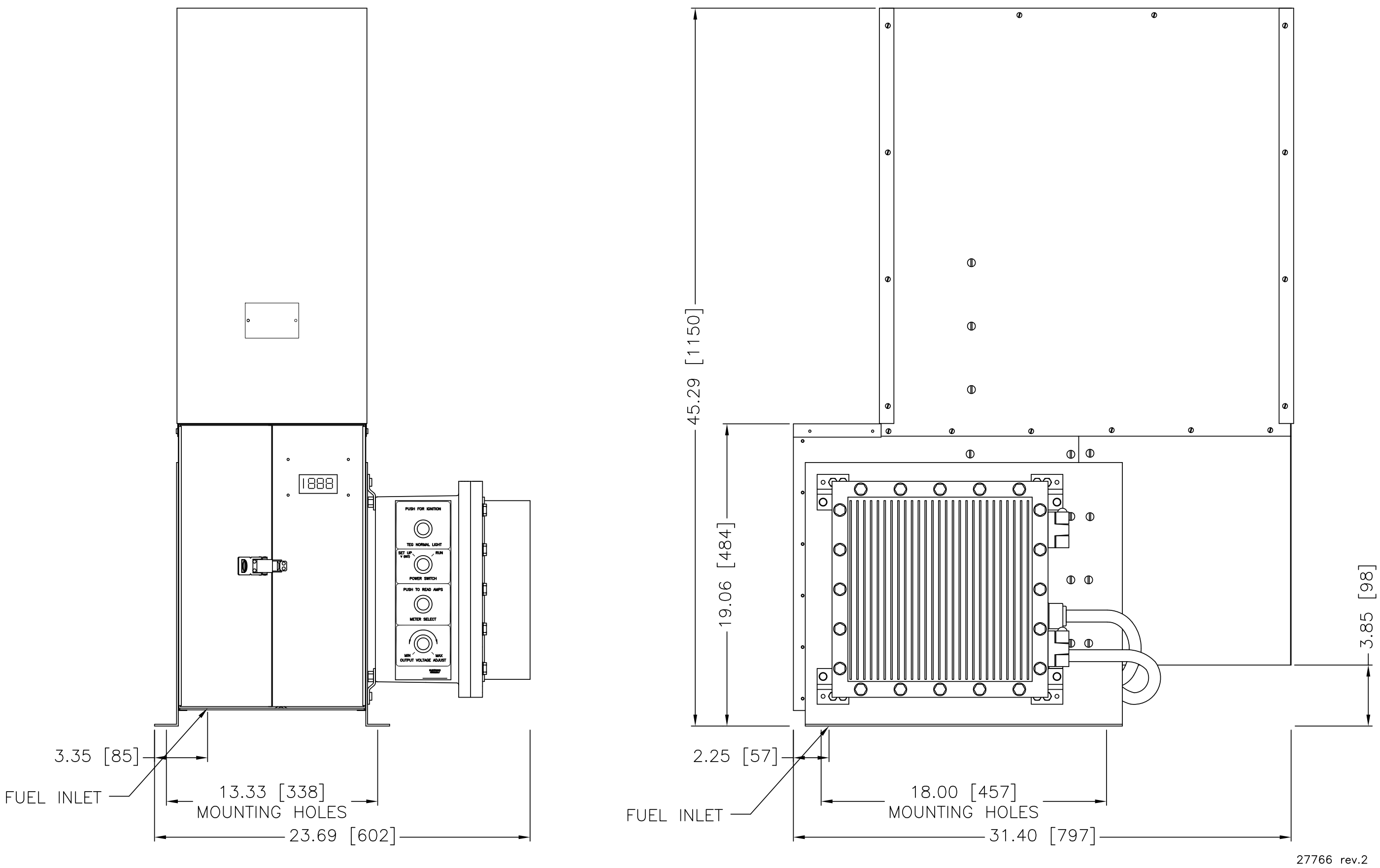
The TEG is supplied with a protective device which prevents its output voltage from rising beyond 11.4 Volts. This is required because under extended open circuit (or slightly loaded) conditions the hot junction temperature could increase beyond the safe operating range.

The burner operates at moderate pressures from 28 to 70 kPa (4 to 10 psi). The gas is expanded through an orifice and then flows through a venturi where it draws in air needed for combustion. The fuel flow is controlled by a pressure regulator and is adjusted by the operator to obtain the desired power output.

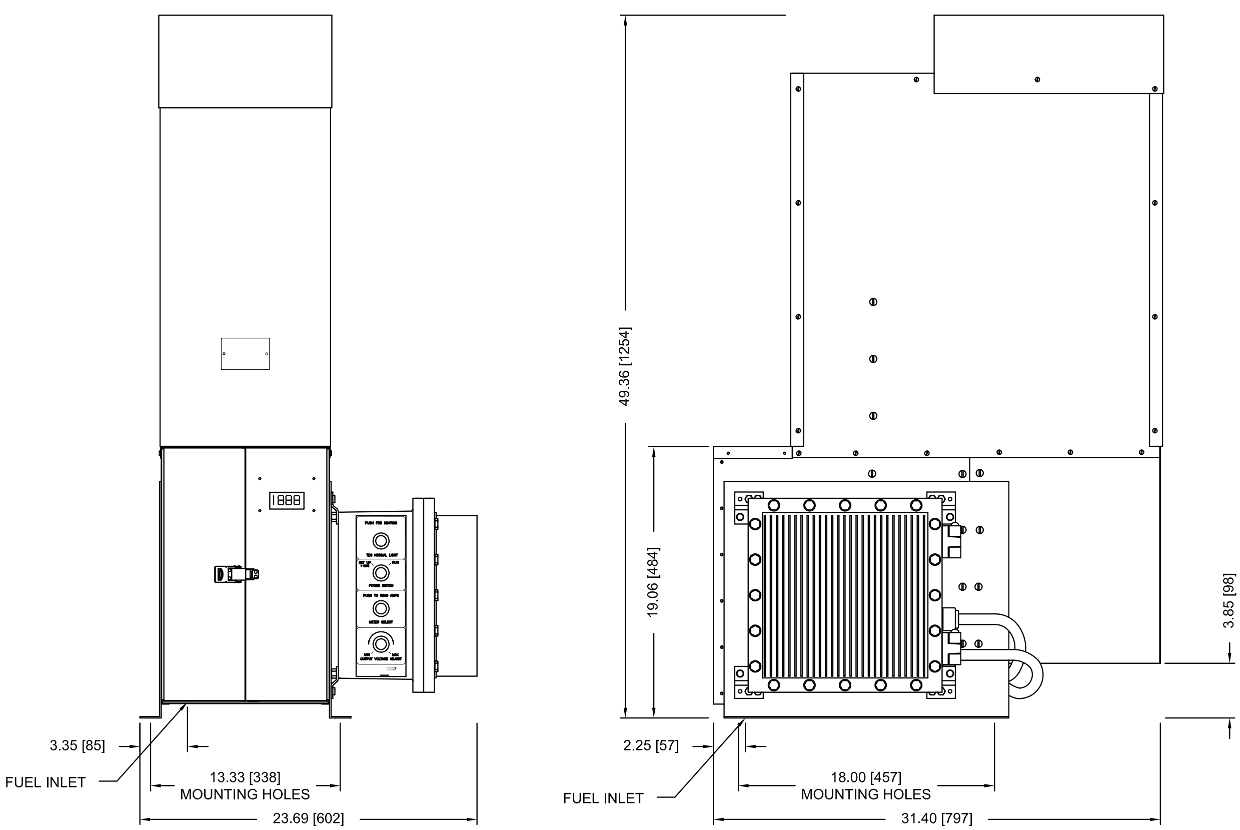
In summary, the TEG produces electrical power when a temperature difference is maintained between the hot and cold junctions of the thermoelectric materials. The temperature difference, and therefore the amount of power produced, depends on the rate at which fuel is supplied to the burner. The operation of the TEG is simply the control of the fuel pressure to the burner which results in the desired power output.

1.4 Physical Description

Figure 2 shows the generator in its normal operating position.



1120 TEG w/ Drip Cap



1120 TEG w/ Rain Shroud

Figure 2 Physical Description

1.5 Electrical Output Characteristics

Figure 3 shows the electrical output characteristics of the Model 1120 power unit, which gives the power, current and voltage as a function of the load resistance. The TEG will operate at any load condition from short circuit to open circuit. Observe that the power goes through a broad maximum between 0.3 and 0.5 ohms. Rated power (120 Watts) can be obtained only if the load resistance is within this range. The graph is useful in determining power, current and voltage at various customer load conditions. Refer to the graph and consider the following example:

1) You are installing a Model 1120 TEG at a gas wellhead to cathodically protect the well-casing from corrosion.

2) You have measured and determined your total ground bed resistance to be 1.0 ohm.

3) Find 1.0 ohm on the horizontal axis.

4) Read vertically until intersecting the power, current, and voltage curves.

5) Read horizontally to the vertical axis to determine the values of power, current and voltage.

6) Which are 106 Watts, 10.2 Amps and 10.3 Volts.

1.6 Ambient Temperature Effects

The electrical output of the TEG is dependent on ambient temperature as shown in Figure 4. Observe that the power decreases as ambient temperature increases.

Statement of Rated Power

1) The Power Unit produces 120 Watts when operated at an ambient temperature of 20ºC.
2) With the fuel flow held constant, the power changes at a rate of 0.288% per ºC (0.16% per ºF) of temperature change.
3) The TEG can be operated at rated power to a maximum ambient temperature of 40ºC (105ºF). Consult GPT if ambient temperatures exceed 40ºC.

1.7 Rated Power

The TEG can be adjusted for rated power at an ambient temperature by using the rated power curve as shown in Figure 4. Consider the following example:

1) The present site temperature is 40ºC.
2) Find 40ºC on the horizontal axis.
3) Read vertically until intersecting the rated power curve.
4) Read horizontally to the vertical axis to find the set-up power.
5) Which is 114 watts.

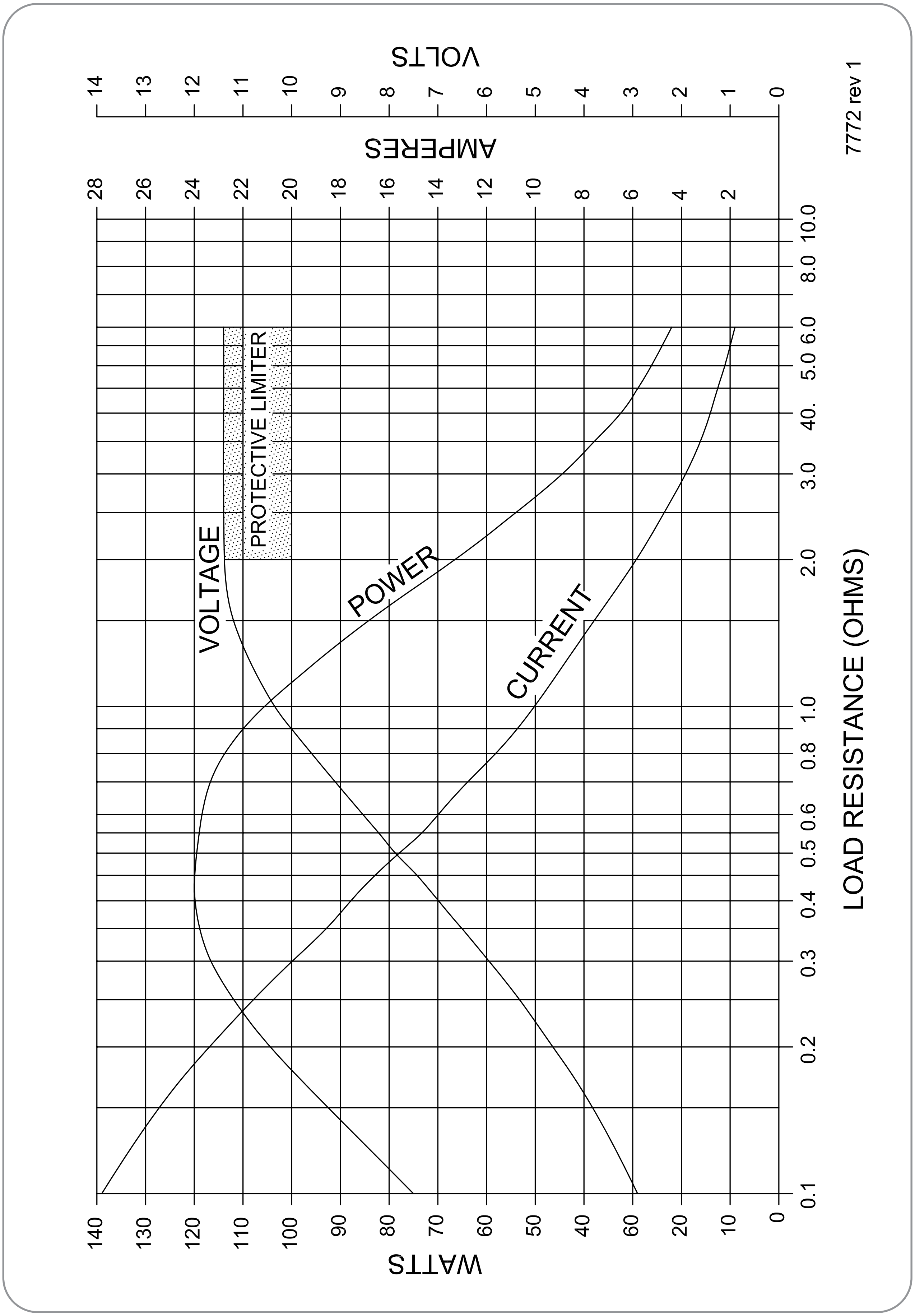


Figure 3 Power Unit Electrical Output Characteristics @ 20°

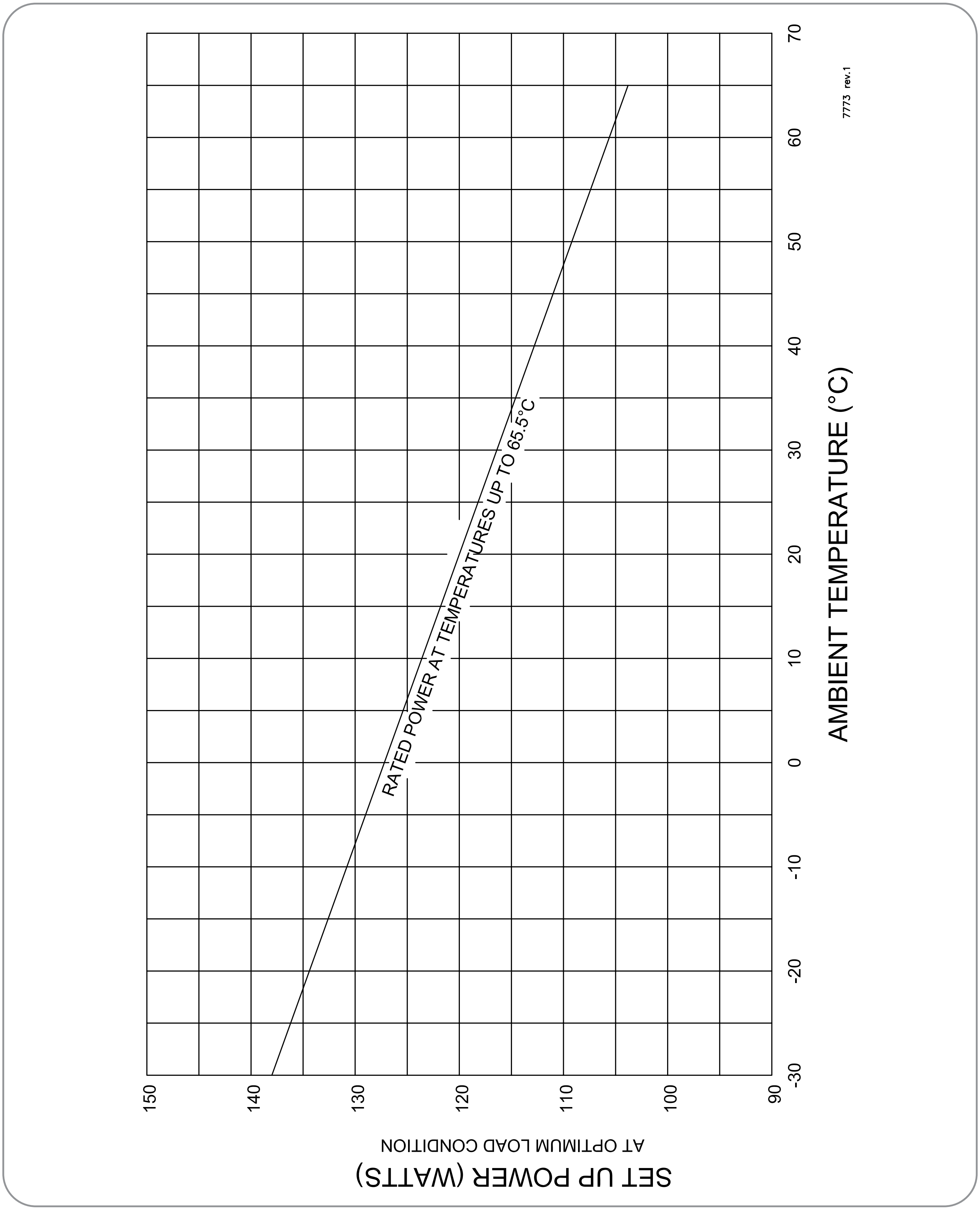


Figure 4 Gross Power from 1120 Power Unit Vs Ambient Temperature

1.8 Fuel Consumption

The fuel consumption of the TEG operated at rated power is shown below. The TEG can be operated at less than rated power, down to 75% or 90 Watts.

FUEL CONSUMPTION AT RATED POWER	PROPANE C_3H_8	BUTANE C_4H_{10}	NATURAL GAS METHANE CH_4
LB/HR	0.54	0.54	-
GAL/HR	0.13	0.13	-
KG/HR	0.25	0.25	-
L/HR	0.48	0.42	-
CU FT/HR	4.70	3.52	13.0
CU M/HR	0.133	0.099	0.368

1.9 Boiling Temperature of Fuel

Boiling point of liquefied fuels at atmospheric pressure are:

methane - 166.5ºC (-258.7ºF)
propane - 42.1ºC (-43.7ºF)
butane - 0.5ºC (+31.1ºF)

1.10 Installation

This generator must be installed by qualified personnel in accordance with international and/or local electrical codes.

Carefully unpack the TEG from shipping container. Retain the shipping container until the TEG is operational.

Identify and locate the following items from the shipping container:

A. Generator System Complete.
B. Customer Assy Kit.

Mount the TEG on a generator stand, if a stand has not been prepared, a field proven mounting arrangement is shown in Figure 5. Ensure that the TEG is mounted in accordance with following notes:

A. The TEG must be mounted with the fin duct in a vertical position.
B. The air flow through the cooling fins must not be obstructed.
C. The TEG should be mounted at a height sufficient to prevent direct flooding or heavy snowfall from interfering with the flow of cooling or intake air.
D. When the generator is installed near a building, field experience has shown that the best locations are on the roof or on the windward side, with a minimum distance of 3.0 meters (10 feet) from the building. Be sure that the TEG location relative to buildings and fuel containers are in accordance with local regulations.

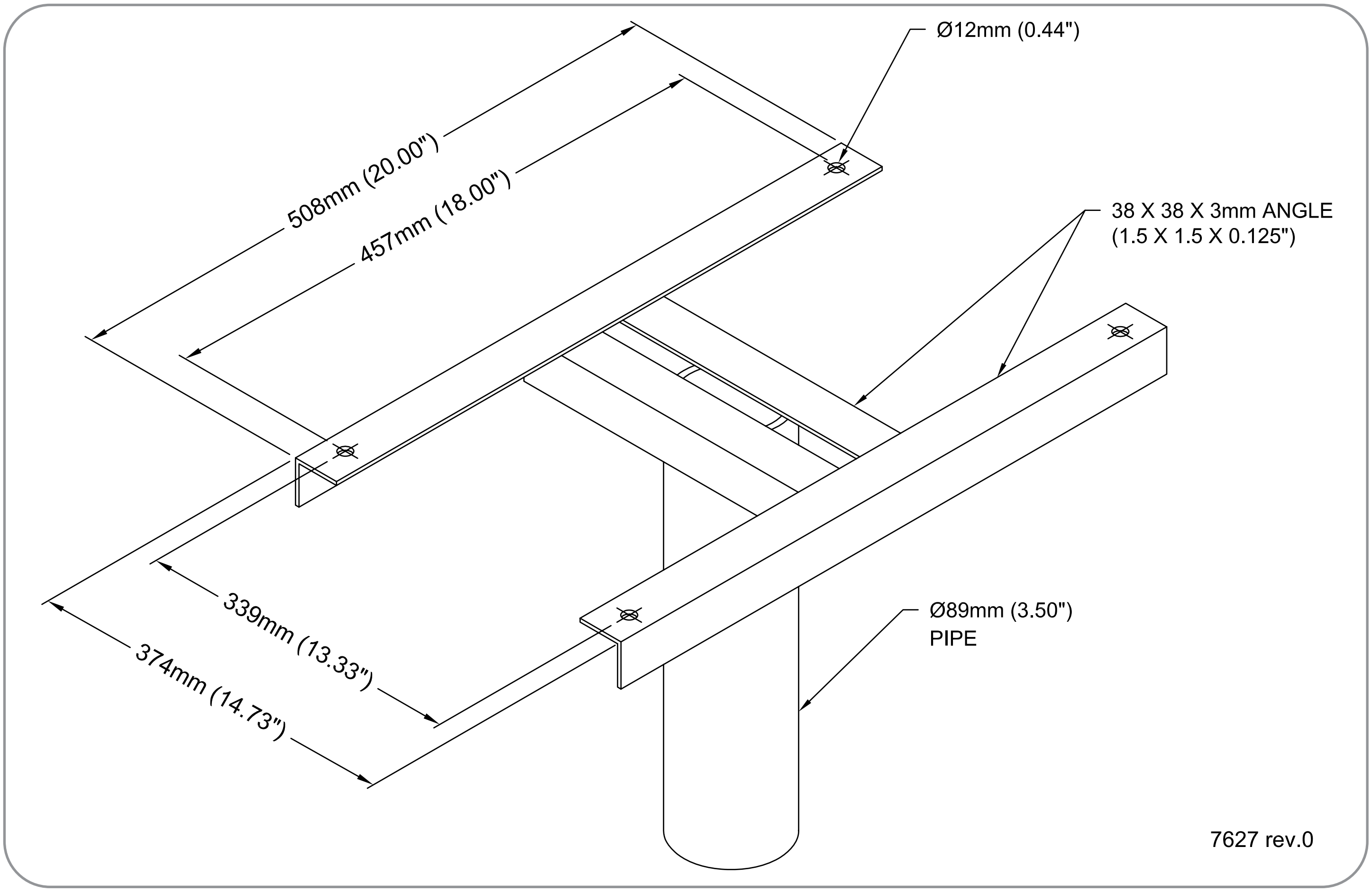


Figure 5 TEG Mounting

Remove the rain shroud (if the TEG c/w a rain shroud), the fin duct front cover, the drip cap (if the TEG c/w a drip cap). With a suitable lifting device and the Lifting Lug (shown in Figure 6), gently lift and move the TEG to place. When the TEG has been mounted on the stand, proceed with a complete mechanical inspection.

1.11 Mechanical Inspection (see Figure 6)

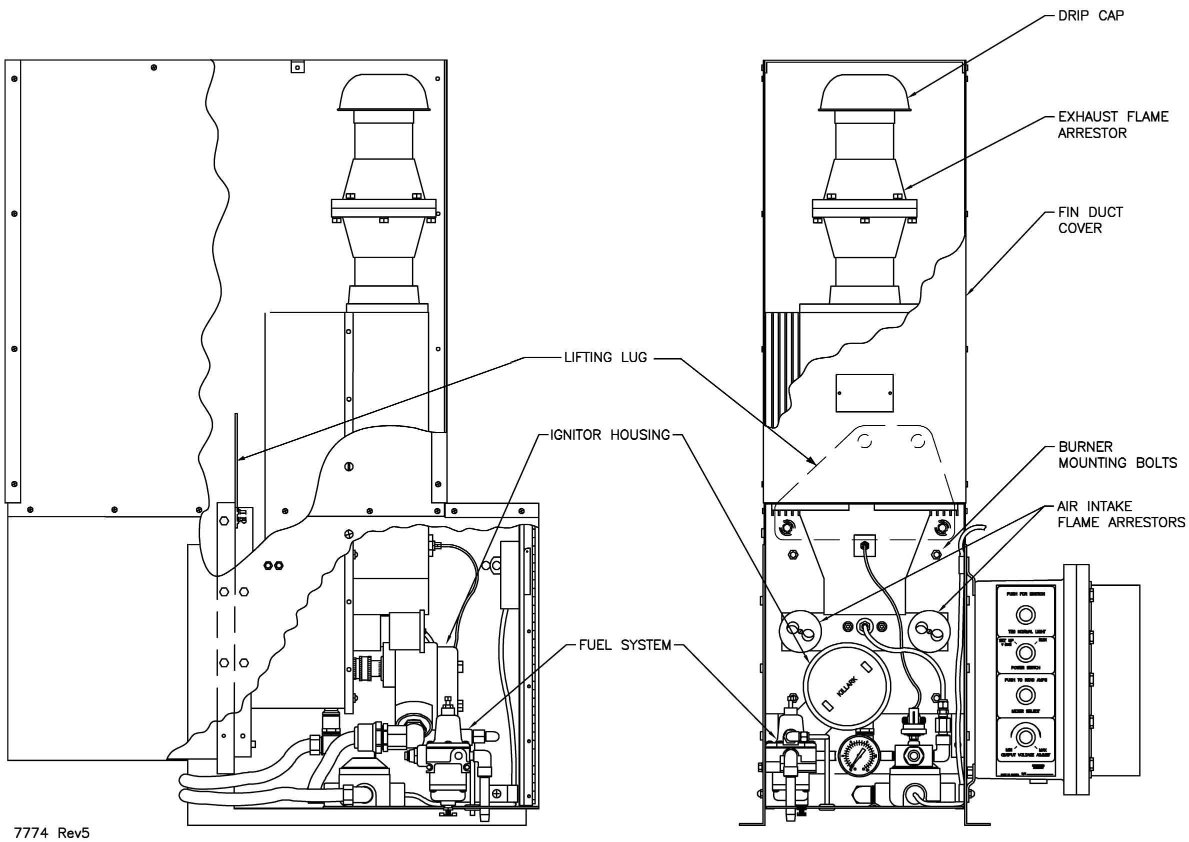
Ensure the exhaust flame arrestor assembly is screwed tight to the exhaust stack, and all screws on the flame arrestor assembly are tight. Visually inspect the flame arrestor element by looking down the exhaust pipe to ensure that there is no visual damage or fractures. Replace the drip cap (if the TEG c/w a drip cap), the fin duct front cover, the rain shroud (if the TEG c/w a rain shroud).

Open the front doors of the cabinet and locate the burner mounting bolts, tighten the cap nuts, and locate the air intake flame arrestor assemblies. Ensure that they are tightly secured.

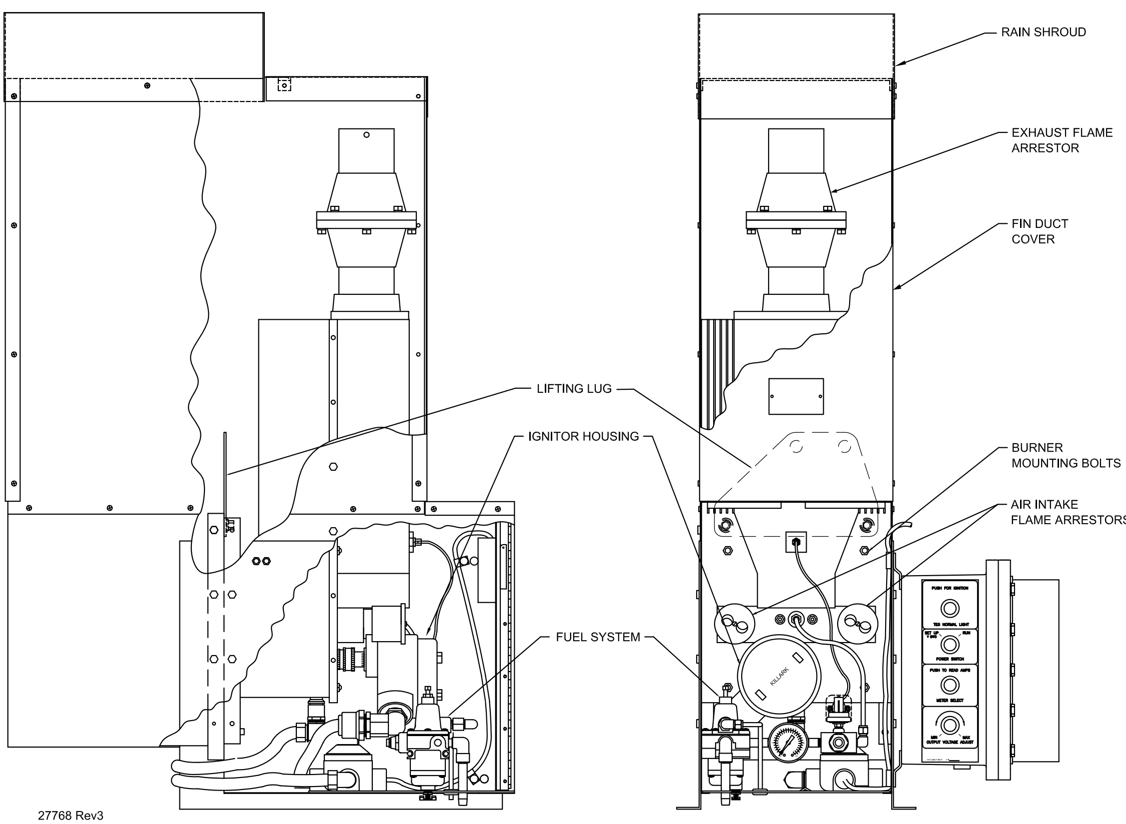
Locate the Igniter housing assembly, remove the cap and visually inspect the ignitor connections, re-installing the cap securely. Check that all conduit connections are secure and the mountings are tight.

Locate the fuel system assembly and ensure that all the connections are tight.

Check that all hardware and mountings are secure and tighten as necessary. When the mechanical inspection is complete, proceed to electrical connection.



1120 TEG w/ Drip Cap



1120 TEG w/ Rain Shroud

Figure 6 Mechanical Inspection,

1.12 Electrical Connection

NOTE: This TEG incorporates a high voltage ignition system that operates from an internal 2 Volt battery. This battery is charged by the TEG. Disconnect one end of the 2 Volt ignitor battery and proceed with connection of the customer wiring (see Figure 7). Proceed to fuel connection.

Ensure that circuit breakers or disconnects are used at the load end of the wiring and that the circuit is open prior to connection to the TEG (see Figure 7). If the 2 Volt battery and the disconnects are not open then the ignition system is still live and could cause an explosion.

Provision has been made in the electronics housing for two 3/4" NPT rigid conduit entries. Sealing of these fittings must be used to maintain the system integrity. For access to the electronics assembly, remove the twenty 3/8-16 bolts installed in the lid and swing the lid open. Terminal blocks have been factory installed for customer connection. TB2-2 is +24 Volts, TB2-3 is -24 Volts. The voltage sensing relay terminals are located on the Limiter Converter board mounted on the lid.

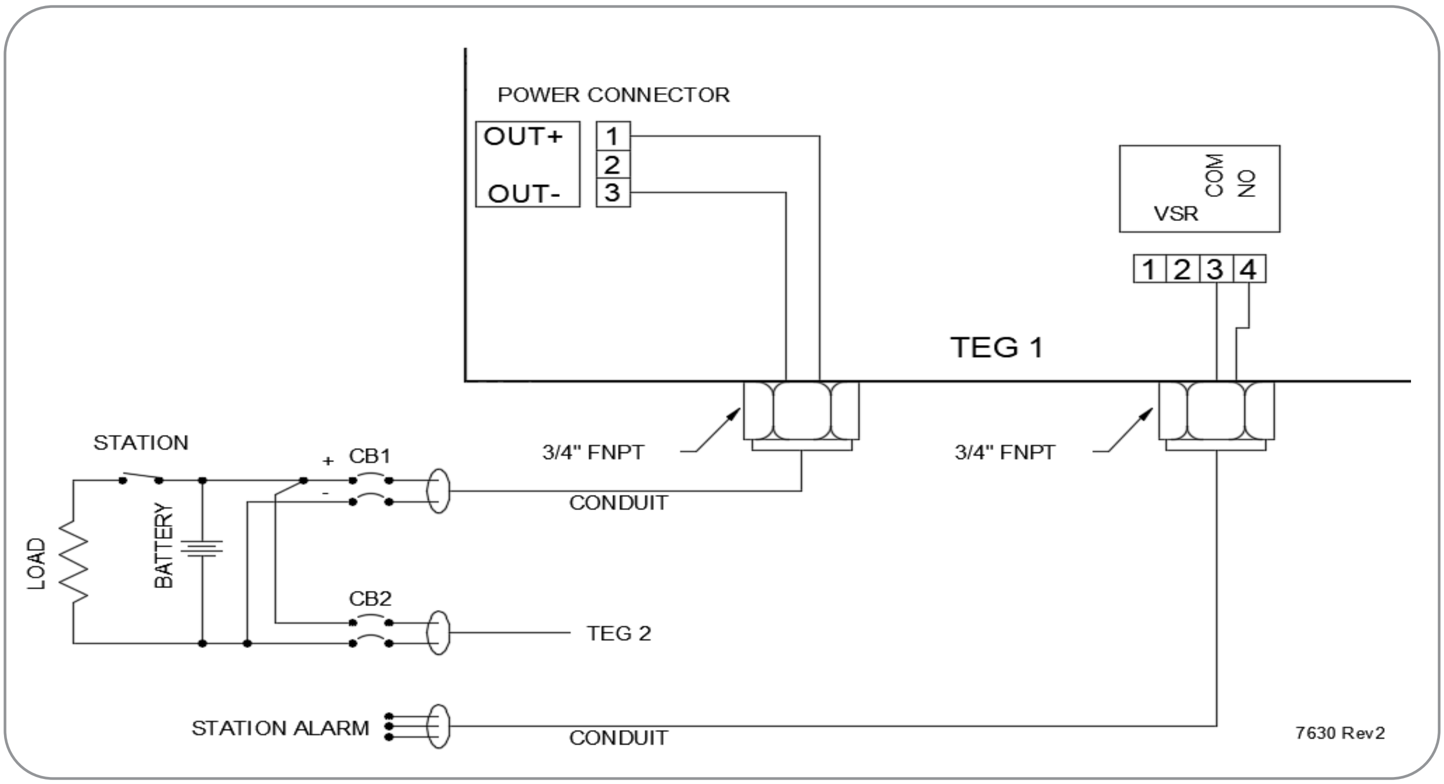


Figure 7 Recommended Connections

1.13 Fuel Supply Connection

Although the TEG fuel regulator incorporates a liquid trap and 40-50 micron stainless steel filter, the generator system has been designed to operate on sales or instrument quality fuel. Due to site specific fuel characteristics, ensure that necessary pre-filtration has been installed prior to connection to TEG fuel lines.

The maximum regulator input pressure is 172 kPa (25 psi). For good stability it is recommended that the regulator input pressure be a minimum of 69 kPa (10 psi) in applications where multi-stage regulation is employed. Install a shut off valve immediately upstream to the TEG connection in a convenient and readily accessible location. Connect the fuel supply to TEG as follows:

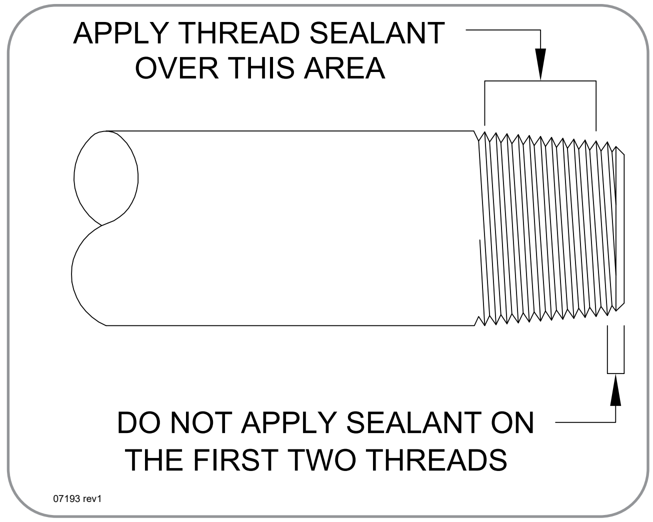


Figure 8 Applying Thread Sealant

1.13.1 Check Data Plate for type of fuel. Data plate is located on the inside right-hand cabinet door. An X is stamped in the appropriate box for fuel type, natural gas or propane. **Important: Each fuel type requires a particular orifice. Use only the fuel indicated on Data Plate.**

NOTE: If unit was ordered for use with butane, the Data Plate will indicate propane. This is because the energy contents are the same, therefore they require the same orifice.

Also note that in the case of propane and butane ensure that the fuel input is a vapour fuel as opposed to liquid fuel, unless the generating system has been ordered with a vaporizing system. Next if ambient temperatures below 5ºC (41ºF) are expected, be sure that the fuel contains an additive to prevent any moisture in the fuel from freezing. Anhydrous methanol added in the ratio of one litre of methanol to 800 litres of fuel tank capacity is recommended.

1.13.2 Apply thread sealant to all pipe connections using the method illustrated in Figure 8. A "Union" type connection is recommended at the TEG.

1.13.3 Inspect the fuel line from the fuel supply and insure that it is free of foreign material. Purge fuel line prior to connection.

The TEG is Equipped with a 1/4" NPT Male Input Connection. Remove the protecting plastic cap and connect the fuel line. Test all connections to ensure they are leak tight with leak detector.

1.14 Start Up Preparation

1.14.1 Ensure that the fuel is turned off.

1.14.2 Reconnect the 2 Volt battery. Ensure that all electrical connections are secure. Install ionizing corrosion inhibitor on the floor of the electronics housing.

1.14.3 Close the electronics housing and install the twenty 3/8-16 bolts. **The Customer must Tighten all Bolts to Establish Explosion Proof Seal** of the assembly and provide weather proofing.

1.14.4 Test the ignitor system. While pushing the manual ignitor button, listen at the ignitor housing. A sharp snap should be heard as the ignitor discharges. If this is not audible, refer to Trouble Shooting (section 3.9) for set up of ignitor system and correct.

1.14.5 Proceed to Section 2, Operation.

2 OPERATION

2.1 Data Plate

2.1.1 Model Number

The model number is interpreted as below.

1120X-##-SI-SO

Fuel Type
- L= Propane
- N= Natural Gas

Power Conditioner Voltage
- 12 or 24 Volts

Spark Ignition

Safety Shut Off Valve

2.1.2 Serial Number

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

2.1.3 Fuel Type

‘Natural Gas’ or ‘Propane’

IMPORTANT: Each type of fuel requires a particular 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.

2.1.4 Output Rating

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

2.1.5 Design Altitude

The design altitude is the maximum design altitude of the TEG.

2.1.6 Fuel Input Rating

The fuel input rating is the maximum fuel energy input rate of the TEG.

2.1.7 Inlet Pressure

The inlet pressure is the maximum permitted fuel supply pressure range.

2.1.8 Burner Fuel Pressure

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

2.1.9 **Factory Settings**

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

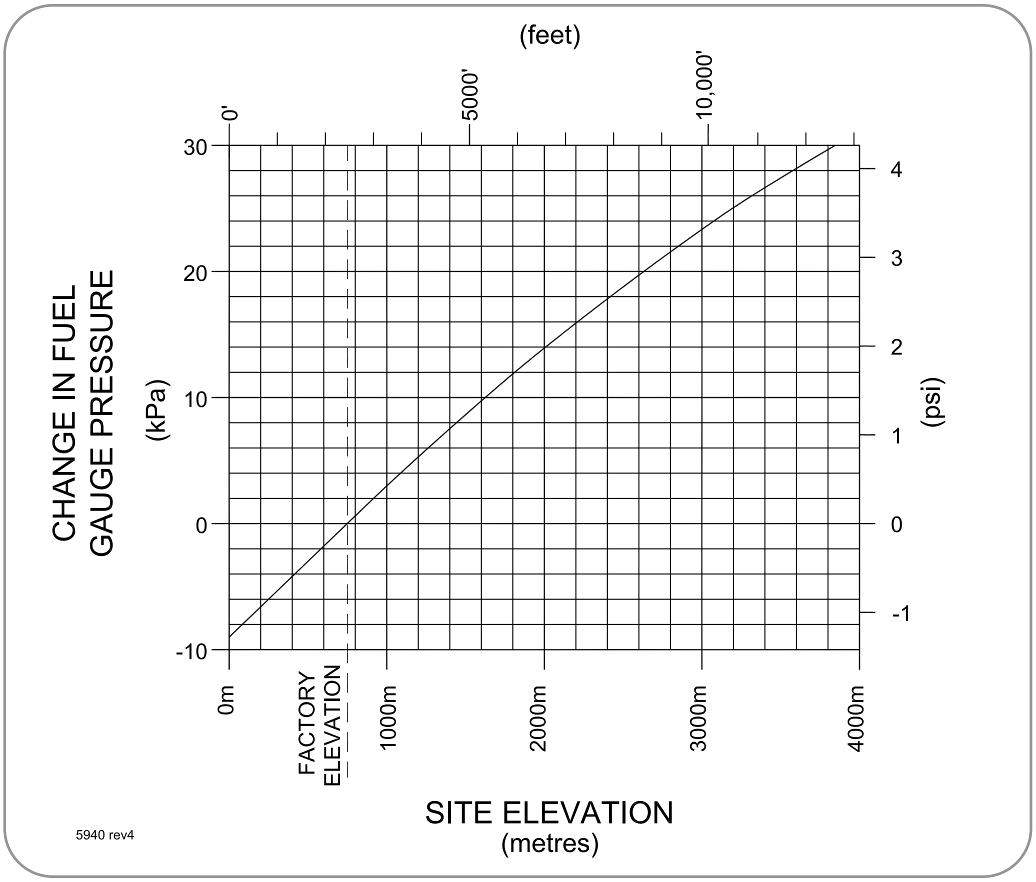


Figure 9 Change in Fuel Pressure Vs Elevation

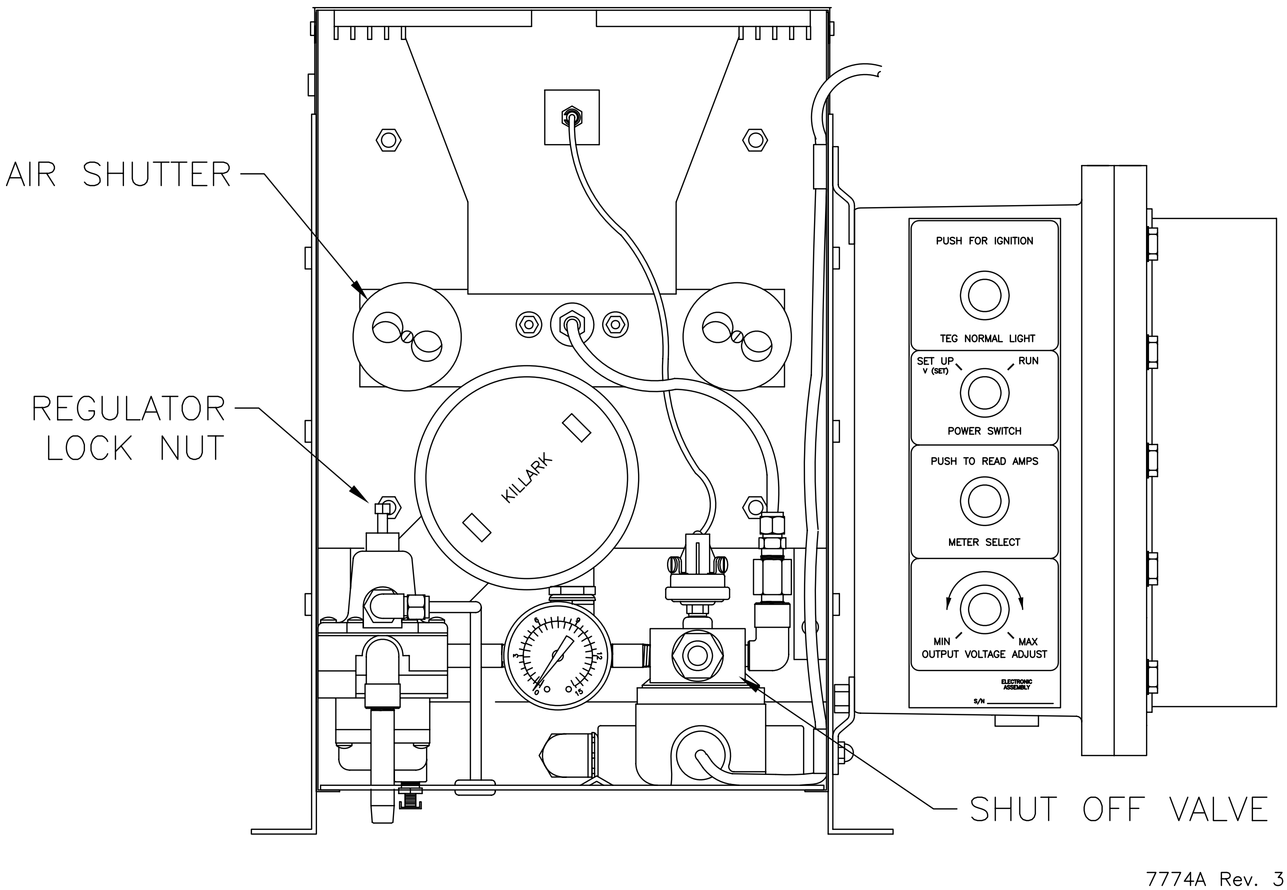


Figure 10 TEG Start Up

2.2 Start-Up Data Sheets

Start-up Data Sheets are provided at the back of this manual to assist you in setting up the TEG properly. During set up you will be asked to record data on these sheets so keep them available. It is recommended that a Data Sheet be used each time the TEG is started. They are valuable for future reference. If additional sheets are needed they can be duplicated.

2.3 Starting Generator

Perform the following steps (see Figure 10):

2.3.1 Turn on fuel. Loosen the lock nut on the fuel regulator.

2.3.2 If required, correct the factory set fuel pressure for the elevation as per Figure 9, **Change in Fuel Pressure Vs. Elevation.**

2.3.3 Adjust the air shutters to slightly fuel rich from the factory set position. Note that the air shutters should always be adjusted equally in small increments.

2.3.4 Set the “Power Switch” to set up position.

2.3.5 Set the “Output Voltage Adjust” to middle position.

2.3.6 Press down the button on the shut off valve. The TEG should immediately start firing, as noted by a popping inside the combustion chamber. The TEG will pop until sustained ignition occurs (purring sound). Record the time of sustained ignition.

Note: If popping and sustained ignition cannot be obtained quickly, adjust the air shutters to air rich position until sustained ignition occurs, then using several small steps, return the air shutters to the factory set position.

2.4 Heat Up to Rated Power

TEG performance is determined by measuring the voltage across the precision load. This voltage is defined as V_{set} and is measured by the digital panel meter when the power switch is in the set up position.

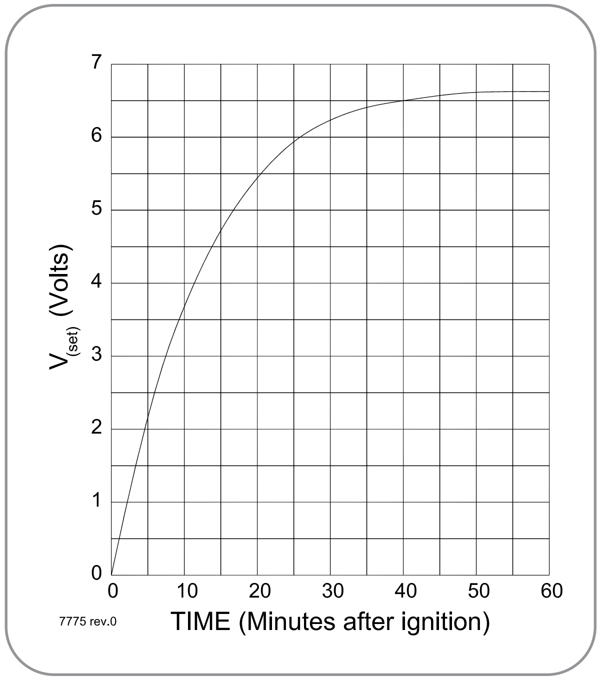


Figure 11 V_{set} Vs Time

2.5 V_{set} Versus Time

The heat up characteristic of the TEG is shown in Figure 11, which gives V_{set} as a function of time after ignition. This curve is for a TEG set at the fuel pressure that produces rated power. During this heat up period, measure the V_{set} and record it as item 2 on the start up data sheet at the time intervals specified. To monitor progress during heat up, compare your measurements with those shown in Figure11.

After 20 minutes of operation observe the V_{set} and determine the following:

1) If V_{set} is near 6 volts, the fuel pressure is set for rated power.

2) If V_{set} is less than 5.5 volts, the fuel pressure is set for less than rated power, but do not adjust at this time.

3) If V_{set} is greater than 6.5 volts, the fuel pressure is set for more than rated power. Reduce the fuel pressure by 9.8 kPa (1.4 psi) at this time, see Figure10 and Figure 13.

WARNING: To prevent damage to the TEG do not allow the V_{set} to exceed 7.1 volts at ambient temperatures above 24ºC (75ºF).

2.6 V_{set} Versus Power

V_{set} the voltage across the precision load, is a measure of power. The value of the precision load (0.387 ohms) is selected to provide the optimum load condition for the TEG.

The relationship between V_{set} and power (P) is:

$$P = \frac{V_{set}^2}{0.387}$$

This relationship is shown in Figure 12. The graph gives V_{set} as a function of set-up power. In determining power (P) consider the following example:

1) Your V_{set} is 6.12 volts.

2) Locate 6.12 volts on the vertical axis.

3) Read horizontally until intersecting the curve.

4) Read vertically downward to the horizontal axis to determine power which is 97 watts.

In determining V_{set} consider the following:

1) The power is 120 watts.

2) Locate 120 watts on the horizontal axis.

3) Read vertically until intersecting the curve.

4) Read horizontally to the vertical axis to determine V_{set} Which is 6.8 volts.

2.7 Determining Required V_{set}

This heat up period is the ideal time to determine the V_{set}. V_{set} is based on set up power as follows:

SET UP POWER from Figure 4 → V_{set} from Figure 12

Set up power is found by adjusting the desired power for ambient temperature. V_{set} is determined from set up power as shown in Figure 12.

1) Estimate the maximum ambient temperature expected at the side and record on the start up data sheet as Item 3.

2) Measure or estimate the present ambient temperature and record as Item 4.

If rated power or maximum allowable power is desired:

3) Use the information in Figure 4 and the procedures in section 1.7 to determine the corresponding set up power and record as Item 5.

4) Use Figure 12 to determine the related V_{set} and record as Item 6.

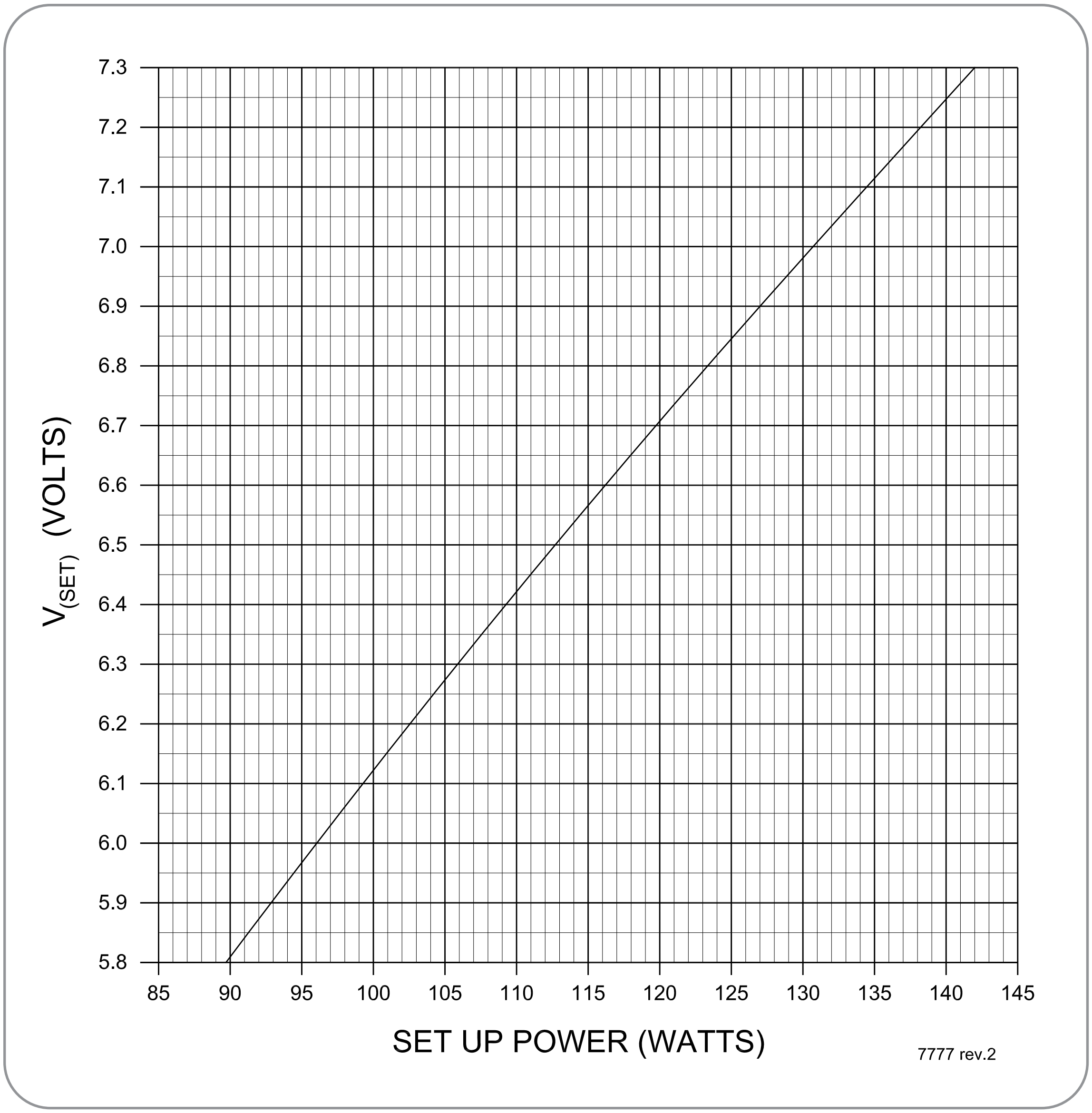


Figure 12 V_{set} Vs Set up Power

If less than rated power is desired:

5) Determine the desired power output.

6) Determine the corresponding set up power by adding 0.3 watts to the desired power for each ºC difference between the present and maximum ambient temperatures.

7) Refer to Figure 12 to determine the related V_{set} and record as Item 6.

2.8 Fuel & Air Adjustment

After the TEG has been operating for one hour, V_{set} should not be changing with time. The readings on the start up data sheet at 40 and 60 minutes should not differ by more than 0.2 volts. When you are satisfied that V_{set} is not changing with time, compare the measured value of V_{set} with the required V_{set}, Item 6. Proceed with air shutter adjustments to optimize the burner first (section 2.9) then adjust the fuel pressure as required (section 2.10).

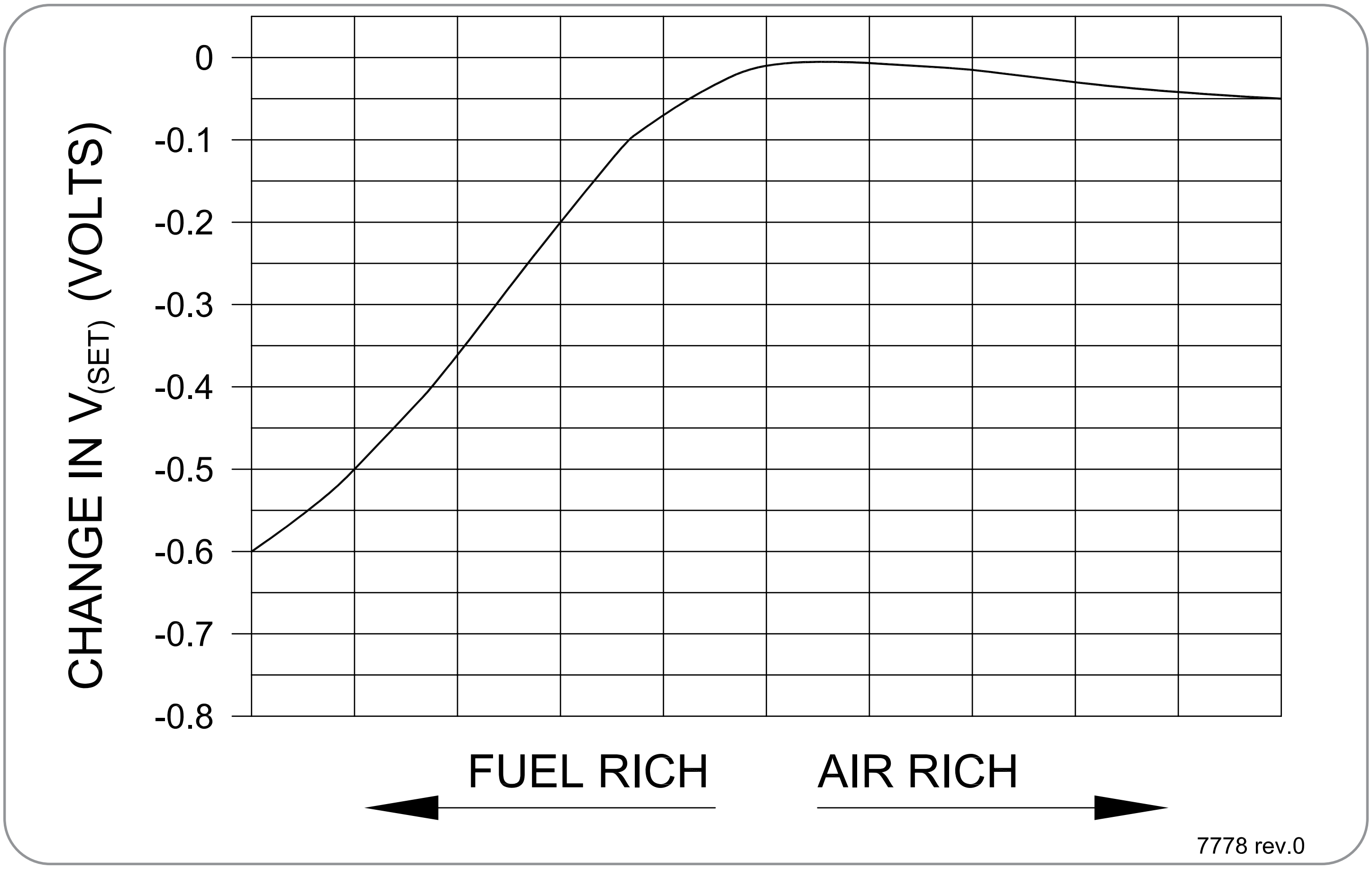


Figure 13 Change in V_{set} Vs Air Shutting Setting

2.9 Air Shutter adjustment

This burner contains dual air shutters which control the amount of air used for combustion. See Figure 10.
If too little air is used (fuel rich), combustion is incomplete and not all the energy in the fuel is converted to heat.
If too much air is used (air rich), additional energy is required to heat the excess air to exhaust temperature.

In both cases fuel is being wasted. When the air shutter is at its optimum setting (neither of above) the TEG is operating at maximum efficiency.

NOTE: If available a combustion analyzer will facilitate rapid air shutter optimizing as you need not wait for V_{set} to change.

Figure 13 shows change in V_{set} as a function of air shutter settings. Observe that V_{set} decreases more rapidly on the fuel rich side than on the air rich side. For this reason a fuel rich operation is to be avoided.

Make initial adjustments of air shutters towards the fuel rich side by decreasing the air holes.

Both air shutters are to be adjusted equally in small increments. Wait 5 to 10 minutes for burner to stabilize. Note the V_{set} and record.

If V_{set} increased or did not change, the burner is air rich. Continue decreasing the air holes until a slight decrease is observed.

Note: You must wait the required time after each adjustment. When a decrease in V_{set} has occurred, increase the air hole size by rotating the air shutter back about 2.5mm. This should ensure slightly air rich (optimum) settings.

If V_{set} decreased you are presently fuel rich. Enlarge the air holes until V_{set} peaks then increase the air holes slightly more towards the air rich side (optimum settings).

After the unit has stabilized, read V_{set} and compare with required V_{set} Item 6.

If these values are not within ±0.1 volts, proceed to fuel pressure adjustment (paragraph 2.10).

If these values are within ±0.1 volts, the TEG is ready to switch to operate mode.

2.10 Fuel Pressure Adjustment

To change V_{set} it is necessary to change the fuel pressure. Figure 14 shows the change in V_{set} as a function of the change in fuel pressure for a typical TEG operating at rated power. The following examples will illustrate how this curve can be used.

1) Suppose the measured V_{set} is 6.5 volts, but 6.7 volts or a change of +0.2 volts is required.

2) Locate the ±0.2 volts on the vertical axis and read horizontally until intersecting the curve.

3) Read vertically down to the horizontal axis and find the required change in fuel pressure.

4) Which is 5.5 kPa (0.8 psi).

You must increase the fuel pressure by 5.5 kPa or 0.8 psi.

5) Suppose the measured V_{set} is 6.8 volts and that 6.5 volts or a change of -0.3 volts is required.

6) Locate -0.3 on the vertical axis and read horizontally until intersecting the curve.

7) Read vertically down to the horizontal axis and find the required change in fuel pressure.

8) Which is -8.3 kPa (-1.2 psi).

You must decrease the fuel pressure by 8.3 kPa or 1.2 psi.

2.10.1 Use the following procedures to make the adjustment in fuel pressure:

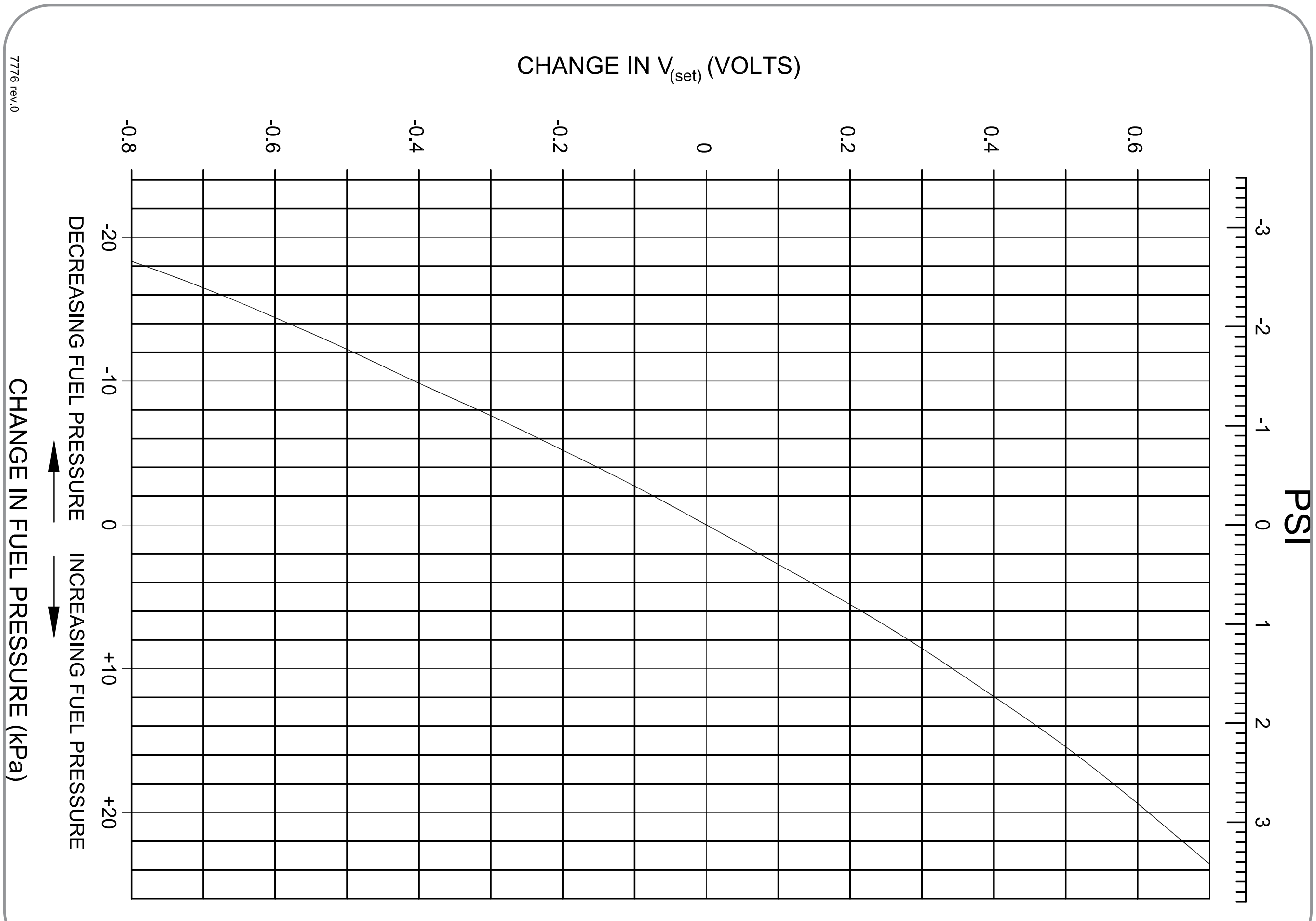


Figure 14 Fuel Pressure Vs V_{set}

1) Record V_{set} after a minimum of one hour of operation as Item 7.

2) Determine the required change in V_{set} by subtracting Item 7 from Item 6 and record as Item 8.

3) Record the fuel pressure as Item 9.

4) Determine the required change in fuel pressure from Figure 14 and record as Item 10.

5) Determine the new fuel pressure by adding Item 10 to Item 9 and record as Item 11.

   EXAMPLE:

   Item 9 = 37.9 kPa (5.5 psi)
   Item 10 = 2.1 kPa (0.3 psi)

   New Fuel Pressure = 35.8 kPa (5.2 psi)

6) Adjust the fuel pressure to the value in Item 11. Close the cabinet doors and record the time.

7) Wait at least 10 minutes and record V_{set} as Item 12.

8) Compare this new value of V_{set} in Item 12 to the required value in Item 6. If the two are still different by an unacceptable amount, repeat this procedure using the latest values of V_{set} and fuel pressures as Items 7 and 9.

9) When the measured and required values of V_{set} are in agreement, the TEG is ready to switch to operation mode.

2.11 Applying Customer Load

The TEG is now operating at the required power output. If this is a single TEG system, it is ready to connect to the customer load. If there are multiple TEGs ensure that all units are ready before proceeding.

1) If station batteries are present, measure and record their voltage. Batteries should be fully charged; if they are too deeply discharged, the 1120 TEG will not charge the station battery.

2) Set power switch to “Run” position, see Figure 10. The TEG “normal” light should come on. Adjust the voltage control to the desired operating voltage plus 0.7 volts using the Output Voltage Adjust dial on the electronics box and the reading on digital panel meter. If a multiple TEG system is in use, ensure that all outputs are equal.

Note: The TEG incorporates a protective series diode. The output voltage will drop 0.7 Volts from the no load to loaded condition.

Push the red “Meter Select” button to read the current.

3) Connect the customer load via disconnects mentioned in Electrical Connection section 1.12. The TEG “Normal” light should remain as a steady glow, if the lamp dims or the output voltage drops significantly, the TEG is being overloaded. Ensure that the load is no more than 100 watts at 24-30 volts.

4) In multiple generator systems ensure that all outputs are set the same.

3 SERVICE

3.1 1120 TEG

This section contains service information and theory of operation on the 1120 generator system only. If the system contains any options, they are described in the Special Options section.

The 1120 Generator can be broken down into several subsystems consisting of the following (see Figure 15):

- Power Unit Assembly
- Burner Assembly
- Igniter Housing Assembly
- Fuel System Assembly
- Conduit Assembly Electronics
- Electronics Assembly

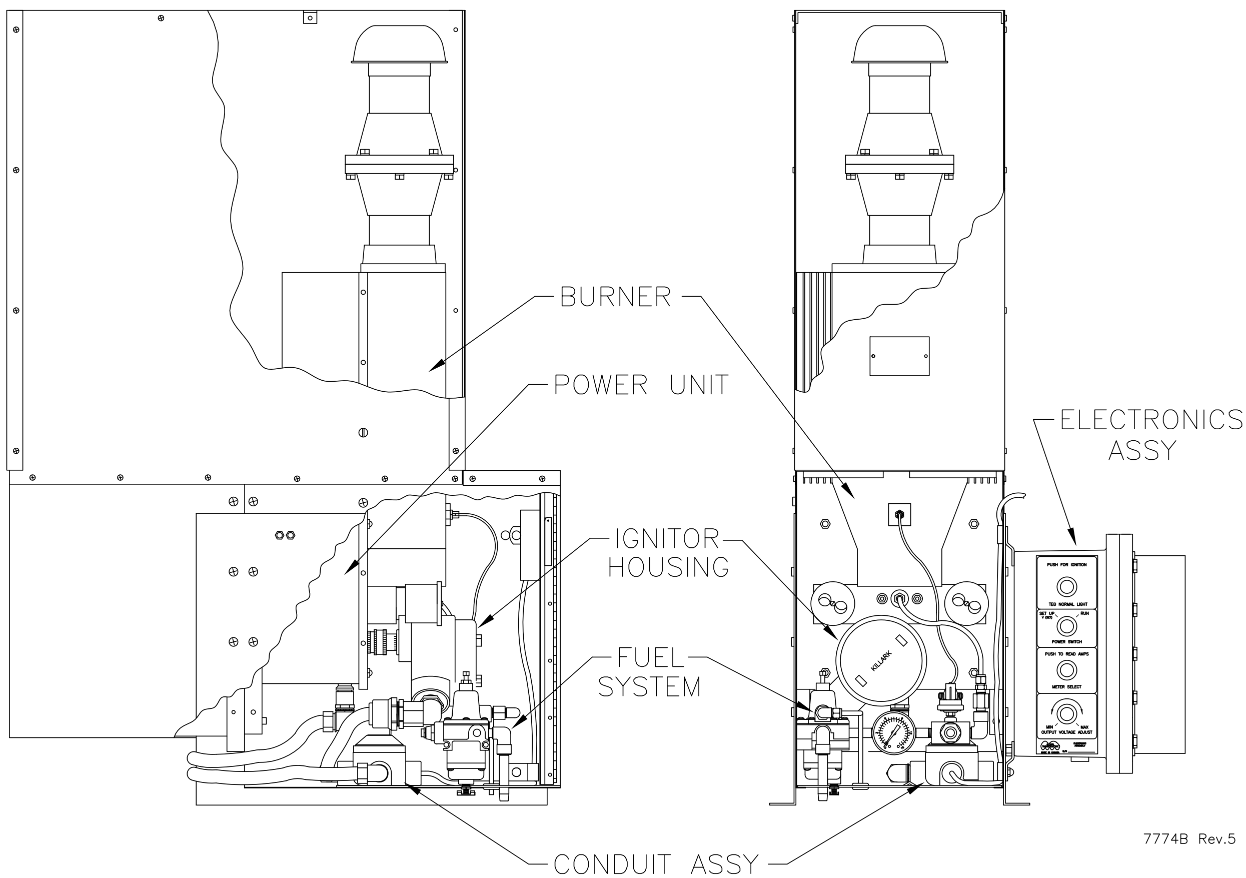


Figure 15 TEG Subsystems, 1120 w/ Drip Cap

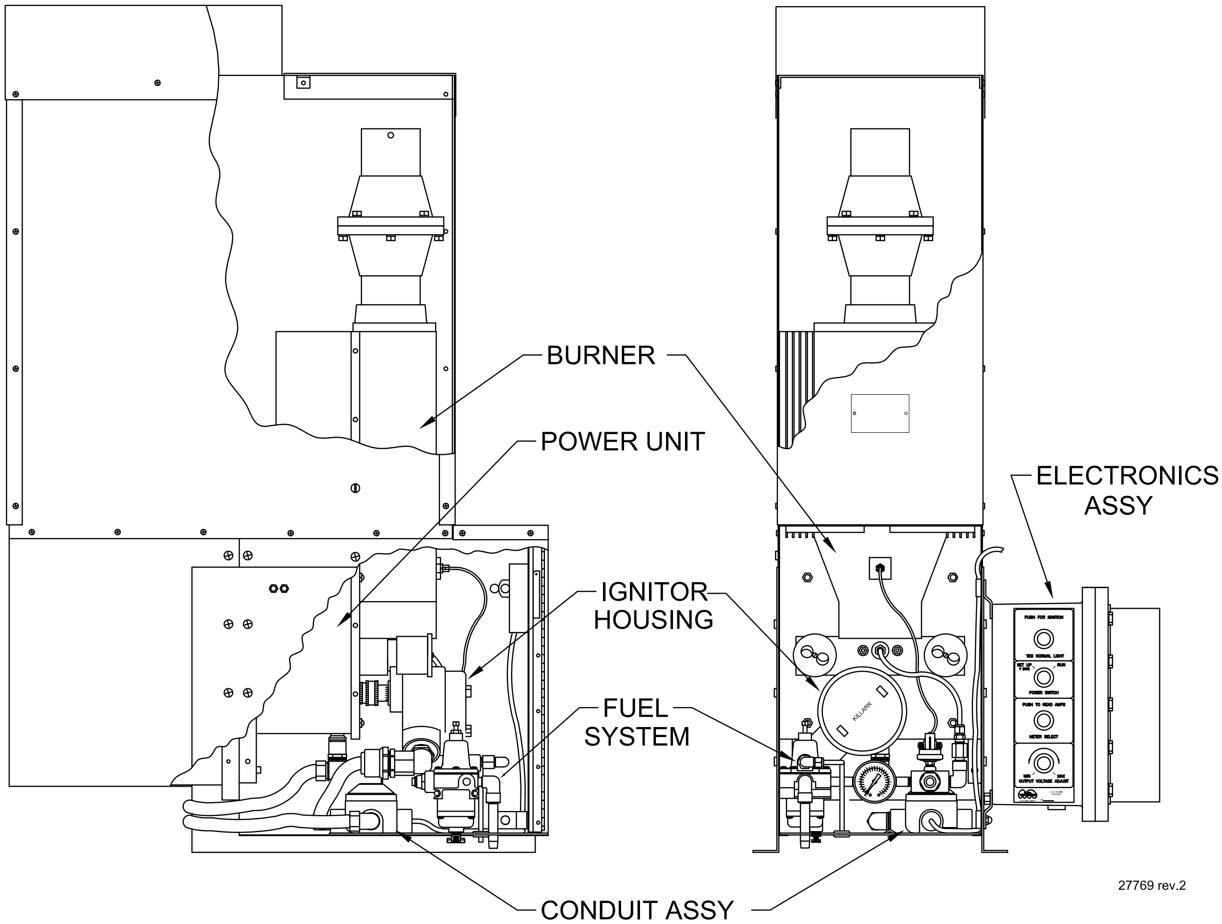


Figure 15 TEG Subsystems, 1120 w/ Rain Shroud

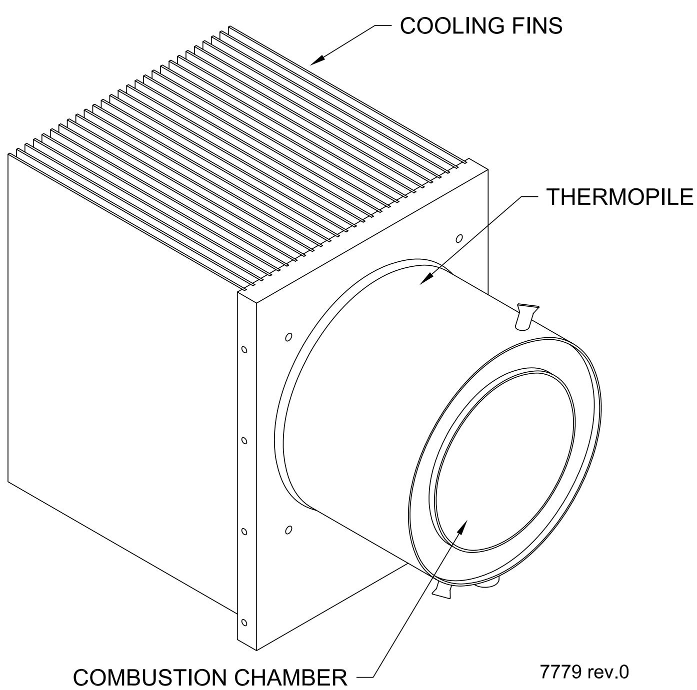


Figure 16 Power Unit

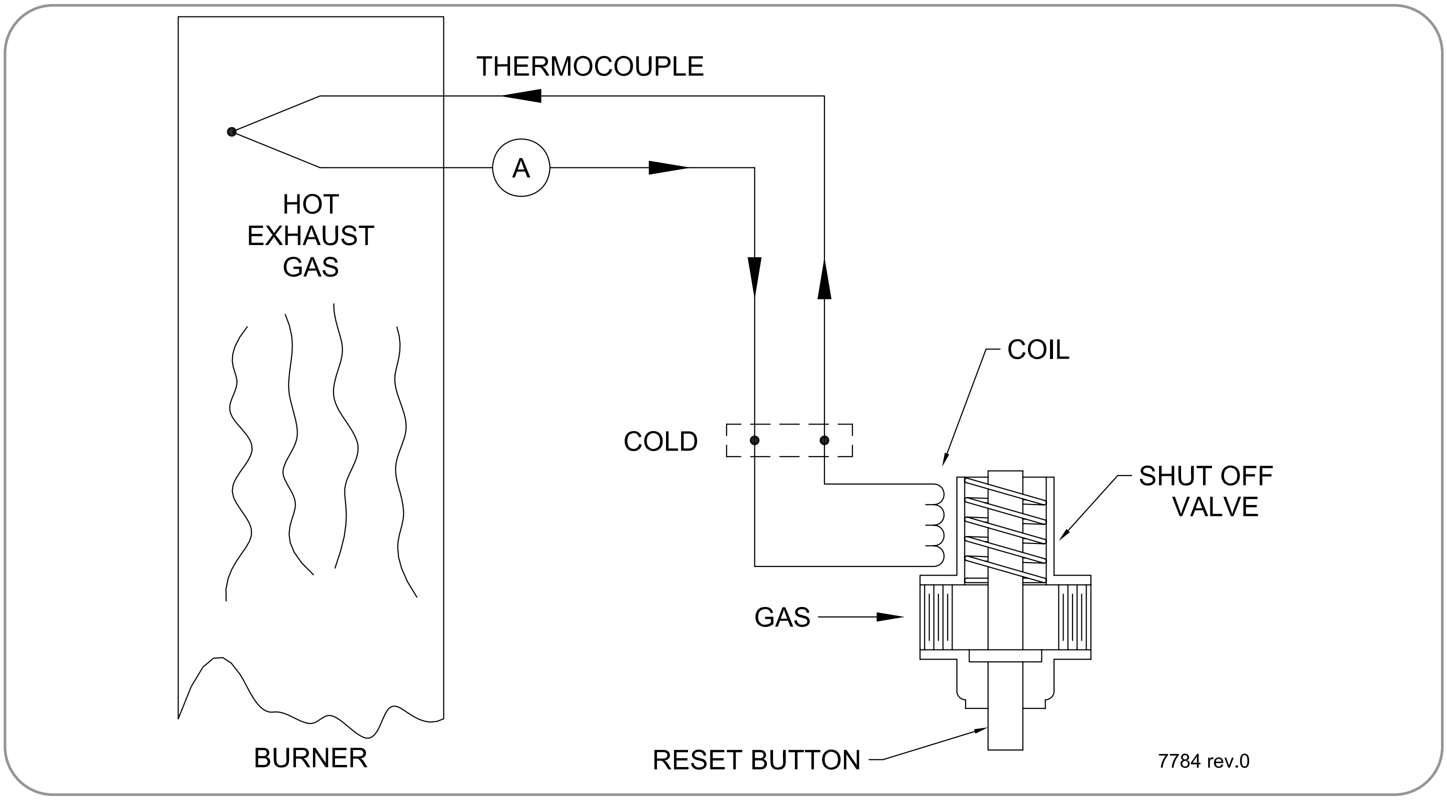


Figure 17 Auto Shut Off

3.2 Power Unit: See Figure 16.

The power unit is a solid state high reliability design that requires little maintenance. It produces constant output power if the correct temperatures are maintained. See discussion in Theory of Operation section 1.3.

Note: The correct temperatures will be maintained if:

a) The fuel and air flow to burner are constant.
b) The flow of cooling air to the fins is not obstructed.

The power unit assembly consists of cooling fins on one end, a hermetically sealed thermoelectric pile in the middle and a combustion chamber on the other end which accepts the burner assembly.

3.3 Burner Assembly: See Figure 25

The burner assembly consists of the burner components, the heat exchanger, and flame arrestors, air intake and exhaust . This assembly performs several functions.

The orifice introduces fuel at a predetermined pressure to the burner. This fuel flows through the venturi tube and the venturi effect causes air to be drawn in through the intake flame arrestors. The air shutters regulate the combustion air quantity. Thus fuel and air are mixed in the venturi tube and passed through the burner screen to the back of the combustion chamber, where it is ignited and burned to produce the operating temperature required. See Figure 1, section 1.3.

The exhaust gases from the combustion chamber are then drawn through the heat exchanger and exhaust flame arrestor to the atmosphere. The function of this heat exchanger is to reduce the temperature of these gases to below the T3 temperature rating of 200ºC (392ºF) and maintain surface temperatures below this rating as well.

The function of the intake and exhaust flame arrestors is to prohibit the propagation of any flame from the combustion chamber to the surrounding atmosphere. The flame arrestors come into play mainly on a cold ignition of the generator. The flame arrestor elements are a 45 grade nickel chromium foam metal able to withstand corrosion and the operating temperatures encountered.

The burner assembly requires no maintenance.

3.4 Fuel Assembly: See Figure 26.

The major components of the fuel assembly are the regulator, pressure gauge, shut off valve and thermocouple, pressure switch, fuel line and orifice.

The regulator used here is a Fisher type 67 CF. Maximum inlet pressure is 172 kPa (25 psi). This regulator incorporates a liquid trap and a 40-50 micron filter for added protection. The actual outlet adjustment range of this regulator is from 0 to 103 kPa (0 to 15 psi), which is monitored with a pressure gauge of this range.

The fuel supply is then fed to the shut off valve which in conjunction with the thermocouple works as an auto shut off system designed to shut off the gas supply if the TEG burner should go out for an extended period of time. Figure 17 shows the electrical operation of the shut off valve and thermocouple.

NOTE: The time required for dropout of the shutoff valve can vary from 1 to 7 minutes. This time being determined by the holding current requirements of shut off valve coil, spring pressure, thermocouple output and operating temperature.

The auto shutoff valve is a manually operated valve and must be reset by pushing the button and holding it in until sufficient heat acting on the thermocouple will hold the coil energized.

The pressure switch mounted on the output side of the shutoff valve operates at approximately 14 kPa (2 psi). This switch on closing applies 2 VDC and power to the ignition system discussed above. This feature gives auto ignition at start up and a short term auto re-ignition in the event of a flame out, due to blow out, short term loss of gas, or short term severe hazard condition.
The fuel is next fed to the flexible fuel line and then to the orifice. The flexible fuel line is standard, however the orifice is unique to the type of fuel used, natural gas or propane.

3.5 Igniter Housing Assembly: See Figure 28.

The ignitor housing assembly consists of a junction box housing, the associated fittings and the high voltage ignitor module. Also it contains the ignitor electrode assembly, the interconnect cable and the mounting connector.

The ignitor housing is mounted to the heat exchanger with the electrode inserted into the burner and connected to the high voltage ignitor module.

The electrode is inserted through the burner into the combustion chamber and properly gapped (1/8” to 3/16” from the combustion chamber wall). The electrode is then connected by the cable to the output of the high voltage ignitor module and is ready for ignition.

The ignition system operates on 2 VDC applied to the high voltage ignition module, which in turn generates a 12 kilovolt spark which arcs from the electrode to the combustion chamber wall. When power is applied the module will generate approximately one spark per second until ignition occurs and combustion is sustained, at which time flame ionization causes a small current to flow and holds off the sparking module.

Power to the ignitor assembly is supplied by the electronics assembly (see Figure15) and routed through the conduit assembly.

Control is by the manual ignition switch of the electronics assembly or the pressure switch of the fuel assembly.

3.6 Conduit Assembly: See Figure 27.

The conduit assembly is a distribution system for the routing of signal and control wires to and from the fuel system, ignitor system, electronics system and digital panel meter. It consists of a junction box for distribution and interconnection, flexible conduit assemblies with seals for maintaining the integrity of assemblies, and a digital panel meter for display of voltage and current settings. The digital panel meter is not field repairable and requires replacement of both the display section and monitor board (located in electronic housing) in the event of failure.

3.7 Electronics Assembly: See Figure 18, Figure 19, Figure 29.

The electronics assembly consists of a housing assembly, protective limiter, converter, precision load resistors, voltage sensing alarm circuit, battery charger control module and battery, protective diode and current shunt, voltmeter input circuits, and all associated switches and controls. Refer to Figure 29 for physical location of circuits and Figure 18 and Figure 19 for schematic diagram of these circuits.

3.7.1 **Electronic Housing**: This box has been designed to meet the requirements of Class I, Division 2, hazardous areas. It also performs as a heat sink capable of dissipating the full output power of the TEG when in a set up or no load condition.

3.7.2 **Precision Load**: Two 0.75 ohm, 50 watt resistors connected in parallel (resulting in 0.375 ohm) as well as their associated wiring, which when switched to the power unit, give us a precision load resistance of 0.387 ohm (approximately), provide the optimum load condition for the TEG. This precision load is used for adjusting the TEG and evaluating its performance. A load voltage of 6.87 volts would give 120 watts from the TEG.

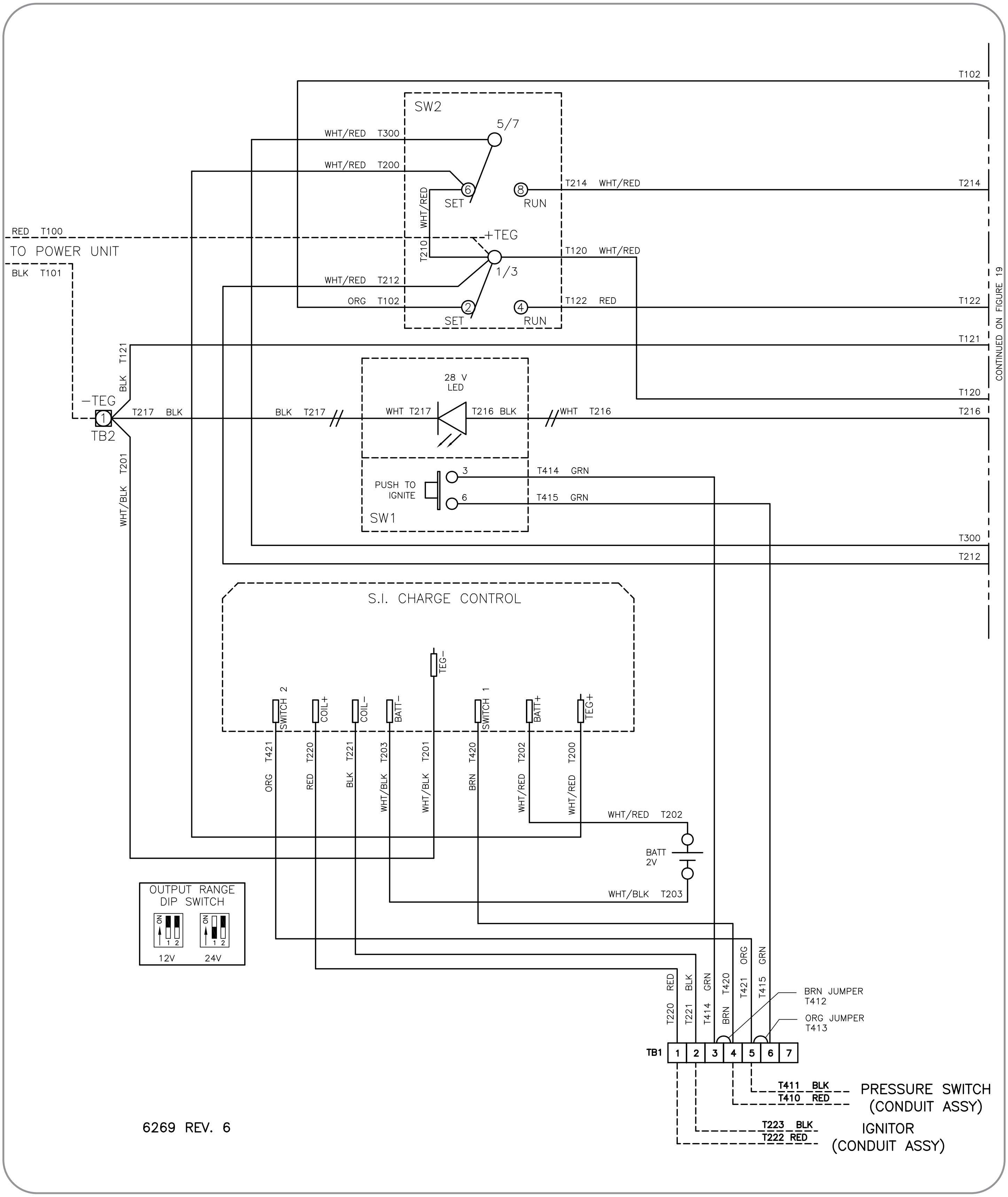


Figure 18 Schematic Diagram, 1120 TEG (sheet 1 of 2)

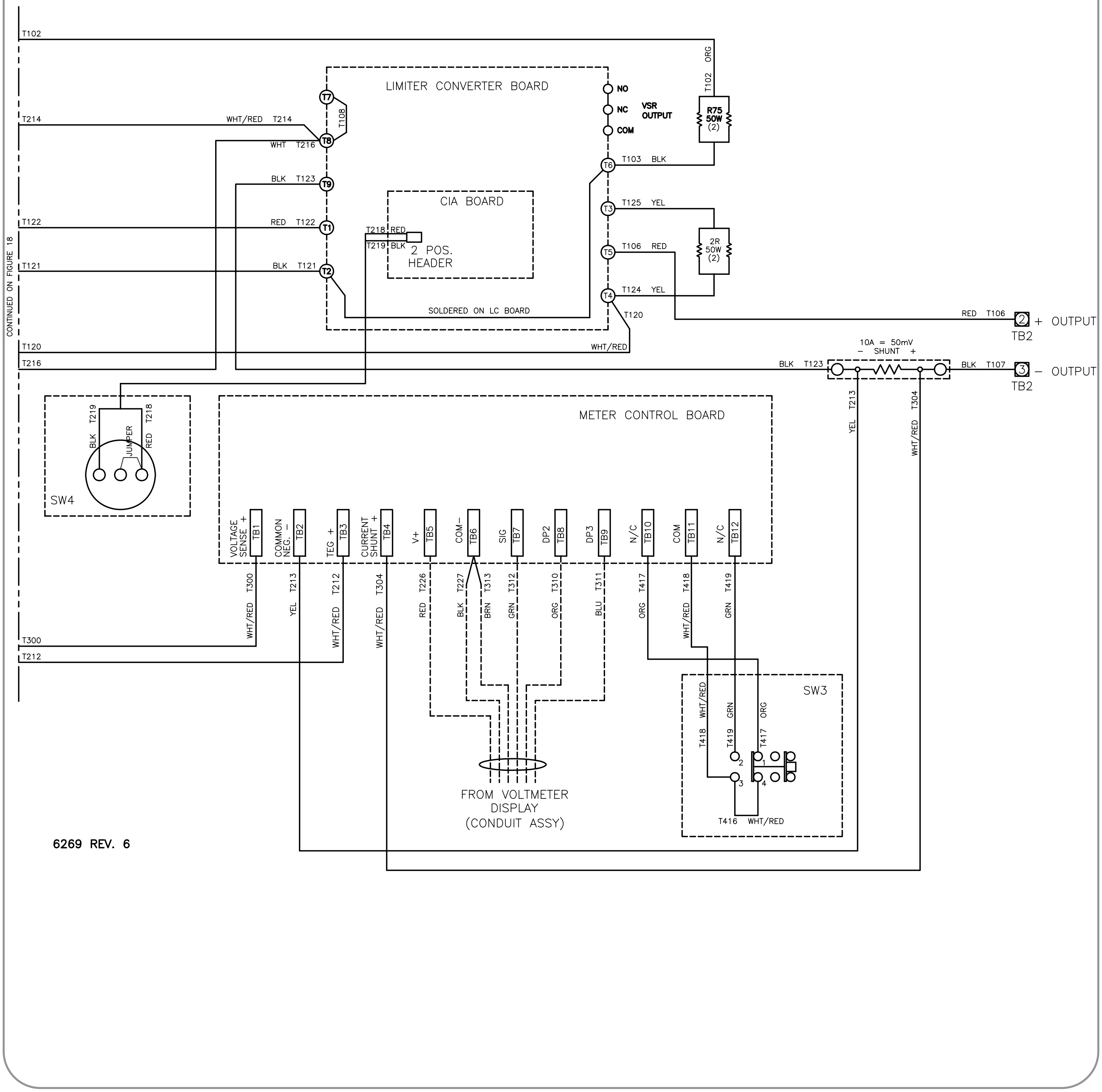


Figure 19 Schematic Diagram, 1120 TEG (Sheet 2 of 2)

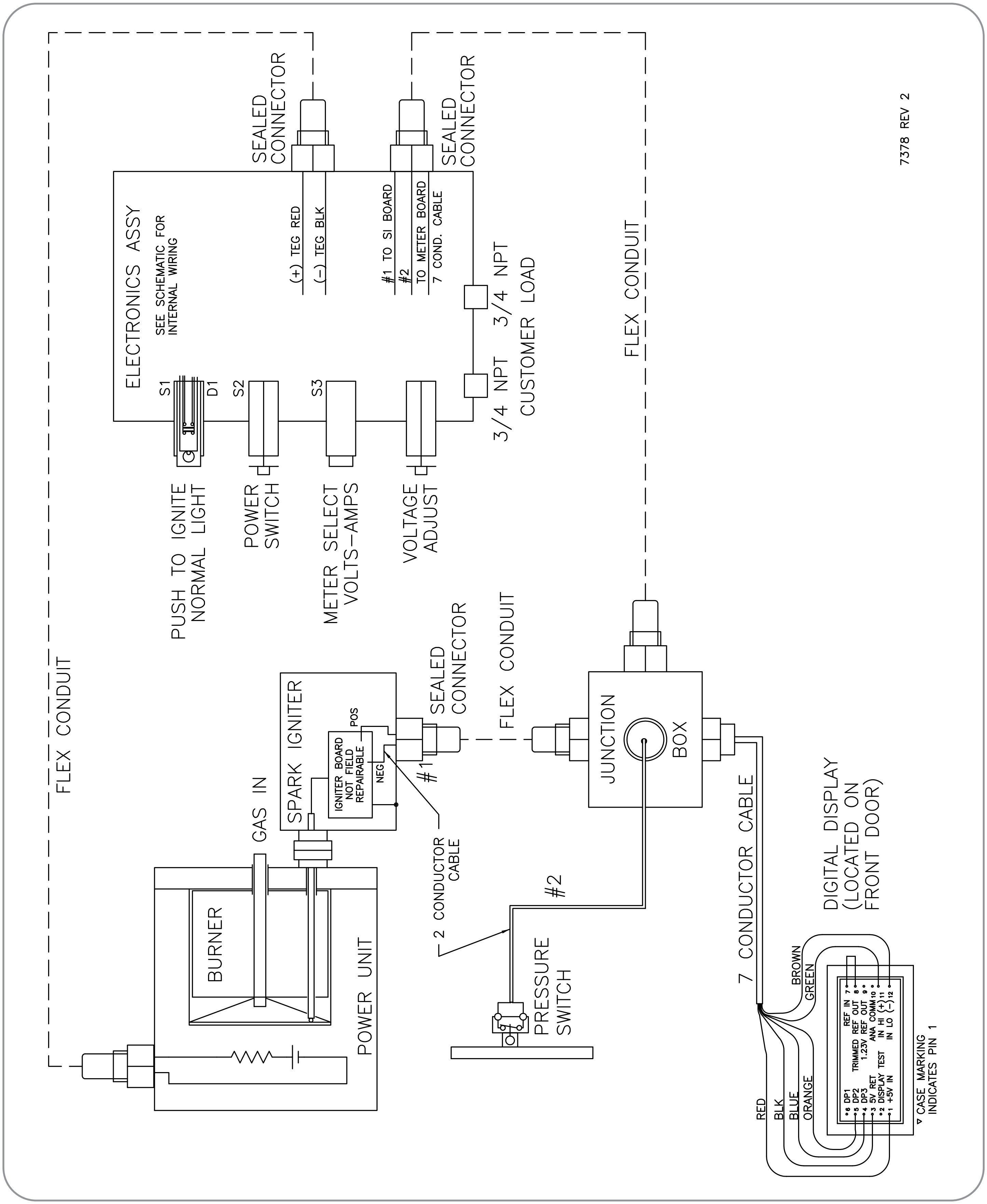


Figure 20 Electronics Diagram, 1120 TEG

3.7.3 **Protective Limiter**: This is a protective device connected directly across the output of the power unit which prevents its output voltage from rising beyond 12 volts. The schematic diagram for the protective limiter is shown in Figure 19. Refer to Figure 29 for the location of the limiter resistors and limiter converter board.

The limiter is designed to operate in a linear mode (good regulation) up to a power level of 102 watts. Above 102 watts it saturates (fully on) and the limiter goes into a nonlinear mode. As it goes from linear to nonlinear the limit voltage begins to increase slightly.

When the TEG is set up to produce rated power, its output is 90 watts at 11.4 volts (or 12 watts below the saturation point of the limiter). In no case will the limiter allow the voltage to rise beyond 12 volts.
The limiter circuit operates in the following manner. Referring to Figure 18 and Figure 19, note that the limiter is connected directly across the TEG output. The normal state of the limiter circuit is that all transistors are turned OFF. As the TEG voltage approaches the limiter set point, dictated by the voltage divider adjustment of the 10K trim pot, the 2N4403 and IRFPO44 transistors gradually turn ON. The degree at which the IRFPO44 is turned ON depends on the current flow from the TEG required to maintain the set point voltage. The limiter will have a good regulation until the IRFP044 becomes saturated.

3.7.4 **DC/DC Converter**: The converter PCB assembly is shown in Figure 29, item F11. All components are mounted on the PCB attached to the door assembly. The DC/DC Converter schematic is shown in Figure 18.

This converter is a high efficiency switching regulator designed to step the TEG output voltage up to 12 V or 24 V nominal. The dip switch settings for the different outputs are shown in Figure 18. Fine tuning of the output voltage is accomplished by adjusting S4 located on the front of the electronics box.

The TL497A switching regulator IC is used to drive the IRFD110 FET, which in turn drives the IRFPO44 FET. The pulse width modulation from the TL497A determines the switching duty cycle of the FETs which determines the increase in voltage across L1. The SR3040 isolation diodes are located before and after the low pass filter which consists of transformer T1 and two 2200 μF capacitors.

The input current is limited through the shunt mounted to the main PCB. The LM2908 Op-Amps drive transistor 2N4401 which increases the current limit sense voltage drop at pin 13 of the TL497 as it turns on. The 20K trim pot is used to set the gain of the OP-AMP to limit the current at 15 AMPs. This is factory set and should not be adjusted by field personnel.

3.7.5 **Voltage Sensing Relay Circuit (VSR)**: Refer to Figure 19. The VSR circuit uses a LM311 voltage comparator to operate the relay K1. The 2.5 Volt level created by the LM285Z 2.5 voltage reference is used as one input while the output from the tap of the 10K trim pot is used as the other. The LM317T is configured as a 10.0 volt regulator to provide a stable voltage for the relay and comparator to operate with either a 12 or 24V output voltage. The 10K trim pot is set so that the relay is energized for normal operation, and de-energizes for an alarm. The relay contacts are brought out to the edge of the main PCB shown in Figure 30.

3.7.6 **Battery Charge Control Module and Battery**: Refer to Figure 29 for the location of the battery and control module. Refer to Figure 19 for the schematic diagram. The primary purpose of this circuit is to supply 2 VDC to the spark ignitor module (located in ignitor housing assembly). The main source for this supply voltage is the 2 volt sealed re-chargeable lead acid battery. As all batteries tend to self-discharge, the control charger circuit is incorporated to maintain the battery at a constant charge. The charging circuit will accept an input voltage of 2.3 volts to maintain the battery at a fully charged condition. The dual inductor and two 100uF caps filter any noise. Power to the ignitor circuit is switched by the manual ignition switch (Push to Ignite) or the fuel system pressure switch.

Note: The battery charge circuit is normally charged from the 6 volt TEG output.

3.7.7 **Digital Panel Meter**: The digital panel meter consists of two subassemblies, the display portion (Figure 27, item D10) which is a light emitting diode display and the control portion (Figure 29, item F7) which conditions the voltages for the display portion.

The digital panel meter is a 3.5 digit auto-ranging meter. When the power switch is in the “Set Up” position, the meter will show the V_{set} voltage. When the power switch is set to the “Run” position, the meter will show the output voltage of the system. In addition when the “Meter Select” switch is pressed the meter will show the output current flowing to the load.

The meter is powered directly by the power unit. When the TEG is first started, the panel meter will not function until the TEG voltage reaches 4.5 volts.

3.8 Service

3.8.1 On Site Visits

1) Drain the sediment bowl of the fuel regulator by opening the drain cock.

2) Read and record the fuel pressure and the output of TEG pressure regulator. If a master fuel gauge is present, record this pressure.

3) Notice if the normal light is lit. The lamp should glow steady (generator running). If the lamp is out, check and replace the bulb. If the lamp is flashing, overload condition exists. Trouble shoot the system.

4) Read and record the output voltage and current.

5) Visually check for loose components or hardware. Tighten any loose hardware and connections.

NOTE: No adjustment should be made to any devices, unless malfunctions were found and corrected.

3.8.2 Annual Service

1) Perform on site visit as above and record data.

2) Check and record the power output of the generator. Switch the power switch to set up position, allow approximately 10 minutes to stabilize. Read the V_{set} voltage, calculate the output power of the TEG, E^2/R, using the precision load resistance (0.387 ohms). Record and compare with set up figures.

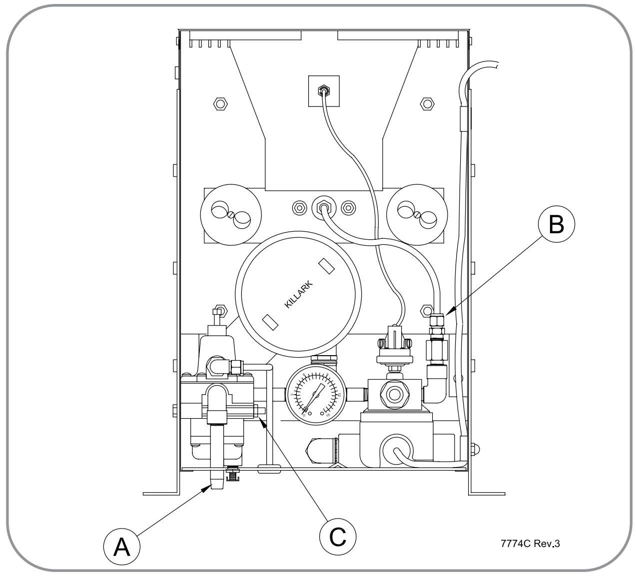


Figure 21 Removing Fuel System

If power is within ±5% of set up power then the unit is performing properly. If the power output exceeds this limit then troubleshoot the system.

3.9 Field Troubleshooting

NOTE: This generator has been designed for use in hazardous areas. If this unit is being used in a hazardous area, no housings, junction boxes or fittings may be removed or disconnected while unit is running. The field troubleshooting section assumes that whenever a test, check or remedy requires that a housing, junction box or fitting be removed or opened that the generator is first turned OFF.

Whenever major work or repairs are required other than that called out in field troubleshooting:

1) The generator or electronics assembly must be removed to a safe area. Or:

2) The area in which the generator is being used must be rendered safe in accordance with all regulations governing the operations area.

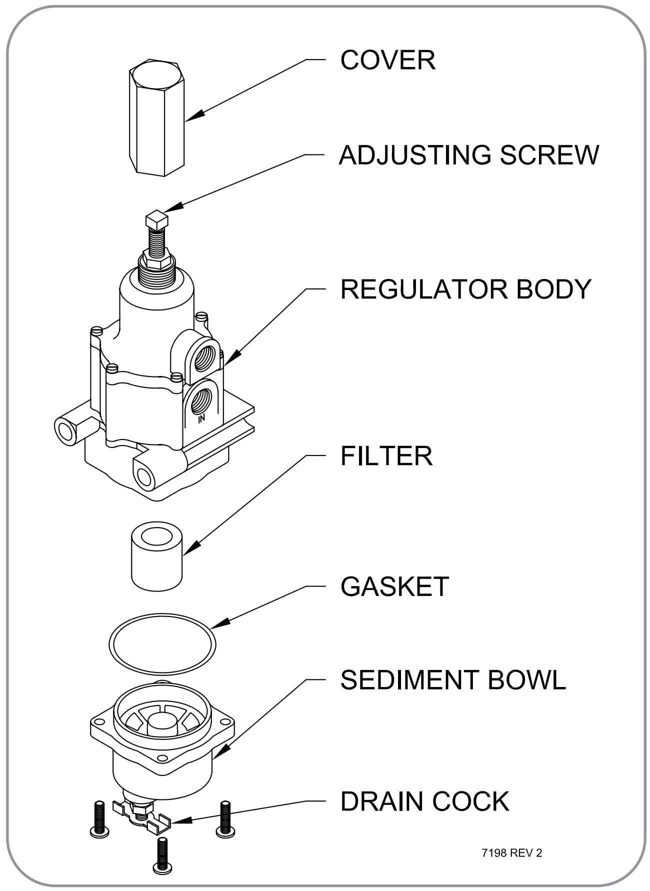


Figure 22 Fuel Regulator

3.9.1 Changing the Fuel Filter (Figure 20, Figure 21)

If it is necessary to remove the fuel filter, the complete fuel assembly must be removed.

1) Shut off fuel, disconnect the fuel input at point A.

2) Disconnect the flexible fuel line at point B.

3) Remove the two nuts holding the regulator to the mounting bracket (point D).

4) Remove the four socket cap screws from the bottom of the regulator. Remove the bottom, complete with the rubber gasket (see Figure 22).

5) Remove and inspect the filter, clean or replace as required.

6) Re-assemble in reverse order.

7) Ensure that all joints are leak checked prior to starting generator.

FIELD TROUBLE SHOOTING	
SYMPTOMS	**CAUSE AND/OR REMEDY**
Burner does not ignite.	No fuel: Turn on fuel. Adjust regulator.
	No spark: Listen for audible spark, if not present try manual ignition switch. If spark is present, check the pressure switch and pressure switch wiring. If no spark is present check if electrode is gapped. Check the battery. Replace if necessary. Replace the high voltage ignition module.
Burner does not remain ignited.	If ignition occurs and unit continues to fire, but will not stabilize (sustained combustion) note the position of the air shutters and adjust for sustained ignition. Reset the air shutters when the unit warms up.
Burner does not remain ignited when shut off valve button is released	Replace thermocouple. Replace shut off valve.
Output power or voltage low (TEG in Set Up position).	Incorrect fuel adjustment, see section 2.10. Incorrect air adjustment, see section 2.9. Dirty fuel filter, orifice, or intake flame arrestors. Protective limiter faulty.
Output power or voltage high.	Incorrect fuel adjustment, see section 2.10.
Output power or voltage low (TEG in Operate position).	If any problems are encountered with the power conditioner, the generator or electronics assembly should be removed to a safe area.

3.9.2 Electronics Trouble Shooting

ELECTRONICS TROUBLE SHOOTING	
SYMPTOM	**CAUSE AND/OR REMEDY**
TEG Normal light is dim.	The converter circuit is being overloaded. Disconnect the load; the light should come on steady. If steady, the problem is on the load side. Trouble shoot the load. If the light remains flashing, the problem is internal (electronics housing). The generator will have to be moved to a safe area for testing, or make area safe. Trouble shoot the electronics.
TEG Normal light is out, voltmeter reading is OK, TEG is running.	TEG lamp burned out. Replace the lamp. Lamp driver circuit is bad.
TEG Normal light is out, voltmeter is out, TEG is running	Possible short circuit condition, disconnect the load. If the lamp lights OK and the voltmeter is OK then trouble shoot the load. If the lamp does not light and the voltmeter does not come on switch to “Set Up”. If the voltmeter reads 6 Volts or more there is probably an internal short in the electronics housing. Trouble shoot the electronics assembly.

3.10 1120 TEG Parts Lists

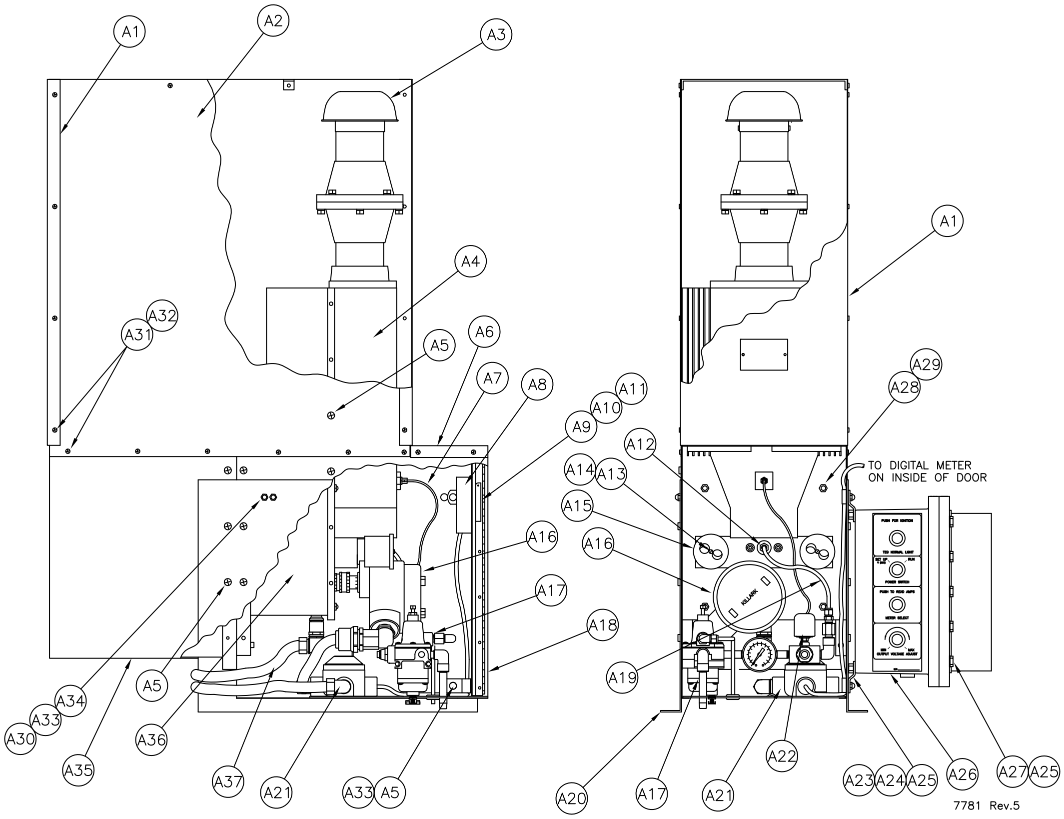


Figure 23 1120 Parts Illustration

Item	Part No.	Description	QTY
A1	5260	Fin Duct, Upper, Front	1
	5261	Fin Duct, Upper, Back	1
A2	5258	Fin Duct, Upper, Left Side	1
	5259	Fin Duct, Upper, Right Side	1
A3	25899	Rain Shroud Kit	1
	2275	Drip Cap Assy	
A4	2446	Burner Assy	1
A5	20954	Screw, Mach, P-H-P, 1/4-20 X 5/8, 316 SS	28
A6	7028	Cabinet Top Assy	1
A7	20828	Thermocouple, 24”, K16RA-24, Soldered	1
A8	57210	Heat Shield, 1120 Meter	1
A9	3322	Cover, Digital Panel Meter	1
A10	7336	Bezel, Digital Panel Meter	1
A11	29606	Screw, Mach, P-H-P, 6-32 X 3/8, 316 SS	4
A12	2405	Orifice Assy, #7, Propane	1
	2406	Orifice Assy, #8, Natural Gas	1
A13	2394	Washer, Disc Spring, #8 SS	2

3.10 1120 TEG Parts Lists (Cont'd)

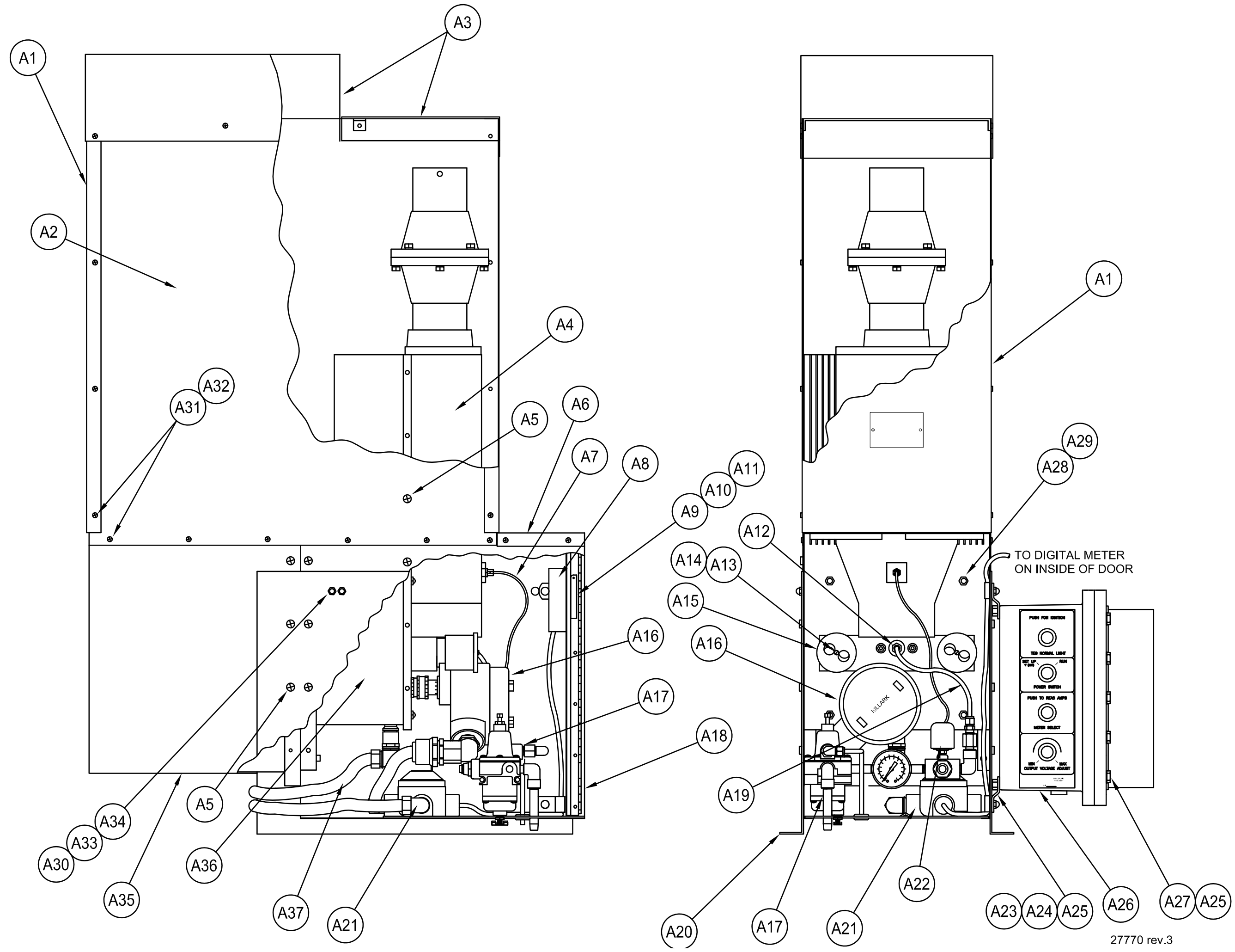


Figure 23 1120 Parts Illustration

Item	Part No.	Description	QTY
A14	29603	Screw, Mach, P-H-P, 6-32 X 5/8, 316 SS	2
A15	2460	Air Shutter, Teflon	2
A16	2311	Ignitor Housing Assy	1
A17	22383	Fuel System Assy, W/CF Regulator	1
	20955	Screw, Hex, HD, 1/4-20 X 3 1/2", 316 SS	2
	22024	Washer, Lock, 1/4, 316 SS	2
	20952	Nut, Hex, 1/4-20, 316 SS	2
A18	21773	Cabinet Assy	1
A19	5286	Fuel Line Kit	1
A20	2218	Leg, Left	1
	2219	Leg, Right	1

3.11 Ignitor Detail

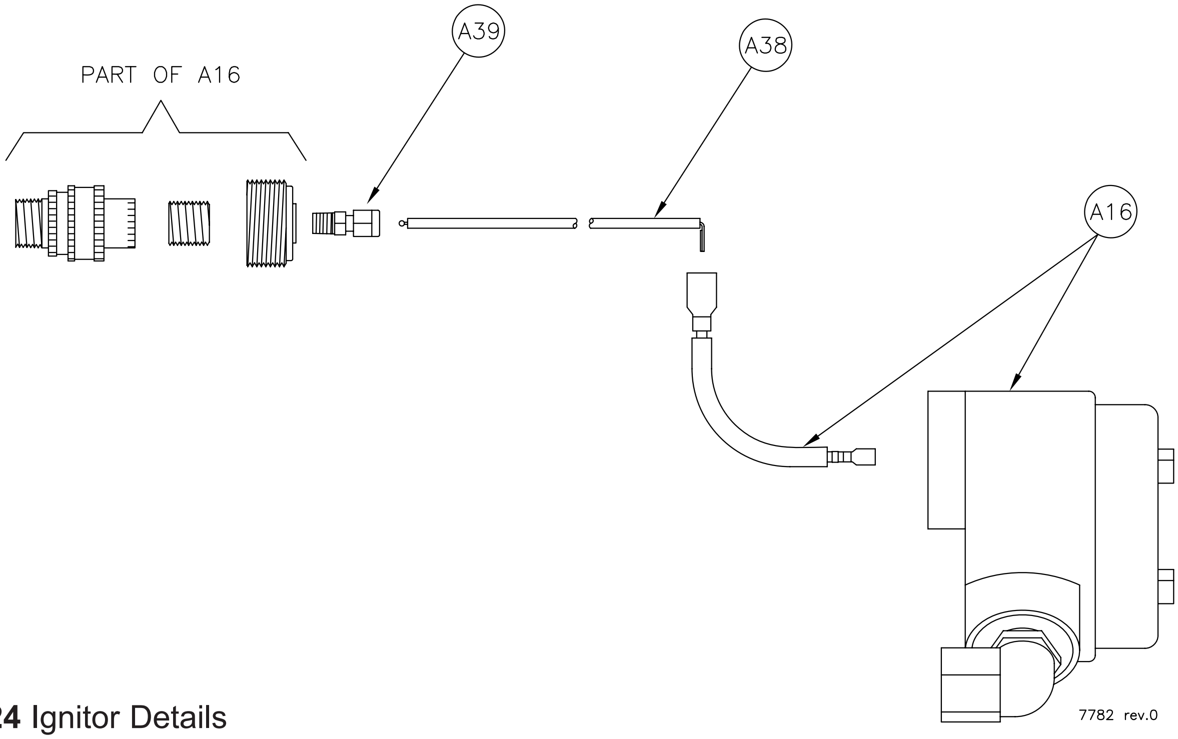


Figure 24 Ignitor Details

Item	Part No.	Description	QTY
A21	7615	Conduit Assy, Electronics	1
A22	2419	Pressure Switch Boot	1
A23	29608	Screw, Hex-HD, 3/5 - 16 x 3/4, 316 SS	4
A24	2254	Mounting Bracket, Electronic Box	4
A25	22021	Washer, Lock, Spring, 3/8, 316 SS	24
A26	5667	Limiter Converter Assy	1
A27	23566	Screw, Cap, Hex-HD, 3/8-16 X 1 1/2, 316 SS	20
A28	2266	Mounting Rod, Burner	4
A29	21131	Nut, Hex, 5/16-18, 316 SS	4
A30	24368	Screw, Mach. Hex-HD, 1/4-20 x 3/8, 316 SS	8
A31	24497	Screw, Mach, P-H-P, 8-32 X 1/4, 316 SS	40
A32	23811	Washer, Lock. Spring, #8, 316 SS	6
A33	22024	Washer, Lock. Spring, 1/4, 316 SS	16
A34	20952	Nut, Hex, 1/4-20, 316 SS	16
A35	2339	Fin Duct, Lower	1
A36	8905	Power Unit	1
A37	7625	Conduit Assy, Power Unit	1
A38	2032	Electrode Assy, Spark Ignition	1
A39	6362	Connector, 3/16-1/8, Nylon, NY-300-1-2	1

3.12 Burner Part List

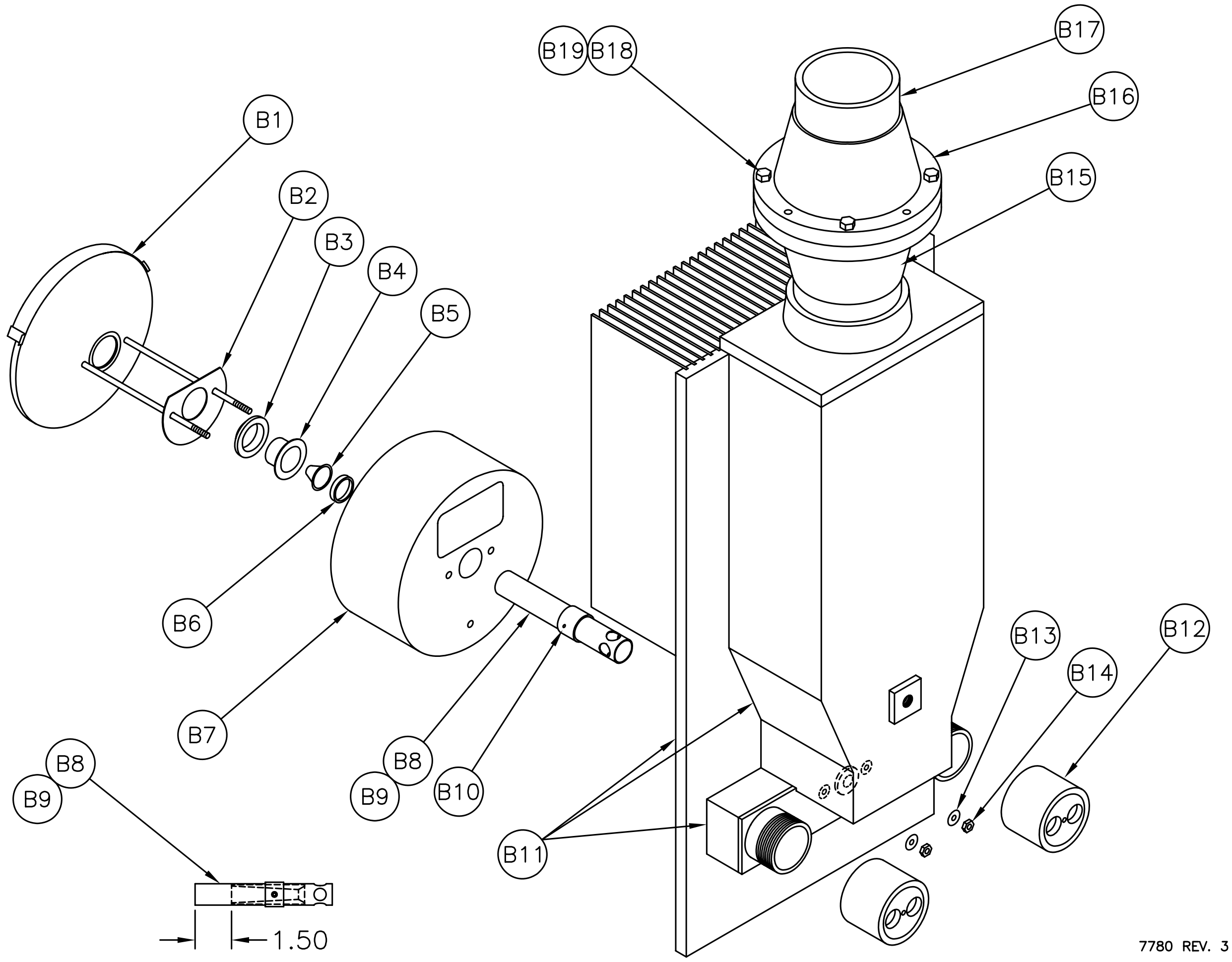


Figure 25 Burner Parts

Item	Part No.	Description	QTY
B1	2278	Burner Back Assy	1
B2	2301	Insulation Support	1
B3	701	Spacer, Insulation	1
B4	693	Screen Holder	1
B5	873	Screen, Burner	1
B6	694	Insert Ring, Burner	1
B7	2302	Insulation Block	1
B8	2401	Venturi Tube Holder	1
B9	971	Venturi	1
B10	479	Screw, Set, Soc. HD, 6-32 X 1/8, SS	1
B11	2389	Burner Cover Assy	1
B12	2454	Flame Arrestor Assy, Air Intake	2

3.12 Burner Part List (Cont'd)

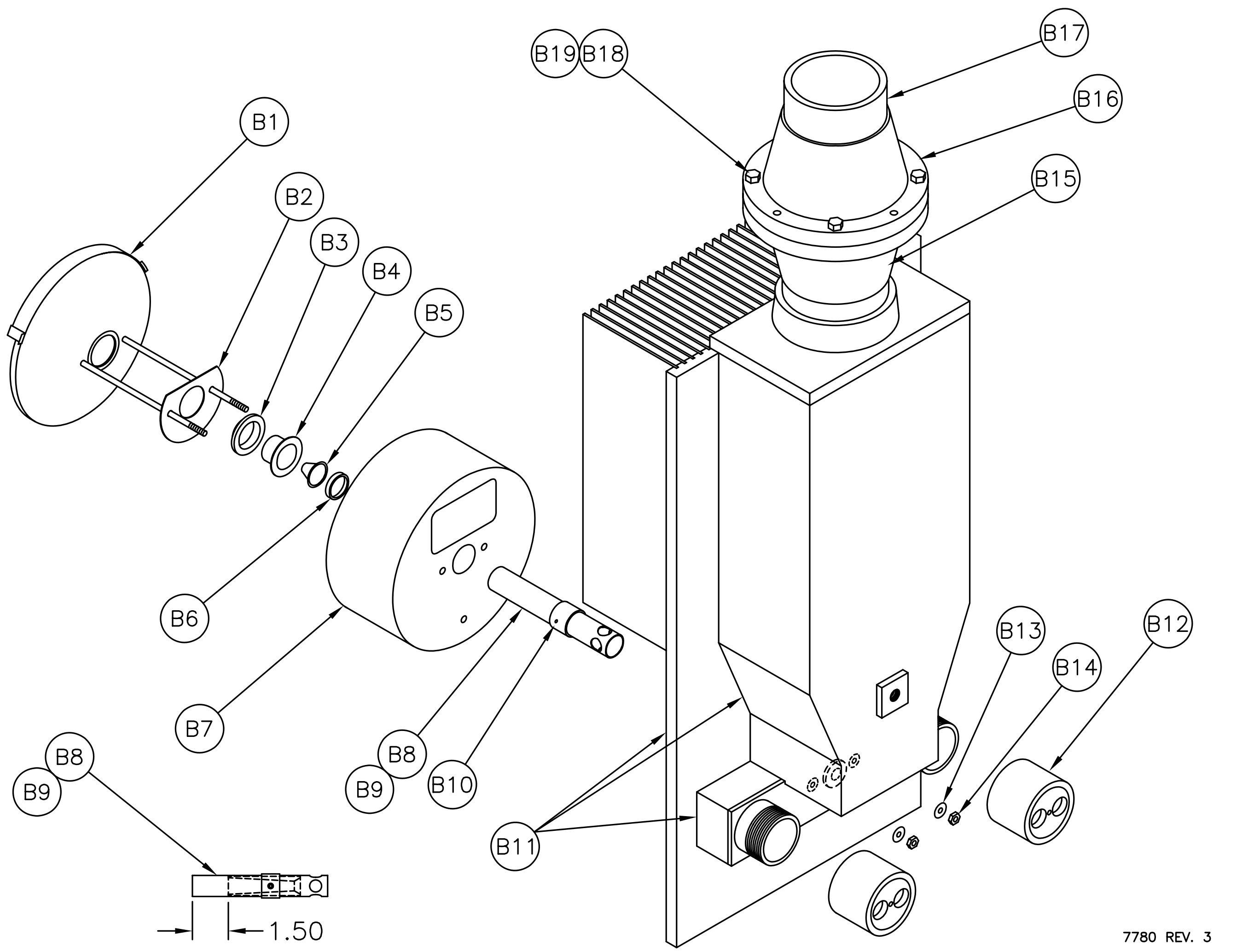


Figure 25 Burner Parts

Item	Part No.	Description	QTY
B13	609	Nut, Hex, 10-32, SS	2
B14	469	Washer, Int. Lock, #10, SS	2
B15	2415	Flame Arrestor Assy, Exhaust	1
B16	5241	Flame Arrestor Housing, Upper	1
B17	2452	Exhaust Stack	1
B18	2413	Screw, Hex HD, 1/4-20 X 1.00, SS	8
B19	541	Washer, Lock, Spring, 1/4, SS	8

3.13 Fuel System Parts List

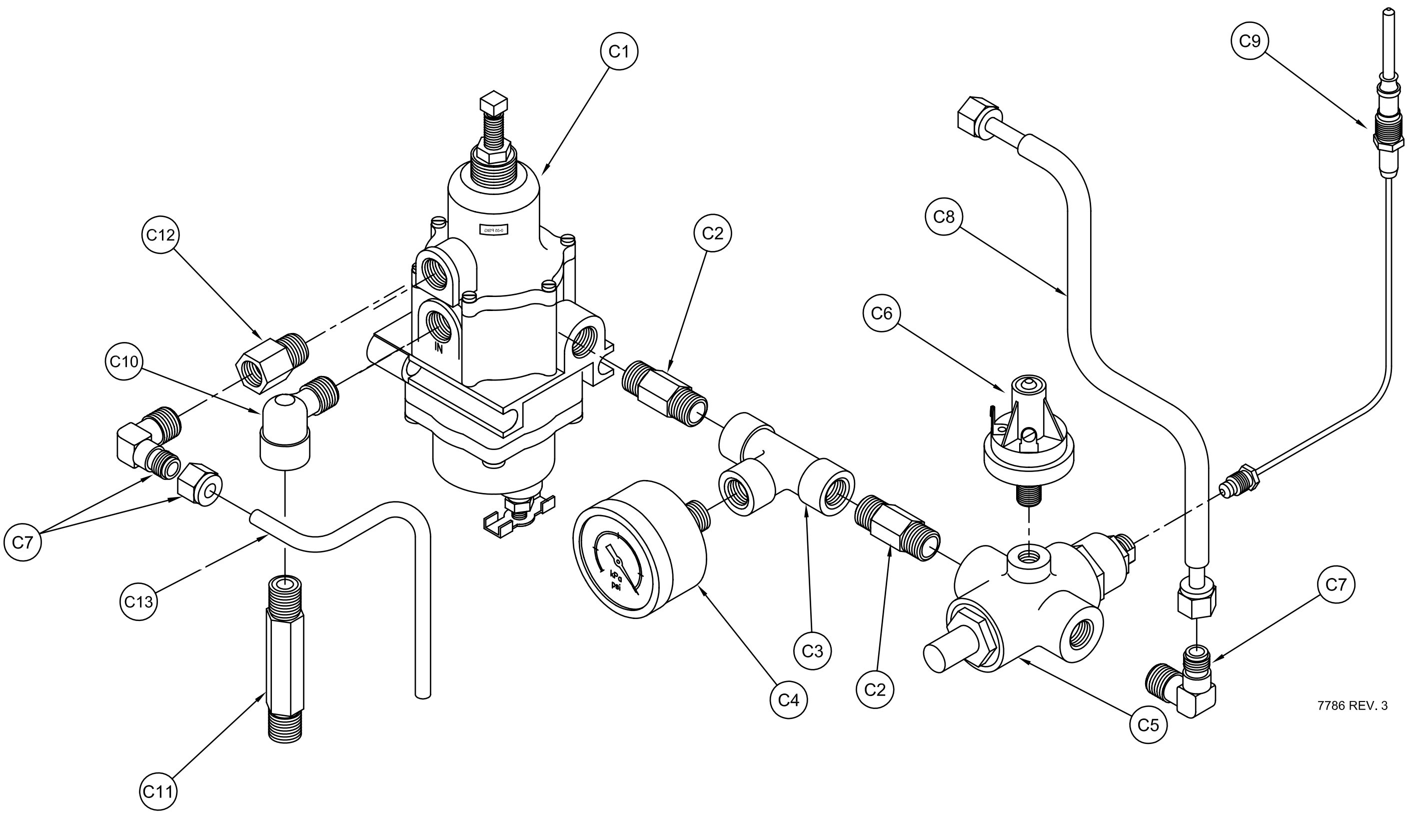


Figure 26 Fuel System Parts

Item	Part No.	Description	QTY
C1	22362	Regulator, Fisher 67 CF, 0-20 PSI	1
C2	2359	Nipple, 1/4 NPT X 1.5 LG, SS	2
C3	2357	Tee, 1/4 NPT, SS	1
C4	2350	Gauge, Pressure, 0-15 PSI	1
C5	176	Valve, Shut off, BASCO H19-TA3	1
C6	1429	Pressure Switch, H0BBS 78628	1
C7	20071	Elbow, 1/4 NPT X 1/4 Tube, SS	1
C8	5286	*Fuel Line Kit	1
C9	20828	*Thermocouple, 24”, K16RA-24, Soldered (order separately)	1
C10	2356	Elbow, Street, 1/4 NPT, SS	1
C11	2358	Nipple, 1/4 NPT X 3”, SS	1
C12	2360	Adaptor, 1/4 NPT, SS	1
C13	20067	Vent Tube Assy, 1120	1
C14	22363	*Fuel Filter Kit, Fisher 67 CFR (not shown)	

*NOTE: Parts not included if ordering entire igniter housing, must be ordered separately.

3.14 Conduit Assembly Parts List

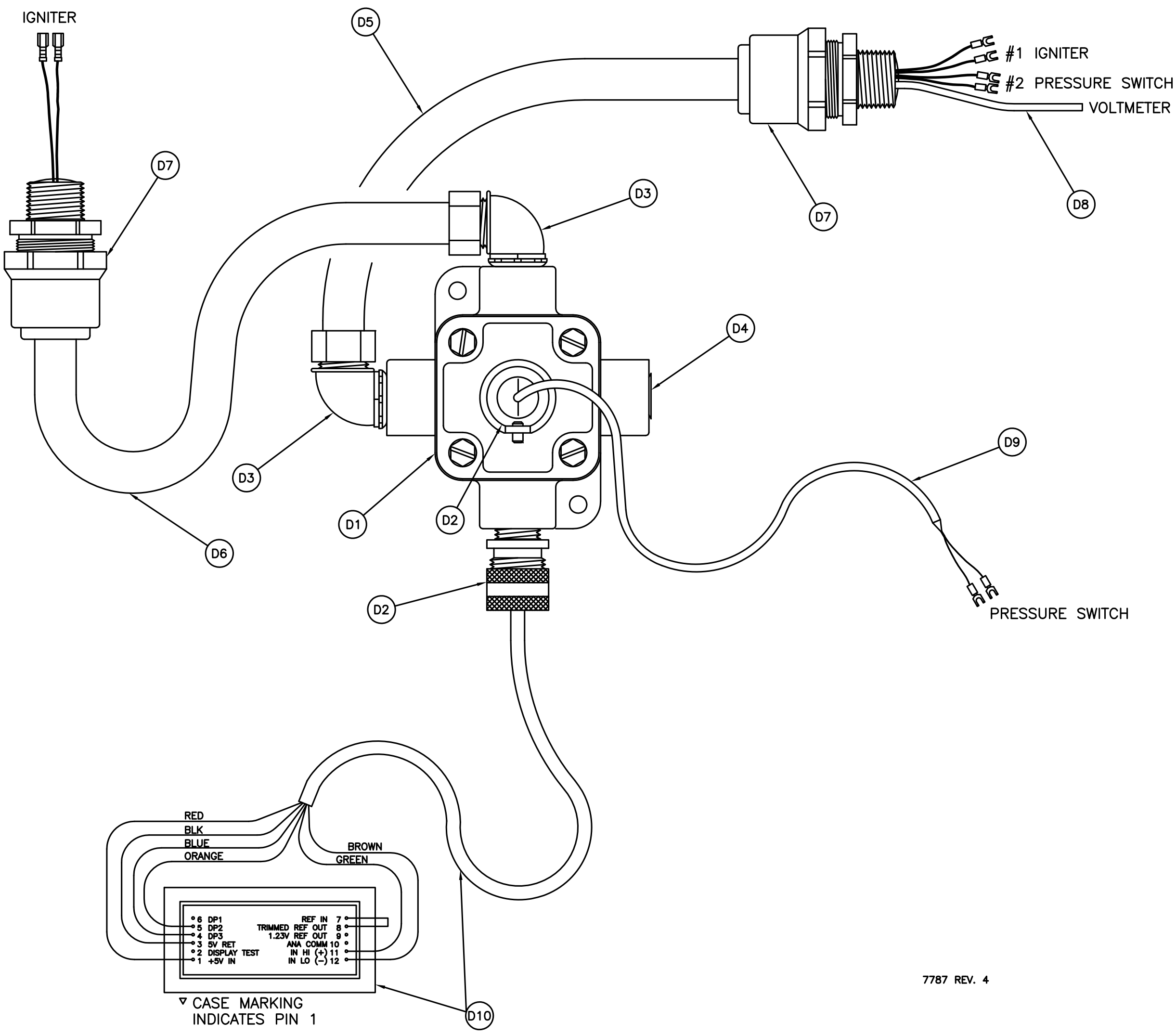


Figure 27 Conduit Assembly Parts

Item	Part No.	Description	QTY
D1	5216	Junction Box, 4 Outlet	1
D2	2428	Connector, Strain Relief, 1/2 NPT	2
D3	2163	Connector, 90 , 3/8 Conduit, 1/2 NPT	2
D4	5222	Plug, Close Up, 1/2 NPT, CUP-1	1
D5	2168	Conduit, Liquid Tight Flex, 3/8”	22”
D6	2168	Conduit, Liquid Tight Flex, 3/8”	10”
D7	20156	Barrier Gland, 3/4 NPT	2
	20155	Reducer Bushing, 3/4” X 1/2”, ALUM	2
D8	2456	Cable Assembly	1
D9	6372	Ignitor Cable, Conduit Assy	1
D10	51084	Digital Panel Meter Assy, 1120	1

3.15 Ignitor Housing Assembly Parts List

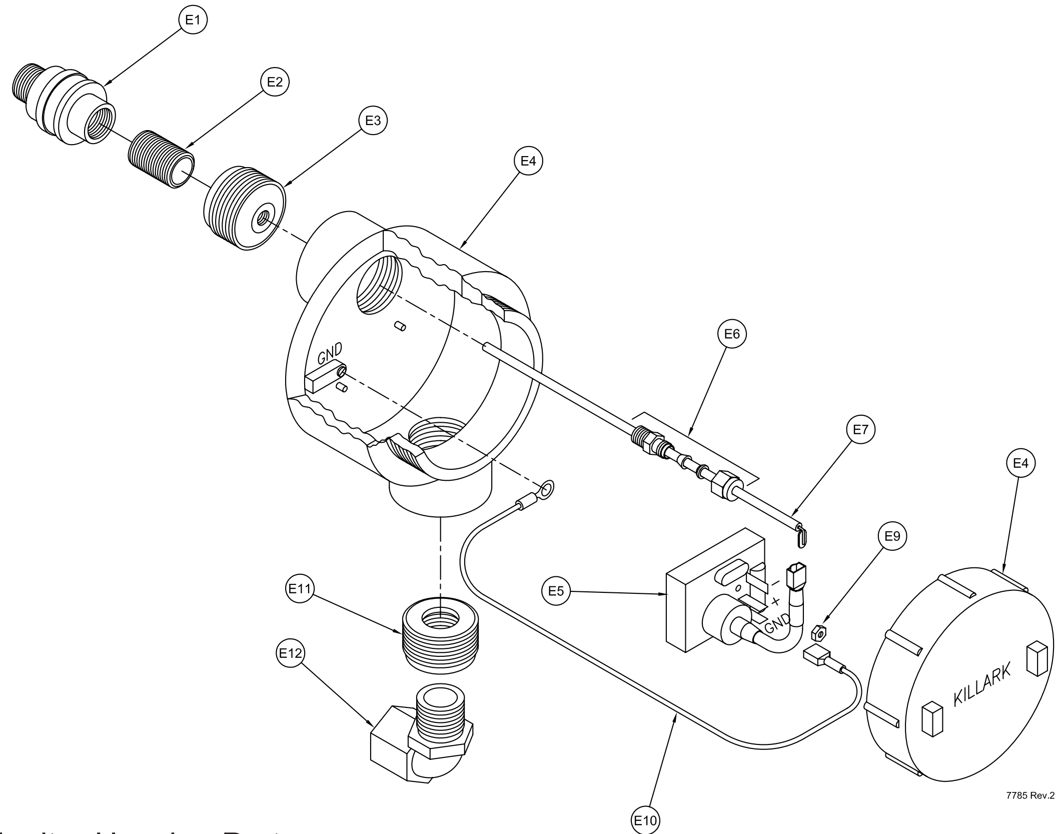


Figure 28 Ignitor Housing Parts

Item	Part No.	Description	QTY
E1	2173	Union, 1/2”, Alum, UL Class I, Group D	1
E2	56640	Nipple, 1/2, Close, SS	1
E3	2340	Holder Assy, Ignitor	1
E4	5247	Junction Box, 1 1/4 NPT, Class I, Group D	
E5	60307	Ignitor Board Assy	1
E6	6362	*Connector, 3/16-1/8, Nylon, NY-300-1-2	1
E7	2032	*Electrode Assy, Spark Ignitor	1
E9	21650	Nut, Hex, 6-32, SS, 1/4” Across Flats	2
E10		Ground Cable, SI	1
	5205	Female Disconnect, DNF18-250Fib	1
	137	Wire, 20AWG,Green, 6”	1
	204	Terminal, Ring, 1/4 RED, PNF18-14R	1
E11	2379	Reducer, 1 1/4 X 3/4 NPT, ALUM	1
E12	2376	Connector, 90 , M-F, 3/4 NPT, ALUM	1

*NOTE: Parts not included if ordering entire ignitor housing, must be ordered separately.

3.16 Electronics box L/C Parts List

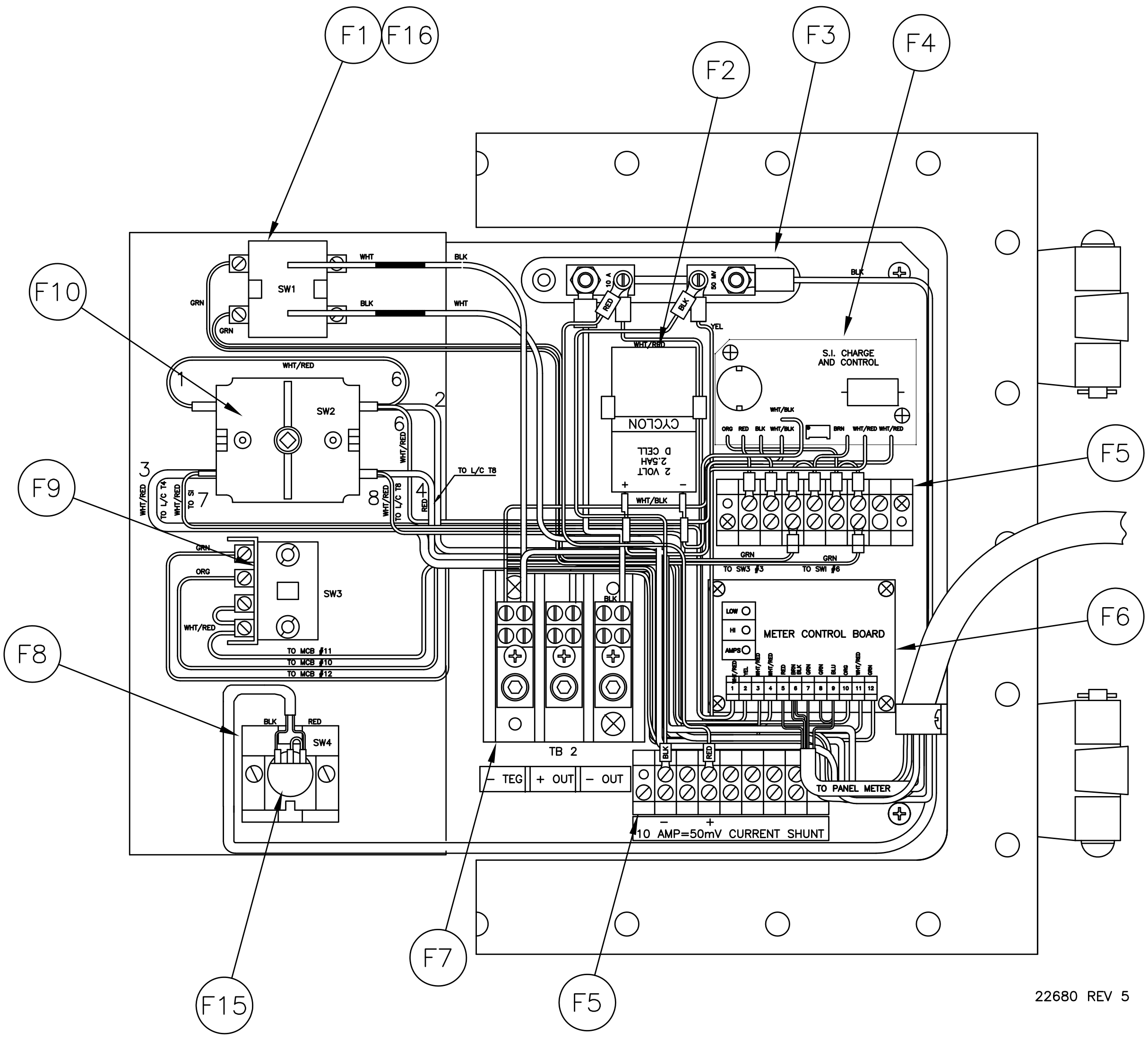


Figure 29 Electronic Box

Item	Part No.	Description	QTY
F1	2373	Switch, Push Button, Illuminated	1
F2	27019	Battery, 2V, 2.5 AH, D Size	1
F3	6527	Shunt, 10A, 50mV, Holloway Type SW w/Base	1
F4	2282	Control Board, Spark Ignitor	1
F5	2418	Terminal Block, 7 Position	2
F6	7329	PCB, Voltmeter Control, LED	1
F7	6714	Terminal Block, 3 Pole, Heavy Duty	1
F8	2374	Actuator, Potentiometer Adjust	1
F9	2160	Switch, Push Button	1
F10	7810	Switch, CAM, BACO PR 26 225	1

3.17 Electronics box Lid L/C Parts List

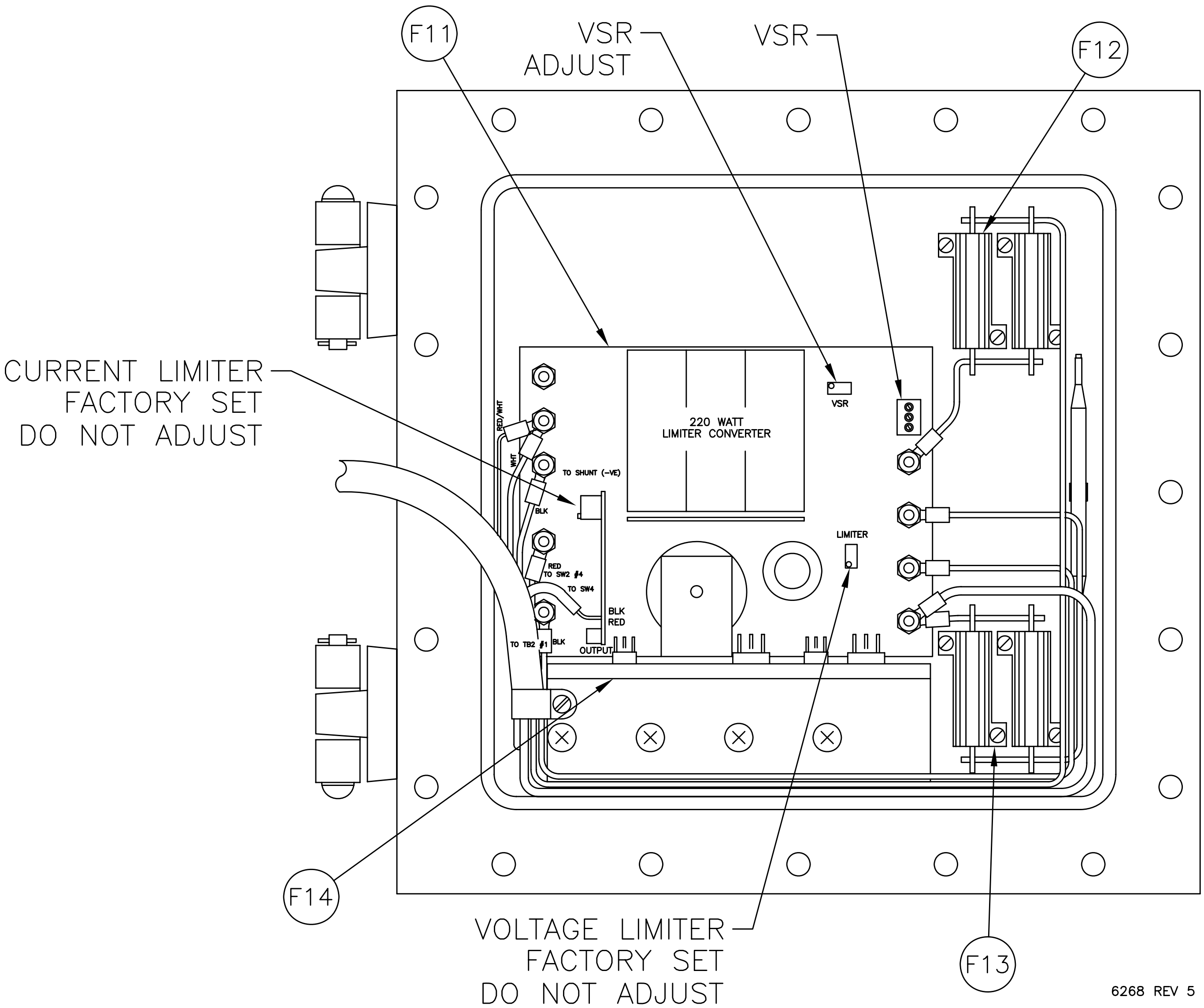


Figure 30 Electronic Box Lid

Item	Part No.	Description	QTY
F11	5317	PCB Assy, Limiter Converter, 220W	1
F12	114	Resistor, 0.75 OHM, 50W, 1%	2
F13	2183	Resistor, 2.0 OHM, 50W, 1%	2
F14	5350	Heat Sink, Limiter Converter	1
F15	6181	Potentiometer, 1 turn 2 KOhm, 2 Watt	1
F16	29529	LED, Green, BA9S-G, 28 Volt	1

4 APPENDIX

4.1 Gas Specifications

STANDARD SPECIFICATIONS FOR GASEOUS FUELS FOR TEGS

A. Shall not contain any particulates larger than 30μm diameter, including but not limited to sand, dust, gums, crude oil, and impurities.

B. Shall not have a hydrocarbon dew point in excess of 0ºC (32ºF) at 170 kPa_g (25 psi_g).

C. Shall not contain more than 115 mg/Sm^3 [2] (approx. 170 ppm) of H_2S.

D. Shall not contain more than 60 mg/Sm^3 (approx. 88 ppm) of Mercaptan Sulphur.

E. Shall Not contain more than 200 mg/Sm^3 (approx. 294 ppm) of total Sulphur.

F. 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.

G. Shall not contain more than 120 mg/Sm^3 of water vapour.

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

I. Shall have a gross heating value of:

Natural Gas:	37 MJ/Sm^3 (1000 BTU/cu.ft.)(1)
Propane/LPG:	93 MJ/Sm^3 (2500 BTU/cu.ft.)(1)
Butane:	108 MJ/Sm^3 (2900 BTU/cu.ft.)(1)

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

Notes:

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

(2) - Sm^3 = Standard cubic meter of gas at 101.325 kPa at 20ºC (NIST).

1120 TEG Start Up Data Sheet

Date: Data By:
Site:
TEG Serial No:

1		← Time of sustained ignition					
2	Time - minutes after ignition						
		10	20	30	40	50	60
	V_{set} →						
3		← Temp. - max. ambient expected at site					
4		← Temp. - Present ambient at site					
5		← Set Up Power - see Figure 4					
6		← V_{set} - required to obtain set up power see Figure 12					
7		← V_{set} - measured one hour after ignition					
8		← V_{set} - change necessary to obtain item 6 V_{set}. Item 6 minus Item 7					
9		← Fuel Pressure - one hour after ignition					
10		← Fuel Pressure - Change necessary to obtain Item 6 V_{set}.					
11		← New Fuel Pressure - Item 9 plus Item 10					
		← Time - of fuel pressure adjust					
12		← New V_{set} - measured 10 minutes after fuel adjust for item 11					
13		← V_{set} - measured 10 minutes after fuel adjust for item 11					
14		← Air Shutter Adjustment					
	ccw cw	← Air Shutter Direction					
		← Time - of air shutter adjustment					
15		← New V_{set} - measured 10 minutes afte air shutter adjustment					
16		← V_{set} - measured (final before applying load)					

Notes:

1120 TEG Start Up Data Sheet

Date: Data By:
Site:
TEG Serial No:

1		← Time of sustained ignition					
2	Time - minutes after ignition						
		10	20	30	40	50	60
	V_{set} →						
3		← Temp. - max. ambient expected at site					
4		← Temp. - Present ambient at site					
5		← Set Up Power - see Figure 4					
6		← V_{set} - required to obtain set up power see Figure 12					
7		← V_{set} - measured one hour after ignition					
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	ccw cw	← Air Shutter Direction					
		← Time - of air shutter adjustment					
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Notes:

1120 TEG Start Up Data Sheet

Date: Data By:
Site:
TEG Serial No:

1		← Time of sustained ignition					
2	Time - minutes after ignition						
		10	20	30	40	50	60
	V_{set} →						
3		← Temp. - max. ambient expected at site					
4		← Temp. - Present ambient at site					
5		← Set Up Power - see Figure 4					
6		← V_{set} - required to obtain set up power see Figure 12					
7		← V_{set} - measured one hour after ignition					
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Notes:

1120 TEG Start Up Data Sheet

Date: Data By:
Site:
TEG Serial No:

1		← Time of sustained ignition					
2	Time - minutes after ignition						
		10	20	30	40	50	60
	V_{set} →						
3		← Temp. - max. ambient expected at site					
4		← Temp. - Present ambient at site					
5		← Set Up Power - see Figure 4					
6		← V_{set} - required to obtain set up power see Figure 12					
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		← Time - of air shutter adjustment					
15		← New V_{set} - measured 10 minutes afte air shutter adjustment					
16		← V_{set} - measured (final before applying load)					

Notes:

1120 System Performance Log

Site: TEG Serial No: TEG Group NO:

Date	Data By	Time	Ambient Temp °C	Fuel Pressure	Air Shutter	V_{set} Volts	Set Up Power Watts	Output Voltage Conv/Limiter	Voltage Customer Load	Amperage Customer Load	Maintenance Repair Notes

1120 System Performance Log

Site: TEG Serial No: TEG Group NO:

Date	Data By	Time	Ambient Temp °C	Fuel Pressure	Air Shutter	V_{set} Volts	Set Up Power Watts	Output Voltage Conv/Limiter	Voltage Customer Load	Amperage Customer Load	Maintenance Repair Notes