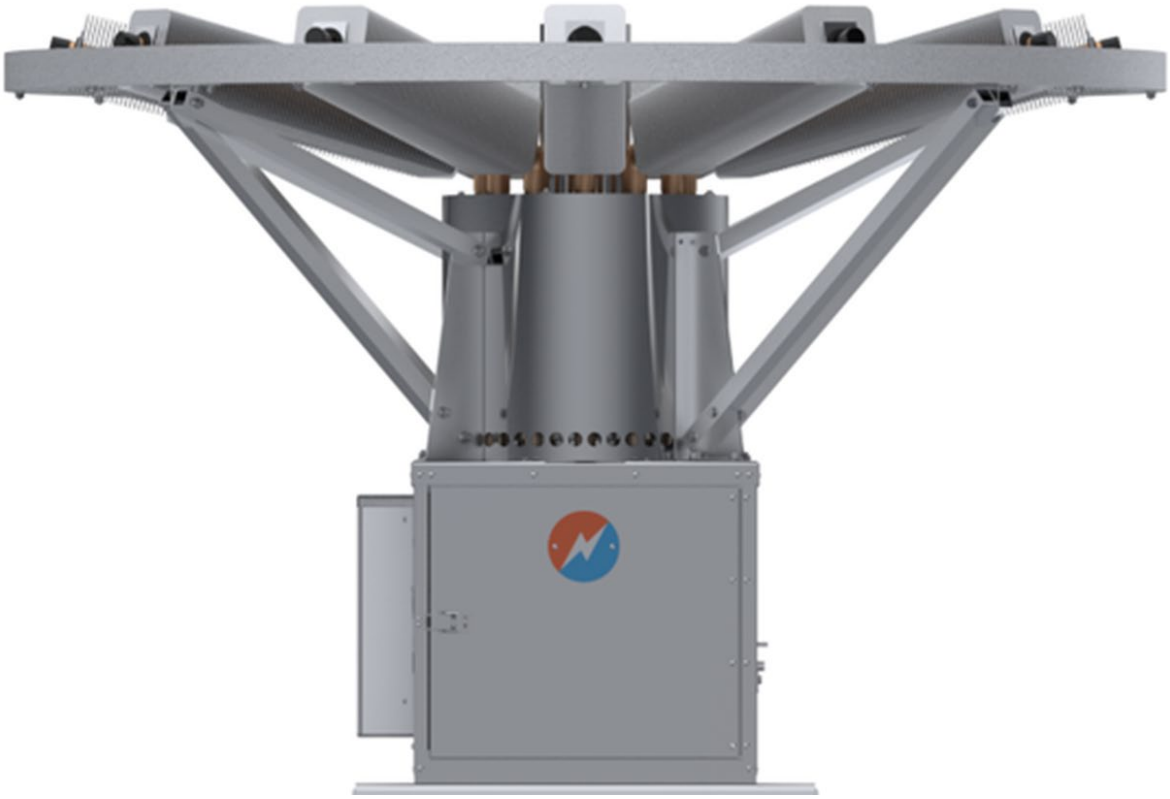

Model 8550-RS

Thermoelectric Generator

OPERATING MANUAL

301955 Rev0

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1 IMPORTANT SAFETY INSTRUCTIONS

WARNING!

Read all application documentation, including manuals for equipped options, before starting assembly, installation, or performing service check or maintenance on the Thermoelectric Generator.

SAVE THESE INSTRUCTIONS – This manual contains important instructions for safe installation, operation, and maintenance of the Global Power Technologies Model 8550-RS Thermoelectric Generator with Over Temperature Shutdown.

Read the following safety warnings and precautions before beginning assembly.

1. The installation must conform with local codes or, in the absence of local codes, with the CSA-B149.1, Natural Gas and Propane Installation Code and CSA-B149.2, Propane Storage and Handling Code.
2. The Thermoelectric Generator, when installed, must be electrically grounded in accordance with local codes or, in the absence of local codes, with the Canadian Electrical Code, CSA C22.1.
3. Do not use this Thermoelectric Generator if any part has been under water. Immediately call a qualified service technician to inspect the Thermoelectric Generator and to replace any part of the control system and any gas control that has been under water.
4. The Model 8550-RS Thermoelectric Generator contains electrical and gas related safety devices as identified throughout this manual. Tampering or rendering inoperative any of these safety devices may result in personal injury or death and possible damage to the equipment and is not permitted under any circumstances.
5. The Thermoelectric Generator is designed to combust gaseous fuels which will result in combustion products including heat, carbon dioxide, and water vapour and may contain traces of carbon monoxide, unburnt hydrocarbons, and nitrous oxides. Emissions from combustion will depend on generator set-up and operation as well as the composition of the gas feed. Ensure that gas supplied meets Global Power Technologies' gas specification.
6. Fuel supplied to the Thermoelectric Generator must not contain liquids. Liquid hydrocarbons in the fuel supply pose a risk of fire and may result in serious damage to the Thermoelectric Generator and danger for the operator.
7. Do not exceed the fuel pressure stamped on the Thermoelectric Generator data plate without factory approval. If fuel pressure exceeds reasonable levels, the power unit may be seriously and permanently damaged.
8. The Thermoelectric Generator exhaust can be very hot. Do not touch any of the exhaust components or bring exposed skin near hot exhaust gases.
9. If the Thermoelectric Generator has not been given enough time to cool, the spark electrode can be dangerously hot.
10. The Thermoelectric Generator consists of some parts constructed from sheet metal. While every effort is made to ensure that edges have been deburred when manufactured, sharp edges may still exist. Exercise caution when handling. Wearing gloves is recommended.
11. When the Thermoelectric Generator is operating, the surface temperatures of the unit can approach 200°C. Avoid contact of skin and clothing with the surfaces of the Thermoelectric Generator to avoid burns.

1.1 MANUAL ICONS AND SAFETY BANNERS

The following banners are used throughout this manual:

 **WARNING!**	**A banner with the word "WARNING!" below an icon with an exclamation point within a red triangle contain important information that, if not adhered to, can cause personal injury and/or property damage.**

 **CAUTION!**	**A banner with the word "CAUTION!" below an icon with an exclamation point within a red triangle contain important information that, if not adhered to, can cause damage to the TEG.**

NOTE:	**A banner with the word "NOTE:" contains supplemental information that provide additional insight on specific topics within this manual.**

1.2 COPYRIGHT, LIABILITY, AND CONTACT INFORMATION

For any technical issues or questions, contact:

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Calgary, Alberta
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Phone: 1-403-236-5556
Fax: 1-403-236-5575
Customer Service/Technical Support: 1-403-720-1190

Copyright	

Liability	Liability The user is expressly warned to consider and adopt all safety precautions that might be indicated by the activities herein and to avoid all potential hazards. The user assumes all risks in connection with such instructions. GPT shall not be liable for any special, consequential, exemplary, or other damage resulting, in whole or part, from the user's use of, or reliance upon this material.

Comments	GPT has compiled this publication with care, but GPT does not guarantee that the information in this publication is free of errors. Comments, criticisms, and suggestions regarding the subject matter are invited. Any errors or omissions in the data should be brought to the attention of GPT. If required, affected pages will be revised and issued.

2 GENERAL INFORMATION

A Thermoelectric Generator (TEG) is a solid-state device that produces electrical power by directly converting heat energy into electrical energy. It is a reliable, low-maintenance source of DC electrical power for applications where regular utilities are unavailable or unreliable.

The Model 8550-RS TEG comes equipped with a 6720 Voltage Limiter which functions as a parallel voltage regulator and will maintain output voltage while the TEG is operating in its rated power range. Due to power unit output resistance, TEGs are relatively immune to moderate overloads and work well as battery chargers. The limiter has an internal load bank capable of sinking entire TEG output power allowing open load operation.

A Cathodic Protection Interface is also available as an option to use with this generator.

Operation and service instructions for both the 6720 Voltage Limiter and Cathodic Protection Interface option are included in this manual.

The Thermoelectric Generator is designed FOR OUTDOOR USE ONLY.

2.1 TERMS AND ACRONYMS

The following terms and acronyms are used throughout this manual:

Thermoelectric Generator (TEG)	A device that produces electrical power through the direct conversion of heat energy to electrical energy.
GPT	Global Power Technologies
Power Unit	The hermetically sealed portion of the generator that contains the thermoelectric materials.
Matched Load	The condition of load where the load voltage of the generator is one half of the open circuit voltage.
Optimum Load	The condition of load where the power output of the generator is maximized.
Power Conditioner	A broad term used to describe an electronic device attached to the generator that converts, adjusts, limits, or otherwise conditions the output power. This manual uses the terms “Power Conditioner” and “Limiter” interchangeably.
Converter	An electronic device attached between the generator and load that converts one level of DC voltage to another.
Limiter	An electronic device attached between the generator and load that limits the voltage level. This manual uses the terms “Power Conditioner” and “Limiter” interchangeably.
Heat Pipe	A hermetically sealed fluid filled heat transfer device, and its associated cooling fins, used to cool the cold junctions of the Power Unit.

Thermostat	A safety device used to shut down the TEG during a heat pipe over temperature event.
Rated Power	The power that the TEG will produce at standard temperature and voltage.
Set Power	The power level to which the Power Unit is set up at non-standard temperatures so that it produces Rated Power when the temperature returns to standard.
Thermal Cut-off (TCO)	A safety device used to shut down the TEG during a cabinet over temperature event.
OTSD	Over Temperature Shutdown
RTD	Resistance Temperature Detector

2.2 DATA PLATE

The data plate shows important information about the TEG and can be used as a quick reference point when performing service or contacting GPT. It is located on the inside of the cabinet door. When contacting GPT, indicate both the complete Model Number and Serial Number of your TEG.

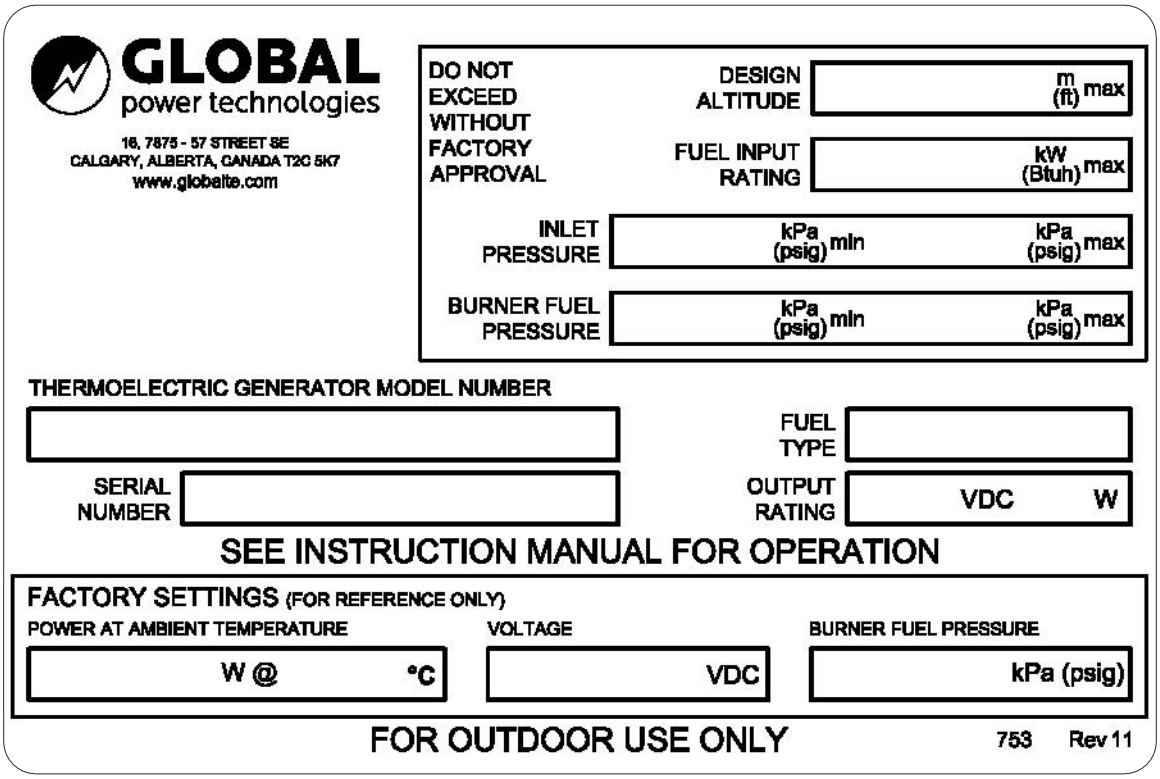


Figure 1 – Data Plate

The information indicated on the data plate is as follows:

Design Altitude	Maximum permitted altitude that the TEG should be operated at.
Fuel Input Rating	Maximum permitted energy rate to the generator.
Inlet Pressure	Minimum and maximum levels of inlet fuel pressure permitted.

Burner Fuel Pressure	Minimum and maximum levels of burner fuel pressure permitted.
TEG Model Number	The TEG's model number. Refer to the model tree on Figure 2 for an explanation of the model number.
Fuel Type	The type of fuel that the TEG fuel system is designed for and has been tested with. L = Propane, N = Natural Gas
Serial Number	A unique number assigned to the TEG unit by GPT for traceability.
Output Rating	Nominal power output of the TEG.
Factory Settings:	
Power Unit at Ambient Temperature	Power Unit power and temperature recorded during the factory acceptance test. This is the maximum power unit power that can be expected from the TEG under similar conditions.
Voltage	Power unit voltage recorded during factory acceptance test.
Burner Fuel Pressure	Burner fuel pressure recorded during factory acceptance test.

The Model 8550-RS TEG model number can be interpreted as follows:

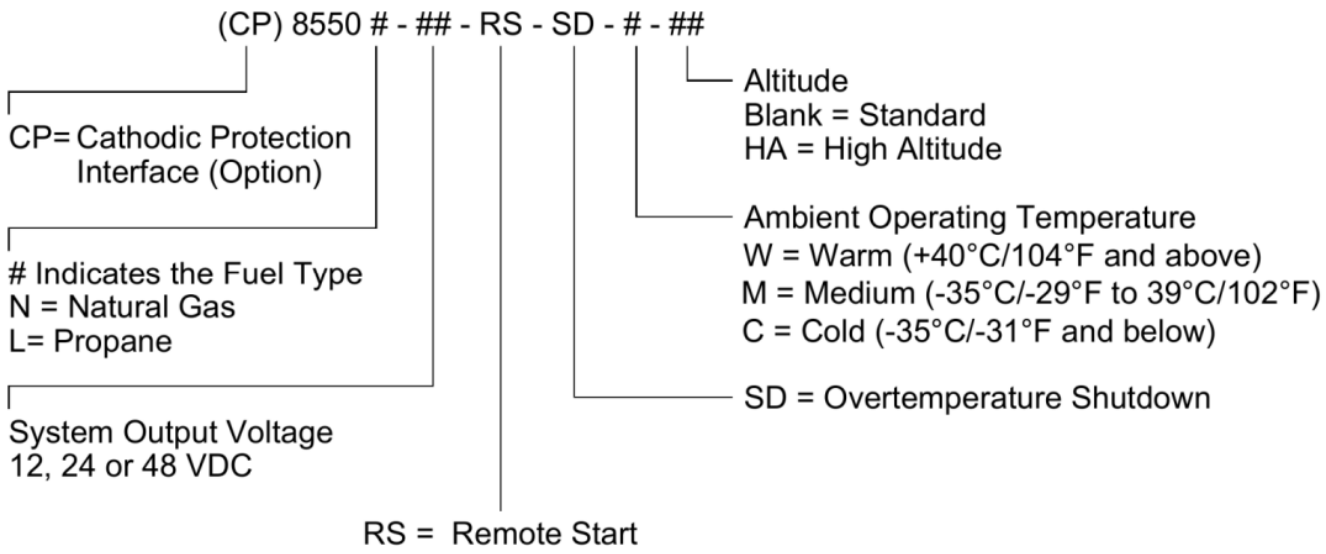


Figure 2 – Model Number Explanation

CAUTION! **Use only the type of fuel that is indicated on the data plate.**

3 REMOTE START OPERATION

3.1 8550RS POWER DISTRIBUTION

8550 Remote Start control uses 24VDC power but is not connected to the power unit and has no internal battery. The TEG is designed to be used with an external controller and an external 24V start battery. The controller distributes 24V control and signals for up to 5 TEGs as shown in the figure below. For TEG arrays larger than 5, a second remote start controller is required. This arrangement is practical for up to 10 TEGs in 2 banks (5.5kW).

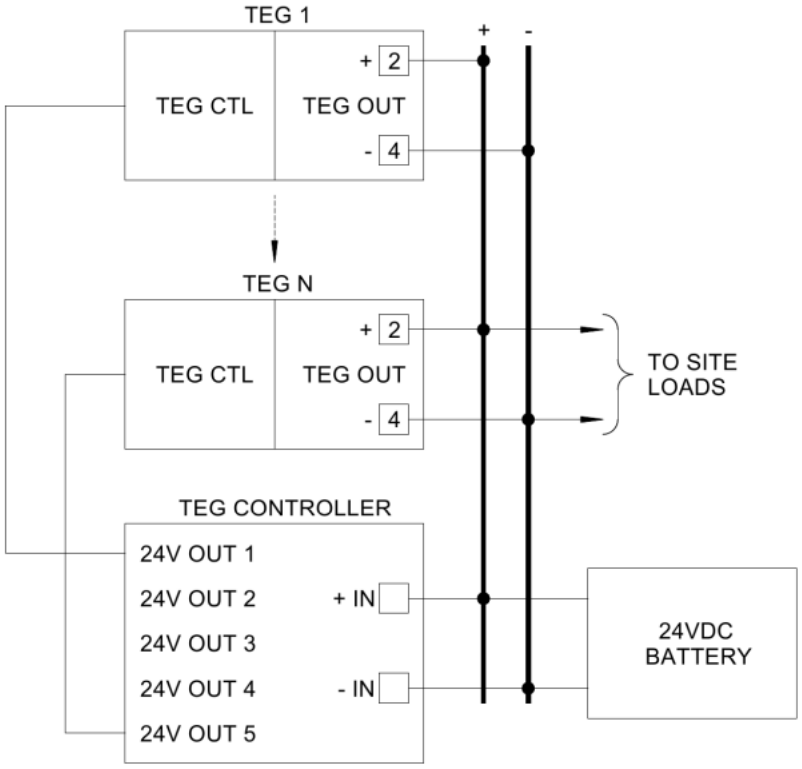


Figure 3 – 8550-RS Power Distribution

Initial starting power comes from a station battery, which can be small if just being used to start TEGs. Prior to TEGs starting, 24V control is a small load and will pull down the battery if no other charging source exists. Once TEGs start, they will recharge the battery and keep it float charged as long as there is enough power generated to supply the required load. A battery continuously float charged in this way will have a long service life. A battery can also be used as a buffer for high inrush loads such as actuators or used to backup site loads (batteries must be appropriately sized).

3.2 8550 REMOTE START INTERFACE

For starting, the 8550 RS requires fuel and ignition. Fuel is turned on when the solenoid activates. The solenoid is activated by the Remote start controller. Once the solenoid activates, a pressure switch will enable ignition to occur. Once ignition is established, the burner thermocouple will send a signal to the set point Module, generating a logic signal that ignition has occurred. At this point the TEG run status signal will be established, and the status relay contacts will close. Note that this process takes approximately 90s to complete due to power unit warmup time.

If the thermocouple has not heated up by this time, the TEG will abort, wait some time for the combustion chamber to purge, and will automatically attempt to restart. After 3 failed attempts, the controller will lock out the TEG, and intervention will be required to unlock the TEG. To unlock the TEG, stop and then start the TEG. In multiTEG systems, lockouts will only occur for the TEGs affected. The TEG controller can control up to 5 TEGs, but TEGs are treated independently. While the TEG controller has provision for a real time clock (RTC) it is not required for TEG control, and the memory retention battery (if present) can be removed or ignored. A diagram showing a typical 8550 Remote Start System is shown below:

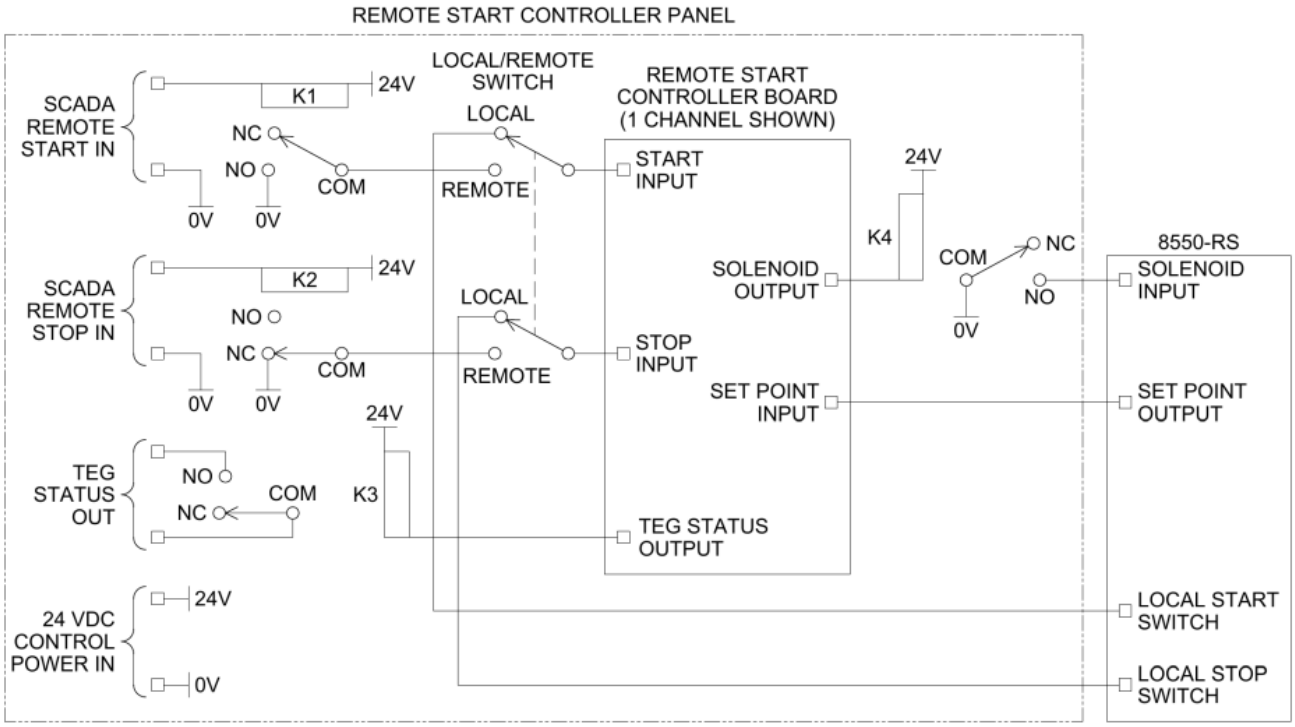


Figure 4 – 8550 Remote Start Scheme

The remote start TEG can be stopped or started as desired using either external SCADA or contact closures from a voltage sensing relay for cycle charge operation. Each time the TEG is started or stopped a thermal shock is generated. To avoid shortening the life of a remote start TEG, do not cycle the TEG off and on frequently. An excessive number of start-stop cycles can unseat the power unit requiring reseating or replacement.

CAUTION!

DO NOT CYCLE REMOTE START TEGS EXCESSIVELY TO ENSURE MAXIMUM OPERATING LIFE.

In “Local” mode, the TEG can be turned off and on using the toggle switches on the lefthand side with the TEG door open. These switches will not have any effect if the TEG controller is in “Remote” mode.

4 Remote Start Controller

The 8550RS is used with an external controller board (P/N 58081) as shown below:

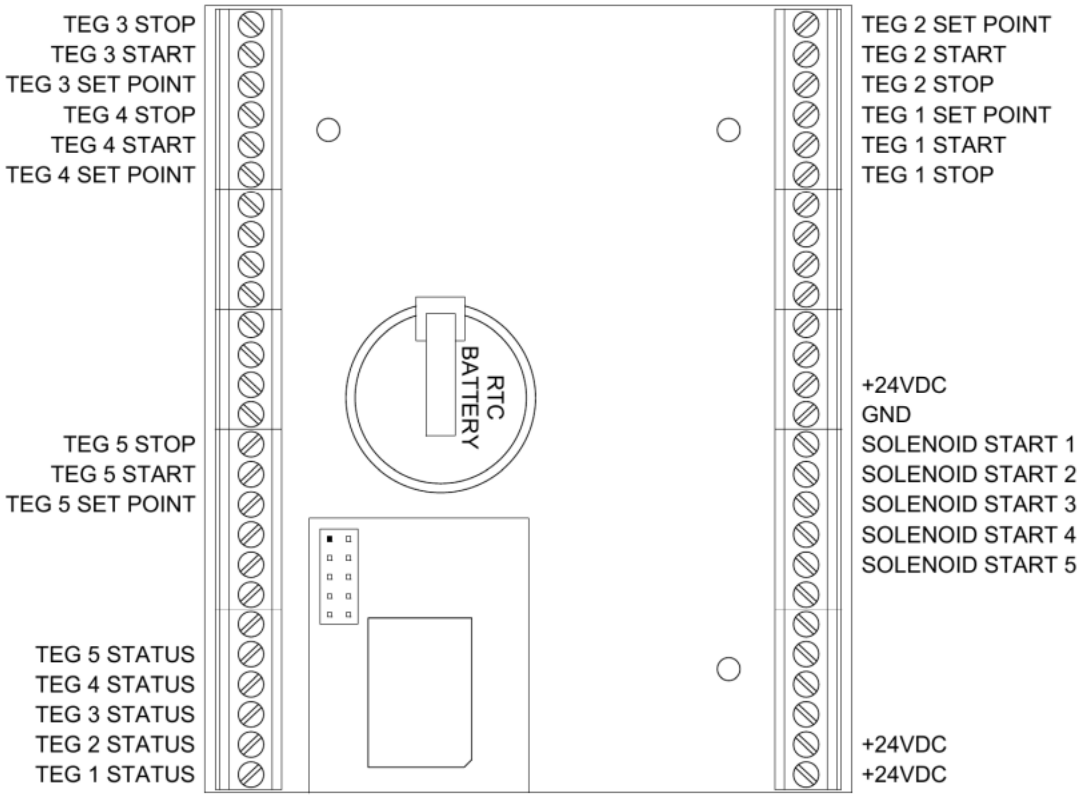


Figure 5 – 8550RS Controller Board

The 8550RS Controller Board (GPT P/N 58081) is a low voltage, low power consumption single board computer board with 36V tolerant inputs and outputs. All I/Os are 24V wetted and pulled to ground for activation. TEG start and stop signals are momentary and are latched and debounced by the controller. An actuation time of 0.5s is required to guarantee input recognition. The fuel solenoid is driven through an interposing relay since solenoid magnetization current is too high for controller board output transistors to handle reliably.

The controller board will be housed in a separate panel usually mounted on the TEG stand. A separate drawing will be supplied for the remote start controller panel, as implementation will vary by TEG array size and end application.

5 INSTALLATION

WARNING!

Read all application documentation, including the documentation for equipped options BEFORE STARTING ASSEMBLY AND INSTALLATION, or performing service check and maintenance on the Thermoelectric Generator.

5.1 PREPARATION

5.1.1 BASE

Before beginning assembly, ensure that the base where the TEG will be placed is level and does not deviate by more than 3° (0.5 inch per foot or 50 mm per meter).

The Model 8550-RS TEG has an optional stand that allows optimal airflow around the TEG and convenience for operators to perform service checks. Larger and custom stands are available for TEG arrays. Contact GPT sales with desired layout and clearance requirements. Custom stands will include fuel and electrical manifolds that allow single point customer connections. If a GPT stand has not been purchased, prepare a platform or stand to mount the TEG on. The TEG should be mounted high enough to prevent flooding or heavy snowfall from interfering with the flow of cooling or intake air around the TEG. The recommended TEG clearance is 36 inches (91 cm) above the ground. Anchor the stand to the base so that it remains stable through inclement weather.

5.1.2 LOCATION

Always follow local regulations when placing the TEG near buildings and fuel tanks.

5.1.3 FUEL SUPPLY

The fuel system on each TEG unit is designed for either propane or natural gas. Check the Data Plate on the inside of the TEG cabinet to verify the type of fuel that is compatible with your TEG.

When preparing the fuel supply to the TEG:

1. Make sure that the fuel is free of moisture or any other type of contamination.
   - ➢ If the fuel is expected to contain moisture or other contaminants, use a filtering or fuel conditioning system. Consult GPT for more information.
2. Make sure that the fuel supply pressure never exceeds 25 psi (172 kPa).
   - ➢ If the supply fuel pressure is expected to vary significantly, use an additional primary regulator to ensure that the input pressure to the Burner Fuel Pressure Regulator stays relatively constant.
3. Make sure that the fuel is appropriate to the environment. If using propane, make the following adjustments if necessary:
   - ➢ In environments with temperatures that fall below 5°C (41°F), use pure methyl hydrate in the ratio of 1:800 by volume as an antifreeze additive.

     NOTE: Moisture in the propane may freeze at temperatures below 5°C (41°F).
   - ➢ In environments with temperatures that fall below -20°C (-4°F), use a liquid withdrawal and vaporization system. Consult GPT for suitable designs before installation.

The fuel consumption of a Model 8550 TEG operating at rated power under standard temperatures conditions is as follows:

Propane:	76.0 L/day (20.1 US gal/day)
Natural Gas:	48.0m^3/day (1695 Sft^3/day)

5.1.4 GASEOUS FUEL STANDARDS

Gaseous fuels provided to Global Power Technologies' thermoelectric generators (TEGs)(1):

1. Shall not contain any particulates larger than 30 µmm diameter, including but not limited to sand, dust, gums, crude oil, and impurities.
2. Shall not have a hydrocarbon dew point in excess of 0°C (32°F) at 170 kPa_g (25 psi_g).
3. Shall not contain more than 115 mg/Sm^3 (2) (approx. 170 ppm) of H_2S.(3)
4. Shall not contain more than 60 mg/Sm^3 (approx. 88 ppm) of Mercaptan Sulphur.
5. Shall not contain more than 200 mg/Sm^3 (approx. 294 ppm) of total Sulphur.
6. Shall not contain more than 10% [CO_2] and/or [N_2] by volume, nor vary by more than ± 1% [CO_2] and/or [N_2] during operation.
7. Shall not contain more than 120 mg/Sm3 of water vapour.
8. Shall not contain more than 1% by volume of free oxygen.
9. Shall have a nominal heating value (HHV) of:

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

10. Shall not exceed 60°C (140°F) in temperature.

NOTES: (1) For gaseous fuels outside of these specifications, please contact Global Power Technologies.
(2) At 1 atm and 15°C (59°F).
(3) Contact local representatives or Global Power Technologies if H_2S concentration is greater than 170 ppm.

5.2 UNPACKING AND MOUNTING

To prepare for assembly and installation, you will need the following tools and equipment:

- ✓ Two voltmeters with leads and clips able to measure the following ranges:
  - 0-30 ±0.1 V
  - 0-30 ±0.1 mV
  - Customer Load Voltage
- ✓ Two small adjustable wrenches that can open to 5/8 inch (16 mm)
- ✓ A medium flat blade screwdriver
- ✓ A fine flat blade screwdriver
- ✓ A Phillips head screwdriver
- ✓ A 3/8-inch wrench
- ✓ Wire strippers
- ✓ Teflon thread sealant tape

WARNING! **Check the TEG for any signs of damage before beginning assembly and installation. Some damage can make the TEG inoperable. Consult Global Power Technologies before operating a TEG with any signs of damage.**

Do not discard the shipping crate until the TEG is fully operational. Before removing the TEG from the crate:

1. Check the TEG for any damage that may have occurred during shipping. If the TEG shows any sign of damage, contact Global Power Technologies to report it. Do not proceed with the installation.
2. Check and re-tighten any bolts that may have loosened.
3. Remove the tie wraps that clamp the ends of the heat pipes to the support ring.

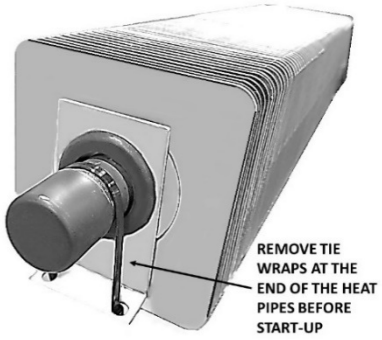


Figure 6 – Heat Pipe Tie Wrap

CAUTION! **Failure to remove the tie wraps can cause the heat pipes to crack when they expand.**

4. Once the tie wraps have been removed, lift the TEG out of the crate. This must be done by two or more persons. Use the upper ring around the heat pipes, or the frame where the ring is mounted, as lifting points.

NOTE: **If lifting with slings, secure the slings to the upper ring in at least three points in equal distance from one another to ensure that the TEG does not swing or rock during lifting.**

5. Locate the installation kit with the following parts:
   - ✓ Mounting Bolts – 1/4 in x 3/4 in, with nuts and washers (x4)
   - ✓ Stand Grounding Set – 3/8 in x 2 in bolt with nuts and washers (x1)
   - ✓ Spare Thermal Cut-off (x1)

The 8550 RS TEG is fully factory tested and in general will be shipped with the fuel system intact. Only the spark ignitor electrode may be removed depending on where and how the TEG is to be shipped. If the spark ignitor is removed, it will be placed in the TEG cabinet.

6. If the TEG was shipped with the optional TEG stand, assemble the stand as shown on Figure 7 and install it on a stable, level base. If the TEG does not have the stand option and a custom platform or stand has already been installed, confirm that the stand is bolted securely to the base level and does not deviate by more than 3°, then proceed to the next step.

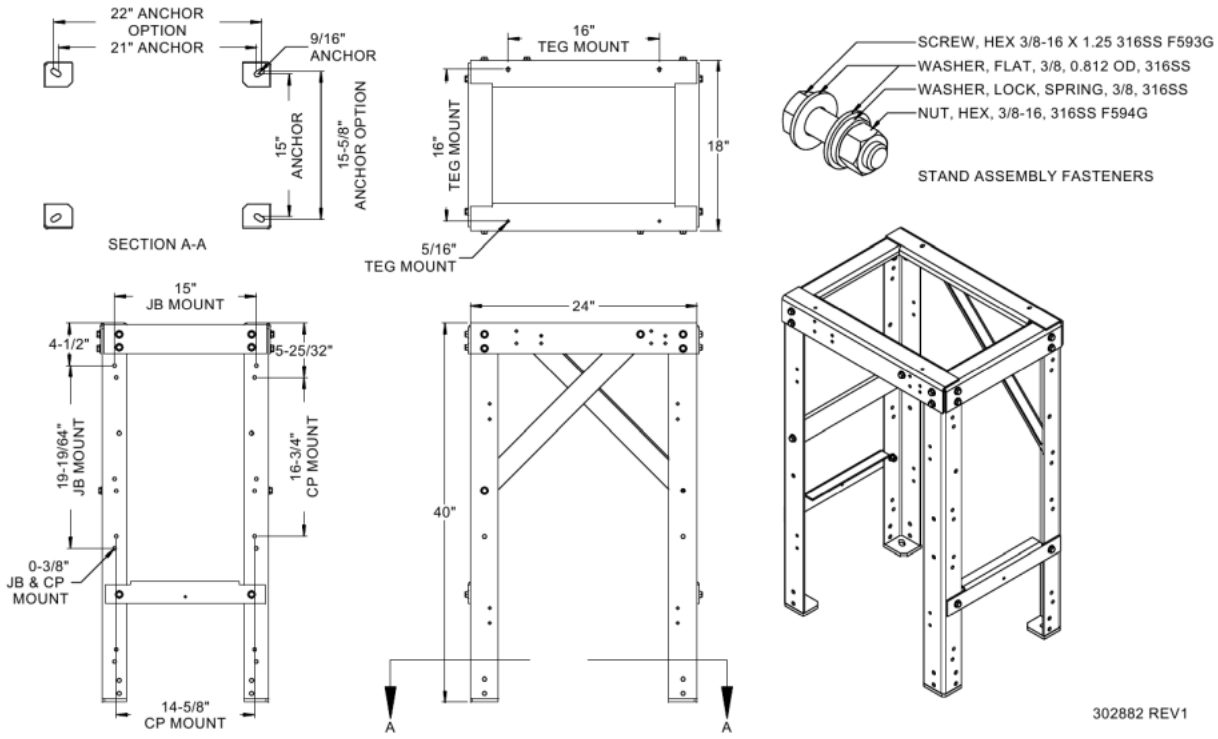


Figure 7 – TEG Stand

WARNING!

Operation of TEG on an unstable or non-level base or in locations where cooling air flow may be obstructed will cause overheating of the TEG.

If the 8550RS is part of a larger array and has been constructed on a GPT supplied stand, there will be additional drawings available. A TEG array stand will include fuel and electrical manifolds allowing single point customer connections.

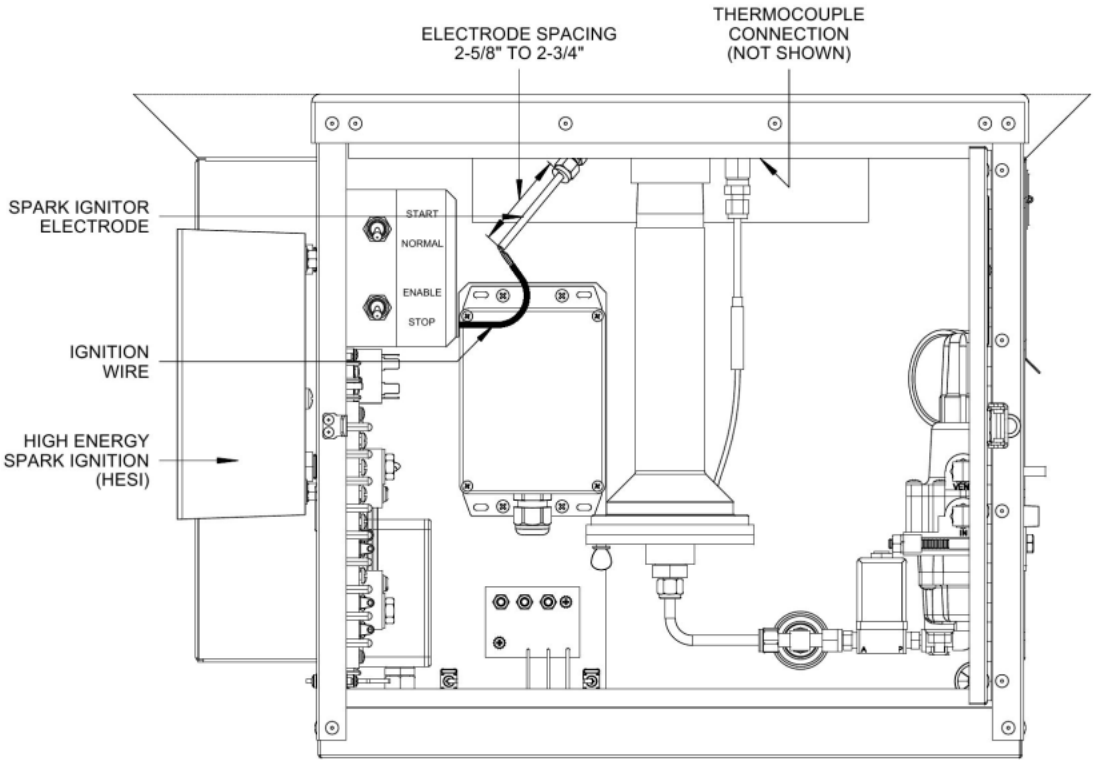


Figure 8 – Installation of Spark Igniter

5.3 INSTALLING THE SPARK IGNITER ELECTRODE

To install the Spark Igniter Electrode:

1. Slide the Spark Igniter Electrode through the fitting on the bottom of the burner until it touches inside, then pull back by approximately 1/8 inch (3 mm). This should leave 2-5/8 to 2-3/4 inches (67 to 70 mm) extruding beyond the fitting (refer to Figure 8).
2. Gently tighten the nut on the fitting to maintain the position of the electrode.
3. Connect the terminal lug of the high-voltage cable to the end of the Spark Igniter Rod.

5.4 CONNECTING THE FUEL SUPPLY

WARNING!

Use only the type of fuel indicated on the data plate. See Section 2.2.
The maximum inlet pressure to the TEG must never exceed 25 psi (172 kPa).

Before connecting the fuel supply to the TEG, review Section 5.1.3 and ensure that all necessary precautions have been made based on the fuel supply used and the environmental conditions.

Connect the fuel supply as follows:

1. Install a fuel shut-off valve between the TEG and the fuel supply.

NOTE: Follow local regulations when installing fuel piping.

2. Inspect fuel lines and fittings to ensure that they are free of foreign material.
3. Remove the plastic protective cap from the TEG 1/4-inch NPT male connector.
4. Apply Teflon tape, or other thread sealant, on the male connector as illustrated in Figure 9 to minimize fuel line contamination.

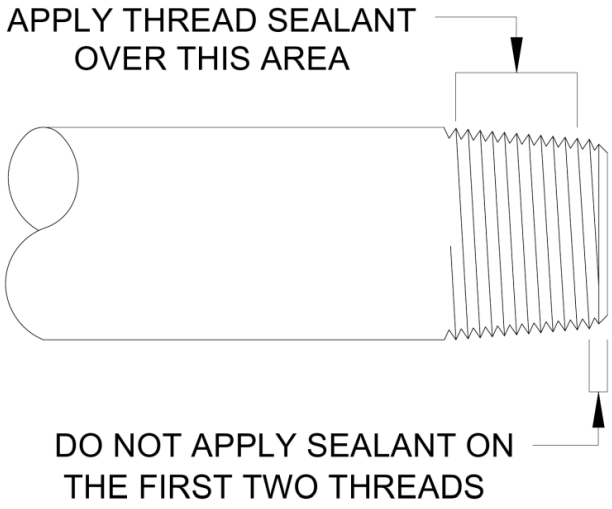


Figure 9 – Applying Thread Sealant

5. Connect the fuel line and check all joints for leaks using a commercial leak detector fluid such as Snoop®.
6. Purge fuel supply lines to the TEG of all air.

5.5 ADJUSTING FOR ALTITUDE

The burner fuel pressure supplied on the TEG, and marked on the data plate, is set for the factory altitude or site elevation of 2460 ft (750 m). At the factory's elevation, the fuel pressure should be in the range of 16 to 22 psi (110 to 150 kPa) for propane or 6 to 10 psi (41 to 69 kPa) for natural gas.

- If the TEG installation site is at a similar altitude, check the burner fuel pressure and confirm that it has not changed from the factory setting as marked on the data plate.
- If the TEG installation site is at a different altitude, adjust the burner fuel pressure as follows:

  a) Determine the altitude of the installation site and mark that number on the graph in Figure 10.

  b) From the marked altitude on step a), follow the line vertically towards the curve and stop when you touch the curve. This is the point to where you will adjust the fuel pressure for TEG site altitude.

  c) From the factory altitude marked on the curve, measure the amount of pressure that adjustment is required for site altitude by counting vertically from the Factory Elevation mark at 0 psi/kPa. Enter this number on the Start-up Data Sheet.

  For example:
  If your TEG will be installed at a site with an altitude of 7970 ft (2429 m), increase burner fuel pressure by 2.61 psi (18 kPa) from the factory setting.

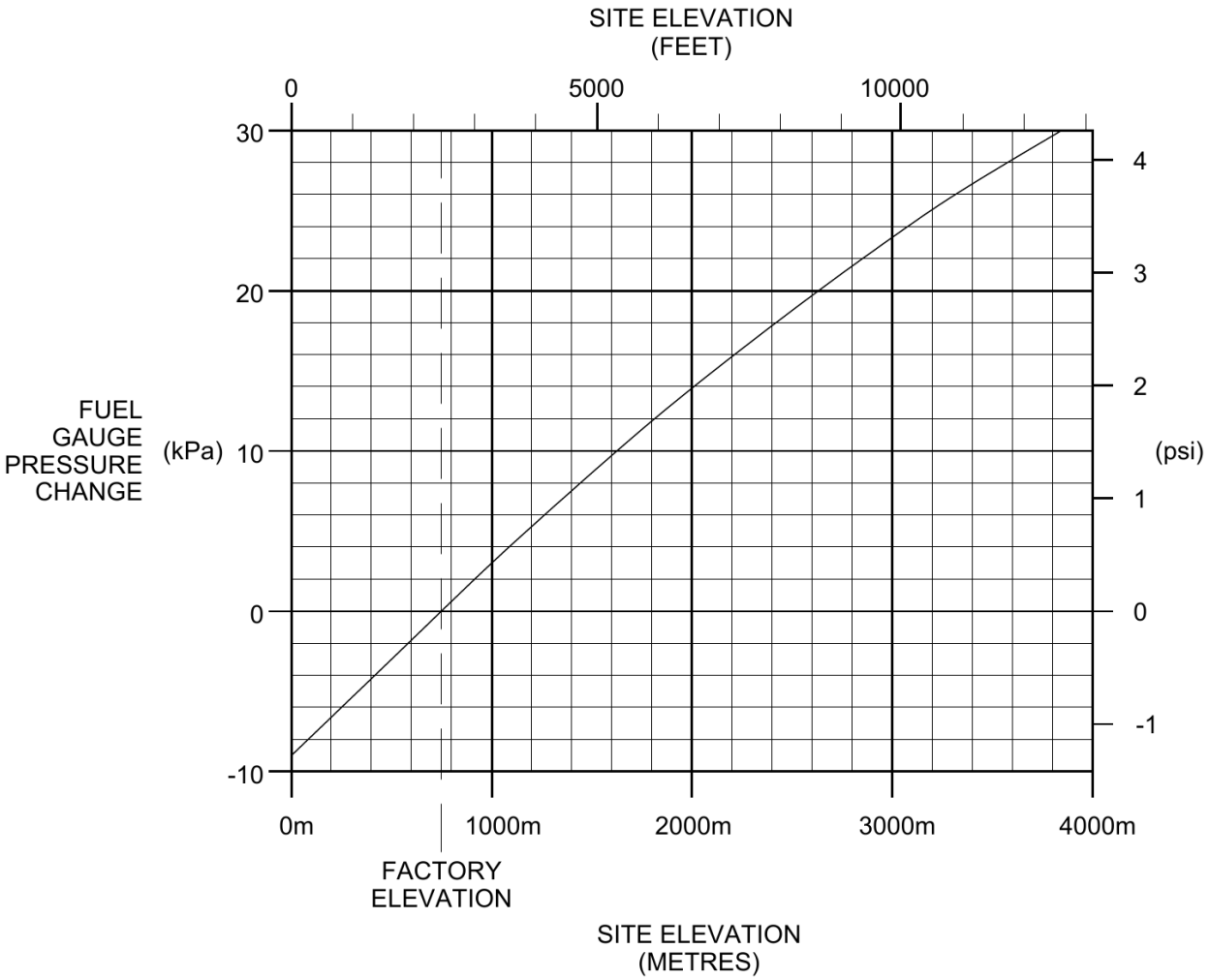


Figure 10 – Altitude Adjustment

6 START-UP AND OPERATION

6.1 IGNITION AND START-UP PROCEDURE

WARNING!

Before initiating start-up, make sure that the Power Unit output wires are connected to the 6720 Voltage Limiter input.

Before attempting to start the Model 8550-RS TEG, make sure to review and understand the Electrical Output Characteristics in Figure 35 and the Terms and Acronyms in Section 2.1.

Before starting the TEG:

- ✓ Ensure that the fuel system has been properly installed as outlined in Section 5.4.
- ✓ Review the Basic Wiring Diagram in Figure 36 or Figure 37 – 8550RS Wiring With 304676 OTSD Module, identify the various components and locate them on the TEG.
- ✓ Review the operations of the 6720 Voltage Limiter in Section 8 and understand how to adjust the voltage.
- ✓ Ensure that the Customer Load is disconnected. Remove both the positive and negative load wires at Terminals 2 and 4 of Terminal Block TB-1. This will need to be done for power adjustments.
- ✓ Shut off the fuel supply at the external valve.
- ✓ Close the air plate on the venturi completely (see Figure 13).

NOTE: **Use the Start-up Data Sheet located at the end of this manual during the start-up process. It helps simplify starting, heating up, and making power adjustments.**

6.1.1 DETERMINE SET POWER

Determine the required Set Power before proceeding with Start-up. Set Power is the power to which the TEG must be set at your ambient conditions so that it generates Rated Power when the ambient conditions return to standard. To determine Set Power:

1. Refer to Table 1 or Table 2 and follow these steps to determine the Corrected Air Temperature:
   a) In the first row of figures, where ambient air temperatures at 0 Wind Speed are listed, find the column with the current ambient temperature of the TEG installation site.
   b) Move down the column to find the cell in the same row as the expected wind speed.
   c) The cell where Air Temperature and Wind Speed meet is the corrected air temperature.

   For example, if the air temperature is 50°F (10°C) and the wind speed is 12.4 mph (20 kph), then the corrected air temperature is 27°F (-3°C).

   Record the corrected air temperature in the Start-up Data Sheet.

Wind Speed (kph) \ Air Temperature (°C)	0	-20	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
5	-27	-21	-16	-11	-6	-1	5	10	16	21	27	32	37	42	47	
10	-34	-27	-21	-15	-9	-3	2	9	13	18	24	29	35	40	46	
15	-40	-32	-24	-18	-12	-6	-1	4	10	15	21	26	32	37	42	
20	-41	-35	-29	-21	-14	-8	-3	2	8	13	19	24	30	35	41	
25	-44	-37	-31	-23	-16	-10	-5	0	6	11	17	22	28	33	38	
30	-46	-39	-33	-25	-18	-12	-7	-1	4	9	15	20	26	31	37	
35	-47	-40	-34	-26	-19	-13	-8	2	3	8	14	19	25	30	36	
40	-49	-42	-35	-22	-20	-14	-9	-3	2	7	13	18	24	29	35	

Table 1 – Corrected Air Temperature for Wind (in km per hour and °C)

Wind Speed (mph) \ Air Temperature (°F)	0	-4	5	14	23	32	41	50	59	68	77	86	95	104	113	122
3.1	-17	-6	3	12	21	30	41	50	61	70	81	90	99	108	117	
6.2	-29	-17	-6	5	16	27	36	48	55	64	75	84	95	104	115	
9.3	-40	-26	-11	0	10	21	30	39	50	59	70	79	90	99	109	
12.4	-42	-31	-20	-6	7	18	27	36	46	55	66	75	86	95	106	
15.5	-47	-35	-24	-9	3	14	23	32	42	52	63	72	82	91	100	
18.6	-51	-38	-27	-13	0	10	19	30	39	48	59	68	79	88	99	
21.7	-53	-40	-29	-15	-2	9	18	28	37	46	57	66	77	86	97	
24.8	-56	-44	-3	-8	-4	7	16	27	35	45	55	64	75	84	95	

Table 2 – Corrected Air Temperature for Wind (in miles per hour and °F)

2. Using the corrected air temperature as determined in Step 1, find the required Set Power using the graph on Figure 11. To do this:

   a) Find the corrected temperature along the bottom of the graph labeled “Ambient Temperature”.

   b) From that number, go up the graph and stop when the path touches the curve (diagonal line).

   c) From that intersection, follow a line to the numbers on the left labeled “Set Power”.

   Continuing with the previous example, if the corrected air temperature is 27°F (-3°C), based on the graph on Figure 11, the Set Power is 620 W.

3. Enter this number in the Start-Up Data Sheet. Do not operate the TEG beyond this number.

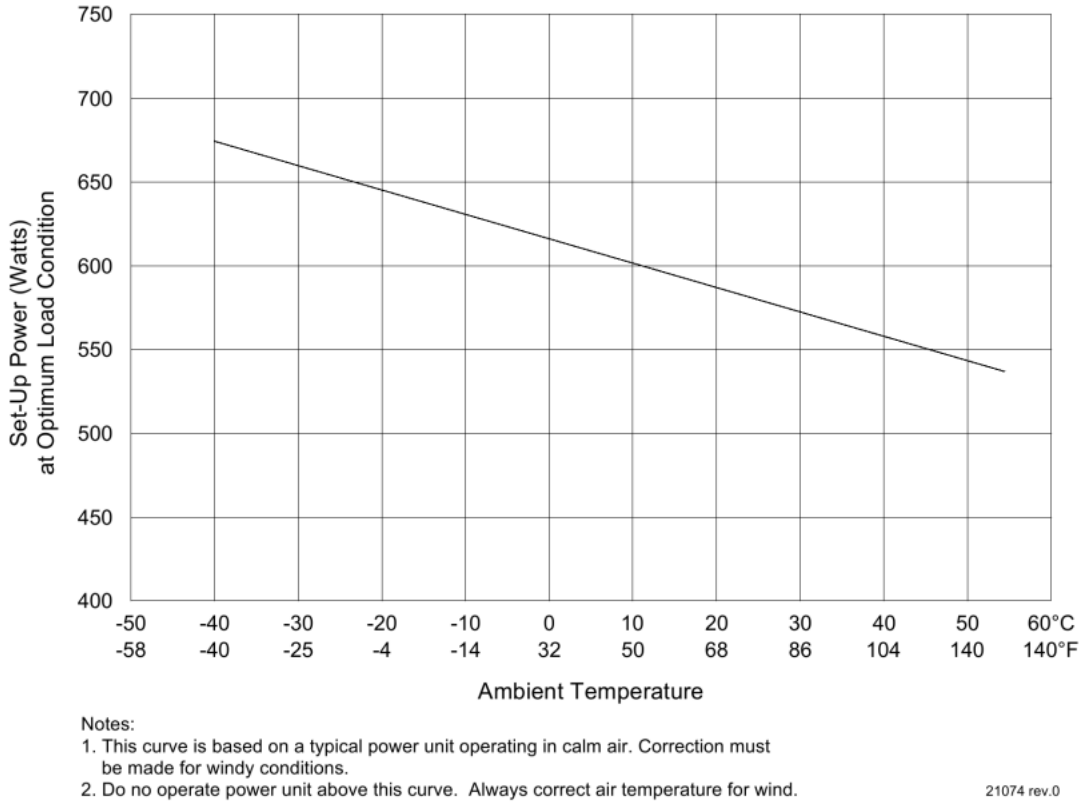


Figure 11 – Power as a Function of Ambient Temperature

WARNING!

Do not operate the TEG above the curve on Figure 11. This may result in damage to the Power Unit.

6.1.2 START-UP

Before starting up, connect a voltmeter across terminals 6 (+) and 4 (-) of TB-1. This will measure the Power Unit voltage during start-up.

Connect the second voltmeter across Terminals 6 (+) and 7 (-) of TB-1. This will measure the Power Unit current (1 mV = 1 Amp).

Follow these steps to start the 8550-RS TEG:

1. Turn on the fuel supply to the TEG and observe the fuel pressure at the fuel pressure gauge. Refer to the Start-up Data Sheet and compare the observed fuel pressure to the adjusted fuel pressure as determined in Section 5.5.
   - If the pressure is lower, increase it by turning the screw on the pressure regulator clockwise until it reaches the correct pressure.
   - If the pressure is higher, decrease it by turning the screw on the pressure regulator counterclockwise and venting the pressure through the burner by momentarily pressing the button on the Automatic Shut-off Valve.

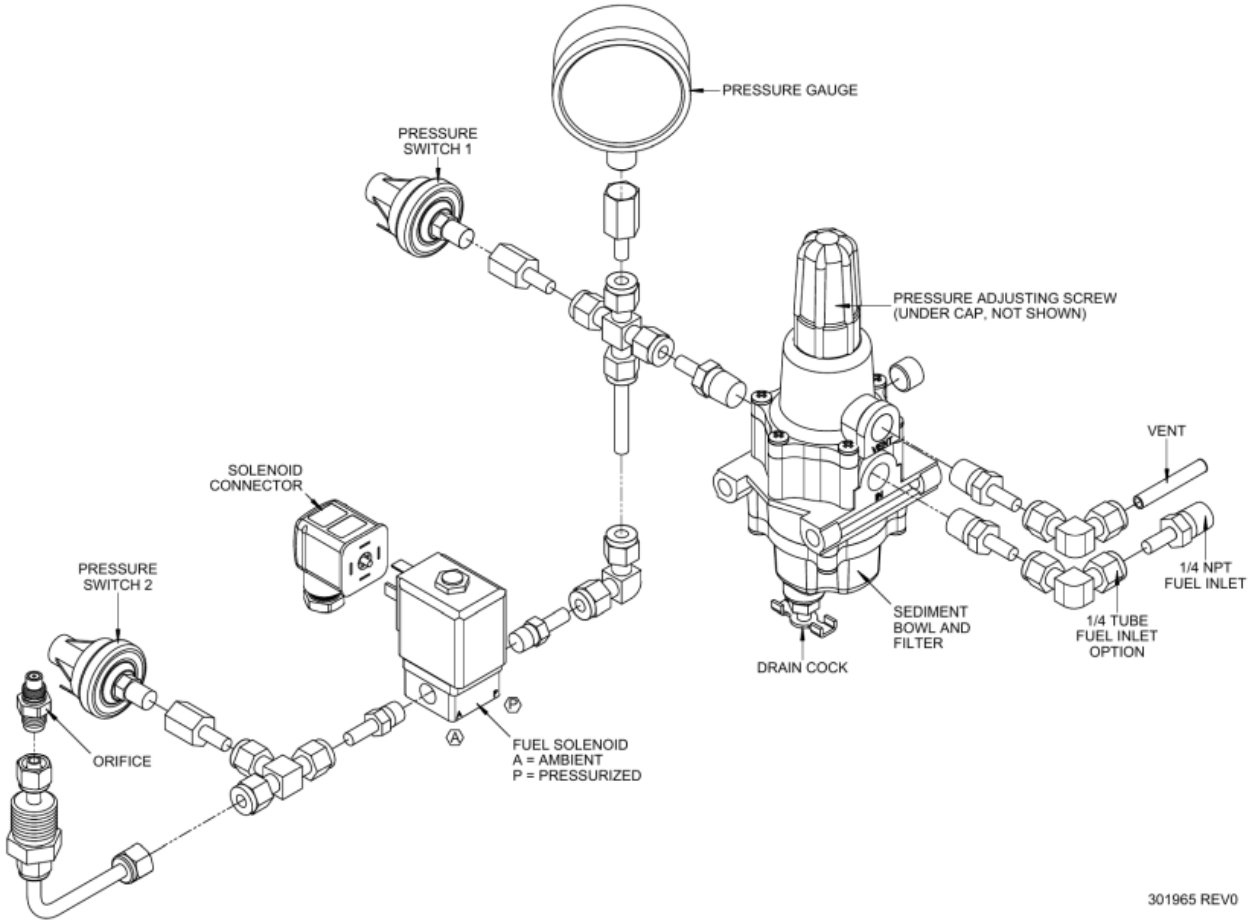


Figure 12 – Fuel System Components

2. Place the Local / Remote switch on the TEG controller to “LOCAL”. Place the “STOP” toggle switch in the “ENABLE” position to allow starting. Activate the (momentary) START switch and verify that ignition occurs. The Spark Igniter should produce a strong and rapid clicking sound. If it does not start clicking, troubleshoot the system as indicated in Section 7.6.

   The Spark Igniter should start clicking followed by a series of popping sounds from the unit as the burner ignites. The Power Unit voltage will start to rise slightly.

   If the flame goes out, the controller will attempt to restart the TEG automatically. The restart time will vary depending on how hot the power unit is and can be as long as several minutes. Once the burner is started, proceed to Heat Up and Power Adjustment in the next section.

   If the operation of the burner must be stopped, either place the “STOP” switch into the “DISABLE” position or turn off the fuel supply at the external valve.

WARNING!

Proceed to the Heat Up and Power Adjustment section as soon as the TEG status relay closes from the TEG Controller. Failure to do so may overheat the Power Unit.

6.1.3 HEAT UP AND POWER ADJUSTMENT

It is normal for the heat pipes to make a crackling sound as they start to operate. Once the burner is operating, the Power Unit voltage will climb rapidly to the TEG's voltage setpoint (set to 27.1 V at the factory).

Continue to monitor the Power Unit voltage at terminals 6(+) and 4(-) of TB-1 for about an hour. The voltage should remain at the voltage setpoint. Adjust the Limiter output adjustment if needed.

During heat up, the current will initially rise rapidly and then slow down as soon as the TEG approaches its operation point.

3. Fifteen minutes after ignition, check the tip of each heat pipe to check if they are getting warm.

   - If one or more heat pipes are not getting warm, check them again after an additional 10 minutes. If they still remain cold up to 2 inches (50 mm) from the tip, troubleshoot the cooling system as outlined in Section 7.3.

NOTE:	**If it's too cold or too windy to assess the temperature of the heat pipes, check the cooling fins instead. If all the fins on a heat pipe are at about the same temperature, then the heat pipe is working well.**

4. Proceed to the next step to adjust the Power Unit output power to the Set Power as determined during Start-up and recorded on the Start-up Data Sheet.

   The Power Unit output power can be measured by multiplying the Power Unit voltage with the Power Unit current. For example, if the Power Unit voltage is 25 V and the Power Unit current is 22.2 Amps, then the Power Unit output power is 555.0 Watts: **25.0 x 22.2 = 555.0 Watts**

5. Using the above formula, measure the output power and record it on the Start-Up Data Sheet at 15, 30, 40, 50, and 60 minutes after start-up.

WARNING!

Do not allow the Power Unit voltage to exceed 35 Volts. Turn off the fuel if the Limiter fails to control the voltage.

As the Power Unit output power climbs, ensure that it does not exceed the Set Power. The power level should be at around 70 to 80% of Set Power within 30 minutes after ignition.

- If the power is above 80% of Set Power after 30 minutes, continue to monitor the Power Unit output power. Be prepared to reduce the fuel pressure if the power rises above the Set Power level.
- If the power level rises to more than 10 watts above Set Power, initially reduce the pressure by 1 psi and wait 10 minutes, then determine if further adjustment is needed. Remember that it will take up to 10 minutes for the full effect of the fuel pressure change to stabilize. Record any changes in fuel pressure on the Start-Up Data Sheet.
- If the power level is less than 70% of Set Power after 30 minutes, the fuel pressure may be too low. Wait until the power level has stabilized and make the necessary adjustment.

NOTE:	**Keep the cabinet door closed, as much as possible, during the warm-up period until the Power Unit output power stabilizes. It takes about one full hour for the power to stabilize.**

6. Review the recorded data on the Start-up Data Sheets and compare the Power Unit output power recorded at 60 minutes with that at 50 minutes. The two readings should be within 5 Watts of each other. If the power level is not yet stabilized, wait another 10 minutes.
7. Once the power level has stabilized determine if the Power Unit output power is within 5 Watts of the Set Power.
   - If the Power Unit output power is more than 5 Watts above Set Power, decrease the fuel pressure by approximately 0.25 to 0.50 psi (1.7 to 3.4 kPa), and wait 10 minutes. After 10 minutes, determine if further adjustment is needed.
   - If the Power Unit output power is more than 5 Watts below Set Power, increase the fuel pressure by approximately 0.25 to 0.50 psi (1.7 to 3.4 kPa), and wait 10 minutes.
   - If the Power Unit output power is more than 20 Watts below Set Power, increase the fuel pressure approximately 0.50 to 1.0 psi (3.4 to 6.8 kPa). After 10 minutes, determine if further adjustment is needed.
8. Once the Power Unit output power has stabilized to within 5 Watts of Set Power and stayed there for at least 15 minutes, proceed to the next section for Air Shutter Adjustment.

6.1.4 AIR SHUTTER ADJUSTMENT

After startup, the air shutter will be in a fully opened position. The air shutter must be tuned for the site conditions to ensure optimal combustion. To test the air shutter during maintenance or service, start testing with the air shutter plate in a fully opened position.

Refer to Figure 13 to identify the parts and follow the steps below to adjust the air shutter.

NOTE:	**The position of the cabinet door affects air intake. For these steps, open the cabinet door only to adjust the Air Shutter and keep the door closed as much as possible.**

1. With the air shutter plate initially fully opened, close the cabinet door for at least 15 minutes then take a power reading and record it on the Start-Up Data Sheet.
2. Close the air shutter by 1/8 inch (3 mm) from its current position.
3. Close the cabinet door and wait 10 minutes for the TEG to stabilize.
4. Take a power reading and compare it to the previous reading.
   - If the new power reading is higher than the previous reading, close the air shutter by another 1/8 inch (3 mm), wait 10 minutes, and then take another power reading.

     Continue closing the air shutter by 1/8 inch (3 mm) and checking the power every ten minutes until the power no longer rises, then proceed to the next step.

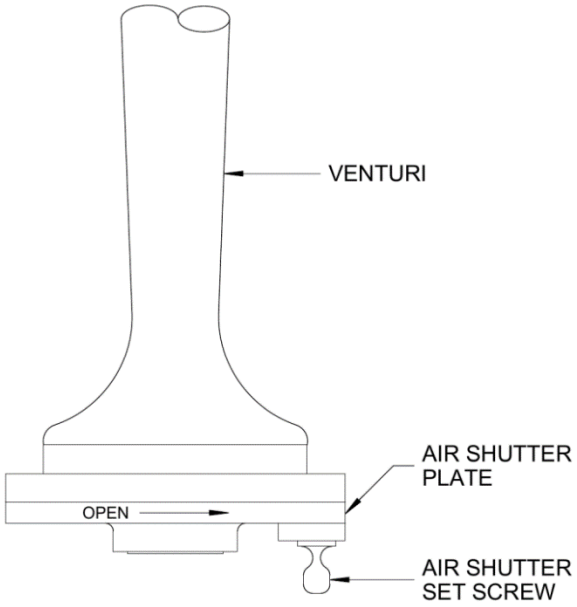


Figure 13 – Air Shutter Adjustment

   - If the new power reading is lower than the initial reading, open the Air Shutter by 1/8 inch (3 mm) past the initial setting, wait 10 minutes, then take another power reading. If this power reading is the same or lower than the previous reading, then the Air Shutter is correctly adjusted. Proceed to Step 7.

NOTE:	**If the Air Shutter reaches its fully open position, then leave the Air Shutter at this position and proceed to Step 7.**

   - If this reading is the same as the previous reading, proceed to the next step.
5. Once the power reading has stabilized, open the Air Shutter by 1/4 inch (6 mm) from its current position. The Air Shutter is now optimally tuned for your ambient conditions and fuel supply.
6. Close the cabinet door and wait another 10 minutes for the TEG to stabilize.
7. Take a final power reading.
   - If the air shutter adjustment has caused TEG power to climb to more than 5 Watts above Set Power, decrease the fuel pressure to bring the power back to within 5 Watts of Set Power. Refer to Section 6.1.3, Step 7.

NOTE:	**If the TEG is new from the factory or has just undergone a major overhaul, the Power Unit output power may drift slightly during the first few weeks of operation. It may be necessary to adjust the fuel pressure slightly to obtain Set Power after this time.**

6.2 APPLYING CUSTOMER LOAD

The TEG should now be operating at the correct power level. Before applying the customer load, ensure that all wire connections are tight and adjust the limiter output to the desired customer voltage as outlined in Section 10.

To apply customer load:

1. Connect the customer load to the TEG at terminals 2(+) and 4(-) of terminal block TB-1.
2. Turn the circuit breaker on the limiter to the ON position.
3. Close and latch the cabinet.

WARNING!

The Power Unit output must always remain connected to the Limiter.

A System Performance Log is located at the end of this manual. Use the log to monitor system performance each time the site is visited. This information is valuable for future reference. If the site is a multiple TEG installation, keep the log in a common maintenance area where service technicians can access it easily during maintenance checks.

7 SERVICE AND MAINTENANCE

WARNING!

Before attempting to service the Model 8550-RS TEG, review Sections 2, 6.1, 6.1.3, and the Limiter manual in Section 10. Do not attempt to service the TEG unless you are thoroughly familiar with its operation.

This maintenance frequency may vary depending on the site conditions including factors such as fuel purity, weather, and other environmental conditions. Under normal conditions, a properly installed Model 8550-RS TEG requires a maintenance check annually.

Perform the following series of service checks at least once per year:

- Power Check – this is the first step in any service visit. Refer to Section 5.1 – Power Check.
- Basic Service – Refer to Section 5.2 – Basic Service.

7.1 POWER CHECK

The purpose of performing a Power Check is to verify that the TEG is operating at the correct Set Power for the current ambient conditions.

Before performing a Power Check, determine the Set Power for your ambient conditions as outlined on Section 6.1.1. Review the Start-up Data Sheet to confirm Set Power and the System Performance Log to make sure that the TEG was left operating at Set Power during the last maintenance visit.

Perform a power check by doing the following:

1. Check the Power Unit voltage at Terminals 6(+) and 4(-) of TB-1.
2. Check the Power Unit current at terminals 6 (+) and 7 (-) of TB-1. The Current Shunt rating is 50 Amps (50 mV).
3. Calculate the Power Unit output power by multiplying the Power Unit voltage by the Power Unit current, then proceed as follows:
   - **If the Power Unit output power is within 10 Watts of Set Power**, the TEG is functioning well. Perform at basic service as outlined on Section 7.2.
   - **If the Power Unit output power is more than 10 Watts above Set Power**, reduce the fuel pressure by approximately 0.25 to 0.50 psi (1.7 to 3.4 kPa) and wait 10 minutes, then proceed with the basic service as outlined in Section 7.2.

     CAUTION!

     Remember to adjust the fuel pressure during restart or before leaving the site, See Section 6.1.3 – Heat up and Power Adjustment. Do not continuously operate the TEG above Set Power.

   - **If the Power Unit output power is more than 10 Watts below Set Power**, proceed to Step 4 to evaluate possible causes.
4. Review the System Performance Log and determine if the TEG was left operating at Set Power during the last service visit, remember that Set Power changes with ambient conditions.

- If the TEG was not left operating at Set Power during the last visit, investigate the reason for this. Check the System Performance Log for additional notes or remarks from the previous service check.
- If the TEG was left operating at Set Power during the last visit and is now not producing Set Power, consider the following causes:

  - **Change in fuel pressure:**

    Refer to the last entry in the log and determine if the fuel pressure has changed. If so, re-adjust the fuel pressure to the last entry.

    If this returns the Power Unit output power to within 10 Watts of Set Power, you can proceed with the basic service outlined in Section 5.2.

  - **Obstructed air flow:**

    Check for obstructions at the Heat Pipe fins, Air Inlet Screens, and Air Shutter. Perform the Air Shutter test, see Section 6.1.4.

    If this returns the output power to within 10 Watts of Set Power proceed to Section 7.2 – Basic Service.

  - **Change in fuel quality:**

    In order to maintain constant output power, it is essential that the TEG be supplied with a fuel of constant heating value.

  - **Poor cooling by heat pipes:**

    Check to make sure that the Heat Pipe fins are not obstructed by debris or dust. Check that the Heat Pipe ends are warm. Test the cooling system as outlined in Sections 7.3.

  - **Change in customer load:**

    An overloaded TEG can see a minor to severe decline in output power and voltage. Verify that the connected load isn't attempting to draw more power than the TEG's Set Power.

If the above causes have been ruled out, the TEG may require more than just the basic service. Keep the TEG operating for now and refer to Section 7.1.1 to isolate the cause of low Set Power condition.

7.1.1 LOW SET POWER DIAGNOSTIC

The procedures in this section are designed to isolate the cause for the Power Unit to have low Set Power. Perform these tests only if previous tests during the Power Check indicate that they are required.

For the following test to be accurate, the TEG must have been operating continuously at the customer voltage setpoint for the last 12 hours.

There are three basic reasons for the Set Power to be low. These are:

- low or inefficient heating by the burner and fuel system,
- poor or inefficient cooling, or
- a faulty or damaged Power Unit.

To perform the test:

1. Take a reading of the momentary open circuit as per the procedure in Section 7.10 – Power Unit Testing.
2. Calculate the open circuit voltage (V_{oc}) and internal resistance (R_{INT}) of the Power Unit as described in Section 7.10 – Power Unit Testing.

   - If the V_{oc} is above 56 Volts and R_{INT} is above 1.40 Ohms, the Power Unit is likely faulty. The Power Unit may still be able to operate at reduced output. Consult Global Power Technologies to determine the safe operating level for the Power Unit under your conditions.
   - If the V_{oc} is below 56 Volts and R_{INT} is above 1.30 Ohms, the Cooling System is likely faulty, see Section 7.3– Cooling System for further tests.
   - If the V_{oc} is below 56 Volts and R_{INT} is below 1.00 Ohms, the Burner or Fuel System is likely not providing enough heating.

     a) Perform the basic service outlined on Section 7.2,

     b) Check and replace the fuel orifice as outlined on Section 7.4, and

     c) Check the complete Burner System for obstructions and damage as outlined on Section 7.5.

     If after servicing and restarting, the Power Unit still does not come to Set Power, a change in the fuel quality is likely the cause.

     Increase the fuel pressure to obtain Set Power, being careful not to exceed the maximum V_{OC} and R_{INT} as determined in Section 7.10. It will take 10 minutes for a change in fuel pressure to take full effect.

WARNING!

Check the maximum V_{oc} and R_{INT} limits in Section 7.10 before increasing the fuel pressure. Do NOT exceed the maximum limits.

7.2 BASIC SERVICE

Perform the following service checks at least once a year to ensure safe and prolonged performance of the Model 8550-RS TEG.

1. Inspect the Cooling System heat pipes. See to Section 7.3

   Record findings in the Heat Pipe Inspection Log located at the end of this manual. Create a new copy of this log for each inspection.
2. Replace the fuel filter in the pressure regulator, see Section 7.4 – Fuel System.
3. Drain the pressure regulator sediment bowl, see Section 7.4 – Fuel System.
4. Check the fuel orifice for clogging and replace if needed, see Section 7.4.
5. Remove debris, sand, and dust from the Heat Pipe fins, cabinet air intake screens, and cabinet interior.

6. Check all bolts and wire connections for tightness.
7. Restart the TEG as outlined on Section 6.1 – Ignition and Start-up Procedure and 6.1.3 – Heat Up and Power Adjustment.
8. Record the service and current operating parameters in the System Performance Log.

7.3 COOLING SYSTEM

In order to ensure the long-term reliability of the Model 8550-RS Thermoelectric Generator and to protect against heat pipe failures, we recommend yearly inspection of the heat pipes.

Overheating of the heat pipes on the Model 8550-RS can, over time, cause performance degradation issues and may eventually lead to heat pipe failure.

Overheating of the heat pipes can occur for several reasons including:

- running the TEG at higher than rated fuel pressures,
- blockage of the flow of cooling air across the fins,
- elevated ambient air temperature exceeding the maximum rated temperature, or
- running the TEG with poorly functioning heat pipes.

If a poorly functioning heat pipe is not identified, it can result in the accelerated degradation of that pipe as well as the surrounding heat pipes. Heat pipes on the TEG Model 8550-RS are serviceable components and should be replaced to prolong the life of the TEG. If you find any evidence of a poorly functioning heat pipe, please contact GPT.

7.3.1 HAND INSPECTION

Before performing this inspection, ensure that the TEG has been operating for at least one hour. If possible, choose a day that is calm and not windy.

This method involves touching the heat pipes with bare hands. Be cautious when touching the heat pipes. Do not keep your hand in contact with the heat pipes for more than one second.

This is a quick test to see if the heat pipes are working well. Perform this test first. If any of the heat pipes fail, then test them by taking their temperature profile as outlined in Section 5.3.2.

WARNING!

Be cautious when touching the heat pipe tips as these can be hot. Hover your hand over the heat pipes first to check for heat and only touch the heat pipe tips for no longer than one second.

With the TEG in operation, hover your hand closely over the heat pipes to check for warmth. Refer to Figure 14.

A warm heat pipe tip is one that can only be comfortably touched for one second.

- If the heat pipe tip is too warm to hold, then it is in working condition and does not require further inspection.
- If any heat pipe does not feel warm up to 2 inches (50 mm) from the tip, perform a detailed check using the Detailed Inspection outlined on Section 7.3.2

On cold or windy days, when it is difficult to feel warm temperatures on the heat pipes, feel along the cooling fins of the Heat Pipe as well.

- If all the fins are about the same temperature, the Heat Pipe is working well.
- If one or more heat pipes feel much cooler than the rest of the heat pipes, check them using Detailed Inspection outlined on Section 5.3.2.

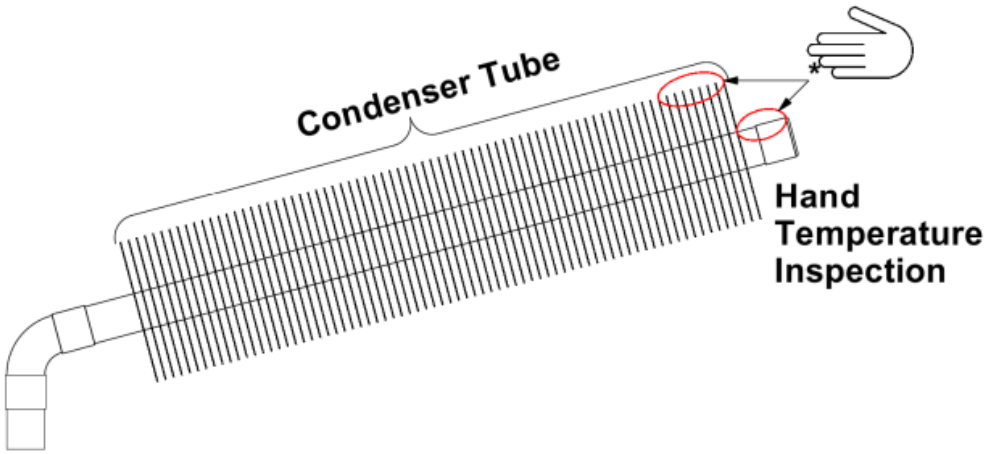


Figure 14 – Hand Temperature Inspection

7.3.2 DETAILED INSPECTION

A detailed inspection of the heat pipes is only required on heat pipes that do not pass the requirements of the hand temperature inspection (i.e., heat pipes that are not noticeably warm up to 2 inches (50 mm) from the tip.

Tool required:

- ✓ thermocouple meter: range up to 150°C (300°F) (example - Digital Multimeter with K type thermocouple adapter)
- ✓ surface temperature probe: > 50mm (2 in.) long, < 5 mm (0.2 in.) diameter (K type thermocouple probe)

Keep the TEG operating for at least an hour in calm weather conditions before taking the condenser tube's temperature profile. Make sure to take the surface temperature of the tube, not the fins or the air around the tube. Refer to Figure 12 for inspection points.

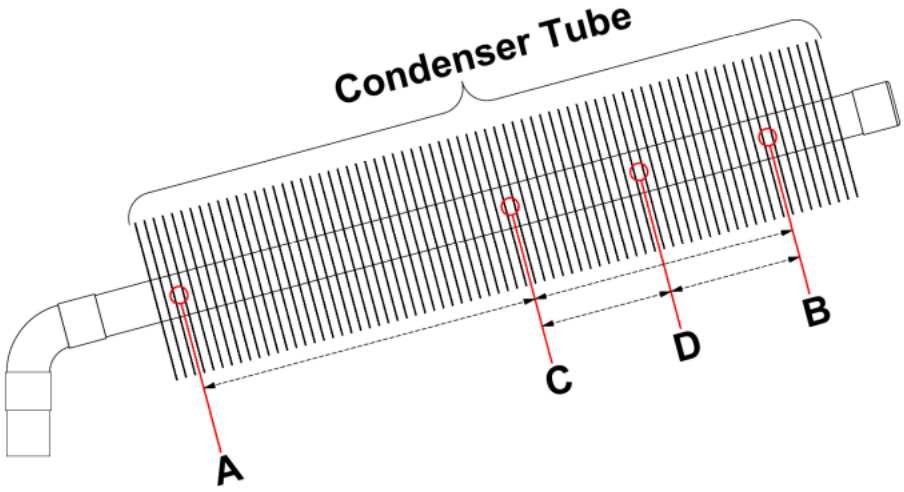


Figure 15 – Heat Pipe Condenser Tube Temperature Inspection Points

Follow the step-by-step guide outlined in the table below.

<table>
<tr><th colspan="6">Heat Pipe Detailed Inspection
> means greater than; < means less than</th></tr>
<tr><td rowspan="2">Step 1</td><td>Take temperatures at points A and B</td><td>T_A</td><td>T_C</td><td>T_D</td><td>T_B</td></tr>
<tr><td>Subtract T_B from T_A.
If $T_A - T_B > 20°C$ (36°F), proceed to step 2.
If $T_A - T_B < 20°C$ (36°F), the heat pipe is good. No further inspection required</td><td colspan="4">$T_A - T_B =$</td></tr>
<tr><td rowspan="2">Step 2</td><td>Only if required as per Step 1. Take temperatures at point C and D. Use step 1 temperature of point A .</td><td>T_A</td><td>T_C</td><td>T_D</td><td>T_B</td></tr>
<tr><td>Subtract T_C from T_A.
Subtract T_D from T_C.
If $T_A - T_C > 20°C$ (36°F) or $T_C - T_D > 15°C$ (27°F), replace heat pipe.
If $T_A - T_C < 20°C$ (36°F) and $T_C - T_D < 15°C$ (27°F), the heat pipe does not need immediate replacement but should be monitored during annual inspections for further degradation.</td><td colspan="4">$T_A - T_C =$

$T_C - T_D =$</td></tr>
</table>

A problem should be suspected with any heat pipe that is operating at a temperature much lower than the rest of the heat pipes. Replacement of heat pipes should only be done by a factory trained technician, consult GPT for heat pipe replacement.

Remove and replace any heat pipe that is visually damaged.

CAUTION!

Do not operate the TEG if it has a damaged heat pipe.

7.4 FUEL SYSTEM

WARNING!

Turn off the fuel supply at the external valve before performing service checks on the fuel system.

The basic components of the fuel system are shown in Figure 16, note that some details may be different depending on the fuel system option on your TEG. Identify the components and their location on the TEG.

- ✓ Pressure regulator – regulates fuel pressure to the fuel orifice. A sediment bowl and drain cock are located on the bottom of the pressure regulator.
- ✓ Pressure gauge – monitors the fuel pressure to the fuel orifice.
- ✓ Fuel Solenoid.

- ✓ Pressure switch 1 – used for external monitoring only and has no effect on TEG operation
- ✓ Pressure switch 2 – used to enable TEG ignition
- ✓ Fuel orifice – a precision-jeweled orifice that controls the flow of fuel to the burner.

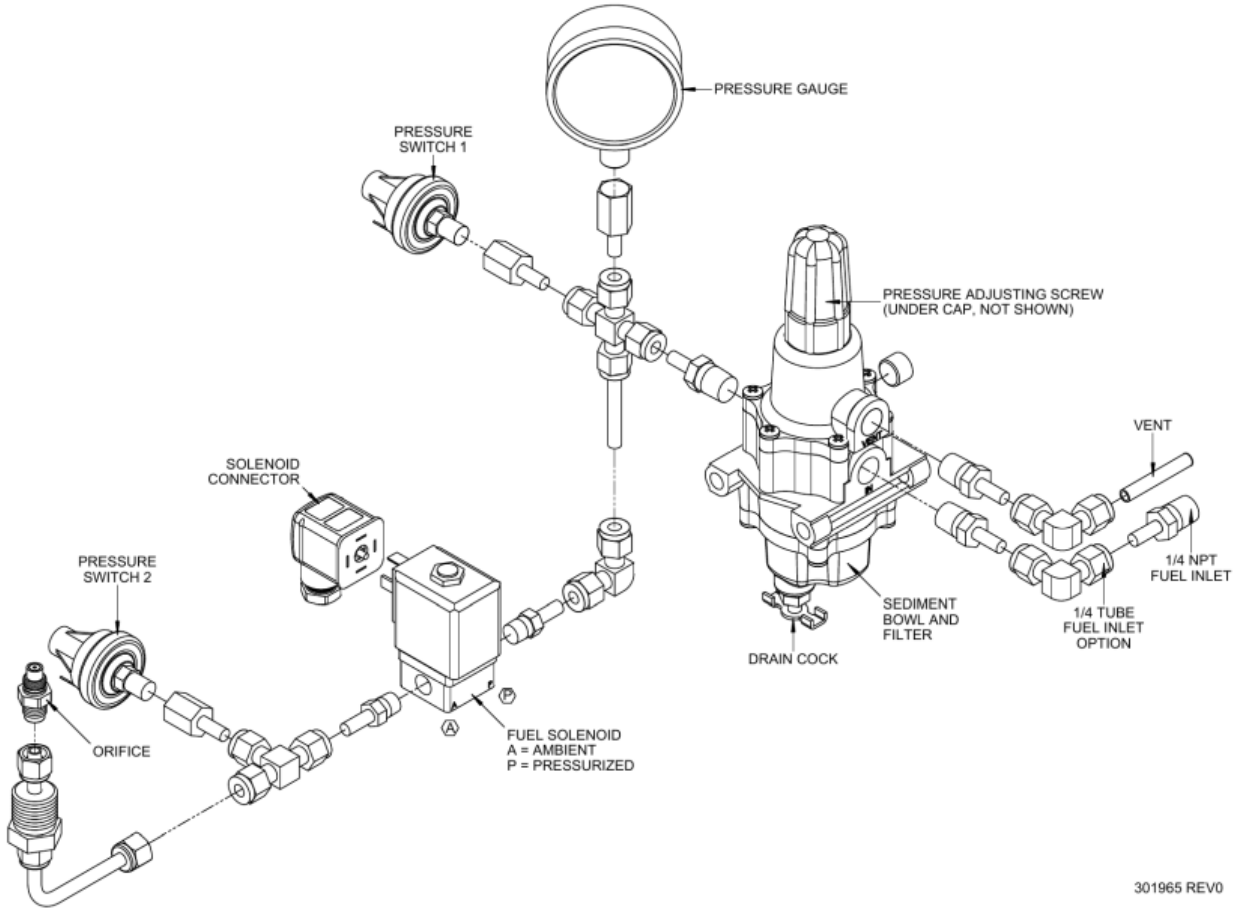


Figure 16 – Fuel System Components

7.4.1 DRAINING THE PRESSURE REGULATOR SEDIMENT BOWL

To drain the pressure regulator sediment bowl.

1. Open the drain cock located under the pressure regulator.
2. Using a small container, collect any liquid impurities that may have collected in the bowl.
3. After the bowl has drained, close the drain cock.

WARNING!

REGULATOR CONDENSATE MAY BE FLAMMABLE.

When draining condensate from regulator, ensure it is removed from cabinet and is a safe distance from ignition sources. If there is a concern about liquids in the fuel line, it is suggested that the customer install a regulator drain line to remove condensate to a safe location away from ignition sources. Condensate collecting/pooling/splashing/etc. inside the TEG cabinet creates a dangerous fire hazard. Contact GPT for assistance with fuel conditioning options to remove liquids from fuel line supply.

7.4.2 CHANGING THE FUEL FILTER

To change the fuel filter:

1. Remove the 4 socket cap screws that hold the bottom bowl on the pressure regulator.
2. Remove the bottom bowl and replace the filter element.
3. Check and replace the gasket if needed.
4. Carefully reassemble the regulator ensuring that the needle valve spring is properly placed over the needle valve centering cup in the regulator body.
5. Check for proper operation.
6. Check all joints for fuel leaks.

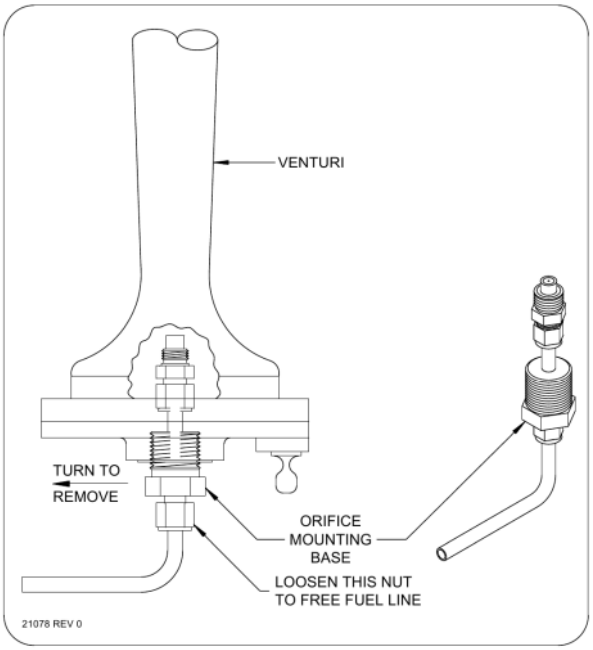


Figure 17 – Orifice Assembly Removal

7.4.3 CHANGING THE FUEL ORIFICE

To change the fuel orifice:

1. Remove the fuel line and orifice assembly by turning the orifice mounting base.
2. Remove the orifice body from the assembly, see Figure 17.
3. Check the orifice hole. It should be free and clean of debris.
4. Replace the orifice body if needed.
5. Reassemble and check for leaks.

WARNING!

Check for leaks after performing any fuel system service.

7.5 BURNER SYSTEM

The Burner System should be disassembled only if a problem with burner operation is suspected.

The Burner System consists of the following components:

- ✓ The burner venturi and air shutter assembly which mixes combustion air and fuel.
- ✓ The burner plate assembly where combustion takes place.
- ✓ The exhaust stack assembly which collects and exhausts the exhaust gases.

Before disassembling the Burner System, remove the fuel orifice as per Section 7.4 and allow the burner to cool. Once the burner has cooled down, identify and locate the components from Figure 18 proceed with disassembly as follows:

1. Remove the venturi and air shutter assembly from the burner plate by turning the venturi, which is threaded into the burner plate assembly, counterclockwise.

2. Remove the air shutter from the venturi by closing the air shutter completely and removing the four screws located in the openings on the air shutter plate.
3. Remove the burner plate assembly by removing the four Burner Plate mounting screws then pulling the burner plate assembly down, out of the Power Unit.

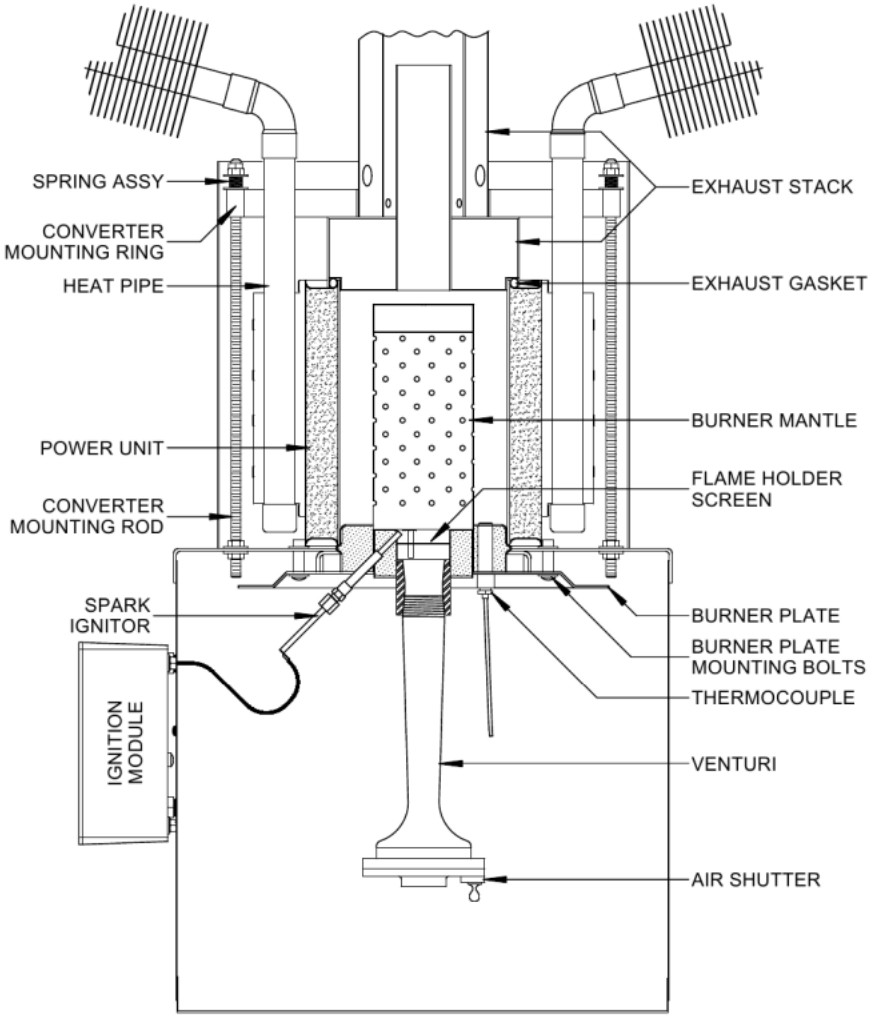


Figure 18 – Burner System Components

Perform the following checks once the Burner System has been disassembled:

1. Check the air shutter assembly and venturi for corrosion or obstructions.
2. Check the flame holder screen, located in the venturi mounting fitting on the burner plate assembly, and the burner mantle for corrosion or obstructions.
   - If these parts are obstructed, clean them with a stiff wire brush.
   - If they are corroded, the burner must be repaired or replaced.

With the burner plate assembly removed, examine the exhaust stack through the Power Unit, remove any obstructions and check for corrosion.

If the exhaust stack is corroded, it must be replaced as follows:

1. Remove the converter shroud which covers the lower portion of the heat pipes. This can be accomplished without removing the heat pipe support frame.

NOTE: Turn off the fuel supply at the external valve before performing service checks on the fuel system.

---

2. Remove the four nut-and-spring assemblies that hold down the converter mounting ring. Before removing the converter mounting ring, mark its position so that it can be reinstalled in the same position.
3. Lift the exhaust stack off.

Before replacing the exhaust stack, check if the high temperature exhaust gasket is still in good condition and replace it if necessary. To replace, tighten the spring assemblies that are holding the converter mounting ring in place until the springs are solid, then back off by about 5 turns (1/4 inch or 6 mm).

Always apply a high temperature nickel-based, anti-seize compound to the threads on the venturi before installing it. It is not necessary to tighten the venturi more than hand tight.

7.6 HIGH ENERGY SPARK IGNITION (HESI)

The Spark Ignition system consists of four major components:

- The spark electrode which ignites the gas.
- The Pressure Switch which turns on the system when there is fuel gas pressure in the fuel system.
- The High Energy Spark Ignition Module which generates the high voltage pulse for the Spark Electrode
- The external Remote Start Controller that monitors and controls system functions.

Whenever there is adequate fuel pressure in the Fuel System, the Pressure Switch is closed. With the Pressure Switch closed, the Ignition Module will generate 12-kV pulses which will arc from the Spark Electrode. The Ignition Module will continue to generate high voltage pulses until the Set Point Module returns a signal to the Remote Start Controller or until the Pressure Switch is opened.

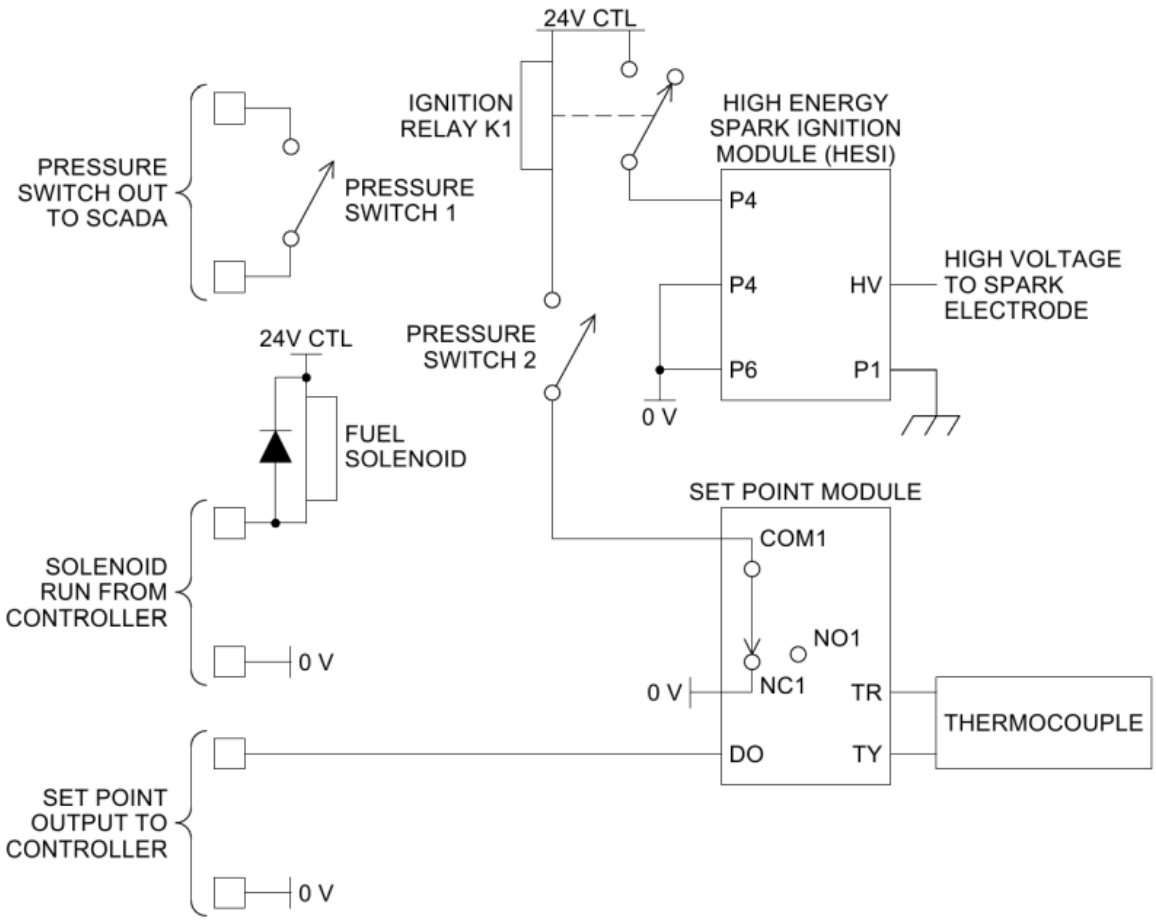


Figure 19 – Remote Start Spark Ignition System Wiring

Power for the fuel solenoid, Ignition Module and Set Point Module come from a start battery routing through the Remote Start Controller as shown in Figure 3 – 8550-RS Power Distribution. The Remote Start Controller will send a start command based on controller inputs, but this signal has to pass through the following hard wired permissives:

1) Fuel Pressure Switch 2 - this will inhibit TEG ignition if there is no fuel pressure to avoid wasting start battery power.
2) Set Point Module Output - this will halt TEG ignition once the TEG is running and will coincide with TEG Status relay output.
3) Over Temperature Shutdown Relay - will inhibit TEG starting if an over temperature fault has been detected in the heat pipe assemblies. The Over temperature Module will latch once a fault has been detected.
4) Thermal Cutout - this is a thermal fuse that will open if the TEG cabinet temperature exceeds a safe temperature and will also activate the over temperature relay.

Figure 19 shows the Spark Ignition system wiring and Figure 20 shows the location of the Spark Ignition system components.

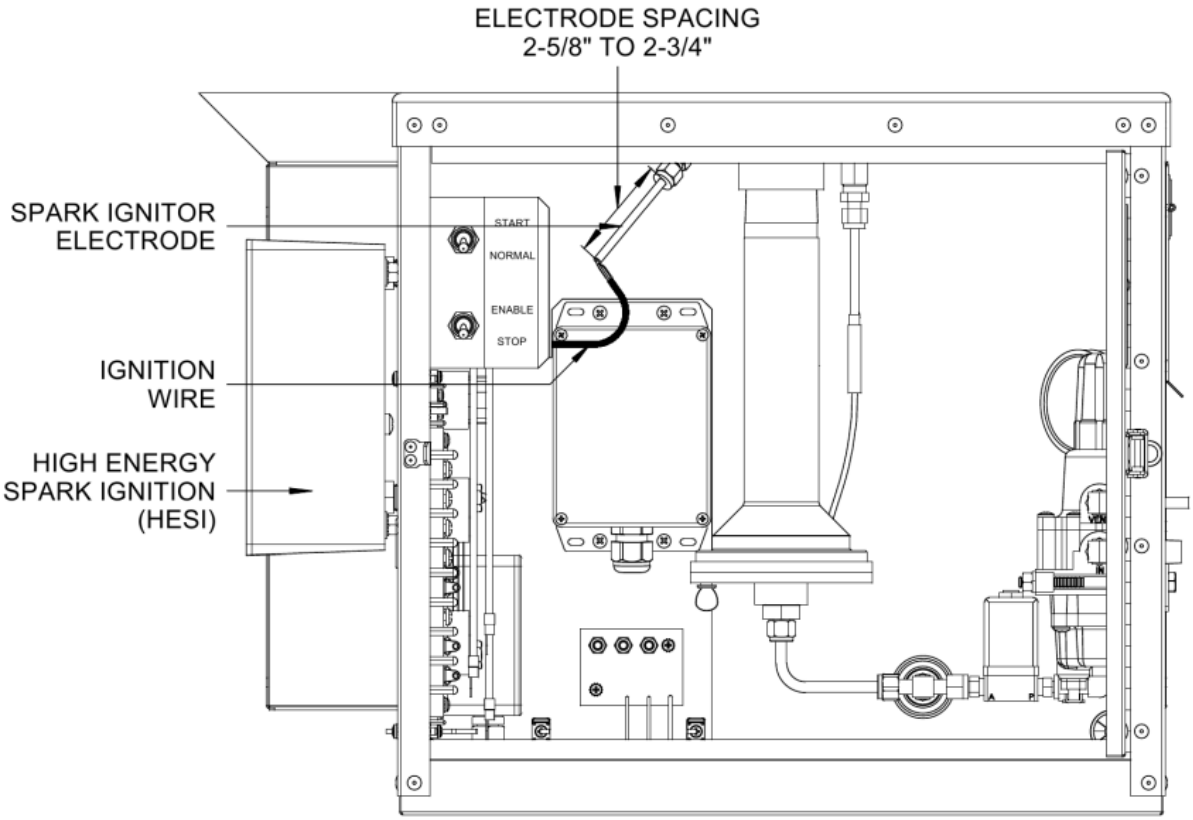


Figure 20 – Spark Ignition Components

If the Spark Ignition System is malfunctioning, follow the procedure below to isolate the problem.

1. Check that the spark gap is correct. Loosen the fitting on the bottom side of the burner and slide the Spark Igniter Rod in until it touches the spark post, then pull back approximately 1/8 inch (3 mm).

   This should leave 2-5/8 to 2-3/4 inches (67 to 70 mm) extruding beyond the fitting, see Figure 20. Confirm that this is correct before proceeding.

2. Remove the orange wire from the pressure switch and isolate it so that it cannot come in contact with the other electrical connections to prevent high voltage shock.

3. Carefully remove the spark igniter electrode assembly, loosen the fitting, and slide out the electrode.

4. Inspect the spark igniter electrode for cracks in the ceramic tube. Check the rod that runs through the ceramic tube for continuity. Replace the spark igniter electrode if it is damaged.

5. To test the function of the Ignition Module, position the spark igniter electrode tip so that there is a 1/8-inch (3 mm) gap to the TEG cabinet. Then activate the TEG “START” switch in “LOCAL” mode. Arcing should occur at the gap at the rate of about one per second. If arcing occurs the system is functioning well.

WARNING!

Do not touch the tip of the ignition wire or allow it to come in contact with other electrical connections.

6. Check the Pressure Switch. The switch should close at fuel pressures greater than 16 kPa (2.5 psi). Replace the Pressure Switch if necessary.

7.7 OVER TEMPERATURE SHUTDOWN SYSTEM (PRE-OCTOBER 2024)

The purpose of the Over Temperature Shutdown (OTSD) system is to interrupt the fuel supply in the event of a Power Unit or cabinet over temperature. Over temperature conditions can occur if air flow across the heat pipes is restricted, ambient temperatures exceed maximum ratings, burner malfunction, or from heat pipe failure. This system is the same in both regular and remote start 8550 TEGs.

The Over temperature Shutdown system consists of the following main components:

- ✓ Six Shutdown Thermostats – Each thermostat is installed in a heat pipe block and protects two heat pipes. During an overtemperature event, the thermostat will cause the respective shutdown fuse to blow in the Shutdown Module.
- ✓ Shutdown Module P/N 6963 – This module houses the thermostat fuses and is powered directly from the power unit. If all six fuses are intact, and the power unit voltage is above 12.5 Volts, this Module will provide 12 Volts to energize the Shutdown Relay.
- ✓ Shutdown Relay Assembly – This assembly is situated between the burner thermocouple and the fuel solenoid. When energized, it allows the thermocouple signal to pass through. If an over temperature event occurs it will de-energize and interrupt the signal, thereby shutting off the fuel solenoid.
- ✓ Thermal Cut-off – This is a thermal fuse that is placed in line with the Shutdown Relay red power wire. While the six thermostats protect the heat pipes and power unit, the thermal cut-off protects the cabinet interior from over temperature. If the cabinet gets too hot, this fuse will open and cause the shutdown relay to de-energize.

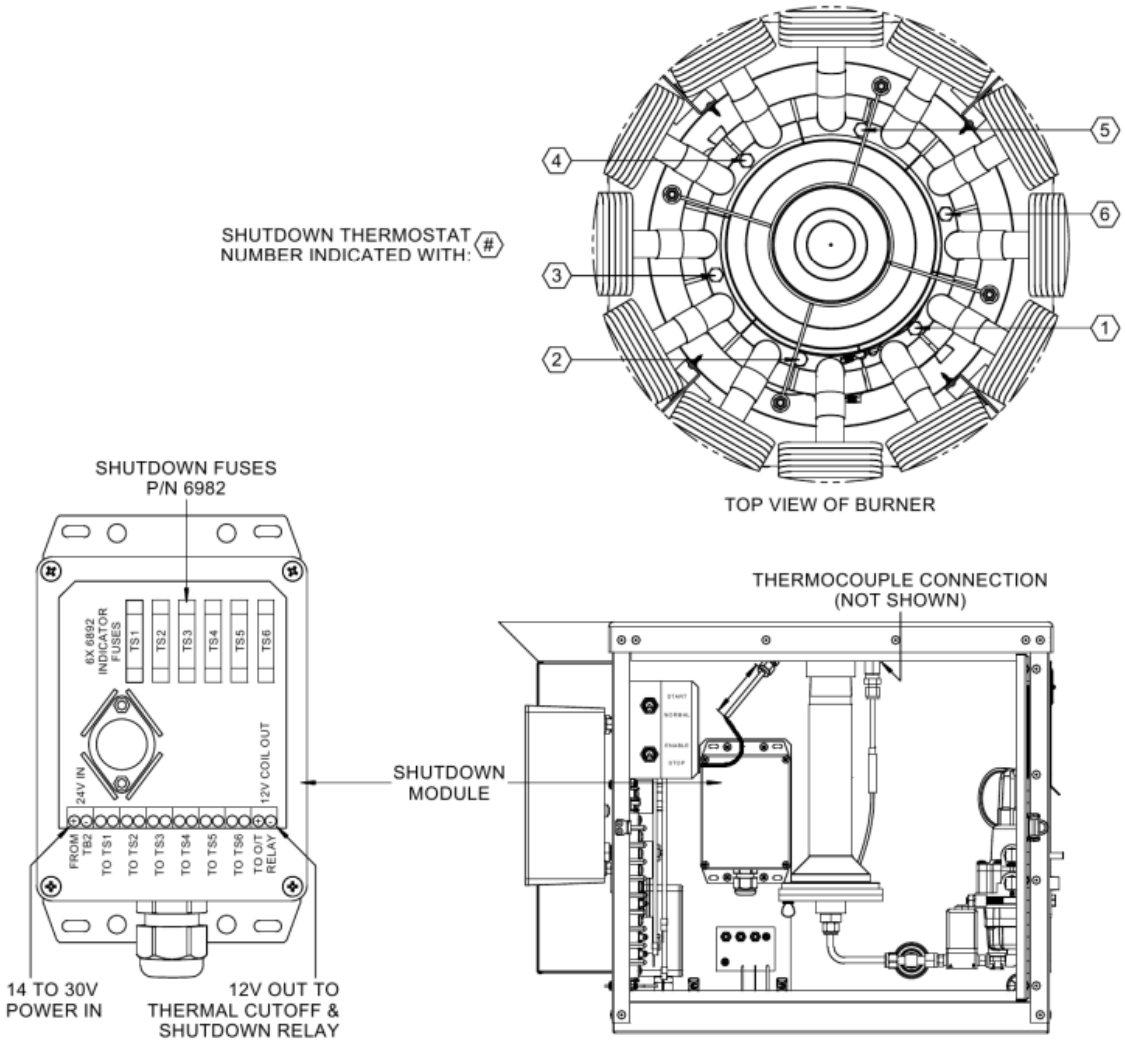


Figure 21 – Over Temperature Shutdown System

If an unexpected shutdown occurs, check the thermal cut-off and six shutdown fuses for continuity. If any of them have opened, then follow these maintenance steps:

1. Inspect all the heat pipes for damage and clean any debris.
2. Inspect thermostat /RTD wiring for loose or broken wires.
   - If the thermal cut-off has opened, check the fuel system for leaks and ensure that the burner thermocouple fitting is tight.
   - If no obvious problems are observed, replace the blown shutdown fuses and/or thermal cut-off.
3. Restart the TEG as normal and run it for at least one hour.
4. Perform a heat pipe inspection, referring to Section 7.3. Check all heat pipes, paying extra attention to the heat pipes nearest to any thermostats that blew a shutdown fuse. Replace all underperforming heat pipes as necessary.
   - If any shutdown fuse repeatedly opens before the TEG fully heats up, the corresponding thermostat is likely damaged and should be replaced.

7.8 OVER TEMPERATURE SHUTDOWN (POST-OCTOBER 2024)

The Over Temperature system now monitors the temperatures of the 8550's six RTD sensors. If an overtemperature condition is detected, the OTSD module will automatically cut off the fuel supply to the power unit, leading to a system shutdown. The key components of the system include:

- **Six RTD Sensors P/N 304959**: These sensors replace the previous thermostats and are installed to monitor heat pipe temperature directly. If a temperature exceeds safe limits, the OTSD module will respond by shutting down the system.
- **OTSD Module P/N 304676**: This module now houses and processes data from the RTD sensors. If the temperature at any of the sensors exceeds the set threshold, the module cuts off the fuel supply by de-energizing the shutdown relay, causing the system to shut down.

NOTE!

Only the new RTD sensors P/N 304959 are compatible with the new OTSD P/N 304676. If you have the original shutdown thermostats, you must continue to use the old OTSD P/N 6963. If upgrading to the new RTD sensors, the new OTSD module P/N 304676 will be required.

- **Shutdown Relay Assembly**: Located between the burner thermocouple and the shut-off valve, this assembly is energized under normal conditions to allow the thermocouple signal to pass through. In an overtemperature event, it de-energizes, interrupting the signal and shutting off the fuel valve.
- **Thermal Cut-off**: A thermal fuse located in line with the Shutdown Relay's red power wire. While the RTD sensors protect the heat pipes and power unit, this thermal cut-off protects the cabinet interior. If the cabinet temperature rises above the safe limit, the fuse opens, de-energizing the shutdown relay.

Note: For troubleshooting and maintenance, please refer to Section 14 for more information.

7.9 AUTOMATIC SHUT-OFF (SO)

The Automatic Shut-Off system is designed to turn off the fuel supply to the TEG in the event of a flame outage. The thermocouple will generate a return signal as long as good burner combustion is maintained. If the flame is interrupted for any reason, the set point module output will go to a logic zero, and the remote start controller will shut off the solenoid drive for that particular TEG. Other TEGs in the system (if present) will be unaffected.

In the event of a flame out, the TEG solenoid will not immediately shut off. The TEG will implement a purge cycle prior to restarting to allow vented gas to clear. After 3 failed starts, the TEG will lock out and will not allow any further TEG restarts. To restart a locked out TEG, the Remote Start Controller must be reset. Since the Remote Start Controller does not use any RTC (Real Time Clock) functions other than minutes and seconds, there is no system impact other than having to restart all TEGs in that bank.

If a Model 8550-RS TEG is experiencing intermittent shutdowns or does not start reliably, follow these steps to troubleshoot the Automatic Shut-Off system.

1. Check that the thermocouple sensor is installed correctly in the Burner Plate assembly.
2. Ensure that the connections between the thermocouple and the Set Point Module are tight.

If no installation issues are identified, verify system operation as follows:

1. Start the TEG by placing the TEG in “LOCAL” mode and activate the “START” switch.
2. Read the thermocouple voltage at the Set Point Module Input (Terminals TY(+) and TR(-). A healthy thermocouple will have a voltage between 15 and 30 millivolts. If the thermocouple signal falls below this range, or if no continuity is observed, then the thermocouple should be replaced.

NOTE:	**When replacing the thermocouple and using anti-seize on the burner fitting, ensure that only high-temperature anti-seize is used.**

3. If the shutdown module is outputting at least 12 Volts and the thermal cut-off has not opened, then the shutdown relay is faulty and should be replaced.
4. If no problems have been detected with the thermocouple signal but the solenoid still cannot open, then the fuel solenoid itself should be replaced.

7.10 POWER UNIT TESTING

The procedure below is designed to evaluate the conditions of the Power Unit and to determine its operating point. This procedure should only be done if a problem with the Power Unit is suspected; it serves no other purpose.

Open circuit voltage and internal resistance test:

The purpose of this test is to determine the momentary open circuit voltage (V_{oc}) of the Power Unit from which the internal resistance (R_{INT}) can be calculated. For this test to be accurate, the TEG must have been operating for the past 12 hours.

1. Measure and record the Power Unit current (I) at terminals 6(+) and 7(-) of TB-1.
2. Attach a voltmeter to read the Power Unit voltage at terminals 6(+) and 4(-) of TB-1. The voltmeter leads must be attached to these terminals because you will need both hands free to do the open circuit test.
3. Measure and record the Power Unit loaded voltage (V_L).
4. Record the momentary open circuit Power Unit voltage (V_{oc}).

   This is best done by removing the positive lead (White/Red) from the bottom of the shunt. With one hand, hold the connector firmly to the shunt until you have removed the screw, then remove the connector and take the voltage reading.

   The reading must be taken within 3 seconds. Immediately reconnect the wire to the shunt. DO NOT allow the Power Unit to remain in an open circuit for more than 20 seconds.
5. Record the open circuit voltage. If you need to take the reading again, wait at least 10 minutes with the screws firmly reinstalled so that the Power Unit can stabilize.
6. Calculate the internal resistance (R_{INT}) using the equation:

$$R_{INT} = \frac{(V_{oc} - V_L)}{I}$$

Where:

R_{INT}	=	internal resistance in Ohms
V_{OC}	=	Power Unit open circuit voltage
V_L	=	Power Unit loaded voltage
I	=	Power Unit load current

WARNING!

Do NOT allow the Power Unit to operate in the open circuit condition for more than 20 seconds.

If this test was conducted because the Power Unit power was below Set Power, see Section 7.1.1 for test result diagnostic.

If the Power Unit is producing Set Power, the open circuit voltage (V_{oc}) should be in the range of 52 to 56 Volts, and the internal resistance (R_{INT}) should be in the range of 1.10 to 1.35 Ohms.

NOTE: **If the TEG has just been started in the last 10 hours or has been stopped and restarted several times in the past days, its internal resistance may be somewhat higher.**

The maximum operating limits are 56.5 Volts for open circuit voltage and 1.45 Ohms for internal resistance. If the Power Unit does not produce Set Power and problems with the Burner System, Fuel System, and Cooling System have been ruled out, increase the fuel pressure until one of the above limits or Set Power is reached. Remember that it will take at least 10 minutes for a change in fuel pressure to take full effect. See also sections 6.1.3 and 6.1.4.

If the Power Unit will not produce Set Power without exceeding these limits, or does not respond to increasing fuel pressure, the Power Unit may be damaged.

NOTE: **In some cases, the Power Unit may be operated at derated power, consult GPT for further information.**

WARNING!

Do not operate the Power Unit above Set Power, maximum open circuit voltage, or maximum internal resistance.

8 TROUBLESHOOTING

When the TEG is not operating correctly it is necessary to determine which part is faulty. First ensure that all wires are making good contact and are connected correctly. Then isolate the customer load from the Limiter (Power Conditioner). Refer to Table 3 as a guide to troubleshooting the TEG and consult the indicated sections of this manual for further information.

Table 3 – Troubleshooting Guide

Problem	Potential Cause	Possible Solution	Lookup Section
Burner does not ignite	Air in fuel line	Purge fuel lines of air	*5.4*
	Supply gas pressure too low	Increase the gas supply pressure to the TEG	*5.5*
	Fuel filter dirty	Drain the regulator sediment	*7.4*
		Replace the fuel filter	*7.4.2*
	Fuel pressure adjustment incorrect	Adjust the burner fuel pressure	*6.1.2*
	Fuel orifice plugged	Replace the fuel orifice	*7.4.3*
	Fuel orifice size incorrect		*7.4.3*
	Air-shutter adjustment incorrect	Tune the air-shutter	*6.1.4*
	Incorrect spark electrode depth	Adjust spark electrode depth	*5.3, 7.6*
	Spark igniter faulty	Replace the spark igniter	*7.6*
Burner will ignite but will not continue to burn	Supply gas pressure too low	Increase the gas supply pressure to the TEG	*5.4, 5.5*
	Fuel filter dirty	Drain the regulator sediment	*7.4.1*
		Replace the fuel filter	*7.4.2*
	Fuel pressure adjustment incorrect	Adjust the burner fuel pressure	*6.1.2, 6.1.3*
	Fuel orifice plugged	Replace the fuel orifice	*7.4.3*
	Fuel orifice size incorrect	Replace the orifice with one of the correct size	*7.4.3*
	Air shutter adjustment incorrect	Adjust the air-shutter	*6.1.4*
	Thermostat fuses have blown	Inspect heat pipes and replace fuses	*7.3*

Problem	Potential Cause	Possible Solution	Lookup Section
	Thermal Cut-Off has opened	Inspect fuel system and replace Thermal Cut-Off	*7.4*
	Poor thermocouple signal	Troubleshoot Shut-Off System	*7.9*
Low output power or output voltage	Set Power incorrect	Determine proper Set Power for ambient conditions	*6.1.1*
	Heat pipes not adequately cooling power unit	Maintain and/or replace heat pipes	*7.3*
	Fuel pressure adjustment incorrect	Adjust burner fuel pressure	*6.1.2*
	Air-shutter adjustment incorrect	Adjust air-shutter	*6.1.4*
	Output voltage adjustment incorrect	Adjust the output voltage screw on the Limiter	*10.2.1*
	Power unit damaged	Evaluate the power unit	*7.10*
Output power is too high	Fuel pressure adjustment incorrect	Adjust the burner fuel pressure	*6.1.2*
Output voltage is too low or too high	Output voltage adjustment incorrect	Adjust the output voltage screw on the Limiter	*10.2.1*
	Limiter is faulty	Replace the Limiter	*10.4*
TEG won't shut off	Controller is damaged	Replace the controller board	*4*

9 PARTS LISTS

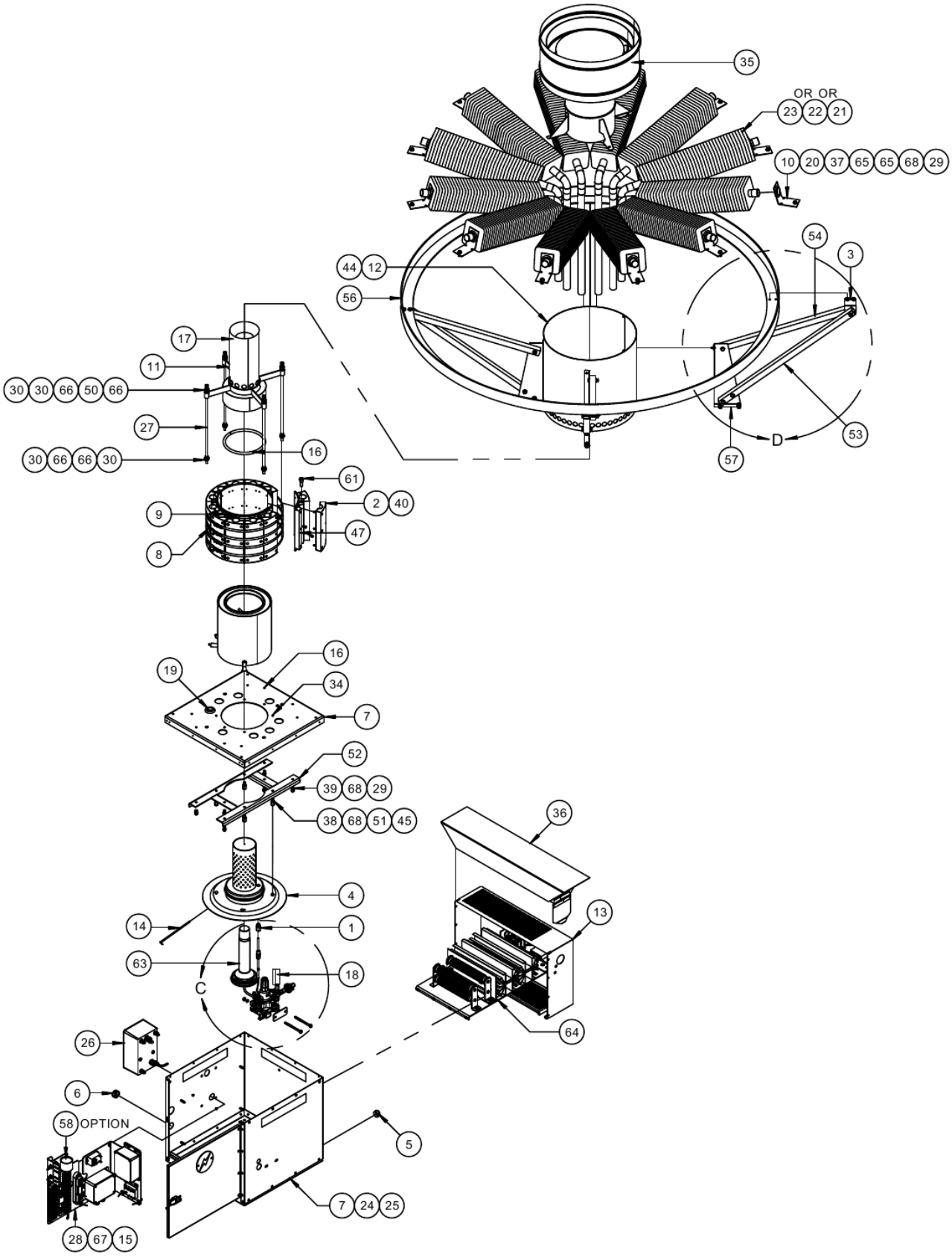


Figure 22 – Model 8550-RS TEG Parts (1 of 2)

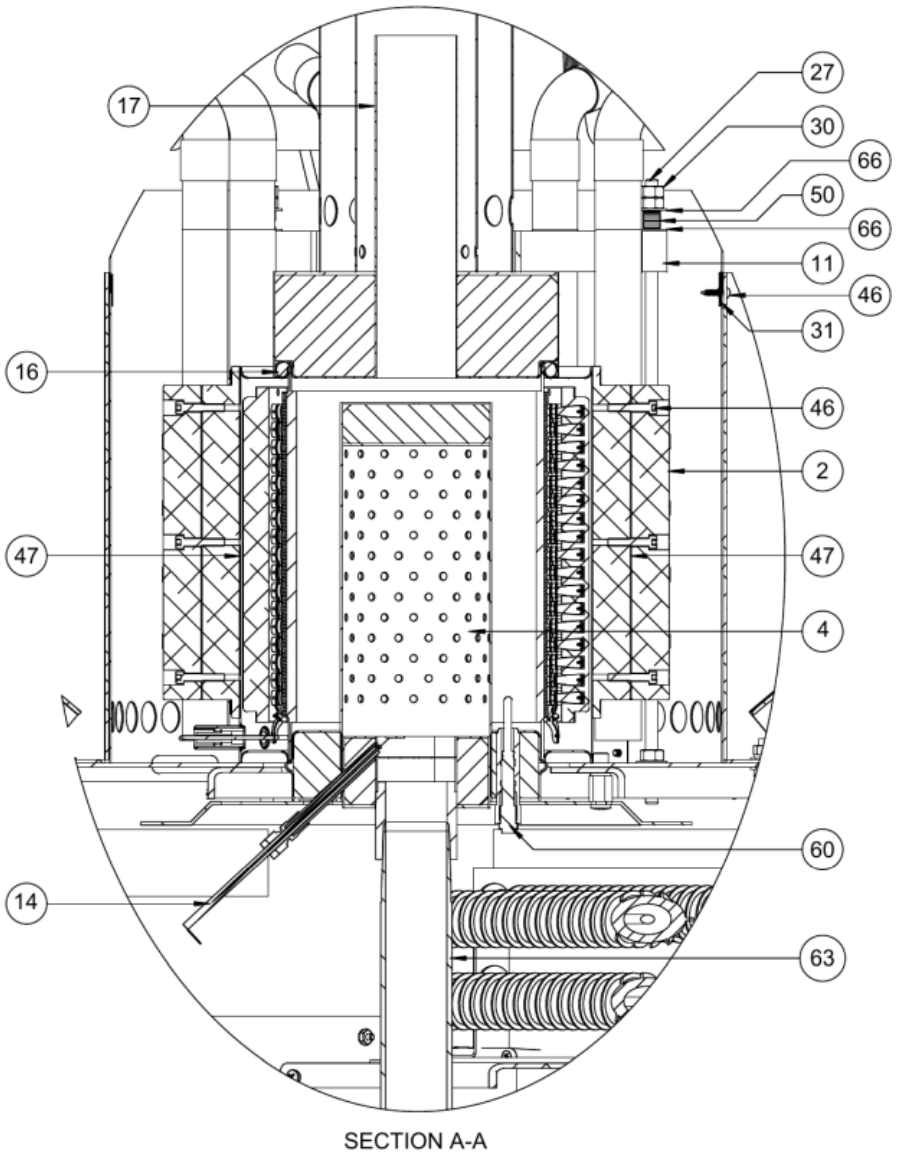


Figure 23 – Model 8550-RS TEG Parts (2 of2)

Refer to Figure 22 and Figure 23 for the following parts:

Item	Part No	Description
1	20567	ADAPTER, THERMOCOUPLE MOUNT, 8550 BURNER
2	6462	BLOCK, HEAT PIPE, 8550
3	6397	BRACKET, SUPPORT, 8550
4	22490	BURNER ASSY, 8550
5	5014	BUSHING, UNIVERSAL, 1, NYLON, 0.125 PNL
6	7790	BUSHING, 1.093, 0.125 PNL THK, NYLON
7	300329	CABINET ASSY, 8550RS
8	6991	CLAMP, STEPLESS, 12"
9	6931	CLAMP, STEPLESS, 9"
10	6396	CLIP, HEAT PIPE, 8550
11	6645	CONVERTER MOUNTING RING, 8550
12	6398	CONVERTER SHROUD, 8550

Item	Part No	Description
13	20184	COVER ASSEMBLY, LIMITER, 8550
14	6768	ELECTRODE ASSY, 6.4 LONG
15	300331	ELECTRONICS ASSY, 8550RS
16	5545	EXHAUST GASKET, 8550
17	5406	EXHAUST STACK ASSY, 8550
18	301402	FUEL SYS, RIGID, 8550RS
19	100153	GROMMET, SILICONE, .88 ID, 1.25 HOLE, .06 THICK
20	6939	GROMMET, 1.25 ID, 1.5 HOLE
21	22897	HEAT PIPE ASSY, COLD AMBIENT, 8550*
22	22896	HEAT PIPE ASSY, MEDIUM AMBIENT, 8550*
23	22895	HEAT PIPE ASSY, WARM AMBIENT, 8550*
24	753	LABEL, DATA PLATE
25	51304	LABEL, STARTING NOTE, 8550 PROPANE
26	25091	MODULE, HIGH ENERGY IGNITION, 24V, HESI
27	6400	MOUNTING ROD, CONVERTOR, 8550
28	20961	NUT, HEX, #8-32, 316 SS
29	611	NUT, HEX, 1/4-20, SS
30	5579	NUT, HEX, 5/16-18, SS
31	5575	NUT, SPRING, HEAT TREATED SPRING STEEL
32	54396	ORIFICE, 0.052, 8550**
33	6433	ORIFICE, 0.061, 8550-N**
34	20980	POWER UNIT, 8550
35	26885	RAIN CAP ASSY, 8550 TEG
36	26883	RAIN SHEILD, 6720 LIMITER
37	3094	SCREW, HEX, 1/4-20 X 0.75, SS
38	266	SCREW, CAP, SOC, 1/4-20 X 1/2, SS
39	62840	SCREW, CAP, SOC, 1/4-20 X 5/8, SS
40	2104	SCREW, CAP, SOC, 10-32 X 1, SS
41	2105	SCREW, HEX 1/4-20X3.5, SS
42	508	SCREW, HEX HD, 1/4-20 X 1.50, SS
43	5580	SCREW, HEX, 1/4-20 X 2.50,
44	7410	SCREW, MACH, P-H-P, #8-32 X 0.25, FULL THRD, SS
45	2221	SCREW, MACH, PHP, 1/4-20 X 0.375, SS
46	5574	SCREW, SELF TAP, PHP, #6 X 0.625, SS
47	21646	SHOE, HEATPIPE, 8550, WITH 1/4 NPT
48	109	SLEEVING, FIBREGLASS, 7 GA., .015
49	6984	SPIRAL WRAP, Ø0.125, TEFLON
50	5576	SPRING, WIRE, 302 SS
51	6968	STANDOFF, 1/2 HEX 1/4-20 X 5/8 SS
52	6958	STIFFENER ASSY, CABINET 8550
53	6395	SUPPORT ARM, LOWER, HEAT PIPE, 8550
54	6394	SUPPORT ARM, UPPER, HEAT PIPE, 8550

Item	Part No	Description
55	26561	SUPPORT PLATE, REGULATOR
56	6393	SUPPORT RING, HEAT PIPE, SANDED, 8550
57	6431	SUPPORT, UPRIGHT, 8550
58	57934	SURGE PROTECTION DEVICE, 8550
59	5546	TERM SPLICE, PARALLEL, 8AWG
60	20101	THERMOCOUPLE, W/ SWAGELOK FITTING
61	21647	THERMOSTAT, SHUTDOWN, 1/4 NPT***
62	6985	TUBING, HEAT SHRINK, .375, BLK, 2:1
63	303892	VENTURI, 8550, ASSEMBLY
64	3162	VOLTAGE LIMITER ASSEMBLY, 6720, 24V
65	557	WASHER, FLAT, 1/4, SS
66	5578	WASHER, FLAT, 5/16, SS
67	20959	WASHER, LOCK, EXT, #8, 316 SS
68	541	WASHER, LOCK, SPRING, 1/4, SS

Notes:

* Fuel orifices are ordered separately from the rest of the fuel system.

** The Heat Pipe Assembly type will vary depending on the TEG type as follows:

- Warm Ambient uses 12 each of 22895.
- Cold Ambient uses 6 each of 22897 alternating with 6 each of 22896.
- Medium Ambient uses 12 each of 22896.
- Check the color of the tip of the Heat Pipe to determine which type to use.

9.1 FUEL SYSTEM PARTS LIST

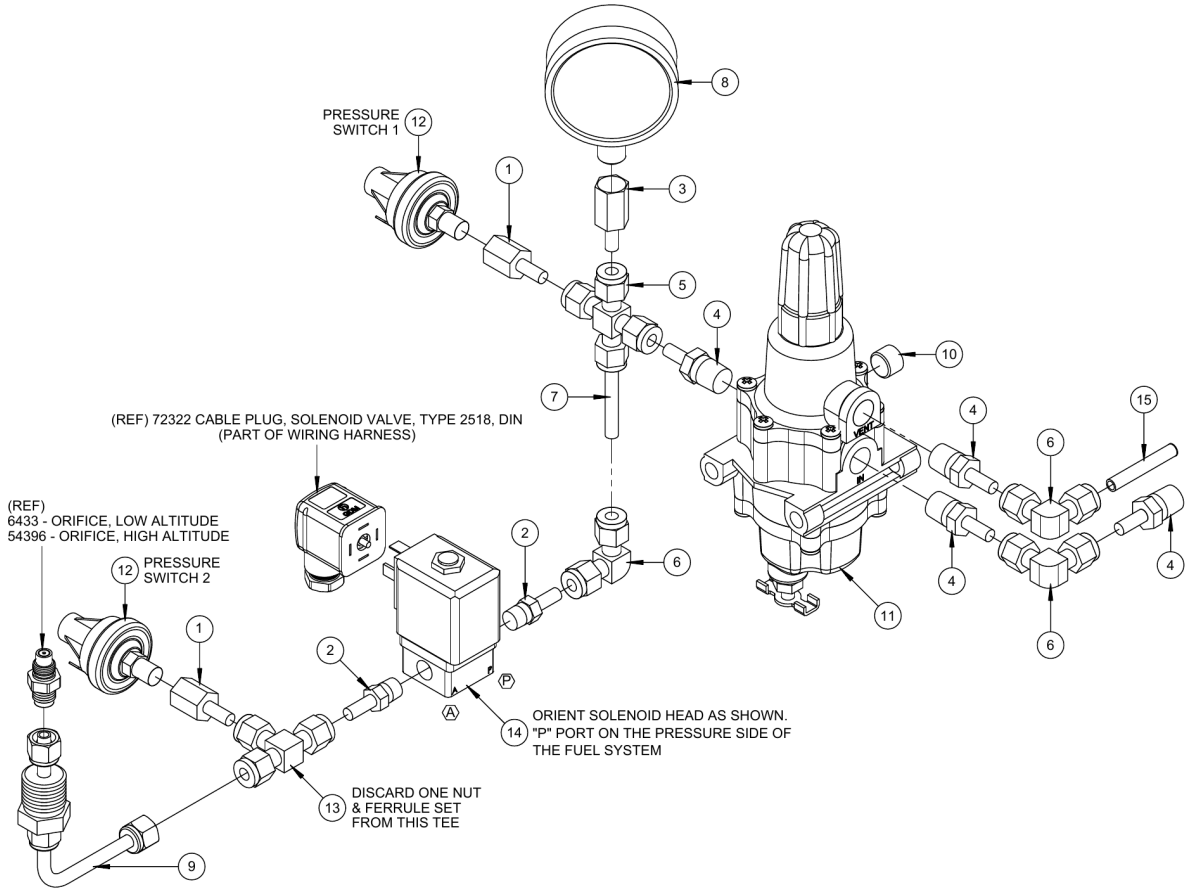


Figure 24 – Fuel System Parts

Refer to Figure 24 to identify the following parts:

Item	Part No	Description
0	301402	FUEL SYSTEM, RIGID, 8550RS
1	301397	ADAPTER, 0.25 TB X 0.125 FNPT, 316SS
2	51601	ADAPTER, 0.25 TB X 0.125 MNPT, 316SS
3	26208	ADAPTER, 0.25 TB X 0.25 FNPT, 316SS
4	51548	ADAPTER, 0.25 MNPT X 0.25 TB
5	65172	CROSS, UNION, 0.25 TB, 316SS
6	20743	ELBOW, UNION, 0.25 TB, 316SS
7	301403	FUEL LINE, RIGID, 8550RS
8	406	GAUGE, PRESSURE, 0-30 PSI
9	5897	ORIFICE TUBE ASSEMBLY, 8550
10	58949	PLUG, 0.25 NPT X 0.875, STEEL
11	22359	REGULATOR, FISHER 67CFR, 0-20
12	6471	SWITCH, PRESSURE 1.6 PSI, BRASS
13	20742	TEE, UNION, 0.25 TB, SS,
14	300426	VALVE BODY, SOLENOID, BURKERT 24VDC
15	20122	VENT TUBE ASSY, REGULATOR, SS 5030/8550

9.2 ELECTRONICS ASSEMBLY PARTS LIST

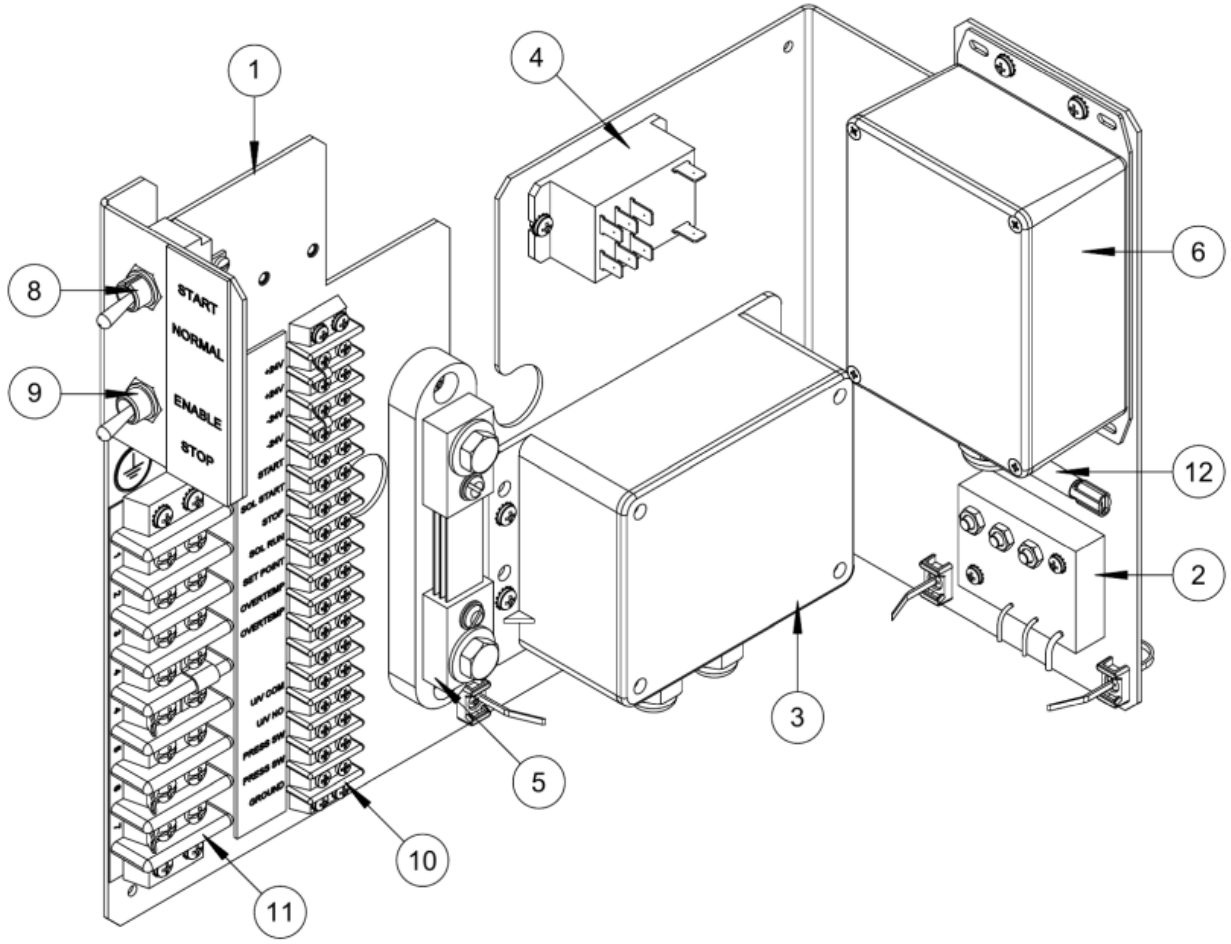


Figure 25 – Electronics Assembly Parts

Item	Part No	Description
1	300325	BACKPAN, 8550RS CABINET
2	25090	MODULE, OVER TEMPERATURE RELAY, 8550RS
3	24408	MODULE, SET POINT, 8550RS, 200/600C
4	29405	RELAY, 24VDC, 30A DPDT, FLANGE MOUNT
5	5238	SHUNT, 50 AMP-50MV
6	6963	SHUTDOWN MODULE, OVER TEMPERATURE 8550*
6	304676	SHUTDOWN MODULE, FLASH MEMORY, 8550*
7	301405	SOLENOID WIRE HARNESS, 8550RS (NOT SHOWN)
8	25102	SWITCH, TOGGLE, MOM, DPST, 8550RS START
9	25103	SWITCH, TOGGLE, 3PST, 8550RS ENABLE
10	25304	TERM STRIP, 18P 2 ROW, 6-32 SCREWS
11	2110	TERM STRIP, 8P
12	300074	THERMAL CUTOFF ASSY

* As of October 2024, the 6963 Over Temperature Shutdown Module is being replaced by the RTD sensor version. This version will not work with older thermostats. Older 6963 parts can be provided until stock is depleted. Older TEGs can be upgraded in the field to the newer flash based OTSD system using part number 305016.

10 6720 VOLTAGE LIMITER FOR MODEL 8550 TEG

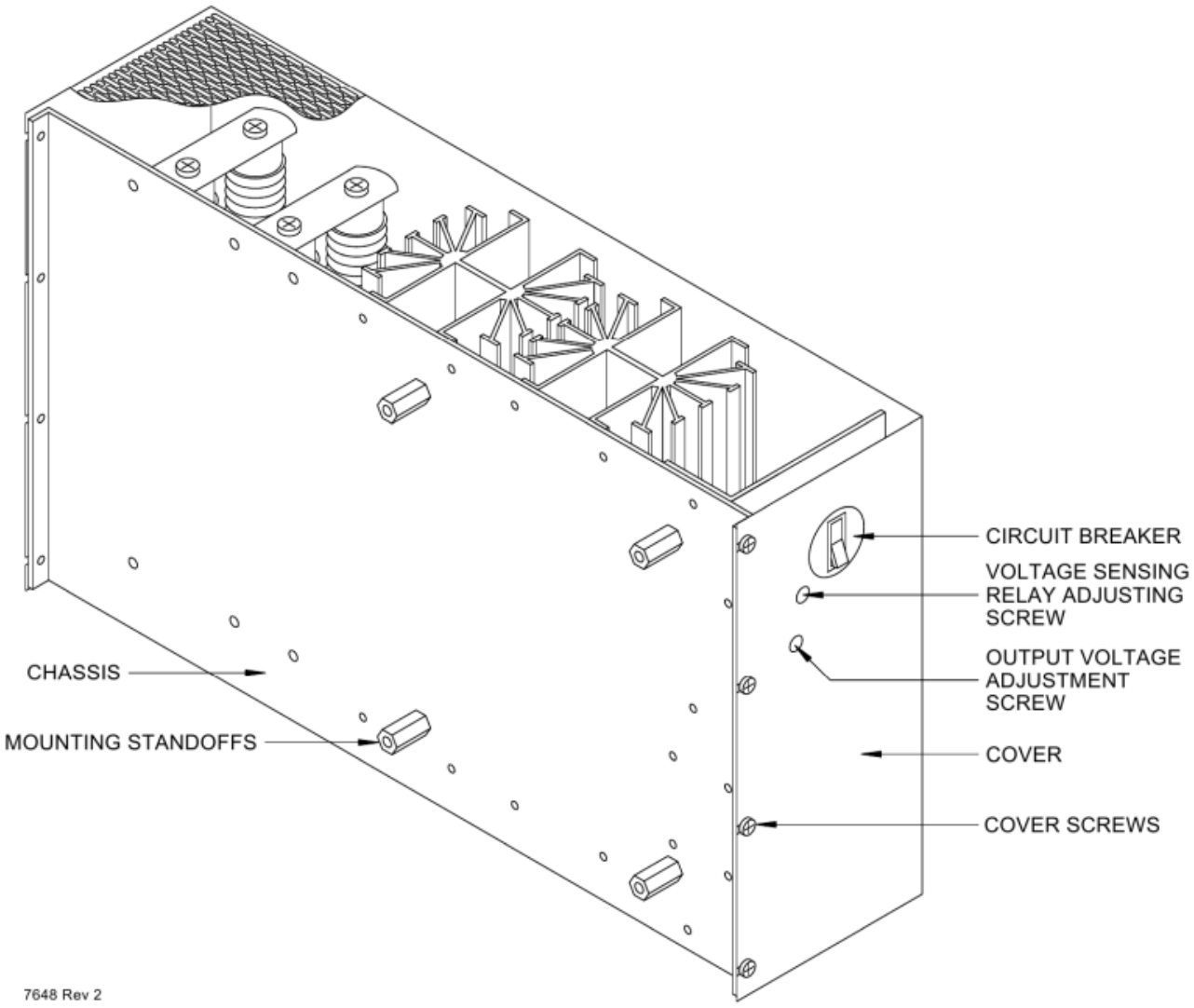


Figure 26 – 6720 Voltage Limiter

10.1 PRODUCT APPLICATION

The 6720 Voltage Limiter is an electronic device connected to the output of the TEG's Power Unit. It is a shunt regulator that is essential for power unit health. Its main functions are to:

- Shed unused power from the TEG's Power Unit to provide optimal load conditions and protect the power unit from overvoltage.
- Provide a constant adjustable voltage to the Customer Load.
- Provide reverse current (back feed) protection from other parallel connected sources.
- Provide a Voltage Sensing Relay (VSR) that can be used for Low-Voltage-Alarm and/or Voltage-Good contacts in customer applications.

10.2 OPERATION

10.2.1 OUTPUT VOLTAGE ADJUSTMENT

Do not adjust the voltage limiter output voltage until the TEG is set up and operating in accordance with Section 6 of this manual.

1. Ensure that the TEG has been running for at least one hour to stabilize.
2. Disconnect all customer load connections from terminals 2 and 4 of TB-1.
3. Connect a voltmeter across terminal 2 (+) and 4 (-) of TB-1.
4. Using a small flat blade screwdriver, adjust the Voltage Adjustment Screw on the 6720 Limiter until the voltmeter reads your desired output voltage.
5. Remove the voltmeter and reconnect your customer load connections.

10.2.2 VOLTAGE SENSING RELAY ADJUSTMENT

The user-adjustable Voltage Sensing Relay allows the customer to monitor the status of the Model 8550-RS TEG. When the VSR is de-energized, the Common (COM) terminal is connected to the Normally Closed (NC) contact. When the VSR becomes energized, the Common terminal is instead connected to the Normally Open (NO) contact.

From the factory, the Model 8550-RS TEG VSR will be set so that the VSR will energize when the power unit voltage climbs above 23 Volts. The VSR also incorporates approximately 0.5 Volts of hysteresis, meaning once the VSR is energized the voltage would need to drop 0.5 Volts below the energize threshold for it to de-energize (22.5 Volts factory default).

The VSR contacts can be easily used to generate Low-Voltage-Alarm or Voltage-Good signals for customer equipment with the factory default 23 Volt VSR setpoint. For example, a connection between the COM and NC terminals indicates the voltage is below standard operating voltage, indicating a Low-Voltage-Alarm. Conversely, if a connection is observed between the COM and NO terminals, then the voltage is confirmed to be above the VSR threshold, indicating a Voltage-Good status.

The VSR energized threshold can be adjusted with the following procedure:

1. Ensure the TEG has been running for at least an hour to stabilize.
2. Disconnect all customer load connections from terminals 2 and 4 of TB-1.
3. Connect a voltmeter across terminal 2 (+) and terminal 4 (-) of TB-1.
4. Connect a multimeter across the COM (+) and NC (-) terminals of the VSR & Control Board within the 6720 Limiter. Set the multimeter to measure continuity (or resistance).
5. Using a small flat blade screwdriver, adjust the Voltage Adjustment Screw on the 6720 Limiter until the voltmeter reads your desired VSR energizing voltage.
6. Carefully adjust the Voltage Sensing Relay Adjustment Screw on the 6720 Limiter until the VSR energizes, as evidenced by the multimeter detecting continuity (under 1 Ohm) between the COM & NC terminals. You want to stop turning the screw the moment continuity changes. If you overshoot by too much, adjust the screw in the opposite direction until the VSR deenergizes, then try again.

7. Re-adjust the Voltage Adjustment Screw to return the customer output voltage to its proper setpoint.
8. Remove both meters and reconnect your customer load connections.

10.3 SERVICE

The all-solid-state high-reliability design of the Voltage Limiter renders it nearly maintenance free. Check for the following during the annual maintenance:

1. Obstruction of air flow through the heat sink area.
2. Output voltage level is correct. Reset, if necessary. See Section 6.1.3.
3. Tighten the wire connections at input and output of the Limiter. Look for oxidized high resistance contacts. If any exist, clean and re-tighten.

10.4 6720 VOLTAGE LIMITER PARTS LIST

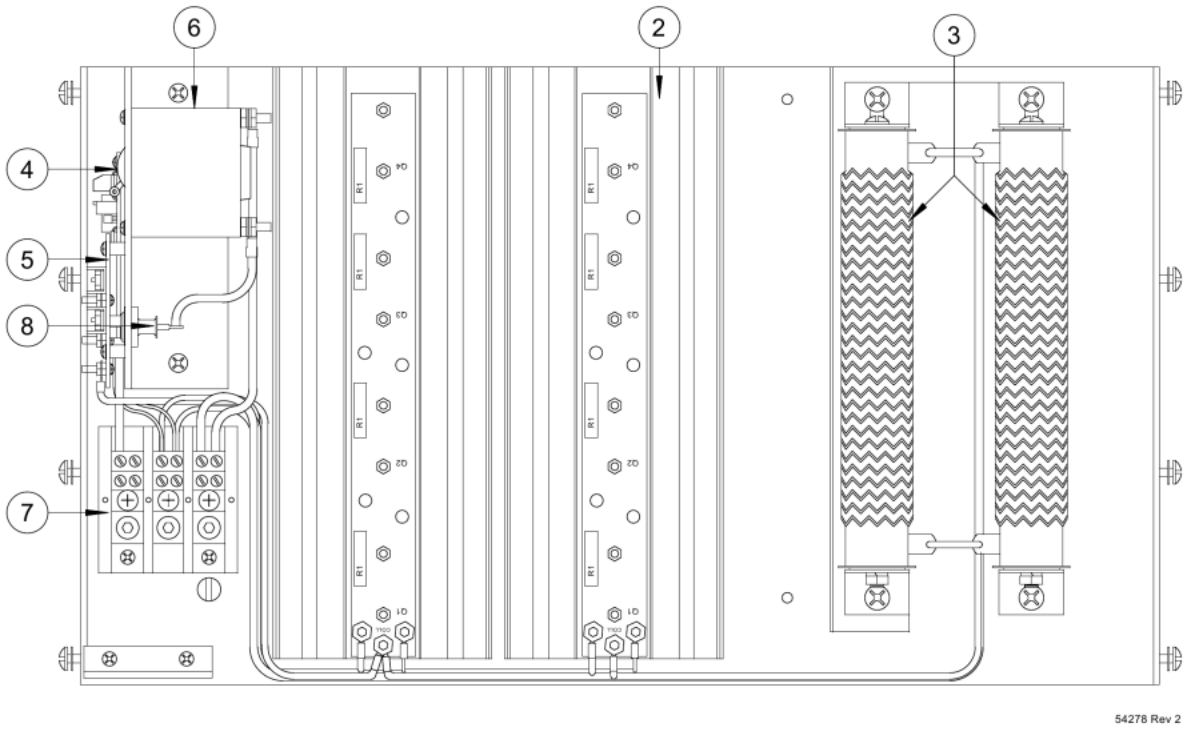


Figure 27 – 6720 Limiter Main Parts

Item	SAP	Description
1	20184	Cover Assembly, Limiter, 8550 (not shown, order separately)
2	3154	Heat Sink Assembly
3	116	Resistor, 2 Ohm, 300 Watts, 10%
4	58439	Control & VSR Board, 24 Volt
5	61042	Driver Board
6	284	Circuit Breaker, 30 Amp
7	6714	Terminal Block, 3 Pole, Heavy Duty
8	2580	Output Diode

11 CATHODIC PROTECTION INTERFACE OPTION

The Cathodic Protection Interface Panel provides for easy 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 the heavy-duty terminal block. The CP Panel will mount to the TEG stand and can be sized for multiple TEG arrays. Refer to Figure 29 for locations and descriptions of the major components of the CP interface cabinet.

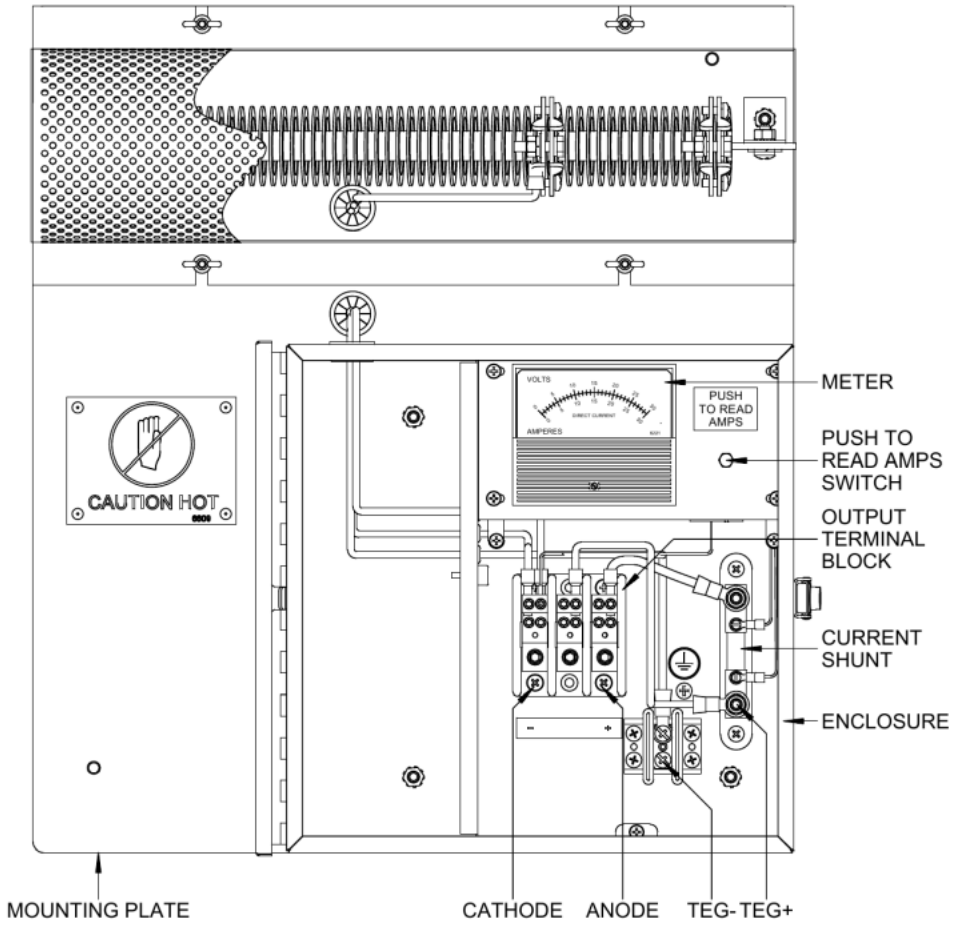


Figure 28 – Cathodic Protection Interface Panel

NOTE: **Do not allow current to the cathodic protection load to exceed 30 Amps as this will trip the circuit breaker.**

The Model CP8550-RS generator is not rated to supply more than 30 amps of current to the load. If total circuit resistance is less than 0.5 ohms, then the 1000-watt variable resistor in the CP box should be wired in series with the circuit and adjusted so that current does not exceed 30 amps.

11.1 METER

The dual scale meter displays voltage at the terminal block, and current when the PUSH TO READ AMPS button is pressed. The meter is accurate to ±3% of full scale (50 mV) and is weatherproof.

11.2 CURRENT SHUNT

A shunt is used to measure the current to the terminal block. The voltage drop across the shunt is proportional to the current flowing through it. The current shunt is rated at 30 Amps = 50 mV.

11.3 ADJUSTMENT

A 0 to 1 ohm, 1000-Watt variable resistor located at the top of the CP panel may be used to adjust the output current of the CP interface. This resistor may be connected in series or parallel with the CP load based on site CP load requirements. The adjustment resistor is a ceramic body ribbed type, and adjustments are made using a slide terminal for coarse adjustment and setting the limiter output voltage for fine adjustment. See Figure 29 for series connection and Figure 30 for parallel connection.

11.3.1 SERIES MODE

The CP Interface panel is wired in Series configuration by default from the factory. By connecting the 1000-Watt resistor in series with the CP load, the maximum allowable power may be delivered to the CP load. This is achieved by moving the tap to the left side of the resistor. To reduce power to the CP load, slide the tap to the right. This configuration is normally used when CP voltage is higher than 50% of rated TEG voltage. The equivalent circuit is shown on the right side showing the voltage divider formed by the CP load and the lower part of the adjustment resistor.

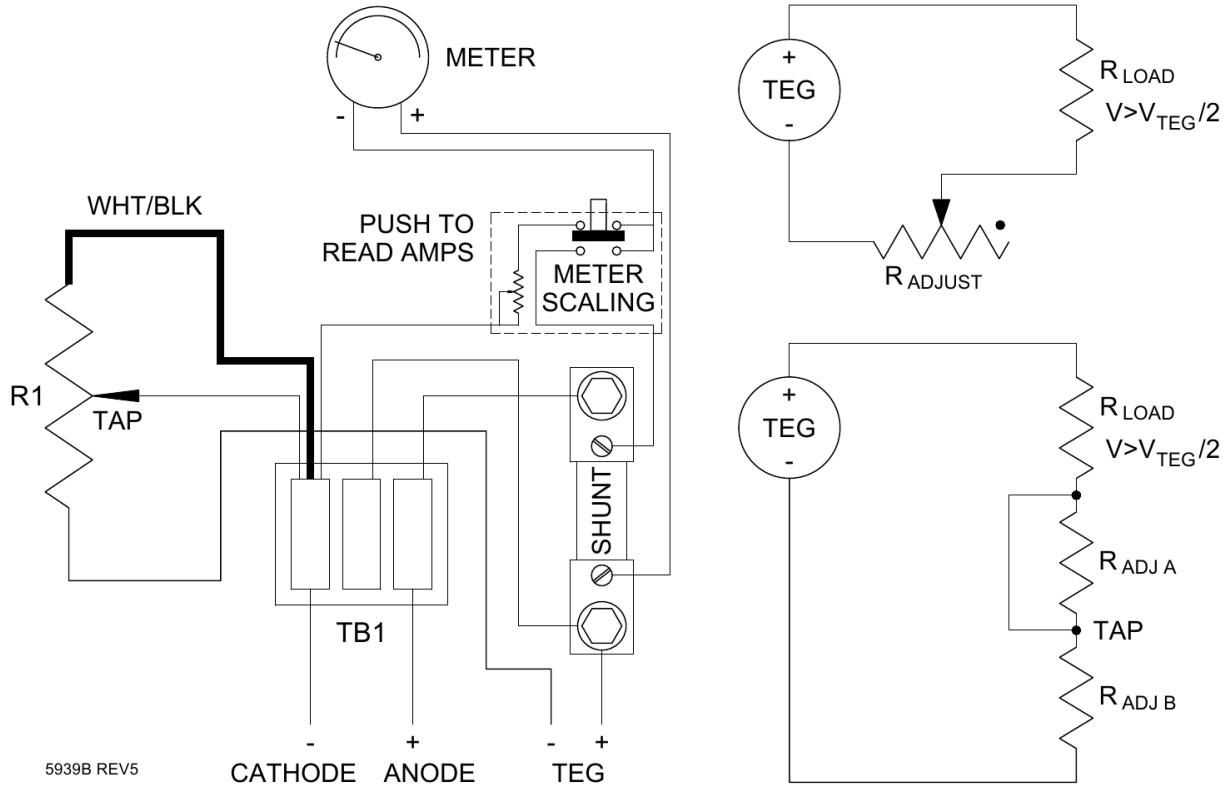


Figure 29 – CP Series Configuration Wiring

11.3.2 PARALLEL MODE

By connecting the 1000-Watt resistor parallel to the TEG, smaller levels of power may be delivered to the CP load. This is often required when the protected structure is new, and protective coating is intact. With the tap located at the right side of the resistor the output power will be zero. As the tap is moved to the left the power to the CP load is increased.

The change from series to parallel configuration is made by moving the wire coming from the right side of the 1000-Watt resistor, from the left position to the center position of the heavy-duty terminal block.

The parallel configuration is used when power requirements are between 0 and 50% of rated TEG voltage. Parallel wiring is shown in the figure below:

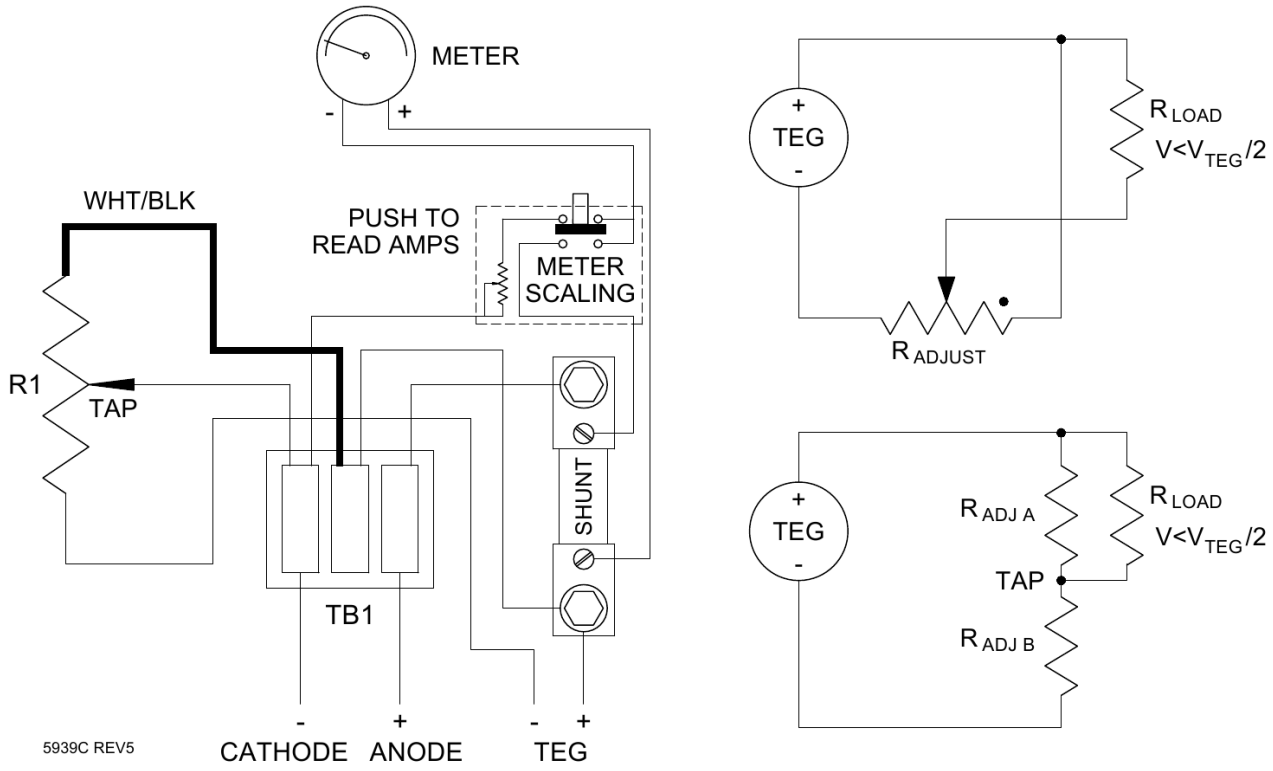


Figure 30 – CP Parallel Configuration Wiring

In this configuration, the CP load is wired as a current divider with the upper portion of the adjustment resistor. Note that once in parallel mode, the TEG is already fully loaded, and output should not be connected to additional loads. A TEG wired in the default series mode can supply current to additional site loads.

CAUTION!

Do not use Parallel Mode on low impedance sources such as batteries without circuit protection.

GPT can customize CP Panels for many configurations including the following:

- Solid State and Mercury Relay interrupters
- 4-20mA analog outputs
- RTUs
- Custom Voltages
- Higher power

Contact GPT sales for further information.

11.4 PARTS LIST – CATHODIC PROTECTION INTERFACE

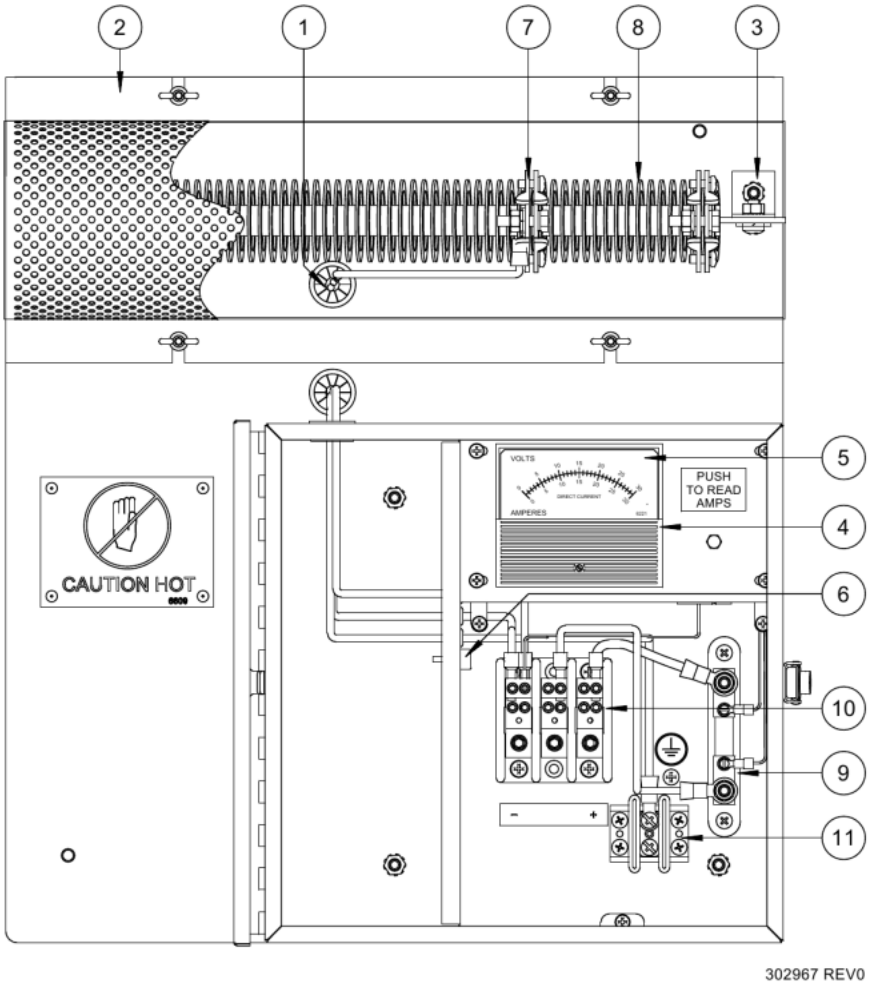


Figure 31 – Cathodic Protection Interface Assembly Parts

Item	Part No.	Description
1	5014	Bushing, Universal, 1, Nylon, 0.125 PNL
2	6594	Cover Assembly, Resistor, 8550 CP Panel
3	21899	Mounting Bracket, Resistor
4	6226	Meter, 0-50 mV DC, 2.5” Custom Scale*
5	6221	Meter Face, 30V, 30A*
6	3192	Plug, Bumper, 0.875 x 0.250
7	6608	Slide, Resistor, 1 Ω, 1000
8	6566	Resister, 1.0R, 100W, 31.6A, Adjustable
9	6217	Shunt, Type 766, 30 Amp, 50mV, Holloway SW w/ Base
10	6714	Terminal Block, 3P, 14/2/0 AWG, 175A
11	7941	Terminal Block, POS

NOTE: ***Panel Meter (6226) comes with a blank face plate. Always order the Meter Face (6221) when replacing the Panel Meter.

11.5 CATHODIC PROTECTION INTERFACE WIRING DIAGRAM

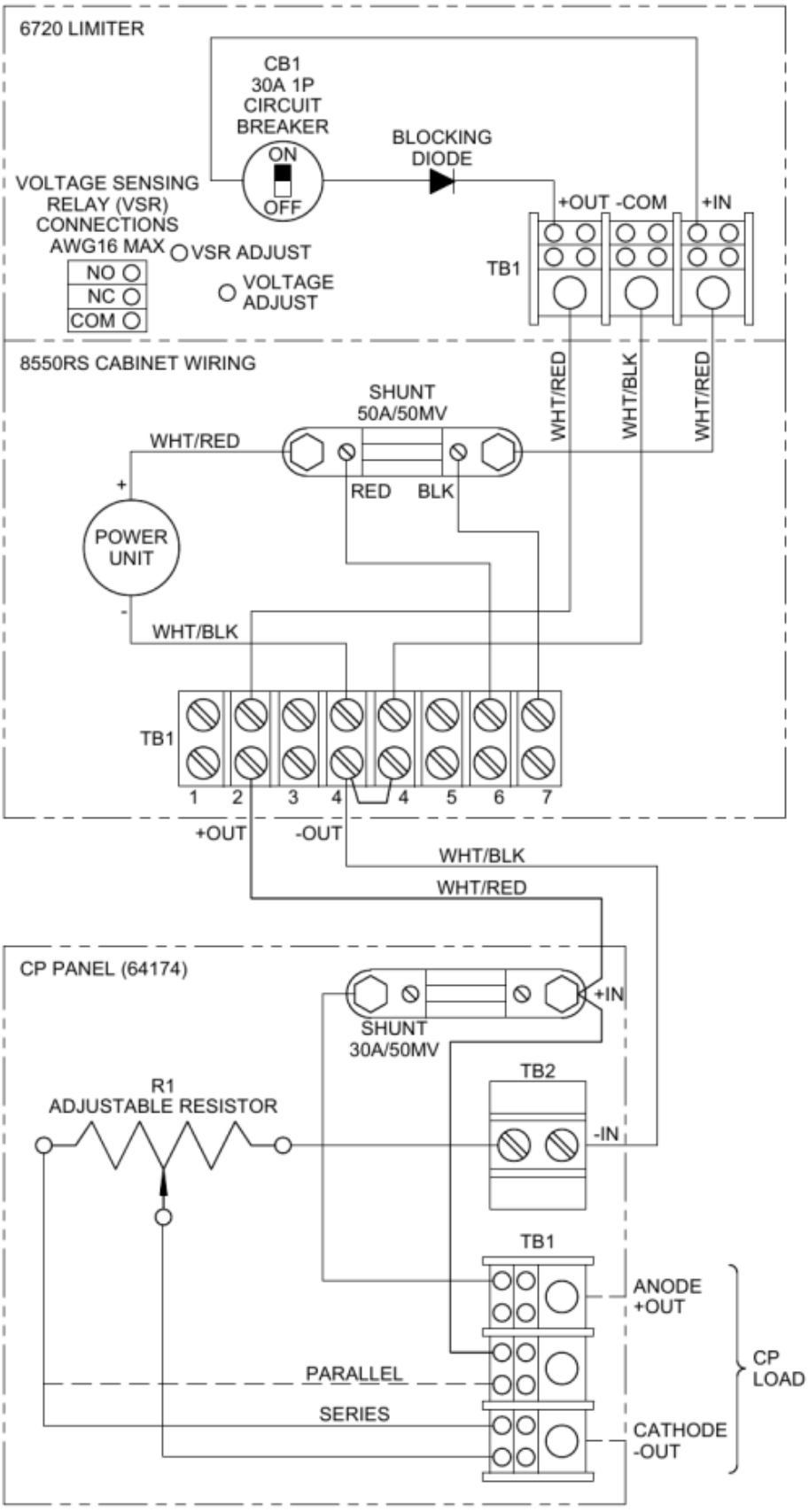


Figure 32 – Cathodic Protection Interface Wiring Diagram

12 WEIGHT, DIMENSIONS, AND ELECTRICAL SPECIFICATIONS

Figure 33 shows the Model 8550 TEG in its normal operating configuration. Weight, dimensions, and electrical specifications are listed below.

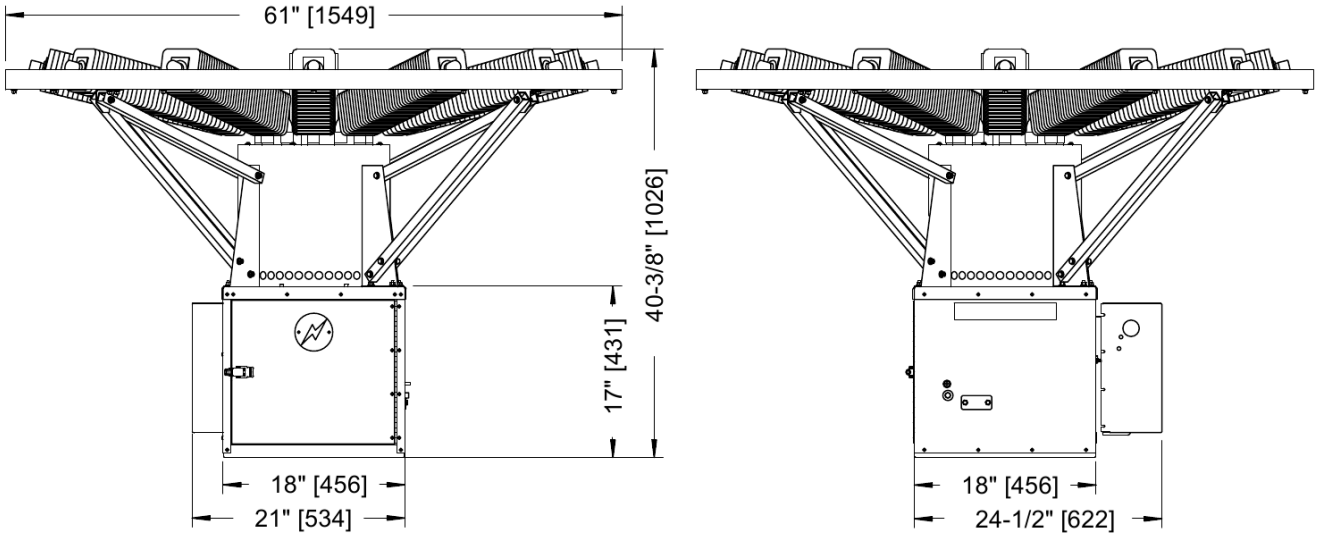


Figure 33 – Model 8550-RS TEG Dimensions

WEIGHT AND DIMENSIONS

Diameter of Top	61 in	155 cm
Overall Height	40 in	102 cm
Length of Lower Cabinet	18 in	46 cm
Width of Lower Cabinet	18 in	46 cm
Height of Lower Cabinet	17 in	44 cm
Weight (with Limiter)	225 lbs	102 kg

ELECTRICAL SPECIFICATIONS

Power Rating at 20°C
480 Watts @ 12 Volts
550 Watts @ 24 Volts
480 Watts @ 48 Volts

Output Adjustment Range		
12 Volt Models	=	11.4-12.6 Volts
24 Volt Models	=	24-30 Volts
48 Volt Models	=	47-57 Volts

13 PROCESS DESCRIPTION

A Thermoelectric Generator produces electrical power by directly converting heat energy to electrical energy with the use of thermocouples. A thermocouple is formed by a P type and an N type thermoelectric element joined electrically by a hot junction electrode. Adjacent thermocouples are joined electrically by cold junction electrodes.

Electrical power will continue to flow through the circuit as long as the temperature difference between the two ends of the thermocouple is maintained.

The Model 8550 Power Unit has a total of 325 thermocouples, each producing 87 mV at standard conditions, connected in series to produce 590 Watts at 28 Volts and 21 Amperes.

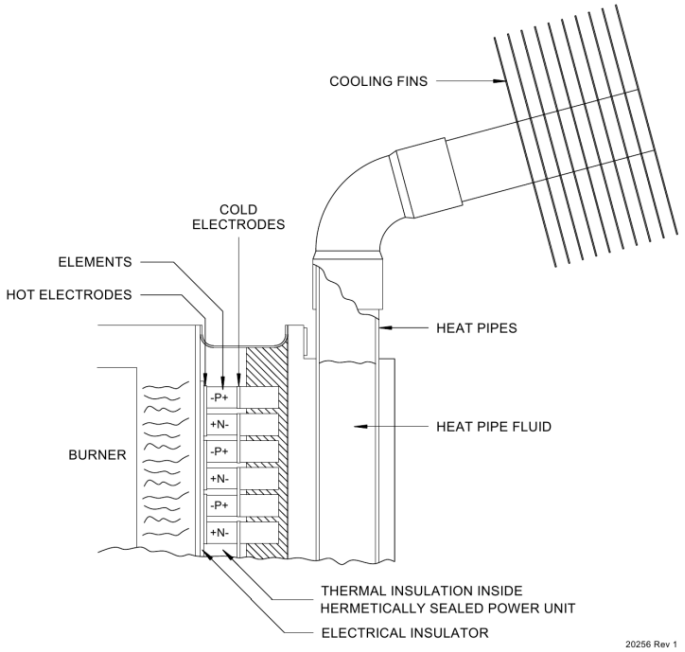


Figure 34 – Design Illustration

The hot junction of the thermocouples is maintained at 1000°F (538°C) or by a burner that operates on gaseous fuels. The burner operates at moderate fuel pressures, approximately 18 psi (124 kPa) for propane and 9 psi (62 kPa) for natural gas. The cold junction of the thermocouples is maintained at 235°F (163°C) by an array of heat pipes that transfer the heat to the ambient air.

The cold junction of the thermocouples is maintained at a lower temperature (163°C or 235°F) by an array of heat pipes that transfer the heat to the ambient air by natural convection. Each heat pipe is hermetically sealed and contains a measured amount of fluid in equilibrium with its vapour. As heat is applied to the fluid it, boils and then re-condenses in the condenser tube due to the cooling effect of the cooling fins. In this way, heat is efficiently transferred to the cooling fin.

The power unit must always be in a loaded condition. This is because under extended open circuit or high voltage conditions, the hot junction temperature may rise above the safe operating range. For this reason, the power unit must always remain connected to a Limiter which will keep the power unit voltage within safe operating regions.

The temperature difference, and therefore the amount of power produced by the TEG, depends on both the rate at which fuel is supplied to the burner and the amount of cooling supplied by the ambient air. The operation of the TEG is controlled by the fuel pressure supplied to the burner.

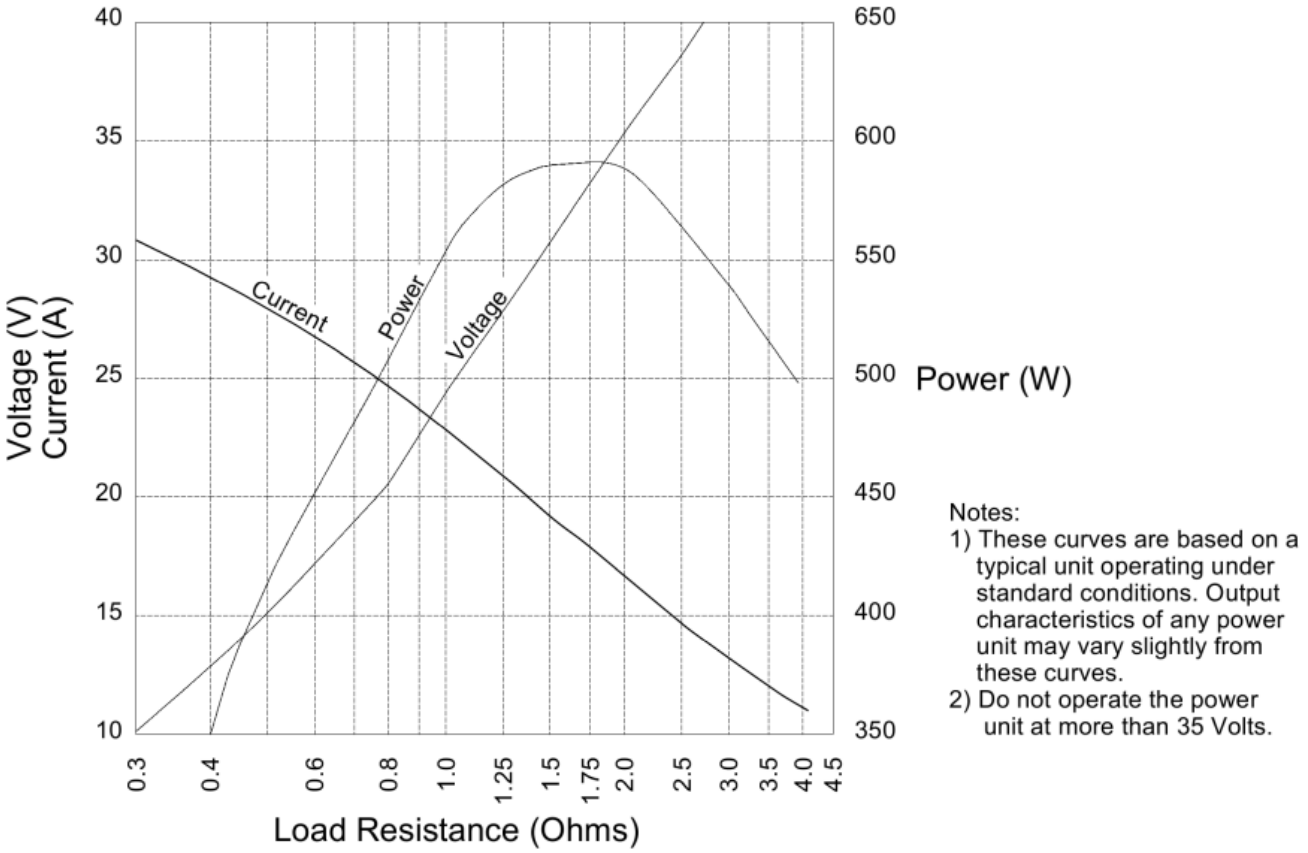


Figure 35 –Power Unit Electrical Output Characteristics at 20°C (New, Without Limiter)

The typical gross electrical output of the Model 8550 TEG Power Unit at nominal ambient temperature is characterized in Figure 35. This figure demonstrates the importance of the Limiter, which prevents the TEG from exceeding the customer voltage setpoint (user-adjustable with factory default of 27.1 Volts). This both ensures that the power unit operates within the optimal power region and that the maximum tolerable power unit voltage is not exceeded.

Operating voltages outside the nominal 24- to 30-Volt range are best achieved by connecting a DC-to-DC Converter to the output of the TEG. Nominal 12-Volt and 48-Volt DC-DC Converter options are available for the Model 8550-RS TEG. Consult GPT for assistance with finding the best system to suit your application.

The available power of a Model 8550-RS TEG is also a function of the amount of cooling supplied by the heat pipes, and this cooling is affected by both the ambient air temperature and the wind speed. The effect of wind will always be to increase the cooling effect, and therefore increase the available power. Refer to Section 6.1.1 for corrected air temperature for wind.

Whenever possible, set up and testing of the generator should be performed during periods of low wind, as these readings are generally more reliable than those using the wind speed corrections.

14 WIRING DIAGRAM PRE-OCT 2024

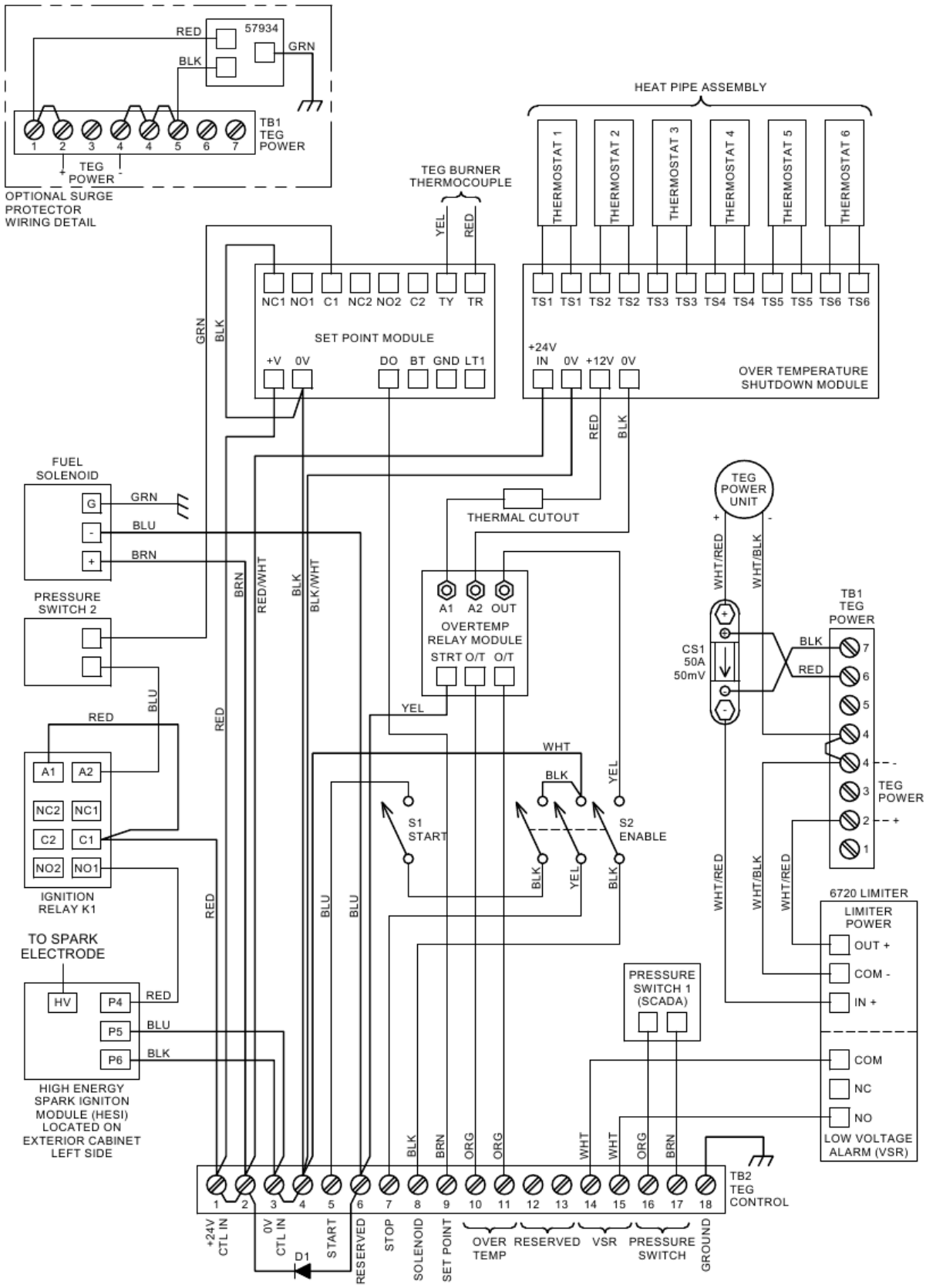


Figure 36 – Model 8550-RS TEG Wiring Diagram

15 WIRING DIAGRAM POST OCT-2024

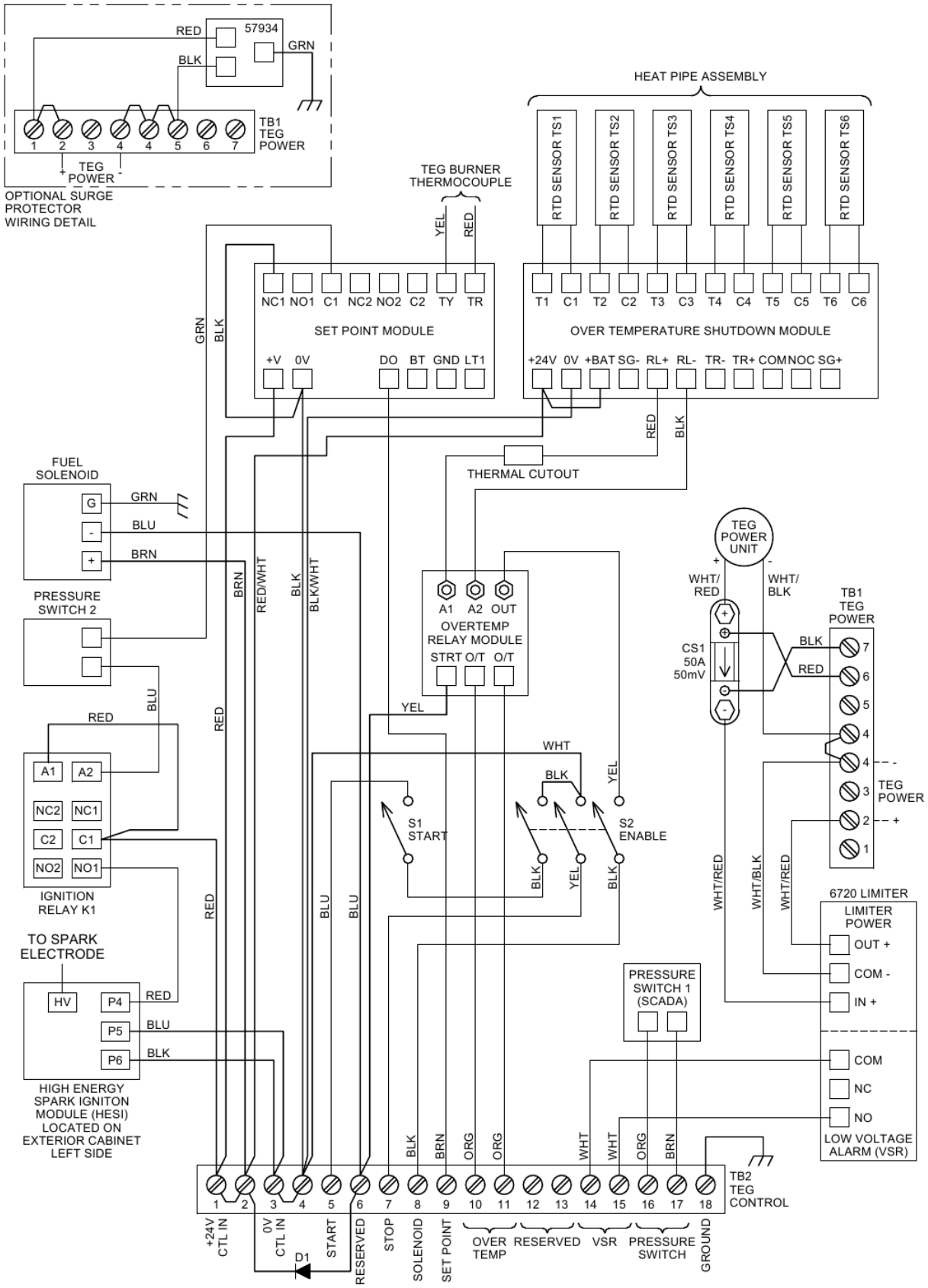


Figure 37 – 8550RS Wiring With 304676 OTSD Module

16 OTSD MODULE UPDATE POST-OCT 2024

As of October 2024, all new 8550 units come with a new Over Temperature Shutdown (OTSD) module and new RTD sensors that are compatible with each other. For these units, and units that are upgraded to the new OTSD/RTD Design, please refer to the sections below.

16.1 OTSD PRIMARY FUNCTIONS

The Over Temperature Shut Down (OTSD) module is designed to monitor the temperature of the six 8550 RTD sensors. If an over temperature condition is detected, the OTSD module will cut off fuel supply to the power unit, causing the system to shut down.

An overtemperature fault condition will be latched in non-volatile memory and will persist while the TEG is powered down. The OTSD module will not continue to supply fuel until the operator has manually cleared the over temperature fault by holding both the OP_SW1 and OP_SW2 switches for 5 seconds.

16.2 OTSD SECONDARY FUNCTIONS

In addition to the primary function, the OTSD module will also output the following information:

- The current temperature of each of the six RTDs
- The current internally measured temperature of the OTSD module
- Fault detection status for all 6 RTD sensors
- Over temperature warning alarm
- Over temperature fault alarm

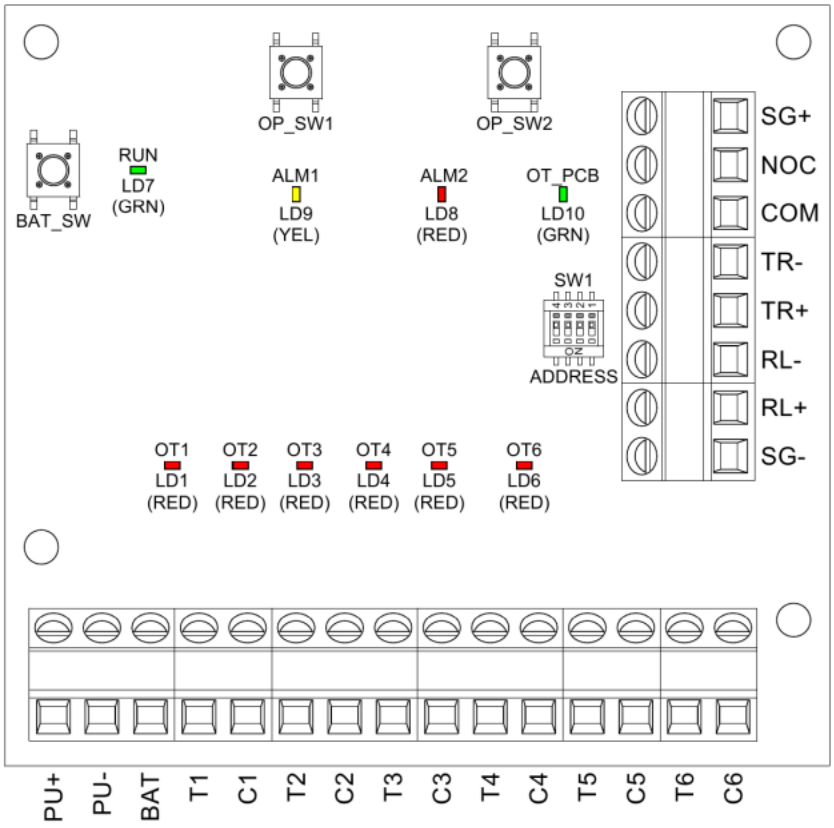


Figure 38 - OTSD P/N 304676 with interface labels and alarm Indicators

16.3 MODES OF OPERATION

The new 8550 OTSD can be operated in the following modes:

16.3.1 PU MODE

This is the normal mode of operation and will perform all the functions described in this section. The OTSD module will run in PU mode as soon as it detects at least 14.5Vdc at the PU power input. Once the module has initiated in PU mode, it will run until PU voltage drops below 9.5Vdc.

16.3.2 BATTERY MODE

The module can be temporarily powered using battery voltage by pressing the BAT_SW switch, this will allow for diagnosis and troubleshooting of an over temperature condition. When turned on in this way, the OTSD module will run for 60 seconds before turning itself off automatically (pressing any button will extend this timer by 30 seconds). The OTSD module will not enable the solenoid relay when in BATT mode. This mode is not required for the remote start 8550RS and can be ignored. If inadvertently activated, TEG starting will be inhibited until the function times out.

16.3.3 SIGNAL OUTPUT VOLTAGE (SIG)

The signal output voltage can be used to measure the temperature of the currently selected RTD channel or MCU temperature. This is done by taking a voltage measurement between the SIG+ and SIG- terminals located on the TM3 connector. This will produce a voltage between 0.025V and 3.28V where: T°C = (SIGV – 1) * 100.

Table 4 - Signal Output Voltage (SIG) and Corresponding Temperatures

Signal (V)	Temperature (°C)	Temperature (°F)
0.60	-40	-40
1.00	0	32
1.50	50	122
1.75	75	167
2.00	100	212
2.25	125	257
2.50	150	302
2.75	175	347
2.85	185	365
3.28	228	442

Note that a minimum or maximum voltage reading will also be measured in the case of an open or closed circuit RTD fault.

By default, the OTSD module will automatically cycle through each channel, at a rate of 5 seconds per channel. The channel select function can be switched to manual mode by pressing the OP_SW1 switch. Once in manual mode, channel selection will be done by pressing the OP_SW1 switch. To return the board to Auto select mode, hold the OP_SW1 switch for 2 seconds.

16.3.4 STATUS LEDS

The OTSD module uses status LEDs to communicate information to the user. The following is a legend of each LED meaning:

Run LED (Green)

The Run LED will flash at a rate of 1Hz, indicating that the board is on and working correctly.

ALM1 LED (Amber)

The ALM1 LED indicates an RTD fault and will flash quickly when one or more RTD channels has failed and is measuring outside the maximum temperature range of -65℃ to +265℃.

ALM2 (Red)

The ALM2 LED (Red) is used to indicate that an over temperature warning or fault condition has been detected on one or more of the RTD channels.

An overtemperature warning indicates a measured temperature between +165℃ and +185℃ and causes the ALM2 LED to flash at a rate of 4Hz.

An overtemperature Fault indicates a measured temperature above +185℃ and causes the ALM2 LED to turn on solid.

OT 1 – 6 LEDs (Red)

There are 7 over temperature (OT) LEDs located on the PCB. One for each RTD channel (OT1 - OT6, Red) as well as one for the internal measured temperature of the OTSD module MCU (OT_PCB, Green). These LEDs work in conjunction with the ALM1 and ALM2 LEDs and will be on solid to show which channels are responsible for the conditions listed above. These LEDs are also used to show which channel temperature is currently selected for the SIG output; respective OT LED will flash at a rate of 1Hz when that channel is selected.

The OT_PCB LED will turn on and flash at a rate of 4Hz when a board temperature greater than +85℃ is measured.

16.3.5 SCADA ALARM OUTPUT

When any alarm or fault condition is met, the OTSD module will pull the NOC output to ground (NPN Open Collector output). This output can be used to monitor fault conditions via a SCADA system or used to power other visual or audio indicators.

16.4 MODBUS COMMUNICATION

The OTSD module status information can also be monitored directly via serial Modbus 485 communication protocol, using the TR+, TR- and COM outputs located on the TM3 connector. Data can be called from read Input registers 0 – 9. Refer to the tables below for Modbus setup.

Table 5 - Signed 16 Bit Registers

Signed 16 Bit Registers		Value
REG #	NAME	X = 0.1°K
00	RTD Ch1 Temp	$°C=X/10-270$
01	RTD Ch2 Temp	
02	RTD Ch3 Temp	
03	RTD Ch4 Temp	
04	RTD Ch5 Temp	
05	RTD Ch6 Temp	

Table 6 - Binary 16 Bit Registers

Binary 16 Bit Registers		Bits															
REG #	Name	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
07	Sensor Faults	-	-	Ch 6 High	Ch 5 High	Ch 4 High	Ch 3 High	Ch 2 High	Ch 1 High	-	-	Ch 6 Low	Ch 5 Low	Ch 4 Low	Ch 3 Low	Ch 2 Low	Ch 1 Low
08	Temperature Warnings	-	-	-	-	-	-	-	-	-	-	Ch 6	Ch 5	Ch 4	Ch 3	Ch 2	Ch 1
09	Temperature Faults	-	-	-	-	-	-	-	-	-	-	Ch 6	Ch 5	Ch 4	Ch 3	Ch 2	Ch 1

Table 7 - Modbus Settings

Quantity	Value
Baud Rate	9600
Data Bits	8
Parity	None
Stop Bits	2

The OTSD module Modbus address can be set using Dipswitch SW1.

Address = (Dipswitch configuration, 0-15) + 112

The desired Modbus address should be set prior to starting the TEG since the address is only read on startup. Note that a board reset is required after changing the Modbus address. To safely perform the board reset for the remote start 8550, shut off 24VDC TEG control power from the remote start panel. For additional information, please reach out to customer service.

CAUTION!

Do not remove power to the OTSD module while the TEG is running, board damage may result.

FORMS AND LOGS

8550 Thermoelectric Generator Start-Up Data Sheet		
Model #:	Serial #:	Fuel Type:
Start-Up By:	Date:	
Ambient Temperature:	Ignition Fuel Pressure:	
Corrected Air Temperature:	Operating Fuel Pressure:	
Wind Speed:	Site Elevation	
Set Power at Corrected Temperature:	Corrected Fuel Pressure for Elevation:	

POWER LEVELS

Time		Burner Fuel Pressure	Voltage (V)	Current (A)	Power (W)
Start Time	*(Start)*				
	(15 minutes)				
	(30 minutes)				
	(40 minutes)				
	(50 minutes)				
	(60 minutes)				

Model 8550 TEG Performance Log

MODEL NO:	SERIAL NO:	FUEL TYPE:

Date	Time	Temperature (°C)	Wind Speed (km/h)	Corrected Temperature (°C)	Set Power (W)	Fuel Pressure (psi)	Voltage (V)	Current (A)	Power (W)	Remarks

Model 8550 TEG Performance Log

MODEL NO:	SERIAL NO:	FUEL TYPE:

Date	Time	Temperature (°C)	Wind Speed (km/h)	Corrected Temperature (°C)	Set Power (W)	Fuel Pressure (psi)	Voltage (V)	Current (A)	Power (W)	Remarks

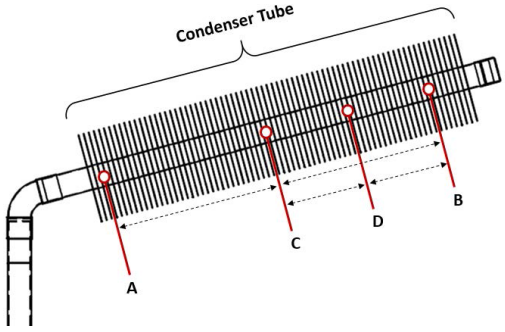
Heat Pipe Inspection Log

(Print a new copy for each inspection)

TEG Location:	Date:
Serial #:	Ambient Temperature:

Heat Pipe	Hand Inspection*	Detailed Inspection – see Section 3.5.2						
	Heat Pipe Status	Step 1			Step 2 (Only required as per Step 1)			
	P: Pass (No further inspection required) **F: Fail** (Proceed to Detailed Inspection)	T_A	T_B	$T_A - T_B$ If >20°C (36°F), Step 2 <20°C (36°F), Good	T_C	T_D	$T_A - T_C$ >20°C (36°F), Replace	$T_C - T_D$
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

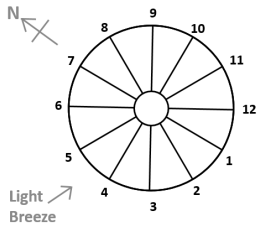
*Hand temperature inspection of Model 8550 TEG heat pipes is done to check that the heat pipe is warm, up to 2 inches (50 mm) from the tip.
If the inspection satisfies the hand inspection as per Section 3.5.1, the detailed inspection described in Section 3.5.2 is not required.

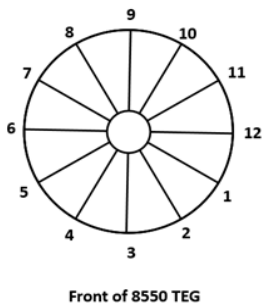


Heat Pipe Geographic Orientation Map and Wind Direction Diagram

(Record the wind direction and geographic orientation of the TEG.

Example:





Notes:

Wind speed and direction:
(e.g., "light breeze from the west")