NOTE: The instructions contained in this manual apply to the installation, operation and service of waste oil fired heaters. The following instructions should be carefully followed for obtaining the best possible installation, operation and service conditions. Specifications are subject to change without notice.

WASTE OIL HEATER

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

INSTALLATION/OPERATION FORM 460-4
EFFECTIVE AUGUST 1989/OBSOLETES FORM 460-3

REZNOR® MERCER, PA. 16137

APPLIES TO: **RA 230, RAD 230**

INDEX

FOR YOUR SAFETY

The use and storage of gasoline or other flammable vapors and liquids in open containers in the vicinity of this appliance is hazardous.

1. WARRANTY IS VOID IF ....

1. Wiring is not in accordance with diagram furnished with heater.
2. Heater is operated in presence of chlorinated vapors.
3. Air through heater is not in accordance with rating plate.
4. Ducts are attached to RA models.

WARNING: This appliance is not designed for use in hazardous atmospheres containing flammable vapors or combustible dust, or atmospheres containing chlorinated or halogenated hydrocarbons.

2. GENERAL

Before beginning installation, become familiar with your model of heater and its particular installation requirements. Clearance requirements differ for blower and fan models.

Model RA unit heaters are designed with a propeller fan for air delivery. Models RAD are blower-equipped unit heaters suitable for attachment to discharge ductwork. Both models require a compressed air hook-up.

These heaters are designed to provide economical disposal of waste oil. Proper operation depends on the consistency of the oil. Any water or foreign material in the oil may cause the unit to shutdown. Due to the nature of the fuel being burned, this unit should not be depended on as the only source of heat. A secondary source of heat should always be provided to the building. This will prevent any building damage if the waste oil heater were to become inoperative during subfreezing weather.

Become familiar with the meanings of **Danger**, **Caution** and **Warning** as defined in the Hazard Intensity Level Chart.

HAZARD INTENSITY LEVELS

1. **Danger:** Failure to comply will result in severe personal injury or death and/or property damage.
2. **Warning:** Failure to comply can result in severe personal injury or death and/or property damage.
3. **Caution:** Failure to comply could result in minor personal injury and/or property damage.

3. UNCRATING

Check the unit for any damage that may have been incurred in shipment, and if any damage is found, file a claim with the transporting agency. The unit was inspected and tested at the factory prior to crating and was in perfect condition at that time.

4. FUEL

WARNING: The supply fuel can be no lighter than No. 1 fuel oil and no heavier than 50 weight. Any deviation from this range will cause the unit to mis-fire and become a potential hazard. See Hazard Intensity Levels, page 1.

The burner is designed and orificed for use with waste oil — 145,000 BTU/Gal. However, the following substitute fuels may be used:

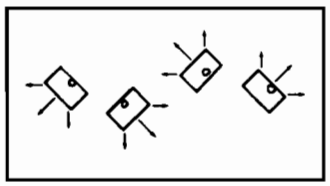
#1 fuel oil — 132,000 BTU/Gal.
#2 fuel oil — 140,000 BTU/Gal.
Kerosene (Domestic only; do not use foreign.) — 132,000 BTU/Gal.
#1 diesel fuel — 132,000 BTU/Gal.
#2 diesel fuel — 140,000 BTU/Gal.

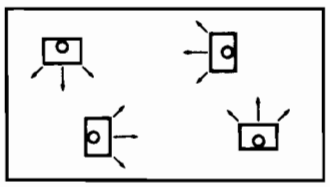
Due to higher viscosity, some #1 oil's BTU/Gal. capacity may be 128,000-130,000 BTU/Gal. Check BTU content of substitute fuel to determine burner input.

Models RA/RAD 230, burn an average of 1.5 gallons of oil an hour.

5. LOCATION

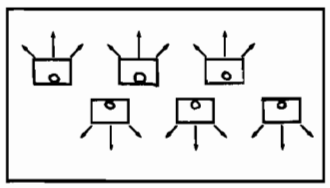
Model Series RA and RAD Unit Heaters should be installed in such a manner as to derive maximum efficiency with a minimum of heat loss to the outside environment. As a rule, single heaters should be suspended over an area of low heat loss with output air directed toward area of greatest heat loss. Where two or more heaters are utilized in a common installation, heaters should be arranged around outside walls and blowing parallel to them. Heaters may be arranged in a supporting consecutive air pattern so that the output of one blows beneath the air-intake side of another. In installations where there are concentrated heat loss areas, a combination of single and multiple heater arrangements is desirable. See illustrations.





Narrow building — Single units arranged to compensate for heat loss from four exposed outside walls.

Wide building — Multiple units arranged to compensate for heat loss from four exposed outside walls.



6. AIR THROW: UNIT HEATERS AT 9 FOOT MOUNTING HEIGHT.

MODEL	Distance
RA 230	50′
RAD 230	50′

7. INSTALLATION CLEARANCES FROM COMBUSTIBLES

	Fan Models RA	Blower Models RAD
Top	6″	12″
Front	48″	48″
Sides	10″	10″
Rear (Burner Access)	20″	20″
Bottom	18″	18″

Installation of barometric draft regulator requires 18″ clearance from flue outlet to ceiling. U/L requires 18″ clearance from flue pipe to combustible material.

8. SUSPENDING THE UNIT

Before suspending the unit, check the supporting structure to determine whether it has sufficient load-carrying capacity to support the weight of the unit.

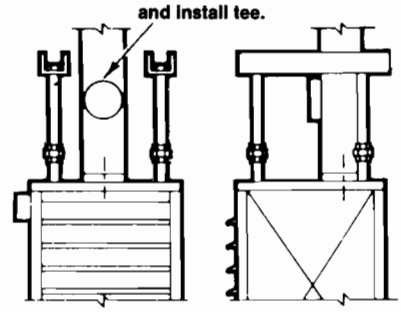
NET WEIGHTS	
Model	Lbs.
RA 230	265
RAD 230	350

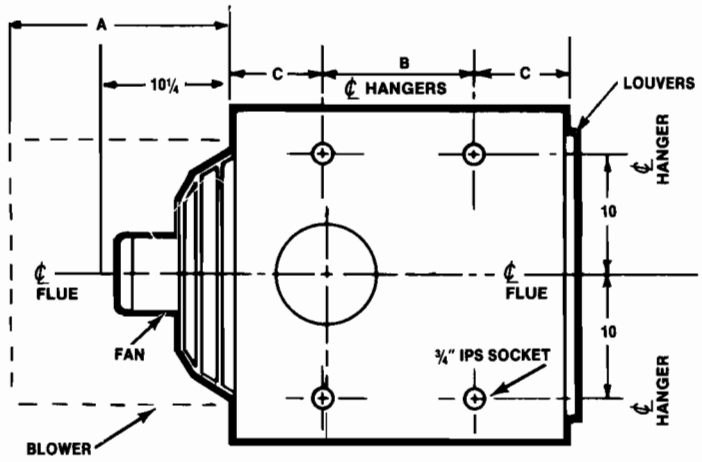
Suspension requires the use of four hangers of ¾″ steel pipe, cut to length. Pipe unions in the hangers are suggested for ease of installation.

WARNING: Units must be supported level for proper operation. Do not place or add additional weight to the suspended unit.

Typical hanger suspension of oil-fired heaters.

Barometric draft regulator should come off the side and install tee.





MODEL	FLUE	A	B	C
RA/RAD 230	8″	22⅛″	16⁵⁄₁₆″	7¹¹⁄₃₂″

9. FUEL SUPPLY TANK AND SUPPLY LINE

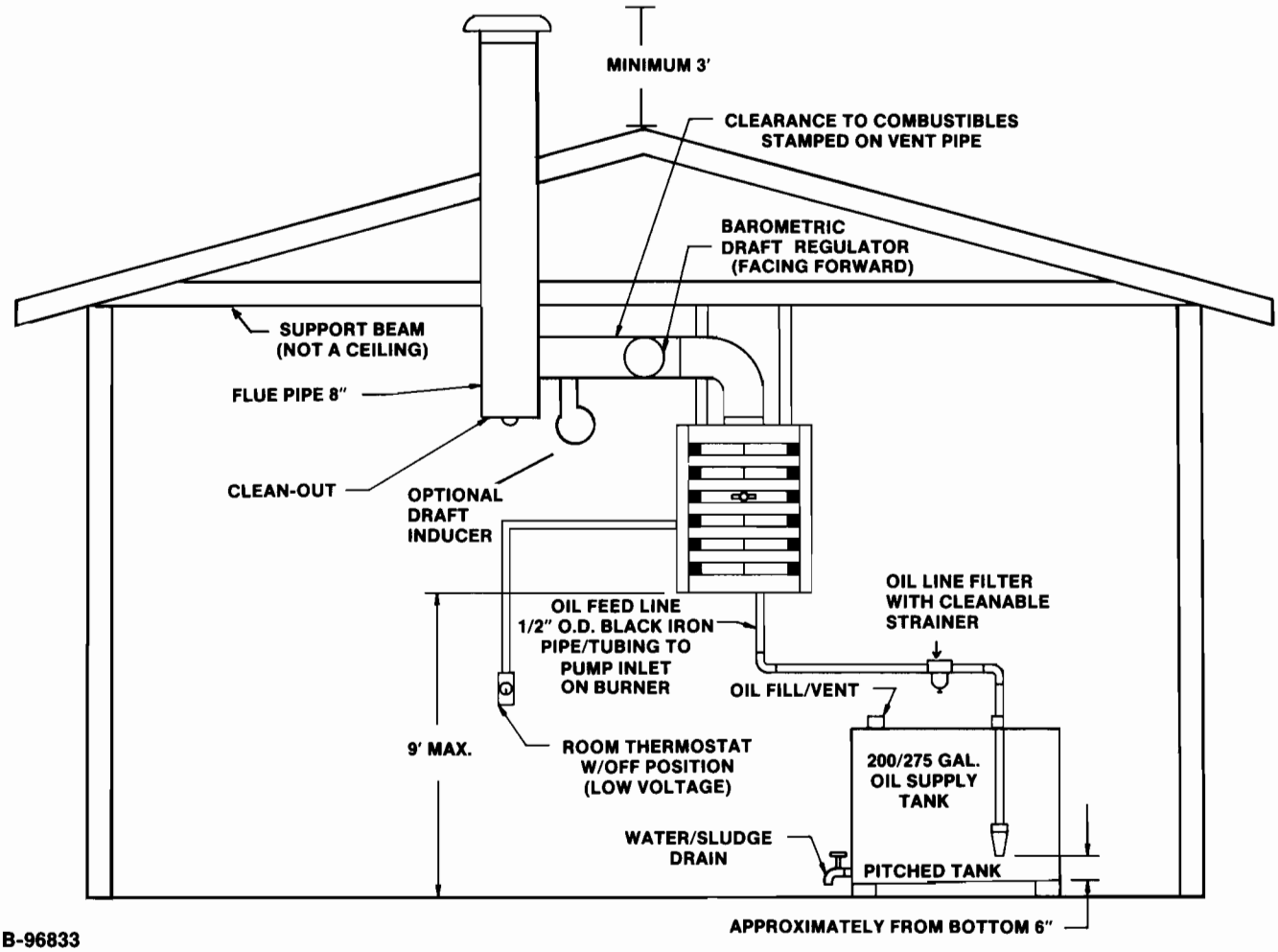
Waste oil must be maintained at a temperature of 50° F, or above, in the supply tank and in the line to the heater. See the drawing on page 3 which illustrates a typical installation. The 200-275 gallon waste oil tank should be no closer than 5 feet and no more than 20 feet from the heater. If more than 20 feet, a booster pump must be incorporated. The tank should be pitched to one side for water drain off.

The fuel lines must be installed in accordance with the National Board of Fire Underwriters requirements and local ordinances where applicable. A fuel line filter with a cleanable strainer is provided with the heater. A vacuum gauge mounted at the fuel inlet of the pump indicates any fuel line restriction, such as a dirty filter. The maximum allowable gauge reading is 20″ w.c.

The outlet of the pump must **always** be the highest point on the fuel feed line. The feed line should be ½″ o.d. black iron pipe.

When burning waste oil, insulate the lines and heat as necessary to maintain the oil above 50° F.

TYPICAL INSTALLATION LAYOUT



A readily accessible manual shutoff valve should be installed at each point where required to properly control the flow of fuel in normal operation and where required to avoid oil spillage during servicing. Install valves to close against the supply.

Where a shutoff is installed in the discharge line of an oil pump that is not an integral part of a burner, a pressure relief valve should be connected into the discharge line between the pump and the shutoff valve and arranged to return surplus oil to the supply tank or to bypass it around the pump, unless the pump includes an internal bypass.

Any fuel oil line incorporating a heater should be provided with a relief valve arranged to discharge to a return line when any valve, pump, or other device may prevent the release of excessive pressure because of the expansion of the oil when heated.

10. VENTING THE HEATER

WARNING: Failure to provide proper venting could result in death, serious injury, and/or property damage. Units must be installed with a flue connection and proper vent to the outside of the building. Safe operation of any gravity vented heating equipment requires a properly operating vent system, correct provision for combustion air and regular maintenance and inspection. See Hazard Levels, page 1.

Masonry chimneys and metal chimneys must be built in accordance with accepted building code practice. A Class A chimney or equivalent is required for this heater. Standards for chimneys can be found in NFPA Standard No. 211, published in National Fire Codes, Volume 4, the National Building Code of the American Insurance Association, 85 John Street, New York, NY, or the National Building Code of Canada published by the National Research Council, Ottawa.

If you are using an existing chimney, inspect to see if it needs cleaning or repairs prior to installing the heater. The smallest dimension of the chimney must be at least 8" in diameter. The chimney must be capable of maintaining a steady draft.

If using an approved factory-built chimney, install it in accordance with the manufacturer's instructions.

The chimney must be at least three feet above the highest point where it passes through the roof, and at least two feet higher than any portion of a building within ten feet of such chimney. Connect the flue outlet of the heater to the chimney with 8" diameter, 24-gauge or heavier, galvanized steel vent pipe. Triple-wall stainless (Type L) vent pipe is recommended. The pipe should not pass through a ceiling. If the pipe passes through a combustible wall, it must be guarded at the point of passage by either a metal ventilated thimble not less than 12 inches larger in diameter than the pipe, or metal or burned fire-clay thimbles built in brickwork or other approved fireproofing materials extending not less than eight inches beyond all sides of the thimble. If a thimble is not installed, all combustible material in the wall or partition must be cut away 18 inches from the pipe. If any material is used to close this opening, it must be non-combustible.

Use a removable section at the connection of the pipe to the furnace so that ash can be properly removed from the heat exchanger. A UL listed type of barometric draft regulator must be installed near the heater flue opening (see Paragraph 11). Install drip leg with a clean-

out cap in your flue pipe to protect the heat exchanger from harmful condensation and premature failure. Keep the piping connection from the flue outlet of the furnace to the chimney as short and direct as possible. Slope the horizontal run upward to the chimney at least one inch for each three feet of pipe. The horizontal run should not be longer than one-half of the chimney height and never over ten feet unless you are installing a draft inducer.

Fasten the piping with sheetmetal screws to make it rigid and support it from above with stovepipe wire. The end of the vent pipe must not extend past the inside wall of the chimney. A thimble may be used in the chimney connection to facilitate removal for cleaning. The thimble should be permanently cemented in place with high-temperature cement.

Avoid sharp turns in the vent pipe or other construction features that would create resistance to the flow of the flue gases. A manually operated damper or any other device that will obstruct the free flow of the flue gases **should not** be used in this installation.

11. DRAFT REGULATORS (Reznor Option DB1)

A UL listed type barometric draft regulator, such as Reznor Option DB1, **MUST** be installed on the flue near the heater flue opening.

As a part of "Check-Test-Start" (Paragraph 33), prior to continued operation, check to be sure that there is sufficient draft for proper combustion. A draft of .02" w.c. is required over the fire. When firing, the draft measurement in the stack should be .04-.06. (Before operating the heater, drill a 5/16" hole in the flue pipe halfway between the furnace and the draft regulator to insert the pressure gauge for measuring flue draft.)

Instructions for measuring draft:

1. Remove louver assembly. To measure draft over the fire, remove the bolt located over the combustion chamber observation port.
2. Insert air pressure gauge (such as Dywer pressure gauge).
3. Draft measurement gauge must read at least .02".
4. If measurement is not correct, adjust draft regulator.
5. Replace bolt and louver assembly.
6. To measure flue draft when heater is firing, insert air pressure gauge in the 5/16" hole that was drilled in the flue pipe halfway between the furnace and the draft regulator.
7. Flue draft measurement when firing must be .04-.06".

If the draft measurement in the flue is too high, it will create a back pressure resulting in oil fumes in the building and/or pulsating when burner starts and stops. It may also result in low CO2, or may cause excess deposits of soot.

If the flue draft measurement is too low, a UL approved draft inducer may be used. Provision must be made to shut off the fuel supply to the main burner in the event of the failure of the draft inducer.

If there is a back draft or down draft, do not continue operation of the heater until the situation is corrected. Back pressure (back draft or down draft) may be caused by the chimney being lower than surrounding objects, such as buildings, hills, trees, rooftops, etc. It may be caused by an exhaust fan in the building. The air intake in the room where the heater is installed must be sufficient size so that there is no change in the draft reading in the flue with the exhaust fan running.

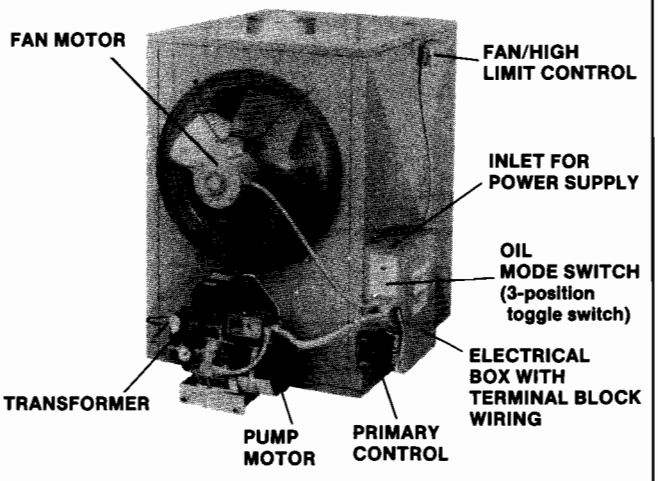
12. AIR FOR COMBUSTION

WARNING: Care should be exercised to ensure that an adequate supply of combustion air is available and free to enter the air openings on all units. Openings equal to one inch square per each 1,000 BTUH should be used to allow combustion air to enter the room in which the unit is installed.

13. ELECTRICAL SUPPLY AND CONNECTIONS

All wiring must be done in accordance with the National Electric Code and local ordinances. In many localities, No. 12 wire run in rigid conduit must be used, but where permissible, two and three wire BX is recommended, particularly for connections to the controls and burner motor. A disconnect switch for the main 115 volt line to the burner should be mounted on a fire-proof wall in an accessible place close to the heater.

1. Check rating plate on furnace for supply voltage and current requirements. A separate line voltage supply with fused disconnect switch should be run directly from main panel to the unit, making connection in the junction box. Connect the field supply wires to terminal blocks 1 and 2, as shown on the wiring diagram. Connect the ground wire to the green wire. All external wiring must be within approved conduit. See wiring diagram on back of unit heater. Conduit from disconnect switch must be run so as to not interfere with service panels of heater.
2. All replacement wiring must be type TEW or equivalent. Use 18 gauge wire for control circuits, 14 gauge or larger, depending on current requirements, for line connections.
3. Install room thermostat in accordance with directions furnished with thermostat. Furnace is equipped with low voltage control (24V).
4. Wiring diagrams and complete instructions are packed with each unit.



ELECTRICAL CONNECTIONS

14. HEATING THERMOSTAT

A 24-volt thermostat is furnished as standard equipment. Note that either a 24-volt or 115-volt thermostat can be used to actuate the low voltage controls. A line voltage thermostat can be used and wired for low voltage. **Do not attempt to wire relays or other accessories to thermostat connections as these are not load terminals.**

Thermostat should be located five feet above the floor on an inside wall, not in the path of warm or cold air currents, nor in corners where air may be pocketed. **DO NOT** install on or directly suspend from the heating unit. **DO NOT** install on cold outside walls. For specific connection details, refer to instructions with thermostat.

There are times when two or more units are cycled from one thermostat. Separately activated relays must be substituted at unit thermostat connections.

CAUTION: MAKE SURE THE THERMOSTAT HAS AN ADEQUATE VA RATING FOR THE TOTAL REQUIREMENTS.

15. OPTIONAL OIL BOOSTER (Option BG6) AND DRAFT INDUCER (Option BG7) RELAYS

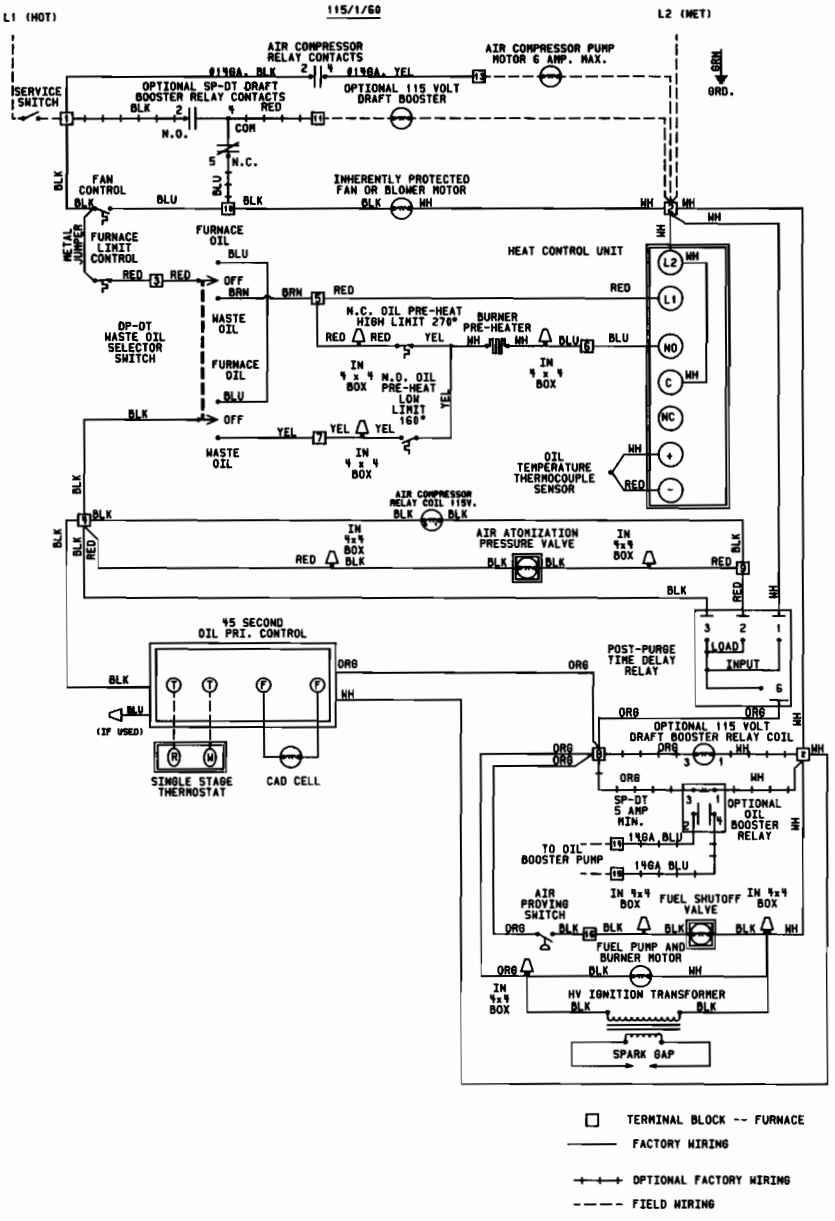
Units ordered with these options are factory equipped with relays for installation of a field-supplied oil booster or a draft inducer, or both. An oil booster is required when the oil must travel more than 20 feet from the supply tank to the heater. A draft inducer is required when the draft in the flue measures less than .04-.06 on a pressure gauge. The wiring diagram on page 5 includes these optional relays.

WIRING DIAGRAM

NOTE

1. Dotted wiring supplied and installed by others.
2. Auxiliary air compressor is required when shop air is not being used. This air compressor requires the addition of a relay as shown below.
3. Units that cannot achieve a sufficient draft in the flue pipe will require the installation of a draft inducer. The proper wiring of this is shown below.
4. Use type TEW-105°C. or equivalent for replacement wiring.

AIR ATOMIZATION SYSTEM



W.D. 99579

OPERATING SEQUENCE

1. Turn on main power switch to unit and atomization air.
2. Set DP-DT switch at "waste oil" position.
3. Turn on thermostat.

Firing Sequence:

1. On a first call for heat, after approximately 2-2½ minutes, the oil heater will exceed the 160 degree setting, allowing power to the ignition controller. On subsequent calls for heat, the heat sink will already be above the 160 degrees point and waiting period will not occur.
2. The ignition controller will turn on the ignition transformer, fuel pump/burner motor and air atomization valve (and booster pump and draft booster, if so equipped).
3. Ignition will occur. If ignition does not occur within 45 seconds, the ignition controller will lock out. If the unit locks out, reset controller by pushing the red reset button. **DO NOT RESET MORE THAN ONE TIME!**
4. Fan will turn on after heat exchanger comes to temperature (approximately 1½ minutes).

Thermostat Satisfied:

1. Burner pump motor, ignition transformer and fuel shutoff valve turn off, (oil booster pump, is so equipped). Post purge time delay relay keeps atomization air on for five seconds to burn off excess fuel in heat sink.
2. Fan (and draft booster, if so equipped) remain on until heat exchanger cools down (approximately three minutes).

NOTE: If Black Beckett microprocessor ignition controller is installed, jiggling of thermostat will put unit into a 60 second wait period before ignition will be attempted again. (See flashing lights on top of controller).

16. FAN AND BLOWER MOTORS
Both the fan and blower motors are totally enclosed and are equipped with internal overload protection.

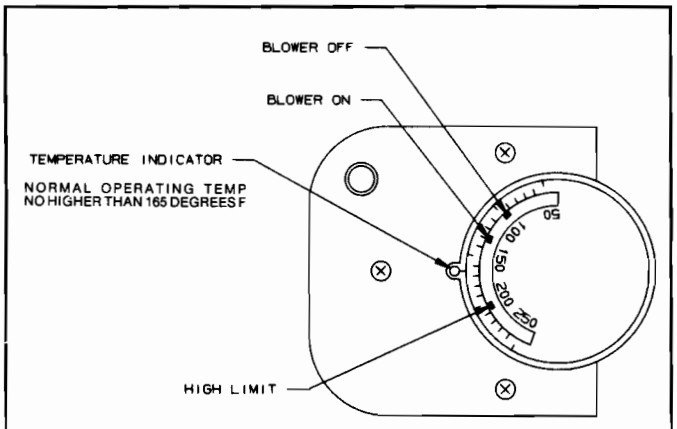
The motor charts list full load amps. Use an ammeter to check motor amps.

FAN MOTOR				
MODEL	**HP**	**VOLTS**	**AMPS**	**RPM**
RA230	1/6	115	4.5	1100

BLOWER MOTOR				
MODEL	**HP**	**VOLTS**	**AMPS**	**RPM**
RAD230	1/2	115	9.8	1750

17. FAN/BLOWER AND HIGH HEAT LIMIT SWITCH is located at the upper left (facing front of unit) side of the cabinet. The white button, on the switch, in the out position automatically controls the fan or blower. When the button is pushed in, the fan or blower will operate continuously for summer air circulation. The limit sensor is located inside the cabinet above the combustion chamber.

The unit is equipped with a factory-set, non-adjustable high limit switch (part of combination fan/blower and limit control) that shuts off the oil in the event of motor failure, or in case of restrictions of circulated air flow. Factory limit control setting is 200°F. **Do not change this setting.**



FAN/LIMIT CONTROL **Dwg. No. 99960**

The fan control provides the following:

a. Delay of fan or blower operation preventing circulation of cold air.
b. Fan or blower operation as long as the unit temperature is above minimum heat switch setting.

The control provides additional safety by keeping the fan or blower in operation in the event that the oil burner continues to fire when the thermostat is satisfied.

To be sure that the fan or blower can continue to operate, the power supply to the heater **MUST NOT be interrupted except when servicing the unit.**

If the customer wants the heater off at night, the oil burner circuit SHOULD BE OPENED by a single pole switch wired in series with the thermostat. Some thermostats are provided with this feature. Multiple units controlled from single thermostat and individual heater relays, should be shut off in the same manner. For most economical operation, the fan control should be set 120°-130° on, 80°-85° off.

18. MODE SWITCH
The mode switch has three functions:

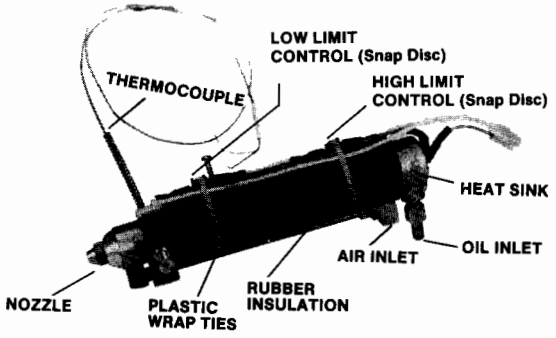
1. In the "up" position, the preheater is activated, and the heater is ready for use with waste oil.
2. In the "down" position, the preheat assembly will be deactivated, and the heater can use #1 or #2 fuel.
3. The "center" position disconnects power to the preheater and the pump motor. Electric power is still connected to the fan or blower motor.

WARNING: Turning the mode switch to the off or center position does not disconnect power to the fan/blower motor.

19. TEMPERATURE CONTROLLER AND PRE-HEAT ASSEMBLY
The temperature controller, located in the junction box on the side of the heater, is preset at 170°F. This temperature controller controls the cartridge heater that heats the waste oil as it is circulated through the pre-heat assembly. The waste oil is heated to a consistency compatible to atomization. When the mode switch is in the waste oil position, the temperature controller activates the cartridge heater.

There are two snap-disc thermal controls on the preheat assembly.
N.O. 160°F — Start-Up and Interlock
N.C. 270°F — High Limit Safety Switch

WARNING: Snap disc temperature switch must be replaced by correct disc.



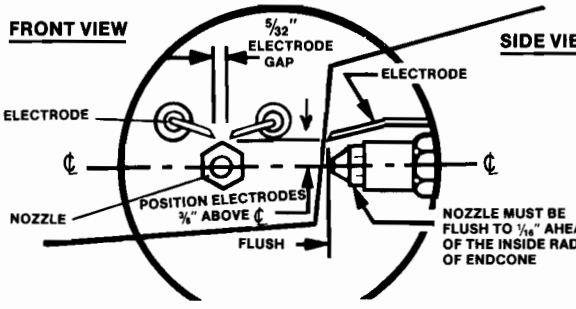
PRE-HEAT ASSEMBLY

20. ELECTRODES AND NOZZLE LOCATION.

IMPORTANT

ADJUST ELECTRODES PRIOR TO FIRING UNIT. Electrodes are adjusted at time of manufacture. However, they should be checked at time of installation to be sure they are set as noted in the following dimensional drawing.

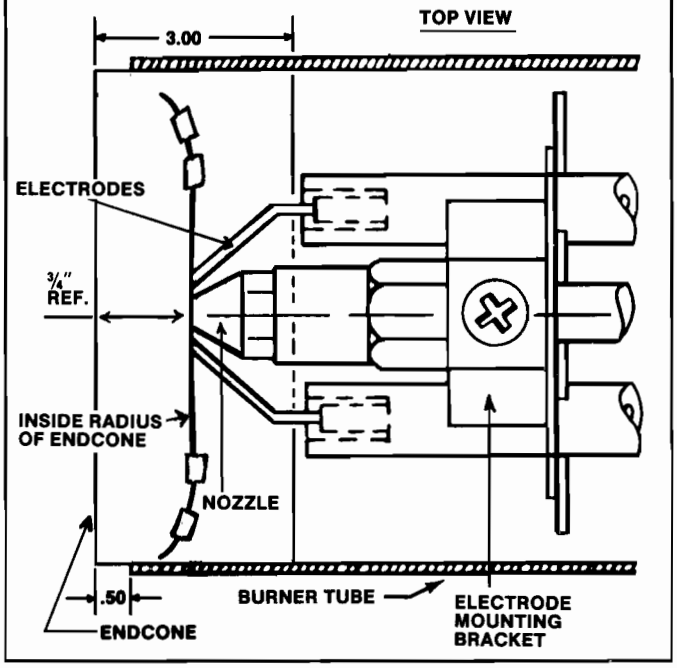
CAUTION: TURN OFF MAIN ELECTRIC SUPPLY SWITCH BEFORE CHECKING OR ADJUSTING ELECTRODE SETTING.



ELECTRODE ADJUSTMENTS

NOZZLE POSITION IN RELATION TO ENDCONE/BURNER TUBE

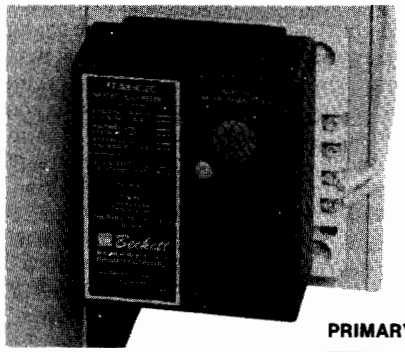
Tip of nozzle must be flush to 1/16" ahead of inside radius of endcone. If nozzle is behind inside radius of endcone, coking will occur and endcone/nozzle will become clogged.



21. PRIMARY CONTROL SYSTEM

The primary control is responsible for starting the burner, supervising a safety operating cycle and shutting the burner off at the end of the call for heat or locking out "on safety" if there is a flame failure beyond the safety timing.

The Beckett primary control system used is a solid state device. There are three status lights on the control. The green light means the control is powered and ignition will occur in 10 seconds or less. A flashing orange light means the control is in a one minute delay period. After one minute the unit will attempt to ignite. The red light means the unit is locked out. Pressing the red button will recycle the ignition process, but do not repeat this more than once without troubleshooting the unit.



PRIMARY CONTROL

22. BURNER PUMP

This heater utilizes a 1-stage, 3450 RPM pump integral with the burner assembly. A threaded 1/4" pipe is threaded into the inlet port. The service line should be either 1/2" black pipe or 5/8" copper tubing. Reznor recommends using black pipe because this will minimize any problems with leaks. All connections should be pipe or flare fittings. **No** ferrule fittings should be used.

Review the burner pump photo, Figure "A", for port, bleed, inlet, regulator, and by-pass plug locations. **Note: by-pass plug must be inserted when return connection is made for two pipe burner system.**

A vacuum gauge is mounted at the fuel inlet of the pump. The gauge is designed to indicate when the supply line filter needs cleaned. The reading should not be allowd to exceed 20" w.c.

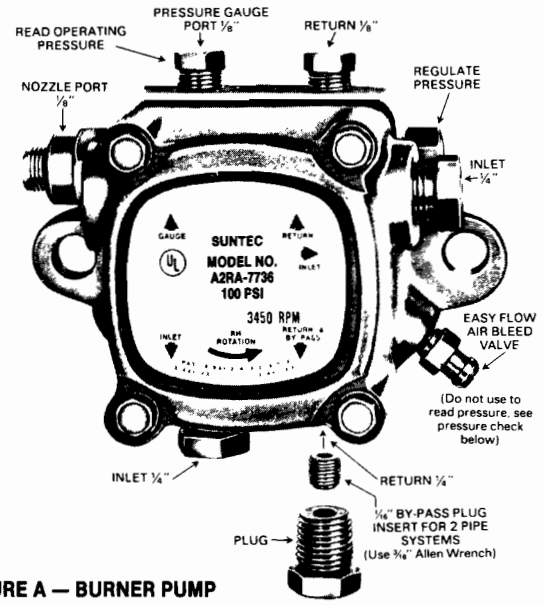


FIGURE A — BURNER PUMP

23. INLET OIL PRESSURE

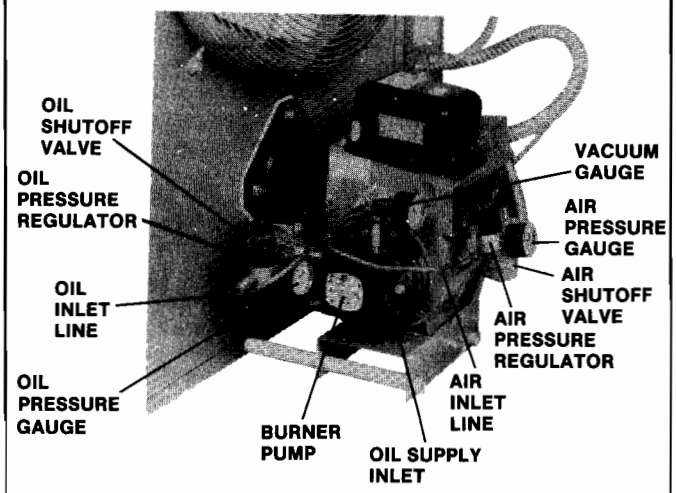
CAUTION: Pressurized or gravity feed installations must not exceed 5 P.S.I. on inlet line or return line at the pump. A pressure greater than 5 P.S.I. may cause damage to the shaft seal.

24. PUMP PRESSURE CHECK

If a pressure check is made, use **GAUGE PORT OR NOZZLE PORT. DO NOT USE EASY FLOW BLEED VALVE PORT.** The Easy Flow Bleed Valve Port contains pressure higher than operating pressures. Setting pump pressure with gauge in the Easy Flow Bleed Valve Port results in the **WRONG** operating pressure.

25. BURNER PUMP SYSTEM LAYOUT

The pump assembly is supplied with a single stage pump, motor, all necessary fasteners and couplings and a shutdown valve. The drawing in Figure B indicates how the fittings and shutdown valve should be mounted..



CAUTION: AIR SUPPLY PRESSURE NOT TO EXCEED 25 P.S.I. — AFTER REGULATOR 8 P.S.I.

FIGURE B — PUMP SYSTEM LAYOUT

Before starting the pump, fill the inline filter and supply line from the tank to the pump with fuel. All connections must be airtight from the tank and filter to the pump. The pump is designed to automatically vent itself when you start the furnace. (If necessary, the pump can be vented in the regular way by opening the pump's vent valve on startup and by closing the vent valve after a solid stream of oil is venting from the pump.)

The ½" unit fuel line connects to the oil pump at the ¼" inlet orifice. At the pump outlet there is a fuel valve and fuel pressure regulator to provide the correct operating pressure into the preheat sink assembly. When burning 100% waste oil, this pressure setting should be 4 psig for Models RA/RAD-230. (Refer to Critical Settings Chart, Paragraph 29, for additional settings.)

26. BLEEDER VALVE is located at the rear of the pump, and is used to purge the fuel oil system of air. Before opening the bleeder valve, turn the compressed air off to the heater. The valve requires a ⅜" wrench to open it. After the system has been purged, turn off the compressed air. It may be necessary to push the reset button on the primary control several times when attempting to start the heater. The fuel pump will run for 45 seconds each time.

NOTE: The controller will go through a 60-second wait period between tries.

27. MODE SWITCH

This switch has three (3) functions:

1. In up position (waste oil), the preheater will be activated.
2. In the down position, the preheat assembly will be deactivated and the heater now becomes conventional — that is #1 and #2 heating oil fuel usage.

   When changing fuels from waste oil to fuel oil, leave the Mode Switch in the "Waste Oil" position for approximately 30 minutes. This is to clear the oil supply line of waste oil. If there is a percentage mixture of waste oil to fuel oil, leave the Mode Switch in the "Waste Oil" position.
3. The center position disconnects the power to the preheater and the pump motor.

28. COMPRESSED AIR HOOK-UP AND AIR ATOMIZATION SYSTEM

The air inlet is connected to a normally closed solenoid valve and an air pressure regulator mounted on the rear of the burner. Compressed air supply pressure must not exceed 25 p.s.i. The valve supplies air through a ¼" line to the nozzle for atomization of fuel. The regulator should be set to maintain an air pressure of 8 p.s.i. at the burner.

Behind the air regulator is a short plastic line leading to the air proving switch which is located inside the electrical junction box mounted on the side of the burner. Access to the junction box is gained by removing the oil primary control. The switch is wired in series with the fuel valve. The purpose of this switch is to shut off the fuel supply in the event of a loss of air pressure.

If shop air is used, it is recommended to use an air filter and water trap. This can be purchased through Reznor as Option DG1.

29. PRESSURE SETTINGS — FUEL AND AIR

The pump pressure setting should be 90-95 psig with fuel feed pressure setting depending on the type of fuel (See Critical Operational Settings Chart). The air supply (after air regulator) into system is set at 8 psig with actual line pressure set to a pressure not greater than 25 psig. The pump pressure is factory set, but it is suggested that on start-up, the pressure be checked and adjusted to a minimum pressure. Pressure setting too high will overfire the unit. Setting too low will prevent complete atomization and combustion of the oil.

CRITICAL OPERATIONAL SETTINGS

MODEL	AIR PRESSURE		OIL PRESSURE TO THE HEATER (Auxiliary Pump)	OIL PRESSURE AT THE BURNER PUMP		FAN LIMIT SETTING	FUEL LINE VACUUM GAUGE
	At Air Regulator Inlet	At the Burner		Waste Oil	No. 2 Fuel		
RA 230 RAD 230	25 psig maximum	8 psig	5 psig maximum	90-95 psig with fuel feed pressure of 4 psig	90-95 psig with fuel feed pressure of 1.5-2.0 psig	160-165° F maximum	20" w.c. maximum

CAUTION: The fuel pressure gauge/fuel inlet line must be set no higher than 4.0 psig fuel feed pressure when using waste oil. When using No. 2 fuel oil, the fuel feed pressure must be set between 1.5-2.0 psig. To operate at the correct pressure for an unknown viscosity, fan limit temperature should be set between 160° F to 165° F. Depending on the mixture of the fuel weights, a correct fuel feed pressure should be set between the high pressure setting of 4.0 psig (waste oil) and the low pressure setting of 1.5-2.0 psig (No. 2 fuel oil).

30. AIR BAND ADJUSTMENT is located at the left side, bottom of the burner assembly. The air shutter adjustment is along side the air band adjustment and used in conjunction with the air band to obtain optimum flame.

AIR BAND SETTINGS		
Model	Opening	Band
RA/RAD 230	1/2"	#3

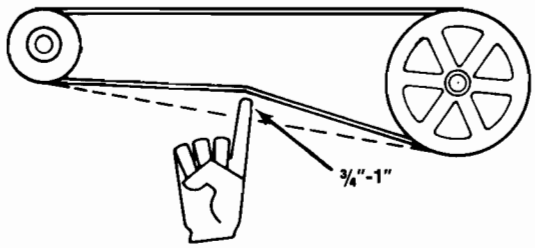
31. USING INSTRUMENTS TO TEST COMBUSTION

Combustion test instruments should be used in adjusting flame. National Bureau of Standards Commercial Standards CS75-76 require a minimum of 8% CO_2 with a smoke reading no darker than No. 2 on the Bacharach scale. However, we recommend a smoke reading no darker than No. 1 on the Bacharach scale. When obtaining the smoke reading, adjust the air inlet to the burner for minimum air for clean combustion while the combustion chamber is hot. Using a Dywer pressure gauge, measure the draft over the fire. (See page 4 for instructions.) The measurement of draft over the fire should be .02. If it is not, adjust the draft regulator. Take your readings and adjust air band so that a minimum of 8% CO_2 is obtained with the least smoke possible. When using instruments in setting a fire, do not attempt to obtain a greater percentage of CO_2 than a clean fire will give. It is more important to keep the inside of the heater clean than to receive a higher CO_2, as most oil equipment will provide adequate efficiency with the CO_2 at 8-12%.

32. FURNACE AIR TEMPERATURE ADJUSTMENTS — RAD Models

This furnace is designed for a minimum of .2" W.C. static pressure and must have the louvered air deflector (standard with the unit). Adjust the louvers so that the fan limit control reads around 120° to 130° F after the unit has run for at least twenty (20) minutes. If necessary, adjust the heat exchanger blower speed to reach the desired temperature. To do this, **"First shut off the power."** Remove or loosen pulley belt. Loosen the set screw on the motor pulley. Hold back half of pulley still while turning the front half counterclockwise to increase the air temperature at the outlet. Turn clockwise to decrease the temperature at outlet. Retighten the set screw on one of the two flat spots and check again.

Align pulley and motor to minimize belt wear. Check that belt tension permits approximately one (1") inch of flexing. Too much tension will cause motor overload and bearing wear. Too little tension will permit belt slippage. If applicable, oil the belt drive motor once a year using a few drops of SAE 10 oil in each oil cup. Blower bearings are permanently lubricated and do not require oiling.



33. BLOWER ROTATION

Each blower housing is marked for proper rotation. Rotation may be changed on single-phase motors by rewiring in motor terminal box.

34. CHECK-TEST-START

Check Test — Prior to Start-up

- ☐ Check clearances from combustibles. Be certain that the clearances listed in Paragraph 7 have been observed.
- ☐ Check hangers. Be certain that all hangers are adequately anchored and that all unions or threaded fittings are snug and do not rotate under conditions of vibration. Heater must be level.
- ☐ Check electrical supply. Be sure that wire gauges are as recommended and that the voltage is as stated on the furnace. A service disconnect switch should be used. Also determine that fusing or circuit breakers are adequate for the load use.
- ☐ Check oil supply. Fill the supply tank. Always screen waste oil when filling the supply or storage tank.
- ☐ Check piping. After installation and before being covered, piping should be tested for leaks. Before testing, disconnect supply piping at the burner and cap. Test piping hydrostatically, or with equivalent air pressure, at not less than 1½ times the maximum working pressure but not less than five pounds per square inch at the highest point of the system. The test shall be made so as not to impose a pressure of more than ten pounds per square inch on the tank. This test shall be maintained for at least 30 minutes or for sufficient time to complete a visual inspection of all joints and connections. Instead of a pressure test to check piping, suction lines may be used under a vacuum of not less than 20 inches of mercury maintained for at least 30 minutes.
- ☐ Check vents. Be sure that vent pipe and chimney meet the requirements shown in Paragraph 10. A UL approved draft regulator is required. (see Paragraph 11) In order to measure the draft in the stack after firing, drill a 5/16" hole in the flue pipe halfway between the heater and the draft regulator.
- ☐ Check electrode adjustment. See instructions in Paragraph 20. Turn off the electric power before making check.

Start-Up Procedure — Models RA and RAD

1. Turn on the main power switch to the unit.
2. Shut off the primary air supply if a valve is available. If not, remove the clear plastic tubing from the air pressure switch. This will prevent the oil valve from opening while the pump is being bled.
3. Turn thermostat on or jump thermostat connections on oil primary control (T.T.).
4. Place 3-position mode switch in the fuel oil position and bleed the pump. Open bleeder valve at lower side of pump until constant stream of oil is attained. While doing this, the primary control may shut the unit down. Reset the control and wait one minute for the pump to restart.
5. Open the air valve or reconnect the clear plastic tubing.
6. Place 3-position mode switch in waste oil position.
7. After approximately 2-2½ minutes, the unit will attempt to fire.
8. Adjust primary air pressure to 8 psig and oil pressure to 4 psig for waste oil, 1.5-2.0 psig for No. 2 fuel oil.
9. Unit will fire.
10. Adjust oil pressure and air band setting to obtain optimum flame. See paragraphs 29 through 32 for specific instructions.
11. **NOTE:** When unit is shut off or the call for heat has been satisfied to the thermostat, a post-purge time delay relay is turned on for 5 seconds (leaves air atomization valve open) to clear nozzle of oil. At the completion of 5 seconds, the air atomization valve is closed.

Check Test — After Start-Up

- ☐ Check draft. Follow instructions in Paragraph 11. Draft over fire should be .02; draft in stack while firing should be .04-.06.
- ☐ Check combustion. Use instruments following instructions in Paragraph 31.
- ☐ Check flame retention and color. Flame should be swirling around and in front of endcone with the color of the flame being a medium yellow/white.

When a change is made in the type of fuel (Waste Oil to Fuel Oil or Fuel Oil to Waste Oil), these start-up test and verification procedures must be redone. When changing from waste oil to fuel oil, leave the Mode Switch in "Waste" position for approximately 30 minutes to clear the supply line of waste oil. However, if there is a percentage mixture of waste oil to fuel oil, leave the Mode Switch in the "Waste Oil" position. The unit can be operated on fuel oil when the switch is in the waste oil position.

35. STORAGE TANK (Installation of Tank and Piping)

Waste oil installations require an indoor supply tank for the heater as shown on page 3. However, the waste oil tank can be supplied by an additional or secondary storage tank (basement/outside tank). Included in this section, are instructions concerning the basic installation of the secondary tank and its general set-up. If you elect to install a storage supply tank, it should be installed in accordance with local regulations and those of the National Board of Fire Underwriters. Galvanized tanks and piping are not recommended.

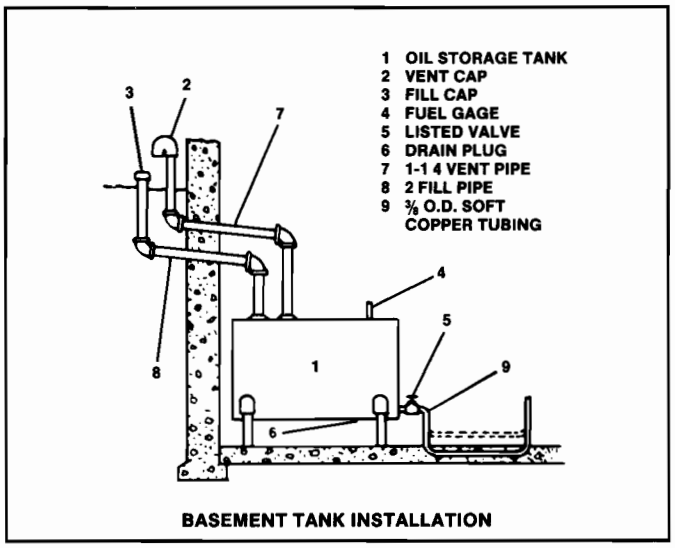
Regulations require that storage tanks located inside buildings shall not exceed 275 gallons individual capacity, or 550 gallons aggregate capacity (in one building). If larger inside tanks are installed, they must be installed in an enclosure or casing constructed of reinforced concrete at least 6" thick, or of brick at least 8" thick, bonded to the floor. If installed in an enclosure, the space between the enclosure and the tank should be completely filled with well tamped earth or sand. Cinders, ashes or other corrosive materials should not be used. Again, be sure to check on any local regulations before beginning installation of an oil storage tank.

Underground oil storage tanks should be located so that the top of the tank is below the level of all piping to which the tank is connected, so that oil cannot be discharged through a broken pipe or connection by siphoning. The tank shall be buried so as to be covered by not less than two feet of earth, or one foot of earth on top of which is placed a slab of reinforced concrete not less than 4" thick. A well-tamped earth foundation shall be provided beneath the concrete slab, which shall extend at least one foot beyond the tank in all directions. The tank shall be set on a firm foundation, and soft earth or sand shall be packed around it. When necessary, to prevent floating, it shall be securely anchored or weighted.

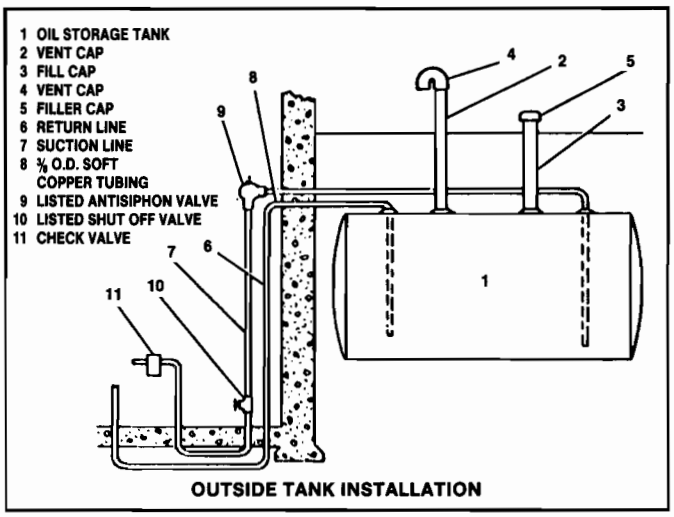
Proper allowance shall be made for expansion, contraction, jarring and vibration. With the exception of fill lines and test wells, pipe lines shall be provided with double swing joints, which will permit the tank to settle without straining the pipe connections. Tanks shall be equipped with an open vent or an approved automatically operated vent which will permit discharge to the open air. Vent pipe and vent opening shall be large enough to prevent abnormal pressure in the tank during filling, 1½" pipe size being the minimum. The vent and fill pipes should drain to the tank, and the lower end of the vent pipe shall not be cross-connected with the fill pipe. The outer end of vent pipe shall be provided with a weatherproof hood which shall be high enough above the ground to prevent its being obstructed with snow or ice. The vent pipe shall not be closer than two feet, either vertically or horizontally, from any windows or other building opening.

The storage tank shall be filled only through a 2" fill pipe terminating outside of the building, no closer than five feet from any building opening at the same or lower level. A metal cover designed to prevent tampering shall be provided.

All piping shall be standard full weight wrought iron, steel or brass pipe, with standard fittings, or approved brass or copper tubing, with UL listed fittings. The piping shall be protected from possible injury and shall be rigidly fastened in place in a workmanlike manner. Pipe joints and connections shall be made tight and unions and tube fittings of an approved type only shall be used. Use only pipe thread compound resistant to oil.



BASEMENT TANK INSTALLATION



OUTSIDE TANK INSTALLATION

UL listed shut-off valve should be installed in the oil supply line in an accessible location close to the storage tank.

Underwriters' Laboratories' requirements stipulate a bottom outlet on all 275 gallon tanks. This is to prevent the accumulation of condensate which causes the tank to rust. A water trap can be installed at the tank outlet.

Adequate ventilation must be provided in any enclosure where storage tanks, pumps or accessories are installed.

36. MAINTENANCE

Before performing any service, be sure to **turn the mode switch to the off position and the power off to the unit.**

CAUTION: Waste oil may contain heavy metal compounds and foreign materials. When burned, these compounds are deposited within or exhausted from this heater. Therefore, care should be taken when using, cleaning and maintaining this equipment.

Whenever any cleaning, including that of the flue pipe and exhaust stack is done, proper protective equipment including gloves and a face mask or respirator must be worn.

Tools required to perform service work are wrenches in the following sizes 7/16", 9/16", 5/8" and 7/8", a screwdriver, a pair of pliers, and a furnace brush.

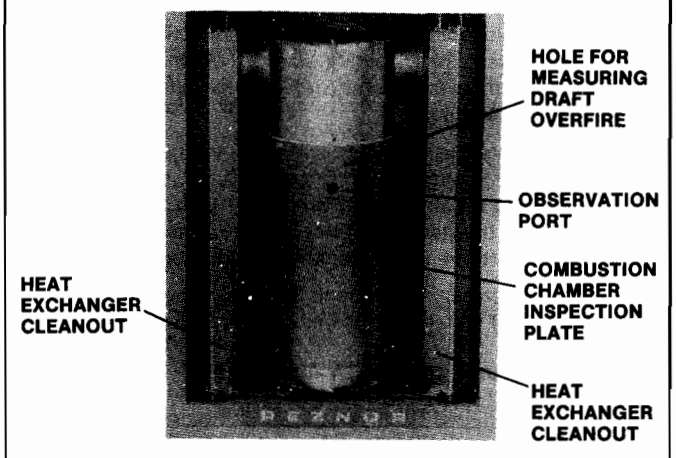
WARNING: Turning the mode switch to the off or center position does not disconnect power to the blower/fan motor.

Supply Line Filter — Clean the metal strainer in the filter. When the vacuum gauge indicates a fuel line restriction (high reading). The gauge reading should not exceed 20" w.c.

Heat Exchanger and Combustion Chamber

Soot and ash should be cleaned from the heat exchanger and combustion chamber as required, but no less than once a year.

For access to the combustion chamber and heat exchanger, remove the louver assembly from the front of the heater. The inspection plate on the combustion chamber is centrally located on the front of the chamber. The clean out covers for the heat exchanger are visible on the bottom of the heat exchangers (one on each side of the combustion chamber).



HEATER WITH LOUVER ASSEMBLY REMOVED SHOWING COMBUSTION CHAMBER AND HEAT EXCHANGERS

The combustion chamber liner can be viewed through the observation port in the combustion chamber. The combustion chamber liner should be inspected annually. If the liner is deteriorated, it should be replaced with a stainless steel replacement liner.

To clean the main combustion chamber (or replace the liner), remove the screws that retain the inspection plate. Remove the cover, being careful not to damage the gasket material. Inside the chamber, carefully scrape the soot down from the side walls and physically remove. If the unit has a fiber liner, **do not vacuum** the combustion chamber walls as this would damage the liner.

To clean the upper chamber, tap the exhaust stack to knock the ash and soot into the collection chamber. Remove the soot and ash from the upper chamber.

To clean the heat exchangers, remove the covers from the clean out holes, being careful not to damage the gasket material. Insert a furnace brush into the heat exchangers, brushing up and down. Tap the heat exchangers vigorously. Vacuum the bottoms.

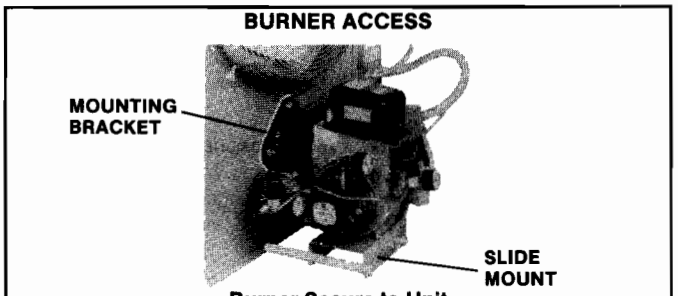
Replace all of the covers, being careful to keep the gaskets in place. Reinstall the louver assembly.

Burner Removal for Cleaning and Adjustment of Endcone and Nozzle

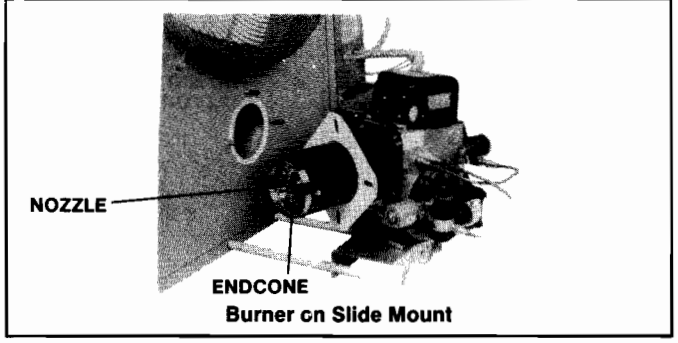
1. Turn the mode switch to the off position and disconnect the power to the unit.

   WARNING: Turning the mode switch to the off or center position does not disconnect the power to the motor.

2. Disconnect the oil line.
3. The burner is mounted on a slide that enables it to be pulled out for easy access. Remove the three mounting bracket nuts on the rear of the heater and pull the burner straight back, being careful not to damage the mounting gasket. After the burner clears the rear of the heater, it may be pivoted to the side. See the illustraton below. The burner is now in a position that regular maintenance and service procedures may be performed.



Burner Secure to Unit



Burner on Slide Mount

NOTE: If it is necessary to remove the entire burner and pump, disconnect the electrical connections and remove the cotter key on the "pivot post" underneath the burner. The burner and pump with support bracket and pivot post may now be lifted straight up.

4. To clean the flame cone, remove the one screw that attaches it to the burner table. To clean the carbon from the flame cone, use a propane torch and brush or scrape thoroughly.

   Replace the flame endcone and check the relationship of the inner portion with the face of the nozzle. The nozzle should be flush to 1/16" ahead of the inside radius of the endcone. If adjustment is required, loosen the knurled nut and the adjustment plate screw. Adjust the entire preheater and nozzle assembly.
5. To clean the nozzle, remove it from the preheater using a 5/8" wrench. The nozzle can be cleaned using parts cleaner and high pressure air. Replace the nozzle and be sure to check the relationship with the endcone. (See #4.)
6. To clean the preheater and/or replace the nozzle, follow the instructions listed below.
7. When all required service is completed, the burner may be reinstalled by turning it so that it is lined up with the hole in the rear of the heater. Push the slide mechanism moving the burner back into the heater. Being sure the gasket is in place, securely fasten the three mounting nuts.

Preheater Removal for Cleaning

To clean the preheater and/or change the nozzle, the preheater must be removed. The nozzle should be changed annually, or more frequently as required.

1. Remove the two screws at the front of the transformer. Raise the transformer (it hinges from the back).
2. Using a 9/16" wrench to secure the brass elbow on the air line inside the chassis, loosen the external nut. Loosen the fuel inlet nut and the knurled preheater mounting nut. Disconnect the air and fuel lines and the knurled nut.
3. Disconnect the multi-wire connector. Lift the preheater assembly. Using a 7/16" wrench, remove the thermocouple wire threaded at the front of the preheater. Remove the electrodes.

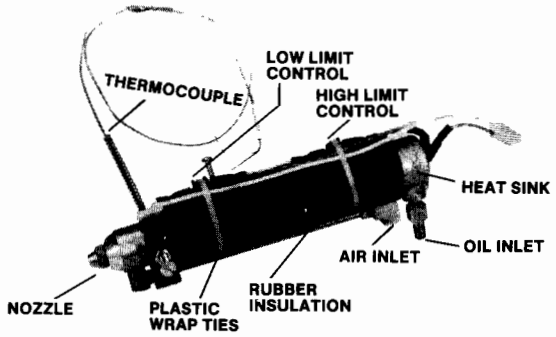


FIGURE C — PREHEAT ASSEMBLY

4. Remove the nozzle using a 7/8" wrench on the preheater and a 5/8" wrench on the nozzle.

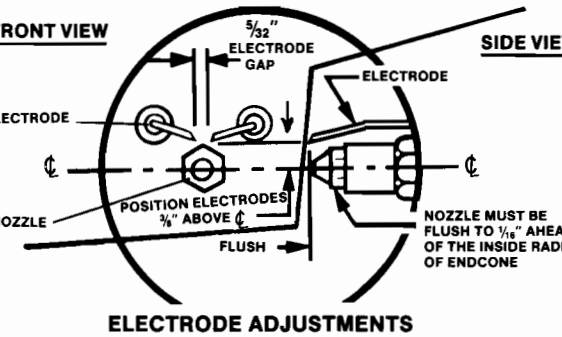
Clean the Preheater

Using the oil inlet connection, fill the preheater with heavy duty carburetor fluid. Let set for five minutes. With air pressure, thoroughly blow cleaner out of preheater. Repeat this procedure until preheater is completely clean.

Reassemble the Preheater, Replacing the Nozzle

Reverse the above procedure to reassemble the preheater. When installing the new nozzle, lubricate the "O" ring that fits behind the nozzle. The nozzle should be replaced at least annually.

Electrode Adjustment



ELECTRODE ADJUSTMENTS

Check the placement of the electrodes according to the above illustration. If adjustments are required, loosen the 7/16 inch locknut. Make adjustments in the order listed below. Recheck, and if necessary, readjust, until electrodes are in proper position.

(1) From center of nozzle orifice to electrode	Up 3/8"
(2) Electrode Gap (distance between electrodes) ..	5/32"
(3) Relationship of the tip of nozzle to the end of the electrodes	Flush
(4) Relationship of the tip of nozzle to the inside radius of the endcone	Flush to 1/16" ahead

Reinstall the Preheater

Reverse the removal procedure, being sure of the following:

1. Remove all slack from the thermocouple braided wire so there is no danger of it coming into contact with the fan or the electrodes.
2. Reinstall the knurled nut with the counter bore facing out. When tightening, lift gently on the preheater and tighten with pliers. Do not overtighten.
3. Tighten all lines.
4. Inspect the bus bar to electrode rods adjustment for proper contact.

Temperature Controller

The temperature controller set point is factory preset and cannot be adjusted. Set point is 170°F. If there are any problems with the temperature controller unit, it must be replaced.

If the high or low limit thermal control discs on the pre-heat assembly need replaced, it is important that the correct replacement part be used.

37. SERVICE AND MAINTENANCE SCHEDULE

Be sure to have a screen on your tank fill funnel to catch the dirt, gasket material, cigarette butts and other foriegn material that always seem to get into waste oil.

WEEKLY

1. Check air and oil pressure

PRESSURE SETTINGS

MODEL	AIR PRESSURE		OIL PRESSURE TO THE HEATER (Auxiliary Pump)	OIL PRESSURE AT THE BURNER PUMP	
	At Air Regulator Inlet	At the Burner		Waste Oil	No. 2 Fuel
RA 230 RAD 230	25 psig maximum	8 psig	5 psig maximum	90-95 psig with fuel feed pressure of 4 psig	90-95 psig with fuel feed pressure of 1.5-2.0 psig

2. Check vacuum gauge reading. Reading should not exceed 20" w.c. When the gauge shows a high reading, clean the filter strainer in the fuel line.

BI WEEKLY

Drain water from storage tank.

MONTHLY

Through front inspection port, check flame and carbon accumulation around flame cone. If needed, pull burner back and de-carbon flame cone. (Refer to Paragraph 36 for instructions.)

YEARLY — Refer to paragraph 36 for instructions.

1. Remove burner assembly and clean flame cone.
2. Remove preheater sink and clean thoroughly.
3. Replace nozzle.
4. Check combustion chamber liner for deterioration. Replace, if required.
5. Clean combustion chamber and heat exchangers.

38A. OIL BURNER TROUBLESHOOTING

To diagnose malfunctions properly, the following testing equipment should be used: (1) An electrical test meter that can measure volts, ohms and amps; (2) An ignition transformer tester; (3) A combustion analyzer kit to measure oxygen or carbon dioxide, smoke, stack temperature, draft and system efficiency; and (4) A pressure/vacuum gauge with a scale for 0-200 Psig and 0-30" Hg.

Before test firing any heater, check the combustion chamber for an excessive accumulation of unburned oil and restore to a safe condition before firing.

SYMPTOM	CAUSE	ACTION
1. BURNER MOTOR DOES NOT START. **NOTE:** Burner motor will not start when the mode switch is in the waste oil position. Motor runs when mode switch is in fuel oil position.	a. Low limit control bad. b. Watlow control bad. c. Heating element bad.	a. The preheater will be warm, but there will be no power at terminal #7. Check low limit control to make sure good contact is made on the preheater. Replace limit if it appears to have failed. b. The preheater will be cold. Listen for relay closing when mode switch is switched to waste oil position. If relay does not close, replace the Watlow control. c. Verify 120 volts at the heating element and a complete circuit through the Watlow control to ground. Replace element.
2. BURNER MOTOR DOES NOT START **NOTE:** Burner will not start with mode switch in either the waste or fuel oil position.	a. Incomplete electrical circuit. b. Primary control activated — Relay in "on safety" position will lock out burner operation. c. Inadequate voltage between motor/primary lead and neutral connection. d. Motor hums but shaft does not rotate. e. Motor bearings frozen. f. Overload protection activated.	a. Measure the line voltage at the primary control input connections. Should have nominal 120 volts. (Lower than 105 volts may cause operating problems.) If there is no reading, check disconnect switch, fuses, and thermostat contacts. b. ★Follow the instructions on page 14 to determine the cause of the lockout. Correct the malfunction. c. Line voltage must be within 10% of the voltage specified on the motor rating plate. d. Start switch may be defective. With the power turned off, rotate the blower wheel by hand. If it turns freely, replace the motor. e. Free shaft and lubricate or replace motor. f. Allow the motor to cool. Start the motor and measure the current draw. This reading should not exceed the rating plate specifications under load conditions by more than 10%. Excessive amp draw usually means an overload condition, defective start switch or shorted windings. Replace motor if necessary. (It is difficult and not usually cost effective to attempt to rebuild the motor.)
3. BURNER MOTOR OPERATES BUT NO FUEL IS DELIVERED AT THE NOZZLE.	a. Oil level below intake line in supply tank. b. Clogged strainer. c. Restricted fuel supply line. d. Clogged nozzle. e. Air leak in the supply line. f. Two pipe system that becomes air bound. g. Motor operates but does not drive the pump shaft. h. Frozen oil pump shaft. i. Suction line oil filter cartridge dirty. j. Clogged heatsink.	a. Fill tank and bleed air from fuel line. b. Remove and clean strainer. c. Open all valves in supply line. Replace any kinked tubing. d. Replace nozzle. e. Tighten all fittings in the line. Tighten unused intake port plug in the fuel pump. If there are valves in the line, be sure the valve stems are packed solid and tightened securely. f. Insert bypass plug if not in place. Re-start unit and prime pump. g. Check the coupling for slippage due to stripped end caps. Replace coupling. h. Replace oil pump. i. Replace cartridge. j. Remove heatsink from burner. Remove nozzle. Spray carburetor cleaner into inlet of heatsink. Let soak five minutes. Blow out heatsink with air line.
4. BURNER MOTOR OPERATES AND DELIVERS OIL, BUT THERE IS NO FLAME.	a. No spark.	a. Measure voltage between transformer/primary lead and neutral connection. Check transformer, insulators and electrodes. The secondary terminals of a good transformer deliver 5000 volts arc to ground, for a total of 10,000 volts between the terminals. Measure this with a transformer tester or use a well insulated screwdriver to draw an arc across the two springs. This should be at least 3/4" in length. Check each secondary output terminal by drawing a strong arc between the spring and base. If the arc is erratic, weak or unbalanced between the two terminals, replace the transformer. Replace electrodes when the tips become worn or eroded. Replace any insulators that are questionable. Transformer failures and ignition problems can be caused by the following: (1) Excessive gap on the ignition electrodes. Gap should be 5/32". (2) High ambient temperatures. (3) High humidity. (4) Carbon residue on the porcelain bushings. (5) Low input line voltage. (6) Arcing between the ignition electrodes and the transformer springs. They must have good contact. (7) Carbon residue, moisture, crazing or pin holes on the insulators. (8) Improper positioning of nozzle in relation to the radius of the endcone. (9) Carbon residue on electrode parts.

38A. OIL BURNER TROUBLESHOOTING (cont'd.)

SYMPTOM	CAUSE	ACTION
5. BURNER STARTS BUT FLAME BLOWS AWAY FROM NOZZLE.	a. Excessive combustion air. b. Excessive draft. c. Poor atomization of oil.	a. Adjust air gap and air shutter to proper setting. **(Paragraph 30)** b. Adjust draft regulator for .02" w.c. over-fire draft. c. Adjust fuel feed pressure; change nozzle; and/or clean heat sink.
6. POOR LIGHT OFF AND SHUTDOWN	a. Air pocket between pressure shutdown valve and nozzle. b. Insufficient draft over fire.	a. Tighten unused intake port plug in the fuel pump. Run burner stopping and starting occasionally until pulsation, smoke and after flame disappear. b. Check venting for excessive length, insufficient pitch upward to chimney, too many elbows, obstructed chimney, or too small chimney. Check for too high combustion air setting.
7. NOISE	a. Noisy motor. b. Clogged strainer. c. Burner vibrations transmitted through rigid electrical conduit or oil lines.	a. Check for alignment of the shaft with the coupling. Tighten or slightly loosen the motor-to-burner-housing bolts in an alternate sequence, which may solve the problem. Check for a loose blower wheel, excessive radial shaft play and for loose start switch parts. Check if thermocouple is laying on the blower wheel. b. Remove and clean strainer. c. Tubing or conduit should not be fastened to studs, or beams so securely that vibration can be transmitted to floor or roof.
8. OIL ODORS	a. Oil leaks. b. Poor burner shutoff. c. Smoky flame. d. Oil carbonization on the burner endcone. e. Downdraft causing smoke to enter the building through the barometric regulator.	a. Check fittings and valve seals. b. Check fuel shutoff valve and time delay relay. c. Check nozzle spray, air gap, and air shutter setting. d. Check nozzle/heat sink location relative to inside radius of endcone. e. Increase draft by extending chimney height, or adding a ventilating cap or draft inducer.

★PROCEDURE FOR DETERMINING THE MALFUNCTION THAT CAUSED THE PRIMARY CONTROL TO LOCKOUT

1. Disconnect the nozzle line connector tube and re-position it so that oil goes into a container. Tighten the flare nut at the pump discharge fitting.
2. Reset the primary control safety switch and immediately be alert to watch and listen for the following:
   a. Contact action of the primary control relay. Relay should pull in promptly without arcing erratically or chattering. If relay does not function properly, see Step 4.
   b. Quality of oil delivery. Oil stream should be immediate, clear and steady. A white, frothy oil delivery indicates air in the supply system. No oil delivery indicates a severe restriction.
   c. Ignition Arc. When the ignition activates, you will hear a buzz. If the ignition does not activate, check the transformer and electrodes.
   d. Motor operating characteristics. The motor should start quickly and smoothly. You can hear the RPM change and a "click" as the centrifugal switch disconnects the start (auxiliary) winding.
3. If the malfunction has not been revealed, reconnect the nozzle line fittings and prepare for a fire test. Be sure to check the combustion chamber and remove any accumulation of unburned oil.

   Reset the primary control, if necessary, and observe the overall performance with concentration on the light-off. Run several cycles. Observe the flame quality using a flame mirror, if possible. Flame base should be stable and close to the combustion head. Flame should be centered, uniform in shape and relatively quiet in operation. Check the heat and combustion chamber for carbon or impingements, indicating a defective or partially clogged nozzle.
4. If the problem is still not apparent, check the primary control system.

   Measure the electrical voltage at the primary input (usually black) and neutral lead (usually white) connections.

   Jumper the thermostat (TT terminals) or otherwise energize the primary control.

   The control relay should pull in. If not, make sure that the wiring connections are secure. If wiring connections are secure, check that the cad cell which controls the safety lockout timing on ignition is not seeing too much stray light. Check the cad cell by starting the burner and disconnecting both cad cell leads from the control FF terminals. Jumper the FF terminals to keep the burner operating. Measure the ohms resistance across the cad cell leads as it views the flame. This should be 1600 ohms or less. A preferred reading is 300-1000 ohms. Next, with the meter still connected to the cad cell leads, turn the burner off. The dark condition should give a reading of 20,000 ohms or infinity. If the reading is lower, let the refractory cool down or look for stray light that might be entering the burner through the air inlet, or around the transformer baseplate. If the cad cell is not performing within these guidelines, replace it. If the wiring connections are secure and the safety lock timing and cad cell are functioning properly, replace the primary control.

   If the primary control relay pulls in and then locks out again quickly, check the safety lockout timing. The safety lockout timing can be checked by removing one of the F (cad cell) leads from the control. Count the seconds until the control locks out. The time should be close to the rating plate specification found on the control body.

   If the primary control relay pulls in erratically and chatters, check the wiring connections and verify that the heat anticipator setting of the thermostat matches the 24 volt current draw. Erratic operation can sometimes be traced to improper anticipator settings of the primary control. These settings are typically .2 or .4 amps (printed on the side of the control). Measure this value by connecting your multitester in series with one of the TT leads and reading the value on the appropriate milliampere scale. If the wiring connections are secure and the anticipator settings are correct, replace the primary control.

   If the primary control relay pulls in, but the motor fails to start, measure the voltage between the neutral lead and the primary control lead for the motor. A severe voltage drop here would indicate that the relay switch contact are defective. Replace the primary control.

38B. ADDITIONAL WASTE OIL TROUBLESHOOTING

SYMPTOM	CAUSE	REMEDY
1. LOSS OF PRIME.	a. Plugged filters. b. Air leak in fuel line.	a. Clean or replace filters. b. Check all fuel connections.
2. FAILS TO START.	a. Inadequate fuel supply — no pressure. b. No air pressure. c. No preheat. d. Auto start snap disc circuit not functioning. e. No arc.	a. Check filters — check fuel pressure and adjust. (Critical Operational Settings Chart, **Paragraph 29**) b. Check pressure regulator and adjust. Check air supply. 9-10 P.S.I. c. Be sure preheater is functioning. d. Check start up snap disc and replace if necessary. e. Check bus bar to electrode rod adjustment (under transformer.)
3. HARD STARTING DIMINISHED FLAME.	a. Partially plugged filters. b. Low fuel pressure.	a. Clean or replace filters. b. Adjust fuel valve.