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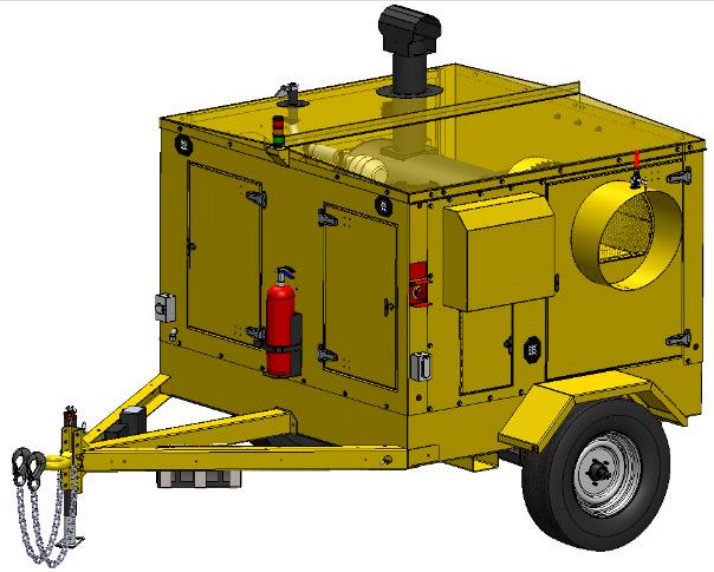

OPERATORS MANUAL

GENERATOR WITH INDIRECT OIL FIRED FORCED AIR HEATER

MODEL
ES500

SPECIFICATIONS

Dry weight:		2540 LB [1270 KG]
Wet weight:		3200 LB [1588 KG]
Firing Rate:		3.25 GPH [12.3 LPH]
Fuel Type:		ULSD
Fuel Storage:	Capacity	82 GAL [310 L]
	Secondary containment	200%
Heater:	Max burner rating	390,000 BTU/HR
	Heat exch. material	304 Stainless
	Burner	Riello 40 F10
	Fan motor	¾ hp, 120V
	Fan capacity	2500 CFM @ 1/2 in. wg
Generator:	Engine	Kubota D1105
	Generator	Mecc Alte
	Engine continuous power	8 kW
	Main breaker rating	50A
	Voltage	120V
	Aux power	20A, 120V, 60Hz

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1 Introduction

⚠WARNING Read and understand this manual before operating the machine to avoid serious injury or death.

1.1 General Description

The ES500 is a portable diesel engine generator set with one auxiliary indirect-fired forced-air heater that has a maximum firing rate of approximately 390,000 BTUs/hour. The heater system is intended for outdoor use and is trailer mounted for jobsite portability. The heater has an integrated 82-gallon [310 L] fuel storage tank with secondary containment. The heater is designed to operate reliably at extremely low temperatures and has been proven on Alaska's North Slope oil fields and in northern Canada. Large doors allow easy and safe service access in industrial environments. All heat exchanger surfaces are constructed from stainless steel for extended life.

1.2 Manual Applicability

This manual is applicable to the following Equipment Source Incorporated (ESI) machine models:

Model	ESI No.	Description
ES500	102638	Single heater trailer system

This manual should be kept with the machine at all times. Immediately contact Equipment Source Incorporated (manufacture) or an authorize dealer to obtain a copy of this manual if missing or damaged. Refer to www.equipmentsourceinc.com for current contact information.

1.3 Manual Scope

This manual contains basic operating and maintenance instructions for the above listed product(s). Specific information concerning trailers, skid frames or other transport provisions are not included in this manual. Refer to the manual provided with the transport accessory. For detailed service instructions concerning specific electrical or mechanical components, refer to the operation and maintenance manual provided by the manufacture of the component or contact an authorized service provider.

1.4 Language Translations

Only English translations of the operator's manual are available at this time. Contact Equipment Source or your authorized dealer to obtain a copy of either manual edition. Other translations may be available on request.

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2 IMPORTANT SAFETY INSTRUCTIONS

⚠WARNING

- Never attempt to operate this machine indoors. Exhaust fumes from the engine and heater can kill.
- SAVE THESE INSTRUCTIONS. This manual contains important instructions that should be followed during the operation and maintenance of the generator, battery and heater.

2.1 Training

- Never allow untrained personnel to operate or service the machine. Take time to read the manual and discuss safe practices with jobsite personnel.
- Read and understand the operating section of this manual.
- Take time to familiarize yourself with the controls and instructional placards before operating or servicing.
- Contact your dealer or rental service provider if additional training is necessary.

2.2 Operating

- Some components are hot while in operation. Keep children, clothing and combustibles away.
- Wear protective clothing appropriate to the jobsite.
- Observe changes in the operating environment and respond accordingly.
- The frame of the machine shall be connected to an approved grounding electrode according to local state or provincial codes.
- Generators vibrate in normal use. During and after the use of the generator, inspect the generator as well as extension cords and power supply cords connected to it for damage resulting from vibration. Have damaged items repaired or replaced as necessary. Do not use plugs or cords that show signs of damage such as broken or cracked insulation or damaged blades.

2.3 Service

- Only trained service technicians should attempt to service the machine.
- Properly shutdown the machine and let cool completely before attempting to service any component.
- Never defeat the safety devices
- Never modify the machine

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3 Transporting and Storage

3.1 Dimensions and Weights

Machine Weights *:	Dry	2540 LB [1153 KG]
	Wet 102638	3200 [1452]
	Trailer 102638 Max GVW	3300 [1497]
	Trailer 102638 Max Tongue	330 [150]

*All weights are approximate

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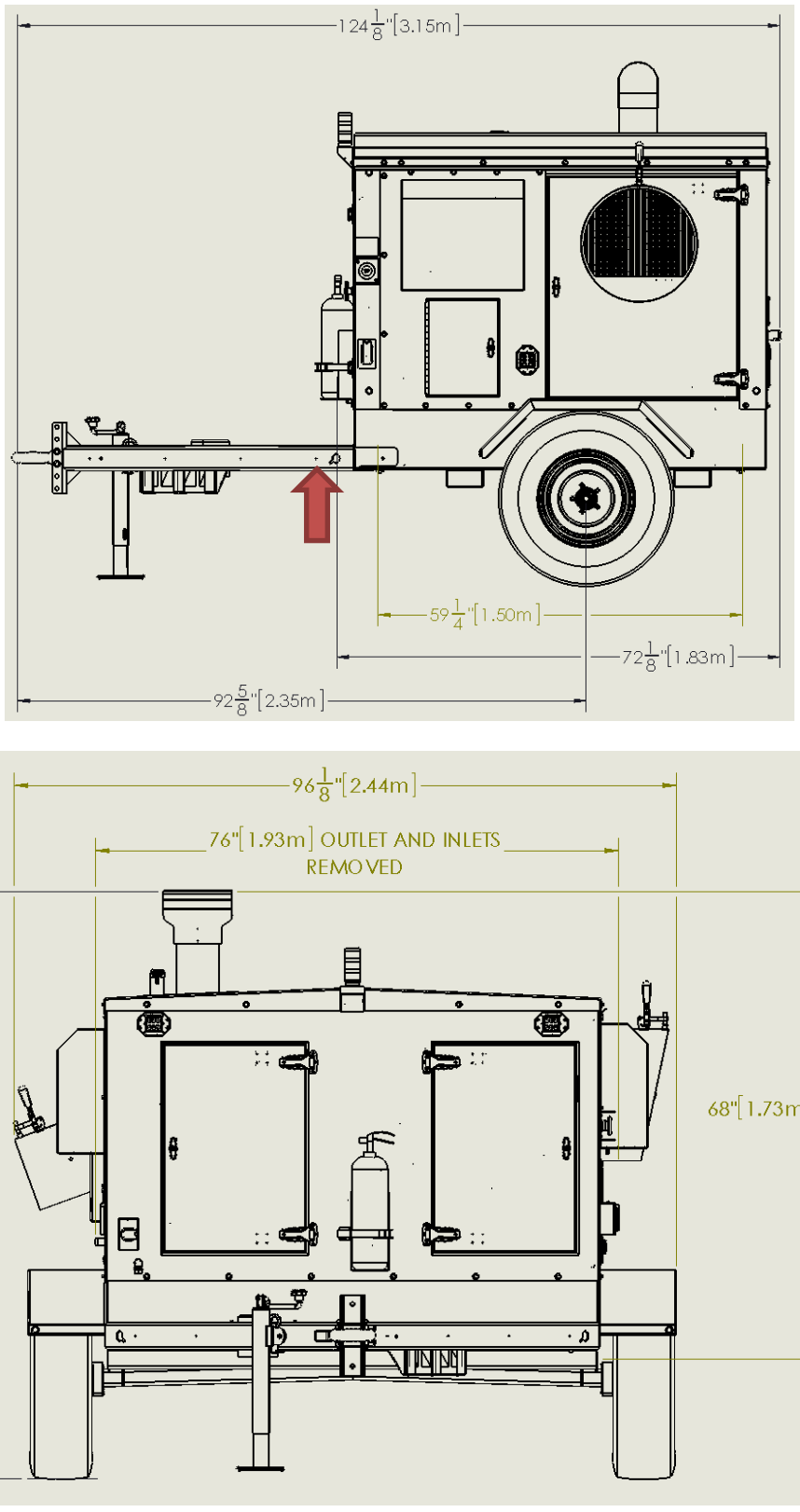

Figure 1. Machine dimensions PN 102638. Red arrow denotes grounding lug location.

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3.2 Lifting

- Use a forklift to lift the machine using the optional (shown) fork pockets **(C)**.

3.3 Transporting on a Flatbed Truck

1. Lift the machine following the guidelines presented in Section 3.2 *Lifting.*
2. Fully retract and pivot the trailer jack stand **(A)** before securing on a flatbed trailer. The trailer can be tilted to rest directly on the hitch. Maximum packing efficiency can be obtained by sliding the tongue of one trailer under the back of another trailer.
3. The chain slot tie-downs **(B)** and the axle are permissible tie down points.
4. Ensure all doors are closed and locked.

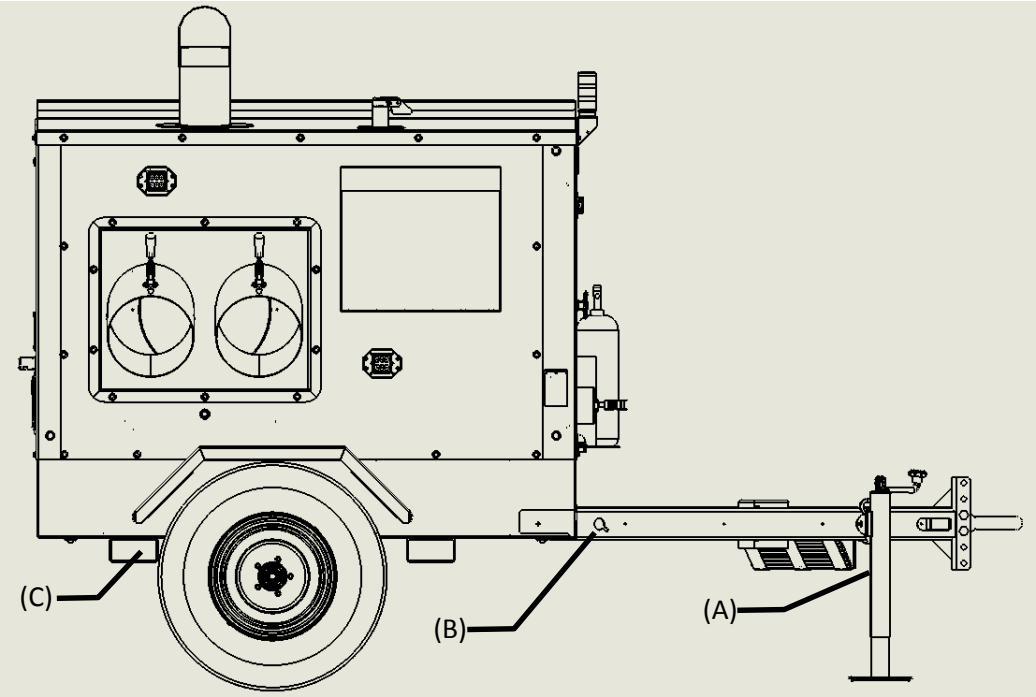

Figure 1. Machine tie-downs and lifting bails

3.4 Transporting by towing

⚠CAUTION The transport vehicle and hitch adapters must be rated to tow a trailer GVW of 3300 LB (1497 KG) minimum.

NOTICE Ensure that the trailer is registered with an applicable transport authority before towing. ES500 fuel tank is not DOT rated to carry fuel while being transported. Therefore it must be emptied of fuel before transportation.

Use the following procedure to prepare the machine for towing:

1. Connect trailer to the vehicle and secure hitch. The trailer should be nearly parallel to the ground; use the adjustable lunette ring or change the vehicle's hitch to level if necessary.
2. Connect trailer lights and safety chains. Always check trailer lights for proper operation.
3. Lock doors. This prevents them from inadvertently opening during transport.
4. Walk around the machine to check for wheel chocks, verify tire pressure and ensure the jack stand is fully retracted.

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3.5 Storage

NOTICE Failure to follow the shutdown procedure can cause serious damage to the burner assembly.

3.5.1 Short-Term Storage (less than 90 days)

1. Shutdown the machine using the shutdown procedure (Section 4.11 *Shutdown*)
2. Verify that main breaker and control switches are in the off position
3. Close and latch doors, stow loose accessories
4. Chock tires

3.5.2 Long-Term Storage (greater than 90 days)

1. Shutdown the machine using the shutdown procedure (Section 4.11 *Shutdown*)
2. Verify that the main breaker and control switches are in the off position
3. Disconnect the battery using the master disconnect switch
4. Drain water from fuel filters
5. After the heater has cooled sufficiently, cover the chimney with a durable material to prevent animal intrusion.
6. Ensure the machine is positioned on thaw-stable ground if applicable. Add blocks to support the tongue as necessary.
7. Chock tires

3.6 Preparing the Machine for Seasonal Operation

Follow this procedure to prepare the machine for seasonal operation or any time the machine is removed from long-term storage:

1. Remove any protective coverings from the exhaust outlets
2. Clean the inside of the enclosure to remove any debris
3. Check containment for accumulation of liquids
4. Replace the burner nozzle
5. Inspect electrical system and controls for damage
6. Inspect fuel system for wear or damage
7. Repack wheel bearings
8. Replace fuel filters
9. Verify burner electrode position
10. Verify fuel pump pressure
11. Verify combustion quality
12. Check all lights and replace as necessary
13. Check tire pressure (if applicable)
14. Run heater for 1 hour to verify operation of all components

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4 Operation

⚠WARNING Always install a CO gas monitor in enclosed environments that are heated with oil burning forced air heaters.

NOTICE Failure to follow the shutdown procedure can cause serious damage to the burner assembly.

Figure 2. ES500 Controls

4.1 Duct Selection

4.1.1 General Guidelines

The ES500 heater is an outdoor heater designed to safely heat enclosures using flexible duct connections. For efficient operation, keep duct lengths as short as possible. Excessive duct lengths will reduce air flow in the heat exchanger and cause the burner to cycle to control the outlet temperature. Excessive burner cycling shortens the life of the heat exchanger and should be avoided. Burner cycling can be controlled by reducing duct length, increasing the duct diameter, or adjusting the burn rate or temperature feeler gauge (see Appendix A).

An inlet duct is not required for normal operation. It can be used to circulate warm air back from an enclosure for re-heating.

4.1.2 Duct Sizes

Minimum inlet duct size (inches) 20

Minimum outlet duct size 10

Available outlet duct sizes 2x10.8, 1x16, 1x20

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4.2 Recommended Fuels and Fueling Instructions

⚠CAUTION Do not overfill tank. Tank should be filled to only 90% of the full volume to allow thermal expansion.

Use ULSD No.1 or ULSD No.2. For continuous duty operation, a daily refilling schedule should be established. The yellow beacon light (see section 4.7) will turn on if the fuel level goes below 20%.

4.3 Access and Clearance

Ensure all sides of the machine are easily accessible. All parts of the machine should be more than 3ft [1m] from any structure. Heater is correctly placed when the operator can walk around the perimeter of the heater with minimal obstruction. Check the placement and accessibility of the fire extinguisher.

4.4 Leveling

Ensure machine is placed on firm ground and the wheels are chocked. Heater should be close to level across the width (±3°). The machine should be slightly lower in the front (generator end). It is important that the heater run out of fuel before the generator to prevent overheating the heater. Use the tongue jack to level the heater and then lower the tongue jack 1 to 2 inches (2.5 to 5cm).

If the machine is placed on frozen ground or ice, frequently check for shifting and reposition/level as necessary.

4.5 Chassis Ground

The machine is equipped with a chassis ground terminal located on the right side of the trailer tongue (refer to red arrow on Fig. 1). The ground terminal is provided for field grounding the machine in accordance with applicable state or provincial codes.

4.6 Engine Heat - 120V Power Input

When operating the machine in cold weather, use the 120V engine pre-heat circuit to warm the engine block and engine oil prior to starting. The engine should be pre-heated for approximately 4-hours if the ambient temperature is below -7 C (20 F). Longer preheat cycles may become necessary in extremely cold conditions.

Use a grounded flexible extension cord rated at 15A minimum to connect the machine to a 120V power supply. The electrical inlet box is located on the exterior of the machine to the bottom-left side of the battery/engine access door.

4.7 Beacon Light

The ES500 is equipped with a three beacon light that indicates the status of the heater. The green light turns on whenever the engine is running. The yellow light turns on whenever the fuel level dips below 20%. The red light turns off whenever the burner exhaust exceeds 250 degrees Fahrenheit. In order for the beacon light to work properly, both the battery disconnect and beacon light switch must be turned on.

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4.8 Pre-Startup Checklist

Use the following checklist to determine whether the machine can be safely started and operated:

1. **Machine is level and on stable ground (per Section 4.4)**
2. **Wheels are chocked**
3. **Exhaust vents are free of obstruction**
4. **3ft [1m] clearance from permanent structures on all sides**
5. **Fire extinguisher is accessible**
6. **Water is drained from fuel filters**
7. **Engine oil and coolant levels normal**
8. **Fuel tank filled with recommended fuel type**
9. **Inlet and outlet ducts are free of obstruction**
10. **Machine safeguards are connected and functioning**

4.9 Startup

Use the following checklist to start and operate the machine. Open the door labeled “Machine Controls” to access all required controls.

1. **Turn off the Master Disconnect Breaker and the Burner Control Switch**
2. **Turn DC disconnect switch to “On”**
3. **Push “Auto” button**
4. **Push “Manual Start” button**
5. **Let generator engine warm for at least 1 minute**
6. **Turn on Master Disconnect Breaker**
7. **Switch the heater control switch to “Manual” or “Thermostat”.**

- **If using Thermostat mode, unit must be started in Thermostat position.**
- **When changing between manual and thermostat operation, the heater changed must be left in the “OFF” position for 30 seconds to prevent the burner from locking out.**

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4.10 Monitoring and Operation

4.10.1 Daily Inspection

- Listen for abnormal sounds
- Check fluid levels
- Check containment for accumulation of liquids. Drain water if necessary.
- Observe burn quality (no smoke should be visible)
- Check if level and secure
- Check vents for icing or other obstructions
- Check fire extinguisher access.
- Observe recommended maintenance schedule

4.10.2 Adjusting Heat Output

- The red beacon light will turn off once the burner exhaust output exceeds 250 degrees Fahrenheit. See the burner maintenance section if the light does not go off.
- Connect an external thermostat (see wiring diagram) to control building heat.
- Increase the outlet temperature by constricting the outlet airflow. The outlet temperature is limited to 250F and undesirable burner cycling will occur if the ducts are excessively restricted. Increasing the outlet temperature by reducing the air flow will never increase the heat output.
- See FVOHC-400 manual in Appendix A for further heater control information

4.11 Shutdown

NOTICE Failure to follow the shutdown procedure can cause serious damage to the burner assembly.

Shutdown procedure:

1. **Shutdown burner by moving the control switch to the “OFF” position**
2. **Let the generator and fan run for 5 minutes**
3. **Turn off generator**

4.12 Combustion Air and Burner Adjustments

Proper adjustment of the burner and temperature feeler gauge is important to maximize performance and heater life. The heaters are factory set for supply air colder than 23 °F (-5 °C). For extreme low temperatures and higher temperatures see pages 9-11 of the Flagro FVO-400 heater manual for detailed instructions.

4.13 Auxiliary Power Connection

All machine models are equipped with a 120V, 20A, 60Hz auxiliary (AUX) GFCI receptacle. The AUX power connection can be used to run work lights and tools as needed on a construction site while the heater is operating. The primary purpose of this product is not a jobsite generator; avoid using the AUX power connection for extended periods while the heater is not operating to prevent under-loading or “wet stacking” the engine.

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5 Maintenance

⚠CAUTION Some of the following maintenance operations should only be completed by a trained technician. Do not attempt to open electrical panels or service the burner unless you are a trained technician.

5.1 Maintenance Schedule

Table 1. Maintenance Schedule

Interval (Hours)	Maintenance Instruction	Notes
Daily *Weekly	▪ Check primary fuel filters for water and drain as necessary	▪ Applies to both burner and engine filters ▪ Replace burner filter* FVO-418
Every 200 hours Or 12 months	▪ Change oil and oil filter	▪ Engine Oil: SAE30, SAE10W-30 or 15-40 Must be API Spec: CF, CF-4, CG-4, CH-4 or CI-4 ▪ Oil Capacity: 1.35 GAL [5.1 L]
Every 1000 hours Or 12 months	▪ Change all fuel filters ▪ Check air filter ▪ Check engine fan belt	▪ Use Racor R60S Primary Filter ▪ Check air filter every 500 hours if operating in a dusty environment
Every 3000 hours Or 12 months	▪ Change oil and oil filters ▪ Change Fuel Filters ▪ Change engine fan belt ▪ Replace burner nozzle and adjust electrodes ▪ Service trailer	▪ Engine oil: SAE30, SAE10W-30 or 15-40 Engine oil must meet API Spec: CF, CF-4, CG-4, CH-4 or CI-4 ▪ Oil Capacity: 1.35 GAL [5.1 L] ▪ Use Racor R60S filters for engine, FVO-418 for burners
Every 6000 hours Or 3 years	▪ Change coolant	▪ Use Rottella ELC or equivalent
Every 9000 hours	▪ Injection pump service ▪ Valve clearance service	▪ Contact Kubota service rep. for valve and fuel injection service

5.2 Engine Service

Use engine operator's or service manual provided for further instruction on how to complete routine service or trouble shooting.

5.3 Cleaning/Deicing Inlet Screen

⚠WARNING Do not attempt to open blower inlet access unless the machine is completely shut down and cooled. Observe all lockout/tagout safety directives specific to the jobsite

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The fan inlet should be periodically checked for icing when operated in winter conditions. If necessary, open both doors to access inlets to clear ice. Do not attempt to open the access doors unless the heaters are shutdown using the shutdown procedure.

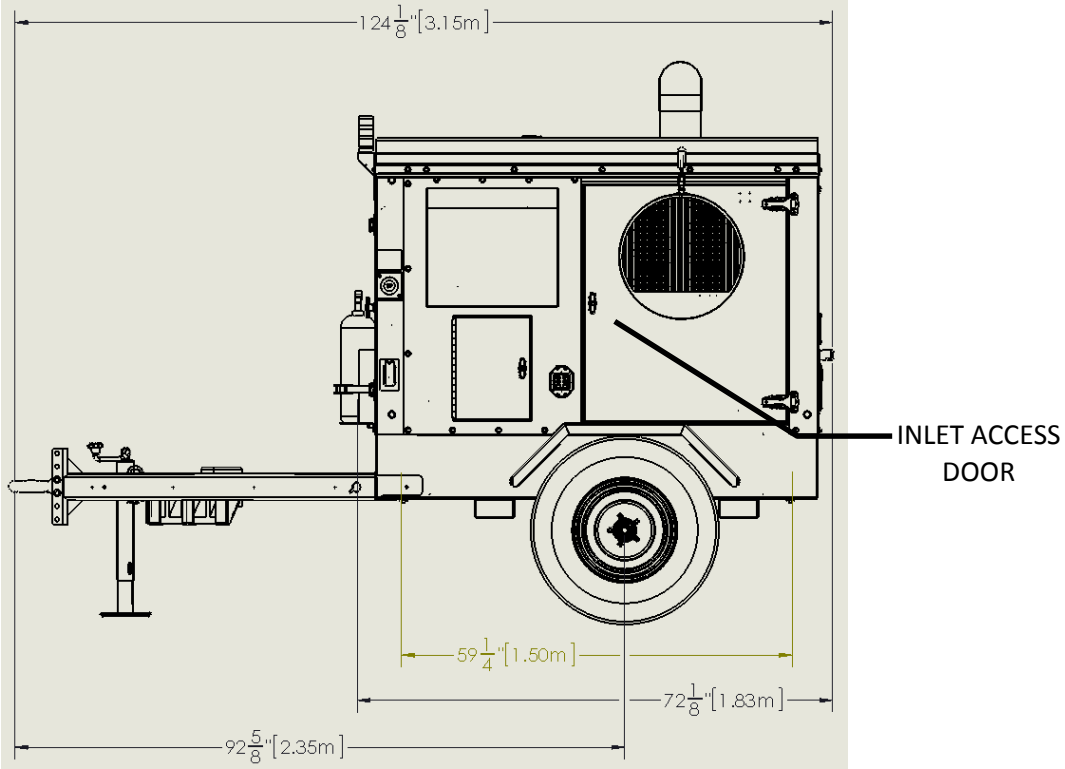

Figure 3. Heater Inlet Access

5.4 Burner Maintenance

Refer to the FV0HC-400 Instruction Manual for further instruction on how to complete routine service or trouble shooting. Only qualified technicians should attempt to service the burner.

5.5 Battery Service

The engine starting circuit is supplied by a single 12V battery. The battery is located in the engine compartment near the generator. The machine is factory equipped with an Optima Redtop 75/25 battery or equivalent. No maintenance is required other than normal charging and occasional replacement.

To replace the battery, sequentially remove the negative ground lead, positive power lead and the bracket holding the battery in the tray. Replace the battery by securing in the tray, connecting the positive lead and then connecting the ground lead.

5.6 Trailer Service

5.6.1 General inspection guidelines

A general inspection of the trailer should be completed every 6 months or whenever the machine in a service center.

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- Check tire pressure
- Test brake lights, turn signals and marker lights
- Test the breakaway battery and charge if necessary
- Check condition of the safety chains and jack stand
- Check tire condition and tightness of lug nuts

5.6.2 Tire and Wheel Service

New tire and wheel combinations must have a minimum load rating of 1650 LB each [749 KG] for a combined load capacity of 3300 LB [1497 KG]. New machines are shipped with ST205/75 D15 tires. Fill tires to the maximum rated pressure indicated on the tire sidewall. Torque lug nuts to 150 ft-lb [200 N-m].

5.6.3 Wheel Bearing and Brake Service

Service wheel bearings and brakes every 12 to 24 months. This can be completed at any qualified trailer service center.

5.7 Spark Arrestor Service

The spark arrestor is located on top of the enclosure at the end of the engine exhaust system. It does not have to be removed for service. The spark arrestor should be cleaned after every 3000 hours of normal operation. Replacement of the spark arrestor is not required for normal service. Replace only if visibly damaged or missing.

5.7.1 Spark Arrestor Cleaning Procedure:

- Remove the metal band around the body of the spark arrestor to expose the cleaning port
- Use a powerful shop vacuum to remove debris collected in the spark arrestor body.
- Replace the metal band and resume normal operation

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6 Basic Trouble Shooting

⚠CAUTION Some of the following maintenance operations should only be completed by a trained technician. Do not attempt to open electrical panels or service the burner unless you are a trained technician.

Use the following troubleshooting guidelines to resolve problems that may encountered while operating the ES500 heater. Contact your service representative or refer to the attached operations manual specific to the burner, engine or fan if the problem cannot be resolved using this guide.

6.1 Burner Trouble Shooting

⚠WARNING Never defeat the burner safeties such as the thermostats.

NOTICE Failure to follow the shutdown procedure can cause serious damage to the burner assemblies.

The heater in the ES500 uses Riello 40 F10 burner. There are two internal thermostats (limit switches) on the heater, that control it, and two external (panel mounted) limit switches. If the enclosure cabinet gets too hot, the panel mounted thermostat (A) will shut the heater off. This switch automatically resets itself. It is recommended that the cause of overheating be investigated if it engages and resets at an abnormal rate.

Figure 4. Rear of control panel (inside enclosure). Enclosure over-temp thermostat (A) and enclosure cooling fan thermostat (B)

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Table 2. Burner Safeties/Controls

Safety	Purpose
Heat exchanger over temperature *See FVOHC-400 manual for location and wiring diagram.*	Air blockage safety: shuts down burner if the heat exchanger working air temperature exceeds 290F [143C].
(A) Enclosure over temperature ***NOTE: This safety must be manually reset.***	Shuts down burner if the enclosure air temperature exceeds 120F [50C]

Table 3. Burner Trouble Shooting Guide

Problem	Solution
Burner cycling or outlet temperature is not hot enough (frequently starting and stopping during normal operation)	▪ Check for flow restrictions in the inlet or outlet ducts ▪ Reduce duct lengths or increase duct diameters ▪ Check temperature feeler gauge adjustment. See FVOHC-400 manual page 10-11
Red LED is on	▪ Reverse polarity in wiring
Both Red and Green LED are on	▪ Try pressing the reset button on the burner
Red LED is blinking	▪ Ground or neutral issue
Outlet temperature is too hot (above 250 °F)	▪ Check high limit switch at the outlet. See FVOHC-400 manual for details.

6.2 Fan Trouble Shooting

Table 4. Fan Trouble Shooting Guide

Problem	Solution
Fan motor does not shut off after heat exchanger has cooled down	▪ Check fan limit switch. See FVOHC-400 manual for details.
Fan motor won't start	▪ Check reset button on back of fan motor

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6.3 Generator Engine Trouble Shooting

Table 5. Engine Trouble Shooting Guide

Problem	Solution
Engine controller fails (no low oil pressure light when the key switch is turned to position I)	▪ Check position of battery main disconnect ▪ Check condition of battery ▪ Reset 30A breaker on controller panel. If repeatedly tripping, refer to 12V electrical schematics and check for a ground fault ▪ Check 40A fuse near the starter terminal. Replace if necessary, and check for ground fault if repeatedly failing.
Starter fails to engage Note: Engine preheat (glow plug) timer prevents engagement of starter until the 15 second cycle is complete	▪ Check if engine controller is functioning (see “Engine controller fails”) ▪ Check condition of battery
Starter engages, but engine fails to start	▪ Check fuel level ▪ There may be air in the fuel line if the engine previously ran out of fuel. Bleed the air out by slightly loosening the injector lines while cranking the engine. Make sure to re-tighten the fuel line to injector connection! ▪ Check for water in fuel and drain completely if present. ▪ Check electric fuel pump. The pump should audibly engage when the controller tries to start the engine. ▪ If cold (less than 0F [-18C]), the engine block/oil pan heater should be plugged in for 4-hours prior to starting. ▪ Check engine preheat (glow plug) circuit. Circuit should draw 15-25A for 15 seconds during the controllers preheat sequence. ▪ Check power supply to fuel solenoid on the engine fuel pump
Engine stops after 20 seconds	▪ Check engine oil pressure switch ▪ Extreme cold may cause the engine oil pressure switch to temporarily malfunction. Plug in engine block/oil pan heater for at least 4-hours if temperature is lower than 0F [-18C]. ▪ Check indicator lights for high temperature alarm. Check sensor for ground fault if the sensor is active when the engine is cold.

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Engine fails from over temp sensor	▪ Check 12V cooling fan for correct operation. See below "12V cooling fan failed" if fan has failed. ▪ Check coolant level. CAUTION! Wait until engine has cooled completely before opening the radiator cap. ▪ Check coolant condition ▪ Check fan belt ▪ Check sensor for ground fault
12V cooling fan failed (Fan fails to engage when the enclosure temperature is over 70F [20C])	▪ If the engine controller is functioning, check 30A auto-reset breaker that's inside the engine control panel enclosure. ▪ If the engine controller fails to activate, see "Engine controller fails" ▪ Check fan thermostat circuit ▪ The fan should draw approximately 17-20A if operating correctly. ▪ Check/replace the 40A Bosch style exhaust fan relay (see ES500/1000 wiring schematic) in the engine control panel. ▪ Replace fan

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7 Electrical Schematics

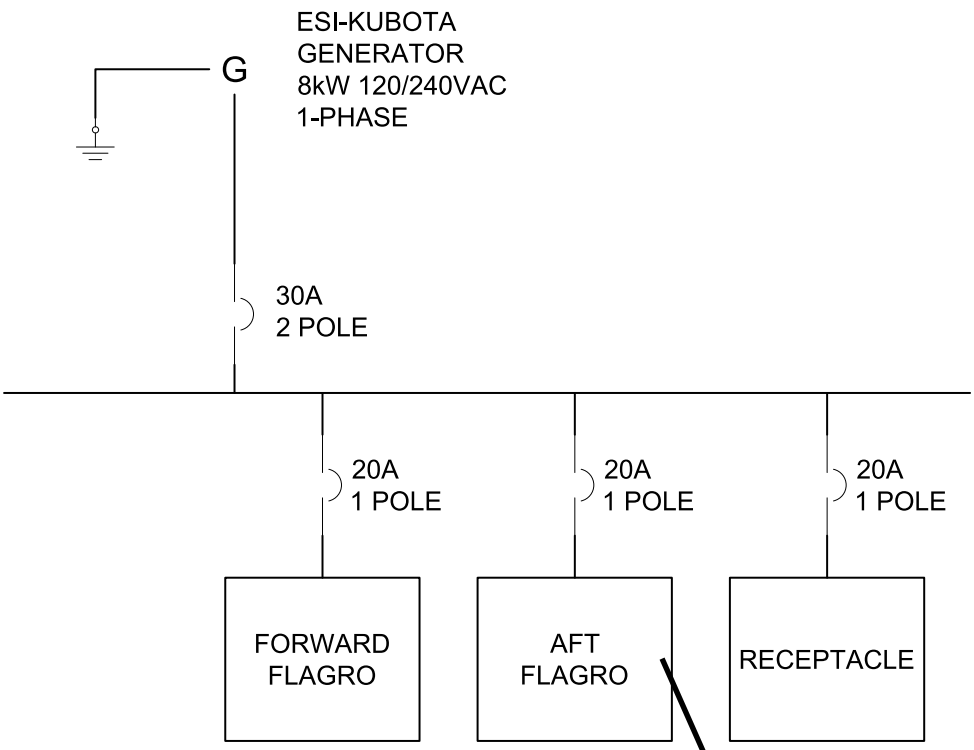

Figure 5. ES500/1000 Generator Wiring

This 20A breaker is only wired to the aft Flagro on the ES1000. Nothing is wired to it on the ES500, since the heater only has one Flagro.

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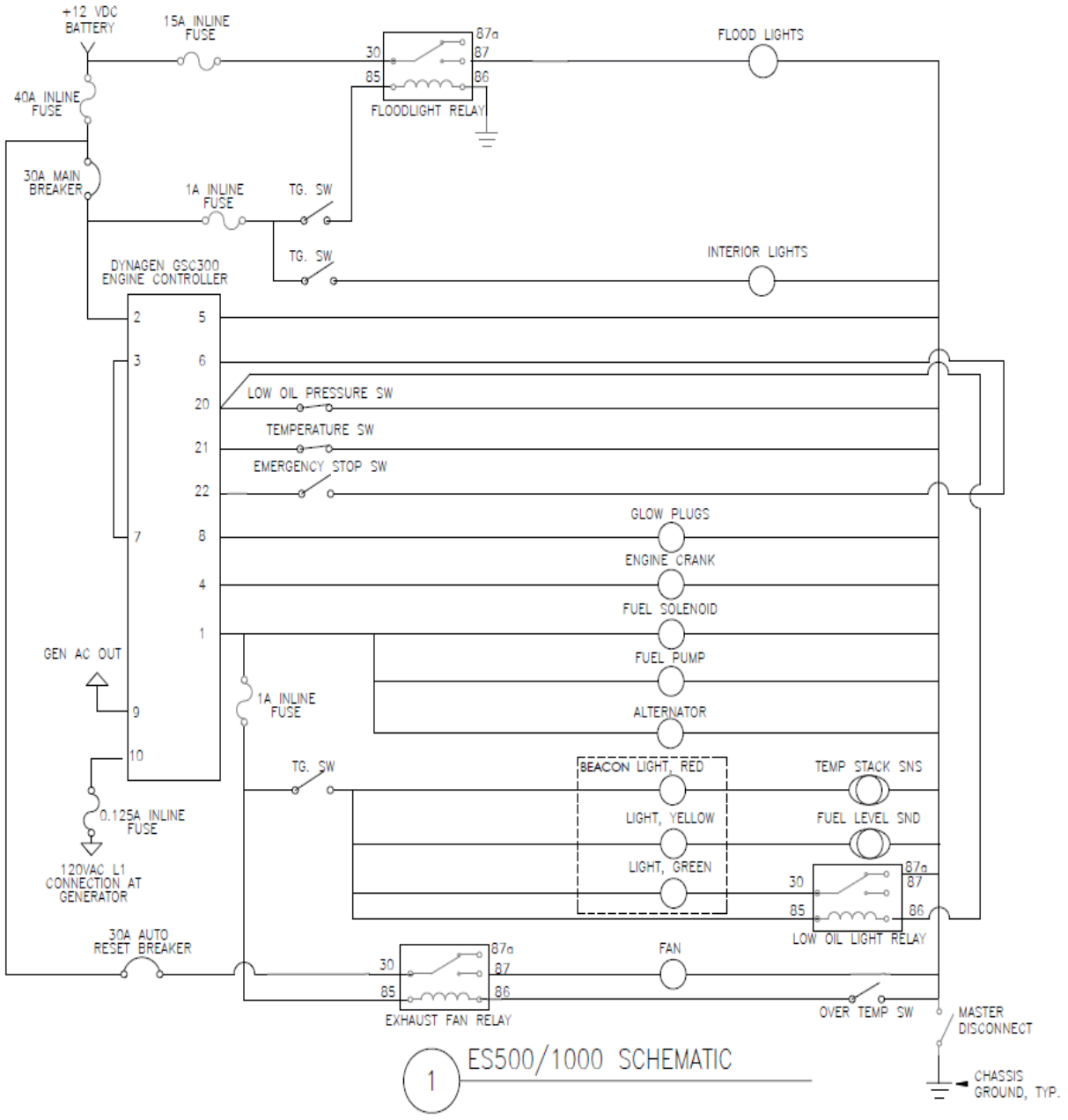

Figure 6. 12V Engine Control Schematic

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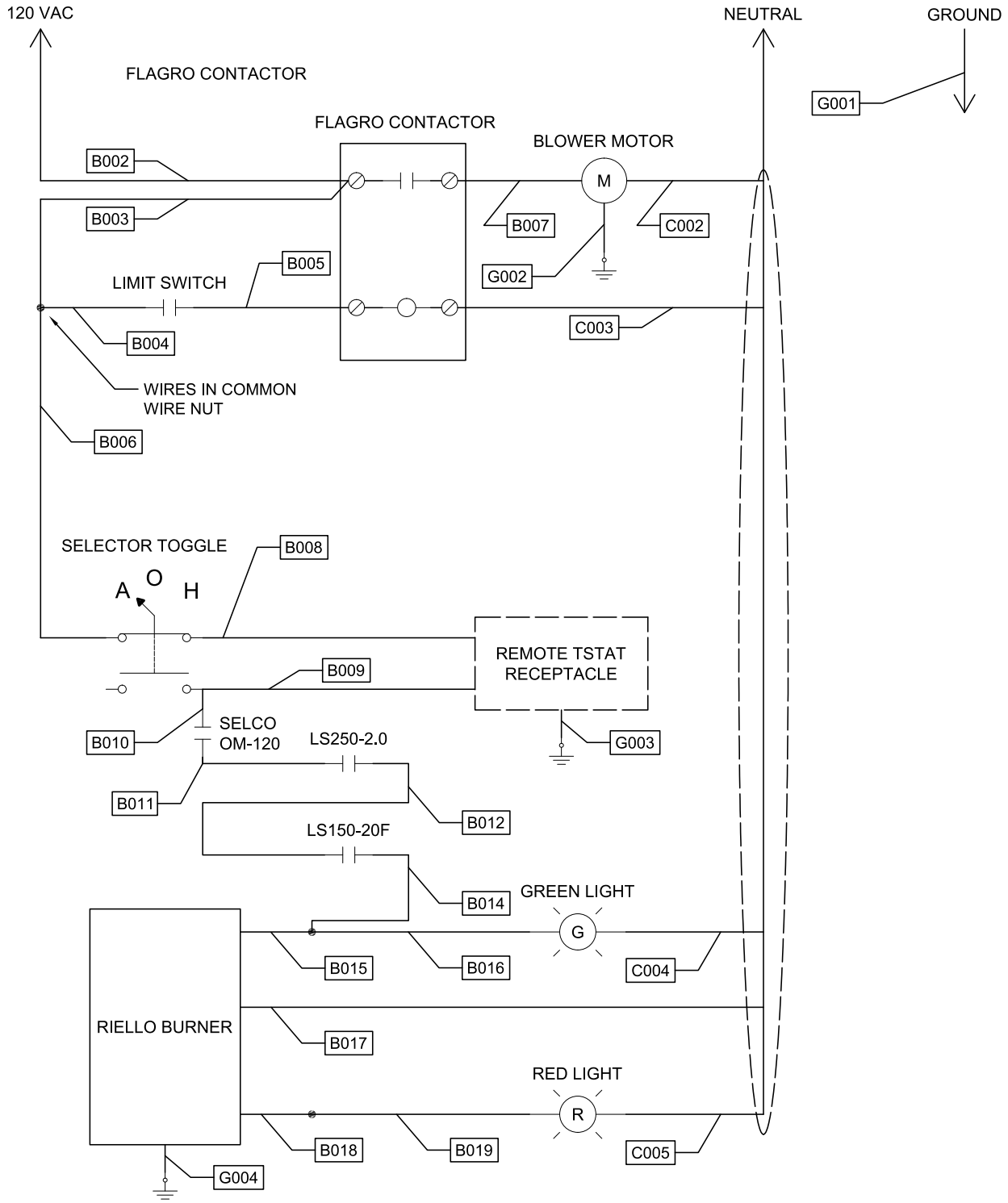

Figure 7. Heater Wiring Diagram

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8 Maintenance Records

Table 6. Machine Data

Machine Serial Number	
Engine Serial Number	
Generator Serial Number	
Trailer Serial Number	

Table 7. Maintenance Records

▪ Date ▪ Engine Hours ▪ Service Personnel ▪ Service Location	**Description of work completed**

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9 Appendix A

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OPERATING INSTRUCTIONS MANUAL

(Please retain for future reference)

For

FVO-400 INDIRECT FIRED SPACE HEATERS

CERTIFIED FOR USE IN CANADA AND U.S.A.
As per CSA B140.8 Portable Oil Fired Heaters / CSA B140.02003 Oil Burning Equipment Construction Heaters Unattended Type.

Issue date October 1, 2008

FLAGRO INDUSTRIES LIMITED
ST. CATHARINES, ONTARIO
CANADA

Appendix item 1. Flagro (FVO-400) indirect fired space heater manual front page

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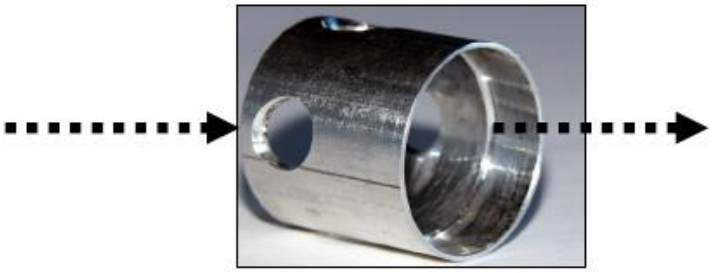
TEMPERATURE FEELER GAUGE ADJUSTMENT
(ATTACHED TO FAN SWITCH)

The temperature feeler gauge is required to be always touching the heater exchanger.

The temperature feeler gauge controls the air flow over the fan switch, which eliminates any unnecessary fan cycling. The temperature feeler gauge can be adjusted for different outside temperatures, by rotating the location of the temperature feeler gauge holes. This will provide maximum performance of the unit in different applications.

If supply air is warm (-5º C, indoor application):

Turn the temperature feeler gauge so that the holes are parallel with the heat exchanger. This will help the fan switch to remain cool and not overheat. See following:



If supply air is cold (under -5ºC):

Turn the temperature feeler gauge so that the holes are closed off as the air goes over the heat exchanger. This will reduce fan cycling and the unit from shutting down. See following:

In extreme cold conditions, cover the holes on the temperature feeler gauge using foil tape. Ensure that the temperature feeler gauge is readjusted for warmer weather conditions. Failure to do so may result in burning out fan switches- not covered under warranty.

Appendix item 2. Temperature feeler gauge adjustment instructions from FVO-400 manual

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OPERATING INSTRUCTIONS MANUAL

(Please retain for future reference)

For

FVO-400 INDIRECT FIRED SPACE HEATERS

CERTIFIED FOR USE IN CANADA AND U.S.A.
As per CSA B140.8 Portable Oil Fired Heaters / CSA B140.02003 Oil Burning Equipment Construction Heaters Unattended Type.

Issue date October 1, 2008

FLAGRO INDUSTRIES LIMITED
ST. CATHARINES, ONTARIO
CANADA

GENERAL HAZARD WARNING:

FAILURE TO COMPLY WITH THE PRECAUTIONS AND INSTRUCTIONS PROVIDED WITH THIS HEATER, CAN RESULT IN DEATH, SERIOUS BODILY INJURY AND PROPERTY LOSS OR DAMAGE FROM HAZARDS OF FIRE, EXPLOSION, BURN, ASPHYXIATION, CARBON MONOXIDE POISONING, AND/OR ELECTRICAL SHOCK.

ONLY PERSONS WHO CAN UNDERSTAND AND FOLLOW THE INSTRUCTIONS SHOULD USE OR SERVICE THIS HEATER.

IF YOU NEED ASSISTANCE OR HEATER INFORMATION SUCH AS AN INSTRUCTIONS MANUAL, LABELS, ETC. CONTACT THE MANUFACTURER.

WARNING:

FIRE, BURN, INHALATION, AND EXPLOSION HAZARD. KEEP SOLID COMBUSTIBLES, SUCH AS BUILDING MATERIALS, PAPER OR CARDBOARD, A SAFE DISTANCE AWAY FROM THE HEATER AS RECOMMENDED BY THE INSTRUCTIONS. NEVER USE THE HEATER IN SPACES WHICH DO OR MAY CONTAIN VOLATILE OR AIRBORNE COMBUSTIBLES, OR PRODUCTS SUCH AS GASOLINE, SOLVENTS, PAINT THINNER, DUST PARTICLES OR UNKNOWN CHEMICALS.

WARNING:

NOT FOR HOME OR RECREATIONAL VEHICLE USE.

WARNING:

INTENDED USE IS PRIMARILY THE TEMPORARY HEATING OF BUILDINGS UNDER CONSTRUCTION, ALTERATION, REPAIR OR EMERGENCIES ONLY.

ALWAYS PROVIDE ADEQUATE VENTILATION. 1 SQ. IN. OF FRESH AIR MUST BE SUPPLIED FOR EVERY 1000 BTUH OF HEAT.

THIS HEATER SHALL BE INSTALLED SUCH THAT IT IS NOT DIRECTLY EXPOSED TO WATER SPRAY, AND/OR DRIPPING WATER.

This heater is designed and approved for use as a construction heater under CSA B140.8 Portable Oil Fired Heaters / CSA B140.02003 Oil Burning Equipment.

We cannot anticipate every use which may be made of our heaters. CHECK WITH YOU LOCAL FIRE SAFETY AUTHORITY IF YOU HAVE QUESTIONS ABOUT APPLICATIONS.

Other standards govern the use of fuel gases and heat producing products in specific applications. Your local authority can advise you about these.

SPECIFICATIONS

Model ……	FVO-400
Input ……...	390,000 btuh
Fuel …….	No.1, No. 2, diesel or kerosene
Fuel Pressure …….....	150 psi
Nozzle ……. (Delavan)	2.25 x 45B
Ignition …….	Direct Spark
……..….	Thermostat Control
Air Circulation …….	2500 cfm
Fuel Consumption …….....	2.75 Gal/hr
Approved …….....	cETLus listed

INSTALLATION:

The installation of this heater for use with No.1, No.2, Diesel or Kerosene and shall conform with local codes or, in the absence of codes, with the National Fuel Gas Code ANSI Z223.1/NFPA 54. Installation of the unit shall be in accordance with the regulations of the authorities having jurisdiction or the CSA Standard B139.

CLEARANCE TO COMBUSTIBLES:

TOP	FRONT	SIDES	REAR	FLUE PIPE
3 ft	10 ft	3 ft	3 ft	3 ft

FUEL: This heater will operate with No.1, No.2, Diesel or Kerosene. **Note:** No.1 Fuel Oil or Kerosene must be used for temperatures less than –10º C (8º F).

ELECTRICAL:

WARNING
Electrical Grounding Instructions

This appliance is equipped with a three-prong (grounding) plug for your protection against shock hazard and should be plugged directly into a properly grounded three-prong receptacle.

115v supply must be available. Please note that the heater requires 15 amps for proper operation. Ensure appropriate gauge extension cord is used.

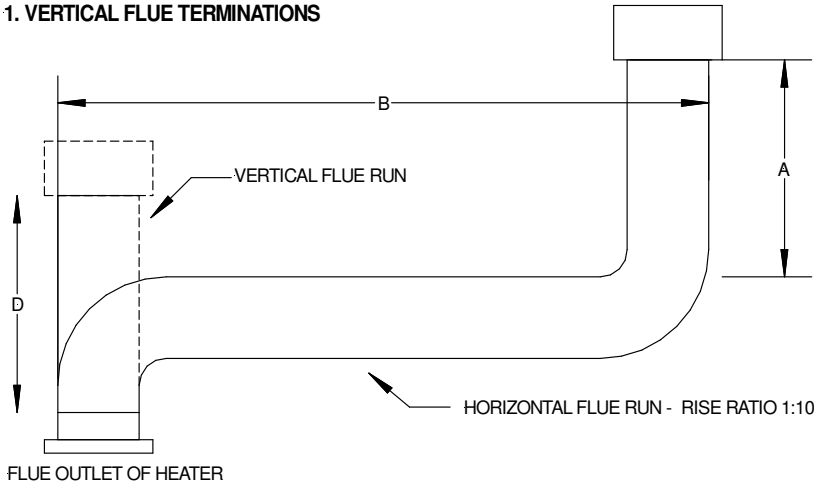
- 12/3 AWG at 50 Feet
- 10/3 AWG at 100 Feet

FLUE PIPE: Flue pipe connection must terminate with a vertical run at least 2ft long.

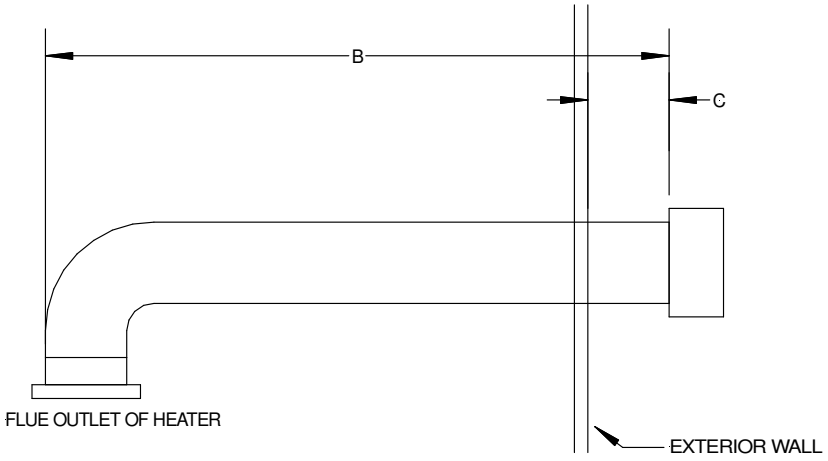
The vent outlet on the heater is 6” diameter. Certified venting must be used at all times. Vent cap should be installed in situations where downdrafts occur. All venting must correspond with the CSA B149 standard or in its absence, local codes.

FV SERIES CONSTRUCTION HEATER – VENTING REQUIREMENTS

1. VERTICAL FLUE TERMINATIONS



2. HORIZONTAL FLUE TERMINATIONS



A - VENT TERMINATION MUST BE A MINIMUM OF 2FT HIGHER THAN ANY POINT WITHIN 10FT.

B - MAXIMUM HORIZONTAL RUN IS 30FT.
NOTE: 90deg ELBOW = 10ft HORIZONTAL VENT ALLOWANCE
45deg ELBOW = 5ft HORIZONTAL VENT ALLOWANCE

C - VENT TERMINATION IN HORIZONTAL POSITION MUST BE MINIMUM 4ft FROM ANY COMBUSTABLE SURFACE

D - EXTERIOR VERTICAL VENT TERMINATION MUST BE A MINIMUM OF 2ft.

NOTE: ALL VENT TERMINATIONS MUST HAVE A RAIN CAP INSTALLED AS PER LOCAL CODE REQUIREMENTS.

DUCTING: Canvas heater duct with a minimum temperature handling of 300 deg F. including wire reinforcement to prevent collapsing. Heater is designed for use with 2 x 12" diameter ducts equipped with pin lock couplings (FV-HD12)**.**

Install ducting to outlet on the heater using pin-locks provided on collar of ducting. Ducting should be inspected periodically for tearing and/or wear marks. Ducting should be stored in a dry area when not in use

MAINTENANCE:

1. **Every construction heater should be inspected before each use, and at least annually by a qualified service technician. Incorrect maintenance my result in improper operation of the heater and serious injury could occur.**

2. Service and Maintenance only to be performed by a qualified service technician.

3. The hose assemblies shall be visually inspected prior to each use of the heater. If it is evident there is excessive abrasion or wear, or the hose is cut, it must be replaced prior to the heater being put into operation. The replacement hose assembly shall be that specified by the manufacturer.

4. The flow of combustion and ventilation air must not be obstructed. Be sure to check the fan assembly and ensure that the motor and blade are operating properly.

5. Compressed air should be used to keep components free of dust and dirt build up. Note: Do not use the compressed air inside any piping or regulator components.

6. Change fuel filter insert (Part# FVO-419) once per month. Change fuel filter cartridge (Part# FVO-418) once every 6 months.

7. Change oil nozzle (Part# FV-435) once per year.

8. Fan Limit Switch (Part# FV-407A) should be replaced if the fan motor does not shut off after the heat exchanger has cooled down.

9. The High Limit Switches (Part# FV-406 & FV-437) should be checked each season. These limit switches will ensure the burner shuts down if the temperature exceeds 150º F at rear of unit and 250º F at the outlet.

10. Fuel tank should be drained on a regular basis by removing drain plug.

CAUTION: Do not have any source of ignition near the heater when draining tank.

NOTE: No.1 fuel oil or kerosene is recommended for temperatures below -10º C / 8º F

11. Heat Exchanger should be cleaned if smokey conditions continue even after the air adjustments on the burner are made.

START UP INSTRUCTIONS:

1. Be sure the switch in is the “OFF” position.

2. Ensure electrical cord is grounded and heater is on a level surface.

3. Plug in supply cord to 115V 15amp outlet.

4. Move switch to “MANUAL” position for manual control.

5. Move switch to “THERMOSTAT” position for thermostatic control.

Please Note:

1. If using Thermostat on unit, unit must be started in Thermostat position.

2 When changing between manual and thermostat operation, the heater must be left in the “OFF” position for 30 seconds to prevent the burner from locking out.

3. When using a generator for electrical supply, make sure the generator is properly grounded and generator is at a 60Hz frequency.

4. In the event that a Generator is being used and the generator runs out of fuel, make sure the heater switch is in the “OFF” position before restarting generator, failure to do so may damage heater.

TO SHUT DOWN:

1. Move switch to “OFF” position.

NOTE: Fan will continue to operate after the burner shuts down. Once the unit cools down, the fan will stop.

IF HEATER FAILS TO START:

1. Press manual reset button at rear of burner. (Red button).

2. Check fuel level. There must be 2-4 gallons of fuel in the tank for the heater to start properly.

3. Make sure there are no air locks in fuel lines or filter.

4. Ensure proper power supply and extension cord is being used.

5. Check for dirty fuel filter or blocked fuel supply line.

6. Check burner nozzle assembly.

NOTE: IF THE BURNER HAS BEEN RESET SEVERAL TIMES THERE MAY BE AN ACCUMULATION OF OIL IN THE CHAMBER! DO NOT CONTINUE TO TRY AND START THE HEATER!

DRAIN OIL FROM HEAT EXCHANGER USING DRAIN HOLE AT FRONT OF HEAT EXCHANGER FOR 15-20 MINUTES BEFORE ATTEMPTING TO RELIGHT. LET REMAINING EXCESS OIL BURN OFF BEFORE CHECKING COMBUSTION OF UNIT.

SAFE OPERATION PRECAUTIONS:

1. Do not fill fuel tank while heater is operation.

2. Do not attempt to start heater if excess oil remains in the heat exchanger.

3. Use switch to shut down the heater. Do not try to shut down the heater by unplugging the electrical cord.

4. Do not plug anything other that the thermostat into the “Thermostat” plug.

5. Do not use any fuel other that those listed on rating plate.

6. Follow electrical requirements shown on rating plate and/or Electrical requirements section of this manual.

7. Before removing any guards or performing any maintenance, be sure that the main power supply is disconnected.

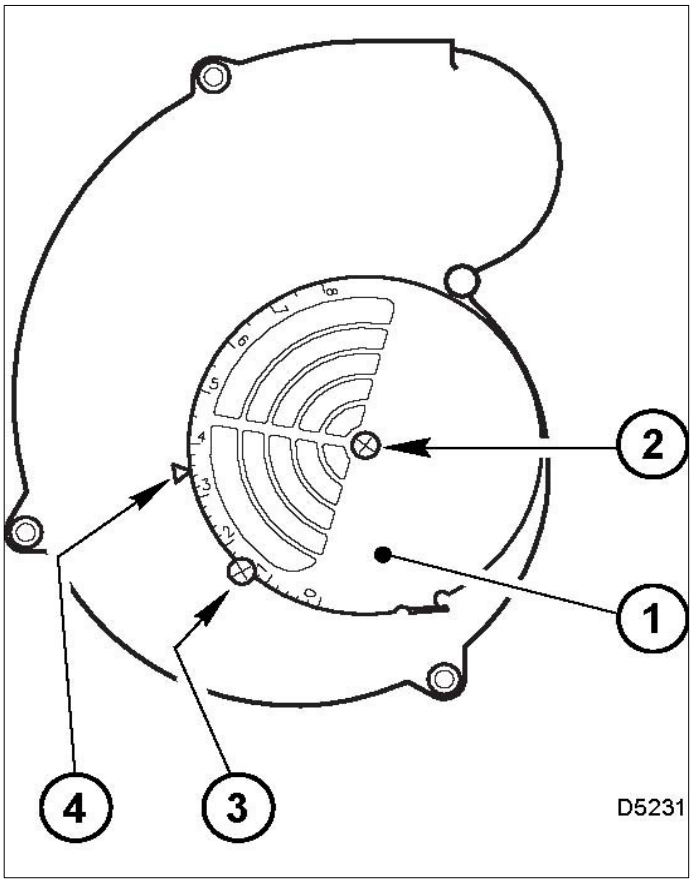
COMBUSTION AIR ADJUSTMENTS:

NOTE: Proper combustion air adjustment must be achieved using a certified combustion analyzer and smoke tester to ensure complete combustion.

The air adjustment should be made to achieve 10% CO_2 and No. 1 or “trace” smoke. (Bacharach Scale)

SETTING THE AIR ADJUSTMENT PLATE

A) Regulation of the combustion air flow is made by adjustment of the manual AIR ADJUSTMENT PLATE (1) after loosening the FIXING SCREWS (2 & 3). The initial setting of the air adjustment plate should be made according to Column 5 in the Burner Set-up Chart.



B) The proper number on the manual AIR ADJUSTMENT PLATE (1) should line up with the SETTING INDICATOR (4) on the fan housing cover. Once set, the air adjustment plate should be secured in place by tightening SCREWS 2 and 3.

C) The final position of the air adjustment plate will vary on each installation. Use instruments to establish the proper settings for maximum CO_2 and a smoke reading of zero.

NOTE: Variations in flue gas, smoke, CO_2 and temperature readings may be experienced when the burner cover is put in place. Therefore, the burner cover **must** be in place when making the final combustion instrument readings, to ensure proper test results.

BURNER SET-UP CHART

1	2	3		4	5
ACTUAL FIRING RATE ± 5%	NOZZLE SIZE	PUMP PRESSURE		TURBULATOR SETTING	AIR DAMPER SETTING
GPH	GPH	PSI	BAR		
2.75	2.25 x 45° 2.00 x 60°	150 170	10 10	5 5	4 - 6 4.5

* Note – Air damper setting is typically set at 4 for operation in colder temperatures. A combustion analyzer should always be used when setting the the burner.

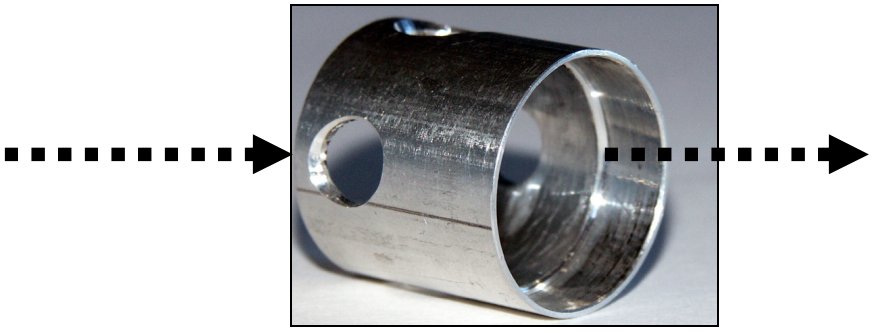
TEMPERATURE FEELER GAUGE ADJUSTMENT
(ATTACHED TO FAN SWITCH)

The temperature feeler gauge is required to be always touching the heater exchanger.

The temperature feeler gauge controls the air flow over the fan switch, which eliminates any unnecessary fan cycling. The temperature feeler gauge can be adjusted for different outside temperatures, by rotating the location of the temperature feeler gauge holes. This will provide maximum performance of the unit in different applications.

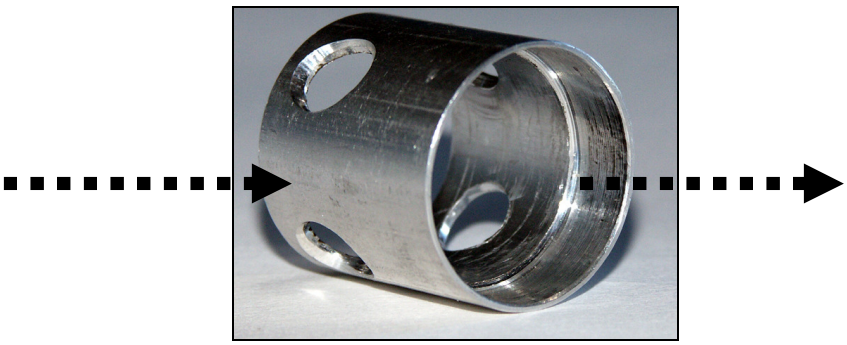
If supply air is warm (-5º C, indoor application):

Turn the temperature feeler gauge so that the holes are parallel with the heat exchanger. This will help the fan switch to remain cool and not overheat. See following:



If supply air is cold (under -5ºC):

Turn the temperature feeler gauge so that the holes are closed off as the air goes over the heat exchanger. This will reduce fan cycling and the unit from shutting down. See following:

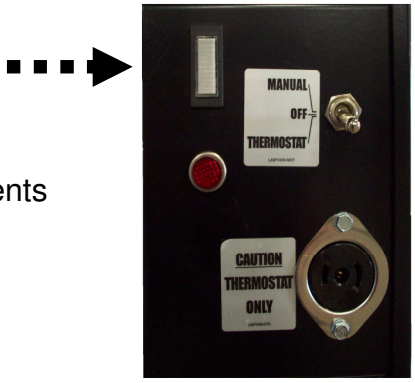


In extreme cold conditions, cover the holes on the temperature feeler gauge using foil tape. Ensure that the temperature feeler gauge is readjusted for warmer weather conditions. Failure to do so may result in burning out fan switches- not covered under warranty.

POWER SUPPLY INDICATOR LIGHT:

The power supply indicator light will help detect any faulty power supplied to the heater such as; grounding issues, reverse polarity or missing/poor connections.

Warning Light Indications



Green Light …… Meets Power Requirements

Solid Red Light…….. Reverse Polarity

Flashing Red Light…….. Ground or Neutral Issue

ATTENTION: IF RED LIGHT IS INDICATED, MAKE CORRECTIONS TO POWER SUPPLY BEFORE TURNING HEATER ON. FAILURE TO DO SO WILL VOID ANY WARRANTY.

ELECTRICAL CONNECTIONS

It is advisable to leave the control box off the sub-base while completing the electrical connections to the burner.

1) Wire access hole
(Use BX electrical connector)

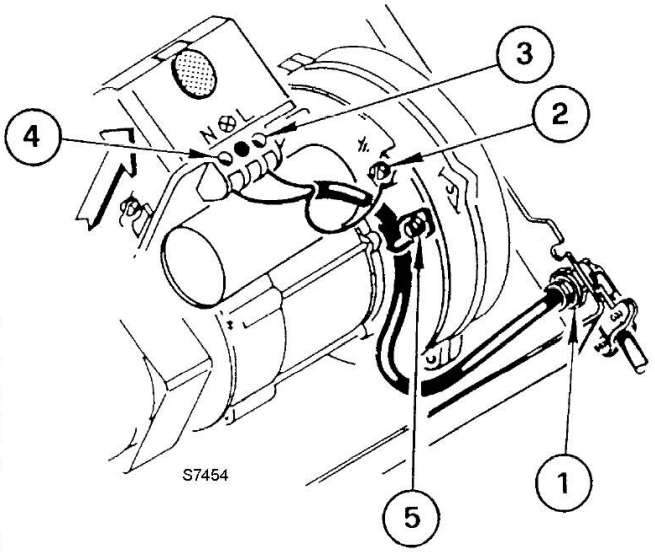
2) Earth ground conductor terminal
(GREEN WIRE)

3) Hot conductor terminal
(BLACK WIRE)

4) Neutral conductor terminal
(WHITE WIRE)

5) Strain relief clamp

WARNING: The hot (black) wire must be connected to the L terminal and the neutral (white) wire must be connected to the N terminal or the primary safety control will be damaged.
Do not connect either wire to the ⊗Terminal.



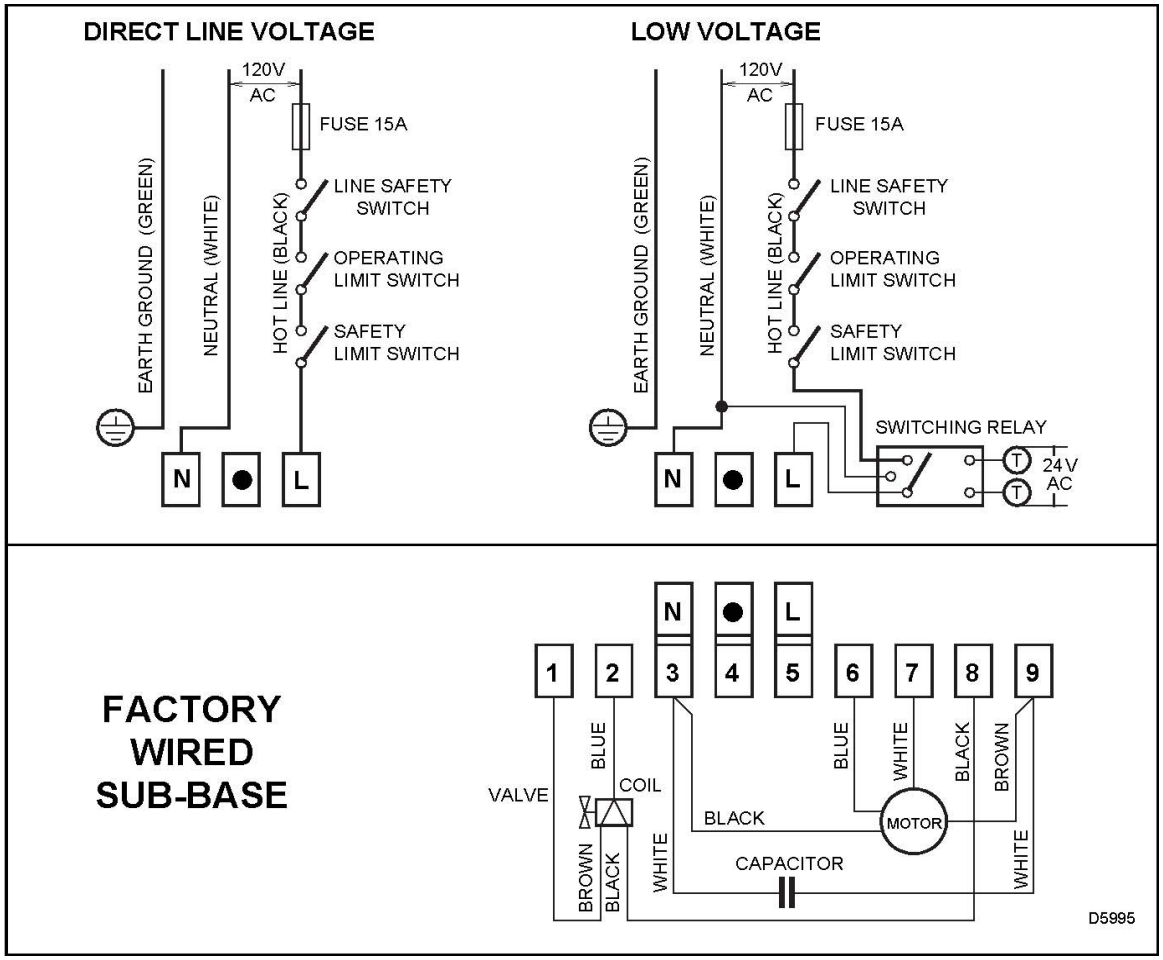
The burner may be controlled using either a DIRECT LINE VOLTAGE control circuit (120V AC 60 cycle) **OR** a LOW VOLTAGE control (24V AC 60 cycle) using a R8038A Honeywell switching relay or equivalent.

Using the appropriate diagram below, make electrical connections to the burner. All wiring must be done in accordance with existing electrical codes, both national and local.

When all electrical connections have been made, the control box may be put back in place on the sub-base.

WARNING: DO NOT activate burner until proper oil line connections have been made, or failure of the pump shaft seal may occur.

APPLICATION FIELD WIRING



REMOTE SENSING OF SAFETY LOCKOUT: The SAFETY SWITCH in the 530SE CONTROL BOX is equipped with a contact allowing remote sensing of burner lockout. The electrical connection is made at terminal 4 (●) on the SUB-BASE. Should lockout occur the 530SE CONTROL BOX will supply a power source of 120Vac to the connection terminal. The maximum allowable current draw on this terminal (4) is 1 Amp.

WARNING: If a neutral or ground lead is attached to this terminal, the CONTROL BOX on the burner will be damaged should lockout occur.

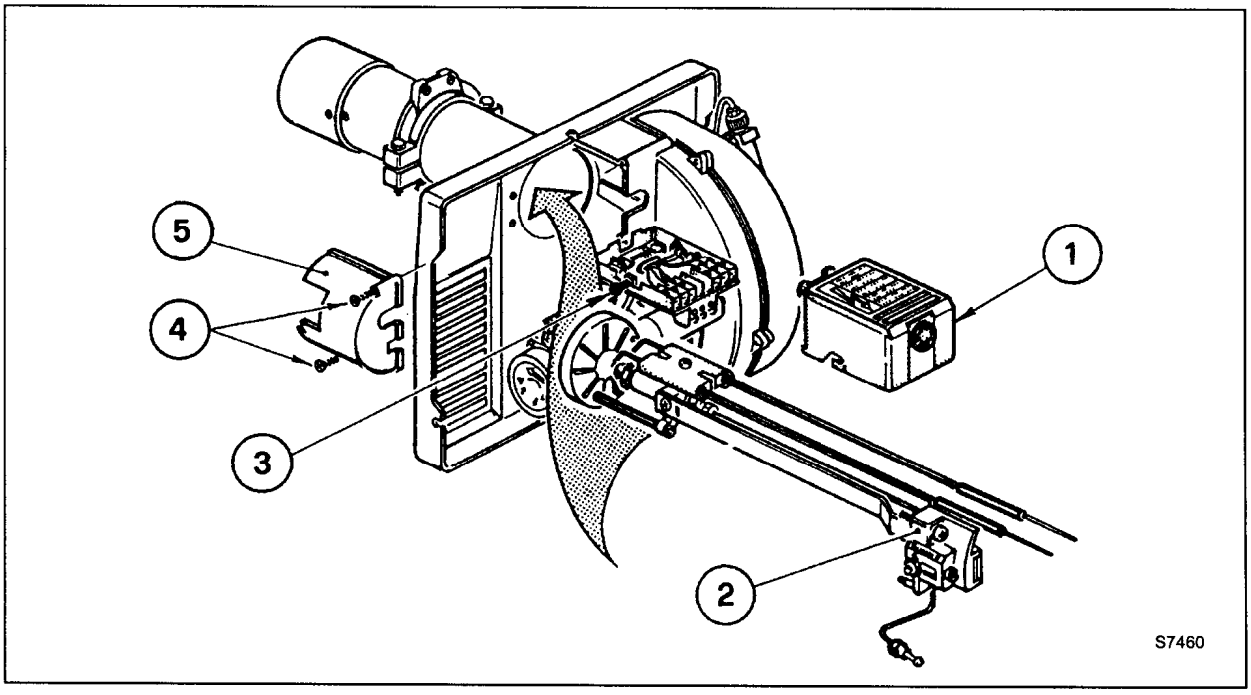
INSERTION / REMOVAL OF DRAWER ASSEMBLY

A) To remove drawer assembly, loosen SCREW (3), then unplug CONTROL BOX (1) by carefully pulling it back and then up.

B) Remove the AIR TUBE COVER PLATE (5) by loosening the two retaining SCREWS (4).

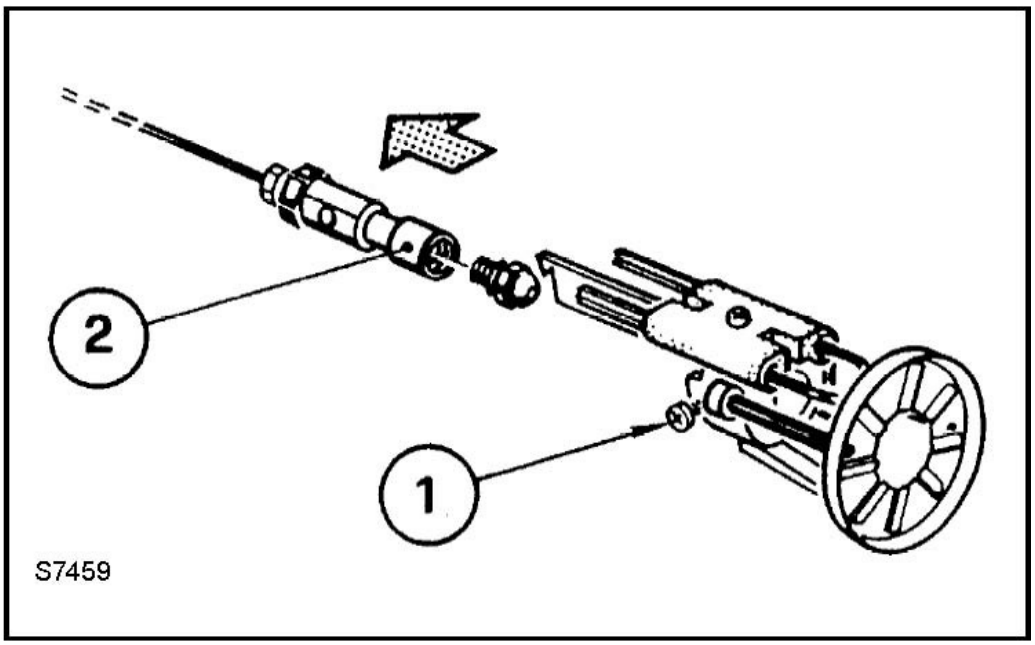
C) Loosen SCREW (2), and then slide the complete drawer assembly out of the combustion head as shown.

D) To insert drawer assembly, reverse the procedure in items A to C above, and then attach fuel line to the pump.



NOZZLE PLACEMENT

A) Remove the NOZZLE ADAPTER (2) from the DRAWER ASSEMBLY by loosening the SCREW (1).



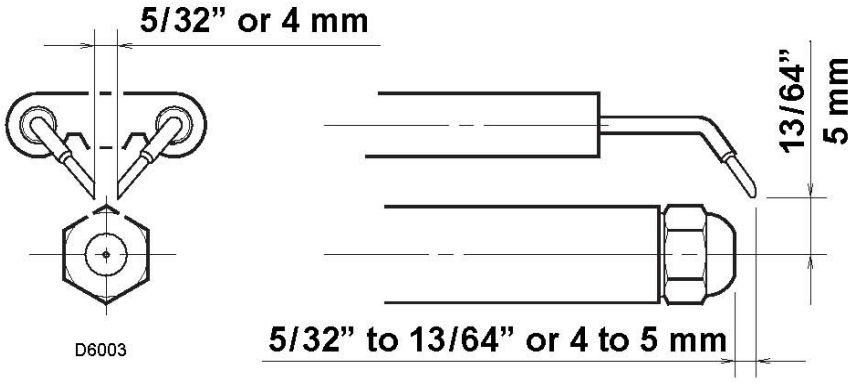
B) Insert the proper NOZZLE into the NOZZLE ADAPTER and tighten securely (Do not over tighten).

C) Replace adapter, with nozzle installed, into drawer assembly and secure with screw (1).

ELECTRODE SETTING

IMPORTANT:

THESE DIMENSIONS MUST BE OBSERVED AND VERIFIED.

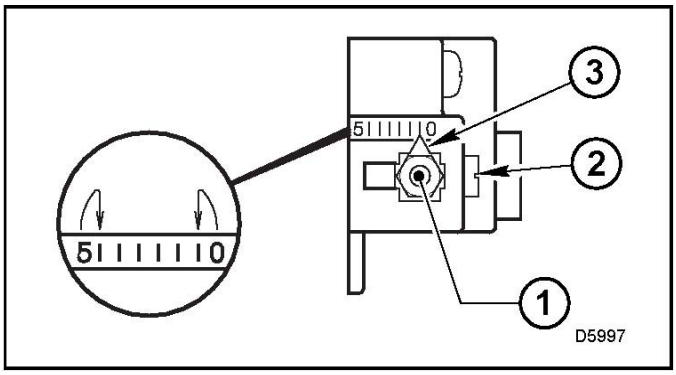


TURBULATOR SETTING

A) Loosen NUT (1), then turn SCREW (2) until the INDEX MARKER (3) is aligned with the correct index number as per the Burner Set-up chart, on page 12.

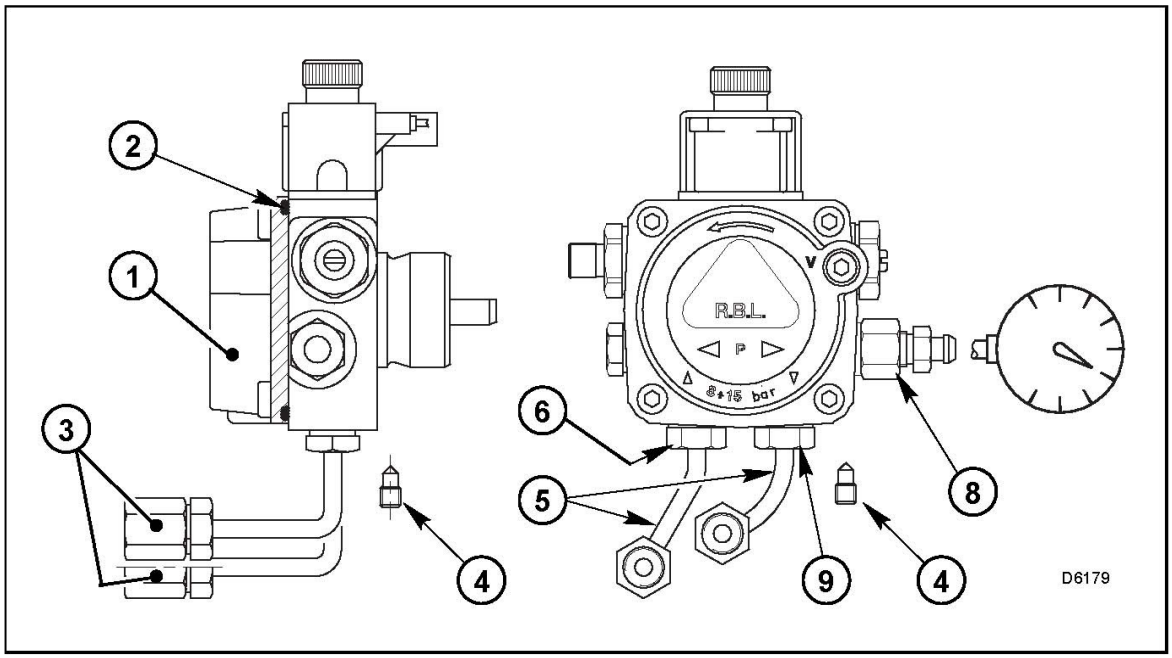
B) Retighten the RETAINING NUT (1)

NOTE: Zero and five are scale indicators only. From left to right, the first line is 5 and the last line 0.

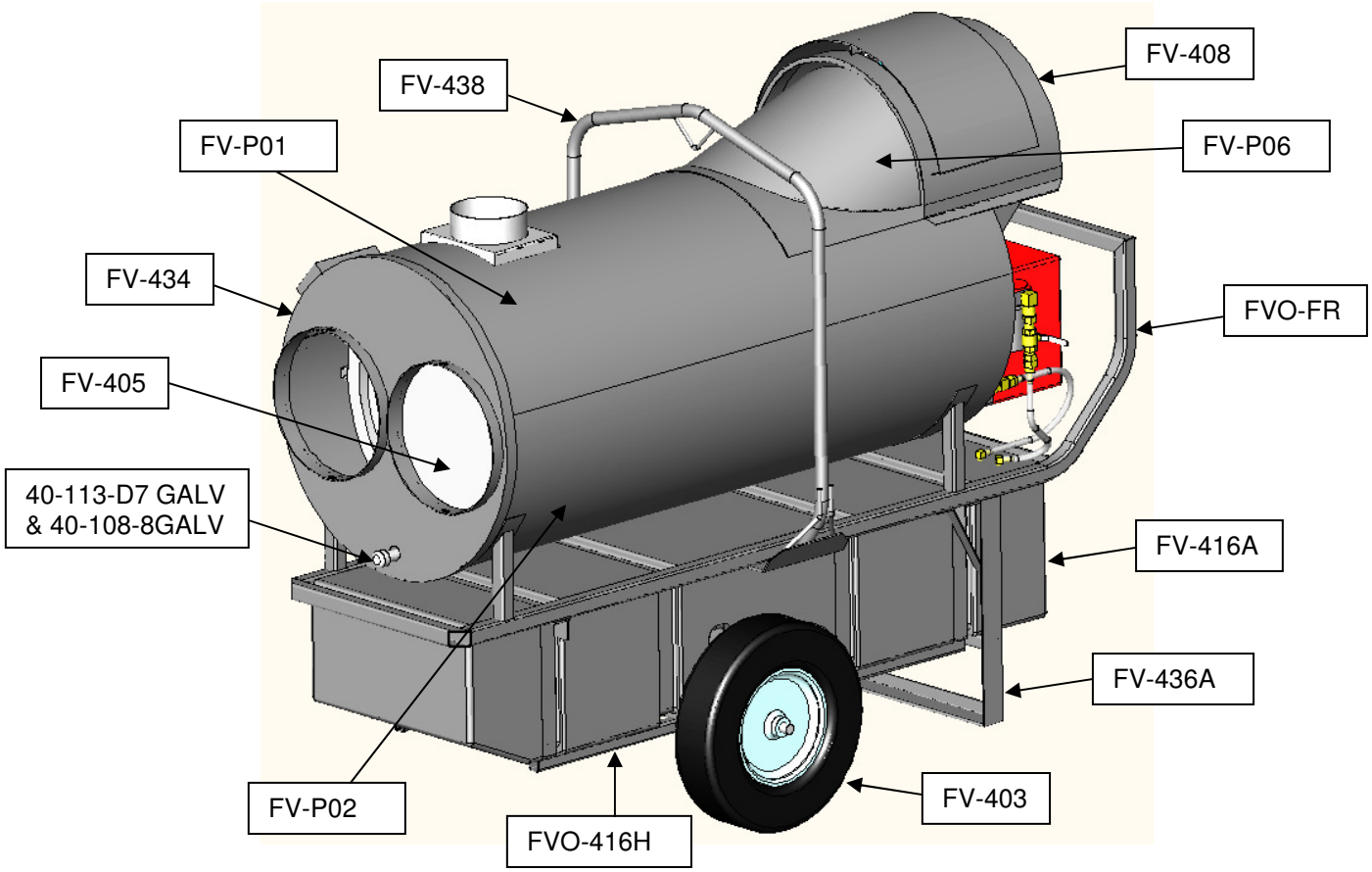


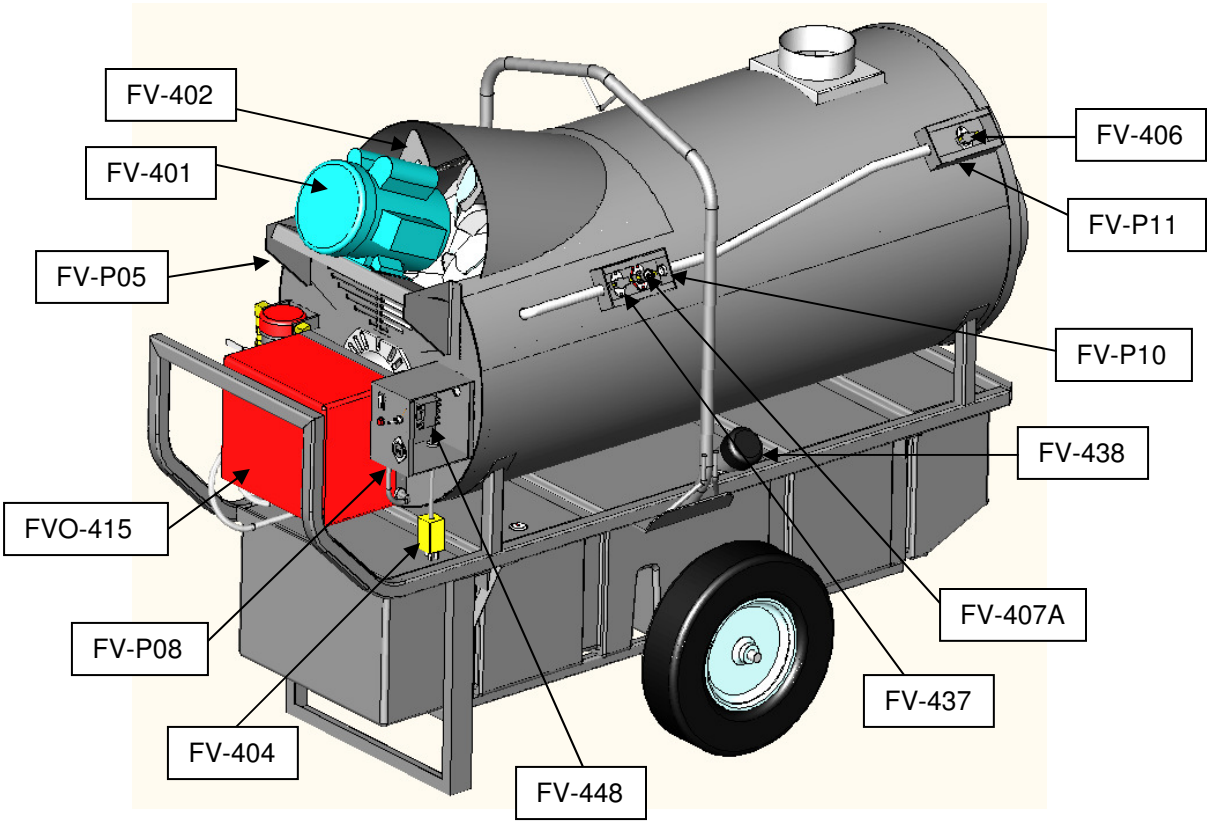
OIL LINE CONNECTIONS

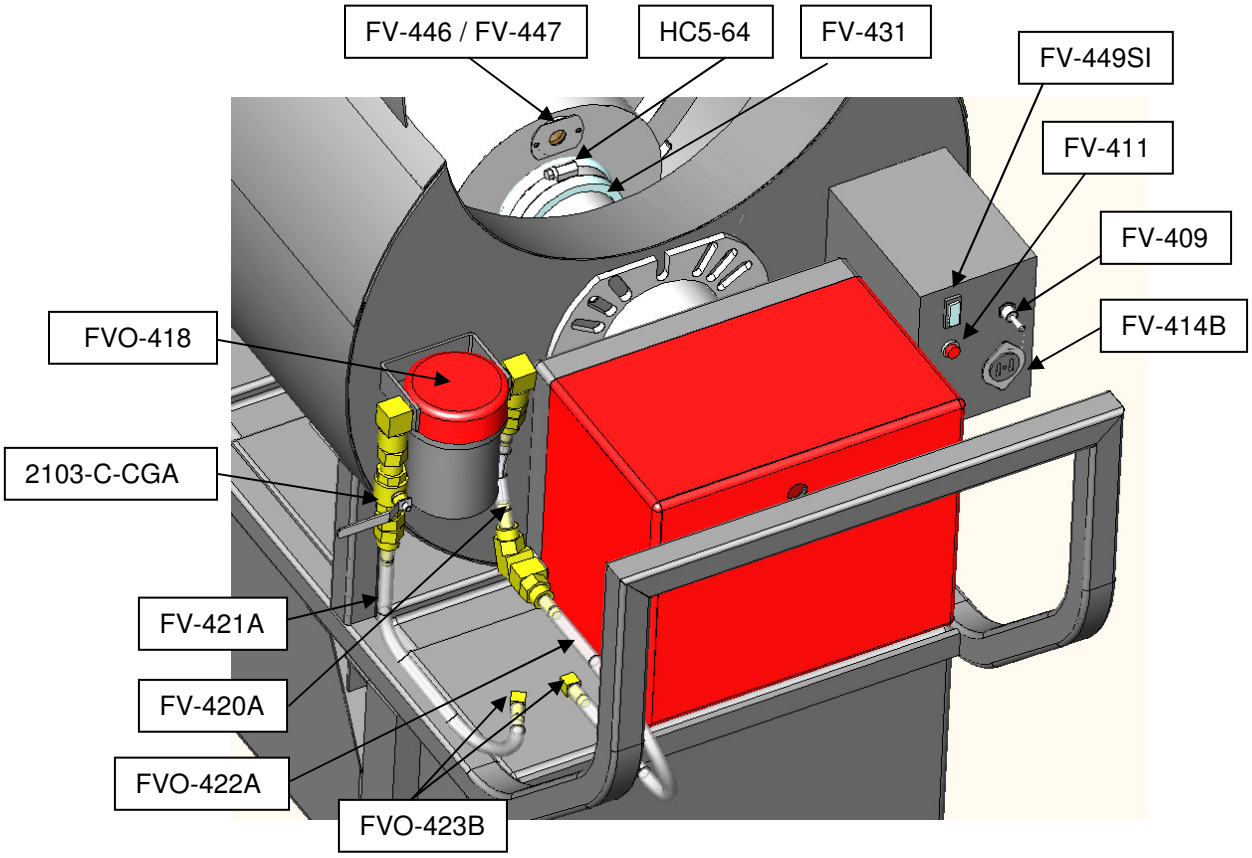
Note: Pump pressure must be set at time of burner start-up. A pressure gauge is attached to the PRESSURE PORT (8) for pressure readings. Two PIPE CONNECTORS (5) are supplied with the burner for connection to either a single or a two-pipe system. Also supplied are two ADAPTORS (3), two female 1/4" NPT, to adapt oil lines to burner pipe connectors. All pump port threads are British Parallel Thread design. Direct connection of NPT threads to the pump will damage the pump body. Riello manometers and vacuum gauges do not require any adaptors, and can be safely connected to the pump ports. An NPT (metric) adapter must be used when connecting other gauge models.

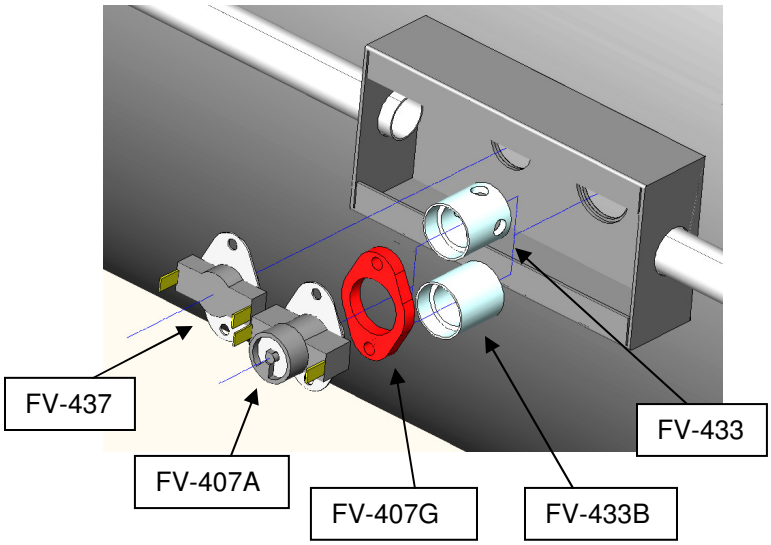


PARTS DIAGRAM – FVO-400






FV-446 / FV-447
HC5-64
FV-431
FV-449SI
FV-411
FV-409
FV-414B
FVO-418
2103-C-CGA
FV-421A
FV-420A
FVO-422A
FVO-423B


FV-437
FV-407A
FV-407G
FV-433B
FV-433

PARTS LIST FOR FVO-400

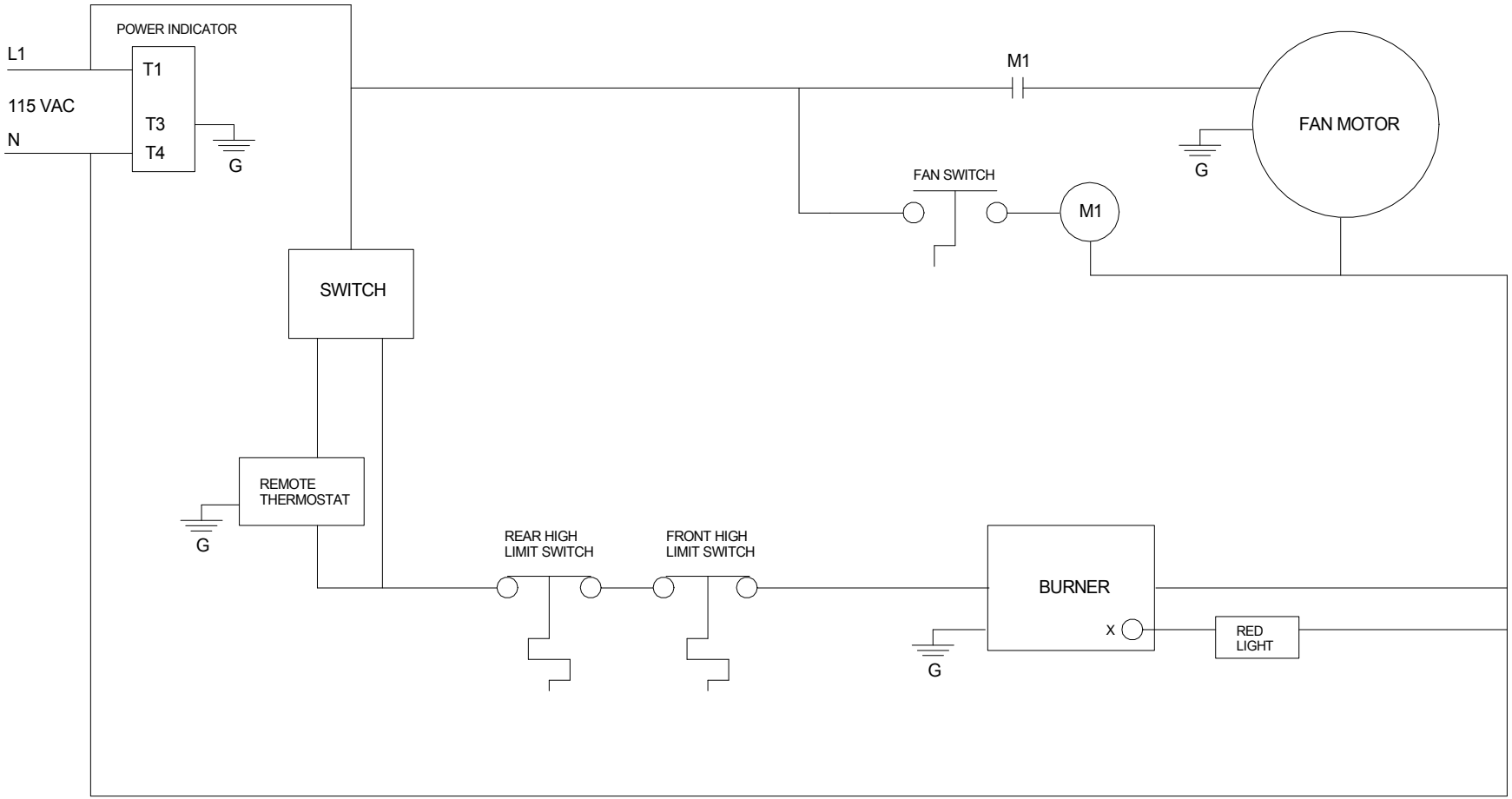
Part Number	Part Description	
FV-401	PRIMARY FAN MOTOR	
FV-402	16" FAN BLADE	
FV-403	16" WHEEL	
FV-404	18" POWER CORD C/W PLUG END	
FV-405	SS HEAT EXCHANGER	
40-113-D7GALV	1/2" X 7" GALVANIZED NIPPLE	
40-108-8GALV	1/2" GALVANIZED CAP	
FV-406	HIGH LIMIT SWITCH (OUTLET)	
FV-407A	FAN LIMIT SWITCH (ADJUSTABLE)	
FV-407G	FAN LIMIT SILICONE GASKET	
FV-408	FAN MOTOR CANOPY	
FV-409	TOGGLE SWITCH (ON CONTROL BOX)	
FV-410	GREEN LIGHT (ON CONTROL BOX) PRIOR TO 2009	
FV-411	RED LIGHT (ON CONTROL BOX)	
FV-414B	THERMOSTAT PLUG (ON CONTROL BOX) 2011>	
FV-415A	MALE CONNECTOR FOR FV-THB	
FVO-415	RIELLO BURNER (OIL)	
FV-416A	42 US GALLON OIL TANK (POLY TANK)	
FVO-416H	42 US GALLON OIL TANK HARNESS (POLY TANK)	
FVO-416G	FUEL GAUGE (PLOY TANK)	
FVO-417B	OIL TANK CAP (POLY TANK)	
40-121-6GALV	OIL TANK DRAIN PLUG (FOR POLY TANK)	
FVO-418	FUEL FILTER (COMPLETE)	
FVO-419	FUEL FILTER (INSERT ONLY)	
FVO-420A	CLEAR FUEL LINE 14" (TANK TO FILTER)	
FVO-421A	CLEAR FUEL LINE 6.5" (FILTER TO BURNER)	
FVO-422A	CLEAR FUEL LINE 14" (BURNER TO TANK)	
48-6C	BRASS FITTING (POLY TANK TO FILTER)	
2103-C-CGA	3/8" SHUT OFF VALVE	
122-C	3/8" BRASS HEX NIPPLE	
49-6C	3/8" MP X 3/8" M.FL BRASS ELBOW	
49-6B	1/4" MP X 3/8" M.FL BRASS ELBOW	

FV-431	BURNER GASKET	
FV-433	FEELER GAUGE	
FV-433B	FEELER GAUGE - SOLID	
FV-434	FRONT FACE PLATE (2 X 12")	
FV-434A	FRONT FACE PLATE (1 X 16")	
FV-435H	OIL BURNER NOZZLE (HI ALTITUDE) (1.75 X 60W)	
FV-435WC	OIL BURNER NOZZLE (1.75 X 60W)	
FV-435B	OIL BURNER NOZZLE (2.00 X 60W)	
FV-436A	SUPPORT LEG (POLY TANK)	
FV-437	HIGH LIMIT (REAR)	
FV-438	LIFTING HARNESS	
FVO-440A	WHEEL AXLE - (POLY TANK)	
FV-446	SIGHT GLASS C/W FIBER GASKET	
FV-447	SIGHT GLASS WASHER	
FV-448	MAIN RELAY	
FV-449SI	SMART INDICATOR - 2009 >	
FV-461	PUMP INLET/OUTLET ADAPTER	
FVO-3000443	PUMP DRIVE KEY	
FVO-3002278	SUB-BASE FOR BURNER	
FVO-3002279	COIL	
FVO-3002280	PHOTO CELL	
FVO-3005844	CAPACITOR	
FVO-3005854	SEMI FLANGE FOR F10 BURNER (FVO-400)	
FVO-3005855	MOUNTING FLANGE	
FVO-3005869	ELECTRODE PORCELAIN	
FVO-3005891	ELECTRODE ASSEMBLY	
FVO-3006553	COIL U-BRACKET C/W KNURLED NUT	
FVO-3006965	NOZZLE ADAPTER	
FVO-3006966	ELECTRODE SUPPORT	
FVO-3006978	TURBULATOR DISC.	
FVO-3006980	NOZZLE OIL TUBE 10"	
FVO-3006992	PIPE CONNECTOR - SUPPLY	
FVO-3006993	PIPE CONNECTOR - RETURN	
FVO-3007223	CHASSIS FRONT PLATE	
FVO-3007234	BURNER BACK COVER	
FVO-3007357	ACOUSTIC LINER FOR BURNER BACK COVER	

FVO-3007568	BLEEDER SCREW	
FVO-C7001010	PUMP	
FVO-C700-1029	IGNITION MODULE	
FVO-C7001034	BURNER MOTOR	

ACCESSORIES		
FV-HD12	12" X 12-FT HITEX VINYL DUCTING	
FV-HD12X25	12" X 25-FT HITEX VINYL DUCTING	
FV-HD16x25	16" X 25-FT HITEX VINYL DUCTING	
FV-THB	THERMOSTAT C/W 25FT CORD/MALE PLUG END (AS OF 2011)	
FV-VK	6" X 3FT C-VENT C/W RAIN CAP	
FVO-C7001001	EMERGENCY SERVICE KIT	
FVO-C7050010	VACUUM & PRESSURE TESTER MANIFOLD	
FVO-3007769	OPTIONAL PUMP	
FV-432	PRESSURE GAUGE ADAPTER/WITH PLUG	

FV-400 SERIES - WIRING SCHEMATIC 2011



FLAGRO INDUSTRIES LIMITED	
TITLE: FVO-400 - WIRING SCHEMATIC	**DWG. NO.** FV-400 WS 2011